Executive Summary*

DEP Chesapeake Bay Wastewater Workgroup

The original DEP Chesapeake Bay Wastewater Workgroup was convened in 2005 to address the need for wastewater facilities to reduce their nitrogen and phosphorus output. At that time there was no reduction number for nitrogen (numbers at that time were often above 20 mg/l) and phosphorus reductions were only limited to 3 mg/l in certain streams.

The original Tributary Strategy suggested plants go to BNR (Biological Nutrient Reduction), 8mg/l TN and 1mg/l TP at 2010 flows, for the 190 major treatment plants (over 400,000 gpd). The workgroup proposed a lower reduction to 6mg/l TN and 0.8mg/l TP, but at design flow, which was accepted by DEP and EPA. The wastewater sector met these goals ahead of schedule, in 2014 for the 2017 midpoint goals, and in 2018 for the 2025 final goals. The estimated cost by Metcalf and Eddy for plant upgrades to achieve these reductions was $1.4 billion.

The workgroup was asked this year to determine the **feasibility for treating to ENR** (Enhanced Nutrient Reduction) in Pennsylvania, a much lower and more expensive treatment approach. The workgroup has been studying data and costs on this option and has concluded it will be a much too expensive additional requirement for minimal additional reductions from a sector already meeting its goals.

Plant optimization was another suggestion for achieving more reductions from wastewater sources. This is a progression that may be difficult for the plants whose technology and capabilities do not allow them to achieve the desired reductions. Financial and technical aid (currently not available) will be necessary for these plants to produce significant reductions but absent this aid, and their low contribution to the TN and TP load, this recommendation may be better implemented at a future time.

Reduction from **Non-Significant Wastewater facilities**, for the same reasons noted above, and the fact that their discharge flow was minimal to receiving streams, did not present itself as a currently viable alternative to generate additional TN and TP reductions.

Very minimal local reductions from **on-lot septic systems** likewise will not add a significant reduction to TN and TP migrating to the Bay. In fact, to add a basic denitrification system to an existing septic system, at an estimated cost of $10,000, is not a cost most of these households can financially bear.

Conclusion: after reviewing the current program of BNR reduction and ongoing success of the significant POTWs, compared to the extreme costs and limited further reductions for ENR and the costs for implementing the other programs noted above, and their anticipated limited reductions, the Wastewater Workgroup proposes continuing the successful reduction program of the 190 significant POTWs moving forward. We also propose a more involved trading program across all sectors, including the potential for trading with sectors across state boundaries.

**Additional information on attached pages*

Background

Appendix Q of the Chesapeake Bay Total Maximum Daily Load (TMDL) segregates Pennsylvania's point sources into four sectors – significant sewage dischargers, significant industrial waste (IW) dischargers, combined sewer overflows (CSOs) and non-significant dischargers (both sewage and IW facilities). All sectors contain a listing of individual facilities with National Pollution Discharge Elimination System (NPDES) permits that were believed to be discharging at the time the TMDL was published (2010). All sectors, except for the non-significant dischargers, have individual wasteload allocations (WLAs) for total nitrogen (TN) and total phosphorus (TP) assigned to specific facilities. Non-significant dischargers have a bulk or aggregate allocation for TN and TP based on the facilities in that sector that were believed to be discharging at that time and their estimated nutrient loads.

The WLAs for all sectors in the TMDL are as follows (edge of segment WLAs, rounded as appropriate):

Sector	WLA Type	Total of TN WLAs (lbs/yr)	Total of TP WLAs (lbs/yr)
Significant Sewage	Individual	10,001,276*	1,314,603*
Significant Industrial	Individual	1,820,139	64,684
CSOs	Individual	212,920	34,709
Non-Significant	Aggregate	3,006,667	842,104
	Totals:	15,041,002	2,256,100

** NOTE – The actual Total TN and TP WLAs in the TMDL for the Significant Sewage sector are 10,635,817 and 1,386,402 lbs/yr, respectively. There were, however, numerous errors with the WLAs in Appendix Q. This document assumes those errors. Additionally, cap loads have been changed based on offsets from onlot system retirements and absorption of TN and TP Cap load from facilities who have removed their facility from operation and sent their wastewater into other facilities. Documentation of those adjustments have been included in the past WIP wastewater supplements.*

