Increasing Preparedness in the San Diego River Watershed for Potential Contamination Events

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Outline

- Background and motivation for the study
- Project objectives
- Results for each objective
- Conclusions
- Outputs

Microbial pollution of the San Diego River

- Human-associated fecal contaminants have been detected in the San Diego River during storm events
- Increased incidents of gastrointestinal illness and infections in surfers after rain events

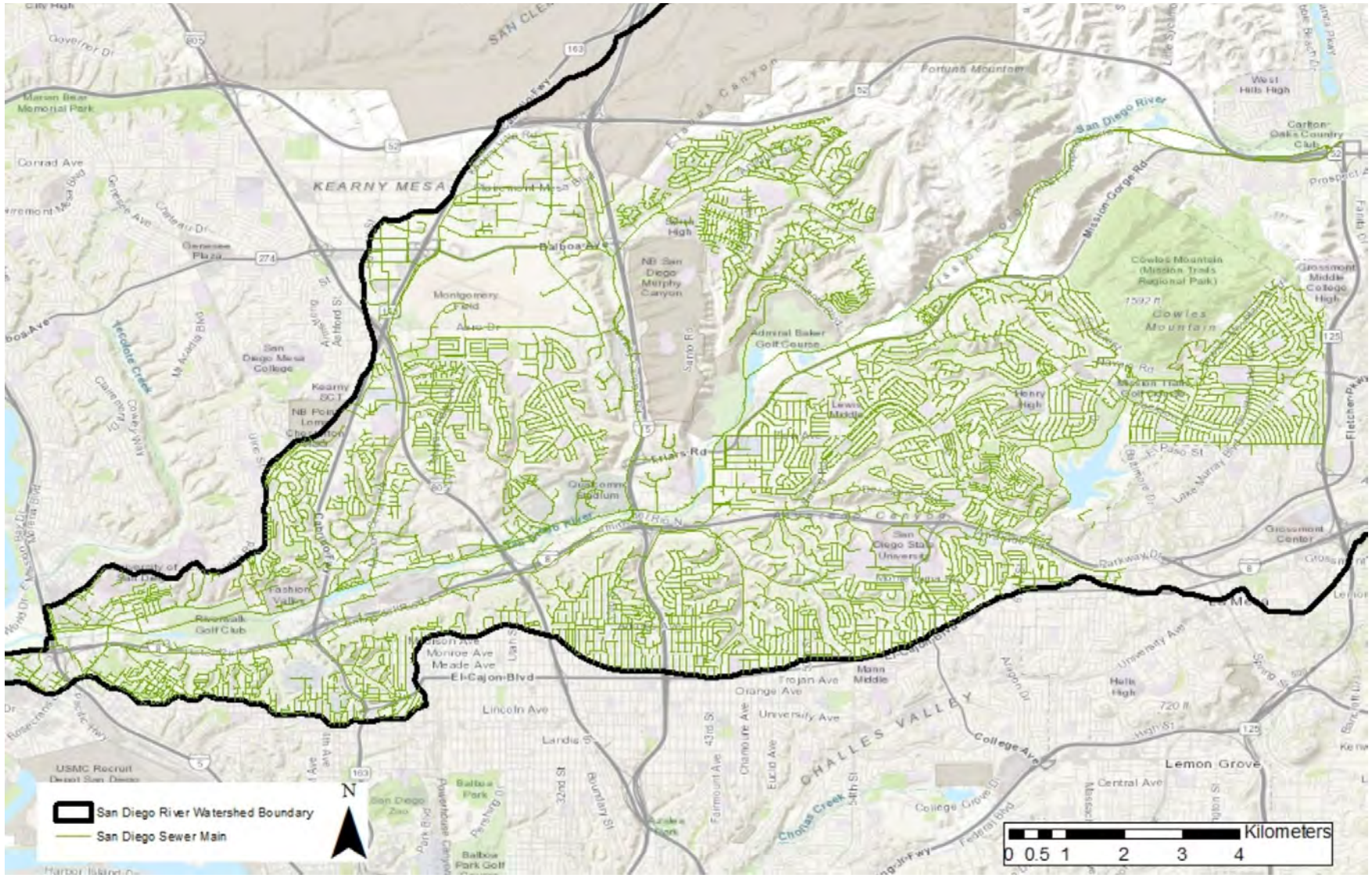
Storms and infrastructure

Sewer infrastructure becomes inundated; sanitary sewers overflow

Photo credit: Eric Frost, SDSU

Photo credit: Eric Frost, SDSU

Sewer infrastructure



Sanitation associated with encampments

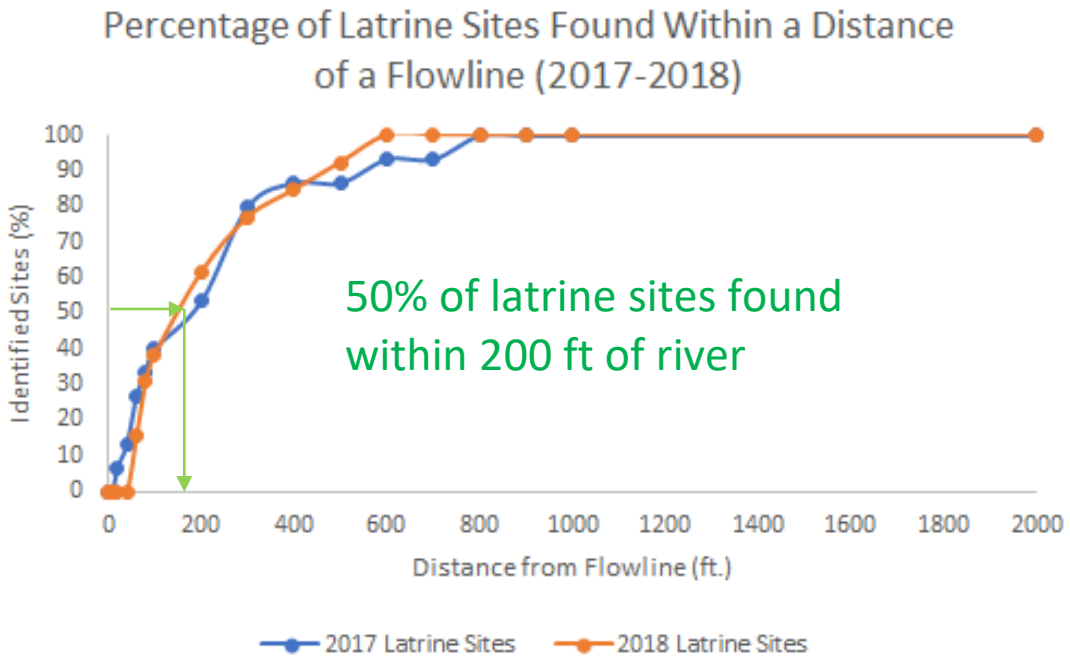
San Diegans experiencing unsheltered homelessness often **lack access to** basic **water, sanitation, and hygiene services**, and sometimes practice **open defecation**.

