Managing Patuxent River Water Quality
Looking Beyond Science and Politics to the Economics of Decision-making

Report to NOAA National Ocean Service (NOS)

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Executive Summary

Statement of the Problem

Recent scientific reports indicate that the health of the Chesapeake Bay is declining and that Bay water quality goals for 2010 will not be achieved.

Nutrient discharges into the Bay have been identified as the primary cause of Bay water quality problems. However, state/federal partnerships, agreements, and commitments aimed at reducing nutrient discharges into the Bay have not been succeeding.

Population growth in the Bay watershed is expected to further increase nutrient discharges and more than offset any small reductions in discharges by existing sources. Unless more effective policies are put in place to reduce nutrient discharges, the health of the Bay will most certainly continue to deteriorate.

Most previous studies of Bay water quality problems stop short of examining economic data to address the causes of these problems. These data are associated with private land and water use decisions that result in nutrient discharges into the Bay, government decisions about what policies to employ to influence these private land and water use decisions, and how effectively they are implemented.

Focus of Research

Our research involved collecting and assessing economic data to address the underlying causes of Bay water quality problems. We selected the Patuxent River watershed as our study area because the Patuxent River is one of the Bay's main tributaries, is the largest river wholly contained in Maryland, and is often considered a microcosm of the Bay. We collected data and conducted interviews related to economic/water quality links and related government policies in each of the seven counties that make up the Patuxent River watershed.

We used this information to address three general questions:

1) How are economic sectors in each of the seven Patuxent River watershed counties contributing to the regional economy?

2) How are these same economic sectors contributing to Patuxent River water quality problems?

3) What policy tools and levels of effort are government agencies within each county using to deal with water quality problems in the river?

Purpose of Research

The purpose of this research was to generate information to improve the basis for choosing and assessing Patuxent River water quality policies, not to develop recommendations about how those policies should be changed. Based on our research, however, we do make recommendations regarding how the reporting of county and state environmental enforcement and compliance information could be improved and standardized to provide a better basis for assessing and comparing policy options.

Because environmental enforcement and compliance data address the causes of water quality problems, they provide realistic "leading indicators" of future water quality at the same time that they provide a useful basis for determining how the implementation of policies may need to change to improve future water quality.

Research Approach

Our research involved the following three tasks:

Task 1 Use county economic impact models (See Appendix A) to estimate how individual commercial, industrial, agricultural, and household sectors within each of the seven counties that make up the Patuxent River watershed contribute to county economic well-being (e.g., jobs, incomes, taxes)

Task 2 Link county level nutrient discharge data by land type/land use and other sources (Chesapeake Bay Program office) with each of these economic sectors within each county to determine their overall contributions to Patuxent River nutrient problems and estimate related economic/water quality tradeoffs (e.g., nutrient discharges per county job, per dollar of county household income, etc.).

Task 3 Use state and county budget and financial data, enforcement and compliance statistics, and interviews with state and county enforcement staff to measure the level of government effort exerted in attempts to control nutrient discharges within each county. This involved examining data related to county environmental spending and enforcement man-power allocations, numbers of environmental permit inspectors and inspections per inspector or per permit, numbers of prosecutions for environmental violations, sizes of penalties, etc.

Research Results

This section presents summaries and illustrations of the statistics, indicators, and analyses that were developed for each county in the Patuxent River watershed.

Economic/water quality tradeoffs

Table S-1 and S-2 provide a statistical profile of the Patuxent River watershed that includes:

- How much each economic sector within the watershed contributes to the watershed economy (e.g. dollar sales, household income, jobs, taxes)
- How much each economic sector contributes to Patuxent River problems (e.g., pounds of nutrients discharged per dollar of household income)
- What economic/water quality tradeoffs to consider when assessing nutrient discharge restrictions related to various economic sectors.

Statistical tables similar to Table S-1 and Table S-2 were prepared for each county in the watershed and are included in Appendix A.

The economic base and nutrient discharge characteristics of counties differ significantly. Since most water quality policies are established, or are at least implemented, at the county level the information presented in county-specific economic/water quality profiles in Appendix A is more useful than the watershed overview provided in Tables S-1 and S-2. Note that county economic statistics were adjusted to account for the fact that only portions of these counties are located within the Patuxent River watershed.

Table S-1: 2004 Direct Economic Impacts and Nutrient Discharges by Sectors within the Patuxent River - All Watershed Counties

Sector	Watershed Direct Impacts: Total $Output All Counties, All Areas [a]	Watershed Direct Impacts: $ Output Based in Watershed - All Counties [a]	Watershed Direct Impacts: Nutrient Discharges to Patuxent River-All Counties (pounds) [b]	Watershed Impacts: Direct Economic Impacts of Business Activity in the Watershed [c]: $ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds of Nutrient to Patuxent River per Direct Economic Impact: Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 3,609,432	$ 134,276	117	120,692	3,244,284	3,720
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 4,502,316	$ 159,475	262	136,234	3,846,178	2,338
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 4,744,374	$ 63,897	57	105,761	7,852,768	8,848
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,088,213	$ 47,940	26	128,948	2,927,076	5,335
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 42,053,414	$ 746,844	735	2,870	161,604	164
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 561,920	$ 14,903	13	130,476	4,919,674	5,458
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 3,209,667	$ 122,345	41	124,545	3,267,398	9,783
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 864,036	$ 165,495	85	205,321	1,071,967	2,086
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 125,456	$ 593	3	58,881	12,459,715	2,754
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 621,582	$ 124,389	214	63,484	317,234	184
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,505,102	$ 47,848	24	14,100	443,528	877
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 165,923	$ 21,379	1	39,267	304,756	6,788
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 6,101,677	$ 1,251,644	195	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 3,040,306	$ 50,827	206	135	8,083	2
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 49,528,893	$ 4,195,493	747	295	3,478	20
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,971,983,527	$ 203,181,273	20,242	138	1,335	13
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 2,810,489,281	$ 37,938,031	42,951	123	9,079	8
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,328,160,396	$ 30,309,364	13,585	174	7,641	17
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 3,650,308,651	$ 989,264,820	68,071	96	356	5
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 2,676,006,054	$ 333,679,883	23,967	88	703	10
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 8,226,939,668	$ 302,998,757	167,752	96	2,596	5
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 4,570,985,504	$ 293,540,534	22,567	69	1,076	14
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 2,549,742,157	$ 73,934	43,986	63	2,160,875	4
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**	**$ 27,906,337,550**	**$ 2,198,133,945**	**405,848**			
Other Sectors									
Point Source (Household Only) [e]			1,679,037						
Septic (Household Only)			536,799						
Atmospheric (All Sources)			602,601						
Undeveloped Land									
Natural Grasses			41,210						
Forest			385,673						
Total Estimated Nutrient Discharge into the Patuxent			**8,493,234**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture
b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)
c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)
d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income
e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table S-2 2004 County Economic Base and Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems Per Unit of County Economic Impacts

Sector	Watershed Direct Impacts			Watershed Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Business Impact[c]			
	Total $ Output All Counties, All Areas [a]	$ Output Based in Watershed - All Counties [a]	Nutrient Discharges to Patuxent River - All Counties (pounds) [b]	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 1,426,511	$ 887,223	$ 45,569	26	18,698	30,064	585,342	1,029
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 1,438,215	$ 814,074	$ 41,764	37	22,257	39,320	766,442	861
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 1,452,164	$ 1,020,768	$ 33,089	13	23,662	33,662	1,038,433	2,584
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,479,158	$ 857,737	$ 49,519	18	18,845	32,498	562,916	1,509
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 1,602,949	$ 1,079,360	$ 43,092	17	614	912	22,844	58
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 1,406,118	$ 992,033	$ 40,572	22	18,675	26,471	647,237	1,214
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 1,467,742	$ 837,669	$ 44,668	11	19,994	35,033	656,977	2,587
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 1,461,891	$ 377,678	$ 49,013	18	6,930	26,823	206,689	571
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 1,536,309	$ 773,579	$ 27,731	13	7,187	14,274	398,174	881
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 1,560,852	$ 380,874	$ 45,696	36	1,416	5,803	48,364	61
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,425,268	$ 487,188	$ 27,175	8	553	1,619	29,024	100
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 1,291,858	$ 402,706	$ 44,845	6	1,069	3,428	30,787	250
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 2,394,679	$ 1,245,266	$ 114,871	51	0	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 1,961,947	$ 1,093,168	$ 54,353	44	8	13	271	0
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 1,679,901	$ 746,458	$ 53,943	10	29	65	897	5
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,720,099	$ 911,521	$ 89,045	9	6	11	110	1
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 1,915,087	$ 1,023,337	$ 55,216	16	10	18	337	1
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,809,730	$ 747,636	$ 43,959	9	7	18	302	1
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 1,835,039	$ 1,001,929	$ 184,334	17	8	15	83	1
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 1,683,902	$ 968,580	$ 106,793	11	6	10	90	1
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 1,967,218	$ 1,145,064	$ 68,579	20	6	11	186	1
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 1,691,162	$ 1,287,597	$ 79,146	11	7	9	141	1
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 1,878,615	$ 1,461,964	$ 43,615	24	9	11	381	1
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**								
Other Sectors											
Point Source (Household Only) [e]			1,679,037								
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a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

County-level Government Response Indices

Table S-3 presents summary indices that reflect how much each county contributes to Patuxent River water quality problems (e.g., nutrient discharges per acre, per capita, per dollar of economic output), and also indices that reflect how much effort each county is putting into controlling Patuxent River water quality problems (e.g., spending on environment as a percent of county budget, number of inspections per permit, average size of penalties from environmental violations). We believe this is the first attempt to use generally available county data to generate county environmental responsiveness indices. We hope that future research will refine and further develop these and other indices, and that improved reporting of county data will allow them to be more useful in determining which policies are working and which are not.

For purposes of comparing across counties all indices are computed using the watershed average as the index baseline set equal to 1. The index value shown for each county reflects what percentage above or below the watershed average that county performed with respect to that indicator. A county indicator of 2.5 with respect to "number of inspections per permit," for example, means the county is 150% above the watershed average and performs 2.5 times as many inspections per permit as the watershed average.

In order to be consistent and to allow indices to be added together to show overall levels of county water quality "stewardship" or "culpability," all indices are computed such that being above the watershed average is "good" and being below the watershed average is "bad." For some purposes this can lead to some confusion since it means, for example, that the lower a county's nutrient discharge figures are (good), the higher its score for that index, and vice versa.

The indices address the following questions:

- How forcefully are county governments enforcing policy decisions (e.g., levels of fines and penalties)?
- What level of financial commitment are counties making to enforce water quality restrictions (e.g., budget and manpower allocations)?
- What level of enforcement effort is being exerted by county governments (e.g., numbers of inspectors and inspections, frequency of enforcement actions and prosecutions)?

Table S-3: Patuxent Stewardship/Culpability Indicators

Nutrient Discharges (lower discharge = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
N-Equivalent Edge of Stream	0.62	2.03	0.53	0.77	9.58	1.09	1.49	1.0
Nutrients lbs. per Capita in Watershed	1.54	2.86	2.83	1.46	0.98	0.84	0.36	1.0
Nutrients lbs./sq. Miles in Watershed	0.95	0.94	0.99	0.75	2.12	1.30	0.78	1.0
Nutrients per $ Output	3.83	1.90	3.19	1.01	0.64	0.73	0.51	1.0
2004 County Environmental Spending (higher spending = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Natural Resources (% of Total Spending)	0.35	0.70	0.00	1.05	0.35	3.50	1.05	1.0
Natural Resources $ per Capita	0.52	0.63	0.21	0.84	0.42	3.45	0.94	1.0
Natural Resources $ per County Acre	0.75	1.84	0.40	1.42	0.18	2.06	0.36	1.0
Pax Nat. Resource $/Pax Nutrient lbs.	0.65	1.67	0.39	1.00	0.37	2.62	0.30	1.0
2005 County Environmental Enforcement Budget (higher budget = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Inspections/Permits (% of Total Budget)	1.39	1.24	0.73	1.53	0.46	0.77	0.87	1.0
Inspections/Permits Budget per Capita	1.54	1.70	0.78	1.50	0.39	0.59	0.50	1.0
Sediment/Erosion (SE) Control Enforcement (lower number of permits or acres per inspector= higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Total Permits Per Inspector	31.59	18.85	3.36	14.39	0.33	2.47	0.32	1.0
Total Permits per Inspector w/o MDE	5.12	3.05	0.54	2.74	n/a	0.44	n/a	1.0
Active Permits per Inspector	7.63	2.86	1.22	1.32	n/a	0.34	n/a	1.0
Acres per Inspector	8.76	1.42	0.54	0.80	n/a	0.92	n/a	1.0
Inspections per Inspector	0.54	1.41	0.77	1.05	0.57	1.43	1.22	1.0
Complaints Received	0.18	1.58	0.47	3.63	0.08	1.00	0.06	1.0
Violation Notices	0.35	2.14	0.40	0.43	n/a	1.68	n/a	1.0
Stop Work Orders	0.13	1.68	1.64	3.24	0.03	0.26	0.02	1.0
Penalties (Total Fines Levied)	0.00	1.60	1.21	2.78	0.50	0.10	0.81	1.0
Patuxent SE Inspectors per Bare Construction Discharge	1.47	1.33	0.58	0.74	0.76	1.79	0.32	1.0
Patuxent Inspections per Bare Construction Discharge	0.76	1.81	0.43	0.75	0.42	2.45	0.38	1.0

Table S-3: Patuxent Stewardship/Culpability Indicators (Continued)

Federal Agricultural Programs	**Howard**	**Montgomery**	**Prince George's**	**Anne Arundel**	**Charles**	**Calvert**	**St. Mary's**	**Watershed**
Federal Fixed Farm Subsidies	1.06	0.42	2.44	1.94	0.95	2.51	0.76	1.0
Env. Quality Incentive Program $	0.92	0.76	0.19	2.64	1.07	0.77	0.65	1.0
EQIP # of Contracts	0.44	1.81	0.83	1.62	1.27	0.64	0.39	1.0
Total Agric. Programs (Fed.) Score	0.83	1.06	1.16	1.86	1.15	1.34	0.63	1.0

State Agricultural Programs	**Howard**	**Montgomery**	**Prince George's**	**Anne Arundel**	**Charles**	**Calvert**	**St. Mary's**	**Watershed**
Nutrient Management Plans (#)	0.69	1.23	0.86	1.04	0.93	0.71	1.53	1.0
NMP Acres per Ag. Acre in County	0.87	1.35	0.94	0.90	0.96	0.82	1.16	1.0
Maryland Agricultural Cost-Share Capital $	1.09	2.79	0.34	0.02	1.47	0.64	0.67	1.0
MACS Cover Crop $	0.13	2.46	0.65	1.10	1.56	0.43	0.69	1.0
MACS Cover Crop Acres	0.12	2.30	0.63	1.33	1.48	0.44	0.70	1.0

Soil Conservation District (more staff = higher score)	**Howard**	**Montgomery**	**Prince George's**	**Anne Arundel**	**Charles**	**Calvert**	**St. Mary's**	**Watershed**
SCD Staff (Local Funding) per Household	1.06	0.16	0.39	0.74	1.35	1.80	1.50	1.0
SCD Staff (Local Funding) per Total Permits	2.36	1.10	0.49	2.23	0.15	0.47	0.20	1.0
SCD Staff Budget (Local $) per Total Permits	2.44	1.23	0.51	2.15	0.15	0.43	0.09	1.0
SCD Staff (State Funding)/Ag. Acres in District	0.30	0.38	0.96	0.56	0.84	2.11	1.85	1.0
SCD Staff (Fed. Funding)/Ag. Acres in District	1.05	0.66	1.27	0.73	0.89	1.85	0.54	1.0
SCD Staff (watershed)/N-equiv. bare const.	0.61	0.43	0.47	0.63	1.93	1.86	1.07	1.0

Interview Results

Our interviews with county and Soil Conservation District staff covered a range of topics related to activities designed to encourage reduction of nutrient discharges to the Patuxent River. These included discussion of the current and potential impact of education and outreach, monitoring and enforcement, fees and incentives, and political will to protect and restore the Patuxent. Key interview comments include the following:

Staffing Issues

Not surprisingly, county and Soil Conservation District staff had strong opinions about their ability to reduce nutrient discharges, both in terms of education/outreach and monitoring/enforcement.

Education/Outreach Staffing

- Both county and Soil Conservation District staff had a range of opinions about whether current education/outreach staff levels are an important factor in influencing decisions of people to refrain from activities that cause discharge of nutrients to the Patuxent River, with six of 17 agreeing with the statement. But with sufficient funds, 14 of 17 respondents somewhat or strongly agreed that staff level could be an important factor. Eight of these respondents strongly agreed with this statement.
- For technical assistance, nine of 17 agreed that current staffing levels are an important factor in influencing decisions of people to refrain from polluting activities, but with sufficient funds, 16 of 17 somewhat or strongly agreed that this would make a difference.
- However, the range of opinion about the impact of increased technical assistance staffing is illustrated by the following two quotes from county staff:
  - "We need to educate people better; a lot of people just don't understand the impact of their activities."
  - "Some people won't change behaviors, no matter how much outreach we do."
- For agriculture, the staffing challenge is illustrated by the following comment: "Our district is woefully short on agricultural staffing. Urban staff is paid through fees, so they are adequately funded. Federal and state assistance has gone downhill lately. Counties have picked up assistance, in part because counties need the help (from Soil Conservation District personnel) with urban permitting."
- Two SCD managers brought up the problems with implementing fully the post-*Pfiesteria* mandate of adding 110 staff in the field. One said that, by the end of 2005, about 60 to 83 staff had been added since the 1998 Water Quality Improvement Act legislation, depending on who is asked. Another estimated that there are currently 60 funded positions.

Monitoring Existing Permitted Sites

- The response to a question about the effectiveness of current monitoring and inspection staff levels was mixed, with six staffers somewhat or strongly agreeing with the statement, and nine somewhat or strongly disagreeing with the statement. However, there was widespread agreement that more staff resources would make a difference: Fifteen of 17 staffers somewhat or strongly agreed that, with sufficient funds, the

county's or Soil Conservation District's staff level for monitoring of existing sites (or existing best-management-practice contracts) could be an important factor in influencing people to refrain from activities that cause discharges of nutrients to the Patuxent River.

- Both county and MDE officials pointed out the challenge in meeting the state requirement that permitted sediment and erosion control sites be inspected every two weeks. As one county staffer put it, "one of the issues is having enough time to inspect, and putting fear into people who would violate."
- In all areas of the watershed, county staffers noted the difficulty for inspection staff to keep up with the pace of development.
- While data collected from the Maryland Department of Agriculture suggest that MDA is making strides toward enforcing implementation of nutrient management plans, one SCD manager took a somewhat harder line, suggesting that "it would make a big difference if nutrient management plans were enforced."

Effluent Taxes/Fees

- Several staffers mentioned the opportunities and challenges for implementing or increasing a stormwater utility fee for residents. In one county, a stormwater utility fee appears on the residential water bill, "but it is not significant enough to be noticed."
- In another county, in which staffers from two different departments were interviewed, one staffer wondered whether taxes on fertilizer or percentage of impervious surface would work. The staffer then noted that "pocketbook issues drive people, but these are people who are willing to pay anything to have their green lawn."

Inspection/Enforcement Issues

- Some staff believe that their county or district has sufficient inspection authority and ability to deter individuals who otherwise might think they can get away with something. Other county and district staff members, however, believe this is absolutely not the case, and that many individuals take the approach of begging forgiveness if caught, rather than seeking permission.
- One district manager said that, with nutrient management plans, he's hearing a lot of comments from farmers who think that "no one's going to enforce it."
- Only three of the 17 staffers somewhat or strongly agreed that frequency of prosecution was deterring polluting activities.
- "Fines for Critical Area Act violations have been considered low and not a deterrent, although they were just increased. Still, there are lots of wealthy people who just pay."
- "People know nobody gets fined. Such a minimal fine, people go ahead anyway."
- Enforcement of compliance with point-source pollution laws received relatively high marks from both the county and Soil Conservation District staff, with nine of the 17 interviewees saying that enforcement of these laws is moderately strict (usually enforced).
- Still, only one of the 17 staffers said that such enforcement was very strict (always enforced).

- One county staffer noted that, in his county, enforcement of point source pollution laws is not very strict because MDE retains point-source jurisdiction. "They are understaffed at MDE and can take a long time to address an issue. The response is somewhat faster by MDE if (our county) calls them about it."
- Although two managers commented that MDA's enforcement of nutrient management plans is getting better because it now has more resources, none of the managers thought that enforcement of nutrient management plans could be considered strict (monitored at least annually) at this stage.

Political Will

- "There is not a politician who wouldn't say that they don't have the political will to improve the Bay," said one county staffer. "But that doesn't mean they are willing to raise taxes to pay better or hire more staff. The state talks a big game, but if you want help going to court, they are too busy. I don't see any Federal involvement."
- **"**In our county, political will is way below the level of concern for schools and public safety. Sixty percent of county budget is for schools; one percent is for environmental activities."
- This staffer somewhat disagreed at the state and Federal level, too: "The flush tax is a politically expedient way to say that the state did something, but its initial focus is on WWTPs, so it won't affect behavior or land use."

Other County Statistical Comparisons

The following tables and figures provide additional statistical description of the counties in the Patuxent watershed.

Table S-4. Patuxent watershed agricultural economic output and nutrient discharges, by county.

	Contribution to County Economic Output	Contribution to County Nutrient Discharge to Patuxent River
Howard	0.27%	36.07%
Montgomery	0.64%	43.96%
Prince George's	0.18%	25.02%
Anne Arundel	0.35%	21.85%
Charles	0.55%	32.77%
Calvert	0.26%	39.07%
St. Mary's	0.61%	20.93%
Patuxent Watershed	**0.27%**	**29.87%**

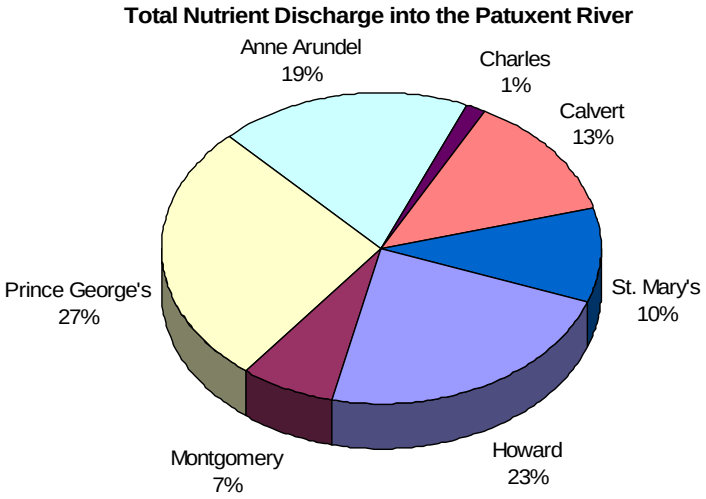
Source: Combination of IMPLAN economic data (See Appendix A) and nutrient discharge data from the Chesapeake Bay Program Office

Table S-5 Nutrient discharges per acre for selected agricultural and urban land uses.

N-Equivalent Discharge per Acre within the Watershed:	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Patuxent Mean
Agriculture Hightill With Manure	51	59	47	41	39	41	47	47
Agriculture Hightill without Manure	59	63	50	41	27	32	32	43
Agriculture Nutrient Mgmt. Hightill with Manure	43	49	43	40	34	34	40	41
Agriculture Nutrient Mgmt. Hightill without Manure	40	40	33	30	23	22	27	31
Urban Low Intensity Impervious	25	28	24	28	23	23	23	25
Urban High Intensity Impervious	26	28	24	28	23	23	23	25
Urban Low Intensity Pervious	13	15	12	13	11	12	11	12
Urban High Intensity Pervious	13	14	12	13	11	12	11	12
Agriculture Hay without Nutrients	6	6	5	5	5	4	5	5
Agriculture Nutrient Mgmt. Pasture	9	2	2	7	2	5	2	4

Source: Chesapeake Bay Program Office

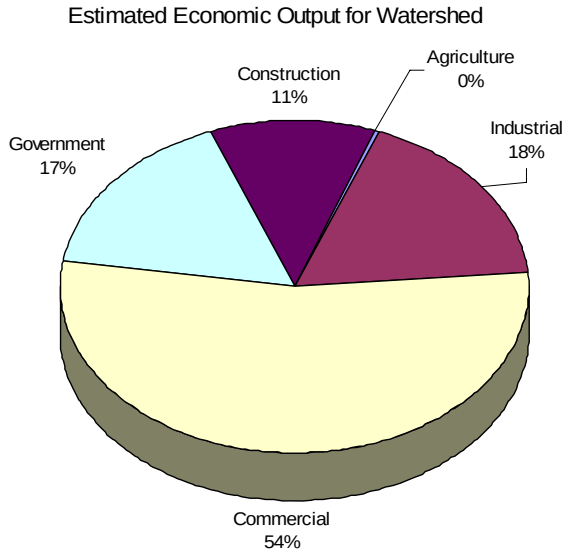
Nutrient Discharges



Total N-Equivalent Discharge into the Patuxent River (lbs.)	
Howard	1,952,457
Montgomery	598,372
Prince George's	2,304,495
Anne Arundel	1,582,774
Charles	126,693
Calvert	1,113,035
St. Mary's	815,408
TOTAL	**8,493,234**

Source: Chesapeake Bay Program Office, 2006

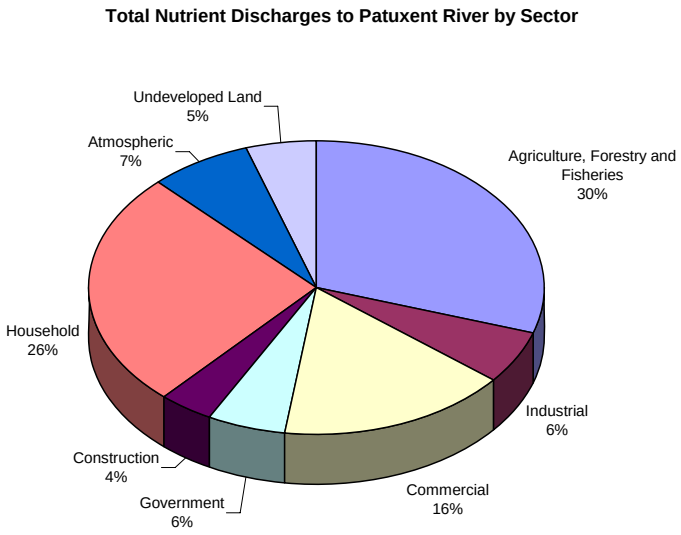
Figure S-1. Total nutrient discharge into the Patuxent River by county.



Estimated Economic Output for Watershed ($1,000's)	
Agriculture	$ 130,062
Industrial	8,566,252
Commercial	25,678,212
Government	8,047,845
Construction	5,391,681
TOTAL	**47,814,052**

Source: 2004 IMPLAN regional economic model (See Appendix A)

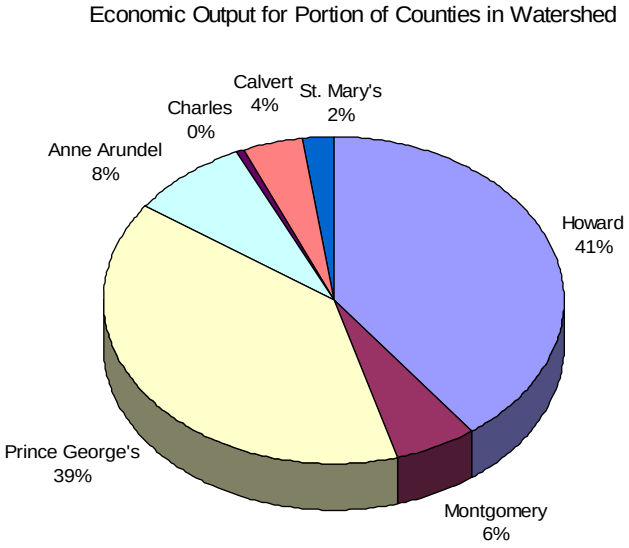
Figure S-2. Estimated economic output for portion of counties in the watershed by sector.



Total Nutrient Discharge to Patuxent River by Sector (lbs.)	
Agriculture	2,536,842
Industrial	517,332
Commercial	1,373,655
Government	475,643
Construction	344,443
Household (sewer/septic)	2,215,836
Atmospheric	602,601
Undeveloped Land	426,883
TOTAL	**8,493,235**

Source: Chesapeake Bay Program Office, 2006

Figure S-3. Total nutrient discharges (in pounds) to the Patuxent River by sector



Economic Output for Portion of Counties in the Watershed	
Howard	18,928,833
Montgomery	2,886,015
Prince George's	18,629,357
Anne Arundel	4,056,901
Charles	204,680
Calvert	2,063,669
St. Mary's	1,044,598
TOTAL	**47,814,052**

Source: 2004 IMPLAN regional economic model (See Appendix A)

Figure S-4. Economic output for portion of counties in watershed.

Table S-6: 2005 County budgets for inspections and permitting offices

	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's
Inspections and Permitting Office (IPO) Budget	$5,441,494	20,825,379	8,696,191	10,108,713	700,100	662,708	614,577
Percent of total operating budget	0.70%	0.63%	0.37%	0.78%	0.24%	0.39%	0.44%
IPO budget dollars per capita	$ 20.59	22.66	10.37	19.95	5.26	7.88	6.63

Source: Maryland Department of Legislative Services, Office of Policy Analysis

Table S-7: Nutrient management plan compliance within the watershed.

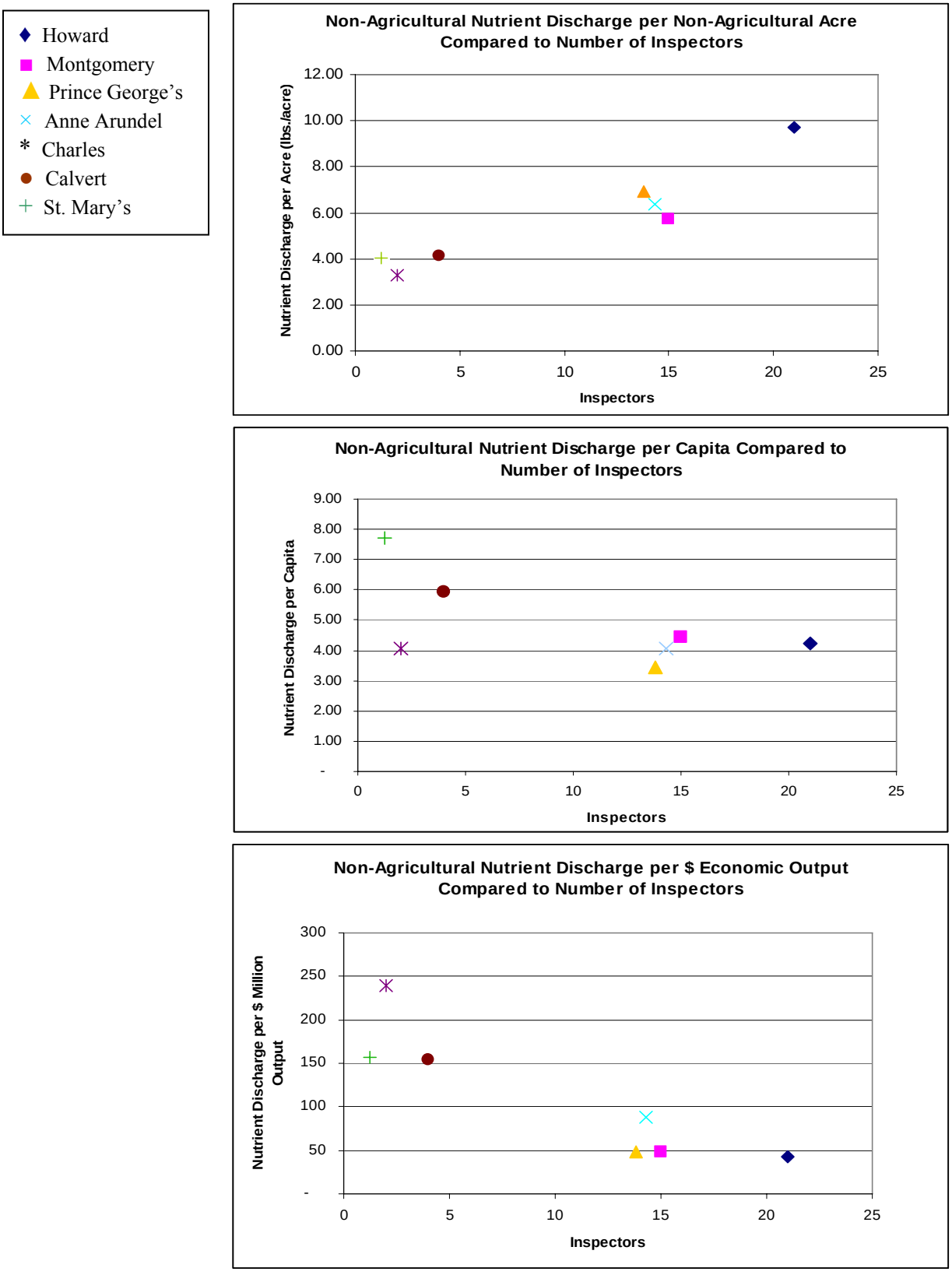
	Non-responsive or justified delay as of 7/1/05	First NOV	Personal visits or telephone contact	Still not in compliance as of 6/30/06
Anne Arundel	48	48	47	21
Calvert	50	39	32	25
Charles	49	36	30	23
Howard	59	33	34	23
Montgomery	121	40	47	70
Prince George's	100	60	47	68
St. Mary's	104	32	17	87

NOV: Notice of Violation

Source: Maryland Department of Agriculture (2006)

Figure S-5a-c.Relationship between 2004 County Non-Agricultural Nutrient Discharges to the Patuxent River and Number of Permit Inspectors

Source: Developed using Maryland Department of the Environment data (inspectors/inspections) and Chesapeake Bay Program Office data (nutrient discharge).

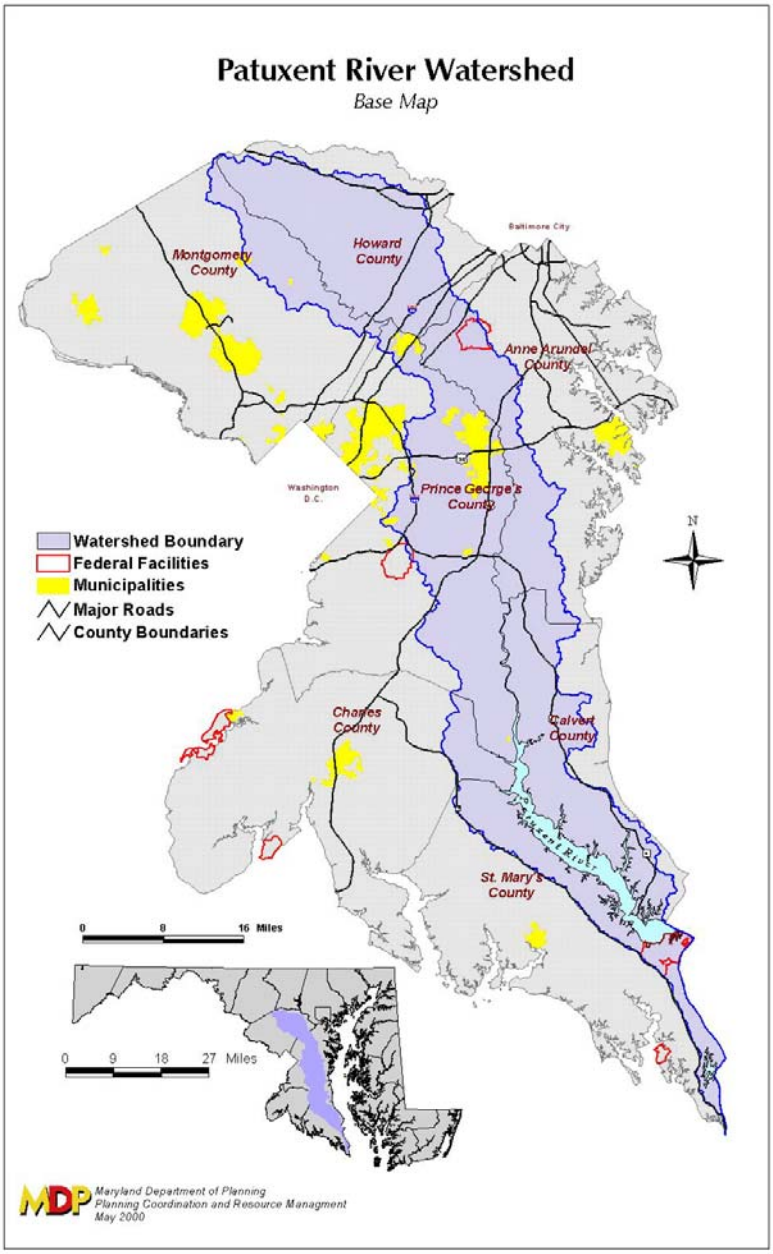


Conclusions

Based on our analysis of data and interview results, we form the following conclusions regarding the implementation of policies to improve Patuxent River water quality:

- The economic base and source of nutrient discharges and implementation of nutrient discharge policies differ significantly from county to county.
- County-level data about how water quality policies are implemented and their successes or failures are not adequate to support meaningful review or justify policy changes.
- Policies that rely solely on private citizens voluntarily restricting their land and water use decisions for the sake of River water quality will not succeed.
- Unless mandatory land and water use restrictions are effectively and uniformly enforced they will not succeed.
- Policies that involve relatively low penalties for violating mandatory land and water use restrictions or penalties that are relatively easy to avoid will not succeed.
- Most counties do not have an adequate number of inspectors to deal effectively with environmental violations.
- Most counties do not allocate enough inspector time to examining environmental violations.
- Most counties do not keep records in a way that allows consistent comparisons of how much county spending and man-power are allocated to enforce environmental laws compared to other jurisdictions.

Figure S-6. Map of the Patuxent River Watershed



Ecological Health of the Patuxent River*

Environmental Health Index (scale: 0.00 – 1.00)

By River Segment (2003)	EHI Score*
Upper Patuxent	0.21
Middle Patuxent	0.52
Lower Patuxent	0.48
Mouth Patuxent	0.58
Overall Patuxent	**0.48 (D+)**

By Category (2007)	EHI Score*
Chlorophyll a	0.19
Dissolved Oxygen	0.62
Water Clarity	0.04
Bay Grasses	0.14
Benthic Index	0.20
Phytoplankton Index	0.21
Overall Patuxent	**0.23 (D-)**

Scoring: Excellent (1.00-0.75), Acceptable (0.75-0.50), Poor (0.50-0.25), and Very Degraded (0.25-0.00)

* based on the Patuxent River Ecological "Report Card" developed by the University of Maryland, Center for Environmental Science, IAN program. For full description of the approach and results visit: http://ian.umces.edu.

1. Introduction

1.1 The Chesapeake and Its Tributaries: Status and Outlook

Recent scientific reports, as well as less technical sources of information, such as the annual "Chesapeake Bay Report Card" and annual pronouncements about how far former Maryland Senator Bernie Fowler can walk into the Patuxent River before losing sight of his sneakers, leave no doubt that the health of the Chesapeake Bay and its tributaries is declining. (Chesapeake Bay Foundation 2006; Wan 2006).

The U.S. Environmental Protection Agency reports that Bay water quality goals for 2010 that were agreed upon by State and Federal agencies in 2000 will not be achieved by then, or any time near then (Fahrenthold 2007). This situation exists despite years of significant public investments in Bay restoration and many highly-publicized State/Federal partnerships, agreements, commitments, and memoranda of understanding aimed at restoring the Bay (Blankenship, 2006).

