FIG. 1. View of the Madrona Marsh Preserve in late spring.

MADRONA MARSH RESTORATION AND ENHANCEMENT PROJECT: PRESERVING THE LAST FRESHWATER MARSH IN LOS ANGELES COUNTY

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Abstract

The Madrona Marsh Preserve in the City of Torrance is the last vernal marsh in the South Bay area of Los Angeles County and is an environmentally sensitive area and valuable habitat for a variety of birds, insects, mammals, and plant species. Once sought out to be a condominium development, the City along with the Friends of Madrona Marsh saved the habitat through an agreement with the developer to donate the marsh and surrounding properties. Over the years, a decline in the quality of water entering the marsh has caused concern over the health of the marsh habitat. The goal of the Madrona Marsh Restoration and Enhancement Program is to improve water quality in the vernal marsh and to improve conditions for the wetland habitat. This paper presents and discusses the centerpiece of the Restoration and Enhancement Program—a storm water treatment project to provide clean water supply to the wetlands. The design, construction, and performance of the treatment facilities, and particularly the challenges of designing a nutrient removal treatment system to treat urban runoff and storm water from a large detention basin used to supplement water in the Madrona Marsh, are highlighted.

Background

Madrona Marsh Preserve (Fig. 1) is located in the South Coast City of Torrance and is the last remaining vernal marsh in Los Angeles County. A vernal marsh is a depression or standing body of water flooded by runoff water from the surrounding area. Madrona Marsh fits in the category, as it is wet during winter and spring when it is fed by rain events, and dry by the end of summer until the following rainy season. This particular marsh was created when the Palos

Verdes Peninsula was geologically uplifted and the natural drainage to the ocean was halted.

The Madrona Marsh Preserve is a former oil and gas recovery site. In the 1920s, the land was used for oil development (Friends of Madrona Marsh, 2012). Then, in the 1970s, it was sought out as a condominium development, but the City of Torrance along with the Friends of Madrona Marsh saved the delicate habitat by forming an agreement with the developer, which resulted in the City purchasing the most critical 54 acres, including the 20 acre seasonal marsh, and designated it a nature preserve in perpetuity.

Upon acquiring the land, the City hired a professional naturalist to institute programs for restoring the preserve. Dedicated to the enhancement of the preserve's four beneficial uses—shelter, water, food, and space—a comprehensive restoration program was implemented. From the beginning, improving water quality entering the marsh was deemed the single most important component of the program. The goal is to deliver water to the vernal marsh that is as clean as when the marsh received it from mountains and rivers, not urban runoff, and is in good quality to support return of the plants back into the natural seasonal growth pattern.

Prior to restoration, a large detention basin (sump; Fig. 2) located at the southeast corner of the preserve received untreated runoff via two large storm outfalls. This water is then distributed to the marsh through two pumps without any type of filtration or treatment (Fig. 2). Under normal conditions, wetlands are nature's best filtering system, but the situation in Madrona Marsh was anything but normal. The main concern was high phosphate concentrations found in the water entering the marsh, which was causing rapid algal growth, leading to oxygen depletion—a condition otherwise known as eutrophication. With funding and