The criteria for division of the three (3) main categories, significant sewage, significant industrial, and non-significant (both industrial and sewage) are:

Significant Sewage (Sig Sew) – Sewage Discharges with Design Flows Greater than 0.400 mgd

Significant Industrial (Sig IW) – Non-Sewage Discharger with loadings of 75 lbs/day TN and 25 lbs/day TP or greater

Non-significant (Non-sig) – Includes both sewage and IW below the "significant" thresholds

The original Point Source Allocation Strategy was developed and implemented with the goal of meeting the WLA for the wastewater sector in the existing TMDL. Nutrient Cap Loads were established in NPDES permits for the Sig Sew and Sig IW Facilities. The original Bay Tributary Strategy targeted significant reductions from the wastewater sector. Prior to the upgrades most sewage facilities TN levels were typically in the 25 mg/L range for TN, so a reduction to 6 mg/L TN was significant. The Sig Sew dischargers constituted around 95% of the overall wastewater TN loading at the time of development of the Bay Strategy.

Nutrient CAP Loads for Sig Sew dischargers are based on the facility design flow and a discharge concentration of 6 mg/L TN and 0.8 mg/L TP. CAP loads have been established in all NPDES permits for Sig Sew dischargers. There are 190 Sig Sew facilities. Initially, the Department recommended cap loads

for TN and TP based on Biological Nutrient Removal (BNR) reductions at 2010 Flows. BNR effluent levels are considered to be 8.0 mg/L TN and 1.0 mg/L TP. After a detailed program evaluation, the cap loads were set at 6.0 mg/L TN and 0.8 mg/L TP at the facility permitted flow. Establishing cap loads rather than concentration based effluent limits for TN and TP allows the facilities the flexibility to meet the cap load with treatment or nutrient credit purchase. The majority of the Sig Sew dischargers upgraded their treatment processes to meet permitted cap loads in the initial five years of implementation.

Nutrient CAP Loads for Sig IW dischargers were based on the facility specific nutrient reduction evaluations. There are 23 Sig IW facilities with nutrient cap load in their permits. Industrial facilities waste streams vary widely (food processors, paper mills, landfill leachate dischargers), so an across the board concentration-based load limit was not feasible. A site-specific nutrient reduction evaluation allowed each facility to propose reductions based on what was possible at that facility.

Non-sigs were not provided with cap load in their permits. However, an overall bulk nutrient allocation was determined based on available discharge information and our knowledge of these facilities. DEP continues to monitor this load in order to determine if additional controls are necessary.

Accounting for growth in Sewage Facilities

Facilities with nutrient loads are limited by their cap loads. For these facilities, nutrient load increases must be offset with improved treatment or nutrient trading/offsetting. For facilities without loads, non-sigs, can only increase their hydraulic capacity beyond current design capacity through a NPDES permit amendment. In the event a non-sig sew facility requests an increase, they are given nutrient CAP loads based on the lesser of two scenarios. The two scenarios compared are:

1. Existing load based on their current annual average flow and TN and TP concentration, or;
2. 7,306 lbs/yr TN and 974 lbs/yr TP, the load based on lowest possible significant facility load (load based on 0.4 mgd with a TN Concentration of 6 mg/L TN and a TP Concentration of 0.8 mg/L,).

Accounting for growth in Industrial Facilities

The Sig IW facilities WLA is at capacity. Cap load from the non-sig sector has been shifted to the sig IW sector to allow for growth within this sector. IW facility expansion allocations had been based on the available nutrient load in reserve for the wastewater sector in the past. The ability to provide loading is diminishing so in many cases of IW expansions, minimal load is available for allocation.

Since Industrial Facilities vary widely, general assumptions for the ability to make reductions to loads is not realistic. Increases in loading from the industrial sector are controlled by the established CAP loads and the inability to expand when receiving a CAP load.

Reduction Scenarios

The wastewater sector is unique as the only sector that routinely monitors, reports, and demonstrates compliance through analytical data. The sector is successfully operating under the original strategy obligations. Upgrades to facilities have been accomplished through private and public financing and significant increases in user rates. Cost for the upgrades for the 190 facilities was about $1.5 billion. Reductions within this sector require reduction of the actual TN and TP in the effluent that is discharged. Reduction of nutrients in effluent can be achieved by optimization of existing facilities or upgrading the treatment technologies at a facility to achieve additional nutrient reductions.

