NACWA
A Clear Commitment to America's Waters

November 9, 2012

Betsy Southerland
Director, Office of Science and Technology
Office of Water, U.S. Environmental Protection Agency
Ariel Rios Building, Mail Code 5204P
1200 Pennsylvania Ave, NW
Washington, DC 20460
Via Electronic Mail: Southerland.Betsy@epa.gov

Dear Betsy,

The National Association of Clean Water Agencies (NACWA) appreciates this opportunity to provide the U.S. Environmental Protection Agency (EPA or Agency) with additional information as the Agency prepares its response to the Natural Resources Defense Council's (NRDC) 2007 petition to include nutrient removal as part of the federal secondary treatment regulations. NACWA understands that EPA plans to provide a response to the petition by mid-December. Over the past several years, NACWA has provided the Agency with legal and technical information on this critical issue and this letter provides additional perspective from the municipal clean water community to help inform EPA's decision-making process.

The secondary treatment regulations are of vital importance to NACWA's nearly 300 clean water utility members from around the country, and the action EPA takes in responding to NRDC's petition will impact not only NACWA's members but potentially all of the over 16,000 publicly owned treatment works (POTWs) in the United States. The regulatory and economic stakes for the Nation's municipal clean water agencies could not be higher. Our public clean water agency members recognize that they are an important part of nutrient reduction efforts and stand ready to do their share. Indeed, many of the gains in nutrient control made to date are because of the investments and efforts made by POTWs. The approach contemplated by NRDC's petition, however, is simply not the most the effective nor environmentally sensitive way to address the Nation's nutrient challenges.

NACWA has previously communicated with EPA regarding the NRDC petition, including letters from February 2008, September 2009, and June 2010. The

National Association of Clean Water Agencies
1816 Jefferson Place, NW
Washington DC 20036-2505
p 202.833.2672 **f** 202.833.4657
www.nacwa.org · info@nacwa.org

content of these letters makes NACWA's position clear – EPA must deny the petition. The purpose of this letter is not only to reiterate some of NACWA's arguments outlined in these previous communications, but to provide EPA with some additional considerations on key issues – legal and technical – presented by the NRDC petition. NACWA hopes these additional comments will be useful to EPA as it works to develop its response to the secondary treatment petition over the coming weeks.

EPA Has Clear and Unambiguous Legal Authority to Deny NRDC's Petition to Modify the Secondary Treatment Regulations

NRDC makes essentially two basic requests of EPA in its 2007 petition. First, it requests that EPA publish information on the state of effluent treatment technology for POTWs, specifically the degree of reduction attainable for nutrients – nitrogen and phosphorus – through the use of secondary treatment technology, pursuant to Clean Water Act (CWA) §304(d)(1). Second, NRDC requests EPA issue generally applicable nitrogen and phosphorus removal requirements for POTWs, essentially by requesting EPA amend its current effluent limitations for POTWs under CWA §301(b)(1)(B) – often generically referred to as the "secondary treatment regulations" – to include an effluent limitation for nutrients at all POTWs.[1]

NACWA's previous communications to EPA have made clear the Association's legal position on the petition's requests – that EPA does not have the statutory authority to include generally applicable effluent limits for nutrients through the secondary treatment regulations, and that Congress never intended secondary treatment standards under the Act to include nutrient removal. This legal position is evident based on the legislative history of the CWA, as previously outlined in our letters to EPA. Given EPA's lack of legal authority to promulgate generally applicable nutrient removal standards, the publication requirements of CWA §304(d)(1) do not apply to nutrient removal technologies and NRDC's "duty to publish" claim is without merit. NACWA has also indicated to EPA that even if §304(d)(1) applies to nutrient removal technology, EPA has already satisfied this obligation through its 2008 publication of the *Municipal Nutrient Removal Technologies Reference Document*.

EPA's Duty to Publish Is Distinct from its Duty to Regulate

NACWA recognizes, however, that EPA may not agree with all of the legal arguments as outlined in the Association's previous letters. In particular, NACWA understands that EPA may feel the need to publish updated information on the current effectiveness of secondary treatment technology. As discussed below, if EPA feels obligated to publish such information, the requirement to publish information on the state of secondary treatment techniques can be met without making any changes to the underlying secondary treatment regulations. The following comments and observations about EPA's legal options are not meant to alter NACWA's fundamental legal position that EPA does not have the statutory authority to include generally applicable POTW effluent limitations for nutrients. Instead, they are meant to suggest a secondary, alternative approach for EPA to consider if the Agency does not agree with NACWA's primary arguments.