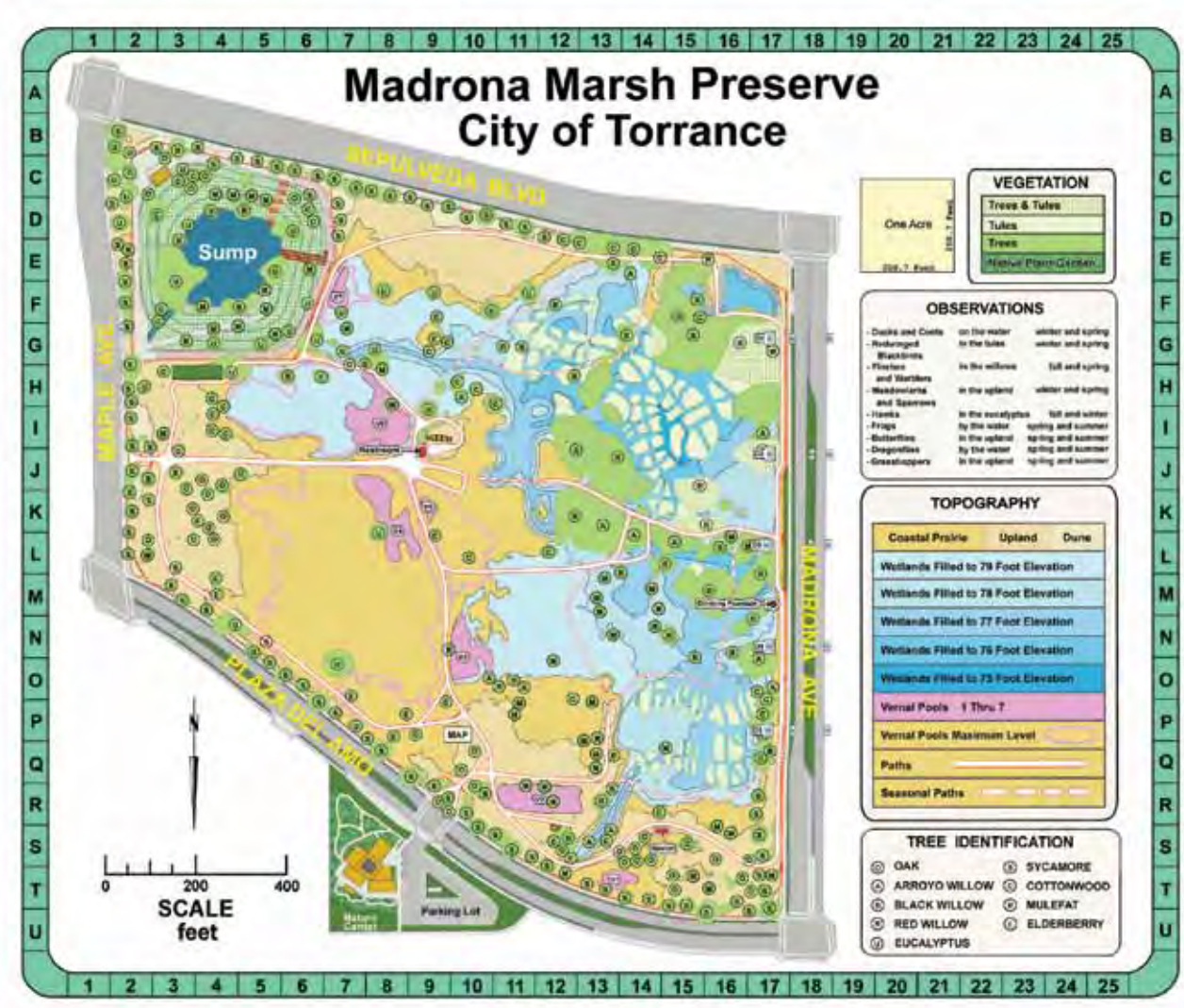

FIG. 2. Madrona Marsh site map. The detention basin (sump) is located at the upper-left corner of the map.

