

# **FLOATING ISLANDS – AN INNOVATIVE NATURAL TREATMENT SYSTEM FOR ENHANCED WASTEWATER TREATMENT THROUGH LAGOONS**

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## **INTRODUCTION**

Pennsylvania is a Commonwealth, where government is through local municipal rule. In a commonwealth the local government in every small town, borough, and village is responsible for all needs of the public: land development, resources protection, sewer, water, streets, etc. In Pennsylvania, there are thousands of small townships, villages, and communities having population less than 10,000. As a result, Pennsylvania has a large number of small isolated wastewater treatment facilities. In this environment, natural wastewater treatment systems are advantageous as they are simpler and less expensive than conventional mechanical systems. This paper summarizes the application of an innovative natural treatment process, the floating island, which is being implemented at Wiconisco Township in Dauphin County, Pennsylvania. The floating islands are designed to enhance carbon sequestration as well as nutrient removal.

Wiconisco Township owns and operates a 0.125 MGD lagoon wastewater treatment plant (WWTP), which services Wiconisco Village. The system comprises two lagoons which can be operated in series or in parallel. Each lagoon (total volume 1.7 MG) is divided into two sections with a baffle. The inlet section (0.77 MG) is completely aerated and the second section (0.996 MG) is partially aerated resulting in facultative conditions. Surface aerators provide aeration and mixing. The facultative section of the lagoons also serves as the biosolids (sludge) storage area.

Current average daily flows at the facility are 0.05 MGD or 50,000 GPD with peaks of more than 75,000 GPD. Thus the facility operates at less than half of its design capacity. Total hydraulic residence time in the facility at present flows is more than 28 days in the aerated zones and more than 36 days in the facultative zones.

## **METHOD**

In 2006, Wiconisco Township installed three floating islands wetlands units, each 25 ft × 25 ft, into one of the lagoons to verify nutrient uptake capability of this system. The floating islands are constructed wetlands and larger macrophytes (woody plants) which are planted on an artificial buoyant matrix which is porous enough to allow roots to penetrate the matrix into the water column:

Floating islands are a natural treatment process aimed at removing nitrogen and phosphorous species primarily through the root zone area which develops below the water line, the microbes which populate this area and island matrix, and the synergistic interactions between the plant rhizomes and microbes. The floating islands are also designed to recycle the wastewater via solar pumps onto the island and down through the

matrix establishing bacteria similar to a trickling filter or tertiary filter. Aeration under the islands can be supplemented with solar- or wind-powered aerators.

Wiconisco Township, Dauphin County, PA WWTP is the Beta test site for the application of floating islands technology in wastewater treatment plants. Floating islands have been studied previously in the wastewater treatment nutrient uptake arena. A 1999 peer review paper indicated that the islands were successful in removing approximately 520 mg/ft<sup>2</sup>/d of nitrogen (ammonia and nitrate) and up to 52 mg/ft<sup>2</sup>/d of phosphorous. In another test the removal rate for nitrate was similar (520 mg/ft<sup>2</sup>/d) (Boutwell and Hutchings<sup>1</sup>, 1999). Data from ongoing laboratory studies suggest that these nutrient removal rates could potentially reach 400+ mg/ft<sup>2</sup>/day of phosphorous and 10,000 mg/ft<sup>2</sup>/d of nitrogen species.

The project is being monitored through regular wastewater sampling and analysis according to the following protocol:

Table 1: Wiconisco Township, Pennsylvania, USA Floating Islands Sampling and Analysis Protocol

