Water Quality and Discharge Monitoring to Enhance Community Involvement in the Sausal Creek Watershed, Oakland

Water Resources Experiential Learning for USDA Careers
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Acknowledgements

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EXECUTIVE SUMMARY

Over the past year I was part of the Water Resources Experiential Learning for USDA Careers program. I completed an internship with the Friends of Sausal Creek (FOSC). As a water resources intern I assisted FOSC with developing new curriculum, connect with schools and teachers around the Fruitvale neighborhood, and outline a citizen creek monitoring program. I built on an established FOSC water quality monitoring program to include streamflow measurement. This work was completed in collaboration with my project advisors and FOSC members and a detailed literature review informed field work carried out in the watershed to establish appropriate flow monitoring methodologies for citizen scientists. This work is designed to help create a sustainable volunteer creek monitoring effort within a broader education program to enhance community involvement.

INTRODUCTION

Urban creeks are vital in providing natural habitat and community amenity values through human access to scenic trails. Sausal Creek is located in Oakland, California and flows into the San Francisco Bay. The creek flows above ground through different neighborhoods with diverse communities. A majority of Sausal Creek was confined in a system of culverts or artificial channels over the last century. However, natural channel segments still exist in a limited area of open spaces and various different organizations are focused on managing the creek and its watershed. One entity that plays a significant role in managing the creek is the FOSC. This project helped to develop suggestions for FOSC to promote community engagement in the Sausal Creek Watershed.

PROJECT OBJECTIVES

Different programs implemented by FOSC promote watershed awareness through various volunteer established activities that include: bird monitoring, invasive species removal, native plant species restoration, rainbow trout monitoring, *E.coli*/coliform testing, conductivity monitoring, and educational programs designed to learn about local ecosystems both in the classroom and in the watershed. FOSC has historically focused most of its efforts in the upper watershed due to ease of accessibility to the creek and more spontaneous community engagement. Developing a citizen's creek monitoring program will facilitate the promotion of education programs in the lower watershed as well as providing a broader set of information on the characteristics and health of the creek. Students and volunteers would gain first hand experience in collecting data on the creek, storage of data, analysis of data to assess spatial and temporal patterns and variations, and of the characteristics of different neighborhoods the creek runs through.

The original goal of this experiential learning internship was to gain experience in the career of hydrology. Objectives of this project were designed to match the skills of a hydrologist. The first objective was to learn about taking water quality measurements while developing a water quality monitoring program that produces usable data. Establishing a streamflow measurement protocol would be the second objective. The last objective was to prepare a curriculum for an environmental education program and develop a map useful for Sausal Creek watershed management and restoration. This project subsequently shifted based on a needs assessment to focus principally on establishing a streamflow measurement protocols to connect it to the education program already developed by FOSC. The map was not completed during the term of this USDA grant but will be by June and will be included in the course work of GEOG 6899, part of the graduation requirements for the CSUEB master's program and supervised by Prof. Michael Lee, co-advisor for this grant.

PROJECT APPROACH

Each objective completed had a variety of different approaches implemented. Approaches included the following: literature review, data collection, shadowing FOSC members in different tasks, community engagement through spanish translations, and making contacts with school administrators within the watershed. Another approach was to research what FOSC has already established and what similar groups are doing in the realm of citizen science. Below I discuss the approaches to each objective discussed above in chronological order.

The first objective was to prepare a curriculum for an educational program to help students discover the relationship between the creek, the street and storm drain system, and the watershed, from the headwaters to the Bay. I was first tasked with reaching out to schools who already had a partnership with FOSC in some way to determine interest in taking part in FOSC's education program. The goal was to try and make connections with the schools located in the lower watershed. This required lesson plans to be developed that were site specific to Sausal Creek allowing students to work in the classroom and out in the creek. Lesson plans were developed with help from Michelle Krieg and example lessons from other organizations such as USGS were tailored to the environment found in the Sausal Creek Watershed. The lesson plans included themes in: 1) Mapping to help students discover the creek corridor in relation to their school, major streets, parks, and the BART station, 2) Birds of Prey to help students discover importance of birds of prey, and 3) Estuarine Wildlife to help students discover the San Francisco Bay Trail segment from Fruitvale Bridge Park to the High Street Bridge. The other objectives had similar approaches along with similar timelines to complete each task associated with it.

