DRAFT

TO: Secretary John Hughes, DNREC
FR: Murderkill Tributary Action Team
RE: MURDERKILL RIVER WATERSHED POLLUTION CONTROL STRATEGY RECOMMENDATIONS
DATE: March 2005

The Murderkill Tributary Action Team was formed in April of 2001 in order to recommend a Pollution Control Strategy to the Department of Natural Resources and Environmental Control. This Strategy, attached, outlines the actions needed to implement the Total Maximum Daily Load (TMDL) of nutrients for the Murderkill River and its tributaries.

Section 303(d) of the Federal Clean Water Act (CWA) requires states to develop a list of water bodies for which existing pollution control activities are not sufficient to attain applicable water quality criteria and to develop Total Maximum Daily Loads (TMDL) for pollutants of concern. The TMDL Regulation for the Murderkill was promulgated in 2001, setting goals for a 30% reduction in nonpoint source nitrogen loading and a 50% reduction in phosphorus loading to the River and its tributaries. The TMDL also reduced nutrient discharges from the point sources in the watershed.

Specifically, Articles I through V of the TMDL Regulation identified the pollutants and their sources and the number of pounds of each pollutant the River and its tributaries could include and still meet the water quality criteria established in the CWA. Article VI states if the requirements in the first six articles are met, then water quality will be sufficient. The final article requires accomplishment of the first six articles through the implementation of a "Pollution Control Strategy" developed by DNREC in concert with the Department's Whole Basin Management Program, the Murderkill River Tributary Action Team, and other affected parties.

The Murderkill River Tributary Action Team ("Team") studied water pollution in the watershed and discovered there were several pollutants, numerous sources, and many possible remedies. As a result of their study, the Team concluded the most effective plan would be one favoring remedies that had the greatest impact on pollution . The team then reviewed data from DNREC to determine the most pertinent data for pollutants and their sources as depicted in Table 1.

Table 1: Proposed Amended TMDLs for the Murderkill Watershed

	Baseline[1][2] lb/day	**TMDL requirement[3] lb/day**	**Percent change**	**Change Lb/day**
Total Nitrogen (N)	1471	1338	-9	-133
N from point sources	796	778	-2	-18
N from nonpoint sources	675	560	-17	-115
Total Phosphorus (P)	416	158	-62	-258
P from point sources	274	62	-77	-212
P from nonpoint sources	142	96	-32	-46

The data in Table 1 suggests two conclusions: First, more stringent reductions in phosphorus are needed than nitrogen reductions; and second, phosphorus enters the watershed from point sources to a far greater extent than it does through nonpoint sources. These conclusions led to actions the Team recommends be implemented to achieve an adequate water quality in a hierarchical, prioritized structure. This structure places all the recommended action in context with each other and makes a complex subject easier to understand.

A drawback to this approach is that some significant elements may be low in the hierarchy while others will even be outside of it entirely. For example, even if point source pollution were eliminated, agricultural run-off would remain a major source of phosphorus and nitrogen. Sediment that washes into waterways would still affect water quality. Septic systems and other kinds of onsite waste treatment could still have serious effects. Even pet and waterfowl droppings can ruin a waterway. Some necessary elements of a good Pollution Control Strategy, such as education, cannot even be placed in the hierarchy with pollutants and sources. There are many behaviors, events, conditions, and interrelations that make water pollution a difficult problem. In order for our plan to work it must take into account as many of these factors that we are aware of and we can reasonably afford to address.

The attached recommendations for addressing nutrient pollution in the Murderkill River Watershed are presented in priority of importance of actions required to meet water quality goals set forth by the TMDL. The specific recommended actions are followed by a brief explanation of why the action was included, whether nutrient load reductions for the action have been prescribed, and any additional commentary needed to be added for clarity. In some of the strategies, a Departmental perspective was added for the Teams

[1] The "baseline" for the pollutants nitrogen and phosphorus and CBOD5 compounds is the number of pounds of each deposited in the watershed per day in 1997.
[2] Tables 2.3 and 3.1 in the *Technical Analysis for the Murderkill River TMDLs*. December 2001. Delaware Department of Natural Resources and Environmental Control. Division of Water Resources.
[3] Table 1 in *Draft Technical Analysis for Amendment of the 2001 Murderkill River TMDLs*. August 2004. Delaware Department of Natural Resources and Environmental Control. Division of Water Resources.

edification and to indicate the knowledge base the Team used to forward this particular strategy to you. If you have any questions, please feel free to contact the Team through your own Watershed Assessment Section.

Thank you for your kind attention to the Team's Strategy. Together, your Department and the Team can work together design a plan that will reduce pollutants in our watershed and serve our community. As you will see when you read the last enclosure, the Team has met with great success to date, but much more remains to be done. We look forward to working with your Department in the future to complete the work the Team began four years ago.

Sincerely,

Murderkill Tributary Action Team

This Page Intentionally Left Blank

MURDERKILL RIVER WATERSHED TRIBUTARY ACTION TEAM POLLUTION CONTROL STRATEGY RECOMMENDATIONS

1 BROAD PURPOSE

Return the impaired waters of the Murderkill Watershed to a condition permitting use of the waterways as required by the Clean Water Act (CWA) so they can be removed from the 303d list.

2 SPECIFIC GOALS

Limit pollutants to levels at or below the Total Maximum Daily Load (TMDL) values specified in the regulation, i.e., an overall reduction of phosphorus in the waterways by 62%, or 258 pounds per day (from 416 to 1583 lbs per day), and a reduction in nitrogen of 9%, or 133 pounds per day (from 1471 to 1338 lbs per day).

3 STRATEGY PRIORIZATION

The strategies are organized according to pollutant loads and the nutrient reduction strategies that will reduce the most nutrients. Since the phosphorus reductions were more onerous than the nitrogen reductions called for by the TMDL, the Team attempted to prioritize the recommendations by the strategy that would have the most impact at reducing phosphorus within the watershed. The Team believes this hierarchical, prioritized structure will lead to the ultimate goal of achieving adequate water quality within the watershed. In addition this structure helped greatly improve the ability of the Team to understand this complicated subject because it places all the recommended actions in context with each other.

4 NUTRIENT REDUCING STATEGIES

The following prioritized strategies are listed in bold. Under each strategy is the basis for the recommendations. In cases where the Team was given data regarding the actual nutrient reductions that could be anticipated from the strategy, that information is given as well.

Nutrient Reducing Strategy 1

> The Kent County Waste Water Treatment Facility should (will?) investigate the possibility of utilizing spray irrigation for a significant portion of their wastewater load.

Basis for Recommendation: There are four point source discharges in the Murderkill River Watershed:

- Canterbury Crossing Mobile Home Park treatment facility,
- Southwood Acres Mobile Home Park treatment facility,
- City of Harrington Wastewater Treatment Plant,
- And the Kent County Waste Water Treatment Plant.

