Middletown's experience with the Chesapeake Bay Tributary Strategy

KEEPING PACE WITH CHANGE

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Middletown Borough, like many other municipalities throughout Pennsylvania, Maryland and Virginia will have to make significant changes to the way it currently treats its wastewater to meet new mandates being imposed by the Pennsylvania Department of Environmental Protection (DEP). DEP's mandates are aimed at improving the significant water quality problems in the Chesapeake Bay.

Behind the Strategy

Reductions in water clarity and excessive growth of algae blooms and grasses have significantly reduced the population of fish, oysters and crab within the Bay. The reduction in water quality is attributed to the current nutrient and sediment loads received by tributary water bodies. The Pennsylvania Chesapeake Bay Tributary Strategy (Strategy) is a comprehensive approach to reducing the nutrient and sediment contributions within the Bay's drainage basin by reducing sediment from land run-off to improve water clarity and by reducing the nutrients, most notably nitrogen and phosphorous, which contribute to the growth of algae and grasses. Although nitrogen and phosphorus are essential nutrients to the growth of living organisms, excessive quantities of these nutrients cause an overabundance of plant growth, such as what is occurring within the Bay. Reduction of sediment and nutrients should improve the Bay's water clarity, reduce the algae and grasses, increase water-dissolved oxygen and increase zooplankton, which is a significant food source for the Bay's aquatic life.

The sources of nitrogen and phosphorus entering the Chesapeake Bay are mainly from precipitation, land run-off, discharges from industrial and municipal wastewater facilities, and groundwater that is contaminated from improperly functioning on-lot septic systems and fertilizers that leech into the water table. Phosphorus and nitrogen are found in lawn fertilizers and animal wastes that combine with the groundwater run-off. In addition, nitrogen and phosphorus are also present in human waste, laundry detergents and household cleaning products that enter surface water through wastewater treatment facilities' effluent. The Strategy addresses these sources of nutrients and the sediment entering the Bay, and provides approaches to manage soil erosion from agricultural and other lands and to reduce nutrients from wastewater treatment facilities.

As noted above, nutrients and sediment are introduced to the Bay from a number of sources. These sources can be categorized into two distinct groups: point sources and non-point sources. Point sources are regulated contributors, such as wastewater treatment facilities. Non-point sources are the unregulated nutrient and sediment contributors such as agricultural practices. Although more than 85 percent of Pennsylvania's nutrient loads originate from non-point sources[1], it is the point sources that are legally required to significantly reduce their nutrient loadings. DEP is enforcing the nutrient reductions by capping the amount of total nitrogen (TN) and total phosphorous (TP) each treatment facility within the Chesapeake Bay Drainage Basin is allowed to discharge under its permit and by setting compliance dates.

Intermunicipal Negotiations and Lessons Learned

When faced with the challenge of meeting the nutrient removal standards of the Strategy, Middletown had to overcome many legal, political and technical obstacles. The mandates set by DEP forced many years of intermunicipal negotiations to be completed, and it also challenged the community's political leaders to make important financial decisions that would accomplish the necessary redesign and technology upgrades at the wastewater treatment plant without overburdening the ratepayers.

[1] *The Department of Environmental Protection Agency's April 24, 2007 article titled "Pennsylvania's Chesapeake Bay Tributary Strategy Implementation Plan for Sewage Facilities Planning."*

Photo by Dan Helm, CET Engineering Services

Middletown, like many municipalities, has a wastewater system that is owned by a Borough Authority but operated and maintained by borough employees. Because of this type of organizational structure, major decisions had to be agreed upon by the two groups of officials. To further complicate matters, the Middletown wastewater treatment plant also serves two neighboring municipalities through intermunicipal agreements – all of Royalton Borough and a portion of Lower Swatara Township. These neighboring municipalities also had to be consulted before final technical and financial decisions were made.

An intermunicipal agreement between Royalton and Middletown was previously in place. However, Middletown Borough, Middletown Borough Authority, Lower Swatara Township Board of Commissioners and Lower Swatara Township Authority had to conclude two decades worth of discussions regarding the contractual relationships between the four parties. Many scenarios were discussed, including the potential benefit of severing the relationship. However, in the end, the discussions led to an acceptable joint agreement, which all parties believe will be adopted prior to any new construction.

The lessons Middletown learned from these negotiations are many. First, it is the officials themselves, rather than DEP and engineers or other consultants, who must see the wisdom of the intermunicipal agreement. Second, a level of trust and candor must be maintained, or intermunicipal talks can easily break down. Finally, no agreement is perfect and the competing issues or agendas of each municipality, such as growth versus non-growth and the ability to phase in costs, must be recognized before a fair agreement can be reached.

Middletown's Compliance Options

The borough's wastewater treatment plant cap loads are set at 40,182 lbs of TN and 5,358 lbs of TP, which is equivalent to 6 mg/L of TN and 0.80 mg/L of TP based on the plant's current design flow of 2.2 million gallons per day. The existing facility is not capable of meeting the Strategy's nutrient limits and will need to be upgraded. The borough's compliance date is set at September 2011.