Establishing a water quality monitoring program first started with reviewing data with respect to location where samples were collected. A key aspect was to understand why the data was collected at the specific locations, what variables were being measured (pH, conductivity, water temperature, and *E. Coli*/coliform), and the frequency with which monitoring was taking place. Before going out into the field to measure different variables in the creek, it was necessary to learn how to use each piece of equipment to collect accurate and usable data. Meters available at the beginning of this project were a pH meter and a conductivity meter. With the budget allotted from this internship, a dissolved oxygen meter was purchased to enhance the water quality monitoring program thanks to matching funds provided by CSUEB through advisor Prof. Michael Lee. A goal of this project was to develop a set of simplified and easy-to-use manuals with photos on how to use each meter and explanations of FOSC standardized protocols for collecting data. These manuals would be aimed at students and adults inexperienced in water quality monitoring.

One thing that has been missing from creek monitoring has been streamflow data. There are a variety of ways to collect streamflow data. They vary in complexity, accuracy, resource intensity, and potential risk to personnel. Natural resource management agencies such as USGS measure stream flow using automated gaging stations and rating curves. Citizen science groups commonly use velocity and cross-sectional area measurements. For the urbanized Sausal Creek Watershed and FOSC citizen monitoring program, we are designing a discharge monitoring approach that uses culverts and drop structures within the stream system for high and medium flow stages combined with temporary weirs for low stages (Appendix C).

Streamflow measurement protocol was developed with the help of grant co-advisor Prof. Michael Lee, a literature review, and an assessment of the hydrological and physical characteristics of the creek. Without streamflow data, many water quality variables have little meaning because they cannot be used for mass balance or volumetric calculations. With most water quality variables collected as concentrations (i.e. mass or count per unit volume), making sense of them requires knowing the volume of flow at the time of sampling. A review of the literature revealed how a characteristic of urban creeks that has traditionally been considered an aesthetic and environmental negative, i.e. the presence of engineered structures such as culverts and weirs, can be used to the advantage of citizen creek monitoring. Such anthropogenic structures (culverts and weirs) provide a convenient, safe, and relatively accurate way to estimate and even to semi-continuously monitor streamflow. Multiple locations along the creek were identified (by hiking through the watershed and photo monitoring) as being suitable for co-opting for stream discharge estimates due to their ease of access by the public and the safe conditions offered for data collection at all flow stages. Each location was measured to attain dimensions of each structure. At high flow stages, discharge can be estimated at these structures visually by noting the depth of water flowing into the culvert or at the lip of the weir, since the form and size of the structure acts as a control that dictates a constant relationship between depth and discharge that has been empirically determined and published in the literature. At low-flows, temporary V-notch weirs fabricated by or for the volunteer monitoring team can be installed to physically capture and register the flow volumes, the design of the weir ensuring a constant depth-discharge relationship for the water flowing through for which predictive formulae have been derived in the field. Each of the locations identified as suitable for discharge measurement isolate different sub-areas of the watershed - the main tributaries and the upper, middle and lower portions of the main channel (Appendix A-C). They can be coupled with water quality measurements to provide snapshots in time and space of where water moving through the watershed originates spatially and a sense of water quality variations across those locations. The culverts and weirs used for discharge measurement requires that water depth staff gauges be fixed in the stream that are aligned to the lowest elevation of the culvert entrance or weir lip and/or depth markers can be stenciled onto the structures that allow a convenient visual reading of depth to be taken without the need to enter the water at medium and high flow stages. At low flow stages, the temporary V-notch weir structures would be used to provide a more accurate and reliable flow estimate. Once taken in the field, the depth of flow at the structure or the depth of flow through the V-notch weir need to be entered into a spreadsheet where the empirical formula applicable to it would estimate the discharge measurement. The spreadsheets for these structures have been developed as part of this project based on the literature research performed.

PROJECT OUTCOMES

Streamflow and water quality monitoring programs can be tailored to all audiences. They can be simplified to be understood by different ages of students and adults from different backgrounds. The new equipment (dissolved oxygen meter and weir) would allow for additional opportunities for citizens to be engaged in the monitoring program. Data collected can be used in classrooms to be applied as real life math examples. By allowing citizens to partake in data collection they can gain insight into what is occurring in their local watershed and develop a stronger connection and commitment to its stewardship.