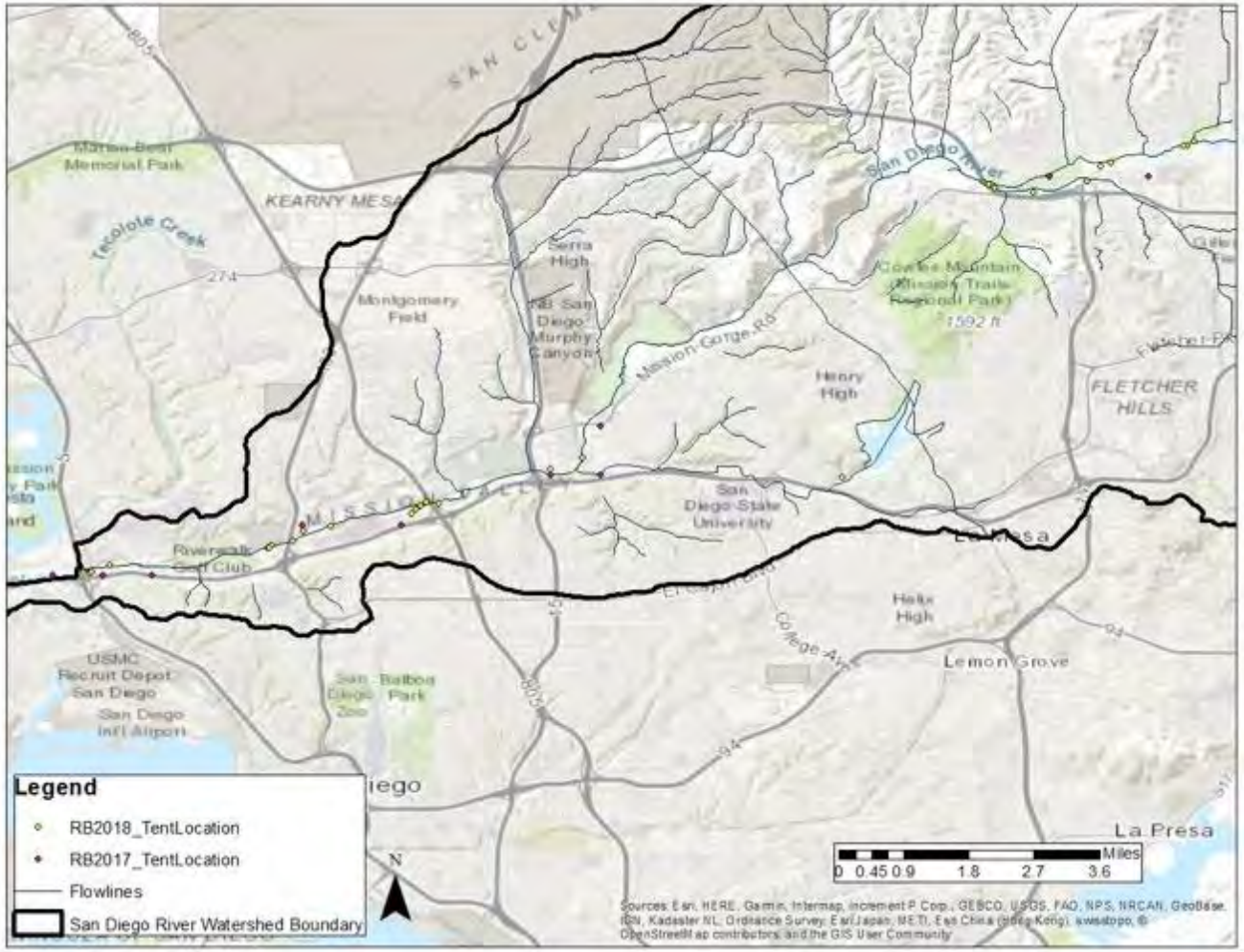
https://www.realchangenews.org/2017/11/15/one-man-s-quest-provide-sanitation-homeless-people-just-drop-bucket

https://en.wikipedia.org/wiki/Flying_toilet

Encampments: distance from river

- 2017 had 31 encampments, >39 tents, 15 “latrines”
- 2018 had 26 encampments, ~16 tents, 13 “latrines”





Interviews with people experiencing homelessness: Reported sanitation and hygiene practices

	River/canyon dwelling individuals (n=56)	Non-river dwelling individuals (n=28)	Full sample (n=84)
Use soap when able to wash hands	45 (80.4%)	21 (75%)	66 (78.6%)
Defecate in port-a-potty or public restroom	28 (50%)	14 (50%)	42 (50%)
Defecate at business establishment (e.g., gas station or coffee shop)	32 (57.1%)	20 (71.4%)	52 (61.9%)
Self or group practices open defecation	41 (73.2%)	11 (39.3%)	52 (62%)
Use river water for drinking	1 (1.8%)	0	1 (1.2%)
Use river water for non-drinking purposes	11 (19.6%)	2 (7.1%)	13 (15.5%)

Source: Welsh and Flanigan, 2019

Project Objectives

- Evaluate pollutant inputs **from homeless encampments** during **dry weather** conditions.
- Evaluate pollutants during and after **encampment cleanups**.
- Quantify the **leaching of pollutants** from wastewater-contaminated and feces-contaminated soils.
- Quantify changes in pollutant concentration and loadings **during storm events**.

Microbial markers

- *E. coli*
- Enterococci
- PhiX174
- HF183
- Pepper Mild Mottle Virus
- Hepatitis A Virus
- Norovirus
- *Campylobacter coli*
- *Campylobacter jejuni*