Phosphorus: The Kent County Waste Water Treatment Plant was found to account for 63.8 percent[4] of the total amount of phosphorous in the waterways of the watershed in 1997.

Table 2: Point Sources in the Murderkill River Watershed (Proposed)

Nutrient Allocation for Point Sources[5]	**Flow (mgd)**	**Total Nitrogen (lbs/d)**	**Total Phosphorous (lbs/d)**	**CBOD5 (lbs/d)**
City of Harrington[6]	.75	25	.15	8.2
Kent County Facility	15	751	62.5	1001
Canterbury Crossing Mobile Home Park	0.05	4.3	0.2	9.6
South wood Acres Mobile Home Park	0.024	2.0	0.1	4.5

The baseline total discharge for phosphorus into the Murderkill River from point sources was given as 274 pounds per day (in 1997) to be reduced to 62.8 pounds per day. The Kent County facility will be responsible for most of the load reduction. The facility receives wastewater from all over Kent County and part of southern New Castle County. The sewerage collection system for the facility is old and has significant inflow and infiltration during wet periods after significant storm events[7]. Consequently, the treatment plant must handle large volumes of water before the treated wastewater is discharged into the Murderkill River. Kent County should encourage the reduction of Inflow and Infiltration throughout the wastewater collection system. Additionally, a mechanism needs to be established to compensate the Murderkill Watershed for the increased water quality burden from assimilating the nutrient load from all over Kent County. In any case, the Kent County Facility bears a significant task in treating wastewater load from the entire County and at the same time meeting the local watershed TMDL mandate.

After the daily loads are reduced to the values called for in the TMDL regulation, the Kent County facility will account for over 96 percent of the phosphorus from point sources and 20.3 percent of the phosphorus from all sources. Of the 123.3 pounds per day of phosphorous allowed under the amended TMDL, the Kent County Wastewater Treatment facility would be allowed to discharge 25 pounds per day. Thus, the Kent County Waste Water Treatment Facility would be contributing 96 percent of the point source phosphorus and 68.7 percent of point source nitrogen load to the Murderkill River. In addition, because the TMDL regulation calls for greater reductions of phosphorus from point sources than nonpoint sources, consequently the other point sources must also be addressed.

[4] Table 3.1 in *Technical Analysis for the Murderkill River TMDLs*. December 2001. Department of Natural Resources and Environmental Control.
[5] The figures listed in this table are limits proposed in the 2005 TMDL amendments.
[6] The City of Harrington wastewater treatment facility point source discharge is in the process of converting to spray irrigation since the original TMDL was written.
[7] Personnel Communication Kent County Treatment Plant, 2003

Less wastewater being discharged into the Murderkill River would mean that, fewer pounds per day of phosphorus or other nutrients will be entering the River. Spray irrigation has been shown to reduce phosphorus and nitrogen load to groundwater by 90% and ultimately into the surface waters. If spray irrigation is not utilized, growth in the County could be stymied due to the lack of the facility's ability to handle any more wastewater i.e. nutrients, from the proposed growth. Reduction of the nutrient load by diverting some of the wastewater flow to spray irrigation would ultimately allow for more growth within the County. Spray irrigation will also promote groundwater recharge where as the treatment facility discharges all of its wastewater into the Murderkill River and tributaries with no opportunity for groundwater recharge.

EXPECTED REDUCTION: 44 lbs/day assuming that you have 15mgd flow and current performance of plant with no stream discharge

Ancillary reduction of N: 300 lbs/day assuming that you have 15mgd flow and current performance of plant with no stream discharge

Nutrient Reducing Strategy 2

The Kent County Wastewater Treatment Facility should (will?) upgrade to the best available technologies for decreasing the amount of nutrients in the effluent and, therefore, decrease the pounds per day of these contaminants discharged into the Murderkill River.

Basis for Recommendation: Strategy 2 would be costly; consequently the team recommends that the County produce a Financial Impact Study before undertaking it. Potential funding sources could include, such things as bond sales, Federal and/or State grants, low interest capitalization loans, increased impact fees, increased user fees, utilization of a portion of county tax revenues, etc.

Department's Perspective: In Nutrient Reducing Strategy 1 the Team recommended the utilization of spray irrigation for the Kent County Wastewater Treatment Facility; however, Strategy 2 may not be beneficial for the utilization of spray irrigation within the watershed. Wastewater that is treated to high a level may not provide adequate nutrients for the vegetative growth within the spray field and additional fertilization may be needed to meet nutrient needs of plants for growth which may not achieve the TMDL.

Nutrient Reducing Strategy 3

Support Harrington's Sewage Treatment Plant (STP) conversion to a spray irrigation facility on near by farm ground.

Basis for Recommendation: The proposed amended TMDL calls for the Harrington Waste Water Treatment Facility to totally eliminate any direct discharge into the Murderkill River; however, Harrington Waste Water Treatment Facility wants to spray irrigate most of its wastewater but still be allowed to discharge a portion of the load into Browns Branch when it is too wet to spray irrigate. The amended waste load allocation for the Kent County Facility is established based on

the assumption that surface discharge from the City of Harrington STP will be eliminated in the near future. This provided additional assimilative capacity for the Kent County Facility. However, if because of practical and/or logistical considerations, Harrington STP facility could not spray its treated wastewater during certain periods and discharges into the surface waters, the waste load allocation for the Kent County Facility should be reduced by the amount of nutrient loads being discharged to the surface waters by the Harrington facility

Department's Perspective: Article 4 of the proposed amended TMDL presented to The City of Harrington and Kent County. " Treated wastewater from the City of Harrington wastewater treatment facility shall be used for spray irrigation. However, during the winter season, as well as during wet weather periods, when spray irrigation of treated wastewater is not practical, the effluent may be discharged into Browns Branch. During periods of surface discharge, the maximum discharge flow rate shall not exceed 750,000 gallons per day and daily waste loads shall not exceed 140 pounds per day for total nitrogen, 0.75 pounds per day for total phosphorus, and 37.5 pounds per day for CBOD5. Furthermore, the total annual waste load discharged from the City of Harrington wastewater treatment facility to the surface waters of Browns Branch shall not exceed 9125 pounds per year for total nitrogen, 55 pounds per year for total phosphorus, and 3000 pounds per year for CBOD5."

EXPECTED REDUCTION: 0.15 lbs/day of TP
Ancillary reduction of N: 25 lbs/day

Nutrient Reducing Strategy 4

Mitigate Canterbury Crossing and Southwood Acres point source nutrient loads by utilizing best management practices to reduce nonpoint source nutrients coming from the communities and minimize their respective discharges.

