

Coupling Benefits to Water Quantity and Quality through Stormwater Collection Linked to Managed Recharge

Galen Gorski, Hannah Dailey and Andrew Fisher

University of California, Santa Cruz



16th Biennial Symposium on
Managed Aquifer Recharge
March 7th, 2017

16th BIENNIAL SYMPOSIUM
ON MANAGED AQUIFER RECHARGE
BSMAR 16
RECHARGE
TO THE RESCUE!



Talk Outline

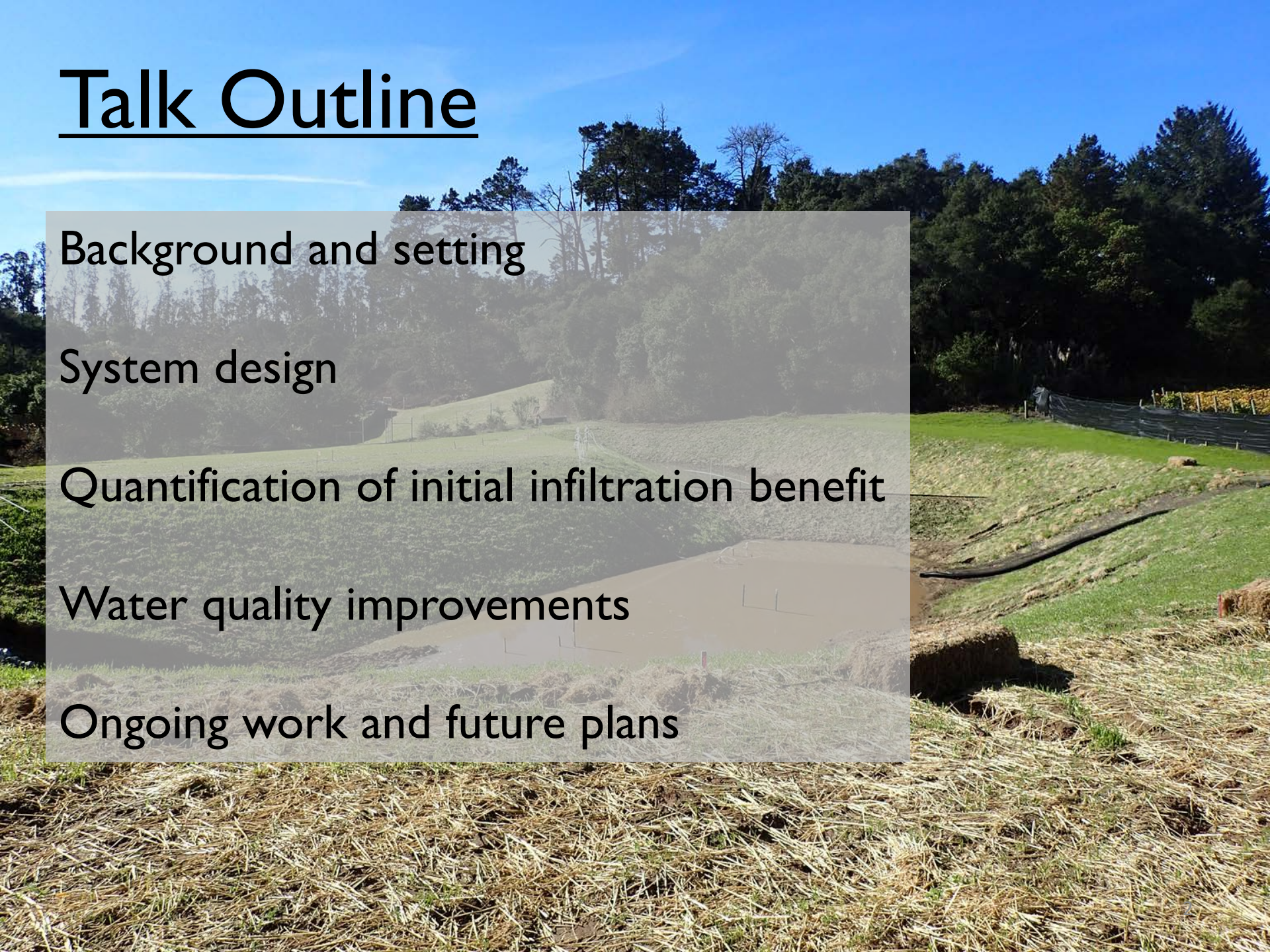
Background and setting

System design

Quantification of initial infiltration benefit

Water quality improvements

Ongoing work and future plans



Talk Outline

Background and setting

System design

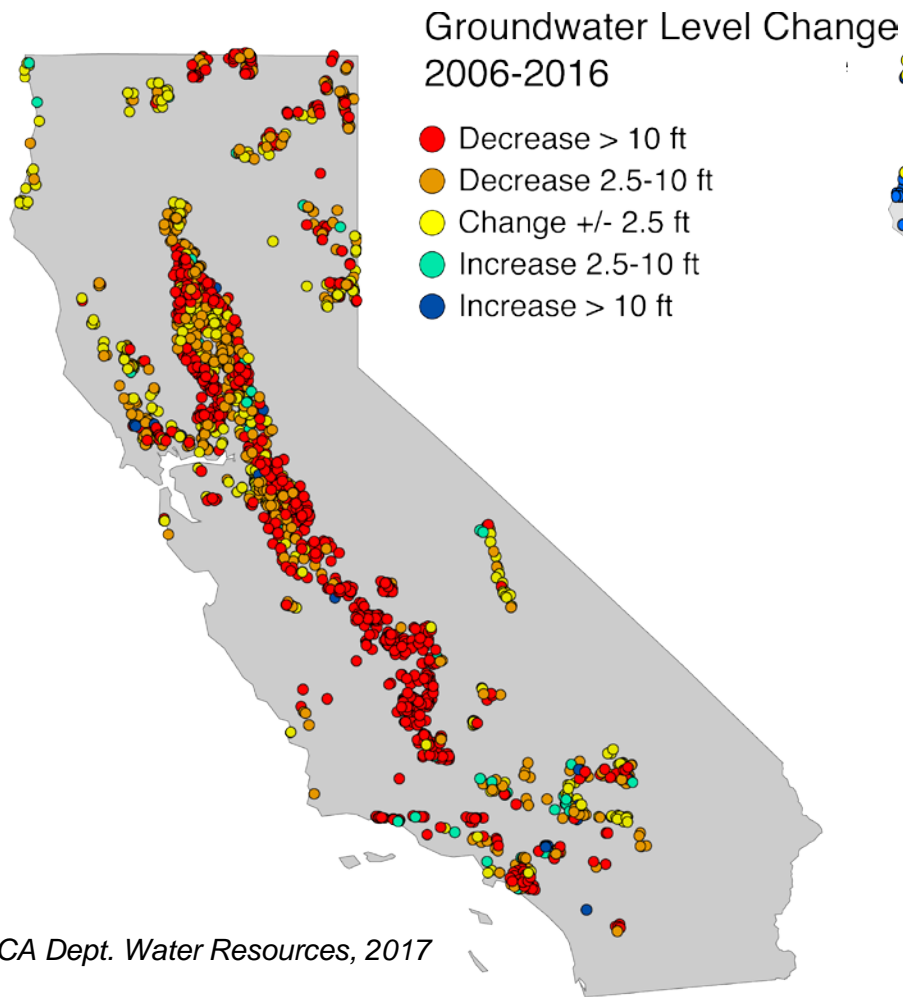
Quantification of initial infiltration benefit