Chemical markers

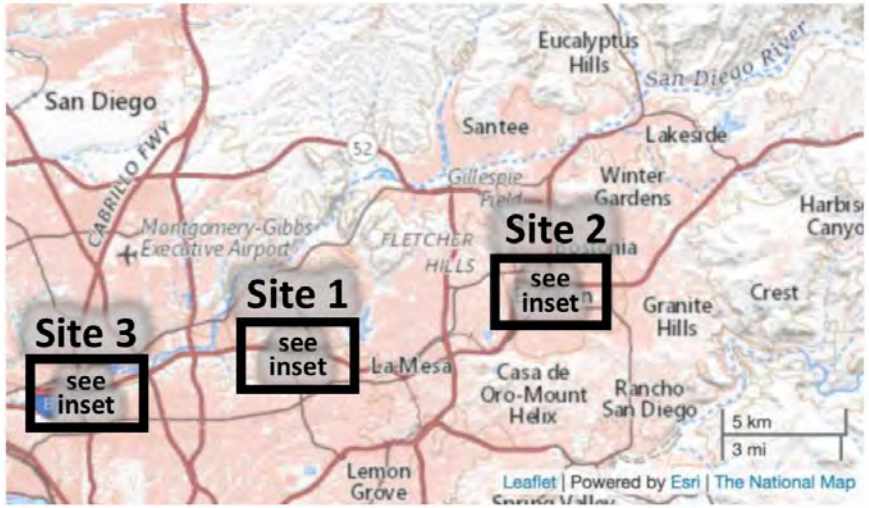
Caffeine: biodegradable

Sucralose: persistent

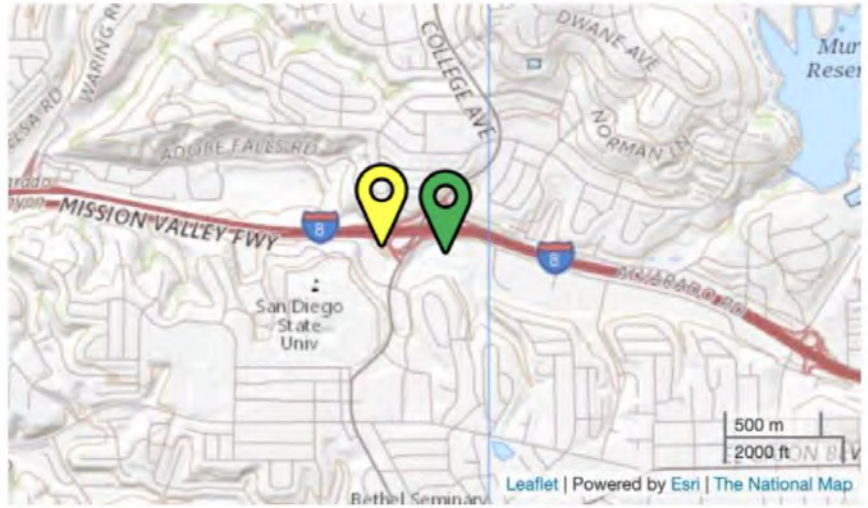
Objective 1

Measure pollution from homeless encampments during dry weather conditions

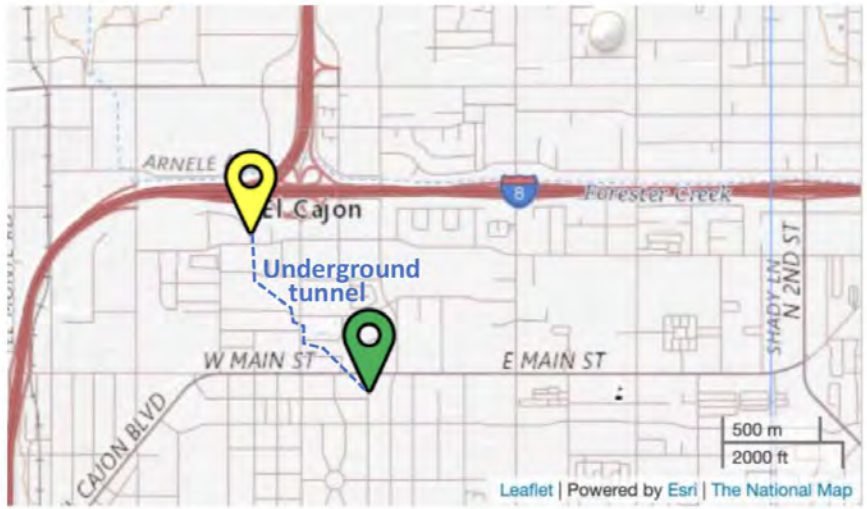
Overall Map of Sampling Sites



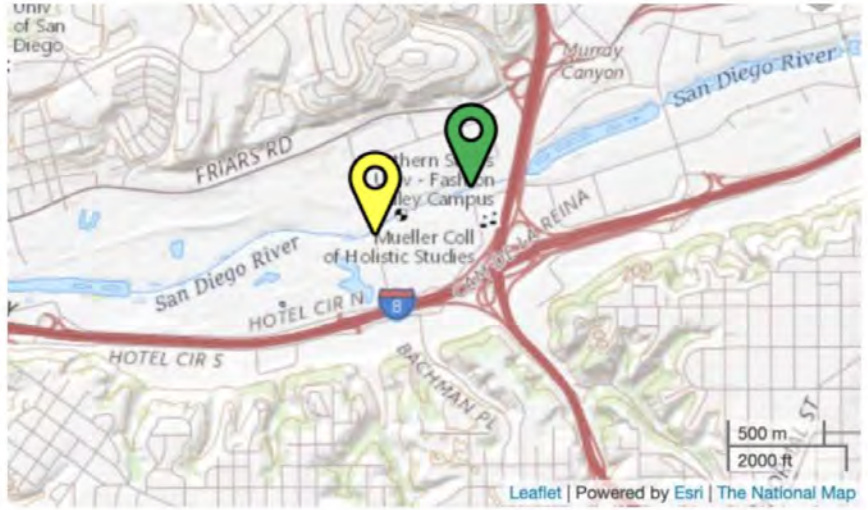
Inset for Site 1: Alvarado Creek



Inset for Site 2: Forester Channel



Inset for Site 3: Fashion Valley



Upstream sample location

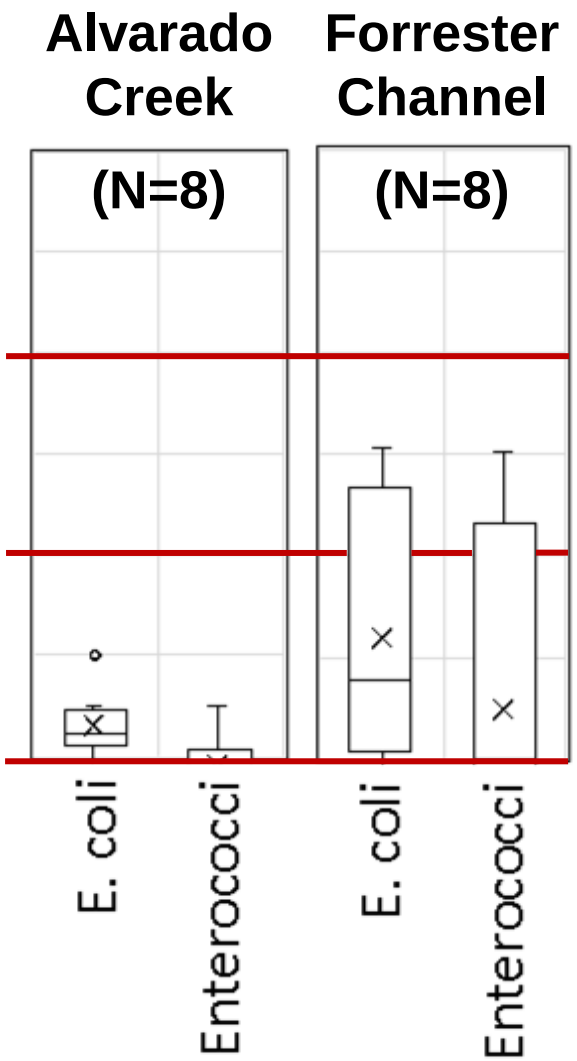
Downstream sample location

Bacterial Fecal Indicators

Concentrations were 100x higher downstream

Concentrations were 10x higher downstream