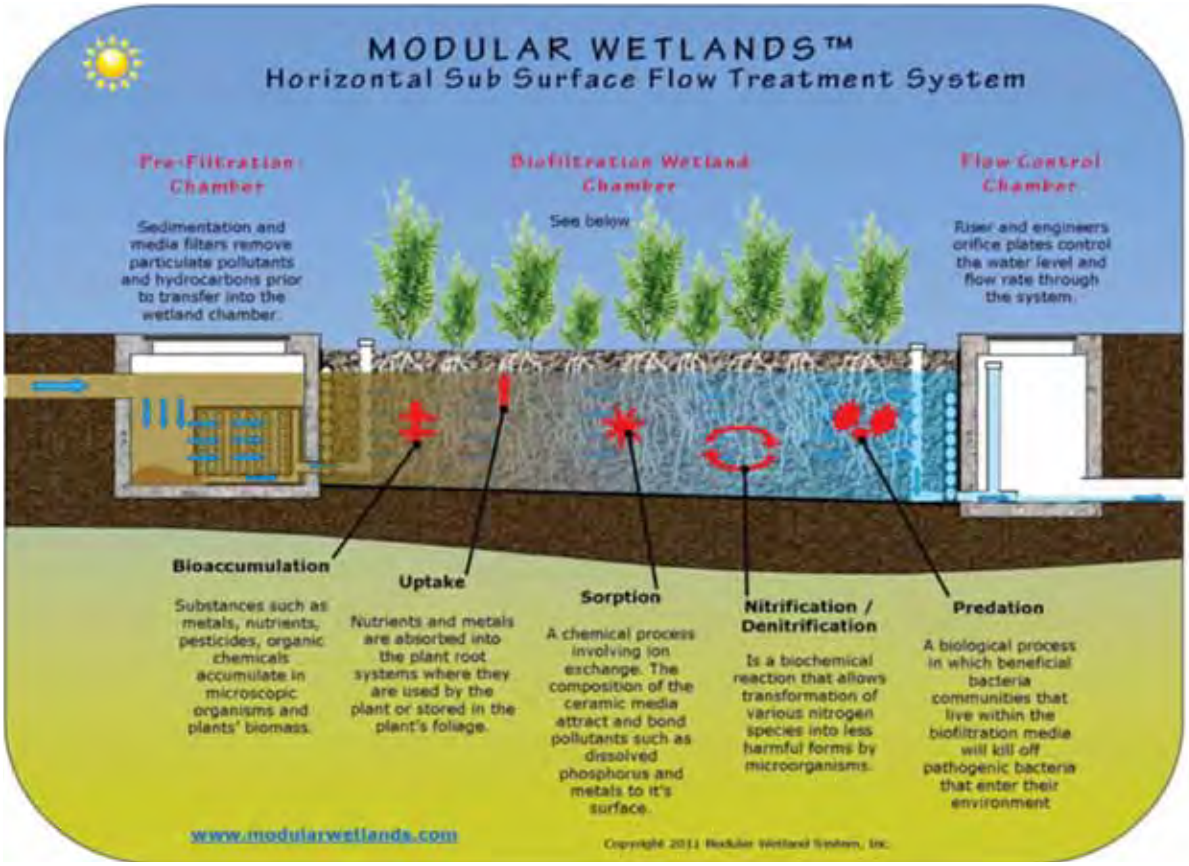

FIG. 3. Modular wetlands horizontal subsurface flow treatment system.

Contaminant	Influent (mg/L)	Effluent (mg/L)	Reduction %
Phosphorus	0.17	ND	*
Dissolved Phosphorus	0.11	ND	*
Chromium	0.0022	ND	*
Copper	0.0088	0.0036	59%
Lead	0.0011	ND	*
Nickel	0.0024	ND	*
Zinc	0.056	ND	*
Dissolved Copper	0.0068	0.0029	57%
Dissolved Zinc	0.047	ND	*
Total Nitrogen	1.1	0.6	45%
Total Kjeldahl Nitrogen	0.75	ND	*
Total Suspended Solids	13	ND	*
COD	29	ND	*
BOD	4.8	2	58%
Turbidity	5.8	1.1	81%

ND = Non Detectable * Indicates High Removal

TABLE 1. Contaminant concentrations in influent and effluent samples collected in April 2012.

FIG. 4. Dropping of the precast box during construction of the WetlandMod system.

FIG. 5. Construction of the riprap waterfall into the wetland basin.

support from the Santa Monica Bay Restoration Commission and the California Coastal Conservancy, the City began researching alternative sources of water, as well as methods to reduce nutrients in the basin before the water was pumped to the marsh.