Water quality improvements

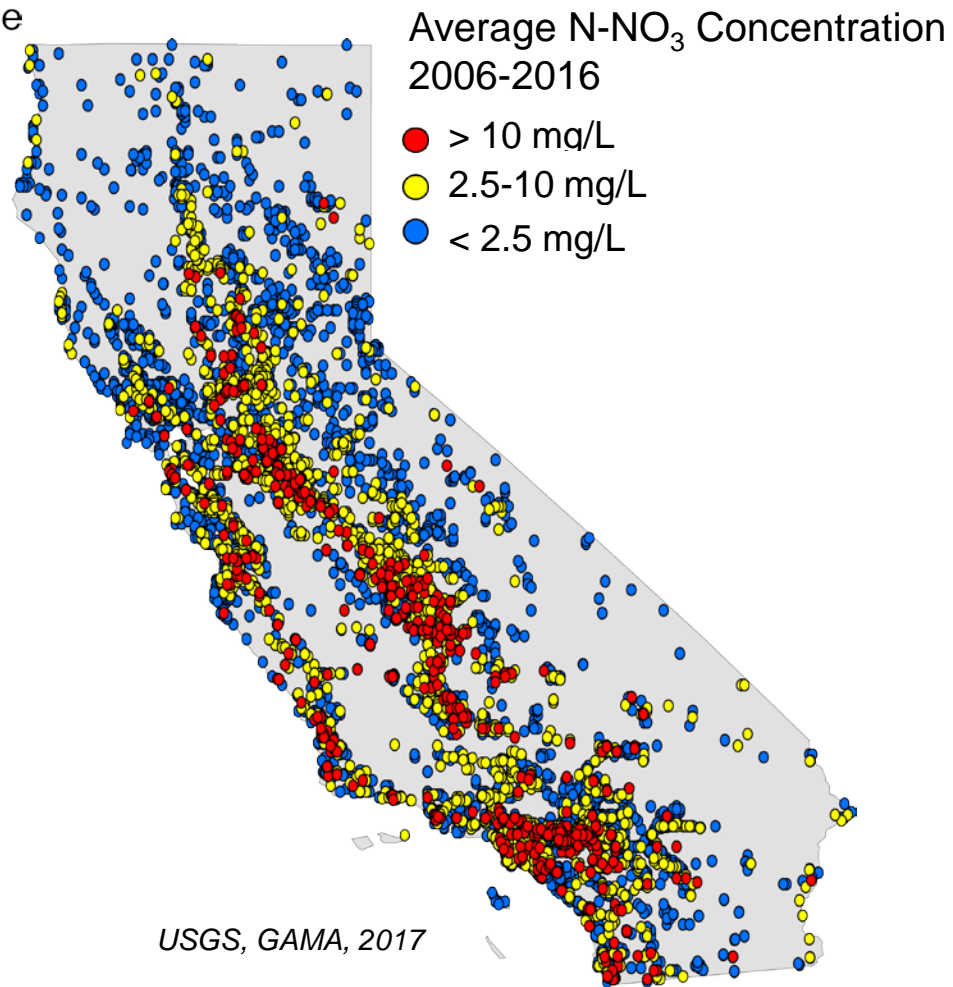
Ongoing work and future plans



Water Quantity

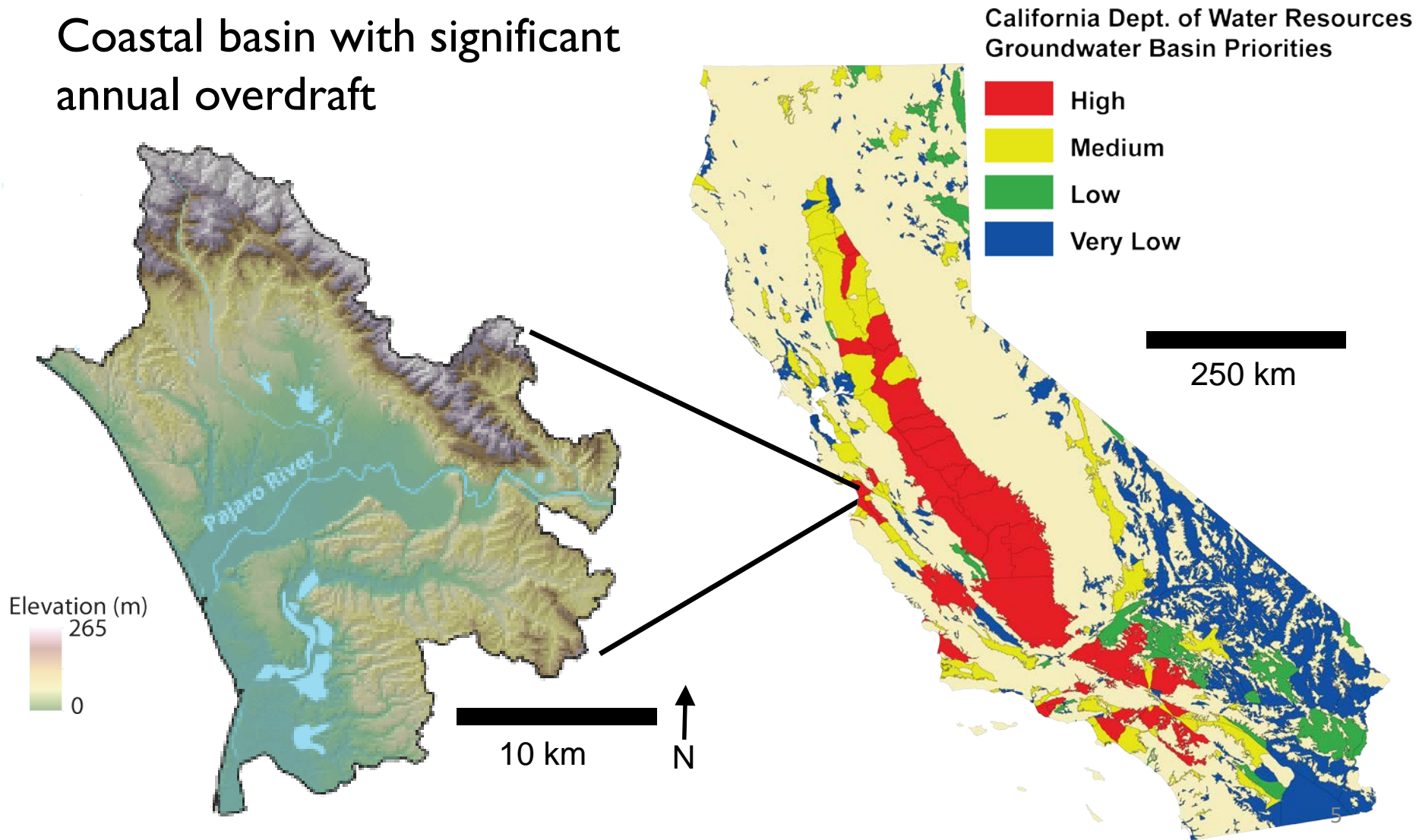


Water Quality



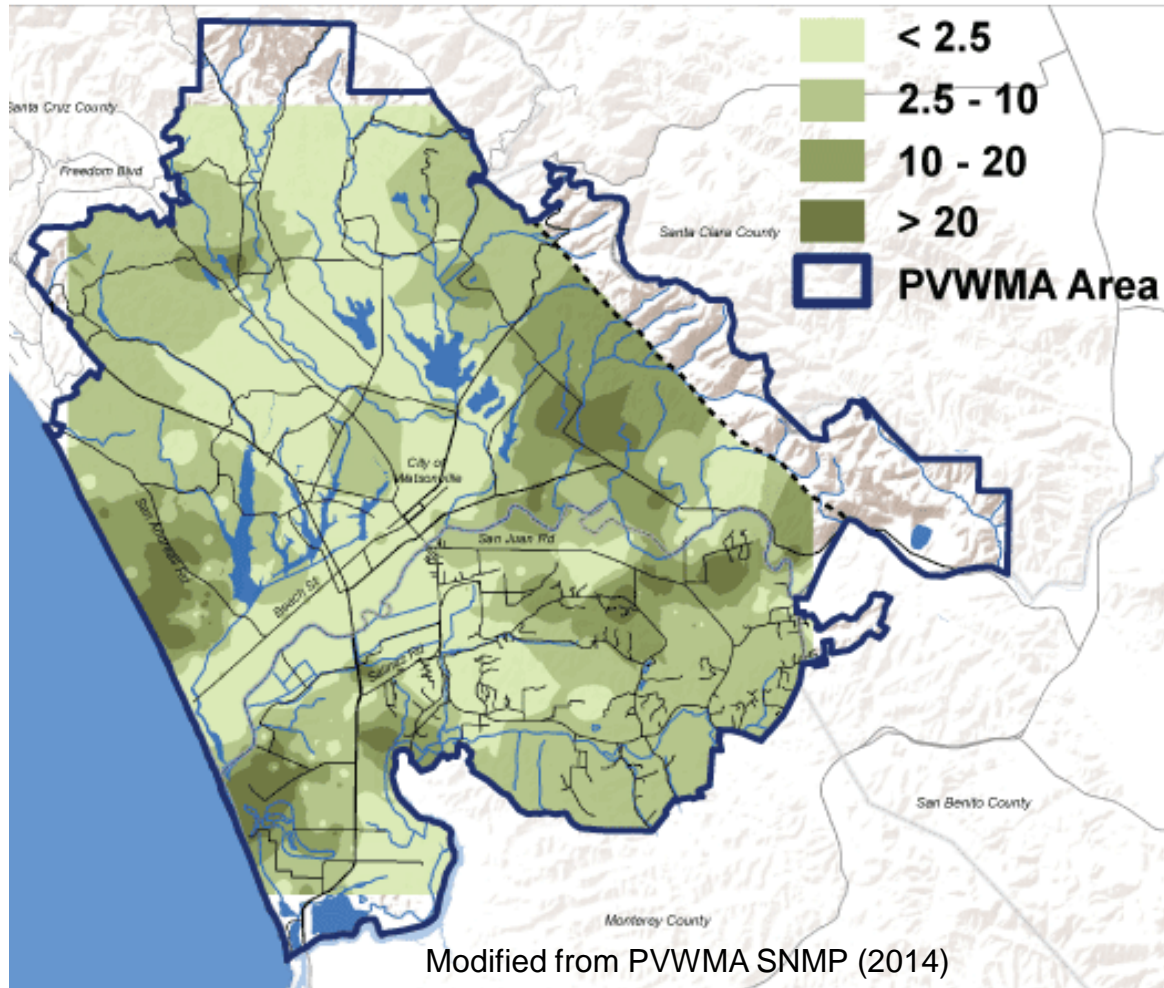
Pajaro Valley Groundwater Basin

Coastal basin with significant annual overdraft



Pajaro Valley Groundwater Basin faces water supply and quality issues

N-NO₃ Concentration (mg/L)