Concentrations did not change

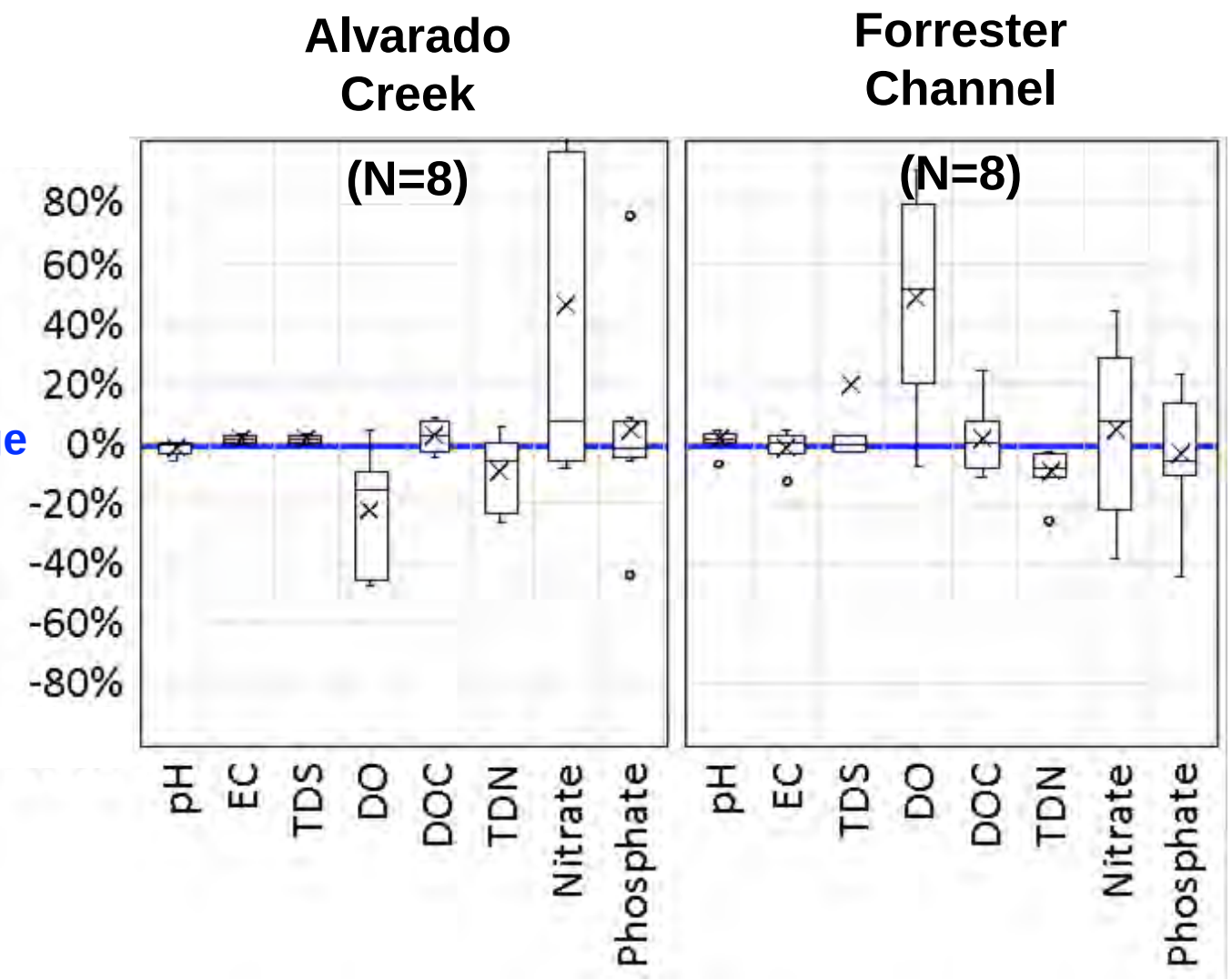


General Water Quality Indicators

Higher downstream from encampment

No change

Lower downstream from encampment



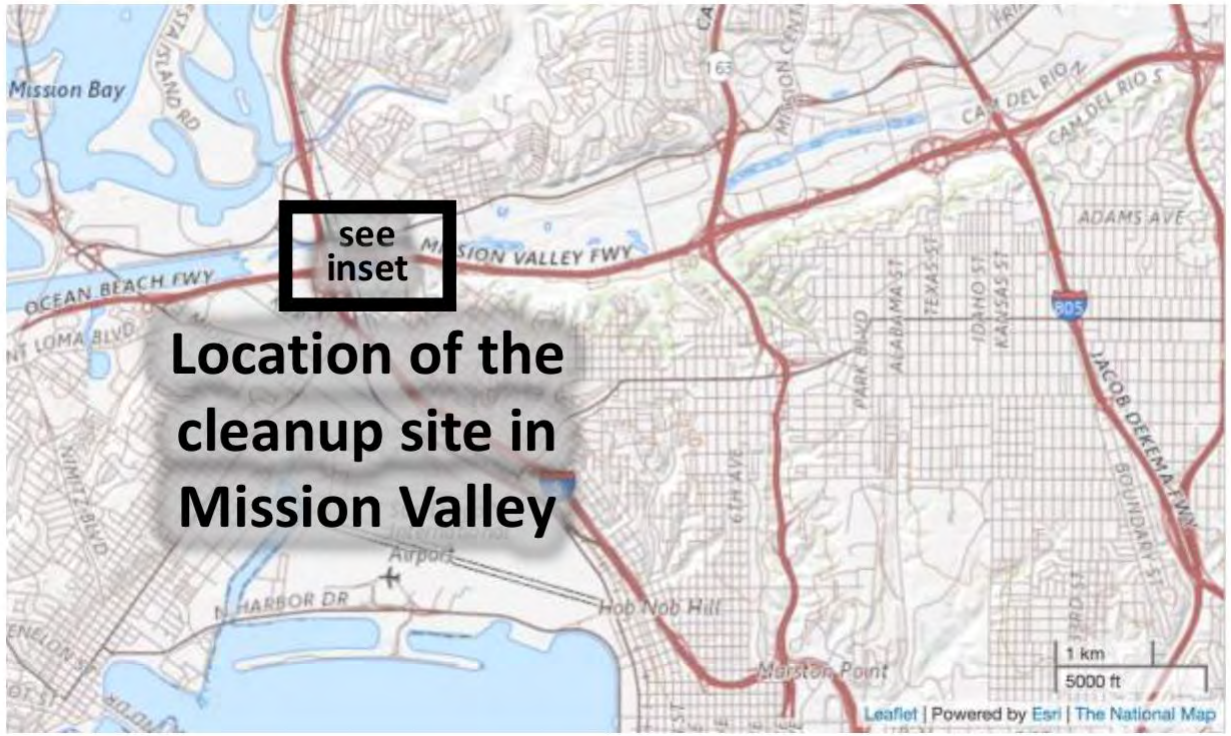
We analyzed upstream and downstream samples for bacterial fecal indicators, HF183, caffeine, sucralose, and a variety of other general water quality indicators.

"Encampments did not have a significant influence on the microbial pollution of surface waters during dry weather."

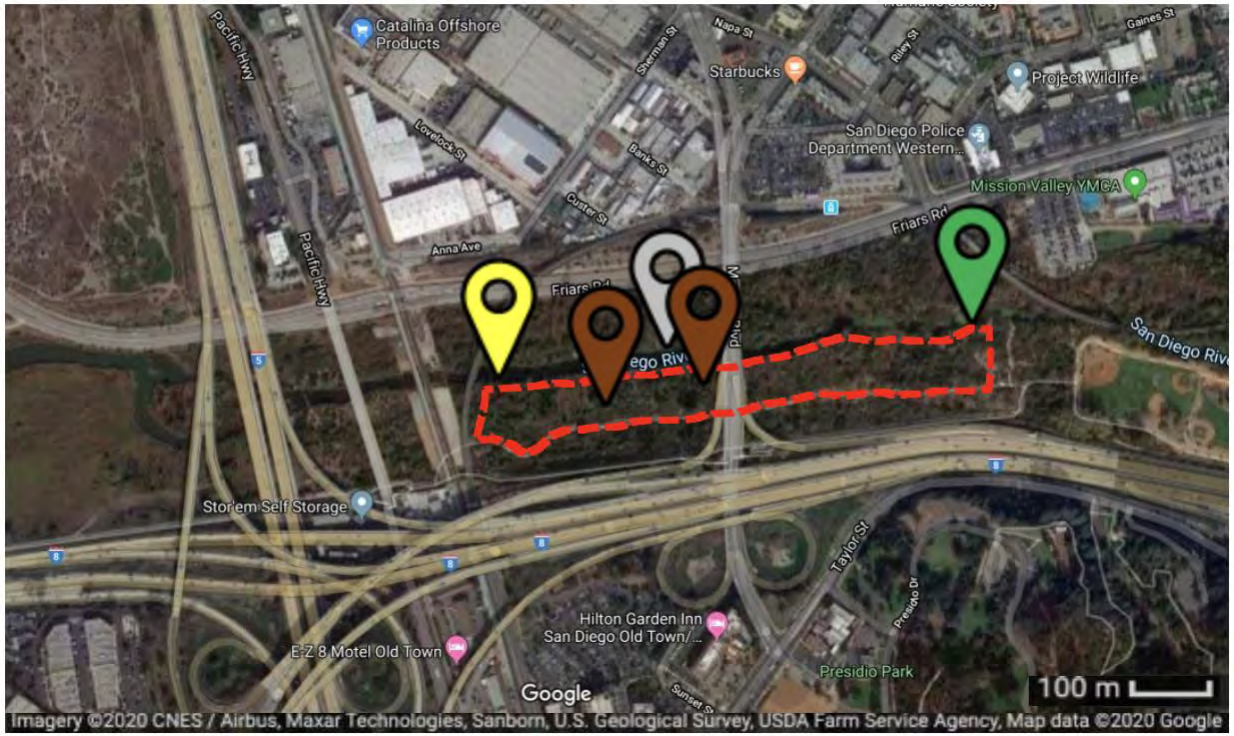
Objective 2/3

Evaluate pollution in water and soils during and after riverbank cleanup activities