Improvements in water-quality monitoring techniques allow increasingly precise documentation of the water quality problems in the Bay. Integrated hydrological/geophysical/ecosystem models have linked these problems to particular types of nutrient discharge sources and particular changes in land and water use patterns (Jordan et al. 2003, Weller et al. 2003, Mayer et al. 2006).

Recent reports predict that expected population increases in the Bay watershed will result in further increases in nutrient discharges that will more than offset the planned reductions in discharges by existing sources (Blankenship 2006). This evidence suggests that the health of the Bay will continue to deteriorate unless new, more effective policies are put in place to reduce nutrient discharges into the Bay.

The types of studies referenced above are performed primarily by scientists based on examinations of physical and biological data that focus primarily on symptoms and sources of water quality problems. These studies nearly always stop short of examining economic data related to the causes of these problems which include private land and water use decisions and public decisions about how to influence private land and water use decisions that are, apparently, not working. Despite widespread concern expressed by scientists and political leaders about the deteriorating health of the Bay, for example, our research shows that clear economic incentives remain for thousands of self-interested private land and water users in the Bay watershed to continue making decisions that harm the Bay. Although political leaders prefer to rely on voluntary rather than regulatory strategies for restoring the health of the Bay, our research shows that the economic and social well-being of most of the more than 16 million people who live in the Bay watershed are barely influenced by the ecological health of the Bay. Aside from the influence of laws and regulations, they have no real incentive to restrict their conversion of land or to modify their water use in order to improve Bay water quality.

From this perspective, understanding why the health of the Bay is deteriorating does not require consulting the scientific literature or studying the policies and institutions that have been put in place to deal with Bay health problems. It is only necessary to examine whether the specific government policies that have been put in place to protect and restore the health of the Bay are adequate to change the incentives and constraints faced by the thousands of private land and water users in the watershed whose decisions are harming the Bay.

1.2 Collective Action to Solve Chesapeake Bay Problems

The policy tools that government agencies can use to influence private land and water decisions that harm the Bay include laws and regulations, subsidies and taxes, zoning and land use restrictions, educational and outreach programs, and appeals for voluntary restraints. (These are discussed further in Section 2.) The success or failure of government activities to influence water quality, of course, depends not only on what policy tools are chosen, but on the amount of effort put into making them effective. For example, during our interviews for this project (discussed further in Section 3), several different county enforcement officials reported in one way or another that the general attitude of land developers in their county is "Do what you please, and pay the fine if you get caught and can't get out of it."

It is difficult to measure how much political will exists at the county level to implement and enforce land use restrictions, construction regulations, and nutrient and sediment discharge restrictions in order to protect and restore the Bay. However, it is possible to infer the level of commitment by examining how much effort county governments put into solving the problem, and how they allocate that effort between preventative (before-the-fact) and reactive (after-the-fact) strategies. For example, this level of effort can be measured, to some extent, in terms of county spending on environmental enforcement, manpower committed to environmental monitoring and enforcement, and numbers of inspections, citations, prosecutions per permit issued, and other indices.

1.3 Focus on the Patuxent River Watershed

In order to focus our research on the causes of Bay water quality problems and related economic and enforcement issues, we decided to collect and assess data and conduct interviews related to private and public decision-making in the seven counties in the watershed of one of the Bay's main tributaries, the Patuxent River. The Patuxent River is the largest river wholly contained in Maryland and because of the land use characteristics of this watershed and problems within the estuary, it is often considered a microcosm of the Bay. The Patuxent River, like the Bay, is also in poor health and faces the prospect of growing threats from the increasing population in its watershed (See Figure 1).

1.4 Research Overview

This paper summarizes the results of our research that focused on three general questions: 1) How are economic sectors in each of the seven counties that make up the Patuxent River watershed contributing to the regional economy; 2) how are these same economic sectors contributing to Patuxent River water quality problems, and 3) what policy tools and levels of effort are government agencies within each county using to deal with the water quality problems in the river.

We considered the causes of these water quality problems to be associated with a two-tier decision-making process. Government decisions about how to deal with the problem are important but, with few exceptions, have no direct effect on water quality. They can be effective if they indirectly influence the millions of land and water use decisions made by thousands of individual households, farmers, businesses, and municipalities in the watershed.

Political leaders prefer to appeal to land and water users to voluntarily restrict their decisions to help the river rather than imposing and enforcing regulations that compel them to restrict their decisions. The available evidence, however, indicates that restricting private land

and water use decision to protect and restore the health of the river is not in the short-term economic interest of most land and water users in the watershed. The economic evidence also shows that the health of the river has very little effect on the economic welfare of the vast majority of households, businesses, and farmers in the watershed.

From an economic perspective, therefore, it is reasonable to expect that where water quality policies are based on education and outreach programs that appeal for voluntary restraints, they are not likely to be effective. On the other hand, in the absence of any significant enforcement of environmental regulations or any significant financial penalties for violators, it is not likely that mandatory restrictions to improve water quality will be much more successful. Residents of the watershed, if they conclude that that their decisions to limit or not limit their land and water use decisions will have no significant effect on the long-term prospects for the health of the river, will not be driven to follow the rules. They will conclude, correctly, that it makes no economic sense to follow the rules if it is generally recognized that the policies that are in place are not preventing others from breaking the rules.

We decided to focus a significant share of our economic analysis on the effectiveness of environmental enforcement in the Patuxent watershed for two reasons. First, we aimed to help determine the social causes of Patuxent water quality problems. And second, we aimed to reveal the incentives that drive decisions that affect Patuxent water quality and how such decisions might be influenced by public policy. As the watershed population grows, the consequences of failing to provide incentives to change economically rational behavior have serious implications for the long-term health of the river.

1.5 Specific Research Tasks

Our research involved the following three tasks:

Task 1. Use county economic impact models (See Appendix A) to estimate how individual commercial, industrial, agricultural, and household sectors within each of the seven counties in the Patuxent River watershed contributes to county economic well-being (e.g., jobs, incomes, taxes).

Task 2. Link county level nutrient discharge data by land type/land use and other sources (Chesapeake Bay Program office) with each of these economic sectors within each county to determine their overall contributions to Patuxent River nutrient problems and estimate related economic/water quality tradeoffs (e.g., nutrient discharges per county job, per dollar of county household income, etc.).

Task 3. Use state and county budget and financial data, enforcement and compliance statistics, and interviews with state and county enforcement staff to measure the level of government effort exerted in attempts to control nutrient discharges within each county. This involved examining data related to county environmental spending and enforcement manpower allocations, numbers of environmental permit inspectors and inspections per inspector or per permit, numbers of prosecutions for environmental violations, sizes of penalties, etc.

1.6 Presentation of Results

The purpose of this work was to provide information to help county governments assess how they target and develop strategies for dealing with the causes of Patuxent River water

quality problems. To make it easier for them to assess how their policies are performing, we present information in ways that facilitate cross-county comparisons. This information included measures such as overall county nutrient discharges and discharges by particular industry per dollar of business sales, per dollar of household income generated, etc. We also present measures of and indicators of county environmental spending per capita, per acre, and per dollar of household income and compare counties in terms of number of county inspectors per permit, permit violations per permit issued, average dollar amount of penalties for violations, and so on. We present absolute values of these measures for each county. However, we also use the average for all counties in the Patuxent watershed as a baseline and present results for each county as an index showing how far that county is above or below the watershed average.[1]

Statistics and indicators for each county are presented in two parts:

1) Private Sector Economic/Nutrient Discharge Tradeoffs

- How much do economic sectors within each county contribute to the county economy (e.g. dollar sales, household income, jobs, taxes)?
- How much do economic sectors contribute to Patuxent River problems (e.g., pounds of nutrients discharged per dollar of household income)?
- What are the economic/water quality tradeoffs to consider when considering tightening nutrient discharge restrictions on various sectors?

2) County Government Responses to Nutrient Discharge Problems

- What forms of collective action can county government use to try to influence land and water use decisions by various sectors that are having adverse effects on nutrient discharges and water quality?
- How forcefully do county governments need to enforce the decisions they make in order to assure that they have some effect?
- What level of financial commitment are counties making to enforce water quality restrictions (e.g., budget and manpower allocations)?
- What level of enforcement effort is being exerted by county governments (e.g., numbers of inspectors and inspections, frequency of enforcement actions and prosecutions, levels of fines, etc.)?

In this report we organize and summarize all the information we could collect regarding the economic structure of the seven counties in the Patuxent River watershed, the contribution of various economic sectors to county economies and to Patuxent River problems, and the amount of effort that county governments, sometimes with assistance from State and Federal resource agencies, are investing in reducing those contributions. In the final section of the report we offer

[1] All counties in the Patuxent River watershed are contained only partially within the Patuxent watershed. For purposes of matching economic and land use and nutrient discharge data, we determined the percent of the county land area that is in the watershed and assumed that the same percent of county businesses and households are located within the Patuxent watershed.

suggestions for increasing and standardizing data related to environmental enforcement and compliance.

1.7 Caveats Regarding Cross-County Comparisons

We discovered that hard statistics related to county level environmental enforcement and compliance are difficult to find, because what is available is often incomplete and can be very difficult to interpret. For example, county statistics that show a low number of environmental violations cited per inspector could imply either weak enforcement or more successful strategies by inspectors to prevent violations. A high number of inspections per inspector or inspections per permit might be a useful indicator of whether such a strategy is in place. However, this indicator may also reflect the geographic extent and distribution of development in a county which affects the area that must be covered by an inspector. Similarly, reported county spending on the environment sometimes includes spending on parks and recreation and, for any given year, could include large capital outlays by one county that were made in different years by other counties.

1.8 Format of the Paper

After this introduction, **Section 1**, the paper is organized into five sections as follows:

Section 2: **National and Regional Policy Context** provides information about the new challenges facing environmental managers dealing with Patuxent River water quality problems.

Section 3: Research Approach presents the conceptual basis for examining the economics of environmental enforcement. This includes a brief theoretical and practical justification for examining enforcement economics at the county scale that is based on a Nobel Prize-winning view of how governments attempt to influence private sector decision-making and how private sector decision-makers "game" governmental programs. This section also describes how we attempted to collect and organize information to describe the economic impacts and nutrient discharge impacts of economic sectors in the Patuxent River watershed and the level of government effort aimed at controlling nutrient discharges.

Section 4: **Watershed and County-Level Economic and Nutrient Discharge Profiles**, summarizes what can be learned from county-level data regarding how various economic sectors contribute to the economic health of the county and to the deteriorating environmental health of the river. This section also shows what kinds of economic/environmental tradeoffs county governments in the watershed should consider when targeting nutrient discharge reduction policies.

Section 5: **Watershed and County-level Environmental Enforcement Profiles**, provides what might be called county-scale river impact "stewardship" or "culpability indices." These indicators show, on an absolute and relative basis, the portion of public spending and resource commitments within each county that are committed to addressing Patuxent River water quality problems. The indicators provide an assessment of how much effort each county exerts in preventative strategies, such as technical assistance and outreach, and in reactive strategies, such as citing and prosecuting violators of discharge restrictions, imposing meaningful fines, and so on. These commitments by each county are compared with the contribution of economic sectors within each county to Patuxent River water quality problems.

Section 6: Results, Conclusions and Recommendations, summarizes the results of the analysis of county level contributions to and responses to Patuxent River problems and presents some conclusions regarding what county governments in the watershed need to do to deal realistically with the economic forces that are contributing to the deteriorating health of the Patuxent River. This section also describes what new county-level data need to be collected to allow county managers and those overseeing Patuxent River water quality management at the State and Federal level to determine if spending and regulatory decisions regarding monitoring and enforcement are adequate and are being implemented in ways that make it likely that they will succeed.

2. National and Regional Policy Context

2.1 National Context

In 2004, the chairman of the U.S. Commission on Ocean Policy (USCOP) introduced the Commission's report to the U.S. Congress by stating, "We are facing a new generation of environmental problems, such as non-point source pollution, that require better data, more coordinated and integrated management strategies, and changes in human behavior" (Watkins 2004).

Based partly on that challenge, we designed our research project to collect and assess what would be needed in terms of "better data" to help design "more integrated management strategies" to help "change human behavior" with emphasis on one specific example of the "new generation of environmental problems" identified by the USCOP--excess nutrients from nonpoint sources. We chose the Patuxent River as our study area for three reasons. First, it is the largest watershed wholly contained in the state of Maryland; therefore, we had ready access to consistent nutrient discharge data and corresponding economic and policy-response data for each county in Maryland. By keeping the analysis contained within a single state, we were able to evaluate conditions in the entire watershed while maintaining consistent state-level regulations and policies. Second, the Patuxent is among the most thoroughly-studied rivers in the Chesapeake Bay region; this increased the likelihood that information about causes of Patuxent problems would contribute to an existing body of information about effects to form the basis of some new decision-support tools. Third, the Patuxent River watershed is often viewed as a microcosm of the Chesapeake Bay watershed, including primarily upstream causes of nutrient problems and downstream effects. Therefore, useful research results generated here are likely to be applicable to other parts of the Bay and to the Bay overall.

We focused our research on new types of data (e.g., economic impacts on water quality and enforcement statistics) and new ways of presenting data to help show where economic decisions in the watershed are contributing the most and the least to nutrient problems in the river. We pulled together statistics and generated indicators that show where government activities are having the most and the least impacts on those decisions.

The questions posed in the 2004 Ocean Commission report are being asked throughout the Bay watershed and in the Patuxent River basin in particular. From an economic perspective, these questions can be interpreted to be: What incentives and disincentives are resulting in human behavior that results in nutrient discharges in this watershed? What additional data about human behavior and economic incentives and penalties might be collected to help understand and change those conditions and help Federal, state, and local governments coordinate and integrate related management strategies? What data exist to assess and compare the level and type of effort that governments are exerting now to influence private land and water use decisions? By how much does that level of effort need to increase to result in meaningful change? What data exist or could be collected to determine why current programs do not seem to be working, and what would need to change to make them work?

2.2 Regional Economic/Policy Context

The illustration below, titled "The Trouble with 'Soft' Environmental Strategies," is extracted from one of the project documents provided in Part 2 of this report, and summarizes the general economic perspective that forms the basis of the research that is presented here. From this perspective, a historical reliance on voluntary initiatives and other "soft" strategies rather than regulatory initiatives and other "hard" strategies is one cause of the problems facing the River. A logical collective strategy for solving the problems of the River is a three-step process:

1) Identify what land and water use decisions are contributing to River problems
2) Determine what incentives decision-makers have to continue contributing to River problems
3) Support policies that will change those incentives and result in different decisions

The Trouble with "Soft" Environmental Strategies

A "State of the Patuxent River" summit held in conjunction with the 2006 Patuxent River Appreciation Days (PRAD) festivities opened up with a bleak assessment of the declining health of the river by a prominent environmental scientist. This was followed by a series of presentations by representatives of various State and Federal resource agencies who not only concurred that the health of the river was declining, but emphasized that the situation is likely to get worse if the adverse effects of population growth in the watershed are not offset. Then, in closing comments, speaker after speaker asserted that the health of the regional economy is linked to the health of the Patuxent River, and advised concerned citizens in the audience that solutions will be found not by pointing fingers, but by working together to increase scientific knowledge about the river and improve public education and outreach programs, and by enlisting farmers, households, and businesses to voluntarily sacrifice for the sake of the river and our descendents.

At the conclusion of the summit, former state-senator Bernie Fowler, a longtime champion of the river, issued an enthusiastic "call to arms." He emphasized that "drastic steps need to be taken" and that they should be taken because "if we fail in the Patuxent, we'll fail in the Bay, and if we fail in the Bay, we'll fail internationally."

A few weeks later, more than thirty candidates for state and county public offices, including then-Maryland Governor Ehrlich, took part in a "Meet the Candidates" forum in southern Maryland, where the Patuxent River is a particularly important part of the physical and cultural landscape. Each of the candidates was asked by the moderator how they would respond to Senator Fowler's much publicized "call to arms" if they were elected. One by one, they responded with the same assertions and recommendations that the resource agency representatives had presented at the summit.

All the candidates planned to support and encourage more research, education and outreach, more stakeholder involvement, more cooperation and less finger pointing; and they were all confident that we could find ways to get farmers, land developers, and others to voluntarily restrict their land and water-use decisions. Not one of them mentioned "harder" responses such as closing loopholes that developers use to get around environmental laws, beefing up monitoring or enforcement of land and water-use restrictions, or increasing penalties for violating environmental laws. None of them mentioned any intention of addressing the corrosive effects of the widespread and growing public sentiment that savvy people just do what they want and pay the fine if they get caught.

3. Research Approach

Most of the economic data that could be used to assess nutrient discharge decisions by various economic sectors (e.g., agricultural, industrial, residential) are available for each of the seven counties that make up the Patuxent River watershed. We determined early in our research that most government decisions regarding how to change land and water decisions by these sectors are made, or are at least implemented, at the county scale. For this reason, we decided to collect primarily county level data on: industrial and economic structure, nutrient discharges, population, economic growth and development, environmental spending, and environmental enforcement. EPA's Chesapeake Bay Program Office (CBPO) agreed to make special runs of its Patuxent River nutrient model to provide us with estimates of 2000 nutrient discharges into the river by source for each county in the Patuxent watershed.[2]

Our overall strategy was to collect and organize data in order to compare counties using two criteria. First, we assessed how much businesses and households in each county contributed to River problems in terms of nutrient discharges. Then, we assessed how much effort county governments were putting into activities to reduce those nutrient discharges.

By attempting an integrated county-level analysis of the economic contributions and nutrient discharges of various agricultural, industrial, and commercial sectors, and the county implementation of environmental policies for each county in the Patuxent watershed county, we hoped to achieve three goals:

1) Determine what data are available to conduct this type of analysis and what new data may be needed
2) Draw attention to the causes of nutrient problems in the watershed, including which economic sectors in which counties contribute most and least to the problem and which county governments contribute most and least to finding solutions
3) Contribute to a decision-support tool to help focus, manage, and assess the likely success of future county-level initiatives to reduce nutrient discharges into the river

With regard to water quality enforcement, we had three additional goals:

1) Determine if existing laws and regulations are sufficient to change human behavior.
2) Draw attention to the available information about whether they are being enforced with penalties that are meaningful enough to change behavior.
3) Determine if available data are useful for determining whether the level of county effort put into a blend of preventative and reactionary strategies is adequate to achieve water quality goals given the economic incentives that exist to violate land and water use restrictions.[3]

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[2] Chesapeake Bay Program. Phase 5 model draft, August 2006.

[3] Preventative strategies include permitting activities as well as direct investments in activities taken outside an enforcement context, such as technical assistance and community outreach. Reactive strategies include monitoring and enforcing regulatory compliance, citing and prosecuting violators, imposing stop work orders and fines, requiring removal of unpermitted structures, and so on. A government agency's roles can be divided into two categories: *providing services* (such as technical and compliance assistance) and *imposing obligations* (enforcement) (Sparrow 2000). As we initiated our interviews it became apparent that a county's level of effort or effectiveness in

3.1 Methodology

3.1.1 County Contributions to the Problem

Based on detailed breakdowns of nutrient discharges by source (e.g., point source, septic, wastewater treatment facilities, etc.) and related nutrient discharge statistics of land types and land use, we estimated county nutrient discharges by economic sector (e.g., agriculture, industry, service, commercial, households). For each non-household sector we then determined how each sector contributed to a county's economy (e.g., jobs, household income, taxes, etc.), and then combined the results to show economic impact/water quality tradeoffs related to economic sectors in each county. This also allowed us to develop sets of economic tradeoff coefficients (e.g., pounds of nutrient discharges per job created or per dollar of household income generated) for each sector in each county and to develop relative indicators for making comparisons across sectors and across counties.

The result was an integrated economic/environmental data set that provides:

1) Indicators of the relative contribution of each county to Patuxent nutrient discharges
2) Indicators of the relative contributions of particular economic sectors within each county
3) Indicators of the economic contributions that are associated with the discharge of nutrients by various economic sectors in various counties

A few examples of the many different types of descriptive statistics and indicators we developed will illustrate how they can be used to make comparisons across counties and economic sectors to help focus attention on the causes of nutrient problems in the River and the economic cost of addressing these problems.

- For the watershed in general, the agricultural sector accounts for 30% of nutrient discharges to the River, but less than 0.3% of the region's economic production.
- The combined nutrient discharges into the river from two counties, Prince George's County's (27%) and Howard County's (23%), are roughly equal to the discharges from the other five counties combined in the watershed.

3.1.2 Basis of County Enforcement Economic Assessments

Table 1 lists the alternative forms of collective action that government institutions can undertake to influence private decision-making regarding nutrient discharges. The important question, however, is not whether any of these tools are being used, but whether they are being used effectively. Regulations that are on the books but are not being enforced, or are associated with penalties that are too low or easily avoided, for example, may have virtually no effect on private decision making.

While it is not possible to compare counties in terms of the political will to implement and enforce discharge restrictions, it is possible to compare them in terms of the apparent level of

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controlling nutrient discharges cannot be measured solely by enforcement statistics or by the level of fines assessed to polluters, or by how many polluters are put in jail.

effort they use to detect violators of discharge or land use restrictions, and whether they cite and fine or prosecute violators, and whether they impose meaningful penalties.

Table 1. Environmental Policy Alternatives

Voluntary Programs	
Public Outreach/Education	▪ Inform households and businesses about the adverse effects of nutrients on the Bay ecosystem.
Promote Community Action	▪ Support formation of community organizations/programs to undertake projects/activities.
Public Information Systems	▪ Public disclosure of individuals and businesses contributing to nutrient problems.
Direct Regulation	
Engineering Standards	▪ Regulate technologies (e.g. wastewater treatment methods) to reduce nutrient discharges.
Performance Standards	▪ Require entities to operate in certain ways or only at certain times or require certain emission/output ratios.
Quantity Limits	▪ Establish overall discharge caps and assign allowances to specific dischargers.
Ambient Standards	▪ Require a standard level of water quality that must be met in receiving water (e.g., adjacent to a discharge point).
Prohibitions	▪ Preclude certain activities at certain times or the use of certain inputs (e.g., fertilizers) or prevent activities within certain areas (e.g., critical area designation).
Economic Incentives	
Emission Charges	▪ Taxes on all discharges or fines on discharges above a specified allowance.
WQ Degradation Charges	▪ Taxes or penalties based on contribution of discharge to water quality problems.
Product Charges	▪ Tax applied to products used in a polluting activity (e.g., fertilizer tax) or to products that result from polluting activity (e.g., farm products).
Tax-Subsidy Systems	▪ Taxes collected from some discharge sources are used to subsidize reductions in discharges by other sources (e.g., Connecticut 'trading' program).
User Fee-Subsidy Systems	▪ Fees collected from water/sewer/septic users are used to subsidize wastewater treatment (e.g., Maryland "Flush Tax").
Tradable Credits/Offsets	▪ Set overall cap, allocate to sources, require sources to meet allowance or purchase credits/offsets from others who reduce discharges below their allowance level.
Other Tools	
Assurance/Insurance	▪ E.g., guaranteed yield/income per acre on no-till or low fertilizer acreage will match expected levels from tilled or high fertilizer acreage.
Strict Liability	▪ Dischargers are collectively held fully liable for downstream environmental and economic damages caused by nutrients.

We then examined what each county is doing to address the problem of nutrient discharges into the Patuxent River using the logic of what we are calling "the economics of environmental enforcement."[4] Using this economic model, land and water users are assumed to engage in some informal (mental) or perhaps formal (calculated) benefit-cost assessment when deciding whether or not to comply with laws that limit nutrient discharges, land use, or land conversions.

As part of that assessment they compare the expected economic payoff from not complying with an environmental law (e.g., construction cost savings or increase in real estate value or both) with the expected cost of not complying, which is based on the following factors:

P_d = probability of a violation being detected

[4] For an overview of how "environmental enforcement economics" applies to nutrient discharge problems in the Chesapeake Bay area see King (2004).

P_{se} = probability of an enforcement action, given detection
P_p = probability of prosecution, given enforcement action
P_c = probability of conviction, given prosecution
P = dollar penalty if convicted
R = discount rate
T = time between initial detection and payment of penalty

The expected cost of not complying (CNC) can be significantly lower than the stated dollar penalty if convicted (P) and can be expressed by the following equation:

$$\text{CNC=cost of not complying} = (P_d \times P_{se} \times P_p \times P_c \times P)/(1 + r)^t$$

For example, consider the case where a developer or home owner is considering ignoring a wetland or critical area use restriction that will increase the value of his property by $10,000, and assesses the possibility of having to pay a $20,000 fine for the violation as follows:

- 50% probability that a violation will be detected
- 50% probability of an enforcement action, if the violation is detected
- 50% probability of prosecution, if there is an enforcement action for a detected violation
- 50% probability of conviction, if the detected violation is prosecuted

The expected cost of not complying is assessed at $1,250 or (.50 x .50 x .50 x .50 x $20,000), which results in an expected value, or payoff, of not complying of $8,750. If the individual can expect a delay between initial detection and payment of penalty, the expected cost of not complying could be discounted further to under $1,000, and the expected economic payoff from not complying is even higher.[5]

Time and budget limitations prevented us from attempting to estimate the above equation for any particular class of nutrient discharger in the Patuxent watershed. Instead, we examined the resources that each county is applying to environmental compliance and compared them to the numbers of permits issued. In addition we used that information to make other comparisons that can be used to infer the probability of a violation occurring and being detected within each county. We examined overall county budgets and staffing levels associated with environmental programs, reviewed enforcement statistics, and interviewed enforcement personnel to assess county enforcement efforts. We further attempted to find indicators of the probability of an enforcement action taking place, the size of penalties, and the extent to which penalties might affect behavior, and so on.

Although we chose the county as the appropriate level of analysis for this research, State and Federal government agencies are also involved in both preventative and reactive efforts at the county scale. As a result, our study also included collecting and analyzing data from the following State and Federal sources:

[5] For applications of this approach in other contexts, see Sutinen 1987 (fisheries), Akalla 2004, and Akalla and Cannon 2004 (biodiversity protection).

- The watershed's seven Soil Conservation Districts (whose boundaries are the same as those of the seven counties), which provide technical assistance to farmers (and to varying degrees, urban developers)
- The Maryland Department of Agriculture, which tracks compliance with required nutrient management plans and the State's "green payment" programs for agricultural best management practices, as well as the U.S. Department of Agriculture for Federal green payment programs
- The Maryland Department of the Environment, which delegates enforcement of certain state environmental laws to most of the Patuxent counties
- The Maryland Department of Natural Resources, which houses the Critical Areas Commission
- The U.S. Environmental Protection Agency, for compliance with water discharge permits under the National Pollutant Discharge Elimination System (NPDES)

Besides collecting enforcement/compliance data from county governments and from the organizations listed above, we also conducted face-to-face interviews with more than 20 individuals, including staff involved in enforcement and/or planning/zoning in Patuxent watershed counties, the manager of each of the seven Soil Conservation Districts in the watershed, several private lawyers, county committee members, and other individuals at the state and local level who are knowledgeable about environmental enforcement in the watershed. We ensured anonymity to all those interviewed for this project.

4. Watershed and County Economic and Nutrient Discharge Profiles

4.1 Watershed Overview

The seven counties that fall within the 886-square mile Patuxent River are shown in Figure 1. The geographic size of these counties and the percent of county land that is in the Patuxent watershed differ significantly. The economic base of each county and how individual economic sectors affect the county's contributions to Patuxent River water quality problems also differ significantly in ways that will be described in this section.

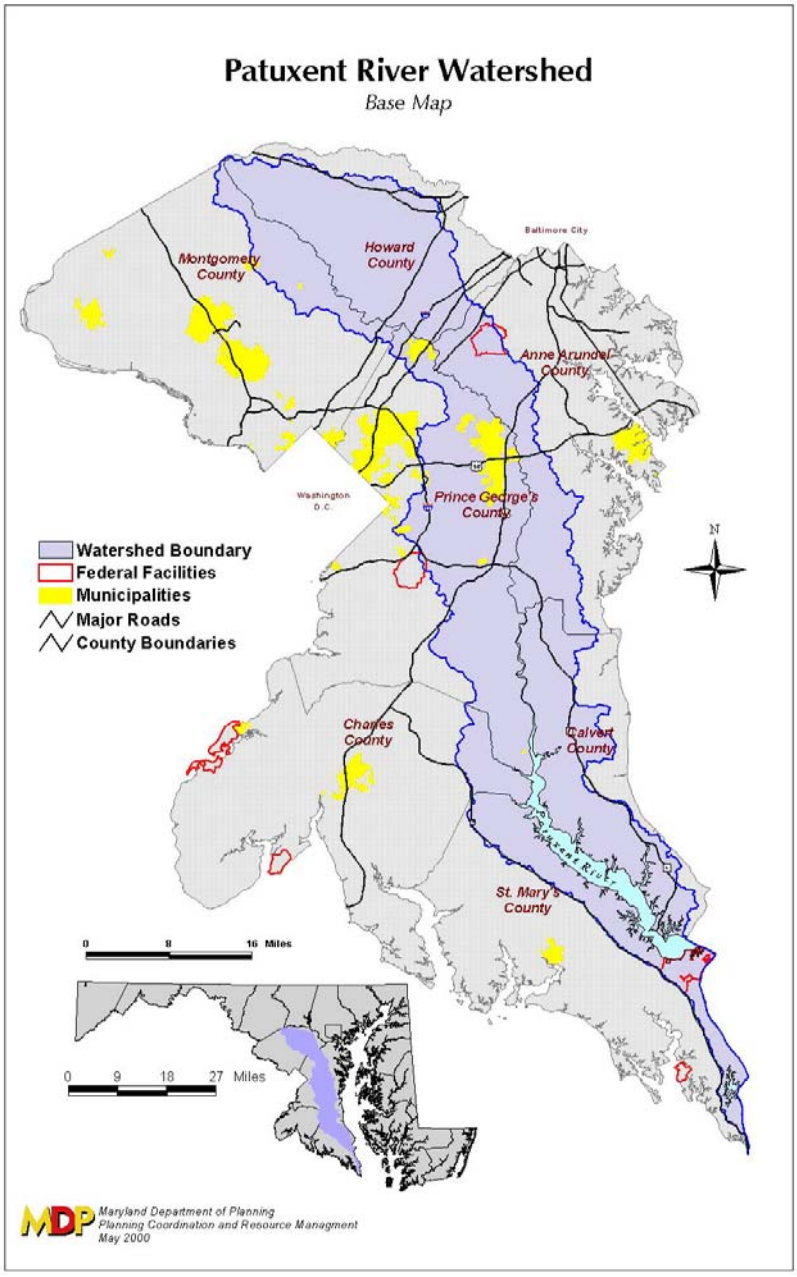


Figure 1. Map of Patuxent River Watershed. (Source: EPA BASINS Data Set)

The differences in county industrial and household characteristics, along with differences in the amount of county land in the Patuxent River watershed, explain some of the differences in the amount of nutrients that each county discharges into the Patuxent. However, differences in nutrient deliveries among counties also depend on what actions are undertaken within each county in attempts to reduce nutrient discharges.

4.2 County economic and nutrient discharge tradeoffs

We collected statistics related to economic impacts and nutrient contributions of specific economic sectors in each county in the Patuxent River watershed. To facilitate the assessment of economic/environmental tradeoffs, we present both sets of statistics in the same table for each county. We also generated some ratios that may help clarify some tradeoffs. These include estimates of the pounds of nutrient discharges per thousand dollars of household income and taxes generated and per full-time job created.

We obtained IMPLAN estimates of dollar output and related economic activities for each of the seven counties in the watershed. To estimate what portion was generated in the Patuxent watershed portion of each county, we used county and watershed land-use data obtained from Maryland Department of Planning. These data provided us with acreages (totals for each county, and for the portion in the Patuxent watershed) for developed, residential/other, commercial/industrial, extractive, forest, pasture, row crop, and feeding operations, which we then assigned to corresponding economic sectors in IMPLAN. For example, if 30% of industrial acres for a particular county are in the Patuxent watershed portion of the county, then we assumed that 30% of industrial output for the county is also within the watershed.

Combined economic/nutrient discharge statistics for the Patuxent watershed overall (all counties) for the year 2004 are presented in Tables 2a and 2b, and are described in the following section. Identical tables for each of the seven counties that make up the Patuxent watershed are included in Appendix A.

4.2.1 Overall Patuxent Watershed Profile (All Counties)

4.2.1.1 Table 2a: Direct Economic and Environmental Impacts

Each row of Table 2a provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Column 1, Total $ output, presents the total dollar output (sales) by each industrial sector in all counties that are located at least partially within the Patuxent River watershed. For example, oilseed farming output in those counties during 2004 is shown to be worth $16.3 million and total dollar output by all sectors in those counties is shown to be $210.9 billion.

Column 2, $ output based in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the Patuxent watershed. Of the $16.3 million in total oilseed farm output in counties that make up the Patuxent River watershed, for example, only $5.5 million are shown to have been produced by farms located within the watershed. Of the $210.9 billion in total

county output for these seven counties with land in the Patuxent watershed, only $47.8 billion or 22.7% was produced within the watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 5).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

4.2.1.2 Table 2b: Multiplier Economic Impacts and Nutrient Discharges

Each row of Table 2b provides statistics related to the industrial sectors listed along the row headings (e.g., grain farming, mining). Non-industrial sources of nutrient discharges are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Columns 1 - 3 are the same as in Table 2a and are provided for reference purposes. The rest of the columns in Table 2b are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Not surprisingly, the contribution to nutrient problems per unit of economic impacts are significantly higher for resource-dependent industrial sectors, especially agriculture, than for manufacturing, service, commercial, or mining sectors. Note, however, that the nutrient-related cost of achieving county economic goals is not the same for all agricultural sectors.

Table 2a: 2004 Direct economic impacts and nutrient discharges by sectors within the Patuxent River for all watershed counties

Sector	Watershed Direct Impacts: Total $Output All Counties, All Areas [a]	Watershed Direct Impacts: $ Output Based in Watershed - All Counties [a]	Watershed Direct Impacts: Nutrient Discharges to Patuxent River- All Counties (pounds) [b]	Watershed Impacts: Direct Economic Impacts of Business Activity in the Watershed [c]: $ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Watershed Impacts: Pounds of Nutrient to Patuxent River per Direct Economic Impact: Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 3,609,432	$ 134,276	117	120,692	3,244,284	3,720
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 4,502,316	$ 159,475	262	136,234	3,846,178	2,338
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 4,744,374	$ 63,897	57	105,761	7,852,768	8,848
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,088,213	$ 47,940	26	128,948	2,927,076	5,335
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 42,053,414	$ 746,844	735	2,870	161,604	164
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 561,920	$ 14,903	13	130,476	4,919,674	5,458
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 3,209,667	$ 122,345	41	124,545	3,267,398	9,783
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 864,036	$ 165,495	85	205,321	1,071,967	2,086
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 125,456	$ 593	3	58,881	12,459,715	2,754
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 621,582	$ 124,389	214	63,484	317,234	184
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,505,102	$ 47,848	24	14,100	443,528	877
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 165,923	$ 21,379	1	39,267	304,756	6,788
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 6,101,677	$ 1,251,644	195	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 3,040,306	$ 50,827	206	135	8,083	2
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 49,528,893	$ 4,195,493	747	295	3,478	20
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,971,983,527	$ 203,181,273	20,242	138	1,335	13
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 2,810,489,281	$ 37,938,031	42,951	123	9,079	8
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,328,160,396	$ 30,309,364	13,585	174	7,641	17
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 3,650,308,651	$ 989,264,820	68,071	96	356	5
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 2,676,006,054	$ 333,679,883	23,967	88	703	10
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 8,226,939,668	$ 302,998,757	167,752	96	2,596	5
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 4,570,985,504	$ 293,540,534	22,567	69	1,076	14
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 2,549,742,157	$ 73,934	43,986	63	2,160,875	4
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**	**$ 27,906,337,550**	**$ 2,198,133,945**	**405,848**			
Other Sectors									
Point Source (Household Only) [e]			1,679,037						
Septic (Household Only)			536,799						
Atmospheric (All Sources)			602,601						
Undeveloped Land									
Natural Grasses			41,210						
Forest			385,673						
Total Estimated Nutrient Discharge into the Patuxent			**8,493,234**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 2b: Multiplier economic impacts and Patuxent River impacts by sector for all watershed counties

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

	Watershed Direct Impacts			Watershed Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Business Impact [c]			
Sector	Total $ Output All Counties, All Areas [a]	$ Output Based in Watershed - All Counties [a]	Nutrient Discharges to Patuxent River - All Counties (pounds) [b]	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 1,426,511	$ 887,223	$ 45,569	26	18,698	30,064	585,342	1,029
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 1,438,215	$ 814,074	$ 41,764	37	22,257	39,320	766,442	861
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 1,452,164	$ 1,020,768	$ 33,089	13	23,662	33,662	1,038,433	2,584
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,479,158	$ 857,737	$ 49,519	18	18,845	32,498	562,916	1,509
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 1,602,949	$ 1,079,360	$ 43,092	17	614	912	22,844	58
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 1,406,118	$ 992,033	$ 40,572	22	18,675	26,471	647,237	1,214
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 1,467,742	$ 837,669	$ 44,668	11	19,994	35,033	656,977	2,587
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 1,461,891	$ 377,678	$ 49,013	18	6,930	26,823	206,689	571
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 1,536,309	$ 773,579	$ 27,731	13	7,187	14,274	398,174	881
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 1,560,852	$ 380,874	$ 45,696	36	1,416	5,803	48,364	61
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,425,268	$ 487,188	$ 27,175	8	553	1,619	29,024	100
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 1,291,858	$ 402,706	$ 44,845	6	1,069	3,428	30,787	250
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 2,394,679	$ 1,245,266	$ 114,871	51	0	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 1,961,947	$ 1,093,168	$ 54,353	44	8	13	271	0
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 1,679,901	$ 746,458	$ 53,943	10	29	65	897	5
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,720,099	$ 911,521	$ 89,045	9	6	11	110	1
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 1,915,087	$ 1,023,337	$ 55,216	16	10	18	337	1
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,809,730	$ 747,636	$ 43,959	9	7	18	302	1
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 1,835,039	$ 1,001,929	$ 184,334	17	8	15	83	1
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 1,683,902	$ 968,580	$ 106,793	11	6	10	90	1
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 1,967,218	$ 1,145,064	$ 68,579	20	6	11	186	1
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 1,691,162	$ 1,287,597	$ 79,146	11	7	9	141	1
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 1,878,615	$ 1,461,964	$ 43,615	24	9	11	381	1
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**								
Other Sectors											
Point Source (Household Only) [e]			1,679,037								
Septic (Household Only)			536,799								
Atmospheric (All Sources)			602,601								
Undeveloped Land											
Natural Grasses			41,210								
Forest			385,673								
Total Estimated Nutrient Discharge into the Patuxent			**8,493,234**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

4.2.2 County-Level Profiles and Comparisons

Appendix A presents tables comparable to Tables 2a and 2b for each of the seven counties that make up the Patuxent River watershed. The numbers presented for different counties provide a basis for comparing the economic cost of nutrient discharge reduction strategies across counties as well as across industrial sectors.

In section 4.3, for example, we outline the contribution of each county to Patuxent River edge-of-stream nutrient discharges. According to Chesapeake Bay Program nutrient modeling, Prince George's County has the highest nutrient discharge of the seven counties, with 27% of the overall amount to the river. This is not unexpected because Prince George's also leads Patuxent counties in terms of the size of population in the watershed (approximately 40% of the watershed total) and acreage in the watershed (approximately 28% of the overall watershed acreage).