Basis of Recommendation: The Team does not recommend the expenditure of a large amount of resources in ameliorating their respective discharge; instead their loads should be reduced by installing best management practices within each development that will reduce their nonpoint source load. Their combined load proposed amended TMDL only amounts to 0.3 pounds of phosphorus per day and 6.3 pound for total nitrogen. Even if this discharge were completely eliminated, the benefit to the Murderkill River would be slight. The Team believes that the installation of best management practices within these developments would lead to decrease load to the Murderkill at much cheaper cost than the cost of eliminating them.

Department's Perspective: Canterbury Crossing Mobile Home Park plans to connect to the Kent County Facility when the Walnut Shade Sewer project moves forward (see attached map of proposed sewer district).

EXPECTED REDUCTION: 0.2 lbs/day of TP
Ancillary reduction of N: 4.3 lbs/day

Nutrient Reducing Strategy 5

Designate the Murderkill River Watershed as a Critical Environmental Area in order to enhance the potential to receive available cost-share and grant funds.

Basis for Recommendation: Because of the amount of agricultural land in the watershed it is important to prioritize and recognize the watershed in order to maximize assistance for farmers to address nutrient management. In 2003, the Team requested Secretary Hughes to submit a letter to the Nutrient Management Commission requesting the Critical Area designation. In September 2003, the Department recommended that the Nutrient Management Commission (Commission) designate the Murderkill Watershed as a "Critical Watershed." The declaration targets the watershed for increased cost share funds, when available.

EXPECTED REDUCTION: Reduction achieved will be a function of the acreage and type of new agricultural best management practices constructed with the watershed.

Nutrient Reducing Strategy 6

Encourage farmers to comply with the Nutrient Management Act (NMA) and to actively participate in establishing nutrient reducing best management practices (BMPs) on their farms.

The Department and Delaware Department of Agriculture should assess the impact of nutrient management planning as required by the Nutrient Management Law.

Basis of Recommendation: As of 2007 all lands (over 10 acres) that have nutrients applied must be in compliance with NMA. The NMA requires all farms over 10 acres or with 8 animal units to establish a nutrient management plan, which includes the use of fertilizers and the fate of manure. Assessing the impact of this requirement will quantify the efficiency and reduction of nitrogen and phosphorus.

Since the baseline period (1997), the agriculture community has reduced a significant amount of nonpoint source nutrient loading, leading the efforts to curtail nonpoint source nutrient loading. From the 1997 to 2003, multiple Best Management Practices (BMPs) have been implemented, and the Delaware NMA was passed. As of February 2003, 6116 acres of cropland already has had nutrient management plans developed and by 2007, all farms that apply nutrients to ten acres or more will be required to have Nutrient Management Plans (NMPs). The 2002 Farm Bill has led to unprecedented funding levels of cost-share programs for BMPs that protect the environment, especially water quality.

In many watersheds polluted runoff from cropland, manure-disposal sites, and concentrated animal-feeding operations (CAFOs) are some of the important sources of phosphorus to surface waters. As of 2002, there were 29 poultry operations, which produce approximately 2,490,684 birds annually, 2 dairies, 8 beef cattle operations, 13 equine and 4 goat operations in the Murderkill Watershed[8]. Potential nutrient inputs are related to manure, runoff, erosion, and atmospheric deposition of nutrients. In 2002, 55% of the Murderkill Watershed was used for

[8] Glenn Gladders, Nonpoint Source 319 Program, DNREC. 2004. Personal Communication.

agriculture, which equates to approximately 37,393[9] acres. In 1997, agricultural land use accounted for 58%[10] of the total land area in the watershed; therefore, it is likely that agricultural activity is the second leading source, after the Kent County treatment plant, of phosphorus entering the waterways. In addition, these sources have an ancillary significant loading of nonpoint source nitrogen.

There are 37,393 acres of crops in the watershed.[11] Crops require nutrients in order to produce an economic yield. Crops produced in the watershed may include soybeans, potatoes, barley, wheat, corn, and vegetables. Nutrient inputs include fertilizer and manure application, which if applied improperly may contribute to nutrient over-enrichment in streams and tributaries in the Murderkill Watershed.

The Pollution Control Strategy Workgroup has not been able to assigned nutrient reduction from nutrient management planning due the baseline period (6/6/97 to 9/30/98) being so close to when NMA was enacted (2002). The nutrient management plans from the baseline period used for comparison were essential the same as nutrient management plans required by the NMA.

> EXPECTED REDUCTION: Reduction achieved will be a function of the acreage and type of new agricultural best management practices constructed within the watershed.

Nutrient Reducing Strategy 7

> Establish and prioritize nutrient reducing best management practices (BMPs) in order of efficiency and cost effectiveness.
>
> Assess the array of drainage systems and BMPs on agriculture lands in use along the drainage systems within the watershed in order to identify any areas for possible improvement.

Basis of Recommendation: The establishment of best management practices on agricultural land will address nutrient inputs from all facets of agriculture operations, including the use of manure from animal operations and fertilizers for crops. Voluntary use should be recommended first. Identify areas where BMPs can be implemented. The environmental and quality of life benefits of agriculture should be recognized as a way to encourage and enforce BMP implementation. Encourage use of buffers on agricultural lands where best nitrogen and phosphorous uptake is likely. By targeting areas for BMP implementation geographically, more effective and efficient nutrient reductions can likely be expected.

Department's Perspective: An Agricultural Pollution Control Strategy Workgroup was convened to gather the best available science for nonpoint source pollution prevention from agricultural sources for the Inland Bays. The Workgroup met since April 2002 to gather the best available data on nutrient efficiencies for various agricultural best management practices. Their recommendations and calculations are based on averages over several years from different

[9] 2002 Landuse data
[10] 1997 Landuse data
[11] Glenn Gladders, Nonpoint Source 319 Program, DNREC. 2004. Personal Communication.

studies and are dependent on weather conditions, soil type, crop production intensity, excess manure generation, topography and other site-specific conditions. In addition, the workgroup recognized that a lag time likely exists between practice implementation and benefit observation, which can not currently be estimated since all nutrient fate and transport processes are not well understood at this time. The PCS Workgroup has identified efficiency values for BMPs in the Murderkill Watershed. This data is attached in Appendix X.

> EXPECTED REDUCTION: As of February 2003, agricultural best management practices on the ground in the Murderkill River Watershed have reduced phosphorus loads by 1.38 lbs per day or 1.44 percent of the way towards the P load goal.
> Ancillary reduction of N: 71.87 lbs per day of nitrogen or 12.8 percent of the way towards the nitrogen load goal

Nutrient Reducing Strategy 8

> Ongoing in-stream monitoring must be done in order to quantify the amount of nutrients in the waterways of the Murderkill Watershed.