PA sewage dischargers are unique in several ways. Facility size, colder climatic conditions, and percentage of the overall nutrient loading from this sector play a role in determining if additional reduction from this sector are reasonable. A number of reduction scenarios were considered.

Reduction Scenario No. 1 - ENR for existing Sig Sew Dischargers

Sig Sew discharger were provided with nutrient loads in their NPDES permits. These loads are annual load allocations so the concentration of actual nutrients in the discharge may vary as long as their annual nutrient load (lb/yr) doesn't exceed their allocation. The annual load limit provides permittees the opportunity to comply with their permit limit through purchase of nutrient credits and offsetting of nutrient load. As previously noted, the nutrient allocations were based on a facility design flow and an effluent concentration of 6 mg/L TN and 0.8 mg/L TP. This level of treatment is considered slightly better than Biological Nutrient Removal (BNR) levels which are typically considered to be treatment that achieves 8 mg/L TN and 1 mg/L TP. A more stringent level of treatment is Enhanced Nutrient Removal (ENR). ENR effluent levels are 4 mg/L TN and 0.3 mg/L TP. It is important to note that a concentration-based ENR effluent limit will actual require a facility to target a lower effluent concentration to ensure compliance with the limit.

The reductions gained by an ENR based Cap load would be at a significant cost. Maryland MDE contracted with an engineering firm to evaluate the capital cost for facilities to upgrade to achieve nutrient reductions at 20 facilities. The study was conducted in the mid-2000s. The study found that the cost to upgrade a facility to achieve ENR reductions were similar to the cost to upgrade a facility to go from no nutrient removal to BNR. Additionally, in most cases it would have been more cost effective to go directly from no nutrient removal to ENR directly. Follow up information which included more specific cost information on more MD facilities showed that BNR to ENR upgrade capital costs were more expensive in many cases. Additionally, the report recommended facility and site-specific cost be evaluated in order to truly understand the cost of implementation. The Wastewater Workgroup has gathered site specific planning level engineering cost estimates from eleven (11) facilities. All the facilities are Sig Sew facilities that range in design flow from 0.5 mgd to 32 mgd with an average flow of around 8 mgd. The capital costs include all facility upgrades necessary to meet a ENR effluent limits. The annualized flow weighted present worth of the capital and operating costs of the upgraded facilities were used to calculate the average cost per lb of TN, which is estimated to be $30/lb TN/yr. The variation in the cost per lb of TN removed varies from $2 to $400. The variation in the cost shows that it may not be reasonable to estimate cost by evaluation of these few faciliites. Much like the MD facility evaluations, the cost is dependent on site specific variables. Assumptions on how these facilities costs correlate to other facility cost is strongly cautioned. With this in mind, assuming the total ENR reduction of 3,270,771 (see table below), that equates to approximately $80 million annually for about 3.3 million pounds of reduction. The reduction is calculated based on the assumption that all facilities are receiving design flow. The table below shows the reduction of TN and TP based on the actual flows and loading from the 2017 water year.

	Existing WLA (A)	Actual 2017 Loads (B)	ENR Cap Load @ Design Flow (C)	ENR Reduction in Loading @ Design Flow (A-B)	ENR Load @ Actual Flow (D)	Reduction in Loading @ Actual Flow assuming ENR (B-D)
TN (lbs/yr)	10,001,276	6,491,374	6,730,505	3,270,771	3,761,857	-2,834,091
TP (lbs/yr)	1,312,603	818,941	504,788	807,815	376,186	-470,032

The load reductions from the Sig Sew facilities to this point have been based on the assumption that the facility is receiving their design flow. To estimate 2025 loads, we must determine what the loading will be at 2025. We evaluated potential population increases and resulting load increases based on increased flows. The Center for Rural Pennsylvania, A Legislative Agency of the PA General Assembly, released a report on Pennsylvania Population Projections 2010-2040. Among other things, the report estimates a PA population of 13,504,614 by 2025. The current US Census estimate of PA population is 12,805,537. The Center for Rural PA report discusses the distribution of population increase across the state. In short, it estimates that about 75% of the growth will be in the area tributary to facilities that discharge to the Bay. The percent increase in population based on the current and estimated 2025 populations is 5.2%. Accounting for the fact the 75% of the increase is expected in the Bay tributary area, a flow increase of 3.9% will added to the 2017 water year flows and loads were calculated based on the increase flows. Note that the assumption is very conservative. It assumes that all growth is occurring in sewered areas, which is not the case. The results are shown in the chart below.