In section 5, we examine what counties are doing to address the problem of nutrient discharges. For example, we found that spending on environmental enforcement by Prince George's County lags behind other jurisdictions, with enforcement spending as a percentage of overall county budget ranking sixth among watershed counties, and fourth on a per capita basis. Each county's situation is different, however, and no single indicator presents a full picture of what a county might be implementing. Prince George's, although second in total county population and population density, spends the most among Patuxent counties on sewer, solid waste, and water management on a per capita basis and percentage-of-county-budget basis.

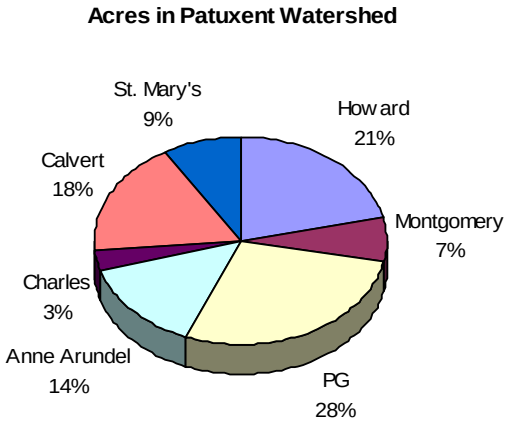
4.3 Patuxent Watershed Economy, Land Uses, and Nutrient Discharges

This section provides an overview of the watershed and the economic sectors within each of the seven counties that make up the watershed. It also presents a profile of how various economic sectors within each county in the watershed contribute to Patuxent River water quality problems.

The watershed can be roughly divided into the four relatively densely populated counties to the north (Montgomery, Prince George's, Anne Arundel, and Howard, in order of both population and population density) and the three less populated counties to the south (Charles, St. Mary's, Calvert in order of population; Calvert, Charles, St. Mary's, in order of population density).

Based on an analysis of US Census Bureau data for 2000, Montgomery County has the highest per capita income in the watershed ($52,854); St. Mary's ($31,140) and Prince George's ($31,936) have the lowest.

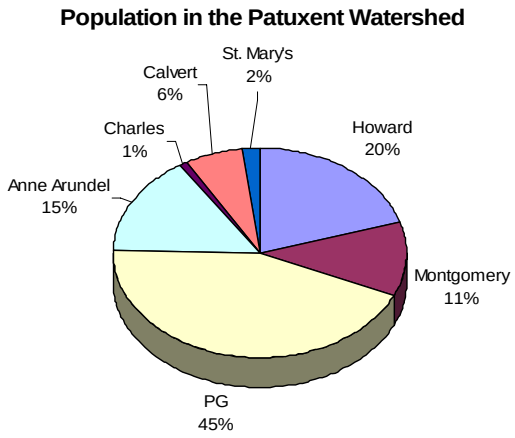
Prince George's County has the most land in the Patuxent watershed, with 242.2 square miles, followed by Howard (197.06 miles) and Calvert (154.3 miles). Charles has the least (28.58 miles) (see Figures 2 and 3).



Acres in the Patuxent Watershed	
Howard	120,759
Montgomery	38,827
Prince George's	158,680
Anne Arundel	79,699
Charles	18,127
Calvert	101,214
St. Mary's	48,531
TOTAL	**565,837**

Source: State of Maryland, Department of Planning

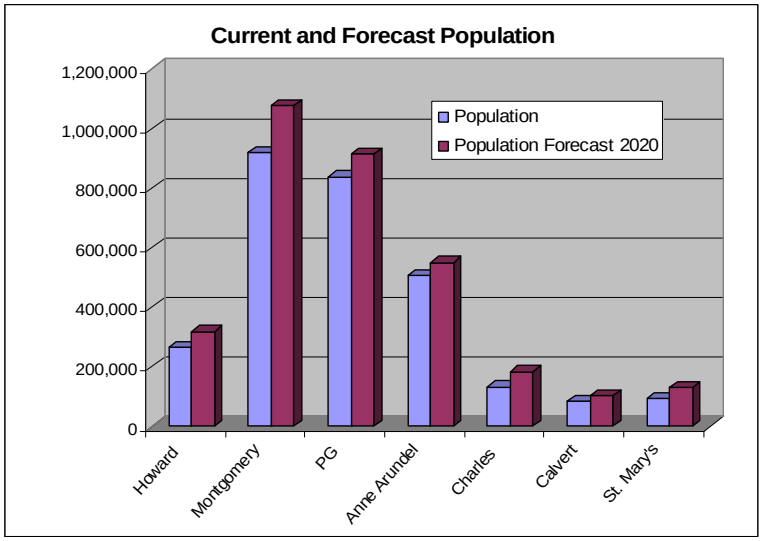
Figure 2. Percent of county acres within the Patuxent Watershed



Population in the Patuxent Watershed	
Howard	197,869
Montgomery	112,503
Prince George's	428,406
Anne Arundel	151,694
Charles	8,174
Calvert	61,811
St. Mary's	19,473
TOTAL	**979,930**

Source: State of Maryland, Department of Planning

Figure 3. Population for portion of counties in the Patuxent Watershed



Current and forecast population for watershed counties		
YEAR:	**2004**	**2020**
Howard	266,532	319,300
Montgomery	921,631	1,077,700
Prince George's	841,642	914,900
Anne Arundel	508,356	551,000
Charles	135,702	184,050
Calvert	86,293	101,950
St. Mary's	94,950	131,200
TOTAL	**2,693,674**	**3,280,100**

Source: State of Maryland, Department of Planning

Figure 4. Total current and forecast population of watershed counties.

The Patuxent watershed counties have experienced tremendous population growth in recent decades, with 537,600 new residents since 1990 (Maryland Department of Planning). Significant additional population growth is forecast for all of the Patuxent watershed counties

over the next 15 years (see Figures 4 and 5). In Section 5, we attempt to develop indicators that relate both past and future population growth to nutrient discharges and to county efforts to control those discharges.

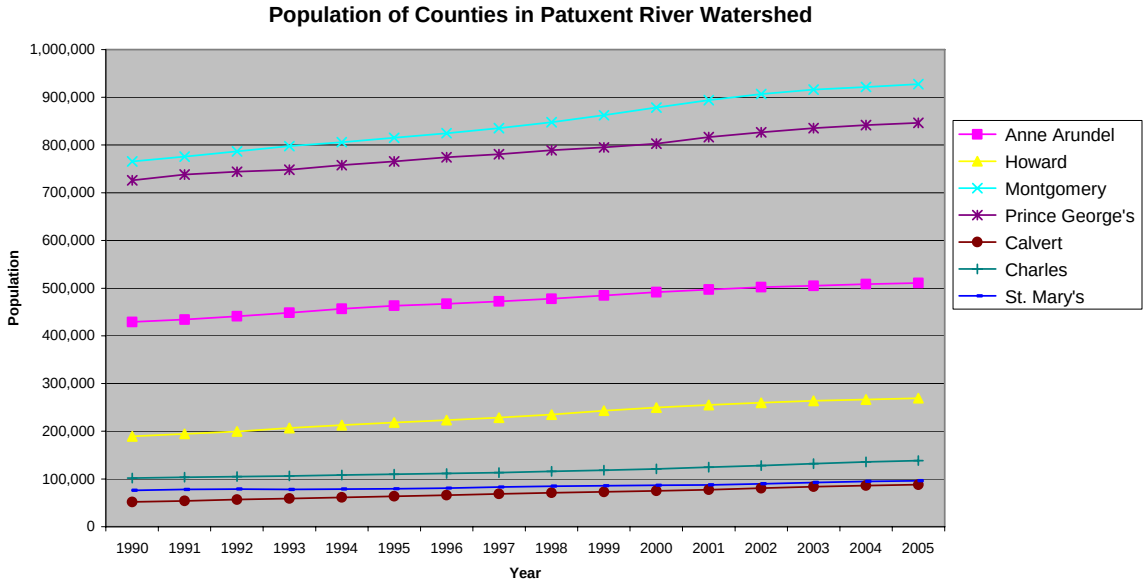
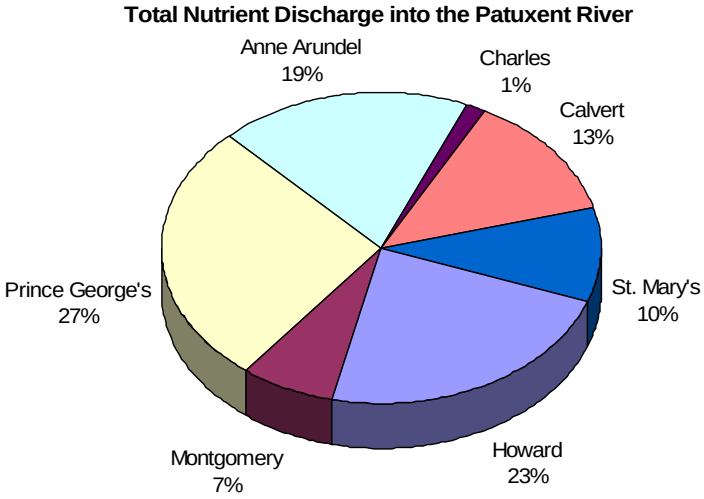


Figure 5. Total population of watershed counties, 1990 to 2005.
Source: State of Maryland, Department of Planning

4.3.1 Nutrient Discharges

Figure 6 illustrates the geographic sources of "edge of stream" nutrient discharges to the Patuxent River. County discharges roughly correspond to the amount of acreage a county has in the watershed, but as following sections show, the sources of nutrient discharges within counties and the economic contributions of industrial/agricultural sectors that are responsible for discharges differ significantly from county to county.



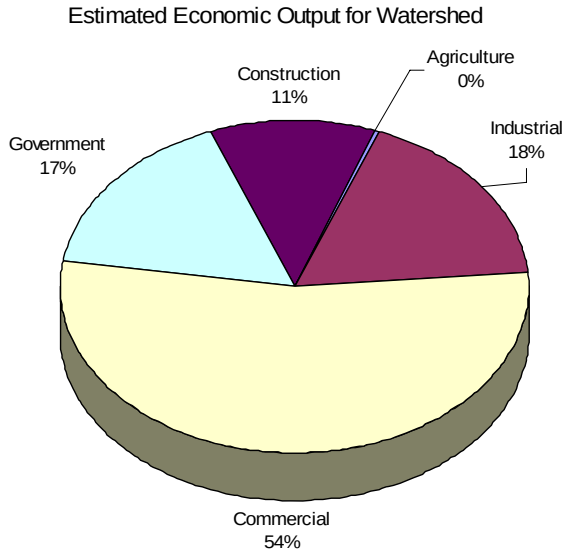
Total N-Equivalent Discharge into the Patuxent River (lbs.)	
Howard	1,952,457
Montgomery	598,372
Prince George's	2,304,495
Anne Arundel	1,582,774
Charles	126,693
Calvert	1,113,035
St. Mary's	815,408
TOTAL	**8,493,234**

Source: Chesapeake Bay Program Office, 2006

Figure 6. Total nutrient discharge into the Patuxent River by county.

4.3.2 The Patuxent Watershed Economy

We used county-scale regional economic impact models to characterize the economy of the Patuxent watershed and of the seven counties that make up the watershed.[6] Because of its location between the Washington and Baltimore metropolitan areas, the Patuxent watershed is characterized by a relatively large amount of commercial and government sector economic activity. As subsequent sections discussed, agriculture accounts for less than 0.5% of the economic output from the watershed region, even though it accounts for over 30% of nutrient discharges into the Patuxent River (Figures 7 and 8).

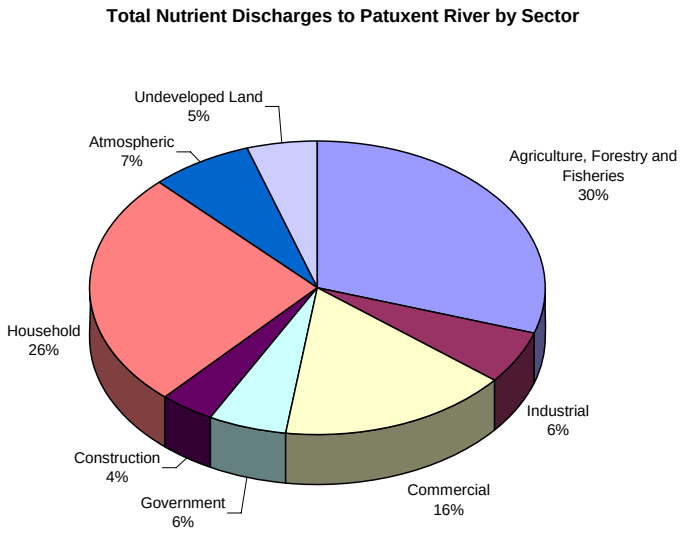


Estimated Economic Output for Watershed ($1,000's)		
Agriculture	$	130,062
Industrial		8,566,252
Commercial		25,678,212
Government		8,047,845
Construction		5,391,681
TOTAL		**47,814,052**

Source: 2004 IMPLAN regional economic model (See Appendix A)

Figure 7. Estimated economic output for portion of counties in the watershed by sector.

[6] The regional economic model we employed is called IMPLAN and is described in Appendix A. We obtained estimates from IMPLAN of dollar output and related economic activities for each of the seven counties in the watershed. To estimate what portion was generated in the Patuxent watershed portion of each county, we used county and watershed land use data obtained from Maryland Department of Planning for each watershed county. These data provided us with acreages (totals for each county, and for the portion in the Patuxent watershed) for developed, residential/other, commercial/ industrial, extractive, forest, pasture, row crop, and feeding operations, which we then assigned to corresponding economic sectors in IMPLAN. So, for example, if 30% of industrial acres for a particular county are in the Patuxent watershed portion of the county, we assumed that 30% of industrial output for the county is also from the Patuxent watershed portion of the county.



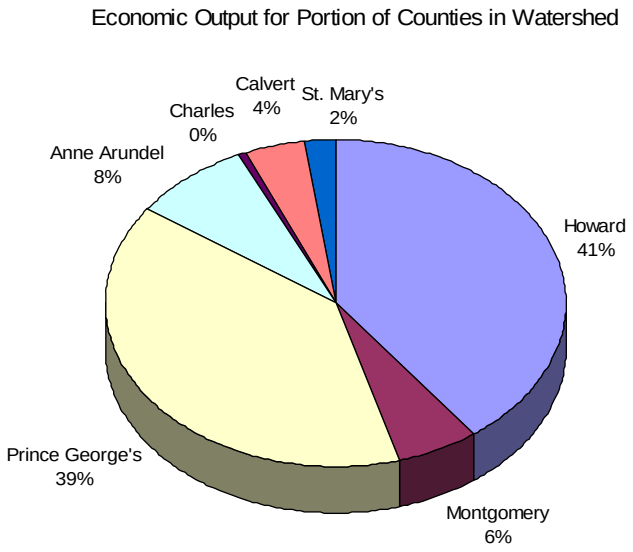
Total Nutrient Discharge to Patuxent River by Sector (lbs.)	
Agriculture	2,536,842
Industrial	517,332
Commercial	1,373,655
Government	475,643
Construction	344,443
Household (sewer/septic)	2,215,836
Atmospheric	602,601
Undeveloped Land	426,883
TOTAL	**8,493,235**

Source: Chesapeake Bay Program Office, 2006

Figure 8. Total nutrient discharges (in pounds) to the Patuxent River by sector (Source: Chesapeake Bay Program).

Within the Chesapeake region, the Patuxent watershed is somewhat unusual with respect to the prevailing mix of nutrient discharge sources. The watershed is characterized primarily by residential, commercial, and agricultural land uses, with relatively little heavy industry. Agriculture, which has received considerable attention as a source of nutrient runoff, is estimated to account for 30% of discharges in the Patuxent watershed (Chesapeake Bay Program). Bay-wide, agriculture accounts for 39% of nitrogen discharge and 46% of phosphorus discharge (Blankenship, 2007). Point sources, which include wastewater treatment plants (WWTPs), account for another 20% of discharges in the Patuxent watershed (Chesapeake Bay Program). Information provided by the Washington Suburban Sanitary Commission indicates that, for Western Branch WWTP, 90% of the discharge from wastewater treatment plants comes from residential sources, and the remainder from industry (Mosby 2006). Commercial land uses account for 16% of discharges and industrial sources contribute the remaining 6% as shown in Figure 7.

Figures 7 and 8 demonstrate that the nutrient discharges from a particular sector do not correlate at all with that sector's importance to the economy. This is most graphically illustrated in the case of agriculture, which leads in nutrient discharges but has a relatively small role for the economy. The commercial and governmental sectors generate far more economic benefits than agriculture in terms of economic output and jobs and generate far less in terms of direct nutrient discharges. However, the people employed in these sectors contribute to nutrient problems as household nutrient dischargers. These discharges are reflected in discharge figures related to sewers, septic systems, and atmospheric sources which are discussed elsewhere.



Economic Output for Portion of Counties in the Watershed	
Howard	18,928,833
Montgomery	2,886,015
Prince George's	18,629,357
Anne Arundel	4,056,901
Charles	204,680
Calvert	2,063,669
St. Mary's	1,044,598
TOTAL	**47,814,052**

Source: 2004 IMPLAN regional economic model (See Appendix A)

Figure 9. Economic output for portion of counties in watershed.

Section 4.3 summarizes what can be learned from county-level data regarding how various economic sectors contribute to both the economic health of each county and to the environmental health of the river. This section also shows what kinds of economic/ environmental tradeoffs county governments in the watershed can consider when targeting nutrient discharge reduction policies.

The following charts demonstrate the relative importance of economic sectors to each of the seven counties. In each of the seven counties, the pattern is similar in that agriculture does not drive the economy.

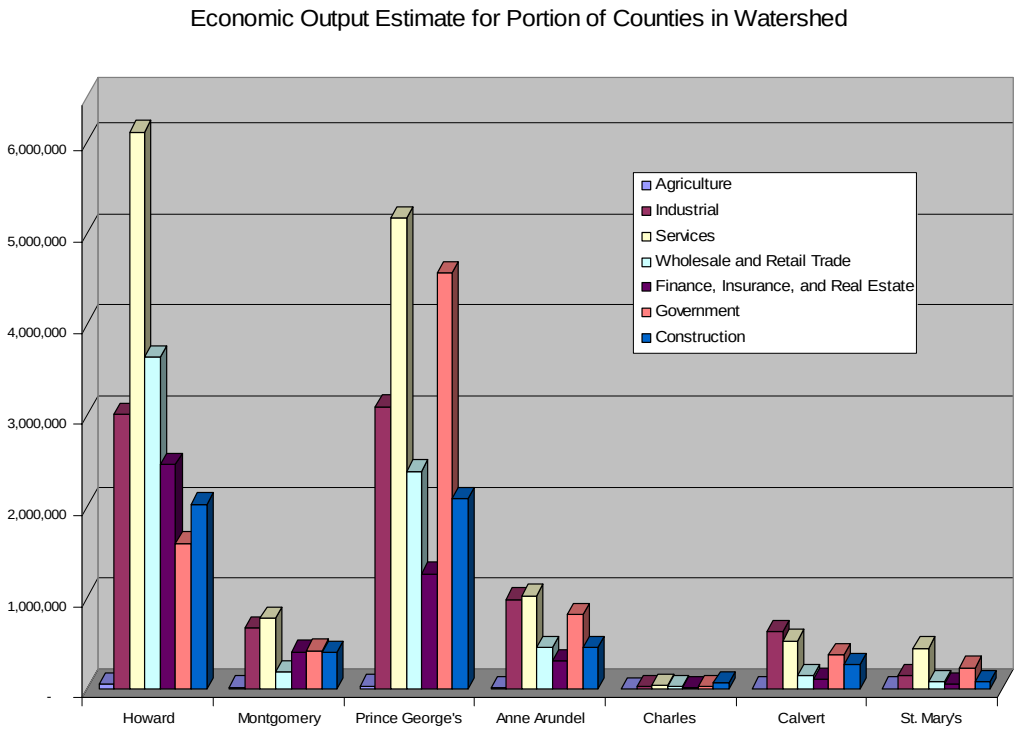
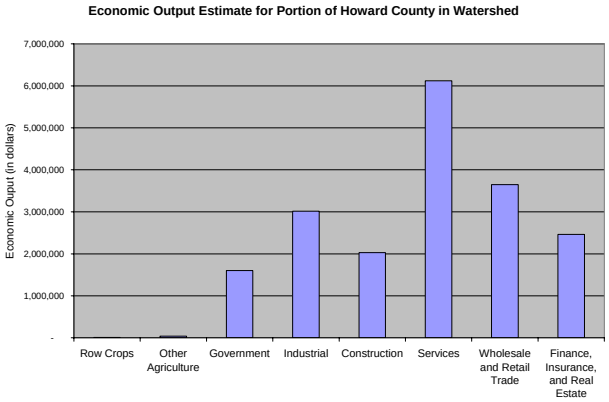
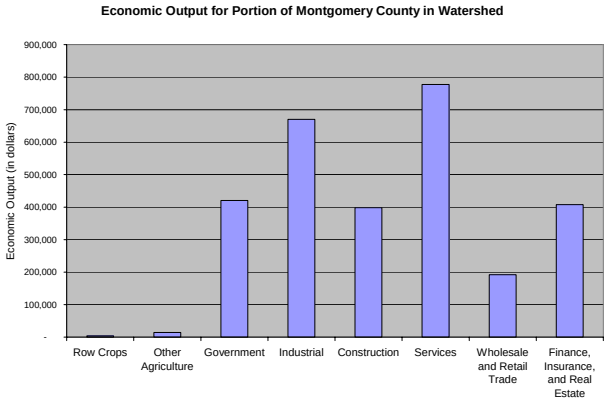
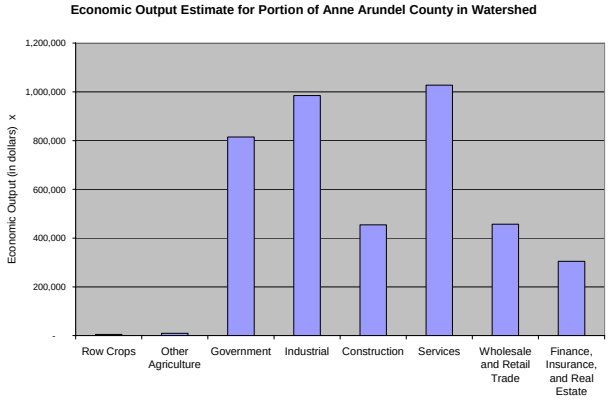
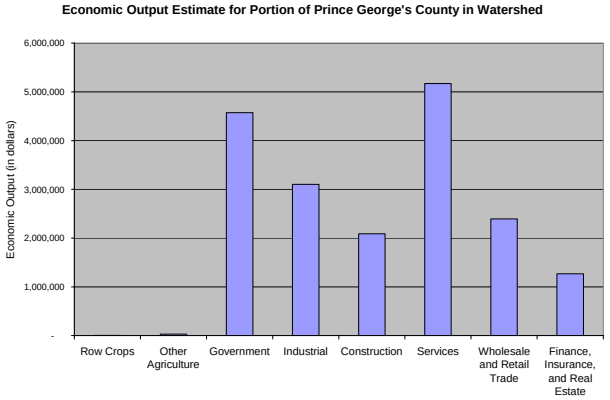


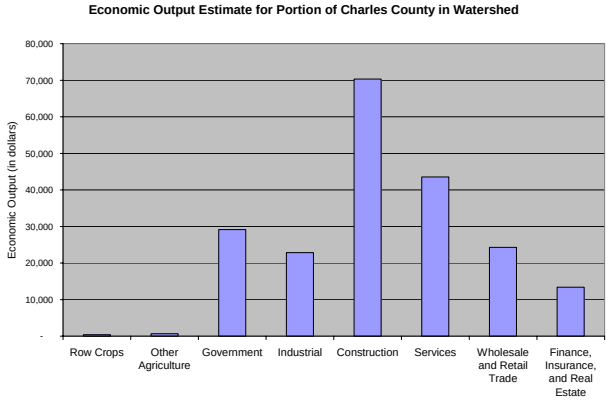
Figure 10. Estimated economic output for portion of counties in watershed
Source: 2004 IMPLAN regional economic model (See Appendix A)

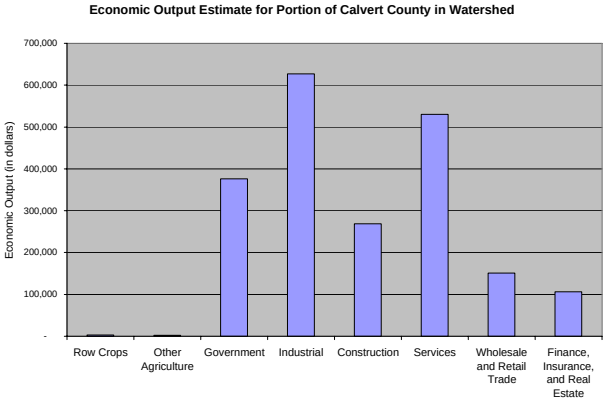


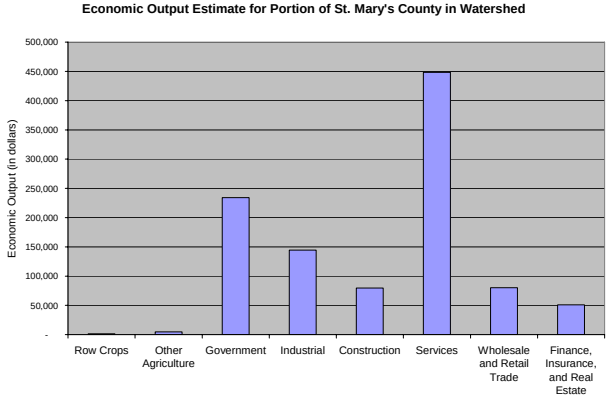












Figures 11a-g. Economic output estimate for portion of watershed counties located within the watershed.
Source: 2004 IMPLAN regional economic model (See Appendix A)

The following graphics illustrate the nutrient discharges from these aggregations of economic sectors in each of the seven counties in the Patuxent watershed. We combined nitrogen and phosphorus discharges into a single "nitrogen equivalent," assuming that one pound of phosphorus discharge is equivalent to five pounds of nitrogen discharge (Wang and Linker 2006). Charles and Montgomery, with the least acres in the watershed, contribute the least nutrients to the edge of the Patuxent. Households in Anne Arundel and Prince George's are among the most significant sources of nutrients to the River.

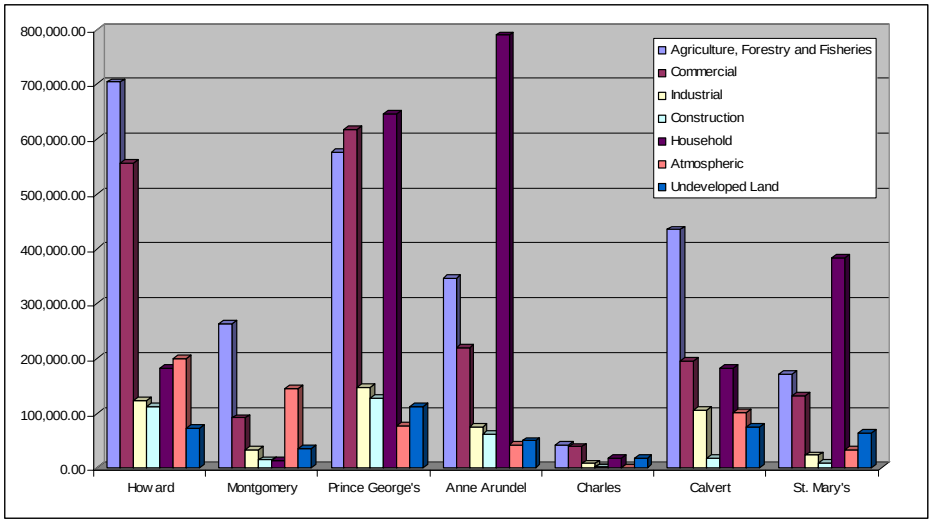
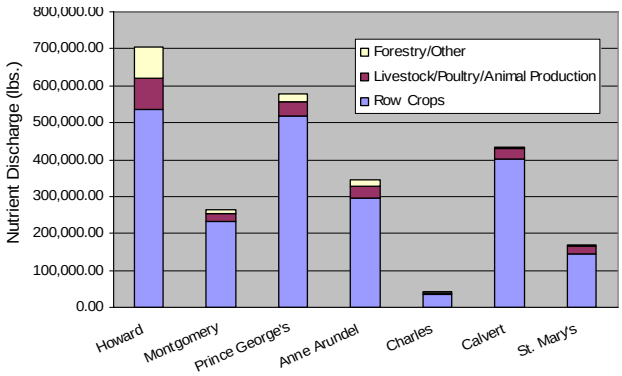


Figure 12. Nitrogen equivalent discharges into the Patuxent River by aggregated sectors within each watershed county (Source: Chesapeake Bay Program Office).
Source: Combination of IMPLAN economic data (See Appendix A) and nutrient discharge data from the Chesapeake Bay Program Office

Figure 13 provides a closer look at the total discharges from three sector aggregations included in the previous graph.

The bar chart illustrates the relative contributions of row crops, livestock/poultry, and forestry to the agricultural sector's nutrient discharges. Row crops in Howard and Prince George's counties contribute the most of any agricultural sectors to Patuxent River nutrient discharges.



Agriculture, Forestry and Fisheries Nutrient Discharge into the Patuxent River (lbs.)

County	Row Crops	Livestock, Poultry, Animal Production	Forestry/ Other
Howard	535,681	83,737	84,829
Montgomery	232,084	20,403	10,558
Prine George's	516,455	39,540	20,681
Anne Arundel	297,715	29,081	19,055
Charles	36,309	3,496	1,719
Calvert	400,791	27,746	6,326
St. Mary's	145,124	20,249	5,262
	2,164,159	**224,252**	**148,431**

Figure 13. Agriculture, forestry and fisheries N-equivalent nutrient discharge into the Patuxent River.
Source: Chesapeake Bay Program Office, 2006

4.3.3 Row Crop Nutrient Discharges

We examined the specific discharges from agricultural land under different types of management using the Chesapeake Bay Program data. The following figures and tables demonstrate the wide range in adoption rates and discharges.

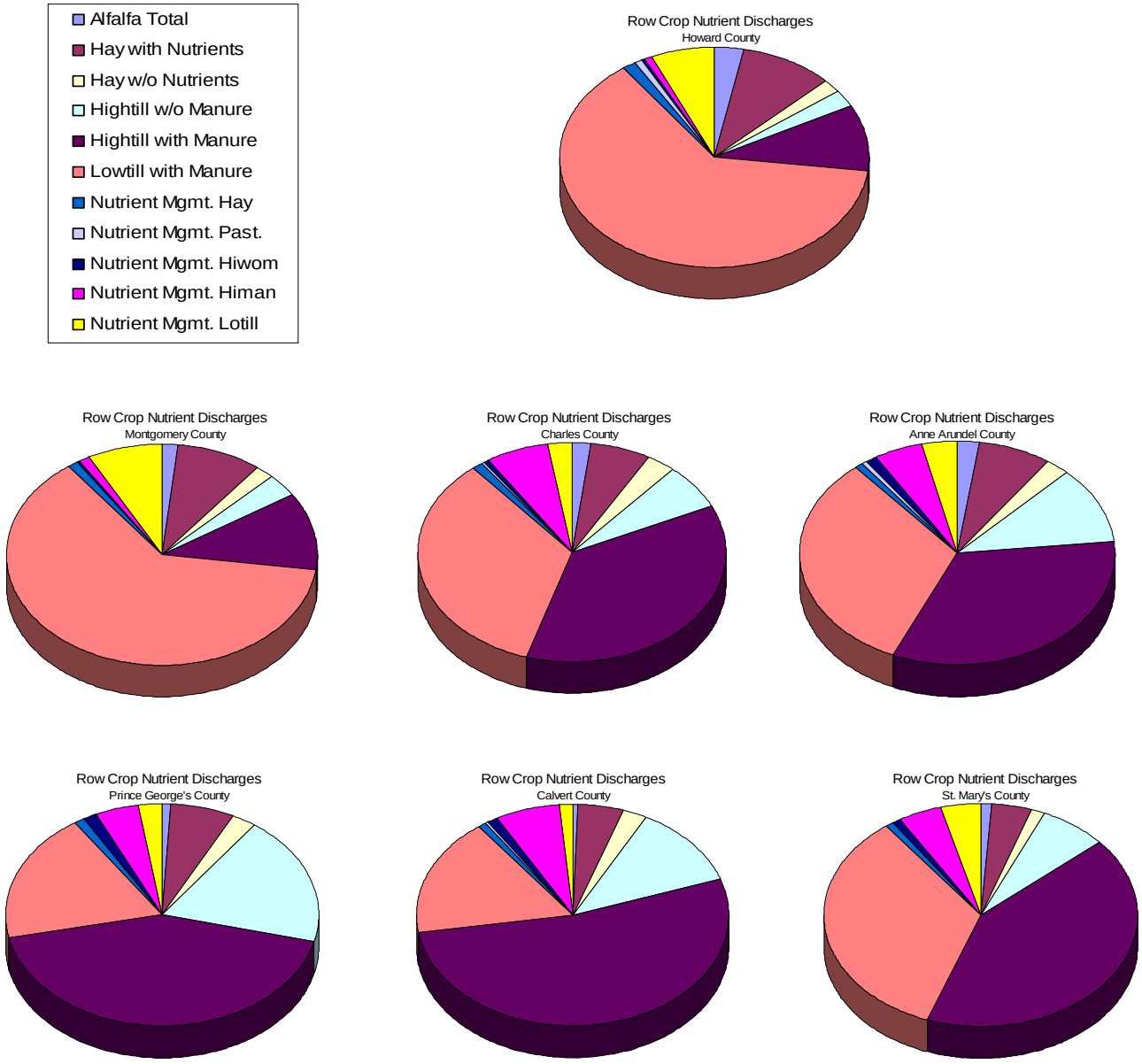


Figure 14. Nutrient discharges into the Patuxent River from row crop land uses. Figures represent percentage of nutrient discharge from row crops in that county that is derived from land using the specified management practice.
Source: Chesapeake Bay Program Office, 2006

Table 3: Row crop nutrient discharges (in lbs.) into the Patuxent River per county

N-Equivalent Discharge by Land Use within the Watershed:	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Land Use Total
Alfalfa Total	16,755	3,939	4,523	6,291	680	1,740	1,549	**35,478**
Hay with Nutrients	52,015	20,424	34,907	22,707	2,339	19,732	5,932	**158,055**
Hay w/o Nutrients	9,779	4,463	12,600	7,727	1,165	10,086	2,268	**48,087**
Hightill w/o Manure	14,095	7,763	97,821	32,369	2,379	47,752	10,101	**212,281**
Hightill with Manure	51,992	26,478	220,934	99,915	13,294	211,634	60,936	**685,183**
Lowtill with Manure	338,180	144,929	97,290	95,257	12,465	68,634	49,424	**806,178**
Nutrient Mgmt. Hay	7,136	2,673	5,093	3,042	390	2,986	1,037	**22,358**
Nutrient Mgmt. Past.	4,489	310	712	1,771	44	1,616	120	**9,061**
Nutrient Mgmt. Alfalfa	0	0	0	0	0	0	0	**0**
Nutrient Mgmt. Hightill w/o manure	1,129	652	7,162	2,714	251	4,259	1,195	**17,363**
Nutrient Mgmt. Hightill w/ manure	4,667	2,427	22,754	15,185	2,370	27,112	6,551	**81,066**
Nutrient Mgmt. Lotill	35,442	18,027	12,660	10,737	932	5,241	6,011	**89,050**
County Totals	**535,681**	**232,084**	**516,455**	**297,715**	**36,309**	**400,791**	**145,124**	**2,164,159**

Source: Chesapeake Bay Program Office, 2006

Table 4: Row crop nutrient discharges (in lbs.) into the Patuxent River per acre of county land in the watershed.

N-Equivalent Discharge per Acre within the Watershed:	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Land Use Mean
Alfalfa Total	16	17	17	14	18	6	18	15
Hay with Nutrients	15	16	14	13	13	15	14	14
Hay w/o Nutrients	6	6	5	5	5	4	5	5
Hightill w/o Manure	59	63	50	41	27	32	32	43
Hightill with Manure	51	59	47	41	39	41	47	47
Lowtill with Manure	39	46	29	33	32	30	35	35
Nutrient Mgmt. Hay	14	14	13	13	13	14	16	14
Nutrient Mgmt. Past.	9	2	2	7	2	5	2	4
Nutrient Mgmt. Alfalfa	0	0	0	0	0	0	0	0
Nutrient Mgmt. Hightill w/o manure	40	40	33	30	23	22	27	31
Nutrient Mgmt. Hightill w/ manure	43	49	43	40	34	34	40	41
Nutrient Mgmt. Lotill	31	38	24	28	24	24	27	28

Source: Chesapeake Bay Program Office, 2006

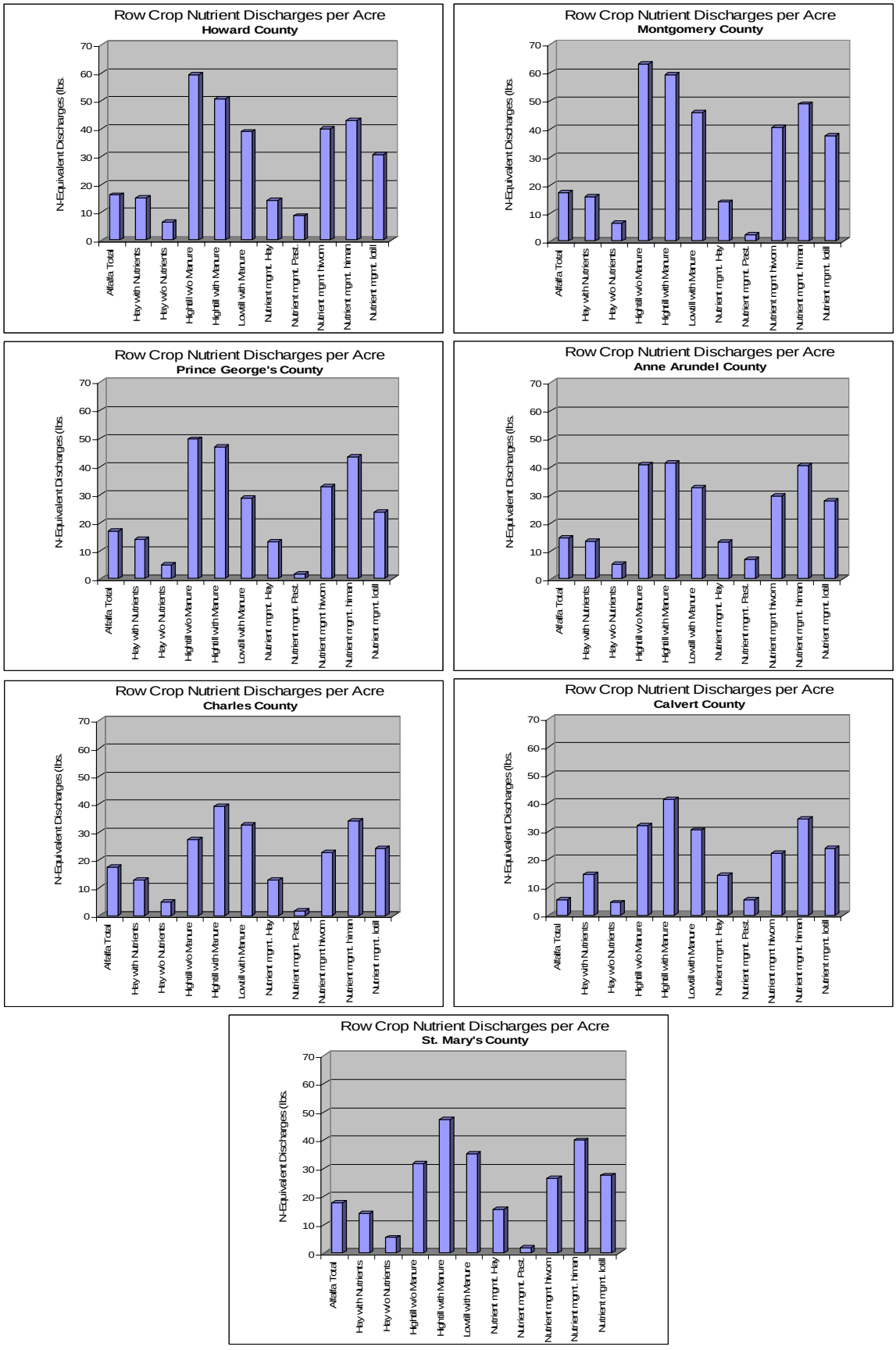


Figure 15. Nutrient discharges into the Patuxent River from row crop land uses per acre of county land
Source: Chesapeake Bay Program Office, 2006

The next figure illustrates the relative contribution of the industrial, commercial, and construction sectors to Patuxent River nutrient discharges. In this bar chart, government sectors are not included with the commercial sector.