Although Sausal Creek is located in an urban setting and generally has low flows, this project's field time coincided with multiple storms which significantly increased the discharge, flow velocity and hence the risk to monitors of physical injury from traditional instream flow measurements. This showed the value of having a methodology that could use visual or physical depth measurement to estimate discharge from safe locations. Moreover, at one point in the fieldwork period, there was a public health warning issued by the City of Oakland for citizens not to enter the creek due to storm-related sewage contamination, further highlighting the risk-avoidance and liability benefits of not having students or adult volunteers enter the creek for monitoring purposes. An additional observation was that the highly varied flow of the creek during the winter rainy season showed the need to have multiple outings scheduled over the course of the year to be able to measure streamflow multiple times and collect sufficient data to develop an accurate impression of the creek's hydrology. Since water quality and hydrology are closely connected, another observation was the importance of using this knowledge of the hydrological variation in time and space to design a water quality monitoring schedule that can yield relevant information for those interested in creek stewardship and in improving the creek for its environmental and amenity values.

CONCLUSIONS

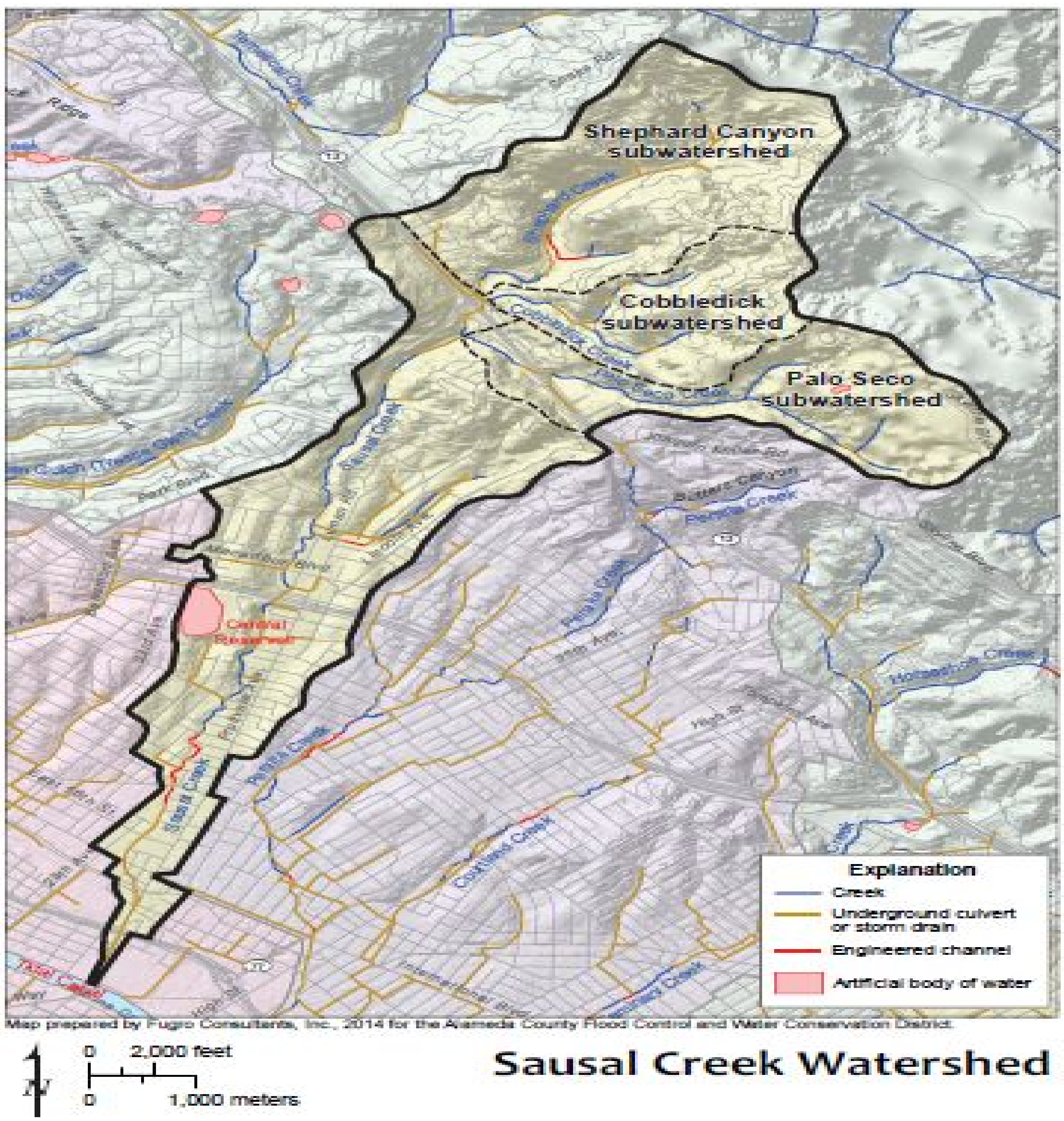
The FOSC staff and advisors have determined that in order to develop a sustainable citizen creek monitoring program for the Sausal Creek watershed that pairs water quality and stream discharge measurements, it is essential that it involve an education program. Such education programs are generally the foundation of citizen monitoring programs as they serve to engage stakeholders and enhance awareness and understanding of the creek by community members living in the watershed, particularly the youth component. An education program is key to fulfilling the goal of improving engagement in the lower watershed where the majority of the population, not least the school-age portion, resides.