Overall Map: Location of the Cleanup Site



Inset: Sampling Locations at Cleanup Site



Location of soil and fecal samples

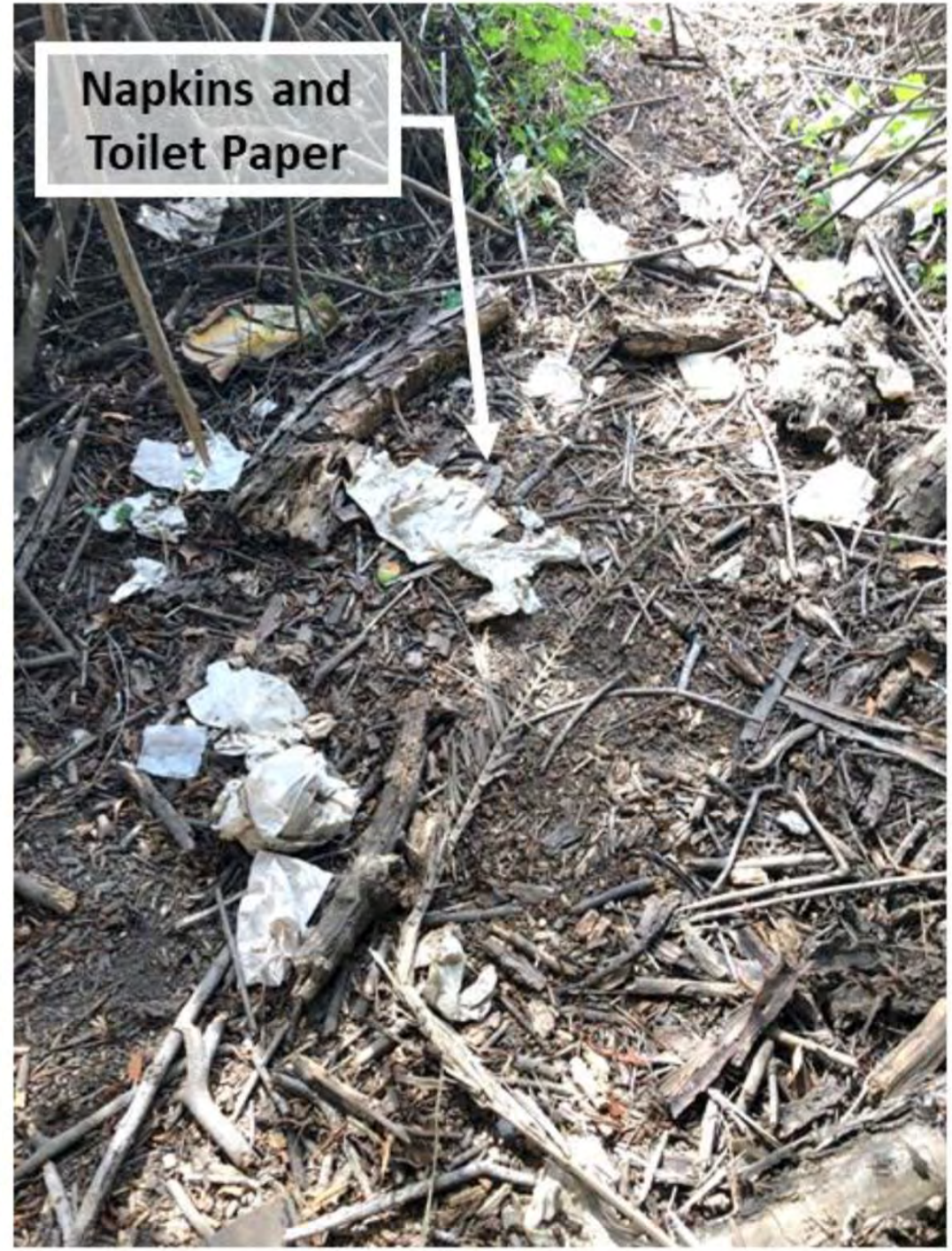
Downstream water sample location

Adjacent water sample location

Upstream water sample location

Approximate delineation of the area being cleaned by volunteers from the San Diego River Park Foundation


Evidence of Open Defecation


Napkins and Toilet Paper

We analyzed soil and water samples at a former homeless encampment near areas with open defecation during and after a cleanup event

“Encampments did result in microbial contamination of soils at sites with open defecation, even after site cleanup.”