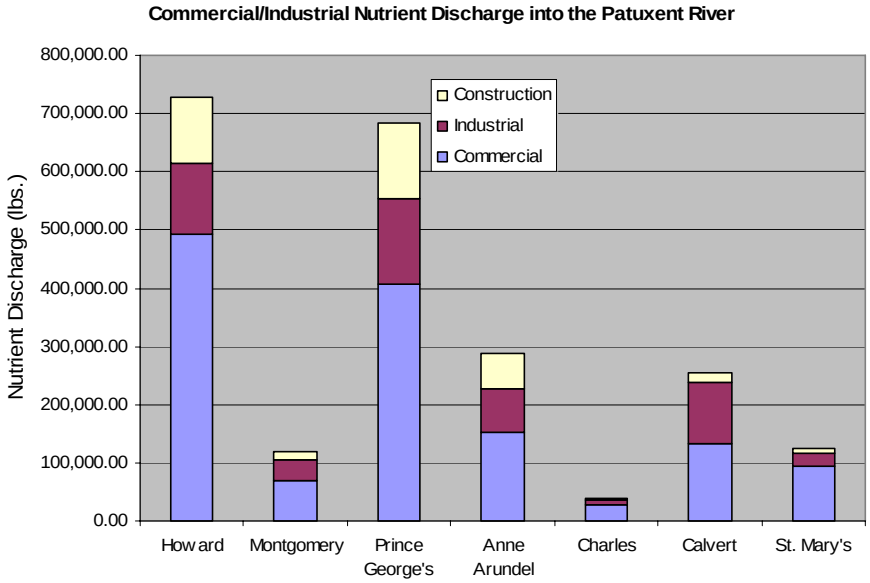


Figure 16. Commercial/industrial nutrient discharge into the Patuxent River.
Source: Combination of IMPLAN economic data (See Appendix A) and nutrient discharge data from the Chesapeake Bay Program Office

It is important to note that nutrient discharges allocated to a particular sector do not take into account household discharges. For example, the government sector accounts for a high percentage of Patuxent watershed economic output and jobs, but relatively low nutrient discharges. The household nutrient discharges from these workers are not accounted for in the economic input-output analysis. The following bar chart demonstrates the relative significance of household discharges from each county.

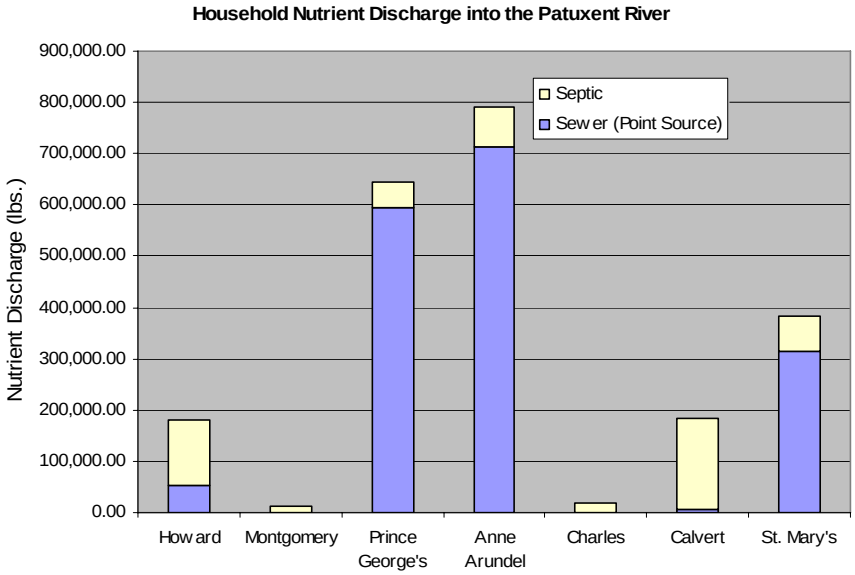


Figure 17. Household nutrient discharge into the Patuxent River.
Source: Chesapeake Bay Program Office, 2006

5. County Stewardship Indicators

This section provides what might be called county-scale river impact "stewardship" or "culpability" indicators. These indicators show, on an absolute and relative basis, how much money and how much effort (e.g., labor, equipment, and material) each county uses to implement and enforce compliance with Federal, state, and county laws, regulations, and ordinances that are intended to reduce nutrient discharges by various economic sectors.

We started by developing indicators to demonstrate trends in county growth and environmental spending (Figures 18-20). As one planning and zoning staff member interviewed for this study noted, "This county is slated for 40% growth (in the next generation), with a lot of that in the Patuxent watershed portion of the county. Pollution levels can only go up, given the population growth that is going to happen."

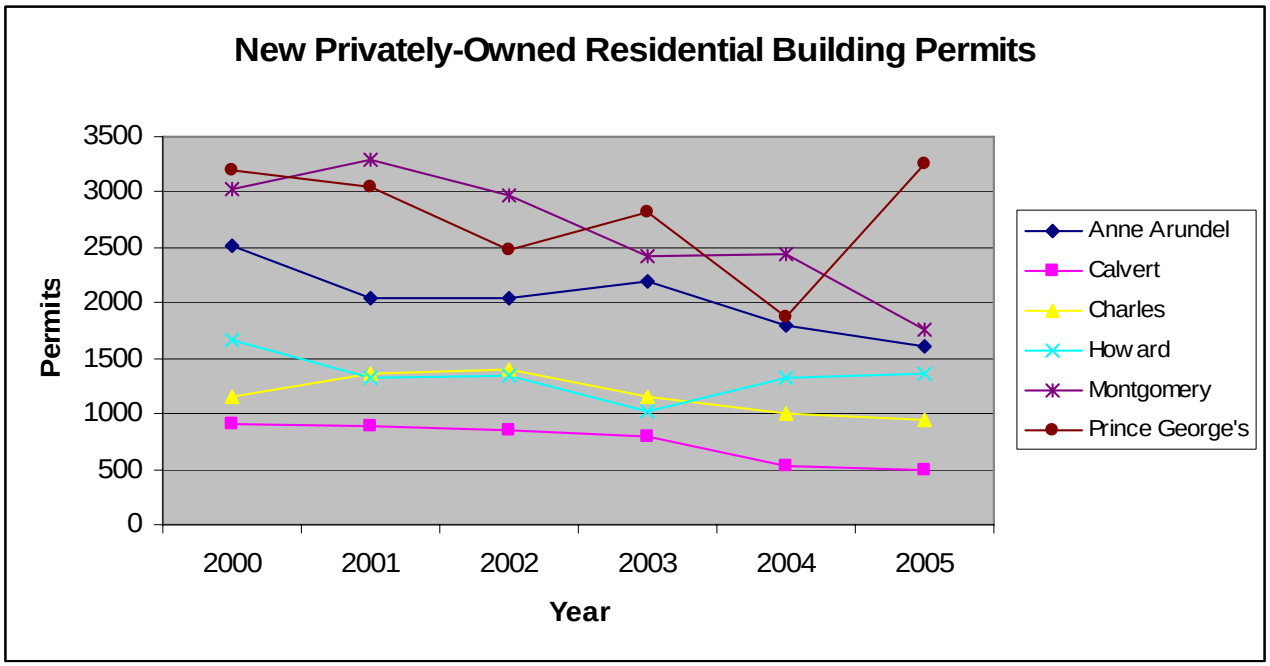


Figure 18. New privately-owned residential building permits
Source: State of Maryland, Department of Planning

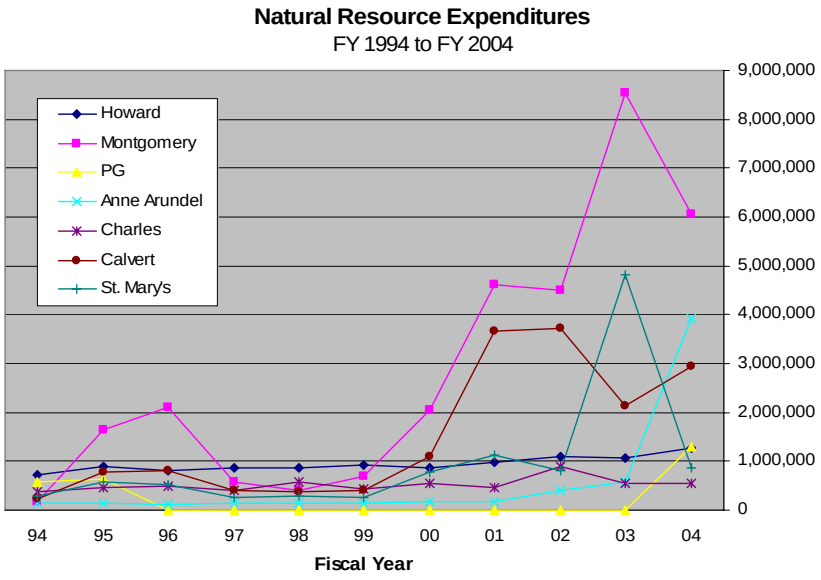


Figure 19. Natural resource expenditures from FY 1994 to FY 2004
Source: Maryland Department of Legislative Services, Office of Policy Analysis

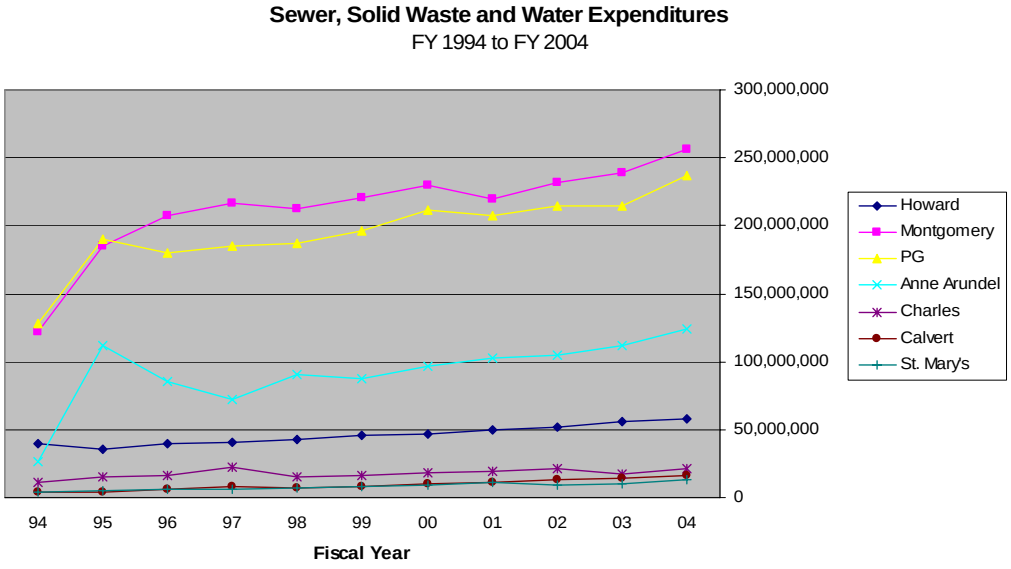


Figure 20. Sewer, solid waste and water expenditures from FY 1994 to FY 2004
Source: Maryland Department of Legislative Services, Office of Policy Analysis

Data on county spending on natural resources and sewer, solid waste and water management, were gathered from the annual Local Government Finances Reports for the years FY1994 through FY2004 prepared by the Maryland Department of Legislative Services, Office of Policy Analysis. Although there is some lag time in availability of current data, these reports use actual expenditure figures, and therefore, are considered to be more accurate than data in approved budgets. However, incomplete data in some years for some counties made comparisons of trends over time difficult. The discussion below focuses especially on FY04 expenditures for the Patuxent River watershed counties. Since counties do not necessarily make a distinction in their environmental spending in terms of the watershed where a funded program

or practice takes place (Patuxent vs. Potomac, for example), we compare spending for the complete county to assess overall effort and investment.

The scale of county government is reflected in overall county government expenditures. Montgomery County had the highest total county government expenditures in FY04 ($3,995,000), followed by Prince George's ($2,350,000). Montgomery's expenditures were more than ten times the expenditures in Charles, Calvert, and St. Mary's, with St. Mary's the smallest at $138,550,000.

Within county budgets, we focused on two categories of spending that are particularly relevant to nutrient discharges to the Patuxent: natural resources spending and sewer, solid waste and water management spending.

5.1 Environmental Spending

5.1.1 Natural Resources Spending

Of the seven Patuxent watershed counties in 2004, Calvert has the highest percentage of the total county budget spent on natural resources. Calvert spent 1% in 2004, compared to a statewide average for counties of 0.3%. The other six Patuxent counties are all below the statewide average.

On a per capita basis in 2004, Calvert again far exceeded spending in the other six Patuxent counties, at $33 per capita (Figure 21). None of the other Patuxent counties exceed the statewide county average of $10 per capita.

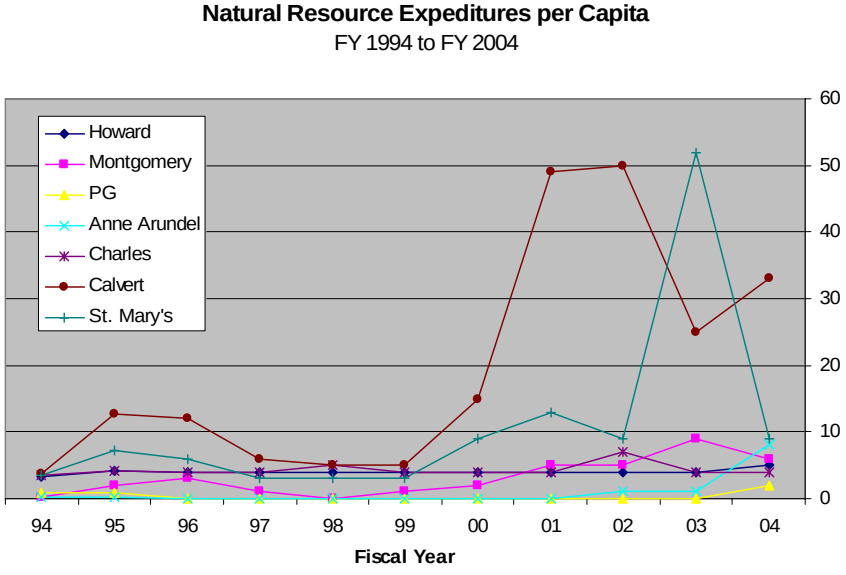


Figure 21. Natural resource expenditures per capita, FY 1994 to FY 2004
Source: Maryland Department of Legislative Services, Office of Policy Analysis

5.1.2 Sewer, Solid Waste and Water Management Spending

The two most heavily and densely populated counties (Montgomery and Prince George's), not surprisingly, spent the most per capita on sewer, solid waste, and water management in 2004 (Figure 22). Montgomery, with the largest population, spent the most in total dollars on sewer, solid waste, and water management. Prince George's, although second in population and population density, spent the most sewer, solid waste, and water management on a per capita basis and percentage-of-county-budget basis.[7]

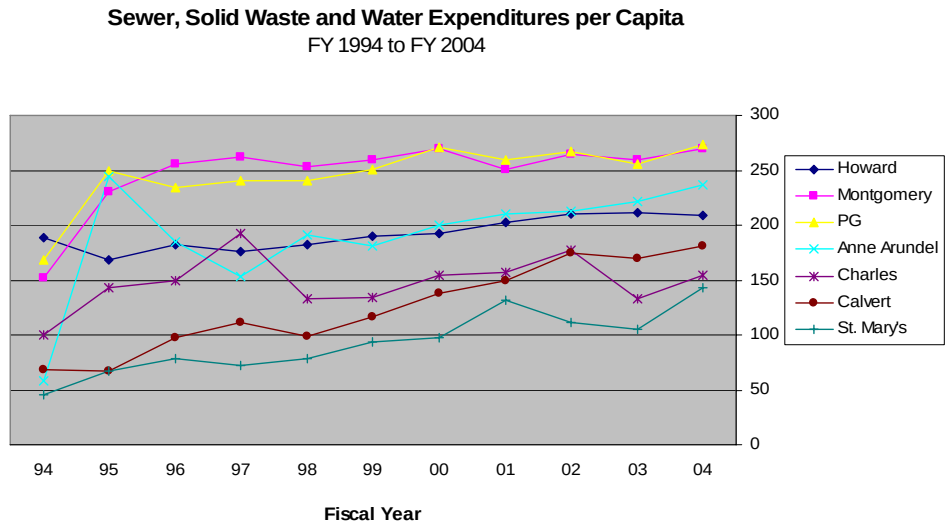


Figure 22. Sewer, solid waste and water expenditures per capita, FY 1994 to FY 2004.
Source: Maryland Department of Legislative Services, Office of Policy Analysis

5.1.3 Environmental Enforcement Budget

Unfortunately, the DLS reports do not compare county environmental enforcement expenditures. Such comparisons over time would be very helpful in assessing progress in individual counties (both in absolute and relative terms) toward meeting cleanup goals for the Patuxent and, more broadly, for the Chesapeake Bay. To help understand this issue, we acquired information about permitting and inspections budgets from a review of each county's budget website, using FY05 data in each case, with the important caveat that each county government has a different structure, which made direct comparisons difficult. Overall county budget data were obtained from the Maryland Association of Counties (MACo) FY 2005 Budget, Tax Rates, and Selected Statistics [8] MACo also has the same caveat about different government structures making comparisons difficult.

Anne Arundel, Howard, and Montgomery are the leaders in inspections and permitting as a percentage of the overall county budget, with Anne Arundel spending 0.78%, Howard 0.70%,

[7] Maryland Department of Legislative Services, Office of Policy Analysis prepares annual Local Government Finances Reports for the purpose of describing the financial conditions of local governments in Maryland. The figures for spending on sewer, solid waste, and water management in 2004 apportion expenditures by the Washington Suburban Sanitary Commission to Montgomery and Prince George's County on a 50/50 basis.
[8] These data are accessible at the following website: www.mdcounties.org/e_files/BTRS/BTRS%202006/County%20Budget%20Data.pdf.

and Montgomery 0.63%. Prince George's is sixth at 0.37% and Charles last at 0.24%. (See table 5).

On a *per capita* spending basis, Montgomery leads inspections/permitting spending at $22.66, followed by Howard at $20.59 and Anne Arundel at $19.95 per capita. Prince George's is fourth at $10.37 per capita, which is about half of the per capita spending for each of the other non-delegated counties. Charles is last at $5.26. Note that Charles, Calvert and St. Mary's counties on both a per capita and percentage-of-total-budget basis did not have sediment and erosion control inspection authority fully delegated by the state in the year for which these data were collected. Charles subsequently applied to the Maryland Department of the Environment (MDE) for this delegation.

Budget information was also collected for the Soil Conservation Districts, which follow the geographic boundaries of the counties but which are separate legal entities.

Table 5: 2005 County budgets for inspections and permitting offices

	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's
Inspections and Permitting Office (IPO) Budget	$5,441,494	20,825,379	8,696,191	10,108,713	700,100	662,708	614,577
Percent of total operating budget	0.70%	0.63%	0.37%	0.78%	0.24%	0.39%	0.44%
IPO budget dollars per capita	$ 20.59	22.66	10.37	19.95	5.26	7.88	6.63

Source: Maryland Department of Legislative Services, Office of Policy Analysis

5.2 Environmental Enforcement Activity

We interviewed county and Soil Conservation District staff to collect data about the number of staff and their responsibilities. In addition, we obtained 2005 data on sediment and erosion control staff levels and inspection activity from MDE (for both delegated and non-delegated counties). We collected data on NPDES permits in the watershed from EPA's Enforcement and Compliance History Online (ECHO) database and from MDE's annual enforcement and compliance report (MDE 2005). We also collected data on Maryland Critical Area Act enforcement for the five Patuxent River watershed counties that have land in the critical area. The responses of Soil Conservation District and county personnel can be found in Appendix B of this report. [9]

[9] For a discussion of Critical Area Act enforcement statewide, see University of Maryland Environmental Law Clinic 2006.

5.2.1 Erosion and Sediment Control for Construction Activity

"MDE should seek increases in State funding to increase the number of staff that enforce sediment and erosion controls."

-recommendation from participants in joint MDE/MDP conference, Fall 2005

The purpose of Maryland's erosion and sediment control program is to lessen the negative impact on the aquatic environment caused by sediment from construction sites. This program applies to any construction activity that disturbs 5,000 square feet or more of land, or results in 100 cubic yards or more of earth movement. In either case, the site must have an approved erosion and sediment control plan. In addition, each site must have a stormwater management plan in order to maintain, after development, the pre-development runoff conditions (MDE 2006).

According to MDE personnel, in 1970, erosion and sediment control was delegated to local jurisdictions, but by 1984, it became apparent that there was a great disparity in enforcement activity/effectiveness from jurisdiction to jurisdiction, and so it became a state responsibility with a process where MDE could delegate enforcement.

Unlike sediment/erosion control, by mandate, stormwater management is to be addressed by the municipality. Within a county, a municipality might let the county take over that function. MDE's Annual Compliance Report provides statewide data about sediment/erosion control and notes the emphasis placed on this activity within its Water Management Administration and at the county level.

MDE now delegates erosion and sediment control enforcement to 23 jurisdictions, including 13 counties, 9 municipalities, and the Washington Suburban Sanitary Commission (WSSC), for any underground utility work in Montgomery or Prince George's County. For any state or Federal projects, MDE retains authority over the local jurisdiction. Each county/municipality has to meet state standards for delegated inspections.

At the time of data collection, four Patuxent River watershed counties were fully delegated (Anne Arundel, Howard, Montgomery, and Prince George's). Calvert County is unusual in that it has partial delegation, with the county responsible for single-family homes, and MDE handling the remainder of permits. Charles County had recently adopted a resolution to apply for delegation, and that process was underway at the time this project's data were collected. St. Mary's County is not delegated.

According to information provided by MDE staff, even if a county is fully delegated for erosion and sediment control, there will often be a state inspector involved with a project. For example, Prince George's County is delegated, but a state inspector would also be on a job if a wetland or waterway is involved. Depending on the job, sometimes one might find several types of inspectors involved.

Bowie, Greenbelt, and Laurel in Prince George's County, and Gaithersburg and Rockville in Montgomery County are jurisdictions in Patuxent counties that are also delegated, although in some cases these jurisdictions do not fall within the Patuxent watershed part of the county.

According to MDE, delegating to the counties has added 116 additional inspectors on a statewide basis, including 93 in counties, four for WSSC, and 13 ½ in municipalities. There is the equivalent of 20 full-time inspectors at MDE to cover the non-delegated counties for sediment and erosion control (MDE). There are 40 MDE inspectors statewide for all media combined, with inspectors now trained in eight to ten different media, such as drinking water, sewage, and erosion/sediment. MDE staff suggested that the saturation point for efficient oversight is about 50 projects per inspector.

MDE also has a memorandum of understanding with the Maryland Department of Agriculture with regard to enforcement on agricultural land. In some instances, MDE can take enforcement actions on agricultural land, and they have done so, including in the Patuxent watershed, but it is rare.

In addition, Soil Conservation Districts are now being asked to do inspections for MDE on development projects, although they do not have a formal enforcement role. MDE has asked them to "be MDE's eyes on development projects," according to one MDE Water Management Administration staffer.

In an interview, an MDE staffer said that, although they are generally good at getting sediment/erosion control plans and permitting in place, *maintenance* of erosion/sediment control efforts is "still a problem" in the state. He noted that more and more, county commissioners are changing their tune about delegation of enforcement, because their constituents are not satisfied with what is being done and want more enforcement.

Is delegation of sediment and erosion control to certain counties working? Does MDE have adequate staff resources to cover the non-delegated counties? To help answer these questions, we reviewed data provided by MDE about both delegated and non-delegated counties. For the delegated counties, the number of county inspectors responsible for erosion and sediment control ranged from 13.8 in Prince George's to 21 in Howard. (Calvert, which has partial delegation, has three inspectors.) For non-delegated counties, MDE assigns inspectors (1.25 full-time equivalents (FTEs) in St. Mary's, 2 in Charles, 4 in Calvert, and 0.3 FTE in Anne Arundel, primarily for Annapolis, which is a non-delegated jurisdiction within the county).

Perhaps more relevant than the number of inspectors are several other metrics tracked by MDE for delegated counties, including total permits per inspector, active permits per inspector, and disturbed acreage of permits per inspector. For the four fully-delegated counties, Prince George's has the highest numbers per inspector in each of these categories:

- Total permits per inspector is 245 in Prince George's, compared to 57 in Anne Arundel County, 44 in Montgomery, and 26 in Howard.
- Active permits per inspector is 94 in Prince George's, compared to 87 in Anne Arundel, 40 in Montgomery, and 15 in Howard.
- Disturbed acreage of permits per inspector is 823 in Prince George's, compared to 556 in Anne Arundel, 315 in Montgomery, and 51 in Howard.

For partially-delegated Calvert County, the total permits per inspector is 334, active permits per inspector is 336, and disturbed acreage of permits per inspector is 488. No data were available from MDE for active permits or disturbed acreage for the two non-delegated counties; however, Charles had 2,522 total permits per inspector, and St. Mary's had 2,542 total permits

per inspector, demonstrating the staffing challenges that MDE inspectors have faced in these non-delegated counties.

Statewide figures for non-delegated counties indicate that on a statewide basis, the workload for the 20 Water Management Administration inspectors exceeds that for the county inspectors, with 474 total permits per inspector, 474 active permits per inspector, and 1,843 disturbed acres of permits per inspector. These figures suggest that WMA inspectors are stretched far too thin to deal effectively with the non-delegated counties in all areas of the state.

MDE also tracks the total number of inspections, as well as the number of inspections per inspector on an annual and daily basis.

For delegated counties, Montgomery County leads the watershed in total number of inspections, with 19,260, followed by Anne Arundel (13,604), Howard (10,303), and Prince George's (9,699). Partially-delegated Calvert had 5,196 inspections. Counties not delegated by MDE had significantly fewer inspections: St. Mary's had 1,380, and Charles 1,040.

Montgomery leads the delegated counties in annual inspections per inspector with 1,284, followed by Anne Arundel (951), Prince George's (703) and Howard (491). Partially-delegated Calvert County had the highest number of annual inspections per inspector in the watershed, with 1,299. St. Mary's had 1,104 inspections per inspector, and Charles 520. For state inspectors of non-delegated counties, the annual number of inspections per inspector is 481.

On a daily basis, Montgomery and Calvert are the most active counties, with 5.4 inspections per day per inspector, followed by St. Mary's (4.6) and Prince George's (2.9). The statewide average for MDE Water Management Administration inspections of non-delegated sites is 2 inspections per inspector per day.

Prince George's County staff provided additional data on frequency of inspections for the periods of January-June 2005, and July-December 2005. The report includes 1,271 permits (grading, stormwater management, and Department of Public Works and Transportation). Of the permitted sites in the first six months of the year, 23% were inspected an average of once every two weeks as required by MDE; 74.4% were inspected within four weeks, and 2.6% after more than four weeks. In the second half of the year, 28.3% of the sites were inspected within two weeks as required. County staff noted that there was a 25% staff shortage in the first half of the year, with four vacancies and one new hire in training, and a 21% staff shortage in the second half of the year. This resulted in an "unrealistic area of coverage per inspector" according to an anonymous staffer. This inspector-to-site ratio is resulting in increased enforcement actions, complaints, and compromising quality of development.

Similar data on frequency of inspections for each of the seven counties would be useful for analysis of whether meeting inspection-frequency requirements leads to more compliance and less need for imposition of stop-work orders or other penalties. In a discussion of successes and challenges in its 2006 annual enforcement report, MDE noted that, while erosion and sediment control inspections remain a priority, "the inspection frequency requirement is not being met" (MDE 2006).

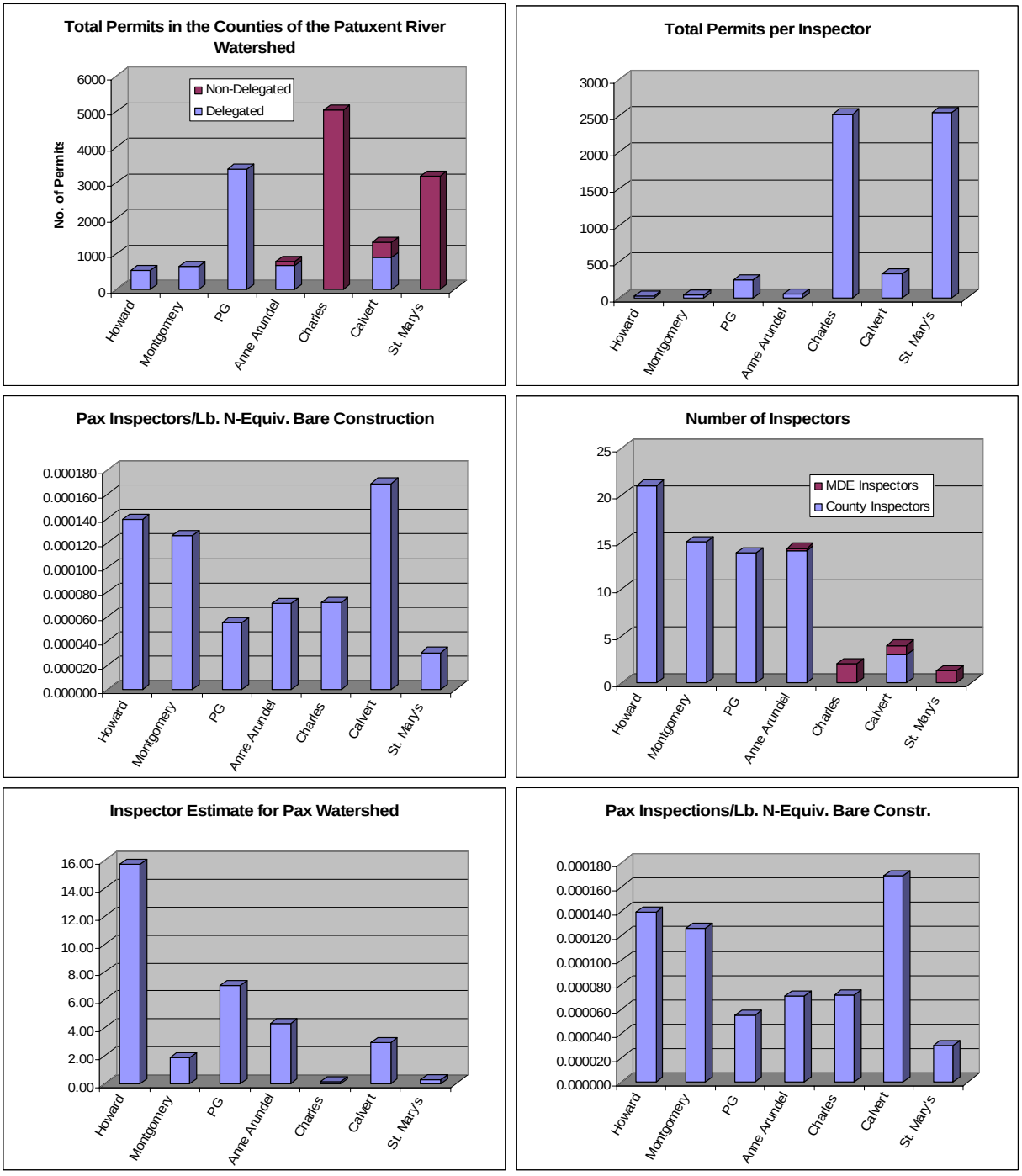
In sum, these data suggest that in most Patuxent watershed counties, whether delegated or non-delegated, the typical inspector has a far bigger workload than the fifty projects or less that MDE staff suggest as being manageable. Only Howard and Montgomery counties are below that threshold, and Anne Arundel (at 57 active permits per inspector) is the only other county that is

close. The data underscore a concern expressed by participants in a joint MDE/Maryland Department of Planning workshop held in fall 2005. Among the participants' recommendations: "that MDE should seek increases in State funding to increase the number of staff that enforce sediment and erosion control programs" (Nemazie 2005).

But even if an inspector's position is funded by a county, several county staffers noted the difficulty in hiring or retaining staff who receive training and then are sometimes recruited away by higher-paying jobs in the private sector or neighboring jurisdictions.

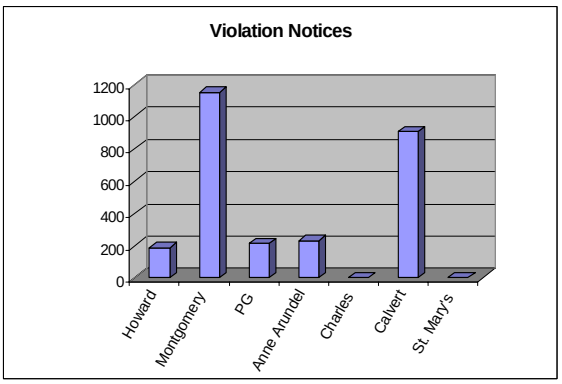
MDE Water Management Administration staff noted that it is important to be careful about analyzing monetary fines or stop work orders as a measure of performance, as there are some very effective inspectors at getting people to comply *before* they are in a situation to be fined. Such inspectors might not have the best numbers for stop work orders or fines levied, but they might get better site results.

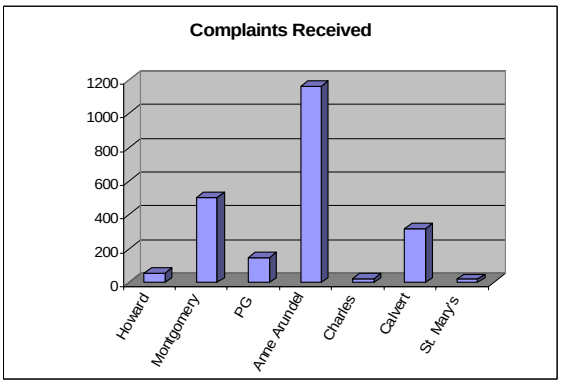
Sediment and Erosion Control Enforcement Indicators

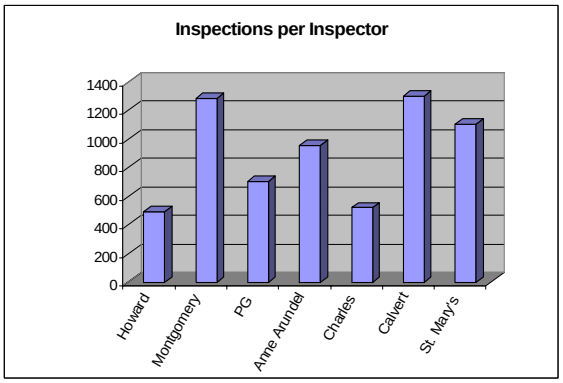


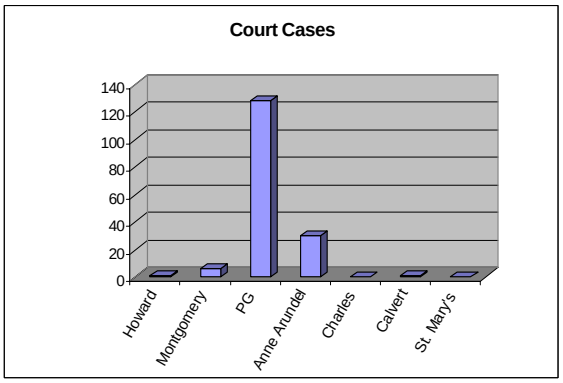
Figures 23a-f. Sediment and erosion control indicators
Source: Developed using Maryland Department of the Environment data (inspectors/inspections) and Chesapeake Bay Program Office data (nutrient discharge).

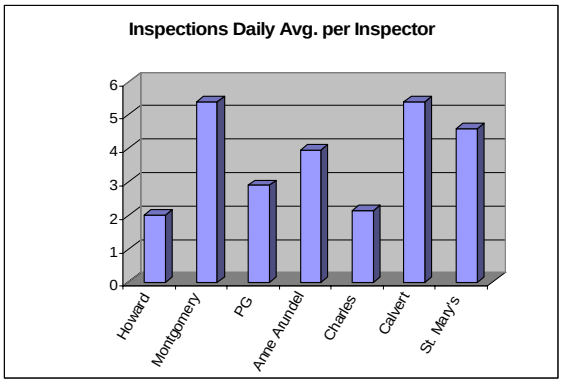
Sediment and Erosion Control Enforcement Indicators

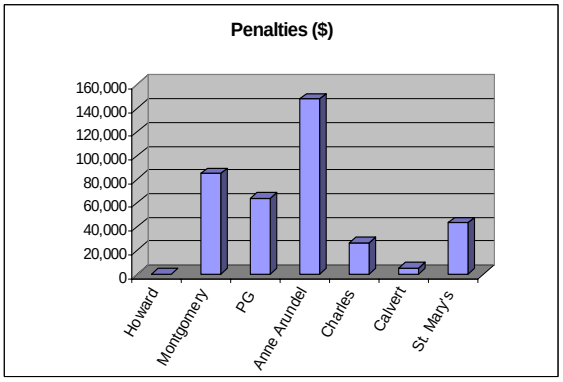












Figures 23g-m. Sediment and erosion control enforcement indicators (continued)
Source: Developed using Maryland Department of the Environment data (inspectors/inspections) and Chesapeake Bay Program Office data (nutrient discharge).

5.2.2 Enforcement of Point Source Discharges: NPDES Permits

In the late 1970s, state senator Bernie Fowler spearheaded a successful lawsuit against the State of Maryland about pollution in the Patuxent watershed. In 1981, the seven Patuxent counties, as well as State and Federal officials, agreed to a set of measures to improve the Patuxent. Legislation was introduced in 2006 that would enforce limits on discharges from wastewater treatment plants and other "point" sources of pollution (Wan 2006).

The opinion of most county staff interviewed for this project is that enforcement of discharge standards from point sources is moderately strict (usually enforced) in the county, with only one county staffer noting that such enforcement is very strict (always enforced) and one saying that it is not strict (rarely enforced). Appendix B includes additional comments by staff about point-source enforcement.

We examined the EPA Enforcement and Compliance History Online (ECHO) database to gather data on point source discharges in the watershed. While ECHO provided a useful initial snapshot of the watershed, this search revealed limitations that suggest it is insufficient for understanding fully the nature of point source discharges.