As a threshold matter, it is clear under existing law that any "duty to publish" EPA may have under CWA §304 is separate and distinct from a duty to regulate under CWA §301. Accordingly, EPA has the legal authority to

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[1] Although the generally applicable POTW effluent limits required by CWA §301(b)(1)(B) are often referred to generically as "secondary treatment regulations" within the wastewater community, these limits can be separate and distinct from the actual pollutants that might be addressed through secondary treatment technology, as will be more fully explained in this letter. Where the term "secondary treatment regulations" is used in this letter, it is used in the generic sense for the generally applicable effluent limits that apply to all POTWs.

publish updated information on the current status and capability of secondary treatment technology while at the same time using its discretion and expertise not to alter the existing generally applicable secondary treatment effluent limitations.

This discretion was made clear in *Maier v. EPA*, 114 F.3d 1032 (10th. Cir. 1997), when the court, in discussing the petitioner's request in that case for the Agency to include limits for nitrogenous biochemical oxygen demand (NOD) as part of the secondary treatment regulations, unequivocally stated that "while it is true....the EPA may have a present duty under §304(d)(1) to publish information pertaining to those reductions....the EPA is not required under that same provision to issue regulations limiting NOD discharges from POTWs." *Maier* at 1041-1042. The *Maier* court is the only federal appellate court to have directly addressed the question of EPA's legal obligations and discretion under CWA §304 regarding nutrients and secondary treatment requirements, and clearly found that a duty to publish under that section is separate from the duty to regulate. This distinction is as valid today as it was when the case was decided.

Furthermore, even if EPA determines that current secondary treatment technology can remove some minimal amount of nutrients and chooses to publish this information, there is no resulting legal obligation to change the underlying secondary treatment regulations. As the *Maier* court made clear, EPA's generally applicable effluent limitations for POTWs need only be based on the *capabilities* of secondary treatment, not *inclusive* of every potential pollutant the secondary treatment technology might remove. The court specifically addressed this point in terms of nutrient controls, holding as follows:

> Thus, even if reductions of....nutrients potentially fall within the definition of "secondary treatment," the EPA must determine if it should promulgate general applicable effluent limitations for these specific pollutants. The statute requires that generally-applicable effluent limitations for POTWs be "based upon secondary treatment." Contrary to Mr. Maier's assertion, the statute does not on its face require that the generally-applicable effluent limitations address all pollutants that might be reduced by secondary treatment.
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> *Maier* at 1043

As this unambiguous language makes clear, the underlying capabilities of secondary treatment technology provide only an informational baseline for EPA. Regardless of what these abilities may be, the Agency still has the legal authority to use its discretion and expertise to craft generally applicable effluent limitations for POTWs under CWA §301(b)(1)(B) that differ from the precise technological achievements of secondary treatment. The fact these regulations are to be based on – but not directly equal to – the technological capabilities of the secondary treatment systems is critical, because it allows EPA to consider other factors in determining appropriate generally applicable requirements. These considerations could include Congress's original intent under the CWA for the scope of secondary treatment requirements, technological feasibility, and cost.[2]

Additionally, the ability of EPA to use its discretion in setting effluent limitations based on secondary treatment allows it to make a reasoned judgment about which pollutants are most critical to be included among the

[2] As NACWA has stated in its previous letters to EPA on this issue, the CWA's congressional history is unmistakably clear that Congress never intended the secondary treatment regulations to include nutrient removal.

generally applicable POTW limits. For instance, some metals, toxics, and emerging contaminants may receive some minimal level of treatment when passing through a secondary treatment process, but this does not mean EPA must establish generally applicable effluent limits for them. Including a generally applicable limit for every pollutant that could conceivably be minimally addressed by secondary treatment systems would start EPA down a very dangerous and slippery slope in terms of unnecessary regulatory and economic burdens on POTWs. Accordingly, Congress and the courts have given the Agency important discretion to use its expertise in deciding which pollutants most appropriately warrant regulation.

EPA's Discretion Remains Strong despite Passage of Time

The Agency's discretion and legal authority on this point is as strong today as it was when Congress passed the CWA and the *Maier* court made its decision. There have been no other legal decisions to overturn or contradict *Maier*'s holdings, nor have there been any legislative changes to the CWA that would cast doubt on the court's findings. *Maier* still stands as the most definitive and unambiguous statement of EPA legal authority to not require nutrient removal as part of secondary treatment requirements. Its holding that EPA's duty to publish is separate from a duty to regulate as outlined above, as well as its holding that the Agency's generally applicable limits need only be based on secondary treatement capabilities, provide EPA with a defensible legal approach to reject the NRDC petition request for changes to the secondary treatement regulations.