Basis for Recommendation: This monitoring will identify areas of high nutrient influx allowing for installation of BMPs to reduce the nutrient load or initiate some mitigation strategy to reduce the high nutrient influx.

The Division of Water Resource's Watershed Assessment Section monitors 14 surface water stations for water quality quarterly in the Murderkill. We recognize that any additional sampling will require more funds which may not be available due to already mandated sampling expenditures.

> EXPECTED REDUCTION: An efficiency and reduction value cannot be assigned to this recommendation. Monitoring does not have a direct reduction.
> Ancillary reduction of N: none Ancillary.

Nutrient Reducing Strategy 9

> Optimize and prioritize areas where individual, large and community wastewater treatment and disposal systems can be eliminated by connecting to Kent County Waste Water Treatment Plant.

Basis for Recommendation: In Delaware, surface and ground water are directly connected. Consequently, impacts on groundwater will impact the quality of the surface water. In the summer, surface water flow is primarily groundwater seepage into the stream. Nutrients from onsite wastewater treatment and disposal systems will reach the surface water through the groundwater. An individual onsite wastewater treatment and disposal system may contribute 5.8 lbs per year of phosphorus and 22 pounds per year of nitrogen to the groundwater. As of 2001, approximately 6402[12] septic tanks were identified in the Murderkill Watershed. In 1997, which is the baseline year for the TMDL, there were 5238 individual septic tanks in the watershed.

[12] J. (Jennings) Volk

Therefore in 2001, the potential contribution of phosphorus from septic systems may be up to 12.1 lbs per day and 376.8 lbs per day of nitrogen to the groundwater and ultimately surface water.

Kent County has targeted Walnut Shade area, where 500 residences are served with onsite wastewater treatment and disposal systems, for connection to central sewer. Many of these systems are old and are malfunctioning. Kent County has also included Woodville and Terry Drives, an area where most of the homes are served by environmentally ineffective and outdated cesspools, in this expansion. This area was included because system failures pose the greatest threat to human health and water quality. This proposed sewer district will be connecting to Kent County Treatment Facility within the next 3-5 years.

EXPECTED REDUCTION: 8 lbs/day of TP
Ancillary reduction of N: 30 lbs/day

Nutrient Reducing Strategy 10

Promote compliance with regular inspections and pump outs of individual onsite wastewater treatment and disposal systems (OSWDS).

Require when a house is sold that the onsite wastewater treatment and disposal system is inspection and pump-out, if necessary, to verify the system was maintained and is operational at the time of inspection.

Basis of Recommendation: Currently septic permits require that the systems be pumped out every three years or when the system contains 30 percent or more of solids. The County and/or Department should institute a program that enforces the inspection and pump out requirement for onsite septic systems. Homeowner's should be notified of this requirement in their tax bills the year their system is due. The County and State should use computer software to track the occurrence of inspections and cooperate to ensure compliance with regulations. Additionally, the state should implement a pilot onsite septic inspection and compliance program for the Murderkill Watershed. The program should assist residents who have not had their septic pumped in the previous two years to have their system pumped and inspected. The State and County should subsidize the cost of inspection and pump out. Following the inspection, the inspector should provide the homeowner/resident with educational materials and receipt of pump out.

By requiring this before closing, new property owners will be educated on their system and gain a better understanding of maintenance and operation requirements, thus reducing long term or future problems with the system. Section 8.0000 of the *"Regulations Governing the Design, Installation and Operation of On-site Wastewater Disposal and Treatment Systems"* dictates owner responsibility for maintaining and operating on-site wastewater treatment and disposal system.

The watershed currently has 6402 OSWD systems within its boundaries. If all systems are pumped once every three years, as required by state regulations,[14] then 2134 systems would be pumped annually. The soils in the watershed are mostly well drained: the actual TP reduction will likely be significantly less. Each system pumped out would reduce TP and TN surface and/or groundwater load by 0.8 lbs/system/year and 2.0, respectively.)

Department's Perspective: On July 11, 2003, the Governor signed House Bill 150 into law which amended Title 7, Chapter 60 of the Delaware Code relating to the Department of Natural Resources and Environmental Control. This legislation authorizes the Department to establish a license for persons who inspect septic systems (Class "H") and other on-site wastewater treatment systems, and sets an annual license fee for septic system designers, installers, site evaluators, liquid waste haulers, inspectors and percolation testers, similar to other license fees charged by the Department. The Class H license authorizes the inspection, investigation, data collection and certification/non-certification of on-site wastewater treatment and disposal systems[13]. The Regulations were updated to include an inspector's license in early 2004. At this point, limited State funds preclude the staff from conducting more than 10 system inspections per week. Currently, a pilot inspection and compliance program has been developed and is being implemented in the Inland Bay Watershed. However, the State does not have specific requirements for onsite wastewater treatment and disposal systems to be inspected and pumped out prior to property transfer. Some bank lenders may require prior to closing once the program is funded, it can be implemented.

EXPECTED REDUCTION: 4.9 lbs/day of TP for 2134 systems
Ancillary reduction of N: 12.3 lbs/day

Nutrient Reducing Strategy 11

Systematically eliminate cesspools and seepage pits as the compliance program and resulting inspections program are instituted and as properties are transferred from one owner to another.

Basis for Recommendation: The DNREC Watershed Assessment Section estimates that there are at least 30 cesspools[15] and/or seepage pits in the Murderkill Watershed, however that estimation may be low. Any existing system would likely be Ancillary with old farmsteads and very old mobile home parks (See Nutrient reducing Strategy 10).

EXPECTED REDUCTION: Unknown
Ancillary reduction of N: Unknown

Nutrient Reducing Strategy 12

[14] Regulations Governing the Design, Installation and Operation of On-Site Wastewater Treatment and Disposal Systems, adopted March 11, 2002.
[13] Onsite Regulations
[15] This number was determined by using a GIS and old aerial photographs to assess large parcels over 10 acres within the Murderkill Watershed with the assumption that large parcels were farmsteads and had a dwelling unit and cesspool.

Provide new homeowners with onsite wastewater disposal systems educational materials on how the systems function and the steps that are necessary for maintenance at the time they close on their homes.

Basis of Recommendation: New homebuyers may not understand the functioning of their system or the impacts a failing system could have on the environment. Therefore, by providing education materials, the homeowner may prevent long-term problems and may save money as well.

EXPECTED REDUCTION: Unknown
Ancillary reduction of N: Unknown

Nutrient Reducing Strategy 13

Provide education about alternative enhanced nutrient reducing onsite wastewater treatment and disposal systems and develop a fund to offset the cost of these systems within the watershed.

