Seadrift Constructed Wetlands: An Engineered Natural Technology Project

In 1996, the Seadrift manufacturing site converted 110 acres of an existing water treatment pond into constructed wetlands for naturally treating suspended solids consisting mostly of algae. The project cost approximately $1.4 MM, while a typical industrial wastewater treatment plant designed to remove the algae would cost approximately $40 MM and take about twice the time to build. The wetlands have been fully compliant with regulations for more than 20 years, and as Dow keeps managing the area responsibly, utilizing the know-how of local Nature Conservancy and university experts, its lifetime is expected to extend over another couple of decades.

THE STORY

The Dow Seadrift site is a large multi-unit petrochemical facility located near the town of Seadrift, Texas. The site treats approximately 5 million gallons (approximately 19,000 m^3) of industrial wastewater daily. Before the constructed wetlands, the water was treated exclusively using a large low-rate anaerobic pre-treatment system followed by large, shallow secondary and tertiary ponds. Once the water was treated, the ponds discharged into the Victoria Barge Canal and then into Mission Bay (an estuary of the Gulf of Mexico).

The large shallow ponds performed an excellent job of degrading any organics in the facilities' wastewater but produced a large amount of algae as a byproduct, which made it a challenge to comply consistently with discharge limits mandated by the U.S. Environmental Protection Agency (EPA). The algae discharged into the Victoria Barge Canal was considered total suspended solids (TSS) under the EPA regulation.

BENEFITS

100 percent compliant from day one for more than **22 years**

Low initial and operational capital required **($1.2-1.4 MM** as opposed to **$40 MM f**or a grey infrastructure alternative)

Low energy and **resource requirements** with the corresponding environmental benefits (e.g., no energy input, pumps, additives, oxygen system, added water, or biosolids to handle or dispose)

Minimal operational support (Managed with a daily drive lasting **30 minutes** vs. **3-4 operators working 24/7**)

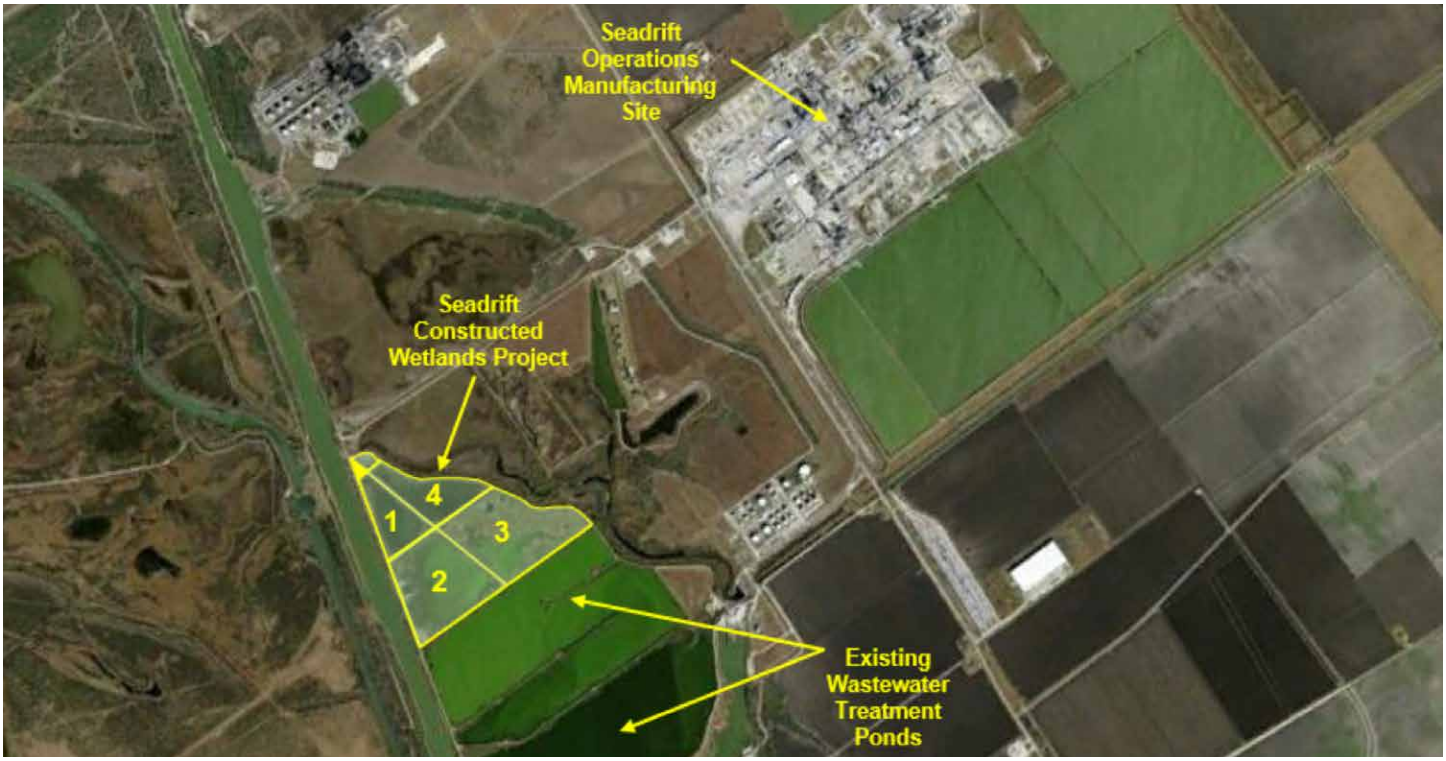
Implementation time reduced by half (**1-2 years** for the constructed wetland vs. **3-4 years** for the grey solution)

