Office of Water Programs Graduate Research Fellowship Problem Statements

Seasonal Wet Pond Simulation Model

The seasonal wet pond is a stormwater BMP that past studies have shown to be an effective treatment BMP. A seasonal wet pond is a detention basin whose outlet is plugged at the beginning of the wet season so that water accumulates between storms. What isn't known is whether the pond would dry up between storms in California's dry climate. Maintaining the water level is important for both treatment and for keeping mosquito fish alive. A simulation model would be written, perhaps based on existing detention basin models developed in-house. The model would then be run with extended rainfall and evapotranspiration data sets from several different climates in the state (north and south coast and central valley). The goal would be to determine the technical feasibility and sizing parameters of seasonal wet ponds.

Potential advisor(s): Brian Currier, David Alderete, John Johnston

Depth Integrated Sampling

The majority of pollutants in stormwater are typically adsorbed to sediment particles. Based on their size, particles naturally distribute themselves vertically within the water column (i.e., smaller particles on top, larger particles on bottom). A typical stormwater sampling set up uses a single sampling location which is usually at the bottom of the flow stream. However, it has been shown in streams and large sewer pipes that depth integrated sampling reduces the variability in event mean concentrations (EMCs) because it captures all of the particle sizes, not just the size at a single point of intake within the water column. The purpose of this study is to identify the minimum depth needed for depth integrated sampling to be beneficial. The approach would likely be to run tests in the hydraulics laboratory using sediment in a flume, but could possibly be done using a numeric model. Depending on the results, a possible follow up project would develop a sampling mechanism for use in depth integrated shallow flows.

Potential advisor(s): Christian Carleton, Cristina Poindexter.

Compounding Variability in Hydrologic Calculations

Many of the deterministic equations and coefficients used in hydrology were developed empirically using statistical methods. Unfortunately, the variability associated with these equations and coefficients are typically not taken into account when calculating the result. Furthermore, because many of the variables used in the equations are not easily obtained, additional equations have been developed to estimate them, also using statistical methods. Currently, there is little discussion on the effect of using a variable that is determined by an equation as an input to another equation. This project will investigate how variability in hydrologic equations is compounded as multiple equations are used to determine a final estimated answer.

Potential advisor(s): Christian Carleton, Ramzi Mahmood

Evaluating Non-Standard Primary Measurement Devices for Stormwater Runoff

Measuring stormwater flows is problematic, especially at the scale needed to study LID BMPs that treat runoff from parking lots, buildings/houses, and roadways. Many of the flumes and weirs available were developed for use with larger flows that are more consistent, such as agricultural irrigation supply or water/wastewater treatment. However, stormwater flows from urban areas are very uneven, often going from no flow to peak flow within just a few minutes as a storm cloud moves overhead. This study will look at some non-standard primary measurement devices that may allow for measurements of widely varying flows that quickly change, such as long-throated flumes and compound flumes. This project will include testing the devices in the hydraulics laboratory to simulate field runoff conditions after a literature review of potential flumes.

Potential advisor(s): Christian Carleton, Christina Poindexter

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Vivianite Formation and its Interaction with Struvite Formation

Vivianite is a ferrous phosphate [$Fe_3(PO_4)_2 \cdot 8H_2O$] mineral that could form in sludge digesters if iron is available. In such conditions, the formation of vivianite may influence the formation of struvite [$MgNH_4PO_4 \cdot 6H_2O$]. OWP developed a software tool that computes the potential formation of struvite in wastewater treatment plants but it does not take vivianite formation into consideration as a reaction that would compete with the phosphate. The objective of this study is to investigate the equilibrium chemistry of vivianite and how it might affect the formation of struvite. The goal would be to create the equations for vivianite solubility and the necessary constants based on ionic strength, temperature, pH, and other variables. Running test cases using standard water equilibrium software is desired. Modifying the OWP software itself is not part of the project.