Basis for Recommendation: In response to the TMDL, Kent County requires that: Individual residential, large or community onsite sewage treatment and disposal systems sited in a watershed with an established Total Maximum Daily Load (TMDL) shall be designed and installed in accordance with the nutrient load reductions prescribed by the TMDL or they shall use the best available technologies in order to achieve the required nutrient reduction targets set for the particular watershed. (See Chapter 187, Subdivision and Land Development (Adopted June 24, 2003)).

Due to the cost of these systems the Financial Assistance Branch administers low interest loans for on-site wastewater systems for persons of low to moderately low incomes from the State Revolving Fund.

EXPECTED REDUCTION: This action will only impact new construction
Ancillary reduction of N: This action will only impact new construction

Nutrient Reducing Strategy 14

Design and implement all permanent sediment and stormwater management plans to include design criteria to further reduce nutrient contributions by the percentage required by the TMDL to the ground and surface waters to the maximum extent practicable.

Basis of Recommendation: Since 1991, stormwater runoff ancillary with new development is regulated under the Delaware Sediment & Stormwater Regulations, administered by the Division of Soil & Water Conservation. As stormwater moves over land, it picks up natural and human-made pollutants from lawns, streets, parking lots and industrial and commercial facilities, eventually depositing them into the waters of the Murderkill. Stormwater management is the primary way to control nonpoint source pollution from developed areas. A variety of methods can be used to control and treat runoff from lawns, homes, parking lots, roads and commercial and industrial facilities. Some of these methods reduce nutrient loading from stormwater more

than others. When possible, these methods should be preferred. However, there may be instances where the pollutant of most concern on the site would not be reduced sufficiently by the most effective nutrient removal technique. In these cases, the method used should be the best at treating the removal of the pollutant of most concern. Reducing stormwater impacts within the Murderkill will require action by all stakeholders and will required innovative management techniques.

The water quality goal under the current regulations is 80 percent removal of the average annual load of total suspended solids (TSS). The Department may require acceptable stormwater quality practices if a receiving water body has been identified as impaired, or designated with a specific pollutant reduction target necessary to meet State of Delaware water quality regulations.[16] Stormwater runoff for specific industries or point sources is managed through the National Pollutant Discharge Elimination System (NPDES) program, administered by the Surface Water Discharges Section within DNREC's Division of Water Resources.

> EXPECTED REDUCTION: This action will only impact new construction
> Ancillary reduction of N: This action will only impact new construction

Nutrient Reducing Strategy 15

> Require vegetated buffers of adequate and proper widths sufficient to reduce or eliminate nonpoint source pollution for lots abutting tidal water and perennial streams.

Basis of Recommendation: Buffers help to filter nutrients and slow overland stormwater flow. Kent County has issued several ordinances related to development and buffers, including an ordinance requiring 100-foot setbacks from blue line streams and tax ditches and a 25-foot buffer/setback for wetlands. However, the County setbacks are not required to be vegetated. The Murderkill Tributary Action Team feels these ordinances may not be strong enough as written to adequately protect the waters of the Murderkill River Watershed. Recommendations are being made to strengthen and supplement County and State requirements with the expectation that these measures will protect and improve water quality and the quality of life for the residents in the watershed. Buffers should be required on, but not limited to the following: stormwater and drainage conveyances, grassed waterways, ponds, catch basins, intermittent streams, tidal and freshwater wetlands, and tile wells and based on individual site conditions. In addition buffer should be free of any encumbrances including onsite wastewater treatment and disposal systems.

Developers should be required to protect existing and/or provide new buffers if necessary as community open space: however, the responsibility for buffer maintenance will fall to civic and homeowners associations or maintenance corporations, not individual homeowners. Buffers should be planted and designed to require zero or minimal maintenance. The developer must also guarantee all trees planted in the development for the first year.

> EXPECTED REDUCTION: For each acre of 100 feet buffer installed 0.003 lbs day of TP could be reduced.

[16] Randy Greer, Sediment and Stormwater Program. August 11, 2004. Personal Communication.

Ancillary reduction of N: For each acre of 100 feet buffer installed 0.14 lbs day of TN could be reduced.

Nutrient Reducing Strategy 16a

Determine the location and acreage of buffers in the watershed and identify areas for improvement, i.e. stream miles with and without buffers.

Nutrient Reducing Strategy 16b

Establish riparian buffers on all public lands, including retrofits. Fifty percent of appropriate public lands should have buffers installed within 5 years, and within 10 years all public lands should have buffers as appropriate.

Basis of Recommendation: Stream reaches within the Murderkill Watershed that either lack forested riparian buffers, or have only narrow forested riparian buffers were identified using ESRI's ArcGIS software. The analysis included the use of multiple layers of data including 1997 forest cover data from the Delaware Natural Heritage Program, hydrography data from the U.S. Geological Survey (USGS), 2002 wetlands maps from the Delaware Statewide Wetlands Mapping Project (SWMP), and public lands data from DNREC's 2004 Outdoor Resources Inventory (ORI). Since the forest cover data was somewhat outdated, 2002 aerial photos were also used to help update some of the forest cover data as needed.

The GIS software was used to identify 100 foot buffer areas around rivers, streams, and tax ditches, and 50 foot buffer areas around freshwater wetlands. Tidal wetland areas were considered unsuitable for the establishment of forested buffers and were removed from the analysis. Tidal portions of the river and any tidal tributaries were included in the analysis. Buffers around tidal areas were considered adequate if the wetlands extended at least 100 feet from the edge of the water. For all non-tidal areas, buffers were considered adequate if the entire designated buffer areas consisted of forests. Stream sections within the watershed were categorized into three groups according to the status of the adjacent forested riparian buffers. The three categories included: 1) adequate forested buffers along both stream banks, 2) deficient forested buffers along either one or both stream banks, or 3) no forested buffers along either stream bank. Since the establishment of additional forested riparian buffers has a greater likelihood of being implemented on public lands than on privately owned lands the analysis was broken out for both publicly owned and private lands.

Within the Murderkill Watershed there are approximately 230 miles of waterways excluding ponds and reservoirs. The analysis found that out of 230 miles of rivers, streams, and tax ditches, only 130 miles (57 percent) are adequately buffered along both stream banks. Sixty-seven miles (29 percent) have deficient buffers along either one or both of the stream banks, and 33 miles (14 percent) have no stream buffers along either stream bank.

Within the Murderkill watershed only 26 miles (11 percent) of rivers, streams, and tax ditches flow through publicly owned lands. Waterways within public ownership fared much better than those in privately owned lands. Within public lands, 21 miles (81 percent) are adequately

buffered along both stream banks, 4 miles (15 percent) have deficient buffers along either one or both of the stream banks, and only 1 mile (4 percent) had no forested buffer along either stream bank.