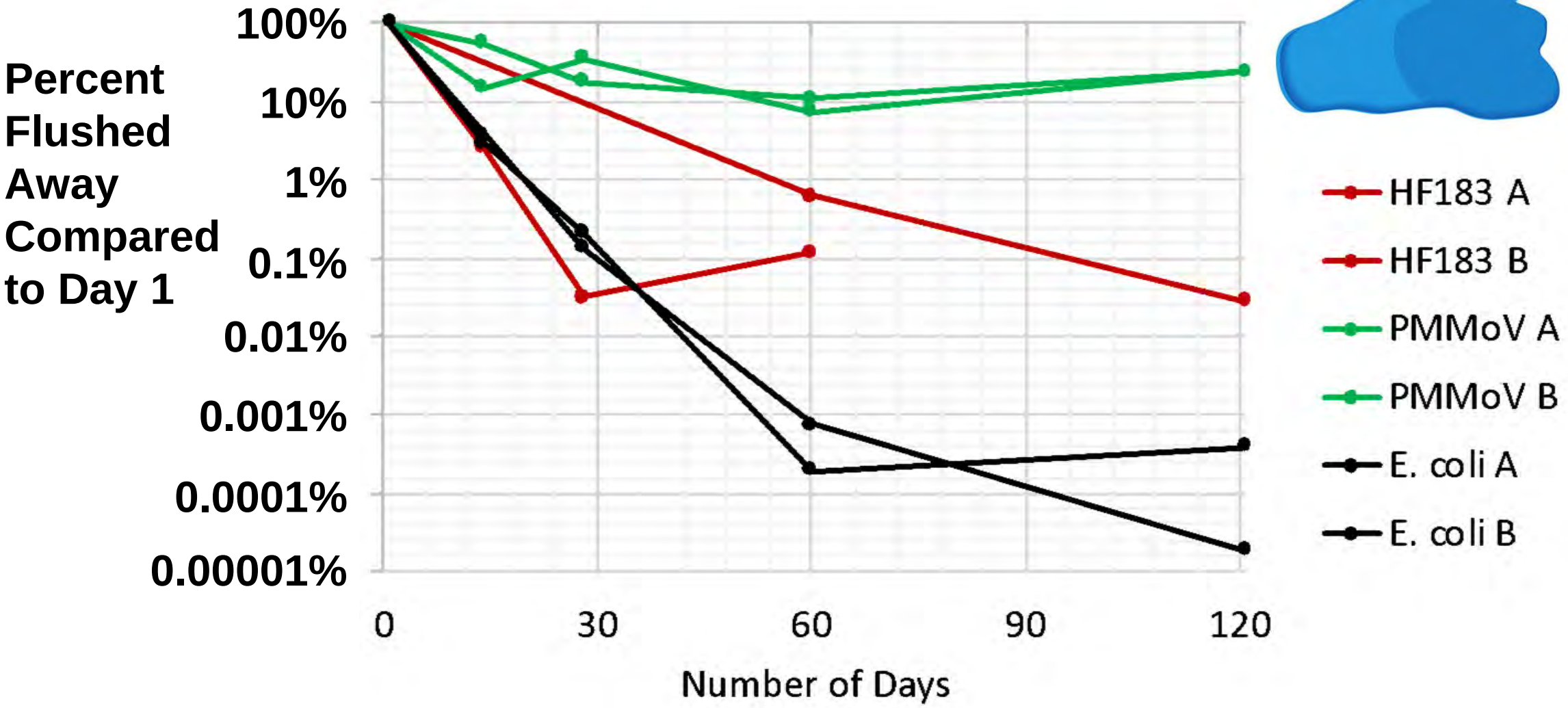
Objective 4

Evaluate the leaching of pollutants from contaminated soils

We simulated sewer exfiltration by spiking clean soil with wastewater, and tested the persistence of microbial pollutants when flushed with rainwater

"Wastewater-spiked soils continued to be a source of *E. coli*, HF183, and PMMoV even after 4 months."

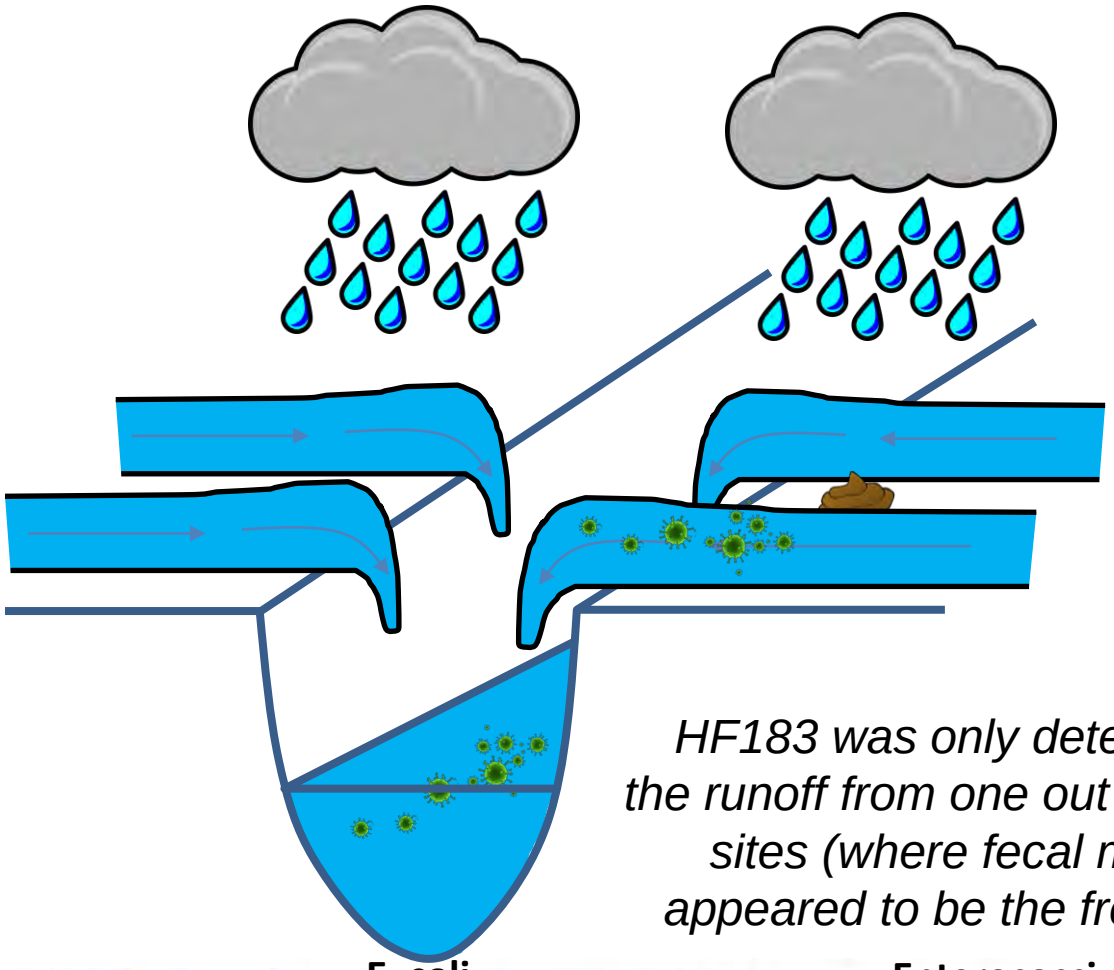
Persistence of viruses/bacteria flushed away from soil after simulated sewer exfiltration



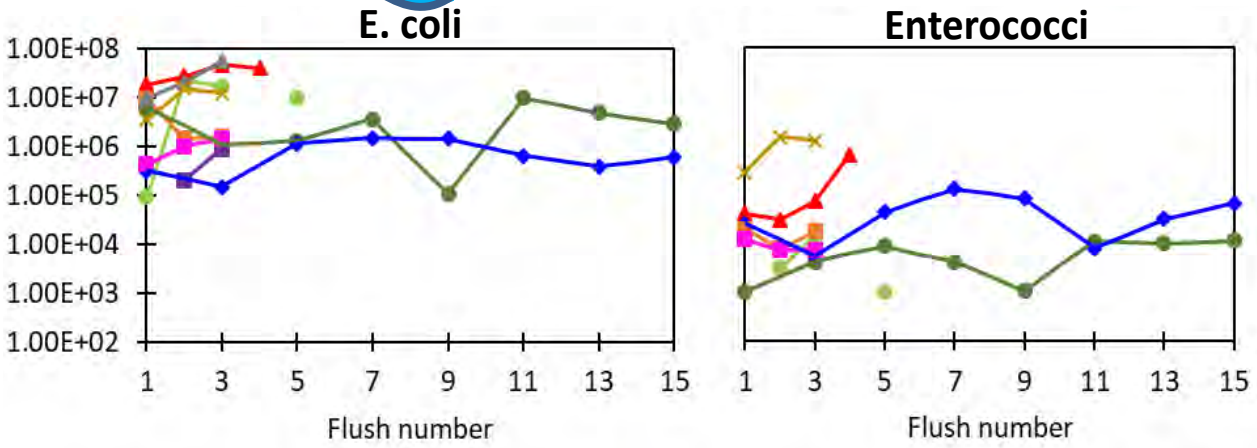

Experimental Set-Up
Evidence of Open Defecation


Napkins and Toilet Paper


Site 4
RE 8
Site 3
RE 5-6
Site 2
RE 3-4
Site 1
RE 1-2, 7, 9
Santee
Tierrasanta Open Space
Mission Gorge
Fanita Dr
Gillespie Field
San Carlos
Fletcher Hills
Serra Mesa
Linda Vista
Mission Bay Park
Mission Valley
Friars Rd
Normal Heights
El Cajon Blvd
La Mesa
Challes Valley
Hillcrest
North Park
Casa de Oro
Lemon Grove
Bancroft Dr
Kumeyaay Hwy
Murphy Canyon
52
15
0 1 2mi



HF183 was only detected in the runoff from one out of nine sites (where fecal material appeared to be the freshest)



Areas of soil with evidence of open defecation were flushed with synthetic rainwater, and the runoff was analyzed