Provides tertiary treatment for approximately **5 million gallons a day** of industrial wastewater

Successfully completed multiple prescribed burns with the help of the local Nature Conservancy staff

The concentration of TSS was well above the industry guidelines. The original TSS ranged between 100 milligrams of solids per liter of water (mg/L) and 250 mg/L, depending on the season, while the regulation prescribed a maximum of approximately 40 mg/L. The algal TSS also contributed to high levels of BOD_5 (5-day Biochemical Oxygen Demand) after treatment, which is a measure that indicates the presence of biodegradable organic compounds.

Past studies looked at multiple solutions to address this issue, from abandoning the shallow oxidation ponds and building a new wastewater treatment facility, to using other methods such as settling, coagulation and filtering devices. An analysis compared the required capital and operating cost, building time and maintenance of each option, and indicated a constructed wetland, or engineered natural technology (ENT), could solve the issue cost effectively.



Satellite view of Dow Seadrift Operations site

In the summer of 1995, Dow built two pilot projects to validate the constructed wetlands solution, utilizing a slipstream of pond effluent. Based on the favorable results of the pilot test, construction of the full-scale wetlands began in spring 1996. The last 110 acres of the shallow tertiary pond was drained, divided into four individual cells, and planted with native bulrushes and other wetlands species from elsewhere on the Seadrift site.

The construction of the wetlands was completed in December 1996 at a cost of just under $1.4 MM vs. approximately $40 MM (USD 1995) for the next best alternative. The wetlands have proven to work exceptionally well. The long-term average TSS from the wetlands is 15 parts per million (ppm), and the long-term average BOD_5 is 10 ppm. Both of these values are well below the EPA Organic Chemicals, Plastics and Synthetic Fibers (OCPSF) Effluent Guidelines and Standards and facility discharge permit limits for TSS and BOD_5. The installation has met the discharge permit limits from day one without exception.

An additional benefit was the stabilization of the bicarbonate cycling in the tertiary pond and effluent. The presence of large amounts of algae produced large amounts of carbon dioxide in the water, which at times pushed the pH beyond the permitted discharge limits. Large amounts of hydrochloric acid were being used to adjust the pH to within discharge limits prior to discharge. This cost amounted to several hundred thousand dollars per year.