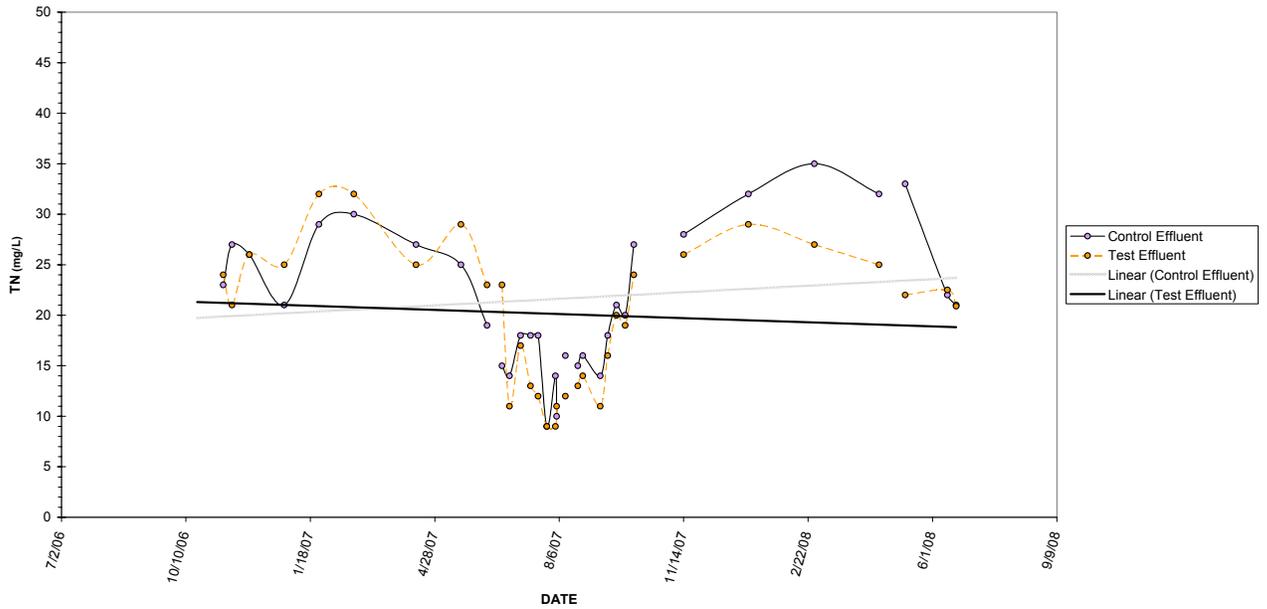
Sample Location	Analyses	Protocol
Influent	BOD <sub>5</sub> , TSS, pH, TN, TP, NO <sub>3</sub> -N, NO <sub>2</sub> -N, TKN, NH <sub>4</sub> -N	1 day/wk/Grab sample. 1/day/month/24-hr-composite Quarterly 24-hour composite split samples for QA/QC
Lagoon (Control) and Test	BOD <sub>5</sub> , TSS, pH, TN, TP, NO <sub>3</sub> -N, NO <sub>2</sub> -N, TKN, NH <sub>4</sub> -N, Temperature	1 day/wk/Grab sample. Performance of DO profiles and temperature profiles once per month.
Effluent	BOD <sub>5</sub> , TSS, pH, TN, TP, NO <sub>3</sub> -N, NO <sub>2</sub> -N, TKN, NH <sub>4</sub> -N	1 day/wk/Grab sample. 1/day/month/24-hr-composite Quarterly 24-hour composite split samples for QA/QC

All sample analysis is being performed with HACH analytical equipment and reagents with QA/QC performed quarterly with split samples going to a local private wastewater analytical laboratory to verify accuracy and precision of methods.