Major National Pollutant Discharge Elimination System (NPDES) permitted facilities are designated as being in Significant Noncompliance (SNC) when reported effluent exceedances are 20% or more above permitted levels for toxic pollutants and/or 40% or more above permitted levels of conventional pollutants. ECHO reports summarize SNC status on a quarterly basis, and these summaries exclude many violations that are still enforceable. EPA bases its numbers on a percent exceedance, so this screens out many violations from being listed in quarterly reports. PCS/ECHO also does not indicate how many times an exceedance occurs in a month. A site could have an exceedance 19 out of 30 days in a month, but the database only records the highest exceedance in that month.

While ECHO may serve as a good initial screen, there are several other reasons that the database is not sufficient. For example, some states do not input all permits (although MDE staff noted that Maryland does submit all permits, both major and minor). Also, discharge monitoring reports (DMRs) that ECHO tracks often do not reflect what is in the permit, include relevant information in permit cover letters, or take into account further clarifications/subtleties reflected in subsequent administrative orders, stays, etc.

A review conducted on a national basis by U.S. Public Interest Research Group with ECHO data from July 1, 2003 to December 31, 2004, found that Maryland ranks fairly high among the states in terms of compliance with NPDES permits. Of 97 major facilities with NPDES permits, 41, or 42.3%, exceeded their permit limits at least once during this period. Only Nevada, Montana, Virginia, Minnesota, and New Jersey had higher compliance rates during this period (Leavitt 2006). Still, the percentage in compliance suggests significant room for improvement on a statewide basis.

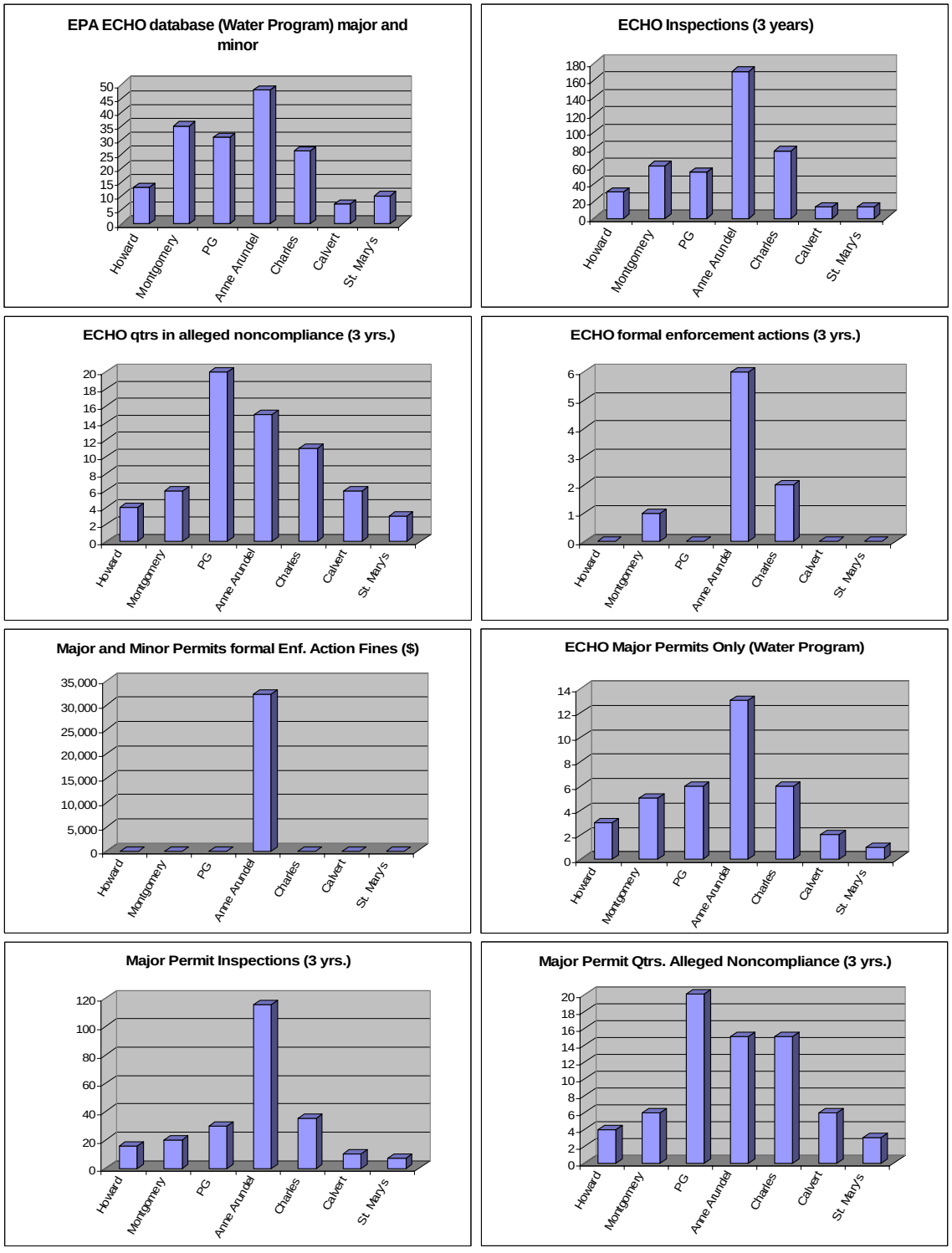
Our review of the ECHO database on October 25, 2006 found the following for NPDES point-source permits in the Patuxent watershed[10] over the previous *three-year* period (see also figures 24a to 24h):

- 27 major or minor permits in the watershed, 10 of which are major permits
- 24 quarters in alleged non-compliance, all of which were by major permit holders
- 112 inspections, 64 of which were of major permit sites
- One informal enforcement action/notice of violation, which was of a major permit site
- Two formal enforcement actions (both in Anne Arundel County), resulting in a total of $14,240 in fines
- No alleged current significant violations for major or minor permits

The fact that there are no alleged current significant violations of NPDES permits in the watershed suggests that enforcement activity of both major and minor point sources is sufficient to bring violators into compliance. But our review of this database might not be presenting the full picture. "There are a dozen reasons why ECHO is incomplete," one environmental advocacy attorney interviewed for this project said. "On the other hand, as a rough screen, it's the best system there is." He also noted that, "Bad and expired permits, or permits with lousy limits" are perhaps a bigger problem.

[10] One advantage of the ECHO database is that it enables searches on a county basis and of that portion of a county within a specific watershed.

National Discharge Pollution Point Source Indicators



Figures 24a-h. National discharge pollution point source indicators
Source : U.S. Environmental Protection Agency, Enforcement Compliance History Online (ECHO) database (reviewed during 2006)

5.2.3 The Critical Area

Maryland's Critical Area Act, passed in 1984, identifies the "Critical Area" as all land within 1,000 feet of the mean high water line of tidal waters or the landward edge of tidal wetlands and all waters of and lands under the Chesapeake Bay and its tributaries (MD DNR 2006). The law is designed to minimize adverse impacts on water quality that result from pollutants that are discharged from structures or conveyances or that have run off from surrounding lands. The state's Critical Areas Commission develops criteria that are used by local jurisdictions to develop individual Critical Area programs and amend local comprehensive plans, zoning ordinances, and subdivision regulations.

Five of the seven counties (all but Howard and Montgomery) have land in the Critical Area. We also collected data on Critical Area enforcement in these counties.[11] We asked staffers to estimate amount of staff resources devoted to the Critical Area for the five counties in the watershed that have Critical Area. Anne Arundel County indicated that it has three staff solely devoted to Critical Area activity out of its total inspection staff of 34, and Calvert indicated that one of its two inspectors is solely responsible for CAA. Charles has one full-time-equivalent focused on the Critical Area on its staff (an estimated 4% of the overall Planning Division staff effort), and St. Mary's estimated that its inspectors devote 12% of their time to Critical Area activity. Prince George's estimated that 10% of its inspection activity is in the Critical Area.

Each of the five Soil Conservation Districts with land in the Critical Area indicated that some staff time is devoted to activities in the Critical Area, ranging from 2% in Calvert to 25% in St. Mary's. Prince George's SCD, which estimated that 15-20% of its time is devoted to agricultural programs in the Critical Area, noted that it used to have 83 farms in the Critical Area (out of 600 in the county), but that number is decreasing over time.

We asked each county staffer if their county had forced anyone to tear down a structure because it did not conform with environmental regulations in the Critical Area. The rare instances in which this has occurred represent a fraction of one percent of the overall number of building permits issued in the county, or even of those within the Critical Area, according to county and SCD staff. However, of the five Critical Area counties, only Prince George's staff was not aware that this had ever occurred.

- St. Mary's: once in the past five years
- Charles: twice in the past five years
- Calvert: yes, but staff was unsure of number
- Anne Arundel: six times in the past five years

We asked each county staffer if anyone had been granted a variance for construction in the Critical Area. Maryland Environmental Law Clinic (MELC) also collected data on this question.

11 Two of these counties—Anne Arundel and St. Mary's—were used as case studies in a recent study by the University of Maryland Environmental Law Clinic about enforcement in the Critical Area (University of Maryland Environmental Law Clinic 2006).

2005

Anne Arundel	175 applications; 143 granted
Calvert	42 applications;
Charles	2 applications; 2 granted
Prince George's	3 applications; no data on number granted
St. Mary's	63 applications; 36 granted

(Sources: interviews with county personnel; MELC; DNR)

"People know nobody gets fined. Such a minimal fine, people go ahead anyway."

Soil Conservation District manager in the Patuxent watershed, October 2005

Calvert County staff noted that, typically, with a Critical Area violation the square footage of disturbance must be replanted and bonded and fees paid according to the fee schedule. A $500 fine/day may be levied if a violator is non-compliant. Charles County provided additional information about Critical Area penalties, noting that violations of the ordinance are liable for a civil monetary penalty not the exceed $1,000, with each day considered a separate violation. Anne Arundel County staff noted that it has the highest civil citation rate of any jurisdiction in Maryland for Critical Area Act violations, and that the county has obtained criminal convictions for CAA violations as well.

But some observers, such as the Soil Conservation District manager who is quoted above, note that, for many people, it is easier to beg forgiveness than to ask permission when it comes to Critical Area violations, particularly if there is little likelihood of a fine being imposed. The following sidebar illustrates how, even in that likelihood, the size of the fine could be considering simply the cost of doing business.

The illustration below describes a real situation showing a second economic dimension of Bay restoration problems. Government action to restrict harmful land and water use decisions that are too timid (e.g., weak enforcement, small penalties) will not be effective in deterring potential violators. More importantly, however, they also undermine public confidence that the health of the Bay will improve, and result in a deterioration of respect for environmental laws. The growing public sentiment that environmental regulations that cannot be sidestepped can be dealt with by just "doing what you want and paying the fine if you get caught" has far reaching implications.

Illustration of the Problem – The Small Picture

To appreciate how households and businesses in the Patuxent watershed responded to the statements made by public officials about the "soft" strategies they plan to implement, consider the situation that was described by one resident of the Patuxent watershed during a recent interview we conducted.

The woman and her husband owned and lived in a home near a creek that feeds into the Patuxent River. Next to their home was a wetland lot on the creek. The lot was not developable because it could not pass tests for a septic system, and as a result, the lot was for sale for only $25,000. For several years the couple considered purchasing the wetland lot with the family that owned property on the other side.

However, in 2002 a developer purchased the wetland lot for the asking price of $25,000, and also purchased a house on the lot immediately upslope of it for $175,000. Over the next few years, the developer built a walkway from the upslope home through the wetland lot to the creek, cleared trees to give the upslope home a water view, and in the process of "repairing" a boat dock that had been damaged years earlier, extended a dock from the newly built walkway out 80 feet into the creek to provide two deep water boat slips.

During this time, the couple we interviewed and other neighbors complained in person and in writing to the county planning and zoning department that all of the land modifications and structures constructed by the builder were in violation of state wetland and local critical area restrictions. The outcome was that the developer paid $17,500 in fines and sold the home with the water view, water access, and two deep water boat slips for $475,000, a net profit (not including the cost of constructing the walkway and dock, of $275,500.

The more important outcome, however, is that the couple we interviewed believe they now know "how the system works" and feel like total fools for not doing the same thing sooner than the developer. If they hadn't been so naive, they would be $275,000 wealthier and, they correctly point out, the health of the River would be the same. Having learned this lesson, they told us they are now looking for similar properties where they can make significant profit by employing what they are now convinced is the most reasonable response to weak, ineffective, and selectively enforced county environmental regulations. They plan to do what they want and pay the fine if they get caught, and are telling their story and advising others to do the same.

5.3 Agriculture

Among the questions driving this research effort on environmental enforcement economics was the following: "What incentives are there for point and non-point sources to participate in a water-quality trading program?" For point sources, the answer is straightforward. If a regulated entity knows that it will need to come into compliance with a strongly-enforced water quality law, it will have the incentive to trade if it can do so with another entity that can make nutrient reductions at a lower cost.

In many instances, the other trading partner would be an agricultural, nonpoint source of nutrient discharges. However, the incentives for farmers to participate in a water quality trading program are somewhat more complex, since agricultural programs are generally voluntary, rather than regulatory under the Clean Water Act. In addition, farmers who are already participating in agricultural subsidy or "green payment" programs have a reduced incentive or ability to participate, since any trading program would be for any newly-implemented best management practices, not for ones already receiving compensation.

And, finally, some farmers may be hesitant to participate in a trading program because the requisite scoring of trades would require regulators to gather information from individual farms that, from a farmer's point of view, could lead to increased regulation of agricultural operations. If regulators are not currently inspecting farms for compliance with existing nutrient management regulations or for participation in green payment programs, then a farmer may be less likely to want to participate in a trading program that will require inspections. To that end, we collected data and interviewed district and state personnel about the level of inspection of existing nutrient management programs and of continued implementation of Federal or state best management practices for which green payments have been made.

Although we chose the county as the appropriate level of analysis for this research, there are many players involved in both preventative and reactive efforts at other levels of government, so our analysis also included data collection from the following sources:

- The watershed's seven Soil Conservation Districts (whose boundaries are the same as for the seven counties), which provide technical assistance to farmers (and to varying degrees, urban developers)
- The Maryland Department of Agriculture, which tracks compliance with required nutrient management plans and "green payment" programs for agricultural best management practices
- The U.S. Department of Agriculture, for information on Federal green payment programs at the local and county level

5.3.1 Agricultural Land Use Snapshot

The Patuxent watershed is not primarily in agricultural land uses. Montgomery has the most land in agricultural use of any county/Soil Conservation District in the Patuxent watershed, with 79,000 acres, or approximately one-quarter of its land. (Of this amount, 14,000 acres agricultural acres are in the Patuxent watershed portion of the county.) Howard has the highest percentage of land in agriculture, with its 49,000 acres comprising 31% of its total acreage. Prince George's has the lowest percentage in agriculture, with 13%.

5.3.2 Federal Farm Subsidy and Green Payment Programs

First, we collected data for each of the seven Soil Conservation Districts on the level of agricultural subsidies and on "green payment" programs such as the Federal EQIP program and the Maryland Agricultural Cost Share Program. Green payment programs are those that provide cost-sharing assistance or other economic incentives to farmers to encourage them to adopt management strategies that improve the environment.

Montgomery County, by far, leads the watershed in the amount of fixed Federal agricultural subsidies provided to farmers in its district, with 76 eligible recipients receiving a total of $551,317 in the 2005 planting year. St. Mary's County received the second highest amount, with 197 eligible recipients receiving a total of $305,604. Calvert (40 recipients; $92,899) and Prince George's (41 recipients; $95,433) received the least amount of fixed Federal farm subsidies (source: Environmental Working Group).

We also looked specifically at payments made for participation in the Environmental Quality Improvement Program, a "green payment" program that provides cost-share grants to protect natural resources on cropland, forested lands, and grazing lands, and to construct animal waste facilities and obtain nutrient management services.

Anne Arundel leads the watershed counties in both the amount of EQIP funds and recipients, followed by Charles (Table 6). Prince George's receives the least EQIP funds, with St. Mary's sixth in funds received and last in number of recipients (Post 2006).

Table 6: Environmental Quality Incentives Program (EQIP) dollars obligated by watershed counties for 2005.

County	Number of Contracts	Cost Share Obligated
Anne Arundel	33	$ 493,986
Calvert	13	144,664
Charles	26	200,100
Howard	9	173,047
Montgomery	37	143,358
Prince Georges	17	34,963
St. Mary's	8	122,041

Source: U.S. Department of Agriculture (See Post, 2006)

5.3.3 State Agricultural Cost-Share and Nutrient Management Programs

Measures of state government efforts are also estimated at the county level through data obtained from state environmental and agricultural agencies. In Maryland, agricultural nutrient management plans are required for virtually all farms under the 1998 Water Quality Improvement Act (MD DNR 2005; Environmental Law Institute 1998). The project

incorporates such plans (whether voluntary or required) into the assessment of impact controls, as well as analysis of "green payments" and other incentives in the agricultural sector. This is a key component, given the agricultural sector's significant contribution to water quality impairment in many watersheds, and the potential for "green payment" programs to be integrated with water quality trading programs.

For reactive strategies, we attempted to collected data at the county/Soil Conservation District level to assess rates of compliance in order to assess measures of the level and success of existing regulatory programs under which a trading program may need to operate. We attempted to collect information on inspection rates and violations.

Appendix B describes in more detail the role of the Soil Conservation Districts in ensuring compliance with environmental regulations and in promoting the adoption of best management practices. According to Soil Conservation District managers, their offices do not have a formal enforcement role, with that responsibility designated to the Maryland Department of Agriculture (MDA) or MDE as appropriate.

5.3.4 Nutrient Management Plan Enforcement

In 2004, Maryland approved regulatory changes to the Water Quality Improvement Act that require farmers to file specific information with MDA, starting in 2005. By March 1, 2005, farmers were required to file an Annual Implementation Report to describe how their NMP was implemented during the previous year. By March 1, 2005, farmers who had not submitted nutrient management plan information were required to submit a Nutrient Management Reporting Form and supporting documentation. By July 1, 2005, farmers who apply organic nutrient sources such as manure and biosolids were required to begin implementing a nitrogen and phosphorus nutrient management plan.

Maryland Department of Agriculture enforcement staff described MDA's enforcement process for non compliance with Nutrient Management Plan filing requirements consists of four steps:

1) notice of violation
2) site visit
3) warning letter
4) charge w/ penalties

As of December 2005, MDA reported that 80% of Maryland's farmland was covered by nutrient management plans. Enforcement actions began in June 2005 to bring the remaining farms in compliance with the law, and by year-end, inspectors had visited 607 farms across the state, bringing 568 of them into compliance (Maryland Department of Agriculture).

Data collected from MDA showed a statewide compliance rate of 68% with this reporting requirement as of June 15, 2005, a slight increase from the 64% who had submitted such forms by December 31, 2004.

Compliance with nutrient management plan reporting requirements by Patuxent counties/ districts, shown as the total of non-responsive operators in the county/district that filed nutrient management plans, was as follows:

Table 7: Nutrient management plan compliance within the watershed.

	Non-responsive or justified delay as of 7/1/05	First NOV	Personal visits or telephone contact	Still not in compliance as of 6/30/06
Anne Arundel	48	48	47	21
Calvert	50	39	32	25
Charles	49	36	30	23
Howard	59	33	34	23
Montgomery	121	40	47	70
Prince George's	100	60	47	68
St. Mary's	104	32	17	87

NOV: Notice of Violation

Source: Maryland Department of Agriculture (2006)

Data collected from MDA indicate that most of the enforcement activity in the Patuxent watershed during the first year of the new nutrient management plan reporting requirements has focused on the first stages of the enforcement process. First notices of violations have been sent to operators, but this varies considerably from district to district in the watershed

Following the first notice of violation and contacts in person or by telephone, the next step is a warning letter. Statewide, 145 such letters had been sent as of June 30, 2006, but only 15 of those letters were sent to operators in Patuxent watershed counties. No warning letters had been sent as of that date in St. Mary's County; of the 104 operations that were out of compliance as of July 1, 2005, only 17 have come into compliance during this period.

Of the 12 people they were considering as highest priorities for charging with penalties as of June 2005, some have come into compliance, and some still need to be taken to administrative hearing, according to MDA. There are four people in the latter category, who haven't responded to charge letters.

MDA staff described their approach as having three prongs, of which "none alone will give us successful implementation":

1) education/outreach
2) technical assistance/incentives (i.e., cost-share)
3) regulatory requirements

One MDA staffer views their approach as a variation on the Washington Post slogan: "If you don't get it, you don't get it." In their case, it is, "If you don't get it, you get it" (get charged).

5.3.5 Agricultural Cost-Share Compliance

Another aspect of state-level inspections of farms is for compliance with requirements of the Maryland Agricultural Cost Share (MACS) program. MACS provides assistance for implementing a range of best management practices, including cover crops, streamside buffers, animal waste systems, manure transport programs, nutrient management plans, and participation in the Federal/State Conservation Reserve Enhancement Program (CREP) to remove environmentally sensitive cropland from production. Soil Conservation District managers play

an important role in helping farmers participate in these programs, although MDA is responsible for MACS compliance inspections.

For MACS capital programs, Montgomery leads the Patuxent watershed counties with at total of $122,566 in cost-share for 8 participating farms, about twice the level of Charles, which is second at $64,492 for 13 farms. Anne Arundel had just one project with a $692 cost share. Montgomery also leads the watershed in cost share funds for cover crops, with $60,939 for 2,031 cover crop acres on 14 farms. Howard had the least amount of cover-crop cost share, with $3,123 for 104 acres on two farms.

In three of the seven districts (Montgomery, Prince George's, and Anne Arundel), no environmentally-sensitive land was retired through CREP. Of the remaining counties, Calvert received the most in CREP funds, with two farms receiving a total of $16,398, and St. Mary's the least, with four farms receiving a total of $3,176.

MDA conducts spot checks of 10% of participating farms annually. In 2005, MDA came very close to achieving the 10% spot-check goal statewide, with 618 of 620 scheduled spot checks completed. In each of the seven Patuxent SCDs, 100% of the scheduled spot checks were completed. Of the 68 spot checks completed in the watershed counties, three were deemed unsatisfactory for physical reasons; one of these BMPs was subsequently repaired. Four were considered unsatisfactory because the property was sold, but the management plan was transferred to the new owner in three of these four cases. Several Soil Conservation District officers noted in interviews that the sale of properties is a problem, with management plans falling by the wayside as land use changes.

In sum, the data collected on compliance with Maryland's agricultural program requirements suggest that investment in more inspection would be helpful. Enforcement of required nutrient management plans is still somewhat in its infancy, with only one full year of data available as of June 30, 2006. Of the Patuxent watershed counties, St. Mary's had the highest percentage of non-compliant operations that had not subsequently come into compliance with the reporting requirement. Data collected from MDA indicate that spot-checks of properties receiving MACS cost-share funding are meeting the 10% annual goal set by MDA in each of the seven Patuxent watershed counties. Perhaps the bigger issue is whether a 10% annual spot-check policy is sufficient, and whether there are enough MDA personnel on staff to handle a bigger inspection load.

5.4 Patuxent Stewardship Index

We have attempted to develop this index as a way for counties and Soil Conservation Districts to get a quick snapshot of how they compare with other jurisdictions. This is a first attempt at developing the index, which we hope to refine over time.

One goal of this project was to provide counties and Soil Conservation Districts with some indicators of how they stack up against other jurisdictions in the Patuxent watershed in terms of both contribution to the problem (nutrient discharges) and contribution to the solution (i.e., spending on environmental programs, effectiveness of enforcement activities).

To provide a quick comparative snapshot, we developed a "Patuxent Stewardship Index" using readily available aggregate data. The index shows how far above or below the watershed mean each county or Soil Conservation District is for some selected indicators. A score above "1" is considered good. It is designed so that someone can understand quickly whether or not a county or district is doing better or worse than its counterparts in the watershed. The geographic and demographic situation for each county/district differ, so there is no one individual score that is considered the magic number for a "good" or "bad" jurisdiction. But if a quick scroll down a column for an individual county/district consistently shows index scores of "1" or higher, then the county/district could be considered to be doing a relatively good job of Patuxent stewardship.

This is a first attempt at developing this index, based on readily available data. In future work, we hope to revise and expand the index to help inform decision-making and environmental investment. In some cases, this may require intensive primary data collection through review of individual case files.

We made some assumptions in this first attempt that may be open to debate. For example, in the sediment and erosion control enforcement section, we considered a higher number of stop-work-orders or fines to be a positive sign of aggressive enforcement. But, as described in section 5.2 (sediment and erosion control), this might also be seen as a sign of not enough monitoring of construction sites, with more intensive up-front inspections preventing violations developing to the point where a stop-work-order or fine is required. (County-by-county data on frequency of inspection would be a useful addition to future versions of this index.)

For Federal agricultural programs, we determined that the higher the amount of Federal fixed farm subsidies, the lower the score, on the assumption that farmers receiving large subsidies would have less incentive to participate in environmental programs. Conversely, the larger the amount of environmental cost-share funds (i.e., EQIP and MACS), the higher the index score.

Table 8: Patuxent Stewardship Index

Nutrient Discharges (lower discharge = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
N-Equivalent Edge of Stream	0.62	2.03	0.53	0.77	9.58	1.09	1.49	1.0
Nutrients lbs. per Capita in Watershed	1.54	2.86	2.83	1.46	0.98	0.84	0.36	1.0
Nutrients lbs./sq. Miles in Watershed	0.95	0.94	0.99	0.75	2.12	1.30	0.78	1.0
Nutrients per $ Output	3.83	1.90	3.19	1.01	0.64	0.73	0.51	1.0

2004 County Environmental Spending (higher spending = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Natural Resources (% of Total Spending)	0.35	0.70	0.00	1.05	0.35	3.50	1.05	1.0
Natural Resources $ per Capita	0.52	0.63	0.21	0.84	0.42	3.45	0.94	1.0
Natural Resources $ per County Acre	0.75	1.84	0.40	1.42	0.18	2.06	0.36	1.0
Pax Nat. Resource $/Pax Nutrient lbs.	0.65	1.67	0.39	1.00	0.37	2.62	0.30	1.0

2005 County Environmental Enforcement Budget (higher budget = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Inspections/Permits (% of Total Budget)	1.39	1.24	0.73	1.53	0.46	0.77	0.87	1.0
Inspections/Permits Budget per Capita	1.54	1.70	0.78	1.50	0.39	0.59	0.50	1.0

Sediment/Erosion (SE) Control Enforcement (lower number of permits or acres per inspector= higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Total Permits Per Inspector	31.59	18.85	3.36	14.39	0.33	2.47	0.32	1.0
Total Permits per Inspector w/o MDE	5.12	3.05	0.54	2.74	n/a	0.44	n/a	1.0
Active Permits per Inspector	7.63	2.86	1.22	1.32	n/a	0.34	n/a	1.0
Acres per Inspector	8.76	1.42	0.54	0.80	n/a	0.92	n/a	1.0
Inspections per Inspector	0.54	1.41	0.77	1.05	0.57	1.43	1.22	1.0
Complaints Received	0.18	1.58	0.47	3.63	0.08	1.00	0.06	1.0
Violation Notices	0.35	2.14	0.40	0.43	n/a	1.68	n/a	1.0
Stop Work Orders	0.13	1.68	1.64	3.24	0.03	0.26	0.02	1.0
Penalties (Total Fines Levied)	0.00	1.60	1.21	2.78	0.50	0.10	0.81	1.0
Patuxent SE Inspectors per Bare Construction Discharge	1.47	1.33	0.58	0.74	0.76	1.79	0.32	1.0
Patuxent Inspections per Bare Construction Discharge	0.76	1.81	0.43	0.75	0.42	2.45	0.38	1.0

Table 8: Patuxent Stewardship Index (continued)

Federal Agricultural Programs	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Federal Fixed Farm Subsidies	1.06	0.42	2.44	1.94	0.95	2.51	0.76	1.0
Env. Quality Incentive Program $	0.92	0.76	0.19	2.64	1.07	0.77	0.65	1.0
EQIP # of Contracts	0.44	1.81	0.83	1.62	1.27	0.64	0.39	1.0
Total Agric. Programs (Fed.) Score	0.83	1.06	1.16	1.86	1.15	1.34	0.63	1.0

State Agricultural Programs	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	Watershed
Nutrient Management Plans (#)	0.69	1.23	0.86	1.04	0.93	0.71	1.53	1.0
NMP Acres per Ag. Acre in County	0.87	1.35	0.94	0.90	0.96	0.82	1.16	1.0
Maryland Agricultural Cost-Share Capital $	1.09	2.79	0.34	0.02	1.47	0.64	0.67	1.0
MACS Cover Crop $	0.13	2.46	0.65	1.10	1.56	0.43	0.69	1.0
MACS Cover Crop Acres	0.12	2.30	0.63	1.33	1.48	0.44	0.70	1.0

Soil Conservation District (more staff = higher score)	Howard	Montgomery	Prince George's	Anne Arundel	Charles	Calvert	St. Mary's	
SCD Staff (Local Funding) per Household	1.06	0.16	0.39	0.74	1.35	1.80	1.50	1.0
SCD Staff (Local Funding) per Total Permits	2.36	1.10	0.49	2.23	0.15	0.47	0.20	1.0
SCD Staff Budget (Local $) per Total Permits	2.44	1.23	0.51	2.15	0.15	0.43	0.09	1.0
SCD Staff (State Funding)/Ag. Acres in District	0.30	0.38	0.96	0.56	0.84	2.11	1.85	1.0
SCD Staff (Fed. Funding)/Ag. Acres in District	1.05	0.66	1.27	0.73	0.89	1.85	0.54	1.0
SCD Staff (watershed)/N-equiv. bare const.	0.61	0.43	0.47	0.63	1.93	1.86	1.07	1.0

6. Results, Conclusions and Recommendations

In this section, we summarize the results of the analysis of county level contributions and responses to Patuxent River problems, and present some conclusions regarding what county governments in the watershed need to do to deal realistically with the economic forces that exist in their counties that are contributing to the deteriorating health of the Patuxent River. This section also describes what new county-level data need to be collected to allow county managers and those overseeing Patuxent River water quality management at the State and Federal level to determine whether the spending and regulatory decisions being made by county government can succeed, and whether they are being implemented in ways that make it likely that they will succeed.

As Admiral Watkins of the U.S. Commission on Ocean Policy stated, "We are facing a new generation of environmental problems, such as nonpoint source pollution, that require better data, more coordinated and integrated management strategies, and changes in human behavior." In this project, we tested an approach for examining county-level watershed stewardship that involved a review of readily-available county-level data about nutrient sources, economic sectors, environmental spending, and enforcement. Our goal was to develop an approach for stewardship indicators that could be used by analysts in any watershed using readily-available data, without having to resort to primary data collection. Our testing of this approach demonstrates the challenges faced by researchers in relying solely on aggregate data for NPDES permits, sediment and erosion control, and other permitting and enforcement activities.

Based on our analysis of these data and interview results, we form the following conclusions regarding the implementation of policies to improve Patuxent River water quality:

- The economic base and source of nutrient discharges and implementation of nutrient discharge policies differ significantly from county to county.
- County-level data about how water quality policies are implemented and their successes or failures are not adequate to support meaningful review or justify policy changes.
- Policies that rely solely on private citizens voluntarily restricting their land and water use decisions for the sake of River water quality will not succeed.
- Unless mandatory land and water use restrictions are effectively and uniformly enforced they will not succeed.
- Policies that involve relatively low penalties for violating mandatory land and water use restrictions or penalties that are relatively easy to avoid will not succeed.
- Most counties do not have an adequate number of inspectors to deal effectively with environmental violations.
- Most counties do not allocate enough inspector time to examining environmental violations.
- Most counties do not keep records in a way that allows consistent comparisons of how much county spending and man-power are allocated to enforce environmental laws compared to other jurisdictions.

In future research, we hope to refine and expand the indicators we developed for this project. We also hope to incorporate data about the extent to which each land use (i.e., high till with manure) is used for agricultural economic sectors (i.e., oilseed crops). As additional data is collected at the county, Soil Conservation District, state, and Federal level, we expect that future "leading indicators" of investments in efforts to prevent or reduce nutrient discharges will lead to more effective policies to restore the Patuxent River and Chesapeake Bay.

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Appendix A

County Economic//Nutrient Discharge Profiles

County profiles include:

Page 1: Summary statistics and description of terms
Page 2: County economic/nutrient discharge profiles
Page 3: County economic multipliers and nutrient discharge tradeoffs

Data Sources

County Economic Statistics (2004)

County economic statistics, including direct and "multiplier" economic impacts, were estimated for each county with land in the Patuxent River watershed using the most recent (2004) versions of county input-output models available as part of the IMPLAN (Impact PLANning) regional economic modeling system. County economic statistics were apportioned to the Patuxent watershed based on the percent of county acres and/or population located within the Patuxent watershed. An overview of regional input-output models and the IMPLAN system is included at the end of this appendix.

County Nutrient Discharge Statistics

County nutrient discharge statistics were provided to us in August, 2006 by the Chesapeake Bay Program Office (CBPO) based on special "county-scale" runs of its draft Phase 5 Watershed Model. These model runs generated nutrient discharge estimates for the portions of each county in the Patuxent River watershed by source and by type of land use and for different classes of agricultural land and agricultural land practice, such as high till with and without manure applications, with and without nutrient management practices, and so on. Model runs were also made to generate comparable nutrient discharge estimates from sewer and septic systems within the watershed.

Patuxent Watershed
2004 Economic and Nutrient Discharge Profile

County	% of County Acreage in Patuxent Watershed	% of Watershed Economic Output	% of Nutrient Discharge to Patuxent River
Howard	74.9%	39.6%	23.0%
Montgomery	12.2%	6.0%	7.0%
Prince George's	51.1%	39.0%	27.1%
Anne Arundel	29.9%	8.5%	18.6%
Charles	6.1%	0.4%	1.5%
Calvert	73.5%	4.3%	13.1%
St. Mary's	21.0%	2.2%	9.6%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 1a: Direct Economic and Environmental Impacts

Column 1, total $ output, presents the total dollar output (sales) by each industrial sector in all counties that are located at least partially within the Patuxent River watershed. For example, oilseed farming output in those counties during 2004 is shown to be worth $16.3 million and total dollar output by all sectors in those counties is shown to be $210.9 billion.