Within two months of initiation of operation, acid use had ceased and pH of the effluent had stabilized. Hydrochloric acid is no longer used as part of the water treatment process since the construction of the wetland. The site went from an installation that required several operators 24/7 to an operation that is managed by a simple daily drive-through.

The installation does not look anything like what was originally installed – nature has increased the biodiversity, which contributes to its resilience and ability to handle variations in water profile and environmental conditions such as droughts.

In addition to polishing the wastewater, controlling carbonate balance and reducing TSS and BOD_5, the wetlands have become a wildlife refuge. The wetlands treatment cells support fish, alligators, nutria, raccoons, bobcats, wild hogs, deer and a large number of birds, both permanent and migratory. The wetlands are a recognized stop on the local Christmas Bird Count and annually have some of the highest counts in the area, with some species only being found in this habitat.

Recent economic analysis has shown that, in addition to the capital cost avoidance of $40 MM, the constructed wetlands have provided $280+ MM in net present value (NPV) to Dow since operations began. In addition, the positive economic benefits are still accruing.

A detailed life cycle analysis (LCA) revealed that the ENT system was advantaged in all reviewed and studied areas, including, but not limited, to land use, greenhouse gases and habitat.[1]

PRESCRIBED BURNING

In 2017, the storm surge from Hurricane Harvey totally inundated the Seadrift constructed wetlands treatment cells. As the storm surge receded, a large amount of debris was left behind, entangled in the existing biomass of the cells. Alternatives for debris removal, and the overall rejuvenation of the constructed wetlands ecosystem, were assessed. A prescribed burn of the biomass was chosen as the most cost-effective and beneficial alternative.

The goal of this effort was to use nature's way of rejuvenating wetlands for Dow's benefit – by removing storm debris while, at the same time, renewing and rejuvenating the constructed wetlands. Research indicated the wetlands would regrow stronger, more diverse and more robust, leading to renewed efficiency in the water treatment process. In essence, a natural process was used to maintain the ENT asset.

The prescribed burns were executed successfully and completed in March 2018. The prescribed burn effort was the result of extensive planning and collaboration with local Nature Conservancy personnel, who developed the approved burn execution plan, oversaw the initial prescribed burn, and educated the local Seadrift operations personnel on executing future prescribed burns. In fact, the last two prescribed burns were performed entirely under the direct control of local Seadrift Operations personnel.

Early results of the prescribed burn activity are very favorable, with the burned areas in each cell growing more vigorously than the adjacent control (unburned) cells. Control of some of the more invasive plant species that had populated the cell edges also was achieved. The treatment cells were returned to operational status within one week of each burn.

Currently, the Seadrift site and Dow's Environmental Technology Center are working with local universities to develop a long-term study plan that would utilize the constructed wetlands as a living laboratory. The focus of these studies is to enhance and further Dow's knowledge and understanding of the design, construction, operations and maintenance of ENT assets, so Dow can better implement similar ENT assets elsewhere.

WIN-WIN-WIN

The constructed wetlands were the **most cost advantaged solution** to address the excess of solids coming out of the water treatment unit in Seadrift.

Biodiversity increased in the area as a result of the constructed wetlands, and the need to use chemical treatments to remove the suspended solids was eliminated

The community benefitted from having the wetlands nearby and it became a popular site for nature observation

[1]Johnathan L. DiMuro, France M. Guertin, Rich K. Helling, Jessica L. Perkins and Scanlon Romer. " A Financial and Environmental Analysis of Constructed Wetlands for Industrial Wastewater Treatment." Journal of Industrial Ecology. 18 April 2014. Yale University, doi: 10.1111/jiec.12129. Accessed: https://onlinelibrary.wiley.com/doi/full/10.1111/jiec.12129