PROJECT TITLE: ECOSYSTEM SERVICE-BASED STRATEGIES FOR OPTIMIZING NATURAL TREATMENT OF STORMWATER IN SOUTHERN CALIFORNIA

OBJECTIVES: The long-term goal of this project is to develop a framework to incorporate the full value of natural treatment systems (NTS) into decision-making of urban planners, developers, and regulators. This will be achieved by developing tools to optimize the processes that improve water quality, enhance water supply, and provide important ecosystem services. Specific objectives of this proposal are to:

(1) Develop a template for quantifying water infiltration, contaminant removal, and water storage services of NTS in Los Angeles. We will evaluate categories of Los Angeles NTS and choose representative NTS for each for application of the template, using UC San Diego NTS as training sites. (2) Identify the market and non-market ecosystem services each NTS category provides and estimate potential rates of functions and processes based on existing data and the literature. (3) Estimate the value of services provided by each NTS category using economic tools. (4) Conduct cost-benefit analysis of each NTS category to compare to non-natural alternatives that treat stormwater in transit to the coastal ocean.

METHODOLOGY: A combination of data from our current USC Sea Grant project (*Cleaning urban stormwater on its way to the ocean: ecosystem services from natural treatment systems*), field work, literature reviews, and economic tools will be used to quantitatively assess water and ecosystem services provided by Los Angeles NTS.

Water infiltration rates will be measured directly while contaminant removal and water storage will be estimated using NTS attributes, e.g. age, size dimensions, design, plant species, soil invertebrates, surrounding land use, proximity and connectivity to the ocean. NTS characteristics will also be used, in combination with existing studies on relative efficiency of plant species for contaminant removal and water retention, to compile a list of ecosystem services and their potential rates of function. Other ecosystem services may include flood and erosion control, carbon sequestration, habitat support, pollination services, biodiversity support, and aesthetic value. We will use these estimated rates of provision to evaluate their context-dependence with regression and principle component analyses. UC San Diego NTS will serve as pilot studies.

We will rely on existing valuation estimates to assign preliminary economic values to identified services. Estimates from published studies will be transferred to a southern California context using benefit transfer methods, which will be supplemented by other nonmarket valuation techniques such as avoidance costs. Permitting, construction, maintenance, and other relevant costs will be recorded for each representative NTS to calculate their net present value. These values will be compared to non-natural alternatives that include non-biological NTS.

RATIONALE: There is urgent need for low energy, multi-disciplinary, and multi-benefit approaches to sustaining adequate water resources. Climate change is predicted to increase the frequency and intensity of southern California droughts, magnifying the California water crisis and allowing contaminants to accumulate. These contaminants can enter ponds, streams, wetlands, and the coastal ocean where they can cause waterborne illnesses and poison marine life.

Current approaches for improving water quality and enhancing water supply are energy and capital intensive. NTS are low-energy alternatives that are designed to use natural processes to remove contaminants (trace metals, organic compounds, and pathogens) and enhance infiltration to groundwater. They not only provide the above mentioned water services, but are also associated with a host of ecosystem services. These services create value for society and should be accounted for when making urban planning and regulation decisions. A substantial portion of southern California's water demand could be offset by identifying locations that would benefit the most from a specific category of NTS and employing a diverse array of capture and treatment systems across the urban landscape.

This proposal will focus on determining the efficiency of different NTS categories and the associated services they provide. Understanding the rate and value of these processes will identify which employed system will reap the most benefits under different contexts, resulting in a useful urban planning, development, and regulation tool.

DATA SHARING PLAN: Information generated by this project will be included on the Center for Marine Biodiversity and Conservation *Water* webpage that will be created during our current USC Sea Grant award to discuss water issues, sustainability, and resiliency. The types of data generated will be concerning which categories of NTS provide which services, and under what configurations and conditions; and which NTS category would be most beneficial at certain locations. The results of this project will be made freely available online, in terms of both access and content, to the general public.

The Southern California Coastal Water Research Project (SCCWRP) will help us communicate findings to their 14 member agencies (including the State Water Board, the Southern California Regional Boards, city and county municipal wastewater treatment plants, and regional flood control agencies (see letter from S. Weisberg). We envision doing this through distribution of printed materials, joining relevant meetings and public seminars in the SCWWRP series.

We plan to work with and communicate results to the UC San Diego Campus Storm Water Management Program to evaluate the effectiveness of on-campus NTS (see letter from K. O'Connell). This group has been pro-active in implementing a range of NTS (Figure 4). Initial meetings have shown tremendous interest in using UCSD NTS for research that tests and increases their effectiveness. The proposed work will provide opportunity for collaboration between varied disciplines and departments such as economics, urban planning, and engineering.