

Manmade Wetland at MCRD San Diego Recycles Wastewater

Water Conservation Possible with the Living Machine

LIKE MANY CITIES in the western part of the U.S., San Diego has increasingly been subject to water restrictions due to an ongoing shortage of water. This is becoming a serious issue in many parts of the world; one that could adversely affect the Navy's mission.

One promising new method for conserving water is currently being demonstrated at Marine Corps Recruit Depot (MCRD) San Diego. A manmade mini wetland system for the recycle and reuse of domestic (sewage) wastewater has been installed by personnel from the Naval Facilities Engineering Command (NAVFAC) Engineering and Expeditionary Warfare Center (EXWC) with sponsorship from the Environmental Security Technology Certification Program (ESTCP), and support from MCRD, San Diego and the Navy Environmental Sustainability Development to Integration (NESDI) program.

The wetland cells alternately fill and drain to replicate and accelerate the tidal action in an estuary but in a much smaller footprint. In comparison to conventional wastewater treatment technologies, this system offers reduced energy use and significant savings in both capital and lifecycle cost while achieving reuse water quality standards.

This ecosystem-based wastewater treatment system centers around a set of wetland modules which look like planter boxes, enhancing aesthetic amenity. Each cell module contains native plants with a bed of engineered gravel. The gravel supports a biofilm of beneficial bacteria and other microorganisms that use the waste as their food source, leaving only clean water for reuse. The water is contained beneath the gravel surface—all the casual observer sees are lush, vibrant plantings.

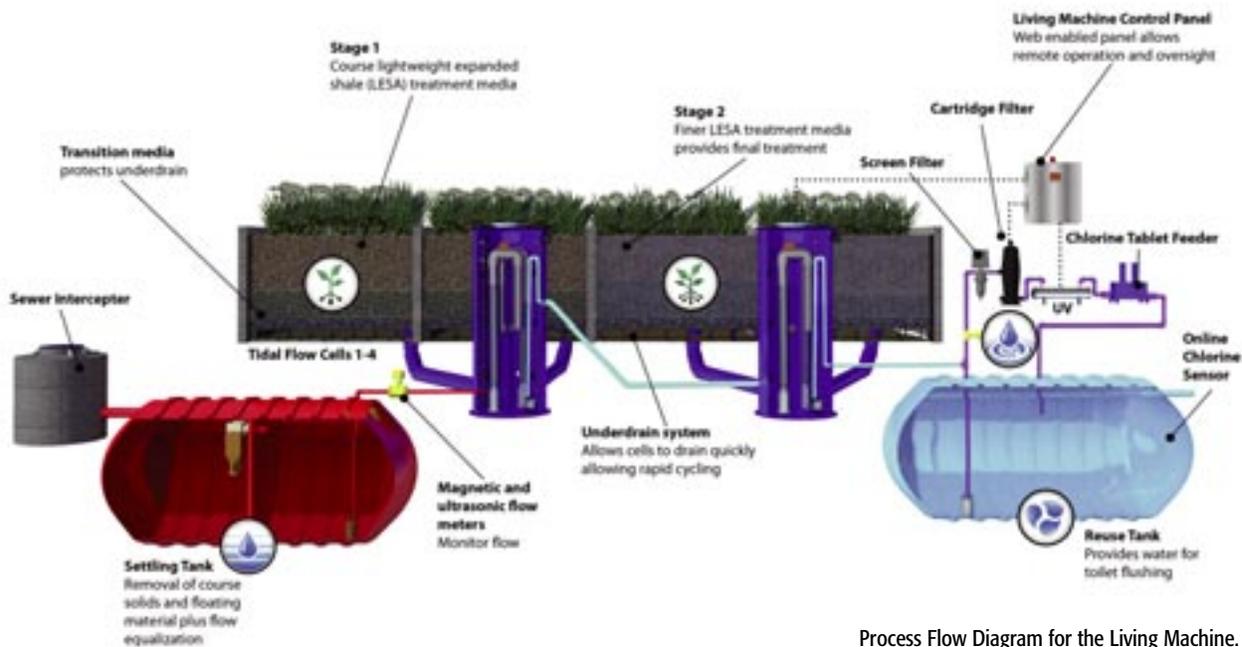
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How It Works

The Living Machine is based on tidal wetland technology consisting of treatment cells where plants are

The Living Machine uses tidal action to maintain an aerobic environment for the biofilm. Through the use of uniquely designed valves and pumps, gravity flow is maximized and energy consumption is minimized. The water level is raised and lowered about 12 times per day to create multiple tidal cycles. As the water level is lowered, air replaces the water and oxygenates the biofilm.



Process Flow Diagram for the Living Machine.

The primary contaminants removed by the wetland modules are suspended solids and dissolved nutrients like phosphorous and nitrogen. The wastewater first goes through a settling tank where the bulk of the solids are removed. Then it goes through treatment cells where most of the treatment occurs. It is then disinfected by ultraviolet light and again by chlorine in a two-stage disinfection step. Thus, the effluent from the treatment subsystem will have been treated to a tertiary level. The end product is colorless and odorless.