“Caffeine and HF183 have high concentrations in untreated wastewater but are almost undetectable in stormwater runoff from soil with open defecation”

Objective 5

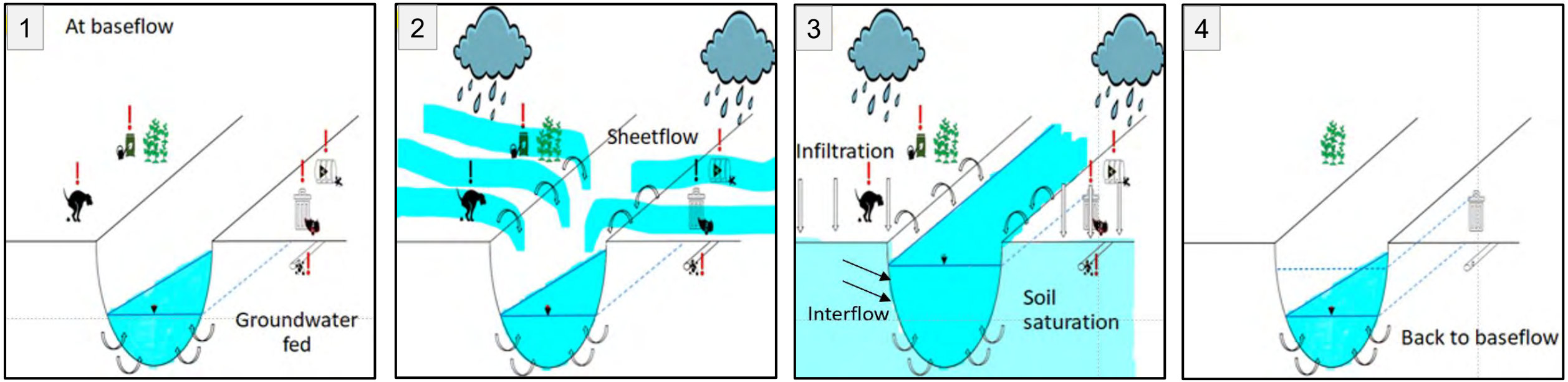
Quantify changes in pollutant concentrations and loadings during storm events

Photo credit: Eric Frost, SDSU

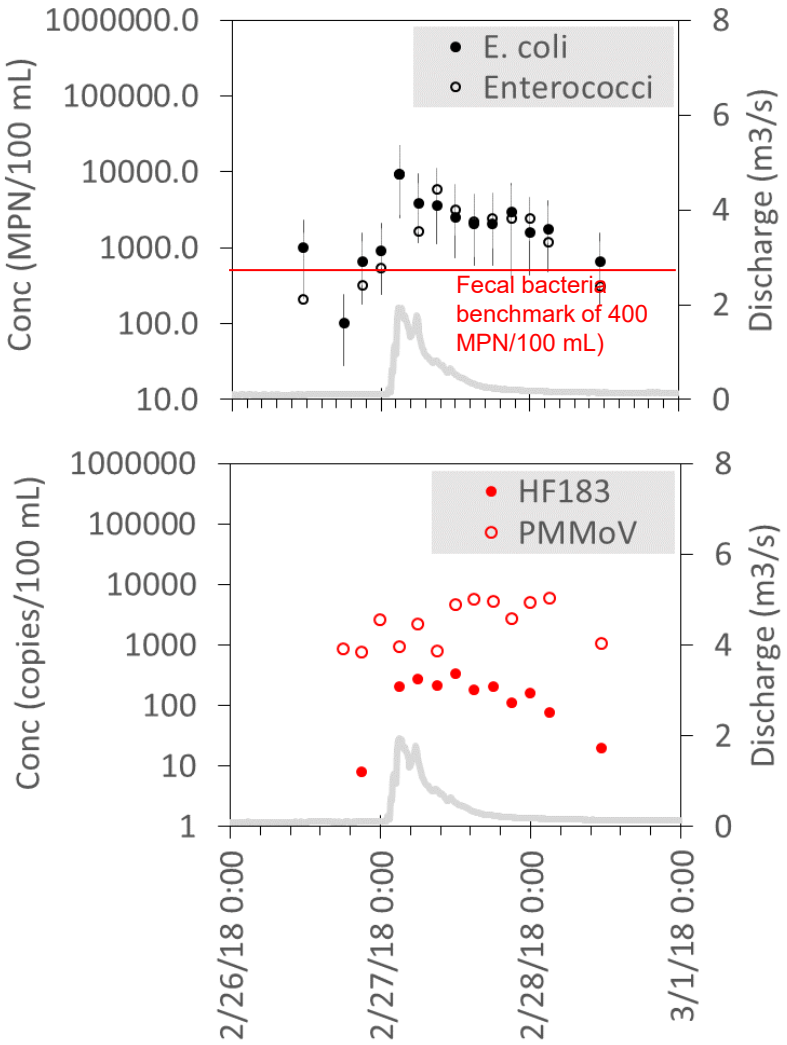
We measured concentrations of chemical and microbial pollutants in the San Diego River and two tributaries during storm events at 1 to 3 hr increments

Chemical and bacterial markers reveal that untreated wastewater is a major source of San Diego River pollution.

Storm Hydrology



Microbial markers during storms

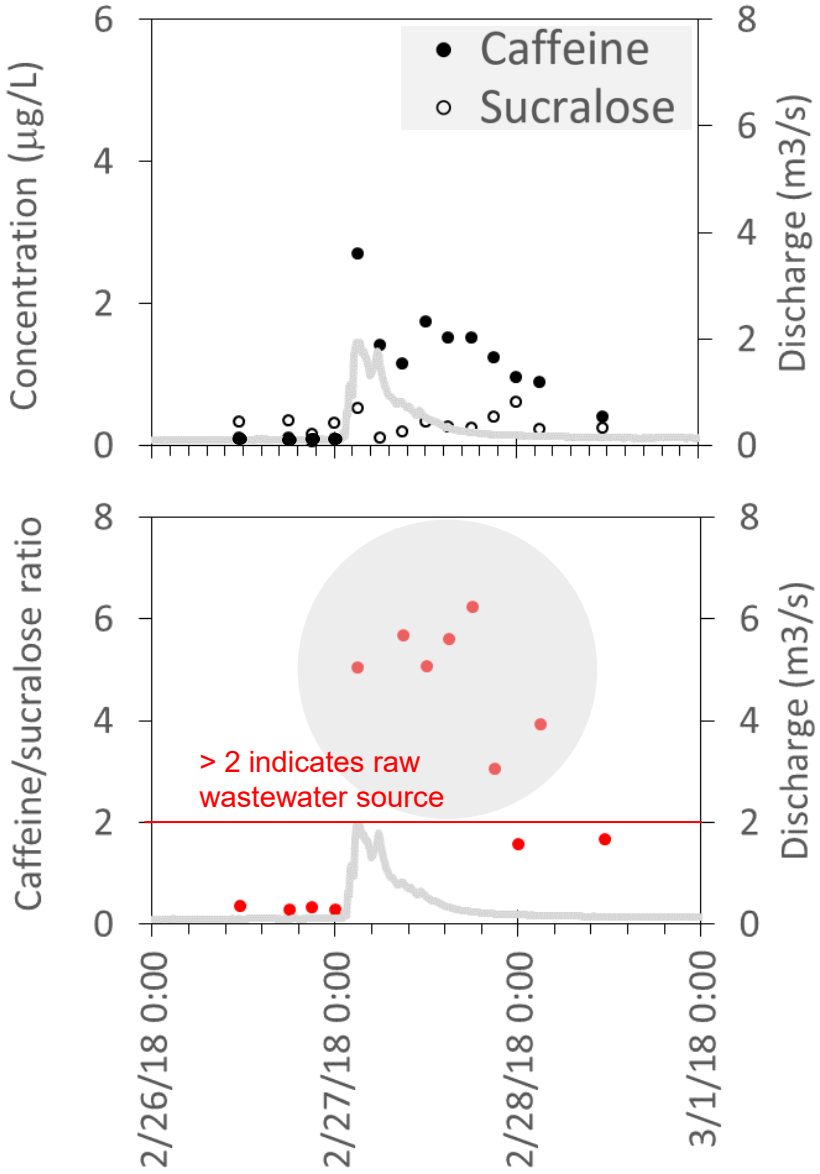


- Fecal indicator bacteria (*E. coli* and enterococci) exceeded benchmarks
- Human fecal markers were detected in **all** storms.
- **Hepatitis A was NOT detected** but other human pathogens were detected in **some** storms.
-