	Actual 2017 Loads (A)	2025 Loads assuming a 3.9% flow increase (B)	2025 Load @ ENR Concentration (C)	2025 Reduction in loading @ ENR (B-C)
TN (lbs/yr)	6,491,374	6,743,683	3,908,507	2,835,176
TP (lbs/yr)	818,941	850,880	283,143	567,737

Recommendation: ENR Scenario not recommended by Wastewater Workgroup

Scenario No. 2 - Plant Optimization

As previously noted, Sig Sew facilities have annual nutrient loads in their NPDES permits. The scenario considers reduction in TN and TP if the Sig Sew facilities would treat to PA established BNR concentration of 6 mg/L TN and 0.8 mg/L TP. For this scenario, loadings are calculated based on actual existing annual average flow data and current TN and TP annual average concentration. The total reduction from this scenario is 1,648,587 lbs of TN and 208,885 lbs of TP. This scenario does not account for the fact that some facilities may not be able to provide treatment to achieve PA BNR concentrations due to the technology employed at the facility. Some facilities comply with annual load limitation through trading rather than treatment, so their plant may not have the ability to reach PA BNR treatment levels.

	Actual 2017 Loads	Load at PA BNR	Reduction	2025 Load @ PABNR	Reduction in load @ 2025 w/ PA BNR Optimization
TN (lbs/yr)	6,491,374	5,642,782	1,648,587	5,862,855	628,519
TP (lbs/yr)	818,941	752,371	208,885	781,714	37,227

The reductions only include the facilities that **are not currently meeting PA BNR concentrations**, 98 for TN and 89 for TP. Currently optimized facilities, treating to less than PA BNR levels, were not accounted for in the reduction calculation.

The DEP has an existing treatment plant optimization program. Its primary goal is help troubled facilities get into compliance. DEP has online, real-time analytical equipment that is deployed at a facility to collection data on effluent quality. DEP deploys the equipment and works with the plant staff on the necessary maintenance of the equipment. The instrumentation monitors the data and transmits it to DEP remotely. DEP used the data to help the facility with improve their process and come into compliance. A report with the recommendations is provided to the facility. DEP only has one staff position dedicated to this program. Additional staffing, monitoring equipment, and resources were provided, this program could be used to help facilities optimize their process for nutrient removal.

Recommendation: A facility nutrient removal optimization program be established, and facilities be encouraged to participate. The existing DEP optimization program does not have the capacity to run such a program. Additional staff, online monitoring equipment, and operation dollars would be necessary. Expansion of the program to support the entire effort would include a section dedicated to the optimization program for statewide implementation. Estimated annual cost for staffing, operation, and annual maintenance of equipment is estimated at $1 million with an upfront cost for equipment of $800,000. Alternatively, the existing optimization program enhanced more moderately if DEPs role would be limited to deploying the online instrumentation and collecting the data for the facilities to use hire their own consultants to optimize their facility. Given that this alternative would rely less on DEP resources, it may be more quickly and easily implemented. It would require less additional DEP staff, but additional online monitoring equipment would still be necessary. This equipment must be maintained as well. Staffing, operational, and maintenance costs could be reduced by half. Upfront cost would be estimated at $600,000.

Additionally, Maryland recently has developed an Operation and Maintenance reimbursement program. At this point, our understanding of the program is that facilities that achieve better than ENR concentrations for nutrients in their discharge are reimbursed for the additional operation and maintenance costs it took to treat below ENR limits. We recommend that the plant optimization program be coupled with an operation and maintenance reimbursement program. The program would incentivize facilities to optimize their process for additional TN and TP reduction. Unfortunately, cost to optimize facilities have not been developed as part of this effort. Costs are plant specific and require an evaluation of each plant's operational and design data which was beyond the scope of this analysis. These costs should be developed in concert with the optimization program.