Column 2, $ output based in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the Patuxent watershed. Of the $16.3 million in total oilseed farm output in counties that make up the Patuxent River watershed, for example, only $5.5 million are shown to have been produced by farms located within the watershed. Of the $210.9 billion in total county output for these seven counties with land in the Patuxent watershed, only $47.8 billion or 22.7% was produced within the watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measure at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 5).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 1b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as in Table 1a and are provided for reference purposes. The rest of the columns in Table 1b are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 1a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Patuxent River Watershed

Sector	Watershed Direct Impacts			Watershed Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	Total $Output All Counties, All Areas [a]	$ Output Based in Watershed - All Counties [a]	Nutrient Discharges to Patuxent River-All Counties (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 3,609,432	$ 134,276	117	120,692	3,244,284	3,720
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 4,502,316	$ 159,475	262	136,234	3,846,178	2,338
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 4,744,374	$ 63,897	57	105,761	7,852,768	8,848
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,088,213	$ 47,940	26	128,948	2,927,076	5,335
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 42,053,414	$ 746,844	735	2,870	161,604	164
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 561,920	$ 14,903	13	130,476	4,919,674	5,458
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 3,209,667	$ 122,345	41	124,545	3,267,398	9,783
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 864,036	$ 165,495	85	205,321	1,071,967	2,086
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 125,456	$ 593	3	58,881	12,459,715	2,754
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 621,582	$ 124,389	214	63,484	317,234	184
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,505,102	$ 47,848	24	14,100	443,528	877
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 165,923	$ 21,379	1	39,267	304,756	6,788
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 6,101,677	$ 1,251,644	195	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 3,040,306	$ 50,827	206	135	8,083	2
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 49,528,893	$ 4,195,493	747	295	3,478	20
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,971,983,527	$ 203,181,273	20,242	138	1,335	13
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 2,810,489,281	$ 37,938,031	42,951	123	9,079	8
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,328,160,396	$ 30,309,364	13,585	174	7,641	17
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 3,650,308,651	$ 989,264,820	68,071	96	356	5
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 2,676,006,054	$ 333,679,883	23,967	88	703	10
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 8,226,939,668	$ 302,998,757	167,752	96	2,596	5
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 4,570,985,504	$ 293,540,534	22,567	69	1,076	14
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 2,549,742,157	$ 73,934	43,986	63	2,160,875	4
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**	**$ 27,906,337,550**	**$ 2,198,133,945**	**405,848**			
Other Sectors									
Point Source (Household Only) [e]			1,679,037						
Septic (Household Only)			536,799						
Atmospheric (All Sources)			602,601						
Undeveloped Land									
Natural Grasses			41,210						
Forest			385,673						
Total Estimated Nutrient Discharge into the Patuxent			**8,493,234**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 1b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Patuxent River Watershed

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	Watershed Direct Impacts: Total $ Output All Counties, All Areas [a]	Watershed Direct Impacts: $ Output Based in Watershed - All Counties [a]	Watershed Direct Impacts: Nutrient Discharges to Patuxent River - All Counties (pounds) [b]	Watershed Multiplier Impacts: Per $1,000,000 direct output in the Watershed [c]: $ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds of Nutrient to Patuxent River per Business Impact [c]: Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 16,332,000	$ 5,507,273	435,631	$ 1,426,511	$ 887,223	$ 45,569	26	18,698	30,064	585,342	1,029
Grain farming	$ 19,162,000	$ 7,760,691	613,369	$ 1,438,215	$ 814,074	$ 41,764	37	22,257	39,320	766,442	861
Vegetable and melon farming	$ 14,603,000	$ 6,187,409	501,769	$ 1,452,164	$ 1,020,768	$ 33,089	13	23,662	33,662	1,038,433	2,584
Fruit farming	$ 5,034,000	$ 1,819,847	140,323	$ 1,479,158	$ 857,737	$ 49,519	18	18,845	32,498	562,916	1,509
Greenhouse and nursery production	$ 122,609,000	$ 57,122,830	120,693	$ 1,602,949	$ 1,079,360	$ 43,092	17	614	912	22,844	58
Tobacco farming	$ 2,792,000	$ 733,483	73,317	$ 1,406,118	$ 992,033	$ 40,572	22	18,675	26,471	647,237	1,214
All other crop farming	$ 13,622,000	$ 5,466,454	399,749	$ 1,467,742	$ 837,669	$ 44,668	11	19,994	35,033	656,977	2,587
Cattle ranching and farming	$ 17,512,000	$ 6,205,800	177,405	$ 1,461,891	$ 377,678	$ 49,013	18	6,930	26,823	206,689	571
Poultry and egg production	$ 669,000	$ 251,676	7,387	$ 1,536,309	$ 773,579	$ 27,731	13	7,187	14,274	398,174	881
Animal production, except cattle and poultry	$ 17,855,000	$ 6,102,639	39,460	$ 1,560,852	$ 380,874	$ 45,696	36	1,416	5,803	48,364	61
Logging	$ 26,907,000	$ 5,514,510	21,222	$ 1,425,268	$ 487,188	$ 27,175	8	553	1,619	29,024	100
Forest nurseries, forest products, and timber	$ 4,719,000	$ 659,437	6,515	$ 1,291,858	$ 402,706	$ 44,845	6	1,069	3,428	30,787	250
Fishing, hunting and trapping	$ 61,636,000	$ 26,729,603	0	$ 2,394,679	$ 1,245,266	$ 114,871	51	0	0	0	0
Agriculture and forestry support activities	$ 27,905,000	$ 5,574,175	411	$ 1,961,947	$ 1,093,168	$ 54,353	44	8	13	271	0
Mining	$ 301,532,000	$ 182,130,044	14,590	$ 1,679,901	$ 746,458	$ 53,943	10	29	65	897	5
Transportation, Communications, and Utilities	$ 27,585,486,000	$ 3,815,760,329	271,149	$ 1,720,099	$ 911,521	$ 89,045	9	6	11	110	1
Construction	$ 18,499,695,000	$ 5,391,681,426	344,443	$ 1,915,087	$ 1,023,337	$ 55,216	16	10	18	337	1
Manufacturing	$ 17,437,900,000	$ 4,568,361,970	231,593	$ 1,809,730	$ 747,636	$ 43,959	9	7	18	302	1
Wholesale and Retail Trade	$ 22,883,904,000	$ 6,945,707,932	351,918	$ 1,835,039	$ 1,001,929	$ 184,334	17	8	15	83	1
Finance, Insurance, and Real Estate	$ 24,357,828,000	$ 4,615,779,457	234,601	$ 1,683,902	$ 968,580	$ 106,793	11	6	10	90	1
Services	$ 61,541,902,000	$ 14,116,724,200	786,725	$ 1,967,218	$ 1,145,064	$ 68,579	20	6	11	186	1
Federal Government Enterprises	$ 28,398,670,000	$ 5,332,501,739	315,881	$ 1,691,162	$ 1,287,597	$ 79,146	11	7	9	141	1
State and Local Government Enterprises	$ 9,626,558,000	$ 2,709,769,111	159,763	$ 1,878,615	$ 1,461,964	$ 43,615	24	9	11	381	1
Total Industrial Sectors	**$ 210,984,832,000**	**$ 47,814,052,036**	**5,247,914**								
Other Sectors											
Point Source (Household Only) [e]			1,679,037								
Septic (Household Only)			536,799								
Atmospheric (All Sources)			602,601								
Undeveloped Land											
Natural Grasses			41,210								
Forest			385,673								
Total Estimated Nutrient Discharge into the Patuxent			**8,493,234**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Howard County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	197,869	20.2%
Annual Economic Output	$18,928,832,957	39.6%
Nutrient Discharge to Patuxent River	1,952,457 lbs.	23.0%
Environmental Spending	$1,255,915	7.4%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 2a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 2b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 2a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 2a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Howard County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 1,595,000	$ 1,230,694	83,243	$ 806,317	$ 30,092	17	103,239	2,766,279	4,904
Grain farming	$ 3,283,000	$ 2,533,146	171,341	$ 1,469,888	$ 51,697	54	116,567	3,314,331	3,172
Vegetable and melon farming	$ 2,595,000	$ 2,002,289	135,434	$ 1,534,702	$ 20,833	13	88,248	6,500,899	10,325
Fruit farming	$ 652,000	$ 503,080	34,028	$ 300,922	$ 13,117	5	113,079	2,594,170	6,300
Greenhouse and nursery production	$ 22,575,000	$ 17,418,757	80,744	$ 12,823,908	$ 227,621	208	6,296	354,732	389
Tobacco farming	$ -	$ -	0	$ -	$ -	0	0	0	0
All other crop farming	$ 2,139,000	$ 1,650,442	111,635	$ 969,123	$ 37,037	9	115,192	3,014,181	12,057
Cattle ranching and farming	$ 3,899,000	$ 2,977,941	72,514	$ 414,727	$ 79,432	29	174,848	912,907	2,498
Poultry and egg production	$ -	$ -	0	$ -	$ -	0	0	0	0
Animal production, except cattle and poultry	$ 3,738,000	$ 2,636,542	11,223	$ 268,733	$ 53,605	81	41,763	209,366	138
Logging	$ -	$ -	2,042	$ -	$ -	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	2,042	$ -	$ -	0	0	0	0
Fishing, hunting and trapping	$ 26,435,000	$ 19,750,143	0	$ 4,691,920	$ 1,015,337	125	0	0	0
Agriculture and forestry support activities	$ 2,963,000	$ 2,298,104	92	$ 1,117,640	$ 18,614	99	83	4,963	1
Mining	$ 2,378,000	$ 1,776,518	2,455	$ 1,083,990	$ 40,341	5	2,265	60,849	469
Transportation, Communications, and Utilities	$ 985,461,000	$ 764,323,828	30,726	$ 375,955,173	$ 31,092,264	4,232	82	988	7
Construction	$ 2,651,763,000	$ 2,030,546,436	113,046	$ 1,080,915,426	$ 14,578,819	15,575	105	7,754	7
Manufacturing	$ 2,900,094,000	$ 2,249,313,721	90,422	$ 611,865,632	$ 14,644,885	6,030	148	6,174	15
Wholesale and Retail Trade	$ 4,701,744,000	$ 3,646,673,967	146,596	$ 1,922,377,261	$ 531,104,702	32,109	76	276	5
Finance, Insurance, and Real Estate	$ 3,176,674,000	$ 2,463,829,246	99,045	$ 1,403,180,350	$ 185,423,535	11,183	71	534	9
Services	$ 7,890,016,000	$ 6,119,498,625	246,003	$ 3,575,345,887	$ 113,641,729	62,997	69	2,165	4
Federal Government Enterprises	$ 1,094,067,000	$ 848,558,672	34,112	$ 603,098,247	$ 95,928,570	788	57	356	43
State and Local Government Enterprises	$ 968,683,000	$ 751,310,807	30,203	$ 701,416,441	$ 23,268	12,566	43	1,298,029	2
Total Industrial Sectors	**$ 24,440,754,000**	**$ 18,928,832,957**	**1,496,946**	**$ 10,299,636,288**	**$ 988,025,498**	**146,125**			
Other Sectors									
Point Source (Household Only) [e]			52,745						
Septic (Household Only)			129,197						
Atmospheric (All Sources)			200,339						
Undeveloped Land									
Natural Grasses			18,142						
Forest			55,089						
Total Estimated Nutrient Discharge into the Patuxent			**1,952,457**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 2b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Howard County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed [c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 1,595,000	$ 1,230,694	83,243	$ 1,087,207	$ 665,950	$ 34,720	13	48,004	78,370	1,503,165	4,113
Grain farming	$ 3,283,000	$ 2,533,146	171,341	$ 1,099,190	$ 609,849	$ 31,739	19	47,481	85,579	1,644,368	2,797
Vegetable and melon farming	$ 2,595,000	$ 2,002,289	135,434	$ 1,086,977	$ 756,910	$ 24,386	7	48,014	68,952	2,140,149	6,980
Fruit farming	$ 652,000	$ 503,080	34,028	$ 1,125,530	$ 638,905	$ 37,528	11	46,369	81,687	1,390,699	4,553
Greenhouse and nursery production	$ 22,575,000	$ 17,418,757	80,744	$ 1,226,348	$ 811,912	$ 33,634	13	2,917	4,405	106,343	285
Tobacco farming	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
All other crop farming	$ 2,139,000	$ 1,650,442	111,635	$ 1,118,047	$ 624,964	$ 33,829	7	46,680	83,509	1,542,764	7,865
Cattle ranching and farming	$ 3,899,000	$ 2,977,941	72,514	$ 1,113,876	$ 275,721	$ 36,747	10	16,697	67,453	506,120	1,875
Poultry and egg production	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Animal production, except cattle and poultry	$ 3,738,000	$ 2,636,542	11,223	$ 1,112,996	$ 259,723	$ 32,024	24	2,698	11,560	93,756	123
Logging	$ -	$ -	2,042	$ -	$ -	$ -	0	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	2,042	$ -	$ -	$ -	0	0	0	0	0
Fishing, hunting and trapping	$ 26,435,000	$ 19,750,143	0	$ 973,023	$ 293,288	$ 46,312	9	0	0	0	0
Agriculture and forestry support activities	$ 2,963,000	$ 2,298,104	92	$ 1,468,853	$ 735,033	$ 38,699	39	21	42	806	1
Mining	$ 2,378,000	$ 1,776,517.9	2,455	$ 1,203,032	$ 699,899	$ 38,608	6	858	1,475	26,737	187
Transportation, Communications, and Utilities	$ 985,461,000	$ 764,323,828	30,726	$ 1,337,881	$ 683,811	$ 57,575	8	23	46	542	4
Construction	$ 2,651,763,000	$ 2,030,546,436	113,046	$ 1,415,071	$ 743,335	$ 40,360	10	30	57	1,056	4
Manufacturing	$ 2,900,094,000	$ 2,249,313,721	90,422	$ 1,374,371	$ 503,827	$ 31,931	6	23	62	976	5
Wholesale and Retail Trade	$ 4,701,744,000	$ 3,646,673,967	146,596	$ 1,355,459	$ 727,196	$ 141,908	11	23	43	220	3
Finance, Insurance, and Real Estate	$ 3,176,674,000	$ 2,463,829,246	99,045	$ 1,262,023	$ 712,601	$ 84,156	7	25	44	370	5
Services	$ 7,890,016,000	$ 6,119,498,625	246,003	$ 1,449,920	$ 818,294	$ 47,103	13	22	38	662	2
Federal Government Enterprises	$ 1,094,067,000	$ 848,558,672	34,112	$ 972,307	$ 657,777	$ 98,227	2	32	47	317	15
State and Local Government Enterprises	$ 968,683,000	$ 751,310,807	30,203	$ 1,375,156	$ 1,053,274	$ 31,935	17	23	30	976	2
Total Industrial Sectors	**$ 24,440,754,000**	**$ 18,928,832,957**	**1,496,946**								
Other Sectors											
Point Source (Household Only) [e]			52,745								
Septic (Household Only)			129,197								
Atmospheric (All Sources)			200,339								
Undeveloped Land											
Natural Grasses			18,142								
Forest			55,089								
Total Estimated Nutrient Discharge into the Patuxent			**1,952,457**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Montgomery County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	112,503	11.5%
Annual Economic Output	$2,886,014,539	6.0%
Nutrient Discharge to Patuxent River	598,372 lbs.	7.0%
Environmental Spending	$6,057,359	35.8%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 3a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 3b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 3a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 3a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Montgomery County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 5,063,000	$ 953,189	53,635	$ 624,853	$ 23,157	9	85,836	2,316,186	6,062
Grain farming	$ 5,661,000	$ 1,065,771	59,970	$ 618,264	$ 21,839	15	96,998	2,746,034	3,933
Vegetable and melon farming	$ 4,757,000	$ 895,579	50,394	$ 686,605	$ 9,413	4	73,395	5,353,451	12,746
Fruit farming	$ 2,338,000	$ 440,165	24,768	$ 263,195	$ 11,672	3	94,104	2,121,893	7,309
Greenhouse and nursery production	$ 52,097,000	$ 9,808,071	8,578	$ 7,220,738	$ 128,209	79	1,188	66,904	109
Tobacco farming	$ -	$ -	0	$ -	$ -	0	0	0	0
All other crop farming	$ 4,089,000	$ 769,818	43,317	$ 452,214	$ 17,132	3	95,789	2,528,404	15,339
Cattle ranching and farming	$ 6,872,000	$ 1,120,230	19,148	$ 156,004	$ 29,832	7	122,743	641,884	2,610
Poultry and egg production	$ -	$ -	0	$ -	$ -	0	0	0	0
Animal production, except cattle and poultry	$ 6,089,000	$ 334,656	1,255	$ 34,131	$ 6,815	7	36,760	184,095	181
Logging	$ -	$ -	990	$ -	$ -	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	990	$ -	$ -	0	0	0	0
Fishing, hunting and trapping	$ 25,049,000	$ 3,135,085	0	$ 573,850	$ 112,267	23	0	0	0
Agriculture and forestry support activities	$ 11,141,000	$ 314,190	16	$ 178,345	$ 3,018	11	89	5,280	1
Mining	$ 70,910,000	$ 540,278	102	$ 309,736	$ 15,917	4	329	6,408	29
Transportation, Communications, and Utilities	$ 17,988,223,000	$ 507,290,701	25,724	$ 254,330,204	$ 30,166,135	994	101	853	26
Construction	$ 6,060,053,000	$ 398,430,844	14,603	$ 210,655,843	$ 2,842,970	3,095	69	5,136	5
Manufacturing	$ 5,768,433,000	$ 162,677,126	8,249	$ 52,191,918	$ 1,136,680	419	158	7,257	20
Wholesale and Retail Trade	$ 6,825,073,000	$ 192,475,714	9,760	$ 100,016,249	$ 28,217,794	1,864	98	346	5
Finance, Insurance, and Real Estate	$ 14,464,649,000	$ 407,921,446	20,685	$ 229,155,355	$ 29,705,101	2,342	90	696	9
Services	$ 27,572,082,000	$ 777,567,679	39,429	$ 473,691,964	$ 16,674,028	9,025	83	2,365	4
Federal Government Enterprises	$ 12,299,395,000	$ 346,858,537	17,589	$ 311,461,010	$ 13,669,973	1,436	56	1,287	12
State and Local Government Enterprises	$ 2,603,268,000	$ 73,415,459	3,723	$ 69,679,270	$ 1,889	1,152	53	1,970,249	3
Total Industrial Sectors	**$ 93,775,242,000**	**$ 2,886,014,539**	**402,923**	**$ 1,712,299,748**	**$ 122,793,840**	**20,490**			
Other Sectors									
Point Source (Household Only) [e]			98						
Septic (Household Only)			13,548						
Atmospheric (All Sources)			145,859						
Undeveloped Land									
Natural Grasses			13,772						
Forest			22,171						
Total Estimated Nutrient Discharge into the Patuxent			**598,372**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 3b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Montgomery County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 5,063,000	$ 953,189	53,635	$ 262,367	$ 164,084	$ 8,404	2	40,377	64,562	1,260,539	4,668
Grain farming	$ 5,661,000	$ 1,065,771	59,970	$ 262,339	$ 149,117	$ 7,597	3	40,381	71,042	1,394,493	3,287
Vegetable and melon farming	$ 4,757,000	$ 895,579	50,394	$ 259,112	$ 184,472	$ 5,623	1	40,884	57,426	1,884,118	7,633
Fruit farming	$ 2,338,000	$ 440,165	24,768	$ 261,806	$ 152,552	$ 8,634	2	40,463	69,442	1,226,924	5,308
Greenhouse and nursery production	$ 52,097,000	$ 9,808,071	8,578	$ 283,517	$ 193,305	$ 7,347	2	581	852	22,411	73
Tobacco farming	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
All other crop farming	$ 4,089,000	$ 769,818	43,317	$ 264,980	$ 151,898	$ 8,002	1	39,979	69,741	1,323,794	8,510
Cattle ranching and farming	$ 6,872,000	$ 1,120,230	19,148	$ 227,217	$ 56,288	$ 7,650	2	12,263	49,503	364,228	1,825
Poultry and egg production	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Animal production, except cattle and poultry	$ 6,089,000	$ 334,656	1,255	$ 81,599	$ 18,827	$ 2,391	1	2,525	10,944	86,184	157
Logging	$ -	$ -	990	$ -	$ -	$ -	0	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	990	$ -	$ -	$ -	0	0	0	0	0
Fishing, hunting and trapping	$ 25,049,000	$ 3,135,085	0	$ 153,200	$ 38,840	$ 5,566	1	0	0	0	0
Agriculture and forestry support activities	$ 11,141,000	$ 314,190	16	$ 53,160	$ 30,183	$ 1,469	1	27	47	973	1
Mining	$ 70,910,000	540,277.65	102	$ 11,823	$ 6,776	$ 419	0	122	212	3,430	17
Transportation, Communications, and Utilities	$ 17,988,223,000	$ 507,290,701	25,724	$ 46,037	$ 24,236	$ 2,541	0	31	59	563	8
Construction	$ 6,060,053,000	$ 398,430,844	14,603	$ 121,532	$ 65,950	$ 3,507	1	20	37	687	3
Manufacturing	$ 5,768,433,000	$ 162,677,126	8,249	$ 48,687	$ 20,070	$ 1,179	0	29	71	1,213	6
Wholesale and Retail Trade	$ 6,825,073,000	$ 192,475,714	9,760	$ 50,418	$ 27,593	$ 5,243	0	28	52	273	3
Finance, Insurance, and Real Estate	$ 14,464,649,000	$ 407,921,446	20,685	$ 47,232	$ 26,930	$ 3,046	0	30	53	470	5
Services	$ 27,572,082,000	$ 777,567,679	39,429	$ 53,804	$ 32,021	$ 1,854	1	27	45	771	3
Federal Government Enterprises	$ 12,299,395,000	$ 346,858,537	17,589	$ 47,116	$ 36,537	$ 2,084	0	30	39	686	5
State and Local Government Enterprises	$ 2,603,268,000	$ 73,415,459	3,723	$ 51,280	$ 40,471	$ 1,164	1	28	35	1,229	2
Total Industrial Sectors	**$ 93,775,242,000**	**$ 2,886,014,539**	**402,923**								
Other Sectors											
Point Source (Household Only) [e]			98								
Septic (Household Only)			13,548								
Atmospheric (All Sources)			145,859								
Undeveloped Land											
Natural Grasses			13,772								
Forest			22,171								
Total Estimated Nutrient Discharge into the Patuxent			**598,372**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Prince George's County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	428,406	43.7%
Annual Economic Output	$18,629,357,142	39.0%
Nutrient Discharge to Patuxent River	2,304,495 lbs.	27.1%
Environmental Spending	$1,301,903	7.7%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 4a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 4b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 4a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 4a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Prince George's County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 1,313,000	$ 981,934	101,574	$ 643,903	$ 23,931	16	157,747	4,244,372	6,468
Grain farming	$ 1,446,000	$ 1,081,399	111,863	$ 627,451	$ 22,436	26	178,281	4,985,925	4,274
Vegetable and melon farming	$ 2,253,000	$ 1,684,918	174,292	$ 1,292,294	$ 17,201	13	134,870	10,132,860	13,709
Fruit farming	$ 552,000	$ 412,816	42,703	$ 246,044	$ 11,218	5	173,557	3,806,681	8,157
Greenhouse and nursery production	$ 30,689,000	$ 22,950,934	13,429	$ 16,896,297	$ 299,890	314	795	44,781	43
Tobacco farming	$ 214,000	$ 160,041	16,555	$ 122,648	$ 2,991	1	134,980	5,534,170	11,068
All other crop farming	$ 898,000	$ 671,574	69,469	$ 394,120	$ 14,957	4	176,264	4,644,565	15,482
Cattle ranching and farming	$ 1,181,000	$ 726,914	30,478	$ 100,943	$ 19,696	8	301,930	1,547,390	3,809
Poultry and egg production	$ 231,000	$ 97,493	600	$ 48,536	$ 422	0	12,365	1,422,011	1,422
Animal production, except cattle and poultry	$ 3,257,000	$ 1,374,615	8,462	$ 139,698	$ 28,277	49	60,573	299,250	174
Logging	$ 817,000	$ 468,430	7,251	$ 126,711	$ 4,013	2	57,227	1,806,752	3,162
Forest nurseries, forest products, and timber	$ -	$ -	0	$ -	$ -	0	0	0	0
Fishing, hunting and trapping	$ 5,864,000	$ 3,008,376	0	$ 603,317	$ 117,996	21	0	0	0
Agriculture and forestry support activities	$ 2,556,000	$ 1,082,131	50	$ 679,084	$ 11,431	30	73	4,358	2
Mining	$ 21,861,000	$ 7,177,109	5,452	$ 4,207,905	$ 186,806	44	1,296	29,185	125
Transportation, Communications, and Utilities	$ 3,608,740,000	$ 1,527,827,982	70,333	$ 784,189,547	$ 71,608,602	9,514	90	982	7
Construction	$ 5,430,498,000	$ 2,090,154,699	128,085	$ 1,085,101,873	$ 14,661,687	16,768	118	8,736	8
Manufacturing	$ 3,699,802,000	$ 1,566,380,793	72,108	$ 455,569,402	$ 10,988,538	5,029	158	6,562	14
Wholesale and Retail Trade	$ 5,655,745,000	$ 2,394,466,066	110,229	$ 1,263,044,234	$ 327,942,755	25,555	87	336	4
Finance, Insurance, and Real Estate	$ 2,996,458,000	$ 1,268,606,877	58,400	$ 760,101,132	$ 85,247,851	7,124	77	685	8
Services	$ 12,212,104,000	$ 5,170,224,015	238,010	$ 3,023,999,831	$ 122,825,644	67,626	79	1,938	4
Federal Government Enterprises	$ 7,359,900,000	$ 3,115,952,151	143,442	$ 2,782,220,674	$ 129,423,847	14,198	52	1,108	10
State and Local Government Enterprises	$ 3,434,041,000	$ 1,453,865,873	66,928	$ 1,382,946,940	$ 36,410	23,802	48	1,838,204	3
Total Industrial Sectors	**$ 44,470,420,000**	**$ 18,629,357,142**	**1,469,714**	**$ 11,563,302,584**	**$ 763,496,600**	**170,151**			
Other Sectors									
Point Source (Household Only) [e]			593,758						
Septic (Household Only)			51,764						
Atmospheric (All Sources)			77,895						
Undeveloped Land									
Natural Grasses			2,022						
Forest			109,342						
Total Estimated Nutrient Discharge into the Patuxent			**2,304,495**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 4b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Prince George's County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 1,313,000	$ 981,934	101,574	$ 1,016,237	$ 641,873	$ 32,079	14	76,124	120,522	2,411,583	5,517
Grain farming	$ 1,446,000	$ 1,081,399	111,863	$ 1,010,759	$ 579,854	$ 28,801	20	76,537	133,413	2,685,979	3,789
Vegetable and melon farming	$ 2,253,000	$ 1,684,918	174,292	$ 1,023,089	$ 732,865	$ 22,078	8	75,614	105,558	3,503,910	9,457
Fruit farming	$ 552,000	$ 412,816	42,703	$ 1,022,662	$ 601,101	$ 33,779	12	75,646	128,697	2,290,171	6,374
Greenhouse and nursery production	$ 30,689,000	$ 22,950,934	13,429	$ 1,144,789	$ 783,923	$ 29,968	14	382	558	14,602	31
Tobacco farming	$ 214,000	$ 160,041	16,555	$ 997,267	$ 716,430	$ 28,122	8	77,572	107,980	2,750,836	9,627
All other crop farming	$ 898,000	$ 671,574	69,469	$ 1,024,332	$ 592,932	$ 30,599	7	75,522	130,470	2,528,227	10,966
Cattle ranching and farming	$ 1,181,000	$ 726,914	30,478	$ 825,608	$ 199,739	$ 27,286	9	31,258	129,202	945,785	2,981
Poultry and egg production	$ 231,000	$ 97,493	600	$ 577,901	$ 291,750	$ 8,970	3	4,496	8,905	289,648	830
Animal production, except cattle and poultry	$ 3,257,000	$ 1,374,615	8,462	$ 598,479	$ 133,707	$ 17,156	16	4,341	19,431	151,440	159
Logging	$ 817,000	$ 468,430	7,251	$ 746,070	$ 251,894	$ 13,710	4	11,896	35,235	647,379	2,168
Forest nurseries, forest products, and timber	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Fishing, hunting and trapping	$ 5,864,000	$ 3,008,376	0	$ 585,620	$ 145,257	$ 23,353	4	0	0	0	0
Agriculture and forestry support activities	$ 2,556,000	$ 1,082,131	50	$ 792,740	$ 480,518	$ 22,529	15	25	41	865	1
Mining	$ 21,861,000	7,177,109.17	5,452	$ 517,707	$ 302,740	$ 17,480	4	482	824	14,267	65
Transportation, Communications, and Utilities	$ 3,608,740,000	$ 1,527,827,982	70,333	$ 719,249	$ 389,255	$ 33,761	5	27	50	577	4
Construction	$ 5,430,498,000	$ 2,090,154,699	128,085	$ 692,787	$ 374,571	$ 19,588	6	34	63	1,204	4
Manufacturing	$ 3,699,802,000	$ 1,566,380,793	72,108	$ 702,860	$ 276,159	$ 16,569	4	28	71	1,176	5
Wholesale and Retail Trade	$ 5,655,745,000	$ 2,394,466,066	110,229	$ 748,057	$ 414,474	$ 73,967	8	26	47	263	3
Finance, Insurance, and Real Estate	$ 2,996,458,000	$ 1,268,606,877	58,400	$ 669,800	$ 400,288	$ 40,850	5	29	49	477	4
Services	$ 12,212,104,000	$ 5,170,224,015	238,010	$ 795,612	$ 465,898	$ 28,016	9	24	42	696	2
Federal Government Enterprises	$ 7,359,900,000	$ 3,115,952,151	143,442	$ 700,422	$ 543,817	$ 31,772	5	28	36	613	4
State and Local Government Enterprises	$ 3,434,041,000	$ 1,453,865,873	66,928	$ 771,003	$ 611,025	$ 17,529	10	25	32	1,112	2
Total Industrial Sectors	**$ 44,470,420,000**	**$ 18,629,357,142**	**1,469,714**								
Other Sectors											
Point Source (Household Only) [e]			593,758								
Septic (Household Only)			51,764								
Atmospheric (All Sources)			77,895								
Undeveloped Land											
Natural Grasses			2,022								
Forest			109,342								
Total Estimated Nutrient Discharge into the Patuxent			**2,304,495**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Anne Arundel County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	151,694	15.5%
Annual Economic Output	$4,056,900,679	8.5%
Nutrient Discharge to Patuxent River	1,582,774 lbs.	18.6%
Environmental Spending	$3,922,336	23.2%

7.1.1.1

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 5a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 5b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 5a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 5a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Anne Arundel County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 2,186,000	$ 1,119,174	64,744	$ 733,658	$ 27,135	16	88,248	2,386,029	3,952
Grain farming	$ 2,679,000	$ 1,371,577	79,345	$ 795,607	$ 28,159	31	99,729	2,817,808	2,583
Vegetable and melon farming	$ 1,331,000	$ 681,437	39,421	$ 522,213	$ 7,168	5	75,488	5,499,857	8,555
Fruit farming	$ 453,000	$ 231,924	13,417	$ 138,745	$ 6,144	3	96,701	2,183,828	5,241
Greenhouse and nursery production	$ 10,623,000	$ 5,438,694	15,566	$ 4,004,145	$ 71,164	69	3,888	218,737	227
Tobacco farming	$ 194,000	$ 99,323	5,746	$ 75,772	$ 2,048	1	75,830	2,805,712	11,223
All other crop farming	$ 3,209,000	$ 1,642,923	95,043	$ 964,558	$ 36,862	10	98,535	2,578,331	9,771
Cattle ranching and farming	$ 793,000	$ 340,843	24,582	$ 47,709	$ 9,026	3	515,253	2,723,481	7,149
Poultry and egg production	$ -	$ -	0	$ -	$ -	0	0	0	0
Animal production, except cattle and poultry	$ 3,792,000	$ 1,495,058	4,498	$ 152,187	$ 30,753	48	29,557	146,269	93
Logging	$ 5,692,000	$ 1,946,316	3,489	$ 526,928	$ 16,755	9	6,621	208,233	408
Forest nurseries, forest products, and timber	$ -	$ -	0	$ -	$ -	0	0	0	0
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	0	0	0	0
Agriculture and forestry support activities	$ 7,292,000	$ 752,082	63	$ 394,812	$ 6,704	29	161	9,459	2
Mining	$ 191,967,000	172,636,139	6,301	$ 43,927,263	$ 3,952,428	694	143	1,594	9
Transportation, Communications, and Utilities	$ 3,280,659,000	$ 338,360,475	28,528	$ 166,217,651	$ 12,493,307	2,500	172	2,283	11
Construction	$ 2,898,475,000	$ 454,281,907	60,920	$ 230,386,938	$ 3,109,080	3,791	264	19,594	16
Manufacturing	$ 4,591,371,000	$ 473,544,636	39,926	$ 175,569,273	$ 2,976,458	1,572	227	13,414	25
Wholesale and Retail Trade	$ 4,430,283,000	$ 456,930,348	38,525	$ 237,414,094	$ 66,716,852	4,832	162	577	8
Finance, Insurance, and Real Estate	$ 2,957,525,000	$ 305,033,093	25,718	$ 181,454,325	$ 20,604,283	2,051	142	1,248	13
Services	$ 9,958,800,000	$ 1,027,130,310	86,601	$ 594,168,398	$ 27,109,606	13,300	146	3,194	7
Federal Government Enterprises	$ 6,118,224,000	$ 631,021,138	53,203	$ 569,195,707	$ 22,943,142	4,465	93	2,319	12
State and Local Government Enterprises	$ 1,772,803,000	$ 182,843,284	15,416	$ 177,696,493	$ 2,269	2,803	87	6,794,119	5
Total Industrial Sectors	**$ 36,238,351,000**	**$ 4,056,900,679**	**701,053**	**$ 2,384,386,476**	**$ 160,149,343**	**36,230**			
Other Sectors									
Point Source (Household Only) [e]			712,553						
Septic (Household Only)			77,231						
Atmospheric (All Sources)			42,338						
Undeveloped Land									
Natural Grasses			1,784						
Forest			47,815						
Total Estimated Nutrient Discharge into the Patuxent			**1,582,774**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 5b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Anne Arundel County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
Sector	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 2,186,000	$ 1,119,174	64,744	$ 761,211	$ 471,005	$ 23,754	10	38,908	62,882	1,246,869	3,101
Grain farming	$ 2,679,000	$ 1,371,577	79,345	$ 772,470	$ 436,089	$ 21,892	14	38,341	67,916	1,352,862	2,156
Vegetable and melon farming	$ 1,331,000	$ 681,437	39,421	$ 763,929	$ 533,105	$ 16,985	6	38,770	55,557	1,743,775	4,973
Fruit farming	$ 453,000	$ 231,924	13,417	$ 793,888	$ 458,298	$ 25,846	9	37,307	64,625	1,145,925	3,384
Greenhouse and nursery production	$ 10,623,000	$ 5,438,694	15,566	$ 865,255	$ 576,558	$ 23,143	10	1,694	2,542	63,316	150
Tobacco farming	$ 194,000	$ 99,323	5,746	$ 739,310	$ 517,906	$ 20,838	6	40,061	57,187	1,421,335	5,181
All other crop farming	$ 3,209,000	$ 1,642,923	95,043	$ 787,820	$ 448,188	$ 23,322	5	37,594	66,083	1,269,916	5,524
Cattle ranching and farming	$ 793,000	$ 340,843	24,582	$ 640,444	$ 171,046	$ 20,873	6	48,403	181,234	1,485,101	4,971
Poultry and egg production	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Animal production, except cattle and poultry	$ 3,792,000	$ 1,495,058	4,498	$ 658,642	$ 173,207	$ 18,709	15	1,801	6,849	63,405	79
Logging	$ 5,692,000	$ 1,946,316	3,489	$ 515,190	$ 179,735	$ 9,852	3	1,190	3,410	62,219	197
Forest nurseries, forest products, and timber	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Agriculture and forestry support activities	$ 7,292,000	$ 752,082	63	$ 212,813	$ 114,674	$ 5,710	5	41	76	1,523	2
Mining	$ 191,967,000	172,636,139.18	6,301	$ 1,657,222	$ 622,059	$ 49,688	10	20	53	661	3
Transportation, Communications, and Utilities	$ 3,280,659,000	$ 338,360,475	28,528	$ 198,326	$ 103,755	$ 7,924	2	44	84	1,097	5
Construction	$ 2,898,475,000	$ 454,281,907	60,920	$ 318,922	$ 168,103	$ 9,036	3	66	125	2,326	8
Manufacturing	$ 4,591,371,000	$ 473,544,636	39,926	$ 201,770	$ 90,526	$ 4,849	1	43	96	1,793	7
Wholesale and Retail Trade	$ 4,430,283,000	$ 456,930,348	38,525	$ 195,019	$ 106,093	$ 19,323	2	45	82	450	4
Finance, Insurance, and Real Estate	$ 2,957,525,000	$ 305,033,093	25,718	$ 174,213	$ 102,545	$ 10,384	1	50	85	837	6
Services	$ 9,958,800,000	$ 1,027,130,310	86,601	$ 210,489	$ 120,539	$ 7,540	2	41	72	1,153	4
Federal Government Enterprises	$ 6,118,224,000	$ 631,021,138	53,203	$ 185,903	$ 141,093	$ 7,710	2	47	62	1,128	6
State and Local Government Enterprises	$ 1,772,803,000	$ 182,843,284	15,416	$ 199,576	$ 156,305	$ 4,551	2	44	56	1,911	3
Total Industrial Sectors	**$ 36,238,351,000**	**$ 4,056,900,679**	**701,053**								
Other Sectors											
Point Source (Household Only) [e]			712,553								
Septic (Household Only)			77,231								
Atmospheric (All Sources)			42,338								
Undeveloped Land											
Natural Grasses			1,784								
Forest			47,815								
Total Estimated Nutrient Discharge into the Patuxent			**1,582,774**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Charles County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	8,174	0.8%
Annual Economic Output	$204,680,009	0.4%
Nutrient Discharge to Patuxent River	126,693 lbs.	1.5%
Environmental Spending	$560,082	3.3%

