Technical Note #113 from Watershed Protection Techniques. 3(3): 717-720

Performance of Stormwater Ponds in Central Texas

Is any more data on stormwater ponds really necessary? After all, the performance of nearly 40 storm water ponds has been investigated over the last two decades. However, there are a few good reasons to acquire still more monitoring data on these stormwater workhorses. First, most of the stormwater ponds monitored in the past were relatively small in size and simple in design. Moreover, these ponds seldom possessed the forebays, aquatic benches, greater volumes, extended detention, pondscaping and other design features now routinely prescribed by many local stormwater agencies. It is thus of more than passing interest whether these new and often expensive features can actually improve the pollutant removal performance of ponds and by how much.

Second, most prior pond research has occurred on the coasts, and mostly within humid climates. Because of this, performance monitoring data has been lacking for stormwater ponds built in semi-arid climates that have very hot and dry summers and the accompanying high evaporation rates. Stormwater managers have frequently wondered whether it is possible to maintain a permanent pool and prevent stagnation in ponds within these regions, and how these factors might influence the pollutant removal capability and maintenance requirements of wet ponds.

Two recent monitoring studies conducted near Austin, Texas shed some light on both of these issues (COA, 1997, and LCRA, 1997). While the Central Texas region typically gets about 30 to 35 inches of rainfall each year, it is not unusual for the area to go many weeks without rain during the summer, when evaporation rates are as high as 10 inches per month. As a consequence, significant pond draw downs must be factored into the design of stormwater ponds, or else they must be supported with supplemental water.

The first stormwater pond, known as St. Elmo's, had a permanent pool of 4.1 acre-feet. The pond served a 27.1 acre catchment that had more than 66% impervious cover, most of which was either street or parking lot. The surface area of the pond was 1.65 acres, with about 40% devoted to shallow wetlands, and 60% allocated for deeper pools. The layout and pondscaping plan for St. Elmo's are depicted in Figure 1. Forebays were located at the primary stormwater inlets, and berms were used to extend the flow path and prevent runoff from short-circuiting through the pond. The pond also provided extended detention storage above the pool, with a one to three day draw down time after a storm. Combined, the permanent pool and extended detention storage provided about 1.8 watershed-inches of storage quality treatment. Overall, the hydraulic retention time in the pond ranged from two to 70 days, with an average of about a month. Clearly, St. Elmo's was not an undersized pond.

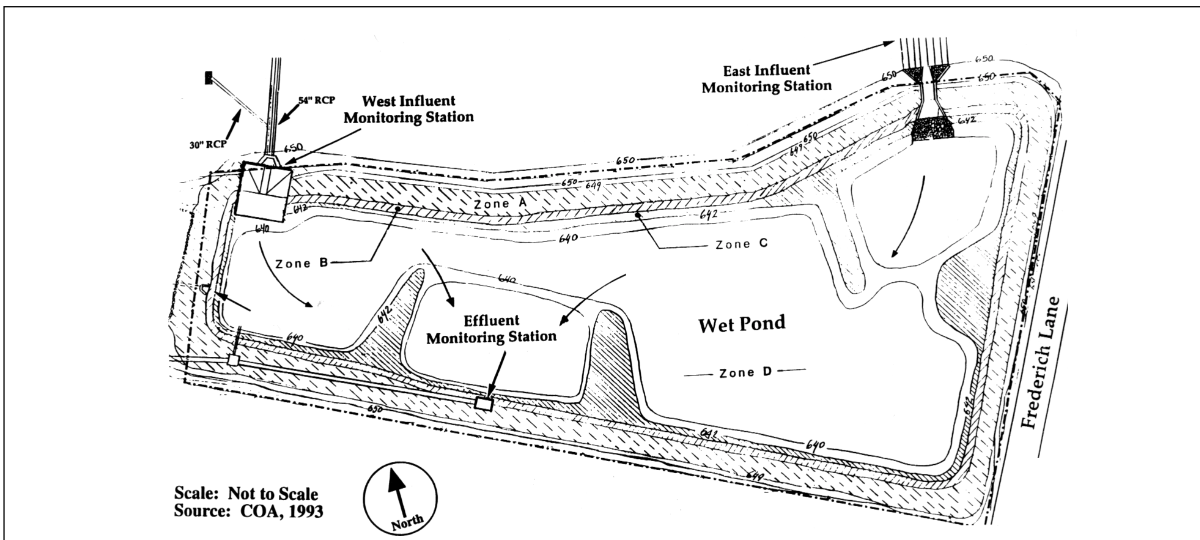

Figure 1: Layout and Pondscaping Plan for St. Elmo's (COA, 1993)