Untreated wastewater

Open defecation

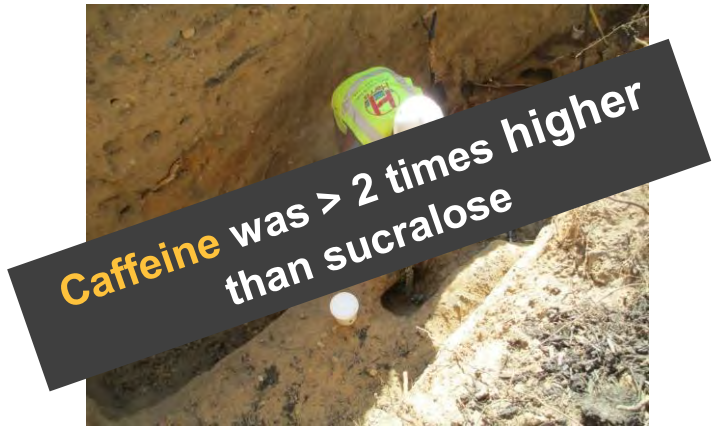
Chemical markers during storms



During and after peak flow:

- Caffeine concentrations increased and exceeded 1 – 5 µg/L; sucralose remained low, at 0.2 to 1.0 µg/L
- Caffeine/sucralose ratio had raw sewage signature

Untreated wastewater



Open defecation

Conclusions

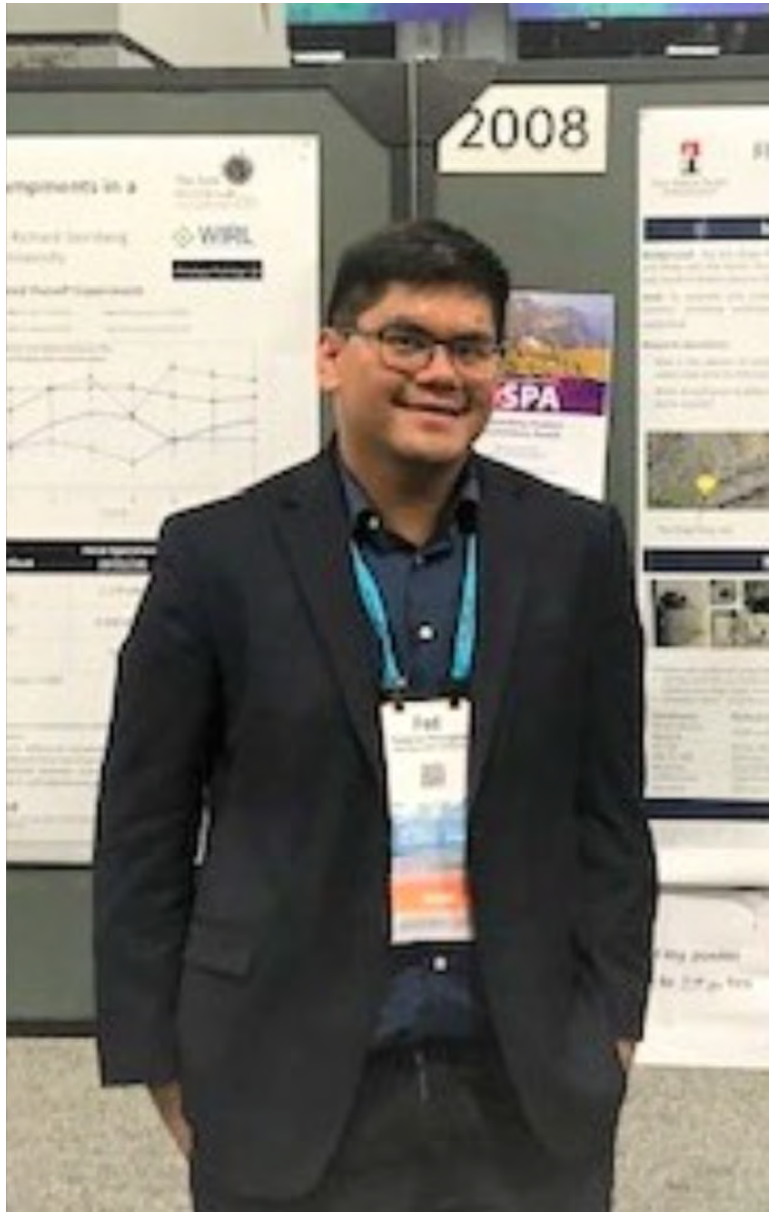
- There was **no** strong evidence that homeless encampments are causing increases in the concentration of pollutants in water during dry weather conditions.
- Soils at homeless encampment cleanup sites did have fecal contamination during and after cleanup.
- Despite no evidence of inputs into water during dry conditions, individuals living near the river should have adequate sanitation.

Conclusions

- Wastewater spills in soils are sources of bacteria and viruses even in flushed soils and after as long as 4 months.
- Evidence from chemical and bacterial markers suggests that untreated wastewater is the **main source** of microbial contamination during storm events.
- Efforts to repair damaged/aged sewers are needed.

Outputs

- MS Theses
  - Pinongcos - *Anthropogenic sources of contamination in the San Diego River during storm events*
  - Calderon - *An evaluation of microbial source tracking markers for human-associated fecal contamination to a river from non-point sources*
  - Garcia - *An evaluation of microbial pollutants in a watershed with homeless encampments: dry weather conditions*
- Presentations
  - Quarterly updates to SDRC and Water Board
  - Conference presentations (2018 AGU, 2019 SDSU Student Research Symposium, 2019 NMC Denver, 2019 AEESP, 2019 ACS)
- Technical Reports
- Executive Summary
- Final report – at end of project (May 2020)



Acknowledgements

Funding and support from:

- San Diego River Conservancy
- California State Water Resources Control Board, Region 9
- San Diego State University Division of Graduate Affairs
- Councilmember Scott Sherman (District 7), City of San Diego
- Councilmember Lori Zapf (District 2), City of San Diego

Assistance from:

- The San Diego River Park Foundation
- The City of El Cajon
- J. Calderon, F. Pinongcos, M. Garcia, M. Gil, H. Bertsch, J. Monroe, C. Batikian, B. Carlson, C. Carr, S. Chao, F. Espinosa, D. Garcia, A. Gaunin, C. Graves, A. Jaramillo, L. Mendoza, I. Musaazi, K. O'Marah, T. Sadeque, J. Simmons, A. Wong, F. Zhao, A. Sanchez, A. Kinney, E. Mikita, E. Winterton and many other SDSU students for field and laboratory analytical support

Photo credit: Fed Pinongcos, SDSU