Furthermore, the *Maier* decision itself addresses what kinds of changes to the legal and regulatory landscape would be necessary for EPA to reverse its previous decisions against inclusion of nutrients in secondary treatment regulations – and the bar is set quite high. The *Maier* court noted that only if there has been a "radical change" of factual issues or if a "significant factual predicate of a prior decision on the subject has been removed" would EPA be required to change its previous decision not to include nutrients as part of generally applicable secondary treatment limits. *Maier* at 1040. No such radical or significant change, from either a factual or legal basis, has occurred since the *Maier* decision, and thus there is no reason why EPA need treat the current NRDC petition any differently from a legal standpoint than it treated the *Maier* petition.

NRDC, in its April 2010 letter to EPA, contests this point and argues that the factual predicates upon which EPA based its prior decisions regarding nutrients and secondary treatment have in fact changed. However, other than a general and unsubstantiated reference to EPA's "case by case" nutrient approach being unsuccessful, NRDC provides absolutely no evidence to suggest that there has been a "radical change" in the factual landscape to invalidate EPA's past denials that would require the Agency to grant NRDC's request for nutrient controls in the secondary treatment regulations. In fact, NACWA believes that recent developments regarding nutrient control, including the Agency's March 2011 framework memo on closer work with states to address nutrient concerns and the growing number of POTW permits including nutrient effluent limitations based on site-specific need, demonstrate EPA's commitment to addressing nutrients and only strengthen EPA's arguments against the inclusion of generally applicable nutrient requirements as part of secondary treatement standards.

In short, EPA continues to have strong legal authority under the CWA and the *Maier* decision to reject NRDC's request for generally applicable nutrient effluent limits at all POTWs. This is true even if EPA grants the petition's request to publish current information on the capabilities of secondary treatement technology. NACWA strongly encourages the Agency to consider these legal options as it prepares a response to the NRDC petition.

NRDC Petition Oversimplifies Nutrient Removal, Ignores Key Technical Information

NRDC's original petition from 2007 includes a lengthy discussion of the engineering and process modifications that it believes can be used to achieve the petition's target levels of nitrogen and phosphorus. NRDC states that "in most cases, minor retrofits to existing wastewater treatment facilities enable facilities to cost-effectively reduce nutrient levels in their discharges." NRDC argues that because these are only 'minor', cost-effective measures, they should be included in the generally applicable definition of secondary treatment. While minor retrofits may achieve nutrient reductions for some treatment plant designs, reliably meeting NRDC's target nutrient levels at all treatment plants across the country is simply not possible without the construction of additional treatment units and/or the use of chemicals. Regardless of whether these retrofits for certain treatment plant designs are 'minor', and regardless of the cost-effectiveness of such reductions, such retrofits are clearly beyond the basic operation of a secondary treatment plant and cannot be considered a part of EPA's secondary treatment regulations. As NACWA points out below, the NRDC petition significantly oversimplifies how retrofits may impact nutrient removal at POTWs.

"Minor Retrofits" Can Achieve Reductions under Limited Circumstances

Modest nitrogen reductions are possible with some potential for incidental phosphorus removal in activated sludge facilities through process changes and low-cost capital modifications. However, any reductions depend on the type of plant, wastewater characteristics, temperature, wet weather events and availability of excess aerated capacity.

Nitrification is the limiting factor in biological nitrogen removal processes, because nitrifying organisms have a much lower specific growth rate than heterotrophic organisms used for denitrification and BOD removal (Water Environment Federation (WEF) MOP-34). Furthermore, nitrifying organisms are more impacted by factors such as temperature, pH, and inhibitory chemicals:

- **Growth rate**: Existing activated sludge plants were typically designed for BOD removal. BOD removal is mediated by heterotrophic organisms which have a much higher growth rate versus the autotrophic organisms that mediate the nitrification process. This difference drives the size of the aerobic bioreactors. For example, a system designed for only BOD removal might require only half the volume of a system designed for BOD removal with nitrification (Metcalf & Eddy, 4th Edition 2003). This means that if an activated sludge plant does not have excess aerated capacity it will be unable to reliably nitrify. If nitrification does not occur, nitrogen removal cannot take place.