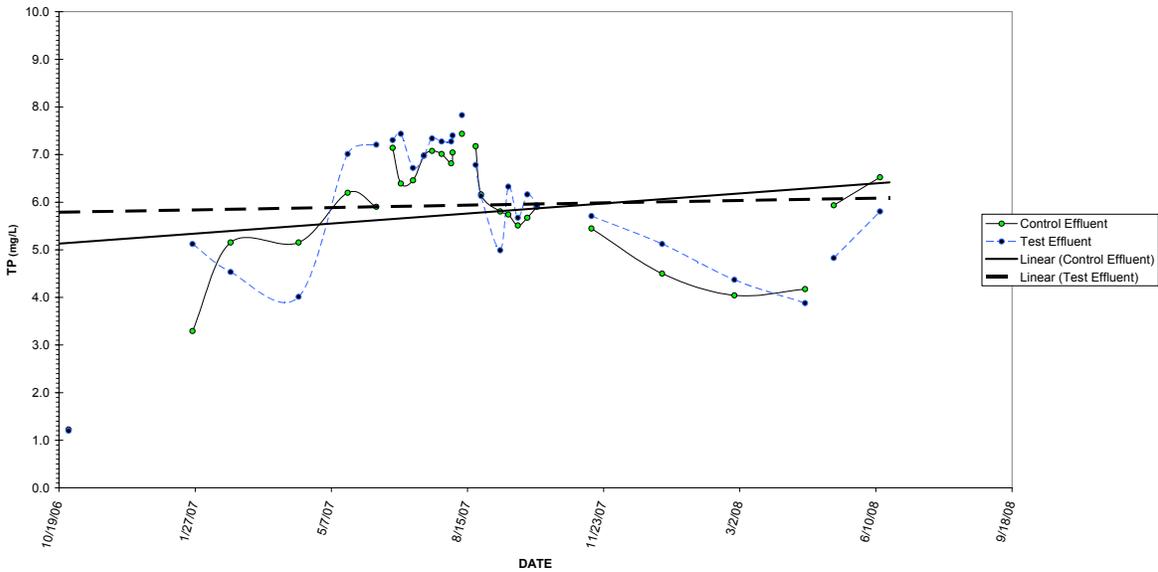
**RESULTS:**

Current results are summarized below:

Wiconisco Township WWTP, Dauphin County, PA  
Floating Islands Effluent Total Nitrogen



Wiconisco Township WWTP, Dauphin County, PA  
Floating Islands Effluent Total Phosphorus



## Discussion

The Floating Islands are just beginning to show signs of performing as anticipated related to both nitrogen and phosphorous removal. This is due in part to the fact that the islands are located in a deep lagoon and their position and growth of roots is critical for removal rates. However, data suggests that under passive treatment (no solar bilge pumps

operating) the islands are making a significant improvement over the control lagoon as can be seen in the last several months of 2008. Winter data shows that the islands provide significant removal of nitrogen compared to control lagoon. Further testing will be performed so that a complete year of operation of the islands with the bilge pumps working (pumping wastewater over the islands matrix) can be examined.

Typically it takes more than 2-3 mean cell retention times (MCRTs) or hydraulic residence times (HRT's) before any significant results are observed in a wastewater treatment plant. With the typical HRT for this WWTP of more than 65 days, more than 120-180 days will have to elapse before any significant results may be observed.

The location of the islands will be analyzed for performance as well. Moving islands to the aeration zone may improve performance for nutrient uptake.

Carbon sequestration rates for the islands are being explored through independent research. These platforms provide carbon sequestration capacity because, unlike typical wetlands, the vascular plant material is not released back to the water but is sequestered on the island matrix.

The results of Wiconisco monitoring will indicate whether the floating islands technology is a viable alternative to conventional infrastructure upgrades for nutrient removal for wastewater lagoons.

Conventional technical approaches for nutrient removal at the Wiconisco Township WWTP average about \$0.25 million in capital costs with annual O&M costs approaching more than double the current O&M budget for the entire WWTP and collection and conveyance system (not including labor). The O&M costs are more of an issue than the construction costs as the O&M costs would drive up user rates proportionately higher than would amortized construction costs for the conventional upgrades. Therefore, the Township was interested in finding an alternative to conventional treatment technology for nutrient removal at the lagoons because of the potential impact of O&M costs for conventional alternatives on users.

## **REFERENCES**

1. Boutwell, John and Hutchings, John, Bureau of Reclamation Technical Memorandum No. 8220-99-03, May 7, 1999, "Nutrient Update Research Using Vegated Floating Platforms, Las Vegas Wash Delta, Lake Mead National Recreation Area, Lake Mead, Nevada