Non-Sig Sewage Nutrient Reduction

Although the non-sig sewage category includes all sewage facilities with flows less 0.400 mgd, it is not practical to assume all sizes of facilities can realistically achieve nutrient reductions even if the facility is designed to achieve nutrient reduction. Staff time on site and staff expertise are additional factors that affect the ability of a facility to perform. Smaller facilities do not have full time staff with the capabilities to operate a nutrient reduction facility in many cases. A facility must perform effective process control and system monitoring to consistently achieve nutrient reduction. The cut-off of 0.075 mgd was chosen as the lower end flow cutoff for facilities that could realistically achieve successful nutrient removal.

The non-sigs sew facilities have no cap loads, so baseline flow and loading information was gathered from available data and our knowledge of these facilities. This group includes 181 facilities. Only 72 of the 181 facilities in this category have an actual annual average flow greater than 0.075 mgd. So, the likelihood of implementation and successful operation of nutrient removal upgrades at these facilities is at question as well. TP data for the non-sig facilities was not reliable, so TP load and load reductions were not determined. The following chart shows the resulting TN loads and TN load reductions assuming PA BNR TN implementation.

	Baseline 2017 Load Data	BNR Cap Load @ Design Flow	BNR Cap Load @ Actual flow	Reduction in Loading @ Actual Flow	BNR Load @ 2025 flow
TN (lbs/yr)	816,625	777,809	414,926	401,699	327,303

Recommendation: Require Non-Sig sewage facilities to perform a nutrient reduction alternative evaluation prior to any upgrade or major capital improvement that includes the biological treatment component. The evaluation should compare the costs and ability to implement a nutrient reduction project to achieve PA BNR reduction. The evaluation would be submitted to DEP for review and consideration prior to moving forward with a project. Requiring Non-sig facilities sewage to upgrade to achieve BNR standards is not feasible. Given that over half of these facilities actual flow falls under the 0.075 mgd cutoff and costs for upgrading these types of facilities vary greatly. Additionally, we recommend these facilities be included in the proposed optimization program.

Scenario No. 3 - Onlot (Septic) TN Reduction

The Current onlot TN load from onlot system is estimated at 2,897,000 lbs/yr. Currently, methods to reduce onlot sources of TN are limited. PA currently has only one approved technology for nutrient removal. The cost of the treatment technology is approximately $10,000. The technology would be an add on component to a traditional onlot system. Additional cost for the septic tank, absorption area, absorption area dosing system, and any other necessary part of the system would be in addition to the cost of the nitrogen removal component. The estimated nutrient reduction from these system is approximately a 50% reduction in TN, if the system is maintained on a regular basis.

Inspection and pumping of onlot systems is essential to ensure proper onlot sewage disposal. Municipal wide program for onlot system oversight are referred to as sewage management programs. PA Sewage Facilities Act (Act 537) requires municipalities to ensure onlot systems installed within their borders to provide long term sewage disposal. A number of municipalities have sewage management programs that require inspections of systems and pumping of septic tanks, however; not all municipalities have sewage management programs. Operation and maintenance of onlot systems provides a reduction in the amount of TN from the onlot system TN load. Properly operated and maintained system provide better protection of local ground water resources as well as a reduction to the TN loading to the Bay. If all municipalities with onlot systems would implement sewage management programs that include inspection of the onlot system and pumping of septic tanks, a 5% reduction, 144,000 lbs, in the TN could be realized.

Recommendation: Given that there is only one technology available for TN removal, total nitrogen removal systems for onlot systems discharges is not recommended at this time. If more TN reducing onlot systems become available, consideration of the option should be considered for new onlot systems to offset some of the new load.

Sewage management programs that incorporate septic system inspection and pumping are recommended. Onlot system oversight is the responsibility of municipalities per the PA Sewage Facilities Act. Recommend that municipalities implement sewage management programs. Recommend that DEP develop a GIS based online monitoring and reporting program that municipalities can use to report information to DEP for Bay reporting.

General Recommendation No. 1 - TN and TP data for all facilities in the wastewater sector categories do not have monitoring and reporting data in electronic format that is easily accessible for data evaluations. Recommended ongoing monitoring and reporting of TN and TP concentration for all bay facilities through the NPDES permit reporting requirements. Data should be reported electronically to ensure quick and easy access to facility discharge information for data analysis.

General Recommendation No. 2 – Develop a program to better facilitate trading between sectors. Sectors that fall short of the load reduction goals could be offset through reductions in the wastewater sector. These wastewater sector reductions should be funded through a dedicated fund to offset costs of facility optimization or capital improvements.