Two options are available to the borough for complying with the TN and TP cap loads established by the Strategy: (1) upgrade the existing

treatment processes to remove additional nitrogen and phosphorus or (2) purchase nutrient credits under the Strategy's nutrient trading program. The borough decided to implement the first option because the age and condition of the existing facilities necessitates an upgrade regardless of the new requirements, and because, over a twenty year period, purchasing credits is more costly than construction.

Proposed Plant Improvements

Middletown's original wastewater treatment plant was built in the early 1950's and was subsequently modified in 1976. The plant consists of primary settling, primary and secondary aeration, intermediate and final settling tanks, aerobic sludge digestion, a belt filter press for sludge dewatering and a high temperature-lime pasteurization process to produce a Class A biosolids end product.

The borough authorized CET Engineering Services to prepare an update to its Act 537 Plan. The plan evaluates several alternatives to upgrade the existing wastewater treatment plant to meet the Strategy's requirements and to provide improved biosolids stabilization and disposal capabilities. Consideration was given to alternatives that would provide increased nutrient reduction to comply with TN and TP limits at design flows within the existing space constraints of the site. The proposed alternatives also had to allow for the plant to remain in operation during construction and reduce the potential for odors, given the plant's close proximity to residential homes. Due to limitations of the existing plant configuration, the borough decided to purchase an adjacent lot, before design began, to give the designers more flexibility. With the additional land available, the decision was made to design a new biological treatment process to fit within the new parcel and to retrofit the existing treatment facilities to provide more efficient sludge handling, digestion and dewatering.

Two alternative processes were evaluated: a sequencing batch reactor and a phased oxidation ditch. Both of the alternatives are capable of adequately reducing the nutrients in the effluent in the small area available. The oxidation ditch process was chosen as the best fit for Middletown, since it is capable of meeting the nutrient limits and is similar to the process the plant staff currently operates. The oxidation ditch process is also well suited to handle the peak flows experienced at the treatment plant during wet weather periods.

The proposed upgrades are further described as follows:

- New raw wastewater screening and grit and grease removal will be

Photo by Dan Helm, CET Engineering Services

added to the head of the plant to provide improved treatability for downstream units and to provide for improved stabilized solids handling and disposal options.

• Following wastewater screening and grit and grease removal, wastewater will flow to a series of un-aerated selector tanks, where conditions are ideal for growing bacteria that can remove nitrogen compounds from the wastewater. Here, recycled biomass from the new downstream final clarifiers will be mixed with the influent wastewater to convert the nitrates within the wastewater to nitrogen gas that is released to the atmosphere.

• From the selectors, the wastewater will flow into one of two new oxidation ditch trains, where a rotor turns and adds air into the mix, or where submerged mixers keep the contents of the wastewater in suspension. The air breaks down the organic components of the waste, and also helps convert ammonia into nitrate. The time when the rotor is off and the mixers are running will allow bacteria to convert more nitrate into nitrogen gas.

• After spending upwards of sixteen hours in the ditch, the wastewater will be sent to the final clarifiers. The clarifiers will separate out the biomass, leaving the clean water to be disinfected and discharged to the Susquehanna River.

• The phosphorus removal component of the upgrade consists of new alum storage and feeding systems. Alum will be fed into the clarifiers to combine with phosphorus, which will then settle out with the rest of the biosolids. A portion of the settled biosolids will be wasted to the digestion process, while the rest will be recycled back to the head of the treatment process as the recycled biomass noted above.

• The disinfection equipment from the old plant will be retained, along with most of the old concrete tanks. Some of the tanks will be removed to provide additional parking and additional room for potential future treatment requirements, while the remaining tanks will be used in the sludge digestion process. The tanks slated for reuse will be converted to process tanks required for the new Auto-Thermal Thermophillic Aerobic Digestion Process.

The design has also taken into account the aesthetics of the area, as can be seen in the conceptual rendering of the proposed plant

Photo by Dan Helm, CET Engineering Services

site. Minimizing the negative visual impact of the new plant was important to the borough officials due to the plant's central location within the borough.

Moving Forward

Middletown's leaders estimate that the cost of the upgrade will be approximately $14,000,000. While the design provides substantial cost savings by incorporating the reuse of existing facilities and the installation of energy-efficient equipment, there is no doubt that the project costs will require significant rate increases for the customers. Much of the existing structural portion of the treatment plant will be reused; however, most of the mechanical systems are nearing the end of their useful life and will be replaced. Wherever possible, new motors and controls will be installed to minimize the electricity used by the new plant, to reduce the annual cost of operations, and to limit the impact on user rates.

Middletown's leaders have determined that a capital improvement project at the wastewater treatment plant is the most effective way to meet the needs of current and, potential, future regulatory requirements. As an example of support, the Middletown Borough Council has approved preemptive rate increases over the past two fiscal years to set aside money in advance of the project to minimize the impact of user rate increases required to pay for the debt service on the loan for the project.

Due to concerns over other rising utility costs, Middletown Borough Council has chosen to incorporate some load-sharing electricity generation into the proposed project. While such an addition adds to the initial capital outlay, the Borough's electrical consultants have calculated a long-term savings that will be realized by including electricity generation into the project's specifications. Unique policy decisions, such as the preemptive rate increases and the inclusion of electrical generation, demonstrate Middletown's commitment to designing facilities that will effectively meet DEPs standards while remaining cost-effective. **(B)**

About the Authors

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