Among potential sources, potable and recycled water were first explored, but were found to be unsuitable. Portable water was too expensive to transport to the site and its high chlorine count was also a concern. The nutrient levels in recycled water were also deemed too high for the wetlands. The focus then shifted to the collection and delivery of urban runoff flow into the wetlands from surrounding areas. The main challenge of such an option is that the selected method must rely solely on urban runoff and rain to maintain the hydraulic conditions needed for preserving and protecting this isolated wetland. There also must be a treatment process, most likely in the form of filtration, built into this option. Without filtration, the increased phosphates and other nutrients will reduce the viability of the marsh, causing the plants to grow too much and die too early, as observed over the past few years by Madrona Marsh Preserve personnel. The effect of this was a reduction of viable habitat and an increase of maintenance required to have vital open-water areas in the wetlands.

Ideally, the restoration program would like to see runoff treatment achieved on site and through uptake of nutrients and other pollutants by wetland vegetation. To further evaluate the need for and feasibility of natural runoff treatment, the restoration program assessed the quality of the existing runoff entering the detention basin through weekly monitoring of a suite of water quality parameters including nitrate, phosphate, turbidity, and color. Through examination of the monitoring data, a few things became evident. First, the phosphate and nitrate loads in the runoff from the surrounding area entering the detention basin were indeed above a level that could cause a serious decline in water quality and degradation in the quality of wetland habitat. Second, the runoff entering the detention basin was dynamic in nature; influent concentration levels of the above parameters changed from week-to-week and sometimes day-to-day. This means that any treatment methods, including bioremediation through the use of wetland vegetations, must be able to deal with flow fluctuation.

The Modular Wetland System

To select an effective treatment method, the City of Torrance paired up with Modular Wetland Systems (WetlandMod or MWS). The two entities joined efforts to brainstorm and design a feasible filtration system and decided on the WetlandMod, a self-contained treatment train including a pretreatment chamber and a horizontal flow biofiltration system (Fig. 3). The treatment train is built into a modular pre-cast concrete structure that incorporates capture, screening, hydrodynamic separation, advanced media filtration, and biofiltration. The biofiltration process replicates natural processes to remove a variety of pollutants from storm water runoff, including fine total suspended solids (TSS), bacteria, oils and grease, heavy metals, and harmful nutrients like nitrate and phosphorus. To adapt the system to the Madrona Marsh project site, the design team tweaked its original module to incorporate a much larger scale wetland bed to treat various flow volumes from the detention basin for use in the vernal marsh.

Construction of the WetlandMod began in October 2011. This included dropping a 22' precast box that houses a pretreatment chamber and media cartridges (Fig. 4). Contractors excavated a 107' x 37' x 3.7' area for the filtration media bed. The clean soil from the excavation was used on site to restore access roads. The wetland media (lightweight ceramic sorptive media) filled the bed and wetland-specific vegetation was planted. Vetiver grass was chosen for its noninvasive yet vigorous root system, drought tolerance,

FIG. 6. Curb grate installed at a catch basin opening in the drainage area.

FIG. 7. Post construction of the Modular Wetland System site.

and pollutant removal capabilities, including removal of dissolved nutrients and heavy metals. The project also included removal of a limited number of trees to allow for increased sunlight and UV disinfection at the basin inlet, and construction of a 150 foot long riprap waterfall from the flow control vault at the top of the site down to the wetland basin (Fig. 5). A small precast flow control vault was dropped at the end of the media bed to direct water down the riprap waterfall back into the basin. In addition to construction within the Madrona Marsh property, numerous retractable curb grates were installed throughout the 241 acre drainage area to prevent trash, foliage, and other pollutants from entering the basin (Fig. 6). In February 2012, after all construction was completed, the pumps were turned on and began filtering water from the basin via the newly constructed filtration system.