- **Temperature**: Specific growth rate is affected by temperature. As the temperature drops the growth rate drops and as the temperature increases the growth rate increases. This is significant for treatment plants in colder climates. When a treatment plant is designed for BNR, temperature is taken into account and the aerated bioreactor volume is increased to accommodate these lower temperatures. This means that unless there is significant excess aerated capacity, the plant will not nitrify reliably and if nitrification is lost in cold weather, it may take several days to weeks to reestablish nitrification.

- **pH:** Nitrification reactions produce acid. Influent wastewater must have sufficient alkalinity measured as calcium carbonate ($CaCO_3$) to buffer the process or the pH will decrease. If the pH decreases to 6.5 or lower nitrification can be inhibited. If there is insufficient alkalinity, chemicals will have to be added,

which means installation of a chemical feed system and purchase of chemicals. This then adds to the operating and maintenance costs of a treatment plant.

If a treatment plant has the excess capacity as discussed above and can install any necessary equipment (e.g., chemical feed system), achieving an annual average total nitrogen concentration below 12 mg/L is still difficult for these modified plants in many cases. Ambient temperatures impact the biological treatment process and the modifications made to achieve nutrient reductions are similarly influenced by temperature. Wet weather, especially in cold weather conditions, can significantly reduce the amount of nitrogen removed even in well-designed biological nitrogen removal plants. Wet weather dilutes influent thus reducing the amount of readily biodegradable chemical oxygen demand (rbCOD) which is needed for denitrification. Significant wet weather events can result in washout of biomass with can reduce even BOD removal efficiency.

NACWA's information from the engineering community indicates that such process modifications and retrofits are increasingly being used and are helping to achieve reductions in nutrient levels. The engineering community has done a tremendous job at finding ways for communities to more cost-effectively meet water quality based effluent limits where local water quality demands it. But such retrofits have their limitations. In addition to the technical limitations and considerations described above, a more highly-trained staff is required for biological nutrient removal facilities and more laboratory testing is also required. In addition, if a treatment plant uses excess plant capacity for nitrogen removal, then that excess is not available for future growth within the community and additional costs would be incurred to expand the facilities capacity.

Treatment Plant Design Is an Important Factor in Removing Nutrients
NRDC's discussion of biological nutrient removal initially focuses on activated sludge plants and some approaches for modifying these plants. But the activated sludge process is just one of many wastewater treatment plant designs that are currently being used to achieve the secondary treatment requirements.

There are thousands of other treatment plants that meet secondary treatment without the use of an activated sludge process, including trickling filters, rotating biological contactors (RBCs) and lagoons and ponds. Trickling filters and RBC's are biofilm processes which use a fixed media such as rock or plastic on which biomass grows. Treatment occurs when wastewater contacts the biofilm growing on the media. These plants are usually only designed for BOD and TSS removal. Nitrification can be achieved in either of these processes but to a limited extent and subject to the same cold weather problems as the activated sludge process. Very little denitrification will occur with either the trickling filter or RBC process. Ponds and lagoons are the simplest treatment plants and are considered natural systems. There are several types such as aerated, facultative, and anaerobic, and they achieve secondary levels for BOD and TSS removal. These processes are often used by smaller treatment plants with limited staff oversight. They are low-tech and require very little operation and maintenance.

The NRDC petition briefly discusses attached growth systems (e.g., RBCs), but these other treatment plant designs, which meet EPA's current secondary treatment regulations, cannot be modified with 'minor retrofits' in the way that NRDC envisions for activated sludge plants.

Phosphorus Removal Requires Additional Treatment
In all of these scenarios, phosphorus is not addressed or is only incidentally removed. NRDC's petition envisions all plants meeting limits for both nitrogen and phosphorus, regardless of water quality benefit.

Phosphorus can be removed by chemical addition which precipitates phosphorus and allows for significant phosphorus removal to be achieved. However, such treatment would not be without major impacts: chemical feed equipment would have to be installed; the plant would have to buy chemicals adding to operating costs; current pumping systems may be too small to accommodate the higher sludge production from the process; solids handing problems may occur because chemical sludge is much different that primary or secondary sludge; and there might be increased solids disposal costs due to the higher mass of solids produced.