7.1.1.2

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 6a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 6b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 6a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 6a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Charles County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 2,381,000	$ 140,391	12,306	$ 92,041	$ 3,420	5	133,706	3,598,525	2,455
Grain farming	$ 1,512,000	$ 89,152	7,815	$ 51,710	$ 1,828	5	151,128	4,275,464	1,578
Vegetable and melon farming	$ 1,048,000	$ 61,793	5,417	$ 47,347	$ 649	1	114,403	8,351,447	5,104
Fruit farming	$ 345,000	$ 20,342	1,783	$ 12,146	$ 531	1	146,806	3,360,236	3,024
Greenhouse and nursery production	$ 2,548,000	$ 150,237	408	$ 110,614	$ 1,946	5	3,686	209,564	88
Tobacco farming	$ 509,000	$ 30,012	2,631	$ 23,054	$ 590	1	114,113	4,461,809	4,958
All other crop farming	$ 1,230,000	$ 72,524	6,357	$ 42,630	$ 1,592	1	149,128	3,993,324	5,990
Cattle ranching and farming	$ 1,339,000	$ 56,484	2,235	$ 7,846	$ 1,519	1	284,811	1,471,523	1,558
Poultry and egg production	$ 102,000	$ 5,302	352	$ 2,651	$ -	0	132,912	0	6,779
Animal production, except cattle and poultry	$ 263,000	$ 13,672	909	$ 1,404	$ 260	1	647,331	3,495,586	832
Logging	$ 6,619,000	$ 368,159	1,014	$ 92,332	$ 2,892	2	10,984	350,641	608
Forest nurseries, forest products, and timber	$ 1,936,000	$ 107,683	297	$ 22,582	$ 3,337	0	13,136	88,885	1,778
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	0	0	0	0
Agriculture and forestry support activities	$ 678,000	$ 22,913	8	$ 13,214	$ 237	1	612	34,178	10
Mining	$ 14,417,000	$ -	0	$ -	$ -	0	0	0	0
Transportation, Communications, and Utilities	$ 432,797,000	$ 14,626,669	5,161	$ 8,528,745	$ 797,984	108	605	6,468	48
Construction	$ 775,542,000	$ 70,311,579	1,723	$ 34,663,590	$ 467,359	613	50	3,686	3
Manufacturing	$ 242,974,000	$ 8,211,471	2,898	$ 2,702,066	$ 52,586	39	1,072	55,102	74
Wholesale and Retail Trade	$ 719,128,000	$ 24,303,419	8,576	$ 12,136,975	$ 3,417,115	335	707	2,510	26
Finance, Insurance, and Real Estate	$ 396,448,000	$ 13,398,229	4,728	$ 8,314,954	$ 1,009,714	93	569	4,682	51
Services	$ 1,289,237,000	$ 43,570,640	15,375	$ 23,394,586	$ 1,284,067	673	657	11,974	23
Federal Government Enterprises	$ 515,722,000	$ 17,429,175	6,150	$ 12,940,028	$ 1,713,711	51	475	3,589	121
State and Local Government Enterprises	$ 345,907,000	$ 11,690,162	4,125	$ 10,887,853	$ 338	208	379	12,206,037	20
Total Industrial Sectors	**$ 4,752,682,000**	**$ 204,680,009**	**90,267**	**$ 114,088,368**	**$ 8,761,672**	**2,143**			
Other Sectors									
Point Source (Household Only) [e]			0						
Septic (Household Only)			17,899						
Atmospheric (All Sources)			1,056						
Undeveloped Land									
Natural Grasses			108						
Forest			17,364						
Total Estimated Nutrient Discharge into the Patuxent			**126,693**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 6b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector
Region: Charles County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts: $ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	County Multiplier Impacts: Per $1,000,000 direct output in the Watershed [c]: $ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]: Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 2,381,000	$ 140,391	12,306	$ 77,983	$ 49,216	$ 2,651	2	66,278	105,018	1,949,522	2,246
Grain farming	$ 1,512,000	$ 89,152	7,815	$ 78,188	$ 44,770	$ 2,422	3	66,105	115,449	2,134,260	1,492
Vegetable and melon farming	$ 1,048,000	$ 61,793	5,417	$ 81,751	$ 58,015	$ 2,094	1	63,223	89,091	2,467,858	4,061
Fruit farming	$ 345,000	$ 20,342	1,783	$ 83,317	$ 48,712	$ 3,104	2	62,035	106,105	1,664,957	2,565
Greenhouse and nursery production	$ 2,548,000	$ 150,237	408	$ 95,666	$ 64,243	$ 3,139	2	1,673	2,491	50,989	71
Tobacco farming	$ 509,000	$ 30,012	2,631	$ 77,050	$ 55,272	$ 2,374	1	67,081	93,512	2,177,522	4,174
All other crop farming	$ 1,230,000	$ 72,524	6,357	$ 80,662	$ 46,596	$ 2,657	1	64,077	110,923	1,945,498	4,792
Cattle ranching and farming	$ 1,339,000	$ 56,484	2,235	$ 66,254	$ 17,607	$ 2,336	1	25,190	94,785	714,288	1,194
Poultry and egg production	$ 102,000	$ 5,302	352	$ 70,734	$ 35,768	$ 1,321	1	48,839	96,584	2,615,246	4,903
Animal production, except cattle and poultry	$ 263,000	$ 13,672	909	$ 78,911	$ 19,766	$ 2,530	4	43,778	174,776	1,365,245	771
Logging	$ 6,619,000	$ 368,159	1,014	$ 87,659	$ 27,531	$ 1,719	1	1,748	5,565	89,157	286
Forest nurseries, forest products, and timber	$ 1,936,000	$ 107,683	297	$ 68,732	$ 18,981	$ 2,403	0	2,229	8,072	63,774	473
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Agriculture and forestry support activities	$ 678,000	$ 22,913	8	$ 59,479	$ 33,679	$ 1,906	1	200	354	6,256	8
Mining	$ 14,417,000	-	0	$ -	$ -	$ -	0	0	0	0	0
Transportation, Communications, and Utilities	$ 432,797,000	$ 14,626,669	5,161	$ 55,133	$ 31,829	$ 3,119	0	216	375	3,824	25
Construction	$ 775,542,000	$ 70,311,579	1,723	$ 155,594	$ 80,122	$ 5,042	2	14	28	441	1
Manufacturing	$ 242,974,000	$ 8,211,471	2,898	$ 53,265	$ 21,486	$ 1,389	0	224	555	8,585	32
Wholesale and Retail Trade	$ 719,128,000	$ 24,303,419	8,576	$ 57,480	$ 30,251	$ 6,203	1	207	394	1,922	16
Finance, Insurance, and Real Estate	$ 396,448,000	$ 13,398,229	4,728	$ 50,301	$ 30,518	$ 3,570	0	237	391	3,340	29
Services	$ 1,289,237,000	$ 43,570,640	15,375	$ 59,532	$ 32,640	$ 2,540	1	200	365	4,696	15
Federal Government Enterprises	$ 515,722,000	$ 17,429,175	6,150	$ 43,317	$ 30,457	$ 3,933	0	275	392	3,032	59
State and Local Government Enterprises	$ 345,907,000	$ 11,690,162	4,125	$ 58,289	$ 45,403	$ 1,585	1	205	263	7,522	14
Total Industrial Sectors	**$ 4,752,682,000**	**$ 204,680,009**	**90,267**								
Other Sectors											
Point Source (Household Only) [e]			0								
Septic (Household Only)			17,899								
Atmospheric (All Sources)			1,056								
Undeveloped Land											
Natural Grasses			108								
Forest			17,364								
Total Estimated Nutrient Discharge into the Patuxent			**126,693**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture
b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)
c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)
d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income
e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Calvert County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	61,811	6.3%
Annual Economic Output	$2,063,668,522	4.3%
Nutrient Discharge to Patuxent River	1,113,035 lbs.	13.1%
Environmental Spending	$2,943,572	17.4%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 7a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 7b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 7a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 7a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: Calvert County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 808,000	$ 705,499	83,185	$ 461,892	$ 17,463	39	180,096	4,763,538	2,117
Grain farming	$ 1,395,000	$ 1,218,034	143,618	$ 706,372	$ 25,321	107	203,317	5,671,847	1,348
Vegetable and melon farming	$ 711,000	$ 620,804	73,199	$ 476,736	$ 6,112	17	153,541	11,976,223	4,412
Fruit farming	$ 166,000	$ 144,942	17,090	$ 87,314	$ 3,493	7	195,730	4,893,239	2,447
Greenhouse and nursery production	$ 1,127,000	$ 984,031	1,599	$ 723,835	$ 13,097	48	2,209	122,097	33
Tobacco farming	$ 278,000	$ 242,734	28,621	$ 185,979	$ 5,239	7	153,891	5,463,134	4,097
All other crop farming	$ 535,000	$ 467,131	55,079	$ 274,167	$ 10,478	10	200,897	5,256,793	5,257
Cattle ranching and farming	$ 949,000	$ 683,130	21,082	$ 95,019	$ 17,996	27	221,870	1,171,472	771
Poultry and egg production	$ 120,000	$ 111,984	2,806	$ 55,992	$ -	2	50,116	#DIV/0!	1,503
Animal production, except cattle and poultry	$ 165,000	$ 153,978	3,858	$ 15,864	$ 2,800	20	243,211	1,378,195	197
Logging	$ -	$ -	2,364	$ -	$ -	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	2,364	$ -	$ -	0	0	0	0
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	0	0	0	0
Agriculture and forestry support activities	$ 710,000	$ 475,891	80	$ 289,556	$ 4,692	15	276	17,051	5
Mining	$ -	-	205	$ -	$ -	0	0	0	0
Transportation, Communications, and Utilities	$ 816,543,000	$ 547,303,517	92,006	$ 302,725,015	$ 51,305,076	1,681	304	1,793	55
Construction	$ 380,655,000	$ 268,384,045	17,424	$ 131,536,420	$ 1,776,042	2,362	132	9,810	7
Manufacturing	$ 118,919,000	$ 79,707,728	13,400	$ 19,925,089	$ 360,605	378	672	37,158	35
Wholesale and Retail Trade	$ 224,676,000	$ 150,593,374	25,316	$ 75,888,534	$ 20,919,098	2,170	334	1,210	12
Finance, Insurance, and Real Estate	$ 158,128,000	$ 105,988,308	17,818	$ 63,066,287	$ 7,950,061	789	283	2,241	23
Services	$ 791,094,000	$ 530,245,840	89,139	$ 275,330,448	$ 13,951,651	8,311	324	6,389	11
Federal Government Enterprises	$ 293,242,000	$ 196,551,043	33,042	$ 142,072,243	$ 21,297,800	241	233	1,551	137
State and Local Government Enterprises	$ 267,186,000	$ 179,086,512	30,106	$ 153,726,211	$ 8,043	2,422	196	3,743,013	12
Total Industrial Sectors	**$ 3,057,407,000**	**$ 2,063,668,522**	**753,397**	**$ 1,167,642,973**	**$ 117,675,065**	**18,652**			
Other Sectors									
Point Source (Household Only) [e]			6,172						
Septic (Household Only)			176,642						
Atmospheric (All Sources)			101,206						
Undeveloped Land									
Natural Grasses			2,586						
Forest			73,032						
Total Estimated Nutrient Discharge into the Patuxent			**1,113,035**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 7b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: Calvert County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 808,000	$ 705,499	83,185	$ 1,105,080	$ 695,267	$ 35,577	51	93,162	148,075	2,893,765	2,005
Grain farming	$ 1,395,000	$ 1,218,034	143,618	$ 1,121,161	$ 636,686	$ 32,938	79	91,826	161,699	3,125,580	1,308
Vegetable and melon farming	$ 711,000	$ 620,804	73,199	$ 1,218,124	$ 856,961	$ 30,997	27	84,517	120,136	3,321,297	3,756
Fruit farming	$ 166,000	$ 144,942	17,090	$ 1,270,403	$ 734,830	$ 47,559	45	81,039	140,103	2,164,706	2,292
Greenhouse and nursery production	$ 1,127,000	$ 984,031	1,599	$ 1,494,669	$ 983,744	$ 51,184	49	949	1,442	27,722	29
Tobacco farming	$ 278,000	$ 242,734	28,621	$ 1,104,644	$ 793,342	$ 32,134	27	93,199	129,770	3,203,798	3,858
All other crop farming	$ 535,000	$ 467,131	55,079	$ 1,176,028	$ 673,036	$ 37,704	23	87,542	152,966	2,730,521	4,489
Cattle ranching and farming	$ 949,000	$ 683,130	21,082	$ 1,143,728	$ 294,220	$ 39,308	37	19,423	75,504	565,152	608
Poultry and egg production	$ 120,000	$ 111,984	2,806	$ 1,268,410	$ 633,702	$ 23,662	16	18,436	36,901	988,251	1,458
Animal production, except cattle and poultry	$ 165,000	$ 153,978	3,858	$ 1,420,695	$ 347,537	$ 45,485	124	16,460	67,286	514,107	188
Logging	$ -	$ -	2,364	$ -	$ -	$ -	0	0	0	0	0
Forest nurseries, forest products, and timber	$ -	$ -	2,364	$ -	$ -	$ -	0	0	0	0	0
Fishing, hunting and trapping	$ -	$ -	0	$ -	$ -	$ -	0	0	0	0	0
Agriculture and forestry support activities	$ 710,000	$ 475,891	80	$ 1,109,837	$ 640,353	$ 33,283	26	102	176	3,385	4
Mining	$ -	$ -	205	$ -	$ -	$ -	0	0	0	0	0
Transportation, Communications, and Utilities	$ 816,543,000	$ 547,303,517	92,006	$ 990,773	$ 544,744	$ 83,907	5	114	207	1,343	23
Construction	$ 380,655,000	$ 268,384,045	17,424	$ 1,112,116	$ 558,905	$ 31,046	10	41	82	1,474	4
Manufacturing	$ 118,919,000	$ 79,707,728	13,400	$ 997,627	$ 331,610	$ 22,180	7	113	340	5,080	17
Wholesale and Retail Trade	$ 224,676,000	$ 150,593,374	25,316	$ 1,077,720	$ 559,125	$ 118,042	14	105	202	955	8
Finance, Insurance, and Real Estate	$ 158,128,000	$ 105,988,308	17,818	$ 964,649	$ 562,003	$ 68,494	8	117	200	1,645	14
Services	$ 791,094,000	$ 530,245,840	89,139	$ 1,124,022	$ 593,078	$ 44,956	15	100	190	2,506	7
Federal Government Enterprises	$ 293,242,000	$ 196,551,043	33,042	$ 788,607	$ 548,293	$ 79,596	2	143	206	1,416	55
State and Local Government Enterprises	$ 267,186,000	$ 179,086,512	30,106	$ 1,077,890	$ 798,242	$ 25,445	13	105	141	4,428	9
Total Industrial Sectors	**$ 3,057,407,000**	**$ 2,063,668,522**	**753,397**								
Other Sectors											
Point Source (Household Only) [e]			6,172								
Septic (Household Only)			176,642								
Atmospheric (All Sources)			101,206								
Undeveloped Land											
Natural Grasses			2,586								
Forest			73,032								
Total Estimated Nutrient Discharge into the Patuxent			**1,113,035**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

St. Mary's County
2004 Economic and Nutrient Discharge Profile

County Contribution (within the Patuxent River watershed):		% of Watershed:
Population	19,473	2.0%
Annual Economic Output	$1,044,598,188	2.2%
Nutrient Discharge to Patuxent River	815,408 lbs.	9.6%
Environmental Spending	$856,223	5.1%

Description of Terms

Each row provides statistics related to the economic sectors listed along the row headings (e.g., grain farming, mining). Sources of nutrient discharges not specifically associated with an economic sector, such as household discharges, are also shown as row sectors in order to provide a comprehensive accounting of nutrient discharges into the river.

Table 8a: Direct Economic and Environmental Impacts

Column 1, $ total county output, presents the total dollar output (sales) by each industrial sector in the county.

Column 2, $ output based on % of county in watershed, presents the total dollar output (sales) by producers in each industrial sector that are located within the portion of the county in the Patuxent watershed.

Column 3, nutrient discharges to the Patuxent River, presents the pounds of nutrient discharges, measured at the stream edge, that were discharged into the Patuxent River during 2004 by each industrial sector.

Columns 4 through 6 show the direct county economic impacts of each industrial sector expressed in terms of the amount of household income generated (column 4), business taxes generated (column 5) and full time equivalent (FTE) jobs created (column 6).

Columns 7 through 9 show the pounds of nutrients discharged into the Patuxent River per $ million in household income generated by each sector (column 7), per $ million in business taxes generated (column 8) and per FTE job generated (column 9).

Table 8b: Multiplier Economic Impacts and Nutrient Discharges

Columns 1 - 3 are the same as Table 8a and are provided for reference purposes. The rest of the columns are significantly different because they are based on the county-scale "multiplier" economic effects of economic activity by each industrial sector.

Column 4 shows the direct, indirect, and induced county output (county output multipliers) for each industrial sector expressed in terms of the amount of dollar output generated in the county per $ million in direct output by the row sector.

Columns 5, 6, and 7, similarly, show the direct, indirect, and induced household income (column 5) business taxes (column 6) and FTE jobs (column 7) generated in the county per $ million in output by the industrial sector listed for that row.

Columns 8 through 11 show the pounds of nutrients discharged into the Patuxent River per $ million in direct, indirect, and induced (multiplier) impacts associated with industrial output (column 8), household income (column 9), business taxes (column 10) and FTE job (column 11) for each industrial sector.

Table 8a: 2004 Direct Economic Impacts and Nutrient Discharges into the Patuxent River by Sector

Region: St. Mary's County

Sector	County Direct Impacts			County Impacts					
				Direct Economic Impacts of Business Activity in the Watershed [c]			Pounds of Nutrient to Patuxent River per Direct Economic Impact		
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River (pounds) [b]	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors									
Agriculture, Forestry, and Fisheries									
Oilseed farming	$ 2,985,000	$ 376,393	36,943	$ 246,768	$ 9,079	15	149,708	4,069,150	2,483
Grain farming	$ 3,185,000	$ 401,612	39,418	$ 233,023	$ 8,196	25	169,161	4,809,368	1,595
Vegetable and melon farming	$ 1,908,000	$ 240,589	23,614	$ 184,477	$ 2,522	5	128,005	9,363,544	5,061
Fruit farming	$ 528,000	$ 66,578	6,535	$ 39,846	$ 1,765	2	163,998	3,701,671	3,048
Greenhouse and nursery production	$ 2,951,000	$ 372,106	369	$ 273,878	$ 4,918	13	1,346	74,987	29
Tobacco farming	$ 1,597,000	$ 201,373	19,765	$ 154,466	$ 4,035	4	127,956	4,898,316	5,056
All other crop farming	$ 1,523,000	$ 192,042	18,849	$ 112,855	$ 4,287	3	167,020	4,396,559	6,228
Cattle ranching and farming	$ 2,479,000	$ 300,258	7,366	$ 41,787	$ 7,994	8	176,266	921,388	869
Poultry and egg production	$ 216,000	$ 36,896	3,628	$ 18,277	$ 171	0	198,514	21,241,002	10,621
Animal production, except cattle and poultry	$ 551,000	$ 94,120	9,256	$ 9,566	$ 1,879	8	967,575	4,925,838	1,106
Logging	$ 13,778,000	$ 2,731,606	4,071	$ 759,132	$ 24,188	12	5,363	168,322	348
Forest nurseries, forest products, and timber	$ 2,783,000	$ 551,753	822	$ 143,341	$ 18,042	1	5,737	45,581	1,037
Fishing, hunting and trapping	$ 4,288,000	$ 835,999	0	$ 232,590	$ 6,044	27	0	0	0
Agriculture and forestry support activities	$ 2,564,000	$ 628,864	101	$ 367,655	$ 6,132	21	275	16,504	5
Mining	$ -	-	76	$ -	$ -	0	0	0	0
Transportation, Communications, and Utilities	$ 473,065,000	$ 116,027,157	18,671	$ 80,037,191	$ 5,717,906	1,214	233	3,265	15
Construction	$ 302,709,000	$ 79,571,916	8,643	$ 37,229,191	$ 502,074	748	232	17,215	12
Manufacturing	$ 116,308,000	$ 28,526,495	4,590	$ 10,337,016	$ 149,613	117	444	30,682	39
Wholesale and Retail Trade	$ 327,256,000	$ 80,265,044	12,916	$ 39,431,304	$ 10,946,504	1,205	328	1,180	11
Finance, Insurance, and Real Estate	$ 207,946,000	$ 51,002,258	8,207	$ 30,733,652	$ 3,739,338	387	267	2,195	21
Services	$ 1,828,568,000	$ 448,487,091	72,169	$ 261,008,554	$ 7,512,033	5,821	277	9,607	12
Federal Government Enterprises	$ 718,120,000	$ 176,131,022	28,342	$ 149,997,595	$ 8,563,492	1,389	189	3,310	20
State and Local Government Enterprises	$ 234,671,000	$ 57,557,014	9,262	$ 53,388,949	$ 1,717	1,033	173	5,394,639	9
Total Industrial Sectors	**$ 4,249,979,000**	**$ 1,044,598,188**	**333,614**	**$ 664,981,114**	**$ 37,231,927**	**12,056**			
Other Sectors									
Point Source (Household Only) [e]			313,712						
Septic (Household Only)			70,518						
Atmospheric (All Sources)			33,908						
Undeveloped Land									
Natural Grasses			2,796						
Forest			60,861						
Total Estimated Nutrient Discharge into the Patuxent			**815,408**						

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Table 8b: 2004 Multiplier Economic Impact and Patuxent River Impacts by Sector

Region: St. Mary's County

2004 County Economic Multipliers (per dollar of direct sales) and Contribution to Patuxent River Water Quality Problems per Unit of County Economic Impacts

Sector	County Direct Impacts			County Multiplier Impacts							
				Per $1,000,000 direct output in the Watershed[c]				Pounds of Nutrient to Patuxent River per Direct Economic Impact [c]			
	$ Total County Output [a]	$ Output Based on % of County in Watershed [a]	Nutrient Discharges to Patuxent River [b] (pounds)	$ Output	$ Household Income [d]	$ Business Taxes	Jobs (FTEs)	Pounds per $1,000,000 Output [a]	Pounds per $1,000,000 Household Income [d]	Pounds per $1,000,000 Business Taxes	Pounds per Job
Industrial Sectors											
Agriculture, Forestry, and Fisheries											
Oilseed farming	$ 2,985,000	$ 376,393	36,943	$ 1,229,681	$ 100,270	$ 4,626	5	10,065	123,429	2,675,417	2,313
Grain farming	$ 3,185,000	$ 401,612	39,418	$ 1,250,597	$ 92,251	$ 4,231	8	9,896	134,158	2,925,234	1,514
Vegetable and melon farming	$ 1,908,000	$ 240,589	23,614	$ 1,342,604	$ 123,634	$ 3,555	3	9,218	100,104	3,481,497	4,161
Fruit farming	$ 528,000	$ 66,578	6,535	$ 1,396,809	$ 106,171	$ 5,863	5	8,860	116,569	2,110,760	2,568
Greenhouse and nursery production	$ 2,951,000	$ 372,106	369	$ 1,603,570	$ 140,900	$ 5,598	5	78	887	22,321	24
Tobacco farming	$ 1,597,000	$ 201,373	19,765	$ 1,229,111	$ 114,433	$ 4,100	3	10,069	108,153	3,018,618	4,367
All other crop farming	$ 1,523,000	$ 192,042	18,849	$ 1,296,943	$ 96,875	$ 4,732	2	9,543	127,755	2,615,251	4,971
Cattle ranching and farming	$ 2,479,000	$ 300,258	7,366	$ 1,618,269	$ 51,403	$ 6,219	5	1,836	57,801	477,734	625
Poultry and egg production	$ 216,000	$ 36,896	3,628	$ 1,276,079	$ 113,267	$ 3,134	2	13,164	148,301	5,359,894	7,654
Animal production, except cattle and poultry	$ 551,000	$ 94,120	9,256	$ 1,448,976	$ 61,743	$ 7,049	16	11,593	272,059	2,383,027	1,023
Logging	$ 13,778,000	$ 2,731,606	4,071	$ 1,518,409	$ 101,988	$ 4,866	2	195	2,897	60,725	155
Forest nurseries, forest products, and timber	$ 2,783,000	$ 551,753	822	$ 1,436,744	$ 102,950	$ 9,310	2	206	2,870	31,740	128
Fishing, hunting and trapping	$ 4,288,000	$ 835,999	0	$ 1,705,938	$ 134,877	$ 8,166	8	0	0	0	0
Agriculture and forestry support activities	$ 2,564,000	$ 628,864	101	$ 1,560,535	$ 226,178	$ 9,219	10	25	174	4,281	4
Mining	$ -	-	76	$ -	$ -	$ -	0	0	0	0	0
Transportation, Communications, and Utilities	$ 473,065,000	$ 116,027,157	18,671	$ 1,536,045	$ 252,957	$ 18,757	4	26	156	2,104	10
Construction	$ 302,709,000	$ 79,571,916	8,643	$ 1,473,164	$ 197,671	$ 9,104	4	19	144	3,136	7
Manufacturing	$ 116,308,000	$ 28,526,495	4,590	$ 1,413,950	$ 148,801	$ 6,543	2	28	265	6,032	18
Wholesale and Retail Trade	$ 327,256,000	$ 80,265,044	12,916	$ 1,489,442	$ 195,125	$ 39,495	5	26	202	999	8
Finance, Insurance, and Real Estate	$ 207,946,000	$ 51,002,258	8,207	$ 1,344,909	$ 200,528	$ 22,373	3	29	197	1,764	14
Services	$ 1,828,568,000	$ 448,487,091	72,169	$ 1,569,486	$ 229,971	$ 11,072	5	25	172	3,565	8
Federal Government Enterprises	$ 718,120,000	$ 176,131,022	28,342	$ 1,393,507	$ 269,376	$ 17,073	3	28	147	2,312	13
State and Local Government Enterprises	$ 234,671,000	$ 57,557,014	9,262	$ 1,521,774	$ 308,503	$ 6,658	6	26	128	5,928	7
Total Industrial Sectors	**$ 4,249,979,000**	**$ 1,044,598,188**	**333,614**								
Other Sectors											
Point Source (Household Only) [e]			313,712								
Septic (Household Only)			70,518								
Atmospheric (All Sources)			33,908								
Undeveloped Land											
Natural Grasses			2,796								
Forest			60,861								
Total Estimated Nutrient Discharge into the Patuxent			**815,408**								

a) 2004 Business Sales by Agricultural/Industrial/Commercial Sectors, Source: U.S. County Business Patterns, U.S. Census of Agriculture

b) Expressed in pounds of "nitrogen equivalents" (one pound of phosphorus = 5 nitrogen equivalents)

c) Includes Direct, Indirect and Induced Impacts; estimated using a year 2004 County input-output model generated via the IMPLAN (**IM**pact **PLAN**ning) regional economic modeling system (a commercial economic modeling system maintained by the Minnesota IMPLAN Group)

d) Household Income is based on Employee Compensation, Proprietors income and Other Property-Type Income

e) 90% of nitrogen equivalents from point sources are allocated to households and 10% to industrial/commercial sectors, based on information provided by Western Branch WWTP

Overview of Regional Input-Output Models and the IMPLAN (IMpact PLANning) System

Introduction

Appendix A presents 2004 economic profiles and sector-specific economic impact multipliers and nutrient discharge statistics for each county located at least partly within the Patuxent River watershed. This section of Appendix A provides a general description of the regional economic models that we used to generate county economic statistics. It starts with an overview of the general type of economic model we used, an input-output model, and then describes the specific county input-output modeling system we applied, the IMPLAN (Impact PLANning) system. The IMPLAN system was developed initially by the U.S. Forest Service and is now maintained by the Minnesota IMPLAN group. Most of the numbers presented, although obtained through the IMPLAN system, can be cited back to government sources. (e.g., Census of Agriculture, Census of Business, County Business Patterns, Bureau of Labor Statistics, Bureau of Economic Analysis, etc.) More information about the IMPLAN modeling system is available at www.implan.com.

Using IMPLAN we developed sector-specific economic statistics for each county, and then adjusted them based on the portion of each the county in the Patuxent River watershed to generate a county-based economic profile of the watershed. We then matched the statistics provided by the Chesapeake Bay Program Office (CBPO) regarding the level and sources of nutrient discharges into the Patuxent River within each county with our county IMPLAN economic sectors.

Input-Output Model Overview

The foundation of all input-output models is the transaction table. This table depicts the dollar flow of goods and services between various sectors of a regional economy. The level of aggregation used to define sectors (e.g., agriculture vs. cattle production vs. feedlot cattle production), and the geographic scope of the model (e.g., national, state, county, zip code) can vary widely. A hypothetical transactions table that employs five broad industrial sectors appears in Table A.1. In order to provide a comprehensive account of inter-industry and other transactions, the table also includes three final-payments sectors and three final-demand sectors.

Each sector appears twice in the transactions table and is associated with a row and a column. The row for each sector accounts for the sales by the firms in that sector to other sectors, to final consumers, and to export markets. The sum of a row is the total output or total sales for that sector. For example, total sales by the manufacturing sector (row three of Table A.1) are shown to be $14,162 million, with $356 sold to the regional service sector, $1,275 sold to regional households, and another $11,750 sold outside the region.

Similarly each column in Table A1 shows the purchases by, or inputs used by, the sector identified at the top of the column from the sector named in the row. Payments by that sector to employees, landowners, capital owners, and governments are shown in the final-payments section of the table. These payments constitute the direct "value-added" by that sector. Purchases from industries outside the region are identified in the last row of the final-payments section as "imports." The sum of the entries in each column represents the total purchases by the sector listed at the top of the column. Since profits, losses, and taxes are recorded in the table as final payments, the total purchases recorded for a sector and must equal that sector's total sales.

The transactions table is a double entry industry-scale bookkeeping system where inputs for each sector must equal outputs. Note, for example, that the purchases or payments made by the

manufacturing industry shown in column 3 of Table A-1 amounts to $14,162 which is the same as the total sales for that sector shown at the end of row 3 of the transactions table.

Table A-1: General illustration of an input-output transactions table

Selling industry / Buying Industry		Extraction (1)	Construction (2)	Manufacturing (3)	Trade (4)	Services (5)	Total industry demand (6)	Household expenditures (7)	Other local final demand (8)	Exports (9)	Total final demand (10)	Total demand (11)
Extraction	(1)	183	31	599	6	73	892	99	88	596	782	1674
Construction	(2)	14	1	43	14	293	364	0	1803	353	2155	2520
Manufacturing	(3)	142	414	1390	110	356	2412	1275	1130	9344	11750	14162
Trade	(4)	52	224	520	72	257	1126	2563	161	970	3695	4820
Services	(5)	102	221	862	558	1990	3733	4262	523	2828	7613	11347
Total local inputs	(6)	493	891	3415	760	2969	8527	8199	3705	14091	25995	34523
Households	(7)	595	665	3696	2385	4603	11944	100	2524	0	2623	14567
Other payments	(8)	261	191	1624	1365	2402	5842	(3789.2)	(943.2)	(1097.5)	0	5842
Imports	(9)	325	773	5428	311	1372	8209	3778	1057	-12994	-8159	50
Total final payments	(10)	1181	1629	10747	4060	8378	25995	3878	3581	-12994	-5536	20459
Total inputs	(11)	1674	2520	14162	4820	11347	34523	12077	7285	1097	20459	54982

The Input-Output Framework

Table A-2 below shows the structure of an input-output model by identifying four quadrants that are all linked with one another through purchases and sales.

Quadrant I describes links with consumers or other final users of goods such as investors or governments. It also includes the export sector, which reflects sales to industries and consumers outside the region. Since sales to these sectors would not normally reappear in the region or generate any further "rounds" of economic activity, they are regarded as final.

Quadrant II depicts production or input-output relationships within the regional economy. It shows the combinations of raw materials and intermediate goods that each sector uses to produce outputs that it sells to other sectors, to consumers, to export markets and so on. This "inter-industry" part of the transactions table is the core of the input-output model. In regional models, this part of the model usually includes between 30 and 500 industrial and agricultural sectors.

Quadrant III shows payments to labor, resource owners and entities outside the region that do not generate any further direct rounds of industrial activity within the region. These payments are called "final payments" and include wages and salaries, depreciation and retained earnings, rents, royalties, sales and excise taxes, and so on. When they are paid to households within the region these payments are called "value-added" payments and reflect the direct effects of a sectors production activity on the economic welfare of families in the region.

Quadrant IV identifies nonmarket transfers between sectors of the economy. It includes "social transfers" such as gifts and donations, savings, and taxes on household income. This quadrant also includes purchases by households within the region from industries outside the region.

Table A-2: Structure of an input-output model

	Production	Final Demands	
Distribution	II Interindustry structure	I Consumption patterns	Total outputs
Final Payments	III Incomes	IV Nonmarket transfers	
	Total inputs		

Regional Impact Multipliers

Developing the regional transactions table is only the first step in performing input-output analysis. By dividing each entry in the transactions table by the column total, for example, we arrive at the purchases that are made by a sector from all other sectors per $1 of output by that sector. This table of "technical coefficients" can then be used to trace through various "rounds" of economic activity to arrive at regional output "multipliers" that reflect the direct, indirect, and induced sales by all regional sectors that are generated by each $1 in output by a sector. Similar analyses showing rounds of changes in various value-added categories (e.g., employee earnings, proprietor income, rents) can be used to generate the other types of impact multipliers discussed in Section 3. These multipliers can then be used to show the regional economic impacts of increasing the output of an industrial sector.

Description of how input-output multipliers can be used and abused is beyond the scope of this paper. However, details are provided in most introductory economic texts and at many university websites. A website at www.math.louisville.edu contains a step-by-step tutorial about input-output analysis and the development and use of regional multipliers.

The particular regional input-output modeling system used in the analysis presented in this paper is called the IMPLAN system. This system was developed by the U.S. Department of Agriculture and is described and illustrated at http://www.mig-inc.com/. That website also has instructions for receiving training, software, and regional data and contains references for further investigations.

Incorporating Patuxent Nutrient Discharge Data

We then incorporated data from the Chesapeake Bay Program (CBP) Phase 5 model (draft; August 2006) for the Patuxent watershed, and assigned the nutrients attributed to the CBP's land uses to corresponding industrial sectors in the IMPLAN model. Because the IMPLAN model was originally developed for use by the agricultural economists, it includes a lot more information about specific agricultural sectors than for some others, and we attempted to do that for nutrient coefficients for agriculture as well.

The CBP model includes different discharge estimates for nitrogen and phosphorus. We combined these into a single "nitrogen-equivalent" number, with N=5P, as described in Section 4.3.2.

The land uses included in the Bay Program model did not always neatly line up with corresponding IMPLAN economic sectors, so we made some assumptions in incorporating the nutrient data into the IMPLAN economic information, which we outline below.

Fishing, Hunting and Trapping: we assumed that there is no significant nutrient discharge from these activities.

N-equivalents for residential and industrial/commercial sources were calculated by taking base numbers for corresponding land uses (urban, point sources) and allocating percentages for residential and for commercial/industrial.

For point sources, we allocated 90% of the CBP nutrient discharge amounts to residential sources, based on information provided by the Western Branch Wastewater Treatment Plant.

The Bay Program model includes discharge calculations for four categories of low and high-density urban land uses. To determine the percentage of urban discharges resulting from commercial use, we used land-use data from the Maryland Department of Planning, with the equation

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%commercial = commercial/(residential + commercial/industrial).
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Appendix B

Patuxent River Stewardship and Enforcement: Perspectives of County and Soil Conservation District Staff

Summary of Interviews

Table of Contents

Introduction

To gather data about efforts to control nutrient discharges in each of the seven Patuxent River watershed counties, we conducted more than 20 face-to-face interviews between August 2005 and July 2006. Individuals who were interviewed included enforcement and/or planning/zoning personnel in each Patuxent watershed county, and the manager of each Soil Conservation District. In addition we interviewed individuals at the state and watershed level who are knowledgeable about enforcement in the watershed.

Collectively, these county and Soil Conservation District staff members have many decades of experience addressing the challenge of controlling nutrient discharges to the Patuxent. In some cases, staff members have been with county government or the Soil Conservation District since more concerted river protection efforts began in the wake of the 1981 charrette spearheaded by State Senator Bernie Fowler. Several of the interviewees have served as representatives to the Patuxent River Commission. The experience of these staff members provides a valuable perspective on the effectiveness of both regulatory and voluntary programs to control nutrient discharges.

This appendix summarizes the responses of the 10 county staffers and seven Soil Conservation District managers that were interviewed. Interviews with county and Soil Conservation District staff members were typically 45 minutes to an hour, and followed an interview protocol that included questions about staffing levels, staff priorities, and funding levels. In addition, staff members were asked to provide their opinion in response to a series of questions about the effectiveness of point and nonpoint source pollution control programs and how they might be improved. In advance of the interviews, the participants were informed that they would not be identified in project reports.

Priorities of the Office

We examined the blend of proactive versus reactive activities in each Patuxent watershed county and Soil Conservation District (SCD), which included discussion of staff priorities for tasks such as enforcement of existing laws, technical assistance, and outreach.

Location within County Government

In requests for interviews with county enforcement personnel, we noted that the purpose of the interview was to collect data to help us understand the efforts underway and resources being devoted in each county to control nutrient discharges. As a result, the interviewees were typically the staff members most directly associated with environmental enforcement related to water discharges and runoff, so these responses reflect those responsibilities.

Each county's program is organized slightly differently. For example, Calvert County, one of five counties in the watershed that has land in the Chesapeake Bay Critical Area, has one staffer who handles permits inside the Critical Area, and another responsible for permits outside the Critical Area. Charles County inspectors reside in the Planning and Growth Management Department, which covers all permitting and land use. Howard County splits these functions, with inspectors housed in the Bureau of Environmental Services, and planning and zoning activities residing in another bureau. In Montgomery County, all Department of Environmental Protection staffers have some outreach and enforcement responsibility. This includes six biologists and four water management division personnel, who are expected to report violations even though they are not technically enforcement staff.

Primary Users of the County/SCD Office

We asked county personnel about the primary users of their county office's services. They replied as follows:

- Home owners/landowners (10 of 10 staffers said they were among the primary users)
- Residential development permit seekers (8 of 10)
- Commercial development permit seekers (8 of 10)
- Farm owners/operators (3 of 10)
- Farm operators renting from others (3 of 10)

Other users of the services of these county offices mentioned by staffers included watershed associations, Riverkeepers (in the Patuxent and in other watersheds), environmental groups, and the executive and legislative branches.

As expected, all seven Soil Conservation District managers cited farm owners as being among the primary users of their services. However, responses indicated the range of activity in these offices, such as review of sediment and erosion control plans required by law for housing developments:

- Farm owners (7 of 7 SCD managers said they were among the primary users of their services)
- Homeowners (6 of 7)
- Farm operators/renters (6 of 7)
- Residential permit seekers (6 of 7)
- Commercial permit seekers (6 of 7)

Soil Conservation District managers noted that other government agencies are among the primary users of their services. While spot checks and enforcement of non-compliance with nutrient management plan regulations are the responsibility of the Maryland Department of Agriculture, the SCD managers play a role because they are monitoring all the time, and "because farm plans are never really finished as land use changes." For example, the once ubiquitous tobacco farms in the Patuxent watershed have transitioned to other types of land uses, requiring different management plans. In some cases, Soil Conservation District offices have staff members who are licensed to write nutrient management plans. With the implementation of required nutrient management plans in Maryland, one district manager noted that farmers now need to start keeping records for nutrient management that they used to just keep in their heads.

The priorities of Soil Conservation District officers also depend on the extent to which the district is agricultural or urban, with more urban districts focusing to a larger extent on working with residential and commercial development rather than agricultural land. One district manager said that, in addition to residential and commercial developers seeking assistance, his office also spends some time helping already-established communities that seek assistance with grading and other issues. Others noted that they deal mainly with consultants, rather than the residential or commercial developers themselves.

Soil Conservation District Staff and Board Background

We asked Soil Conservation District managers to estimate what percentage of their staff has a background in farming. In only two of the seven districts does more than 50% of the staff

have a background in farming, perhaps reflecting the shift in land use (and work responsibilities) for these districts as they become more developed.

In contrast, in five of the seven districts, 100% of the Soil Conservation District board members come from a farming background, and in all cases, at least three of the five board members have a farming background, according to Soil Conservation District managers. Perhaps this is because the average tenure of their board members is more than ten years, according to the managers. Of the five districts for which this was estimated, two boards had an average tenure of 13 years per board member, two had an average tenure of 10 years, and the other board's average tenure was eight years. In response to a question about average district board member tenure, one manager said, "Forever." And another: "Till they die."

In addition, these board members are in many cases active Farm Bureau members, which has not historically been in the vanguard of environmental regulation of agriculture. One manager noted that Farm Bureau members have in the past "wanted financial support without the (regulatory) strings." For two boards, all five members are active in the local Farm Bureau; in another, three of the members are active in the Farm Bureau, and in three others, at least two of the five members are active Farm Bureau members. (See also page B-25 for a discussion of the district managers' views on the level of political will to improve Patuxent River and Chesapeake Bay water quality.)

County Office Priorities

We asked the county and SCD personnel to estimate the portion of the office's resources allocated to various activities. Because of the different missions of the county and SCD offices, these questions were asked about activities most relevant for their respective offices.

- Educational outreach: Seven of 10 county staff interviewed said that 5% or less of the office's resources are dedicated to educational outreach activities/materials, with two noting that about 10% of their office's resources are devoted to outreach. With regard to staff time, the results were similar, with four of the seven respondents indicating that 1% to 5% of staff time is devoted to educational outreach, and three estimating that 10% of staff time was focused on educational outreach. (Three county staffers said zero or that this did not apply to their office.)

- Technical assistance: We received a range of responses from county staffers to this question. Of the eight staffers who responded, one noted that about 70% of his office's resources and 70% of staff time are spent on technical assistance. Two said that no office resources or staff time are used for technical assistance, and 5 of the 8 said that between 2% and 25% was used for this purpose.

- Writing and approving permits: Of the eight county staffers who responded to this question, two said that 50% of the office's resources and staff time are devoted to writing and approving permits, three said between 10% and 30%, and three said that no office resources were used for this purpose.

- Monitoring existing permits: Of the eight county staffers who responded to this question, one said that 60% of his office resources and staff time are devoted to monitoring existing permits, two said between 30% and 50%, and four between 10% and 30%. One said that no office resources are used for this purpose.

- Enforcement of non-compliance: Of the eight county staffers who responded to this question, one said that 45% of office resources are devoted to enforcement of non-compliance, five said between 10% and 30%, and one said 5%. One said that no office resources are used for this purpose. The result was similar for the amount of staff time for enforcement of non-compliance, with two offices indicating that they spent 45-50% of staff time on enforcement, four indicating that between 10% and 20% was devoted to enforcement, and two estimating that 1% to 5 % was used for this purpose. Two counties noted that they had each hired a retired police officer to beef up environmental inspections.

- Percent of staff time is spent in-office and out-of-office: Of the nine county staffers who responded to this question, four noted that 40% to 50% of staff time was spent out of the office, three estimated 15% to 25%, and estimated that the vast majority of his office's time—81%--is spent out of the office.

Office structures varied considerably within the watershed, with some encompassing planning and growth management responsibilities, and others carrying out tasks such as biological monitoring of streams, and designing and managing restoration projects that are funded out of the county capital budget. One office focused especially on inspecting stormwater management facilities in the county.

Soil Conservation District Office Priorities

- Educational outreach activities/materials: All Soil Conservation District managers said that at least 5% of the office's resources and staff time were dedicated to educational outreach activities/materials, with two offices devoting 20%-25% of resources/staff time.

- Technical assistance/Writing and approving contracts/plans: This type of assistance, including technical plan review within the permitting process, is considered to be an important element of most SCD offices, with one estimating that 80% of his resources are devoted to this task, another 50%, and four between 15% and 35%.

- Monitoring existing contracts/plans after the fact: Five of seven SCD offices indicated that some resources are devoted to monitoring contracts after the fact, with one estimating that 50% of resources are focused monitoring, another 30%, and three noting that 10% of resources are used for this purpose.

- Enforcement of non-compliance: However, enforcement of non-compliance is not seen as the role of the Soil Conservation District. Five of seven managers said that no resources are devoted to enforcement, and the remaining two estimated that 2% and 5% of the office's resources were used for this purpose.

Most SCD managers noted that very little of their time is spent on enforcement activities such as spot checks, which are the responsibility of MDA. One pointed out that there are several ways that monitoring takes place, including the annual quality review for Federal programs, and the Maryland Agricultural Cost Share spot check. At times, SCDs do respond to complaints about issues like an operator dumping manure into a neighbor's stream. But most complaints go to MDE or MDA. More urban districts focus more resources on working with commercial/residential development permit seekers, compared to agriculture. For example, one

county spends an estimated 80% of its time on urban issues, and another spends 50%. Most districts also noted the environmental outreach role played by SCD staff in the Envirothon educational initiative.

Regardless of the priorities of the office, Soil Conservation District staff spend considerable time in the field, with all seven saying that 30% to 50% of staff time is spent out of the office.

Regulatory and Other Authority

We asked a series of yes-or-no questions to understand the type of regulatory and other authority provided to the various county offices and Soil Conservation Districts. Nine of the ten county staffers answered this question, and all seven Soil Conservation District managers. (Note that in three counties, staff from two separate offices were interviewed, since these functions were split among offices).

Has authority to	County Office	SCD
Provide technical assistance	1	7
Provide financial support for Best Management Practices	1	3
Provide other incentives for environmental management actions	6	5
Reduce the frequency of regulatory inspections	6	0
Expedite environmental permits	7	7
Consolidate environmental permits	4	1
Approve retroactive permit applications	4	2
Waive environmental regulations	1	0
Require after-the-fact in-lieu fees	3	1
Reduce stringency of regulatory thresholds	1	0

The table above demonstrates the different emphases of the counties and soil conservation districts, with the county staffers coming typically from offices with enforcement authority, and the Soil Conservation Districts focused on their technical assistance mandate and approach.

County Regulatory and Other Authority

County staff provided a range of additional comments about the regulatory and other authority they are granted.

Most counties indicated that their emphasis is not on providing technical assistance and financial support for best management practices, although two counties noted that they provide trees for planting in the Critical Area or other riparian buffer areas. One county staffer noted that most technical assistance is handled by engineering companies.