Discussions with the FOSC board members at periodic meetings during the grant period indicated that there is great interest in developing a sediment monitoring component to the water quality monitoring given that the creek is home to native trout that are sensitive to sediment pollution and that erosion in the watershed headwaters and sediment input from urban runoff are major sources of particulate runoff and hence pollution into the San Francisco Bay. Further research should take place to determine suitable objectives and methodologies for such a sediment analysis. This analysis could be conducted in partnership with the two nearby universities, CSUEB and UC Berkeley, and preliminary discussions were held with Prof. Michael Lee and Prof. Matt Kondolf, respectively, about implementing such a partnership through their courses and student projects when they both return from spending the 2017-18 academic year in Europe (in Spain and France respectively). The sediment study would further improve the monitoring program and provide additional information on the watershed to help identify and understand issues including flooding, sewage leaks, and the effect of landslides. A sediment study would help to monitor what is flowing into the Oakland estuary and eventually into the San Francisco Bay, assisting in watershed management planning efforts designed to minimize sediment non-point source pollution.

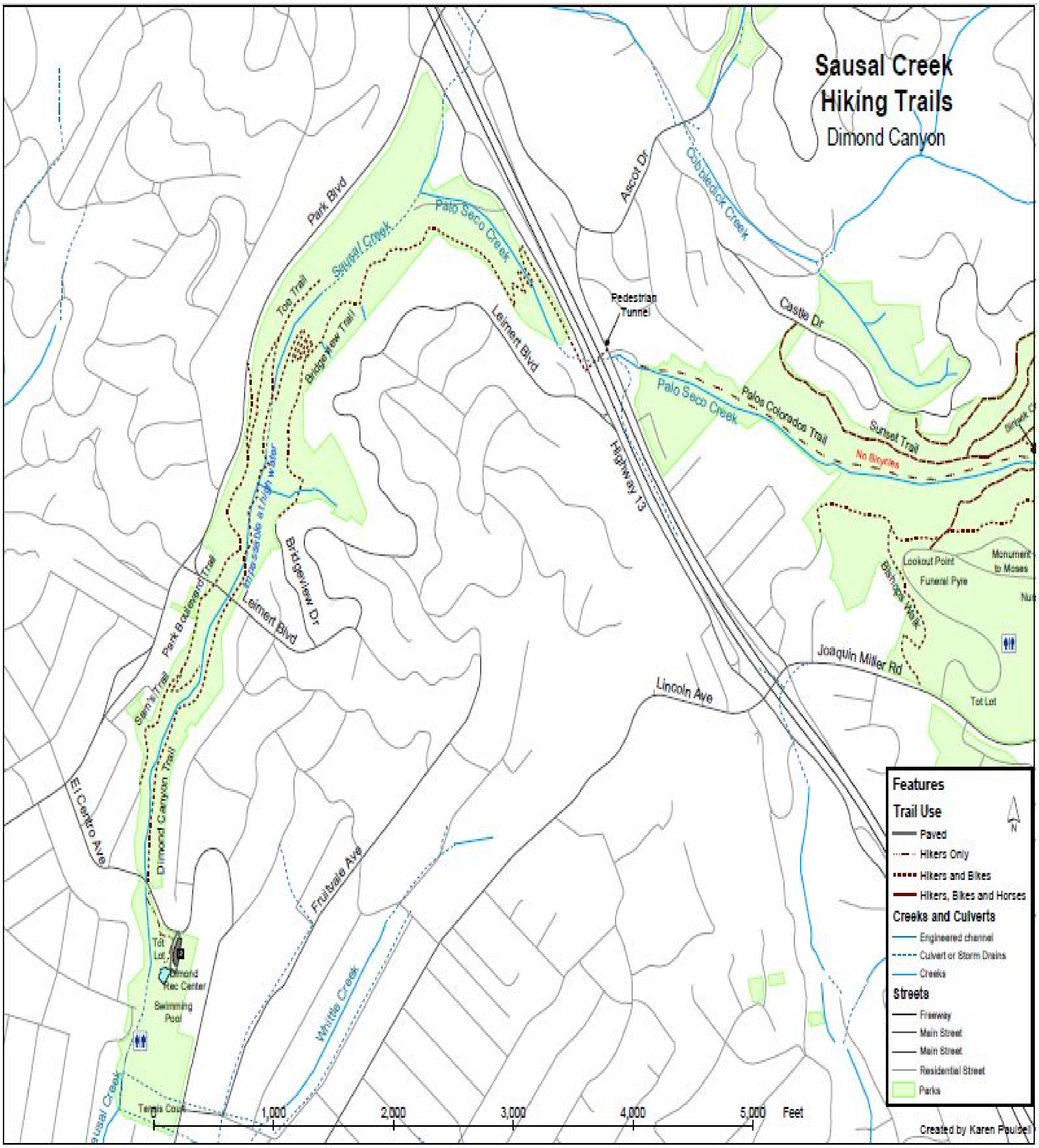
Throughout this project I had the chance to study different scientific methods of measuring streamflow with water quality and then applied my knowledge in the field. I learned that there are many important aspects to effective urban watershed management and hydrology is just one small part. With this experience I have gained the core skills