Biological Processes Are Sensitive to Temperature and Flow Variations that Make Consistent Compliance More Difficult

Any biological treatment process is sensitive to the flow of wastewater passing through it and biological nutrient removal (BNR) is no different. The 'minor retrofits' envisioned by NRDC – through modifications of existing activated sludge plants – are by their very nature sensitive to the higher flows associated with wet weather.

The types of process modifications envisioned by NRDC consume clarifier capacity that would otherwise be used to manage wet weather flows (or accommodate growth) and makes the plant even more sensitive to wet weather flows. Therefore, such process modifications are likely not an option for combined sewer system communities or others that have high peaking factors at their treatment plants.

Retrofits or Modifications to Achieve Nutrient Removal Are Beyond Secondary Treatment

NRDC's petition suggests that because biological treatment technologies can be used to remove nutrients, that the secondary treatment regulations – which are based on the performance of biological treatment – should be modified to include nutrient removal:

> The biological nutrient removal (BNR) processes that have been developed involve biological processes such as those that have been employed across the United States to remove oxygen demanding organic matter. Biological processes that have been updated to remove nutrients simply use types of microorganisms that are cultivated to perform the task of cleaning the wastewater. Therefore, in most cases, minor retrofits to existing wastewater treatment facilities enable facilities to cost-effectively reduce nutrient levels in their discharges.

NRDC Petition at 14

NRDC discusses these minor retrofits – which NACWA agrees can provide for some nutrient removal at a subset of treatment plants under certain conditions – but then goes on to describe numerous nutrient removal <u>technologies</u> as if they would all fall under the umbrella of these 'minor retrofits'. The technologies that NRDC describes are just that, technologies that must be added onto or integrated into a secondary treatment process to achieve meaningful nutrient reduction. In fact, EPA felt obligated to commit two volumes and over 400 pages to describe the "more than 40 alternative technologies that are available for providing nitrogen and phosphorus removal in municipal wastewater treatment…[ranging] in complexity from one-point chemical addition for phosphorus precipitation to a 5-stage Bardenpho system for combined biological phosphorus and nitrogen removal" in its 2008 *Municipal Nutrient Removal Technologies Reference Document*. As detailed in the attached case studies, even where clean water utilities explore the technologies contemplated by NRDC, the upgrades necessary to consistently meet low total nitrogen and phosphorus levels are anything but minor.

NRDC's cost-effectiveness argument is also not persuasive. Section III.B.6 of the petition presents the results of numerous studies that NRDC uses to make its cost argument. As the Water Environment Federation (WEF) points out in its 2010 *Technical Submission to EPA: Removal of Nutrients with Currently Available Secondary Treatment Technologies*, in which WEF looks at the references NRDC uses in Section III.B.6, many of the studies NRDC relies on are from treatment plants that are already achieving nitrification:

> The cost data presented in the petition is mostly from cost studies associated with upgrading plants already exceeding secondary treatment levels to achieve nutrient reduction. Very little cost data for upgrading plants to achieve BNR from plants designed to just meet secondary limits were presented. Cost data that were presented for upgrading secondary facilities to achieve BNR showed the cost is much greater for BNR facilities, because they would need to be upgraded to first be able to achieve nitrification. The cost of going from secondary treatment to BNR is the proper cost to review when looking at the impact of a nutrient requirement being added to the secondary treatment definition.

WEF 2010 Technical Submission at 222

The potential to modify a subset of existing treatment plants under limited circumstances with 'minor retrofits' to achieve some degree of nutrient removal does not support NRDC's broad claims that the generally applicable secondary treatment regulations for all treatment plants should be modified. More importantly, the potential simplicity or cost-effectiveness of a modification to a secondary treatment plant to achieve some measure of nutrient reduction does not mean that removal of nutrients is or should be a component of secondary treatment. This legal distinction between what is and is not secondary treatment, however, does not mean that simple and/or cost-effective nutrient removal should not be pursued. But nutrient control efforts should be driven by water quality needs and a more complete understanding of the sources of nutrients in a particular watershed, not a national standard that applies to everyone regardless of water quality.

Nutrient Removal Case Studies Illustrate Complexity, Expense of Upgrades to Reliably Meet Nutrient Control Requirements

Removal of nutrients to the levels contemplated in the NRDC petition requires additional, often costly treatment, beyond that necessary to comply with EPA's secondary treatment regulations. As the attached case studies illustrate, nutrient removal requires significant capital investment and typically an increase in operating costs. Of course, the specific situation of each community and the multiple variables involved, as evident in the case studies, are much more complicated than what the NRDC petition contemplates and have a major impact on the final cost of a particular upgrade.

