Spring 2022

OWP Fellowship Problem Statements

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., with smaller particles on top and larger particles on bottom). A typical stormwater sampling setup 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 be to develop a sampling mechanism for use in depth-integrated shallow flows.

Potential advisor(s): Christian Carleton, Cristina Poindexter

Evaluating Primary Measurement Devices for Stormwater Runoff

Measuring stormwater flows is problematic, especially at the scale needed to study low impact development (LID) best management practices (BMPs) that treat runoff from parking lots, buildings/houses, and roadways. Many of the available flumes and weirs 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 nonstandard primary measurement devices, such as long-throated flumes and compound flumes, that may allow for measurements of widely varying flows that quickly change. This project will include testing the devices in the hydraulics laboratory to simulate field runoff conditions after engaging in a literature review of potential flumes.

Potential advisor(s): Christian Carleton, Cristina Poindexter

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. The project will include running test cases using standard water equilibrium software. Modifying the OWP software itself is not part of the project.

Potential advisor(s): Ramzi Mahmood, John Johnston

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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), this project will collect financial data from water utilities across California and develop metrics to evaluate performance over time. Fiscal indicators will be correlated with characteristics of the service populations of utilities (income, sociodemographic characteristics, and others) as well as 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

Calculating and Comparing the Cost per Volume of Small-Scale Low Impact Development and Larger Scale Capture and Use

This project will help municipalities identify an appropriate mix of stormwater capture and low impact development (LID) 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 as well as a representative selection of street-level and parcel-scale LID and calculate the life-cycle cost per acre and cost per volume. Conditions that substantially impact cost will be identified as appropriate. Evaluating opportunistic LID that does not include costly features such as underdrains and municipal storm drainage tie-ins will be prioritized. The fellow will have an opportunity to present results to local municipalities to support development of their LID implementation policies.

Potential advisors: Brian Currier, Christian Carleton, John Johnston

Effectiveness of Polyacrylamide for Construction Site Runoff Management

Polyacrylamide (PAM) 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, PAM is used to reduce turbidity and sediment so that water leaving the site complies with discharge regulations. This project will compile a representative sample 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 stormwater 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, Amir Motlagh, John Heltzel

Dissolution of Polyacrylamide

Polyacrylamide (PAM) 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 run a series of hydraulic experiments to better estimate the dissolution rate of PAM under a variety of different flow conditions.

Potential advisor(s): Brian Currier, Amir Motlagh, John Heltzel

Effects of Small-Scale Low Impact Development on Neighborhood-Scale Runoff Volumes

Two approaches to stormwater treatment include: (1) capture and reuse of stormwater in centralized neighborhood-scale facilities, and (2) street- and parcel-scale low impact development (LID) best management practices (BMPs). Small-scale BMPs that promote local infiltration reduce the volume of water available for more centralized capture and reuse. This affects the economics of these facilities in two ways. First, LID reduces the volume of water available for centralized collection, which means that these facilities can be reduced in size (less capital cost). Second, this same effect means that less stormwater is captured for reuse, which may represent a lost opportunity. To address this issue quantitatively, the relationships between various LID implementation schemes and watershed runoff volume that can be captured in a centralized system must be determined. In this project, the OWP fellow will model representative neighborhoods with different degrees of LID implementation. Both engineered facilities and informal BMPs built into the landscape will be examined. In addition, the relative effectiveness of LID in meeting permit requirements and water quality objectives will be assessed. The overall goal is to provide guidance to local governments in identifying appropriate and cost-efficient mixes of larger-scale stormwater capture and smaller-scale LID. This project could be addressed by more than one fellow.

Potential advisors: Brian Currier, Christian Carleton, John Johnston

Assessing the Benefits of a Permeable Paver BMP Installation

The City of Sacramento has been awarded a grant for infrastructure improvements in the Dixieanne neighborhood of Del Paso. Funded under this grant is paving of 3,000 feet of unimproved alleys with permeable interlocking concrete pavers. The fellow would assess the benefits for stormwater runoff achieved by this project. Of particular interest is estimating how much runoff would be diverted from the stormwater drainage system to groundwater recharge and the associated benefits to the urban forest. This would likely be approached through modeling using EPA SWMM for the stormwater runoff and possibly Modflow for groundwater movement. Additional issues to consider include: (1) whether best management practices (BMPs) such as porous pavement or pavement-edge bioswales would have advantages over the proposed concrete pavers, and (2) determining the marginal cost of the captured stormwater by comparing the project costs with the costs of a non-stormwater alternative (i.e., standard concrete or asphalt pavement). If the fellow is on board early enough in the process, there may be an opportunity to contribute to the project design.

Potential advisors: Brian Currier, Zoi Dokou, Christian Carleton, John Johnston