that a water resource manager and hydrologist in the US Forest Service needs to be successful. Along with my project objectives, the partnership with FOSC gave me the opportunity to take part in vegetation monitoring, indexing of biological integrity, to learn about the intricacies of an urban watershed, and to better appreciate the challenges and opportunities associated with citizen-science and watershed stewardship.

APPENDIX

A. *Map of Sausal Creek Watershed* (Fugro Consultants, 2014)



*B. Map of Sausal Creek Upper Watershed (*Paulsell*)*



C. Anthropogenic Structures (culverts,weirs, and temporary weir)

Photo 2: Temporary wier

Photo 1: Culvert capturing flow from the Palo Seco

Photos 1 and 2 show the same culvert. Refer to either map above to locate Palo Seco Creek. This culvert is located where the creek flows south below Highway 13. Measuring flow here captures what is occurring in the upper watershed.

Photo 3: El Centro Culvert

Refer to the Sausal Creek Upper Watershed map to locate photo 3 on the north side of El Centro Ave along the Dimond Canyon trail. This location generates heavy pedestrian traffic making an ideal culvert for continuous monitoring. It captures the middle section of the watershed.

Photo 4: Drop structure/weir

Photo 4 is located downstream of the El Centro culvert at Barry Place. Barry Place is the last easily accessible location in the open channel. The flow measured here would be characterized as the lower watershed.

References:

Fugro Consultants (2014). *Sausal Creek Watershed,* Sausal Creek Watershed [map].Hayward, CA: Alameda County Flood Control and Water Conservation District.

Karen Paulsell. *Sausal Creek Hiking Trails Dimond Canyon,* Sausal Creek Watershed [map]. Sausal Creek Trails, Oakland, CA: Friends of Sausal Creek