NACWA collected this sampling of case studies from utilities in the Chesapeake Bay region where extensive data are available on effluent nutrient concentrations both before and after upgrades. NACWA focused on plants with this data to allow comparison of nutrient removal pre- and post-upgrade, so the average removal rates for plants achieving EPA's secondary treatment regulations could be compared with the removal rates at the same plants after nutrient removal technologies were added. Average total nitrogen removal for the ten case study plants before upgrading was 36 percent. Average total nitrogen removal after upgrading was 90 percent.

As the case studies will illustrate, total nitrogen (TN) removal generally requires greater capital cost (larger aeration basins, secondary clarifiers and potentially denitrification filters) and relatively minor operation and maintenance (O&M) costs, while total phosphorus (TP) removal requires less capital cost and higher O&M cost

(chemical and solids handling costs). Pushing TN to limits of technology (TN<3 mg/l) or enhanced nutrient removal (TN<4 mg/l) levels does require more O&M costs as the need for supplemental carbon increases.

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Again, NACWA stresses that EPA has strong legal authority and technical rationale to deny NRDC's petition. Reverting to a technology-based approach that requires the same level of control regardless of water quality is a step backwards. Instead, we must consider new and innovative approaches to address the unique properties of nutrients as a source of water impairment. All options should be evaluated, including technology-based approaches, but the selection of those approaches must be smart, reasonable, and legally justified. NACWA always welcomes additional dialogue with EPA and other stakeholders to ensure continued progress is made toward addressing the Nation's nutrient challenges. Please contact me or Chris Hornback at chornback@nacwa.org if you have any questions or would like to discuss further.

Sincerely,

Ken Kirk
Executive Director

cc: Rob Wood, Director, Engineering and Analysis Division
Paul Bangser, Office of General Counsel

ATTACHMENT

Attachment – Chesapeake Bay Nutrient Upgrade Case Studies

Unless otherwise noted, all annual capital costs assume a four percent bond interest rate and a twenty year bond period. Cost per pound figures assume plants operate at 80 percent of design capacity.

Alexandria Renew Enterprises
Alexandria, Virginia

The Alexandria Renew Enterprises, previously the Alexandria Sanitation Authority, facility was started in 1956 as an 18 million gallons per day (MGD) facility utilizing three trickling filters to provide secondary treatment. The facility was expanded in the 1960's to 27 MGD. No nutrient removal was originally provided.

The state of Virginia established the Potomac Embayment Policy in the early 1970's to improve water quality in the freshwater tidal Potomac. Stringent total phosphorus (TP) requirements were implemented under the Policy however nitrification and total nitrogen (TN) requirements were not enforced as studies determined that phosphorus was the controlling nutrient for eutrophication control in the Potomac.

The Alexandria facility was expanded to 54 MGD and upgraded in the late 70's. The upgrade included rotating biological contactors (RBCs) to provide secondary treatment. Chemical addition and tertiary clarifiers and filters were included to meet the TP requirements of 0.18 mg/l per month, 0.27 mg/l weekly.

The requirements of the Chesapeake Bay program for reductions in total nitrogen in the Bay necessitated upgrades to the facility. The facility was upgraded from 2000 to 2003 to provide TN reduction. The RBC secondary treatment facility was abandoned and demolished. An activated sludge process that could operate as a Modified Ludzack-Ettinger (MLE) system or step feed for TN removal was built. Dual media filters were also demolished and replaced by deep bed denitrification filters. Several tertiary clarifiers were demolished to make room for additional denitrification filters. The remaining tertiary filters were upgraded with plate settlers. A second phase TN removal project is currently underway. When both phases are complete, effluent TN will have been reduced from 26.7 mg/l to less than 3 mg/l (influent TN 32.8 mg/l).

The combined nutrient removal related capital costs of the projects is $152,000,000. The annual capital cost is approximately $11,184,000. The capital cost is approximately $3.59 per pound of nitrogen removed. Also, annual operating costs increased by approximately $1,100,000 per year.

Army Base Sewage Treatment Plant
Hampton Roads Sanitation District, VA

The Army Base Sewage Treatment Plant has an activated sludge process designed to meet secondary standards of 30 mg/l total suspended solids and biochemical oxygen demand. The plant capacity is 18 million gallons per day (MGD). Previously, metal salt addition (ferric chloride)

was added to help remove total phosphorus (TP). Effluent TP was reduced from 4.4 mg/l to 0.5 mg/l (influent TP 4.9).