Potential advisor(s): Ramzi Mahmood, John Johnston

Financial Performance of Water Utilities in California

Water utilities and municipalities track revenues and expenses to evaluate finances. Public entities, including cities, special and municipal water districts, and others must publicly disclose this data, which can be helpful in understanding the financial capacity of water utilities to provide reliable services for residents. As part of a project with the Environmental Finance Center at Sacramento State (operated by OWP), the project will collect financial data for water utilities across California and develop metrics to evaluate performance over time. Fiscal indicators will be correlated against characteristics of the service populations of utilities (income, sociodemographic characteristics, and others) and correlated with water availability and drought. The study will develop benchmarks for utility fiscal standing in California and examine how hydrologic variability affects water utility finances.

Potential advisor(s): Maureen Kerner, Erik Porse, Ramzi Mahmood

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Developing an Open-Source High-Resolution Map of Impervious Surface Cover in California

Impervious surface cover in cities contributes to stormwater runoff. In developing local fees and taxes to fund stormwater management, some cities use impervious cover as a basis for developing rate structures, with properties having more impervious cover charged a higher amount. To develop rate structures, high-resolution imagery for impervious surface cover is important. While such data is highly useful for stormwater management and other urban planning applications, developing the data and tools to use it is often too expensive for local municipalities. This project will create a large-scale, open-source GIS layer of impervious surface cover for California. Using freely available imagery data and algorithms to classify imagery according to land cover functions, the project will quantify impervious surface cover at the property level for cities across California. The final products will be a report or journal article describing methods for the analysis and a web-based mapping platform with downloadable data to estimate impervious surface cover in a city.

Potential advisor(s): Maureen Kerner, Erik Porse, Ramzi Mahmood

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Extending a Tactical Green Infrastructure Tool

Tactical green infrastructure (TGI) is a term developed by landscape architect Kevin Perry to refer to small, simple stormwater BMPs installed on an ad hoc basis, often by members of the public, without a conventional design process. In practice, these are rain gardens that receive stormwater runoff from small catchment areas. While physically attractive and inexpensive, their stormwater treatment benefits are unknown. This project proposes to develop a tool that technical staff from stormwater agencies could use to assess the water quality benefits of as-built or proposed TGI projects. In a past fellowship project, rain garden BMPs were evaluated using EPA's Storm Water Management Model (SWMM) and historical rainfall to develop a simple methodology to quantify the treatment benefits due to infiltration. In those SWMM runs, impermeable and permeable catchment areas were routed separately to the rain garden. A few test runs produced significantly different results when the permeable and impermeable areas were placed in series such as gutters draining to lawns. The proposed tool would focus on quantifying treatment benefits of this widespread configuration. Among the factors considered would be the size of the BMP relative to its drainage area, the imperviousness fraction of the drainage area, soil characteristics, and characteristics of the permeable portion of the catchment (i.e., lawn vs. other types of landscape).

Potential advisor(s): Brian Currier, John Heltzel, Cristina Poindexter, John Johnston

Evaluating the Cost of Neighborhood-Scale Stormwater Capture and Use Compared to Low Impact Development

This project will help municipalities identify an appropriate mix of stormwater capture and low impact development to manage the volume of water necessary to comply with water quality objectives. The project participant will compile a representative selection of neighborhood-scale stormwater capture projects and a representative selection of street-level and parcel-scale low impact development and calculate the life-cycle cost per acre and cost per volume. As appropriate, conditions that substantially impact cost will be identified. Evaluating opportunistic low impact development that does not include costly features such as underdrains and municipal storm drainage tie-ins will be prioritized.

Potential advisors: Brian Currier, Christian Carleton, Dr. John Johnston

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Effectiveness of Polyacrylamide for Construction Site Runoff Management

Polyacrylamide is a non-ionic, water soluble, and biocompatible polymer that increases the viscosity of water and encourages the flocculation of particles in water. In stormwater applications at construction sites, it is used to reduce turbidity and sediment so that water leaving the site complies with discharge regulations. This project will compile a representative sample size of construction runoff scenarios found in the California State Water Resources Control Board's Stormwater Multiple Application and Report Tracking System (SMARTS) database and contact the qualified storm water pollution prevention plan (SWPPP) developer (QSD) and qualified SWPPP practitioner (QSP) on record to determine if polyacrylamide was used on the construction site. Project participants will perform statistical analysis on this data to determine if there was substantial improvement in water quality outcomes due to the use of polyacrylamide.

Potential advisors: Brian Currier, Christian Carleton, Dr. Amir Motlagh

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