Overall within the Murderkill watershed most of the tidal portions of the watershed and the main stem of the river are adequately buffered. The areas in most need of attention are the agricultural tax ditches, many of which have no forested riparian buffers. The analysis also emphasizes the importance of working in cooperation with private landowners, since a majority of the waterways flow through privately owned lands. Overall, 43 percent of the waterways within the Murderkill River Watershed are not adequately protected by forested riparian buffers that are capable of reducing the loading of excess nutrients and sediment.

> EXPECTED REDUCTION: For each acre of 100 feet buffer installed 0.003 lbs day of TP could be reduced.
> Ancillary reduction of N: For each acre of 100 feet buffer installed 0.14 lbs day of TN could be reduced.

Nutrient Reducing Strategy 17

> (Support research to) identify vegetation that will give the most nitrogen and phosphorus reduction for planting along maintenance right of ways for tax ditches and in buffers.

Basis of Recommendation: Riparian buffers effectively trap the sediments, nutrients, and bacteria in the surface and ground waters flowing from uplands and thus improve the quality of receiving waters. Several studies have examined the effectiveness of buffers at removing sediment from surface runoff, with the general agreement being that as buffer width increases, sediment removal increases (Castelle et al., 1994; Wenger, 1999; Dosskey, 2001). An experiment in the North Carolina Coastal Plain, though, found that although the studied buffer trapped as much as 90% of the sediment eroded from an agricultural field, almost 50% of that sediment traveled more than 300 feet into the buffer (Cooper et al., 1987 as cited in Wenger, 1999). This suggests that wide buffers are necessary for long term sediment sequestration. Sediment can be trapped by forested or grassy vegetation. The deep root structures of trees stabilize soils and promote further sedimentation. Grassed buffers, on the other hand, are effective at minimizing runoff velocity and trapping sediment by maintaining sheet flow through the riparian zone, but they can become covered in high sedimentation environments, which rapidly decrease their efficiency (Wenger, 1999; Dosskey, 2001).

Once nutrients like phosphorus and nitrogen enter riparian buffer zones they either become trapped in the soils, taken up by vegetation, or transformed by other processes. Phosphorus is often found bound to sediment and is mobilized in surface runoff. Thus, particulate P can be effectively removed though the trapping of sediment in wide buffers as described above (Wenger, 1999). Nitrogen, on the other hand, is primarily transported in the dissolved form and is taken up by vegetation or permanently removed from the system through denitrification, a process through which microbial organisms in the soils and streambed reduce nitrate-N to nitrogen gas. Denitrification is likely the more significant mechanism of nitrate-N removal (Peterjohn and Correll, 1984), however, several factors influence where the greatest amount of

denitrification will occur. Denitrification rates are often greatest when the ground water table is near the surface and when carbon and nitrate-N are in good supply (Wenger, 1999; Lowrance, 1992). Thus, these zones of high denitrification can be highly spatially variable and in order to capture as many zones as possible, and hence remove as much nitrate-N as possible, buffer width should be maximized. A width of at least 100 feet has been suggested as an optimal buffer width for this purpose (Wenger, 1999). Grass and forest buffers are both effective at removing N and P from surface waters, however forests are more efficient at removing N from ground waters (Osborn and Kovacic, 1993 as cited in Wenger, 1999).

EXPECTED REDUCTION: Unknown
Ancillary reduction of N: Unknown

Nutrient Reducing Strategy 18

Manage open space for nutrients.

Basis of Recommendation: Open space can have many valuable functions and should include natural areas; however, wetland restoration areas and buffers should be included as open space. Open space should be developed with appropriate native vegetation and protected though easements. In impaired watersheds, it makes sense that water quality protection should be important when developers design open space. Maintenance of these spaces is important for water quality benefits. It is logical that inclusion of open space in a developed area will help to reduce nutrient loads; it is difficult to assign a specific load reduction to this recommendation.

EXPECTED REDUCTION: For each acre of open space 0.003 lbs day of TP could be reduced.
Ancillary reduction of N: For each acre of open space 0.14 lbs day of TN could be reduced.

Nutrient Reducing Strategy 19

Monitor existing and new stormwater BMPs, quantifying the return on investment for different practices, locating and identifying structures, quantifying the types and amount of different pollutants, and identifying the most effective and cost effective practices.

Basis of Recommendation: The Department and Delaware Department of Transportation (DelDOT) are involved in projects monitoring the effectiveness of various stormwater strategies. DelDOT has been investigating the performance of four different types of inlet protection devices in urbanized areas of northern Delaware. They are evaluating and comparing the performance of these inserts with respect to their ability to remove sediment and hydrocarbons from stormwater runoff, as well as their maintenance requirements in different applications. Monitoring will continue year-round over a two- to three-year period, in order to incorporate data from varying seasonal and rainfall conditions. These projects combined with the literature will provide nutrient reduction efficiencies for various practices in the future. Our current knowledge of these elements is listed below and believes that adequate research is being

conducted on new and existing BMPs that the literature will provide adequate information on these BMPs.

Kent County Conservation District is in the process of assessing all stormwater BMPs installed in Kent County, identifying priority areas for stormwater retrofits and evaluating the effectiveness of BMPs already constructed.

Biofiltration/bioswales must be at least 200 ft long for TN reduction and 100 ft. swales are more effective in reducing TP (45 percent) as compared to 200 ft. swales (29 percent)[17].

EXPECTED REDUCTIONS:

TABLE 4.1 Storm water best available technology (BMPs)	**BMP Efficiency as Percent for TN**	**BMP Efficiency as Percent for TP**
Wet ponds	12	55
Dry pond (extended detention)	15	25
Infiltration (swale, infiltration basin/trench)	65	70
Biofiltration*	25	29
Sandfilter	47	41

Nutrient Reducing Strategy 21

Identify areas in the watershed where stormwater retrofits would be effective in reducing nutrients from entering into surface waters.

Basis for Recommendation: Land developed prior to 1990 did not have any stormwater requirements. Kent County Conservation District has delegated authority from DNREC to run the stormwater program in Kent County and is in the process of identifying priority areas for stormwater retrofits.

EXPECTED REDUCTION: Nutrient reductions will depend on the specific systems selected for upgrade and the acreages involved. See the table above for BMP efficiencies.

Nutrient Reducing Strategy 21

Municipalities must separate their stormwater flow from their wastewater flows according to the Kent County Sanitary Code.

[17]

Basis of Recommendation: Based upon information given to the Team by Kent County, flow to the county wastewater treatment plant may double during rain events and nutrient loads may increase from more runoff.