As part of the Chesapeake Bay effort, the plant was upgraded with a BNR system to remove total nitrogen (TN). The upgrade was started in July 2010 and is expected to be completed in 2014. Effluent total nitrogen will be reduced from 29 mg/l to approximately 5 mg/l (influent TN 40.2 mg/l).

The total capital cost of the upgrade will be $107,000,000. The annual capital cost is approximately $7,837,000. Assuming that 100 percent of the upgrade cost was for nitrogen, the capital cost is approximately $7.52 per pound nitrogen removed. No estimate is available for operating cost increases.

Falling Creek Wastewater Treatment Plant
Chesterfield County, Virginia

The Falling Creek Wastewater Treatment plant opened in the spring of 1965. At that time it was a conventional secondary treatment plant with a capacity of three million gallons per day (MGD). Expansions in 1972 and 1984 brought the plant to its current capacity of 10.1 MGD. Chemical addition (alum) was added to reduce total phosphorus (TP) to less than 2 mg/l. The activated sludge secondary system was designed for seasonal nitrification. Nitrification converts ammonia to nitrate but does not remove total nitrogen (TN).

To meet Chesterfield County's combined, bubble waste load allocation for nitrogen and phosphorus, an upgrade was undertaken at the Falling Creek Facility. The upgrade was based on a Preliminary Engineering Report as revised in September 2007. A key component of the upgrade was the conversion of the secondary treatment system to an Integrated Fixed Film Activated Sludge (IFAS) system. The IFAS system reduced effluent TN from 19 mg/l to approximately 5.8 mg/l (influent TN 30.7 mg/l). System improvements and increased chemical feed allowed effluent TP to be reduced from slightly less than 2 mg/l to 0.6 mg/l.

The upgrade capital cost was $26,000,000. Virtually all of the upgrade cost was dedicated to nitrogen removal. The annual capital cost is approximately $1,913,000. Capital cost is approximately $5.89 per pound nitrogen removed. Also, annual operating costs increased by approximately $600,000 per year. The majority of the operating cost increase was related to increased chemical costs (supplemental carbon and alum).

H.L. Mooney Advanced Water Reclamation Facility (AWRF)
Prince William County, VA

The H.L. Mooney AWRF was commissioned in 1981 as a 12 million gallon per day (MGD) activated sludge secondary treatment plant with phosphorus removal. The state of Virginia established the Potomac Embayment Policy in the early 1970's to improve water quality in the freshwater tidal Potomac. Stringent Total phosphorus (TP) requirements were implemented under the Policy, but nitrification and total nitrogen (TN) requirements were not enforced as

studies determined that phosphorus was the controlling nutrient for eutrophication control in the Potomac. A major upgrade completed in 1997 increased the plant capacity to 18 MGD.

A series of upgrades in the 1990's provided total nitrogen removal. The secondary treatment aeration basins were expanded and reconfigured as Modified Ludzack-Ettinger (MLE) biological nutrient removal basins. Denitrification filters were added to convert nitrate to nitrogen gas, which is then released to the atmosphere. An additional upgrade was completed in 2010 that increased the plant capacity to 24 MGD and assured that the facility could consistently meet state of the art (SOA) levels of nitrogen removal. The 2010 upgrade included additional aeration basin capacity, flexible anoxic zones, increased secondary clarification, additional denitrification filters and an upgraded control system. Together, the upgrades reduced effluent TN from over 19 mg/l to less than 3 mg/l TN.

Together, the nutrient related upgrade capital cost was approximately $104,844,000. The annual capital cost is approximately $7,714,000. The capital cost is approximately $8.25 per pound of nitrogen removed.

Kent Narrows, Stevensville & Grasonville Wastewater Treatment Facility (Kent Island)
Queen Anne's County, MD

The Kent Island facility was constructed between 1979 and 1982. It featured rotating biological contactors (RBCs) to provide secondary treatment. The original plant was designed for 800,000 gallons per day; however, it was re-rated for one million gallons per day (MGD). A second RBC train was added in 1986 to bring the facility capacity to 2 MGD. Total phosphorus (TP) removal was also included in the 1986 upgrade.