Other incentives for environmental management actions mentioned by county staff include participation in tradable development rights programs and, to a certain degree, provision of tax credits.

Most staffers made some additional comments about the granting of variances (see also Section 5.2.3 of the report), noting that this is typically handled by a board of appeals, not by their office. In one county, Critical Area appeals are handled by an appeals officer. One county staffer noted that about 90% of permit seekers participate in a pre-application conference with staff, so people don't tend to pursue variances that are unlikely to be approved. Another county

staffer noted that his office has the authority to grant waivers for on-site stormwater management structures that do not need to go to the board of appeals. Another county staffer noted that no one has been granted a variance by their office, but that they do make modifications that are equal to or better than the ordinance.

Two staffers made additional comments on the possibility of reducing regulatory thresholds. One noted that only county commissioners can waive environmental regulations or reduce the stringency of regulatory thresholds. Another, referring specifically to stormwater management structures, said that his county office does not have this authority, since county code and state law require that they be inspected at least every three years. As for reducing the stringency of regulatory thresholds, he said, "there is always some wheeling and dealing."

Soil Conservation District Regulatory and Other Authority

Most Soil Conservation District officers emphasized that they do not have the authority to provide financial support for Best Management Practices (BMPs), but they help farmers/landowners get that assistance from other sources, and help landowners with the associated paperwork.

While one manager commented that his office does not have the authority to waive environmental regulations, they will use common sense to do something a little different. The district has not forced anyone to tear down a structure because it was not in compliance with environmental regulations, but if there were something causing an imminent pollution problem, they would work with the owner or operator to fix the problem. If it were not fixed, it would be referred to MDE or MDA. They would also make an owner re-install a pond if not done correctly. They have not granted variances, but might modify a practice. Barns without plumbing and electricity do not have to be permitted, and SCD doesn't issue permits anyway.

Other district managers offered a range of comments on variances, with most noting that they are not responsible for granting such variances but indicating that the Soil Conservation Districts sometimes play a role in commenting on variance applications. In some cases, these variances (usually for forest plans or grading permits) are approved retroactively, according to one district manager.

We also asked the Soil Conservation District managers some questions with regard to BMPs and their long-term implementation. The first question refers to a state regulation that individuals are required to pay back Maryland Agricultural Cost Share (MACS) funds for BMPs if he or she closes down before the 15-year term of a BMP contract is finished. According to the managers, this has happened only in rare instances. One manager noted that there is now a requirement for projects of $15,000 or more that the BMP contract be included with the deed at settlement if the property is sold. In most cases, though, the new owner has agreed to continue the practice.

We also asked a question about variances from Critical Area 100-foot buffer requirements, which can in some cases be a minimum of 25 feet if there is a conservation plan put in place that provides the same benefits as a 100-foot buffer. No managers indicated that farm or landowners in their district had been cited for violating this requirement. Additional comments, however, emphasized the SCD cooperative approach to BMPs. One manager noted that, if a person has a 25-foot buffer, they would try to get them to increase to 100 feet, but they wouldn't allow them to clear to 25 feet. Another said that no one in his district has been cited for

violating the 25-100 foot buffer rule violation, but the district has kept landowners from being cited by rectifying the problem.

Removal of Structures in Environmental Non-compliance

We asked both county and Soil Conservation District staff if they were aware of their county forcing anyone to tear down a structure because it was not in compliance with environmental regulations (regardless of which agency has that regulatory responsibility). We asked this generally for each county and about land in the Critical Area for the five counties meeting that criterion.

Five of the eight county staff who responded to the question about tearing down a structure anywhere in the county for non-compliance with environmental regulations said that they were aware that this had happened. For those who provided an estimate, one said this had happened once in the last five years, another said it had happened six times, and another 12 times. One of the six Soil Conservation District managers who responded indicated that he was aware of this happening in his county. On average, he said this occurs about once a year.

For the five counties with land in the Critical Area, four of seven county staffers who replied said that their county had forced someone to tear down a structure in the past five years. None of the four SCD managers who responded was aware that this had happened in the Critical Area portion of their county/district. The rare instances in which this has occurred represent a fraction of one percent of the overall number of building permits issued in the county, or even of those within the Critical Area, according to county and SCD staff.

Staffers made the following additional comments in response to this question. One county staffer noted that the lone instance in the past five years in which a structure has been torn down for environmental compliance was a house in 2004. Another noted that they have made people move structures, such as sheds and decks, to spots outside the Critical Area buffer. Another said that two swimming pools had been removed from the Critical Area during the past five years. In another county, in six instances during the past five years, someone has been forced to tear down a structure because of environmental non-compliance, and at the time of the interview there was some litigation pending for a residential structure.

Staff Views on Factors Influencing Citizens to Seek Assistance

We asked county and SCD staff to provide their assessments of five possible factors that are important in influencing the decisions of the citizens of their county or district to seek assistance from their office. In each case, we asked the staff member to answer on a five-point scale, with one indicating "strongly disagree" and five indicating "strongly agree" with the statement that "(factor) is an important factor influencing the decisions of (county/district) citizens to seek assistance from my office."

	County Staff	SCD Managers
Avoiding penalties		
Strongly disagree	2	1
Somewhat disagree	0	1
Neither agree nor disagree	0	1
Somewhat agree	5	3
Strongly agree	4	1
Avoiding delays in permitting		
Strongly disagree	2	1
Somewhat disagree	0	1
Neither agree nor disagree	1	1
Somewhat agree	5	3
Strongly agree	2	1
Availability of Financial Assistance		
Strongly disagree	6	0
Somewhat disagree	2	0
Neither agree nor disagree	0	0
Somewhat agree	0	2
Strongly agree	0	5
Availability of Technical Assistance		
Strongly disagree	1	0
Somewhat disagree	1	0
Neither agree nor disagree	1	1
Somewhat agree	5	0
Strongly agree	2	6
Interest in Environmentally Friendly Methods or Practices		
Strongly disagree	0	0
Somewhat disagree	1	0
Neither agree nor disagree	3	1
Somewhat agree	7	5
Strongly agree	0	1

Two Soil Conservation District managers commented further in reply to these questions. One noted that, for questions about avoiding penalties and avoiding delays in permitting as important factors influencing citizens to seek assistance from his office, for farmers, he strongly disagrees with this motivation for coming into the office. For developers, he somewhat or strongly agreed with this motivation. Another district manager said that he somewhat agreed that avoiding penalties is an important factor influencing decisions of landowners to seek assistance from his office, but noted that their role is to help farmers understand the rules about what they can and cannot do (for example, through nutrient management plans).

Both county and SCD staff noted that it is rare that someone comes in just seeking general advice anymore about environmentally-friendly methods or practices. One SCD manager noted that ten years ago that might have been the case, but now people only come in if they have to do so or if they need something specific.

Staff Views on Influences on Behavior

We also tried to get staffer's perspective on the following factors, asking if "(the factor) is currently an important factor in influencing decisions of people to refrain from activities that cause nutrient discharges to the Patuxent River," and, in a follow-up question, if they *could* be an important factor, *with sufficient funds.*

Education/Outreach Staff Level

Both county and Soil Conservation District staff had a range of opinions about whether current staff levels are currently effective in influencing decisions of people to refrain from activities that causes discharge of nutrients to the Patuxent River, but with sufficient funds, 14 of 17 respondents somewhat or strongly agreed that staff level could be an important factor. Eight of these respondents strongly agreed with this statement.

	County Staff	SCD Managers
The county's (district's) current environmental education/outreach staff level…		
Strongly disagree	2	1
Somewhat disagree	2	1
Neither agree nor disagree	4	1
Somewhat agree	1	3
Strongly agree	1	1
The county's (district's) environmental education/outreach staff level with sufficient funds…		
Strongly disagree	0	1
Somewhat disagree	0	0
Neither agree nor disagree	0	2
Somewhat agree	5	1
Strongly agree	5	3

Education/Outreach Total Funding

We also asked this question with regard to total funding for educational and outreach activities, not limited strictly to staff support. The replies were identical to the previous, similar question.

	County Staff	SCD Managers
The county's (district's) current environmental education/outreach total funding…		
Strongly disagree	2	2
Somewhat disagree	3	1
Neither agree nor disagree	1	1
Somewhat agree	3	2
Strongly agree	1	1
The county's (district's) environmental education/outreach activities with sufficient funds…		
Strongly disagree	0	1
Somewhat disagree	0	0
Neither agree nor disagree	0	2
Somewhat agree	5	1
Strongly agree	5	3

Technical Assistance Staff Level/Funding

While 9 of 17 county or Soil Conservation District staff somewhat or strongly agreed that current technical-assistance staff levels are an important factor, 16 of 17 thought so with sufficient funding.

	County Staff	SCD Managers
The county's (district's) current technical assistance staff level…		
Strongly disagree	2	0
Somewhat disagree	3	1
Neither agree nor disagree	2	0
Somewhat agree	3	3
Strongly agree	0	3
The county's (district's) technical assistance staff level with sufficient funds…		
Strongly disagree	0	0
Somewhat disagree	1	0
Neither agree nor disagree	0	0
Somewhat agree	6	1
Strongly agree	3	6

This question generated many comments from both county and Soil Conservation District staff. Several county staffers, while somewhat agreeing that more funding for technical-

assistance staff would make a difference, noted that, even with sufficient funds, this would not entirely take care of the problem. Others noted that the real source of technical assistance is the Soil Conservation Districts. Responses included the following:

County Perspective

- "We could give people more/better information, but there is no guarantee that they'll follow the advice."
- "Some people won't change behaviors, no matter how much outreach we do."
- "When we staff booths at county fairs, etc., the average citizen tends to be most interested in questions like 'How do I get a permit to build a deck?' rather than learning about environmental issues."
- (With sufficient funds it would be an important factor, but) "it would have to be a whole lot" (of funds).
- "Educating people is not the golden solution; it needs to be made more worth the citizen's while."
- "(Our county has) only one forester--there are a lot of things they could have at the county level that aren't funded."
- "We need to educate people better; a lot of people just don't understand the impact of their activities."
- "We need to educate people."
- "(There is) not enough staff. If we had more resources, more people would be educated, because there is so little of it now. It's currently a limiting factor. Technical assistance staff is stretched pretty thin. Even an outside entity helping distribute and develop information would help."

Soil Conservation District Perspective

Soil Conservation District managers also commented on the adequacy of staffing levels for environmental outreach/education and technical assistance. Several noted the distinction between funding for agricultural programs, which are typically covered by state and/or Federal sources, and for soil conservation activities for residential or commercial developments, which are typically covered by fees from urban permitting.

- "The SCD is woefully short on agricultural staffing. Urban staff is paid through fees, so they are adequately funded. Federal and state assistance has gone downhill lately. Counties have picked up assistance, in part because counties need the help with urban permitting. Federal agencies are trying to privatize some functions through the 'technical services sector.'"
- "We reach a lot of people, but I don't know how that changes decisions or how someone does things. Staff to devote to this activity is the most important factor, not how much

funding is available. For technical assistance activities, our SCD is now well-funded, although in the past it hasn't been."

- "We already do as much education as anybody, but with more funding, sure, we could do more."

- "We don't necessarily have an influence on people's decision-making process. For example, nutrient management plans are required, but people don't follow them."

- Another SCD pointed out the changing nature of agricultural land use in the watershed: "Much of what we deal with involves small horse farms, with lots of seminars and pasture walks to discuss management of these small farms. One-third of agricultural land in our district had less than $2,500 in income from farming, so not a lot is required in that sense."

Two SCD managers brought up the problems with implementing fully the post-*Pfiesteria* mandate of adding 110 staff in the field. One said that, by the end of 2005, about 60 to 83 staff had been added since the 1998 Water Quality Improvement Act legislation, depending on who is asked. Another estimated that there are currently 60 funded positions.

- According to subsequent information provided by one of these managers, eight more staff positions had been added during 2006, "but we are still short (of funded) positions."

- The reason these staff were mandated, according to another manager, is that *Pfiesteria* was a human health issue. His response to the part B question that said, "with sufficient funds," was "Ha. Ha. We need another *Pfiesteria*" for anything to happen.

This manager's view is that his district has the funding to get the word out, but they need funding to get the work done for BMPs. His district only has two people to work on BMP implementation with farmers. A challenge for southern Maryland is that salaries are typically low for these jobs, and qualified, trained people are recruited away, especially by urban-based engineering firms. This is not a problem for very rural areas. He commented that agriculture secretary Lew Riley is aware of this issue.

Level of Staff for Monitoring Existing Permitted Sites

We asked county and Soil Conservation District staff members to assess whether or not they have adequate staff and other resources to enforce existing laws. For county personnel, we asked if the level of staff for monitoring existing permitted sites/facilities is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River. For Soil Conservation District managers, we rephrased this question slightly to refer to the monitoring of existing sites with BMP contracts.

	County Staff	SCD Managers
The county's (district's) staff level for monitoring of existing permitted sites (or, for SCD personnel, of existing sites with BMP contracts)…		
Strongly disagree	1	1
Somewhat disagree	4	3
Neither agree nor disagree	1	1
Somewhat agree	2	1
Strongly agree	2	1
The county's (district's) monitoring staff level with sufficient funds…		
Strongly disagree	0	0
Somewhat disagree	0	1
Neither agree nor disagree	1	0
Somewhat agree	4	2
Strongly agree	5	4

The response to the initial question about the effectiveness of current monitoring and inspection staff levels was mixed, with six staffers somewhat or strongly agreeing with the statement, and nine somewhat or strongly disagreeing with the statement. However, there was widespread agreement that more staff resources would make a difference: Fifteen of 17 staffers somewhat or strongly agreed that, with sufficient funds, the county's or Soil Conservation District's staff level for monitoring of existing sites (or existing best-management-practice contracts) could be an important factor in influencing people to refrain from activities that cause discharges of nutrients to the Patuxent River.

In all areas of the watershed, county staffers noted the difficulty for inspection staff to keep up with the pace of development.[12] This applied both in counties that have sediment and erosion control enforcement delegated by MDE, and in the counties for which MDE is responsible for enforcement. One delegated county provided information from a 2005 internal inspection audit, which noted that each inspector was responsible for 106 sites, for a total of 693 acres per inspector. As the audit noted, this is an "unrealistic area of coverage per inspector. This inspector to site ratio is resulting in increased enforcement actions, complaints, and compromising the quality of development."

[12] Among the recommendations from participants in a joint MDE/Maryland Department of Planning conference in fall 2005 was that "MDE should seek increases in State funding to increase the number of staff that enforce sediment and erosion controls." (Nemazie 2005)

Both county and MDE officials pointed out the challenge in meeting the state requirement that permitted sediment and erosion control sites be inspected every two weeks. [13] As one county staffer put it, "one of the issues is having enough time to inspect, and putting fear into people who would violate."

The county and Soil Conservation District staffs play very different roles, with the conservation districts not having a formal enforcement responsibility. In the case of agricultural programs, the Maryland Department of Agriculture is the primary agency involved in monitoring BMP contracts and nutrient management plans. To the extent that Soil Conservation Districts have an enforcement role, it is by helping with inspections of approved sediment and erosion control plans, and, before the fact, in helping develop and approve those plans.

The SCD role is perhaps best illustrated by one SCD manager. He agreed that more funds for monitoring would be helpful in reducing nutrient discharges, but noted that the distinction for Soil Conservation Districts would be that the additional staff resources would be used "not to beat people over the head, but to make sure that the BMPs are working properly and to help them."

Another SCD manager took a somewhat harder line, suggesting that "it would make a big difference if nutrient management plans were enforced."

At the other end of the spectrum, a manager somewhat disagreed that the staff level (now or with more funds) is or would be an important factor influencing the decisions of farmers to refrain from nutrient-discharging practices. His view is that "farmers don't put in a best management practice because the state tells him to do so; rather, he does it to save soil because the soil is his livelihood."

Technical Assistance (Best Management Practices) Cost Share

	County Staff	**SCD Managers**
The total amount of cost-share available for best management practices…		
Strongly disagree	2	0
Somewhat disagree	2	2
Neither agree nor disagree	2	0
Somewhat agree	0	3
Strongly agree	0	2

[13] As one MDE staffer pointed out, an increase in the number of stop work orders can be seen as a function of not enough inspectors or inspections. Inspectors (whether from the county or state, if not delegated by MDE) are supposed to inspect sites every two weeks. But if a permittee knows that is unlikely, then the permittee might figure that he or she can get away with doing something. When an inspector comes back, say, six weeks later for a surprise visit, the permittee might have an unpermitted practice in place to the point where the inspector has to issue a stop work order.

	County Staff	SCD Managers
With sufficient funds, the total amount of cost-share available for best management practices…		
Strongly disagree	1	1
Somewhat disagree	0	2
Neither agree nor disagree	2	0
Somewhat agree	1	1
Strongly agree	2	3

Four county staffers didn't reply, since their offices don't provide BMP cost share. Two county staffers noted the challenge of funding for urban stormwater BMPs on private property, with one commenting specifically about the lack of resources for private community associations to maintain/upgrade these systems. Another staffer from a rapidly urbanizing county suggested that the availability of agricultural BMP funds is less and less a limiting factor. "There are only maybe four dairy operations left in the county, and with horse farms, agriculture is not the main source of income."

Soil Conservation District managers, who typically are much more heavily involved in assisting landowners with BMP cost-share, suggested a range of opportunities and challenges in this regard.

- "A bigger issue is the shrinking land base and number of farmers; more dollars available doesn't necessarily get you more of a practice. A bigger influence would be increasing the percentage of cost-share. That's why CREP is so big in Maryland."

- "You need to show a good return financially for someone to adopt a BMP. I sell certain BMPs, for example, manure management, as ways of better utilizing a resource, not from a 'protecting the river' standpoint."

- "There is a lot of funding out there, such as the flush tax for Wastewater Treatment Plants (WWTPs) and funds for cover crops and other BMPs, both at the state and Federal level. But the Federal programs have onerous paperwork, and you need to beat the bushes and hold someone's hand to get them through the Federal requirements.

- "The dollars are available for BMPs, but you need to knock on doors to get people/farmers to take advantage of the cost-share programs."

- **"**Cost share has historically been more reactive than proactive, and the program has at times perversely rewarded the bad players, criticized the good players."

- "This year, there is $1.4 million for cover crops, and everyone who asked will get something."

One SCD manager cited an example of a farmer installing a manure shed/lagoon that required him to move cattle in a way that turned out to be more damaging to a stream, even though he received funding for the structural BMP. He is working with an MDA technical committee to make MACS more proactive.

Effluent Taxes/Charges

We asked both county and Soil Conservation District staff their views about the current and possible effectiveness of emission or effluent taxes or charges in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River.

	County Staff	SCD Managers
Emission or effluent taxes or charges are currently important factors…		
Strongly disagree	6	2
Somewhat disagree	0	0
Neither agree nor disagree	4	3
Somewhat agree	0	0
Strongly agree	0	0
If emission or effluent taxes or charges are increased, this could be an important factor…		
Strongly disagree	1	1
Somewhat disagree	0	0
Neither agree nor disagree	2	3
Somewhat agree	6	1
Strongly agree	0	0

This question generated a range of responses, particularly from county staffers, most of whom strongly disagreed that emission or effluent taxes or charges are currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River.

Several mentioned the opportunities and challenges for implementing or increasing a stormwater utility fee for residents. In one county, a stormwater utility fee that appears on the residential water bill, "but it is not significant enough to be noticed." For commercial operators, this county fee is more noticeable. "The best way to make a difference would be through an incentive program: if the fee were, say, $100 per year, and a homeowner put in a rain garden or other BMP to reduce water quality impairments, which would then reduce the amount of the annual fee, that could change some behavior."

In another county, in which staffers from two different departments were interviewed, one staffer wondered whether taxes on fertilizer or percentage of impervious surface would work. The staffer then noted that "pocketbook issues drive people, but these are people who are willing to pay anything to have their green lawn." The other staffer strongly disagreed that increased taxes or charges would make a difference, saying that they would really have to increase before fees/taxes influenced behavior. This staffer also noted that the county has looked into stormwater fees based on percentage of impervious surface. This could be calculated with aerial photography, but the question posed was, "How do you collect the tax?"

In another county, the staffer strongly disagreed that emission taxes/charges are currently an important factor, but somewhat agreed that they could be if implemented. In this county, there is currently an annual wastewater fee, which goes to WWTP upgrades. There has also been discussion about the concept of a stormwater utility fee based on the percentage of impervious surface, which would be dedicated to improvements in green infrastructure. "If people are aware

enough to understand the fee, and the fee is sufficient enough to affect behavior," it could make a difference. "And if residential fertilizer bags are taxed enough, yes, that could make a difference."

Soil Conservation District managers had less to say about emission or effluent taxes, with two declining to answer the question, and three neither agreeing nor disagreeing with the statements. One manager, however, strongly disagreed, saying that he "doesn't think taxes or charges will influence anybody."

Legal Issues Related to Inspecting Properties

Do people violate environmental laws because they know no one will come on their property to witness a violation? We asked county and Soil Conservation District staff if "legal issues (i.e., property rights) related to inspecting properties are currently important factors in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River."

	County Staff	**SCD Managers**
Strongly disagree	0	1
Somewhat disagree	3	2
Neither agree nor disagree	1	1
Somewhat agree	2	1
Strongly agree	4	2

To summarize these responses, some staff believe that their county or district has sufficient inspection authority and ability to deter individuals who otherwise might think they can get away with something. Other county and district staff members, however, believe this is absolutely not the case, and that many individuals take the approach of begging forgiveness if caught, rather than seeking permission.

County Perspective

Some counties noted that increased use of aerial surveillance is making it increasingly difficult for noncompliant landowners to remain undetected. "We had the State Police fly over one property," said one county staffer. "Usually when you catch one, it spreads and others don't do it." In another county, a staffer referred to the state's Article 66b, which provides zoning inspectors the right to enter people's property in Maryland. This relates to the right given to counties to develop land-use regulations. They have no problem getting on properties, and can also observe from neighboring properties. Other counties also pointed out that they do have access to inspect stormwater management BMPs, and that a lot of violations are inspected because of complaints.

In another county, though, a staffer noted that there has been a problem getting on properties, with a requirement that a property has to be posted with a visible no trespassing sign. He pointed out that enforcement officers have been sued over access, but noted that, if there is an open permit, this is not a problem. This same county also has difficulty inspecting certain properties because it does not have use of a suitable boat for observations from water.

Staff members interviewed in another county noted that current laws protect the property owner, although if they receive a complaint, they can knock on the door. One mentioned that

they observe by both boat and helicopter, but weeks can go by before that might happen. "There are lots of cases where citizens have violated the Critical Area Act because they figured they could" (get away with it). One staff member cited a study of another river in the county (not the Patuxent), which identified all the dump sites (for oil filters, batteries, etc.), but county personnel were not permitted to go on private property to inspect the sites. "The only thing overriding (this situation) is a human health hazard."

Soil Conservation District Perspective:

Most Soil Conservation District managers noted that they let farmers know they are coming to inspect, since they consider themselves to be a resource for the farmers, rather than having an enforcement role. Two district managers noted that Critical Area aerial photography is common now to get buffer violators, and that people are aware that they can be caught through aerial photography. One said that compliance is "not an issue any more because of aerial flights." One commented that, if a farmer is in a cost-share program, the SCD and MDA have a right to inspect the property for compliance. However, another district manager said that, with nutrient management plans, he's hearing a lot of comments from farmers who think that "no one's going to enforce it."

Level of Fines/Penalties, Frequency of Prosecution, and Equity of Enforcement

We asked county and Soil Conservation District personnel several questions in order to understand the deterrent effects of penalties and prosecution for violations of environmental laws. The replies were mixed, from both county and Soil Conservation District staff: Nine of the 17 interviewees somewhat or strongly disagreed that the level of fines is currently an important factor in influencing people to refrain from activities causing nutrient discharges, and eight of the 16 who answered saying that frequency of prosecution was influencing people to refrain from activities causing nutrient discharges.

While eight of the 16 staffers strongly or somewhat agreed that the frequency of prosecution for non-compliance is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent, only four of the 16 somewhat or strongly agreed that frequency of prosecution was deterring polluting activities.

To help understand their views on whether environmental laws are enforced in an even-handed fashion, we also asked county and SCD staff if they thought equity of enforcement is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River. Overall, interviewees were mixed in their responses, with six somewhat or strongly agreeing with the statement, six somewhat or strongly agreeing with the statement, and five neither agreeing nor disagreeing. However, the responses were somewhat different from county and from Soil Conservation District staff, with three of the seven SCD staff strongly disagreeing that equity of enforcement is an important deterrent factor.

	County Staff	SCD Managers
The level of fines/penalties typically imposed in your county is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River…		
Strongly disagree	0	1
Somewhat disagree	4	2
Neither agree nor disagree	1	1
Somewhat agree	1	3
Strongly agree	2	0
The frequency of prosecution for non-compliance is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River…		
Strongly disagree	4	1
Somewhat disagree	2	2
Neither agree nor disagree	1	3
Somewhat agree	0	1
Strongly agree	2	0
Equity of enforcement is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River…		
Strongly disagree	1	3
Somewhat disagree	1	1
Neither agree nor disagree	3	2
Somewhat agree	3	1
Strongly agree	2	0

Anecdotal comments provided in interviews of county and Soil Conservation District personnel provided a range of opinions about fines and frequency of prosecution.

County Perspective:

- "Usually when you catch one, it spreads and others don't do it."
- "Yes, penalties (fines) can be effective but stop-work orders are what really hurts. Fines are way too low: Our County has a $1,000 maximum, which could be per day but in practice is really per event."
- "Our county is starting to collect now, with rumors about people having to pay. It is enough of a factor for people to know that they can be prosecuted. Critical Area Act (CAA) regulations are now better understood than in the past. On the other hand, he said that judges don't like hearing zoning cases; if there is a reason or method to postpone or throw out the case, they will.
- "The state has just increased the maximum CAA fine to $10,000, but (our county) hasn't adopted this yet, with the maximum still $500.

- "I am aware of maybe one case that was prosecuted within the past twenty years in the county. Enforcement is usually done through fines and stop-work orders. For builders, paying fines is part of doing business. What really affects them is to give a stop-work order, which gets their attention much more."
- "The level of fines in the county is not high enough, and only the most egregious cases go to court, and even then, they don't necessarily get a conviction."
- "The threat of a fine is more of a factor. We haven't imposed one yet, but we send a notice of violation first (which is rare), and most people/companies have been cooperative. Fines range from $500 to $1,000 per day, with each day considered a separate offense. Forest conservation fines are minimal. Bonds are very small, so developers can walk away from them."
- "Fines for CAA violations have been considered low and not a deterrent, although they were just increased. Still, there are lots of wealthy people who just pay."
- "Guys with dollars know what they can and cannot get away with, though. They are in the process of rewriting an ordinance so that they can go after contractors."
- **"**Enforcement is pretty equal."
- **"**Small businesses are likelier to clean up to address a violation."
- "Developers can't get away from stormwater regulations very much, but have more influence through zoning changes and variances."
- "Laws are enforced pretty equitably, but a lot of times it is difficult to pursue all the way through a court case."

Two county personnel mentioned that, in addition to building inspectors, they have hired retired police officers for CAA enforcement, which increases chance of conviction. One of these counties noted that they have the highest civil citation rate for Critical Area Act violations of any jurisdiction, and that they have received criminal convictions.

Soil Conservation District perspective:

Although Soil Conservation Districts are not considered to have enforcement authority, SCD personnel offered a range of comments about the deterrent effects of fines, penalties, and prosecutions in their district/county, regardless of who has enforcement authority.

- "The authority is there, but not the level of fines that's needed. Although (my county's) urban erosion/sediment control is better than most counties, over more than two decades, I have found the enforcement of urban/suburban areas to be very spotty. For agriculture, though, there is hardly any prosecution."
- "In our case, penalty equals revoking the plan."
- "People know nobody gets fined. Such a minimal fine, people go ahead anyway."

- "People in our county are more concerned now with having to pay a fine if caught. The best way to reduce pollution would be to increase the level of fine." (Note: at the time of the interview, this county was going through a process to increase the level of its fines, which was previously capped at $500.)

- **"**Critical Area aerial photography is common now to get buffer violators, and people are aware that they can be caught through aerial photography."

Another Soil Conservation District manager expressed considerable frustration with the process, noting that "fines are not high enough to influence people." He pointed out that sediment control violations have a ceiling set by MDE, not by the county or district, and he cited MDE for not following up complaints made by his Soil Conservation District board. His view is that there is not enough prosecution. He said that the process is complaint-driven, with complaints referred to MDE or the county by agreement. MDE or the county then asks the SCD to establish a solution, then MDE enforces it. In his district, eighty percent of complaints are either perceived problems or neighbor-to-neighbor feuds. Only two times in 17 years as SCD manager has he found a complaint to involve a significant smoking gun WQ problem. Both times, the complaints were referred to MDE, and no action has been taken since.

Point and Nonpoint Enforcement

We asked county and SCD staff two questions about point-source and non-point-source enforcement, with the latter focusing on nutrient management plan requirements. Typically, SCD staff declined to answer the point source question, and county staff declined to answer the nutrient management plan question, noting that the issue was out of their area of expertise.

	County Staff	**SCD Managers**
First, we asked how they would describe the level of environmental enforcement in their county/district for point sources of water pollution:		
Very strict (always enforced)	1	0
Moderately strict (usually enforced)	5	4
Not strict (rarely enforced)	1	1
Nonexistent (never enforced)	0	0
Declined to Answer	3	2

We then asked how they would describe the level of monitoring/enforcement of required nutrient management plans in their county/district under the Maryland Water Quality Improvement Act:		
Very strict (plans typically monitored at least annually)	0	0
Moderately strict (monitored less frequently than annually)	1	5
Not strict (rarely if ever monitored)	1	2
Nonexistent (never monitored)	1	0
Declined to Answer	7	0

Enforcement of compliance with point-source pollution laws received relatively high marks from both the county and Soil Conservation District staff, with nine of the 17 interviewees

saying that enforcement of these laws is moderately strict (usually enforced). One Soil Conservation District manager did not offer a rating of point source enforcement because he didn't really know how effective the enforcement is, but his sense is that the Washington Suburban Sanitary Commission (WSSC) generally meets its limits.

Still, only one of the 17 staffers said that such enforcement was very strict (always enforced). One county staffer expressed the opinion that, in his county, enforcement of point source pollution laws is not very strict because MDE retains point-source jurisdiction. "They are understaffed at MDE and can take a long time to address an issue. The response is somewhat faster by MDE if (our county) calls them about it."

With regard to the nutrient management plan regulations that are now being implemented in the state of Maryland, most Soil Conservation District managers think that enforcement is moderately strict, with plans monitored less frequently than annually.

Although two managers commented that MDA's enforcement of nutrient management plans is getting better because it now has more resources, none of the managers thought that enforcement of nutrient management plans could be considered strict at this stage. "We would get very strict compliance if they put people in the field," one manager noted. "This is the same mentality as for farm plans. You have to go out and work with people to get them to do this. You can't just send a letter and expect them to roll in."

One manager, emphasizing the arm's length from enforcement activities for the Soil Conservation District personnel, noted that he doesn't know how many people have had spot checks or enforcement of nutrient management plans by the state. He has not been contacted by anyone and doesn't know who gets spot checked.

We also received comments from the Soil Conservation District about urban nonpoint sources, reflecting the SCD role in helping craft sediment and erosion control plans. For urban nonpoint sources, a district manager from one non-delegated county expressed the view that sediment and erosion control by MDE is not strict. "We used to be a delegated county, but MDE didn't think it did a good enough job, so MDE took back the responsibility. It's ironic, as there are only two MDE inspectors for the whole county."

Political Will

We also asked each county and SCD staffer if he or she thought that clear political will at the county level, at the state level, and at the Federal level to improve Bay water quality is currently an important factor in influencing the decisions of people to refrain from activities that cause discharges of nutrients to the Patuxent River:

	County Staff	**SCD Managers**
...at the county/SCD level…		
Strongly disagree	2	0
Somewhat disagree	2	0
Neither agree nor disagree	2	2
Somewhat agree	1	2
Strongly agree	3	3
...at the state level…		
Strongly disagree	1	0
Somewhat disagree	2	1
Neither agree nor disagree	1	2
Somewhat agree	5	4
Strongly agree	1	0
...at the Federal level…		
Strongly disagree	2	0
Somewhat disagree	2	0
Neither agree nor disagree	2	3
Somewhat agree	3	4
Strongly agree	1	0

County Staff Perspective:

- "There is not a politician who wouldn't say that they don't have the political will to improve the Bay. But that doesn't mean they are willing to raise taxes to pay better or hire more staff. The state talks a big game, but if you want help going to court, they are too busy. I don't see any Federal involvement."

- "The Critical Area has the most political support in the county. The mindset is that the Critical Area is very holy."

- "People will do what they want to do." (This staffer strongly disagreed at all three levels of government.)

- "There is more activity at our county level, where there is a very strong political will."

- "There has been a heightened awareness of the Critical Area during (the current County Executive)'s tenure, who stated a zero tolerance policy for CAA violations. Historically,

it has not been that aggressive." This staffer also commented positively on the active involvement of Riverkeepers in the county watersheds.

- "There is some support at the county level, but it's minimal; political will at the staff level is much stronger."

- **"**In our county, political will is way below the level of concern for schools and public safety. Sixty percent of county budget is for schools; one percent is for environmental activities."

- This staffer somewhat disagreed at the state and Federal level, too: "The flush tax is a politically expedient way to say that the state did something, but its initial focus is on wastewater treatment plants (WWTPs), so it won't affect behavior or land use. Senators are always touting dollars secured at Federal level. Environmental groups have influence at the Federal level, but there are almost no active environmental groups in our county."

Soil Conservation District Perspective

- "The laws have been passed, but the budget is not there to follow up. Schools and public safety will always come first."

- "I see a lot of foot-dragging" on a tributary strategies team in which he has been active.

- "(Our) District is more important than the state or Federal government in influencing people. Board members in our district are very environmentally progressive."

- "(Our) district has taken significant (progressive) positions that trump the county's position."

- "Farmers are not very happy with the state, as more and more regulation cuts into the bottom line. For example, farmers now have to get a pesticide application license, and there is no longer a soil testing lab at the University of Maryland—the soil has to go to Delaware to be tested now. I also do not see a lot of respect from farmers for Federal programs like the (Federal) Environmental Quality Incentive's Program (EQIP), which are not run very well and which changed rules halfway through the program. The leadership at the SCD level is a positive factor, but if the SCD were involved in enforcement, then it would lose the farmers' trust, and the farmers would just go ahead and do whatever they wanted. Because the SCD has the farmers' trust, if the SCD says something—good or bad—the farmers believe it."

Discussion of Key Factors

The interviews concluded with an open-ended question that provided the county and Soil Conservation District staff to discuss any factors they thought were important to consider with regard to the ability to make improvements to control of nutrient discharges in their county or district. These might include scientific, economic, or political factors, or ones at scales (i.e., state or Federal) not necessarily under the control of the staffer's office. In general, staffers were asked what they see as the opportunities and constraints faced by their county or district in making improvements in the level of nutrient discharges. The open-ended question resulted in responses that highlighted a wide range of issues.

County Perspective:

- "The most important thing is sediment/erosion control. We are not currently a delegated county from MDE, so this could be improved. The process is complaint-driven, and MDE does not devote much attention to (our) county. To some extent, it is up to the county whether to take this on or not."

- **"**The (environmental protection department) is very strong in the county."

- "Stormwater maintenance had been an issue in the past."

- "Everyone is fighting for funds without increase in taxes. Some educational outreach has been affected negatively by this situation."

- "Other factors for our county include the increase in development of large churches in the agricultural areas, infill development, and replacing smaller houses with large ones, which cause drainage issues from tree removal, etc. The best streams in the county are in the agricultural areas, with impervious surface a bigger issue for streams."

- "What about atmospheric sources? What economic incentives are there for car drivers, businesses, etc. to reduce air pollution (that affects the Patuxent and the Chesapeake Bay)?"

- "Most land is privately owned, so you have to change behaviors. That's extremely difficult to impossible, with decades of people wanting green lawns. Here are the biggest issues: 1) people not wanting to change behavior 2) environmental issues and affects are felt downstream and are not obvious and 3) government can only do so much about development/land use, with land use being the biggest factor. (Our office's) budget is $2 million/year, which is weighed against developers in our county with hundreds of millions of dollars."

- "The biggest constraint is that the eastern 40% of our county is designated for growth. There is a huge demand for growth in our county because of the excellent school system. The county can't afford to buy agricultural easements any more, as they are going for $30,000 to $40,000 an acre. Pollution levels will only increase, given the population growth that's going to happen. There is not a lot of public recognition about what our lifestyle means in terms of impacts on the environment."

- "Our program is 99% complaint-driven."

- **"**Junkyard cars are a problem. One has 150 cars."

Soil Conservation District Perspective

- "For the Patuxent, it is easiest to point fingers at farmers, because they have less political representation. There are more urban votes in the legislature. The real problem is wastewater treatment plants, particularly during high rain events. There are too many people, and there are issues with septic tanks. Ninety-five percent of my time involves writing plans that verify the good conservation practices already being implemented; farmers would be losing soil and going out of business otherwise."

- **"**The county is heading toward build-out. The development pressure in our county is enormous, as families are attracted to the county because of its excellent schools."

- "Eighty-one of 110 mandated agricultural positions have been filled by the state."

- **"**In terms of our county's stage of development, the county is moving more toward enforcement/compliance. At the same time, they have an opportunity to not make the same mistakes as other counties."

- "Every two years, MDE evaluates local programs for purposes of reissuing (sediment and erosion control) delegation. Sometimes a county might not want to have enforcement delegated to it. For years, our county politicians had that view."

- "(Our county) is seeking delegation from MDE, which is a good sign, but it would also be good to see what pitfalls have occurred in other counties."

- "MDE has two inspectors for all of our (non-delegated) county, which is not enough, because they had other responsibilities as well, other than sediment control."

- "There is a different clientele now in our (county/district), with more horse farmers, less traditional farmers. The new horse farmers don't have a conservation ethic of a traditional farmer; their ethic is the horse. Being designated as an agricultural property in our county is a get-out-of-jail-free-card," since agricultural use means you don't have to get a grading permit. For example, a 56,000 square foot riding arena was built that did not require a stormwater or grading permit.

- "Another example: a barn is not considered a commercial structure, which would require a sprinkler, emergency lighting, etc. The county code was expanded this year into what it calls 'agriculture.' So now it doesn't just encompass production, but also processing, such as vegetable packing facilities and wine, which used to have to be in a commercial zone."

- "MDA considers a plan valid for ten years; our SCD considers a plan valid for one year, with the reasoning being that, if the market drops for corn, for example, and a farmer goes into beans, that should require a different plan."

- "The source of funding for the SCD is critical, as the SCD is at the beck and call of the funder." (County funding is for urban issues, so that's what they'll focus on; if MDA, they'll focus on agriculture.) "In our case, MDA funding comes with strings attached, but there are no strings attached from the county."

- "More funding is needed for retrofits of stormwater management systems in older communities that were built before (current standards were adopted). (Current funding is) nowhere near adequate, and needs to be almost a 100% cost-share. Some of these will start failing soon, as they have about a 25-year life span."

- "Better inspection and maintenance of stormwater structures is needed, as a lot of these have been taken over by homeowners associations."

- "Better inspection of urban sediment and erosion control is needed."

- "Restore funding for the non-structural shoreline erosion control program, which used to be a grant program administered by the Department of Natural Resources. This used to be a 50% cost-share, but it is now a no-interest loan program with no cost-share."

- At the Federal level "there is an opportunity for funding in the next Farm Bill."