EXPECTED REDUCTION: UNKNOWN
Ancillary reduction of N: UNKNOWN

Nutrient Reducing Strategy 22

Implement a storm water utility within the watershed

Basis of Recommendation: Stormwater best management practices have maintenance requirements and operational expenses. Most community management associations do not have the knowledge or the financial means to operate and manage their stormwater structures. The Sediment and Stormwater regulations serve as an enabling structure for the local ordinances needed in order to set up the utility. The Sediment and Stormwater program has held several workshops to generate interest in the formation of a utility. Stormwater utilities are designed to become a funding mechanism for stormwater retrofits and maintenance.

EXPECTED REDUCTION: Nutrient reductions cannot be assigned to this recommendation as it is a mechanism for funding practices, not for implementing practice.

Nutrient Reducing Strategy 23

Improve landowner knowledge of stormwater best management practices by establishing guidelines that correlate to national and state curriculum standards with an emphasis on the benefits of stormwater management.

Basis of Recommendation: DNREC could convene a joint working group from Kent County Conservation District, Kent County Land Use and Planning Office, the Nutrient Management Commission, DelDOT, municipalities, EPA and any other relevant agencies to share information and create appropriate methods to integrate stormwater management practices and education.

EXPECTED REDUCTION: UNKNOWN
Ancillary reduction of N: UNKNOWN

Nutrient Reducing Strategy 24

Quantify the amount of nutrients lawn care is contributing to waterways through the use of surveys or other methods as appropriate.

Basis for Recommendation: Nutrient contributions from lawn care are assumed to be high, however it is very difficult to quantify. In Delaware, 58 percent of homeowner turf acres were fertilized[18]. Of these the average nitrogen application rate to home-lawns falls within the range

[18] Avenue, 1994

recommended by the University of Delaware Soil Test Procedure (UDSTP) and phosphorus application rates fall below the range specified by UDSTP[19]. Also in this study, researchers found that professional landscape services used significantly less fertilizer than homeowners.

EXPECTED REDUCTION: UNKNOWN
Ancillary reduction of N: UNKNOWN

Nutrient Reducing Strategy 25

Identify lawn care companies and other fertilizer applicators within the watershed.

Requiring fertilizer applicators to log nutrients applied to individual properties will help to track the amount of nutrients being applied within the watershed.

Require lawn care companies to incorporate soil tests into lawn service, prior to applying fertilizers.

Basis of Recommendation: The Delaware Nutrient Management Commission (DNMC) is the controlling authority for fertilizer application on parcels of land greater or equal to 10 acres within the State. The Nutrient Management law requires nutrient applicators to be certified. Requiring applicators to log the amount of nutrients they are applying will help to track the amount of nutrients being applied to individual non-agricultural properties. The DMNC has also recognized that significant contributions of nitrogen and phosphorous come from land parcels less than 10 acres in size. In response to this knowledge, the DNMC has produced a brochure on proper lawn maintenance. These brochures have been placed in most retail outlets that sell fertilizer in the watershed. In addition, an advertisement was broadcast on local television station reminding people about proper lawn nutrient application and urging people to get a soil test done prior to applying fertilizer.

Lawn care companies must comply with Nutrient Management Act requirement for turf management by 2007. The Team suggests a compliance timeline similar to that being required for the agriculture community. Requiring soil test by lawn service companies would ensure only the necessary amount of nutrients are being applied to lawns.

EXPECTED REDUCTION: Unknown
Ancillary reduction of N: Unknown

Nutrient Reducing Strategy 26

Require impervious cover to be limited to no more than 15% of the watershed to conserve water quality. Local ordinances should be implemented to assist in restricting impervious surfaces and impervious cover calculations should include streets and sidewalks.

[19] Sims and Gartley, 1996

Basis for Recommendation: As impervious cover increases in a watershed, water quality decreases. Limiting impervious cover reduces the amount of runoff that can enter the river and its tributaries. Research has consistently shown that once a threshold of imperviousness is crossed in a given watershed, water quality and stream habitat cannot be maintained at the predevelopment level. The consensus among many independent researchers is that watershed imperviousness should not exceed 10 percent in environmentally sensitive watersheds. As research has uncovered the link between increases impervious cover and deteriorating water quality, businesses have developed pervious paving products that can replace impervious methods.

Kent County Code presently allows 20 percent of each lot to be covered by impervious surfaces; however this allotment does not include streets or other impervious areas outside the lot boundary in the calculation. Consequently, subdivisions have over 20 percent impervious cover. Commercial lots could 100 percent impervious cover. In 1984 (?), impervious cover within the Murderkill Watershed was estimated to be around 0.5 percent and in 2002 data is estimated to have increased to 8.1 percent.

> EXPECTED REDUCTION: Although there have been links between percent impervious cover and watershed health, nutrient loading rates for phosphorus and nitrogen have not been established for percent imperviousness, however logic tells us that by reducing runoff, we will reduce nutrient loads in the river, ponds and tributaries. We do not have the ability to connect a numeric reduction with coverage limits.
> Ancillary reduction of N: Unknown

Nutrient Reducing Strategy 27

> Protect existing wetlands from impacts of impervious area through conservation site design and low impact development.

Basis of Recommendation: Regulations should include the concept and practice of low impact development. There are several ways to approach changing regulations and ordinances to promote low impact development (LID). Livable Delaware Advisory Council has completed *"Better Models for Development in Delaware*" which promotes ideas for creating more livable and prosperous communities. The Sea Grant Marine Advisory Service will be promoting an education program for municipal leaders "NEMO" which educate leaders for various aspects of promoting better development.

> EXPECTED REDUCTION: UNKNOWN
> Ancillary reduction of N: UNKNOWN

Nutrient Reducing Strategy 28

> Develop a comprehensive education plan for the urban/suburban landowner, homeowner's associations, local garden clubs, school districts and other educational facilities on the issues of water quality and urban nutrients.

The plan should:

1. Identify values which are affecting residential activities and target those that will effect behavior change
2. Encourage educational facilities with turf athletic facilities where nutrients are applied to develop nutrient management plan for their facility. (The DNMA requires licenses for facilities personnel applying nutrient fertilizers to educational facility.)
3. Develop an advertising strategy that promotes the use of soil tests to the urban/suburban homeowner.
4. Work the University of Delaware to revise their soil test results sheet for homeowners to make it easier to be understood and provide specific fertilizer application recommendations based upon existing fertilizer blends found within the State.
5. Education of fertilizer retailers such that retailers will pass out educational materials with purchase of fertilizer and will have available soil testing materials at their location
6. Educate homeowners and homeowner associations on stormwater BMPs that can be used around the home to reduce impact on water quality
7. Integrate education into various (State and local) permitting processes and public information campaigns should be based upon goal of behavior change
8. Support a demonstration project/workshop for homeowners on application of fertilizers and composting methods.
9. Support and encourage the use of water conservation measures by individuals to help reduce the amount of nutrients leaving individual properties. Use of these measures will help in the effort to reduce the amount of nutrients ending up in the Murderkill River.
    - Gray water recycling (use of gray water around the home on plants and gardens, etc),
    - Rain collection systems such as rain barrels and rain gardens,
    - Directing stormwater runoff from roofs and impervious surfaces onto grassy areas,
    - The use of water saving devices in and around the home, in addition to
    - The overall reduction of water usage in households and on lawns