Post restoration, the basin continued to receive runoff via two large storm outfalls (Fig. 7). The basin now contains three pumps: Two pumps deliver treated water into the vernal marsh, while the third sends it into the WetlandMod, where water flows through a proprietary media that removes high levels of TSS, hydrocarbons, particulate heavy metals, and nutrients. Reducing particulates in the pre-treatment chamber minimizes pollutant loading and prevents clogging in the media bed. Water is then distributed through a manifold, creating an even flow of water across the media bed. Treated water is diverted back into the basin using a riprap waterfall that oxygenates the water. The pumps run water into the WetlandMod system 24 hours a day. This system is specifically designed to treat continuous low flows, but with inconsistent flow volumes. Native Vetiver grass was planted because it has proven effective at removing pollutants while exposed to inconsistent water and even drought situations (Vetiver Network International). An irrigation system in the media bed allows the grass to survive when treatment through the WetlandMod system is not needed.

Results

The WetlandMod system treats up to 40,000 gallons per day and remove an array of pollutants with a combination of best management practices (BMPs): The media filtration and biofiltration remove nutrients and heavy metals, the riprap waterfall oxygenates the water, tree removal provides UV disinfections, inlet filters remove oil and grease, and curb guards prevents trash from entering the basin. This multi-BMP approach has produced immediate improvement on water quality in the marsh. Samples collected and tested within 24 hours following initial filtration have shown 37% nitrate reduction, over 50% phosphate reduction, and 87% turbidity reduction. The influent water color was a murky, yellow-brown, while the effluent water is colorless.

In April 2012, samples were collected and tested again, showing improved results (Table 1): Nitrogen levels reduced further along with turbidity, and total and dissolved phosphorous became non-detectable. Dissolved metals also showed additional reductions with some even non-detectable. Once again, the effluent water was colorless. Results are expected to continue to improve as the sump water circulates through the WetlandMod system 24 hours a day and after Vetiver grass root systems establish within the wetland media bed.

Besides test data showing improvement in water quality, construction of this project has exhibited many other positive effects. It was evident that running water from the flow control vault down the riprap waterfall into the basin created a wonderful bathing area for birds. During spring migration, it was not uncommon to see over 150 cedar waxwings perched in the trees near the waterfall, preening after having bathed. Hummingbirds seem to prefer the outflow pipe and can be seen there any time of the day. Clean water creates a healthy habitat for all. Other benefits include reduced amounts of trash observed in the basin after rain events, greater

public awareness of the impact of storm water pollution on nature, and most importantly, no algae blooms in the vernal marsh.

Staff at Madrona Marsh will continue to monitor the system on a monthly basis to ensure nutrient levels are low. Project benefits include keeping the City of Torrance in compliance with and exceeding water quality regulations. Most importantly, it is the first time in decades the vernal marsh of the preserve is receiving clean, high-quality water.

About the Friends

The Friends of Madrona Marsh (FOMM) is a non-profit organization dedicated to preserving and restoring the Madrona Marsh. The Friends have been the backbone of the Madrona Marsh Preserve for the last thirty years. They are involved in creating, sponsoring, and conducting various activities to promote the preservation and restoration of the marsh, as well as service to the Nature Center. Members of FOMM and volunteers also assist in tours and projects by Torrance Parks and Recreation.

Tracy Drake is the Manager and Naturalist for the Madrona Marsh Preserve and Nature Center. She is in charge of the overall management of the Nature Center and Preserve, including all educational, research and outreach programs. She is also in charge of the Preserve's maintenance activities including irrigation, mowing and tree-trimming, and non-native plant removal and replacement.

John Dettle is the Engineering Manager of the Public Works Department, City of Torrance, and was the lead engineer on the Madrona Marsh Restoration and Enhancement Project.

Abigail Kent is the Marketing Director for the Modular Wetland Systems and oversees the marketing efforts for several environmental companies. Part of her time is spent researching and writing about innovative project designs implemented to enhance water quality.

References

City of Torrance. 2011. "Madrona Marsh Nature Center: Map of the Madrona Marsh." http://www.torranceca.gov/Parks/6642.htm.

Friends of Madrona Marsh. 2012. "Explore the Marsh." http://www.friendsofmadronamarsh.com/explore.html.

Vetiver Network International. "Contaminated Water and Land." http://www.vetiver.org/g/contaminated_water.htm