The Chesapeake Bay program required the removal of both TP and total nitrogen (TN). RBCs cannot be upgraded to remove TN. Therefore the RBC secondary treatment facility was abandoned and an activated sludge facility with biological nutrient removal was built. Capacity was increased to 3 MGD. The construction was completed in 2007. Effluent TN was reduced from 25 mg/l to 2 mg/l (influent TN 35 mg/l). TP was reduced from approximately 4 mg/l to 0.15 mg/l (influent TP 4 mg/l).

The total capital cost of the upgrade was $14,600,000. The annual capital cost is approximately $1,074,000. Assuming that 80 percent of the upgrade cost was nitrogen-related, the capital cost is approximately $5.11 per pound nitrogen removed. Assuming the TP portion of the upgrade was 20 percent, the capital cost is approximately $7.64 per pound phosphorus removed.

Moores Creek Wastewater Treatment Plant
Rivanna Water and Sewer Authority (RWSA), VA

The Moores Creek Wastewater Treatment Plant is part of the RWSA system serving the citizens of Charlottesville and Albemarle County, VA. Prior to 1981 the plant utilized trickling filters to provide secondary treatment. In 1981 the plant was upgraded at a cost of 28 million dollars to replace the trickling filters with an activated sludge system that provided nitrification (ammonia

conversion to nitrate) but did not provide nutrient removal. The plant capacity is 15 million gallons per day (MGD).

Driven by the Chesapeake Bay program requirements, an upgrade featuring total nitrogen (TN) and total phosphorus (TP) was completed in 2012. The heart of the upgrade was a five stage Bardenpho process. The Bardenpho process is a variant of activated sludge that utilizes aerobic, anaerobic and anoxic zones to remove both TN and TP. The upgrade has reduced effluent TN from 19.3 mg/l to 2.88 mg/l (influent TN 45 mg/l). Effluent TP has been reduced from 3.41 mg/l to 0.32 mg/l (influent TP 9.89 mg/l).

The capital cost of the upgrade was $48,000,000. The annual capital cost is approximately $3,532,000. Assuming that 80 percent of the upgrade cost was nitrogen-related, the capital cost is approximately $4.71 per pound nitrogen removed. Assuming the TP portion of the upgrade was 20 percent, the capital cost is approximately $6.26 per pound phosphorus removed. Annual operating costs increased by approximately $700,000 per year.

Town of Woodstock Wastewater Treatment Plant
Woodstock, VA

The Town of Woodstock Wastewater Treatment Plant was originally constructed in 1987 as an extended aeration facility. While providing secondary treatment, it was not designed to achieve any significant level or nutrient removal. Driven by the Chesapeake Bay program, the town initiated a major facility upgrade which was completed in 2010. The plant capacity is 2 million gallons per day (MGD).

The upgrade included fine mechanical screening to protect downstream units. The core of the new biological treatment system is dual membrane biological reactors. Chemical feeds are included for supplemental carbon addition to drive denitrification and alum for phosphorus removal. Since operations began, effluent total nitrogen (TN) has been reduced to 2.45 mg/l and total phosphorus (TP) has been reduced to 0.1 mg/l (influent TN 44 mg/l)

The total capital cost of the upgrade was $31,000,000. The annual capital cost is approximately $2,281,000. Assuming that 80 percent of the upgrade cost was nitrogen related, the capital cost is approximately $22.64 per pound nitrogen removed. Assuming the TP portion of the upgrade was 20 percent, the capital cost is approximately $24.02 per pound phosphorus removed.

York River Sewage Treatment Plant
Hampton Roads Sanitation District, VA

The York River Sewage Treatment Plant has an activated sludge process designed to meet secondary standards of 30 mg/l total suspended solids and biochemical oxygen demand. The plant capacity is 15 million gallons per day (MGD). Previously, metal salt addition (ferric chloride) was added to help remove total phosphorus (TP). Effluent TP was reduced from 4.4 mg/l to 0.5 mg/l (influent TP 4.4 mg/l).

As part of the Chesapeake Bay effort, the plant was upgraded with denitrification filters, supplemental carbon addition and a new intermediate pump station. The upgrade was completed in 2011. Effluent total nitrogen was reduced from 20.4 mg/l to 5.3 mg/l (influent TN 36.9 mg/l).

The total capital cost of the upgrade was $63,400,000. The annual capital cost is approximately $4,655,000. Assuming that 80 percent of the upgrade cost was nitrogen related, the capital cost is approximately $6.76 per pound nitrogen removed. Assuming the TP portion of the upgrade was 20 percent, the capital cost is approximately $6.55 per pound phosphorus removed. Annual operating costs increased by approximately $508,000 per year.