To prevent evaporation in the summer, the bottom of the pond was sealed by a liner. Still, evaporation made it difficult to maintain the pool at a constant level. To conceal changes in water levels, shallow areas in the pond were planted with spike rush (*Eleoarchis spp.*), Bulrush (*Scirpus*), Duck Potato *(Saggitaria)* and other aquatic plants. The pond was less than two years old when monitoring began in 1994, and more than 20 paired stormwater samples were collected at the inlets and outlet over the next two years. As usual, the monitoring effort and subsequent data analysis followed the exacting standards of the City of Austin Drainage Utility (COA, 1997a). The computed pollutant rates for the St. Elmo's wet pond are provided in Table 1.

It is evident that the St. Elmo wet pond provided a very high rate of pollutant removal, with more than 90% removal of total suspended solids and bacteria. Nutrient removal was also quite strong, with exceptional removal of total phosphorus (87%) and dissolved phosphorus (66%). Removal of various forms of nitrogen ranged from 40 to 90%, as well. However, the removal of metals was not as promising, ranging from 30 to 60%. Overall, the St. Elmo pond consistently achieved removal rates approximately 20% above the national median removal rates for wet ponds. A close inspection of the outflow from the pond revealed very low concentrations of most stormwater pollutants, which is another indicator of a high level of treatment (see Table 1).

A third indicator of the high level of stormwater treatment achieved by the St. Elmo pond was the high pollutant concentrations found in the sediments (Table 2). Despite the fact that the pond was only a few years old, its sediments had trace metal and hydrocarbon levels similar to those found in the sediments of Austin area oil/grit separators. The high level of stormwater treatment achieved at St. Elmo was attributed to its enhanced pond design features and large permanent pool. These resulted in unusually long hydraulic residence times that allowed settling, algal uptake and other pollutant removal processes to operate.

The second pond was a micropool extended detention pond monitored by Bruce Melton and Tom Curran of LCRA (1997). The pond drained roughly 12 acres of office park and roadway, and utilized a much different design concept than St. Elmo's. Most of the water quality storage provided in the pond (about one watershed-inch) was devoted to extended detention (ED), with only a small permanent pool located near the outlet (about 0.29 acre-feet). During dry weather, the pool was maintained by draining excess condensation water from the air-conditioning systems of the buildings in the office park. This supplied about 2.6 acre-feet per year of supplemental water needed to sustain the micropool, which had a fringe of wetland plants. The pond had two inlets, each of which had a forebay formed by a rock or gabion berm to provide pretreatment. Some of the upland drainage was treated with other innovative peat sand filters.

The pond was extensively landscaped with a variety of drought and/or inundation tolerant plant species planted, depending on their elevation within the pond.

Table 1: Performance of the St. Elmo Wet Pond System

Water Quality Parameter	Outflow Concentration	Removal Efficiency
Total Suspended Solids TSS	9 mg/l	93%
BOD, five day	2.4	61%
COD	23	50%
Nitrate-Nitrogen	0.45	40%
Total Kjeldahl Nitrogen	0.47	57%
Ammonia-Nitrogen	0.03	91%
Total Nitrogen	0.92	50%
Total Phosphorus	0.04	87%
Dissolved Phosphorus	0.03	66%
Copper*	4.2 ug/l	58%
Lead*	3.9 ug/l	39%
Zinc*	59.6 ug/l	27%
Fecal Coliform	1324	98%
Fecal Strep	1265	96%

For comparison purposes, the median removal rates for wet ponds was 77% (TSS), 47% (TP), 30% TN and 45% (Cu), according to CWP National BMP Database (see article 69). Pollutant removal rates for trace metals were computed based on means of instantaneous individual inflow and outflow concentrations.

Table 2: Sediment Chemistry of St. Elmo Pond Sediment (mean of five sediment samples)

Sediment Parameter	Units	Level
Lead	mg/kg	21.5
Zinc	mg/kg	471
Copper	mg/kg	46.7
Petroleum Hydrocarbons	mg/kg	5202
Total Organic Carbon	mg/kg	4,414
PAHs (max)	ug/kg	10,210