10. Work with the Delaware Nutrient Management Commission and the Master Gardeners to provide education and programs for homeowner's on lawn and garden best management practices such as:
    - Proper mowing practices,
    - Leaving lawn clippings on the lawn;
    - Encourage proper lawn care maintenance-leave a buffer along stream edge;
    - Reduce lawn size;
    - Water conservation measures and stormwater BMPs for the lawn and garden;
    - Encourage use of native species and noninvasive species;
    - Discourage ideas that lawns need chemicals to be green;
    - Proper use of lawn and garden chemicals (including natural fertilizers and compost);
    - Use of compost rather than chemicals as a means of reducing synthetic chemical fertilizers.

Basis for Recommendation: Based on 2002 land use data, a significant portion of Murderkill Watershed is urban (14.1 percent) and much of it is turf. Over 73,000 acres of residential turf exists in Delaware and 58 percent of it is fertilized, usually with little forethought. The Murderkill Tributary Action Team has identified residential activities as an important origin for nutrients in the Murderkill Watershed and thus has made several recommendations to address this issue. Residential behavior is a difficult source to regulate, thus the Team's recommendations focus on providing education and outreach activities to change residential behavior and increase environmental awareness.

DNREC's Sediment and Stormwater program developed and completed a handbook for homeowners associations that can be used to learn how to maintain their stormwater plan. DNREC, as well as the agencies with delegated authority from the Sediment and Stormwater program, are working with homeowners in forwarding this concept. The Kent and Sussex County Conservation Districts with cooperation from DNREC's Sediment and Stormwater Program and NEMO has held workshops for homeowners associations and residents in Kent and Sussex Counties.

EXPECTED REDUCTION: Unknown
Ancillary reduction of N: Unknown

5 PROGRESS TO DATE

The Murderkill Tributary Action Team has enjoyed success on several fronts, thus improving the water quality of the Murderkill River, its tributaries and ponds. Highlights follow:

- A Nonpoint Source 319 Program grant to repair failing septic systems in the Walnut Shade area of the Murderkill Watershed eventually the tanks will be replaced with sewer.
- Funding for an individual onsite wastewater treatment and disposal system inspection and pump out compliance program. Funding was made available by extending a pilot program started in the Inland Bays to the Murderkill.
- Received funding for FY05 from the Nonpoint Source 319 Program to implement a Smartyards program in the watershed in partnership with the Delaware Nature Society as an outreach and educational opportunity to promote residential behavior change. Smartyards is a component of the Backyard Wildlife Habitats program conducted in partnership with the National Wildlife Federation, the Delaware Department of Natural Resources and Environmental Control, the University of Delaware - Water Resources Agency, the Gateway Garden Center, and Wild Birds Unlimited. The program provides official certification for properties where owners meet the four criteria necessary for wildlife habitat: food, cover, water, and places for wildlife to raise young. By adopting practices beneficial to wildlife such as planting native species and limiting the use of chemical fertilizers and pesticides, participants help to improve local water quality by reducing their reliance on products that contribute to the nonpoint source pollution.
- A farm located in the headwaters of the Murderkill River near McColley's Pond was the beneficiary of a cost-share program administered by the Kent County Conservation District for the installation of farm improvements and BMPs. The farm has cattle and donkeys which have unobstructed access to two streams that define the property boundaries. The BMP and farm improvement project involved the installation of fencing to remove direct livestock

access to the streams that enter McColley's Pond, the addition of water troughs to provide water for the cattle in place of the streams, and manure storage shed. These improvements and BMPs eliminate direct fecal deposition (bacteria and pathogens) and minimize un-off (sediment and nutrients) to the streams.

- DNREC is working with a consultant to develop a build-out map of the watershed, prioritize areas for installation of agriculture BMPs, and identify potential areas for stormwater retrofit projects.
- The agriculture community in the Murderkill Watershed has already gone a long way to help reduce nutrients in the watershed. Table shows the number of acres in the watershed currently being treated by BMPs.

Table 5.1: Agricultural Best Management Practices (BMPS) Utilized in the Murderkill Watershed as of Feb. 2003

BMP	**Number of BMPs installed or Acres**	**Nutrient Reduction (lbs/day)**	
		TN	**TP**
Performance Basis			
Nutrient Management Plans	6166		NA
Farmstead BMPs			
Animal Waste Storage	6		
Animal Mortality disposal	5		
Calibration of application equipment			
Nutrient Loading Basis			
Animal Nutrition Management (phytase)	2,490,684	NA	0.72
Nutrient Management relocation	0	0	0
Soil, plant, manure analysis (PSNT)			
Phosphorus Site Index			
Nutrient credits (legumes)			
Nutrient Loss Basis			
Nutrient source characteristics			
Nutrient timing, application method			
Conservation tillage (acres)	770		
CREP and CRP			
Grassed waterways	0.0	0.0	0.0
Filter strips	195	0.0	0.0
Riparian buffers	5.8	0.81	0.02
Grass buffers			
Forest buffers	82	11.34	0.29
Ponds	54	1.92	0.0
Wetlands	61	8.52	0.18
Wildlife Habitat	148	6.08	0.08
Cover crops (acres)	1,062	43.20	0.09
Water control structures	0	0	NA

Stream Fencing				
Total Agriculture Reduction			**71.87**	**1.38**
TMDL			**560**	**96**
Percentage toward TMDL			**12.8%**	**1.44%**

- DNREC and DELDOT are involved in projects to monitor the effectiveness of various stormwater strategies. These projects, combined with the literature, will provide nutrient reduction efficiencies for various practices in the future. The Kent County Conservation District and the Division of Soil and Water Conservation have compiled a list of Stormwater BMPs installed (1996-2002) for the Nonpoint Source 319 Program. Table 5.2 shows the number of acres in the watershed currently being treated by stormwater BMPs and the Ancillary nutrient reductions.

Table 5.2: Stormwater BMPs on the Ground in the Murderkill Watershed

BMP	**Number of BMPs**	**Acres Treated**	**TN (lb/day)**	**TP (lb/day)**
Wet ponds	29	21	**0.38**	**0.64**
Dry ponds	14	5.8	**0.06**	**0.04**
Infiltration systems	3	0.5	**0.00**	**0.00**
Biofiltration/bioswales*	8			
Total Stormwater reductions			**0.44**	**0.68**