Though this is the first installation of a Living Machine on Department of Defense property, the system is being employed at several institutions around the country, including schools, government and municipal buildings, retail shopping centers, and even private housing developments. The U.S. General Services Administration is currently installing a highly-landscaped Living Machine at its Otay Mesa border crossing station. The range of uses for the treated water includes toilet flushing, cooling towers, and subsurface irrigation, as is the case at MCRD San Diego. While MCRD San Diego will eventually recycle 10,000 gallons of wastewater per day through its Living Machine, other users have recycled up to hundreds of thousands of gallons per day.

The Permitting Process

Once the Living Machine was successfully demonstrated, MCRD San Diego sought permitting to continue to provide

The Basics About the NESDI Program

THE NESDI PROGRAM seeks to provide solutions by demonstrating, validating and integrating innovative technologies, processes, materials, and filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Fleet readiness. The program accomplishes this mission through the evaluation of cost-effective technologies, processes, materials and knowledge that enhance environmental readiness of naval shore activities and ensure they can be integrated into weapons system acquisition programs.

The NESDI program is the Navy's environmental shoreside 6.4 Research, Development, Test and Evaluation program. Sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by NAVFAC, the program is the Navy's complement to the Department of Defense's ESTCP which conducts demonstration and validation of technologies important to the tri-Services, U.S. Environmental Protection Agency and Department of Energy.

For more information, visit the NESDI program web site at www.nesdi.navy.mil or contact Leslie Karr, the NESDI Program Manager at 805-982-1618, DSN: 551-1618 or leslie.karr@navy.mil.





Living Machine subsurface treatment cells/tanks installation.

subsurface irrigation at the base. For past installations of the Living Machine at other locations, it has been the duty of the local Water Quality Control Board and the local Board of Health to review such a system. The system is designed to meet potable water reuse (toilet flushing, laundry, etc.) and equipped with ultraviolet and chlorination disinfection to meet this strict requirements. However, since the treated wastewater for this application will be used for sub-terrain irrigation only, a “discharge to land” permit will be applicable. This type of permit is easier and

cheaper for MCRD San Diego to obtain and requires less wastewater monitoring.

NAVFAC EXWC is working with the base to prepare a Report of Waste Discharge (ROWD). The ROWD contains a complete technical description of the Living Machine’s operation, with the following sections:

- Wastewater Characterization (including flow rate, constituents and concentrations)
- Treatment System (including the process by which the wastewater is treated and the capacity of that system)
- Best Management Practices (This section is not applicable to the Living Machine since the system itself is a BMP.)
- Disposal Site (including a description of how and where the wastewater will be disposed)
- Groundwater (including a description of how the wastewater will interact with the groundwater and demonstration that the system will be in compliance with water quality criteria)

In turn, the San Diego Regional Water Quality Control Board will assess any impacts to the groundwater caused by the operation of the Living Machine. Then, the Board will impose Waste Discharge Requirements (WDR) on the operation, along with an annual fee. WDRs apply to discharges to land, as opposed to discharges to surface water. The purpose of WDRs is to protect the groundwater from contamination. Past WDRs for Living Machine installations in California have included waste discharge specifications, general prohibitions, additional system design and

The Living Machine ribbon cutting ceremony at MCRD San Diego with Brigadier General Daniel D. Yoo.





The Living Machine wastewater treatment system at MCRD San Diego.

operations specifications, and monitoring requirements.

An Environmental Protection Specialist at an installation may also expect to coordinate with their local Board of Health to ensure that people do not come into contact with unhealthful water.

Currently, MCRD San Diego's Living Machine is operating at about 7,000 gallons per day. Eventually, the system will be ramped up to 10,000 gallons per day. Long-term performance data is still being collected by the system's computer (including pH, oxygen, flow rates, and power consumption). The

treated water will be tested for total suspended solids, total dissolved solids, and eight other criteria, in line with California reuse requirements.

Cost Avoidance

Through the use of the Living Machine, MCRD will avoid the cost of obtaining potable water (\$5,022 per million gallons) and the cost of disposing of used water (\$5,347 per million gallons). The savings will be about \$39,000 per year.

The cost for a basic system similar in size to the one installed at MCRD is about \$250,000, resulting in a simple

payback period of 7.1 years. MCRD San Diego's cost includes an additional \$200,000 that ensured complete integration of the system with their landscape

Future work includes documenting the true water and cost savings of the Living Machine system at MCRD San Diego and disseminating the results. NAVFAC EXWC is also exploring a funding and contracting arrangement where an activity would receive a Living Machine system and then pay for it over time using the savings generated by the system. Currently, some energy conservation projects are funded this way.

The Living Machine system, along with the subsurface irrigation system are working together to help MCRD San Diego conserve water, save money, and enhance mission readiness. ⚓

Photos by Sonny Maga.



The lawn at MCRD San Diego will be irrigated by water from the Living Machine.

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