Groundwater accounts for 98% of total water supply

Highly productive agricultural region

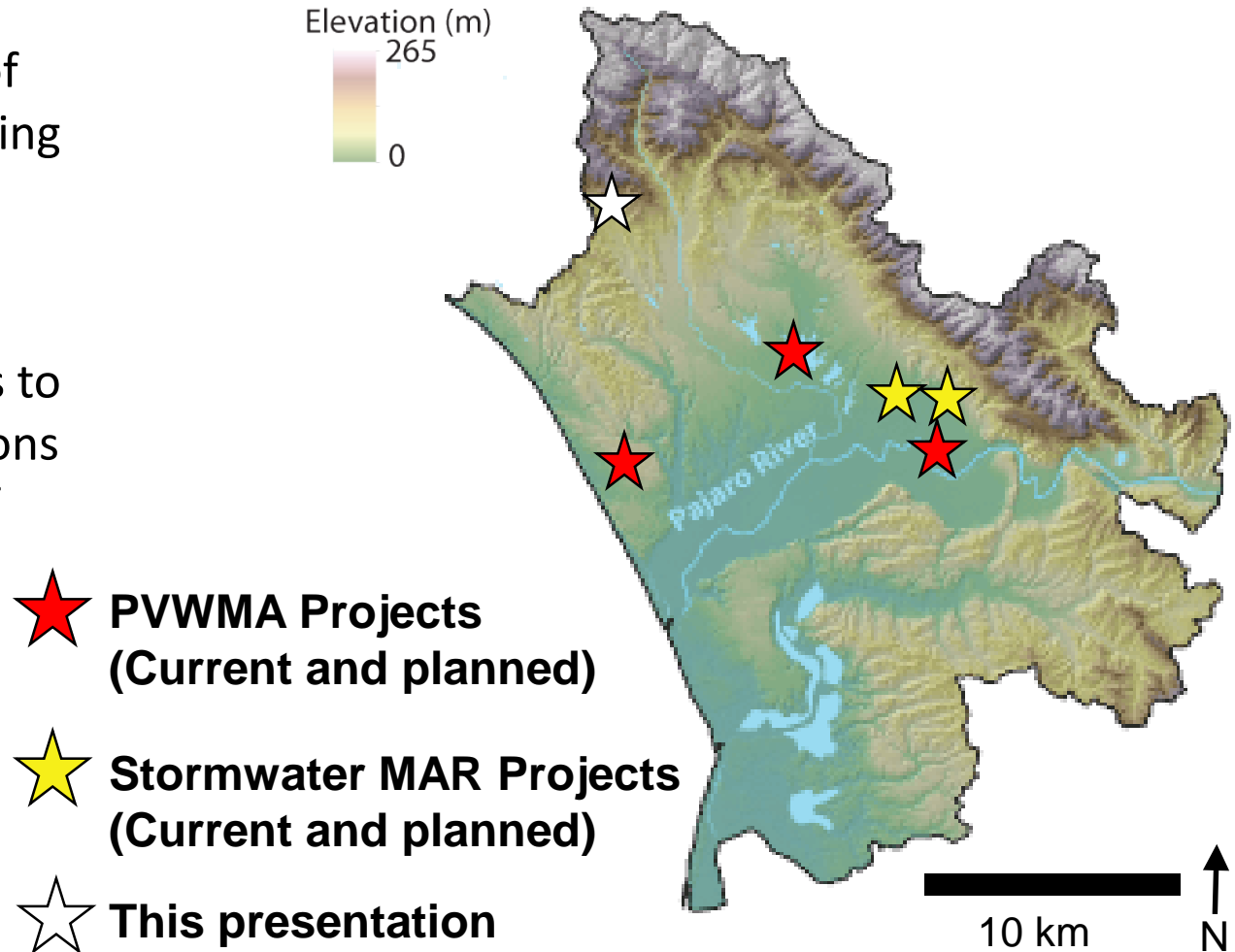


*California Maximum Contaminant Level 10 mg/L N-NO₃

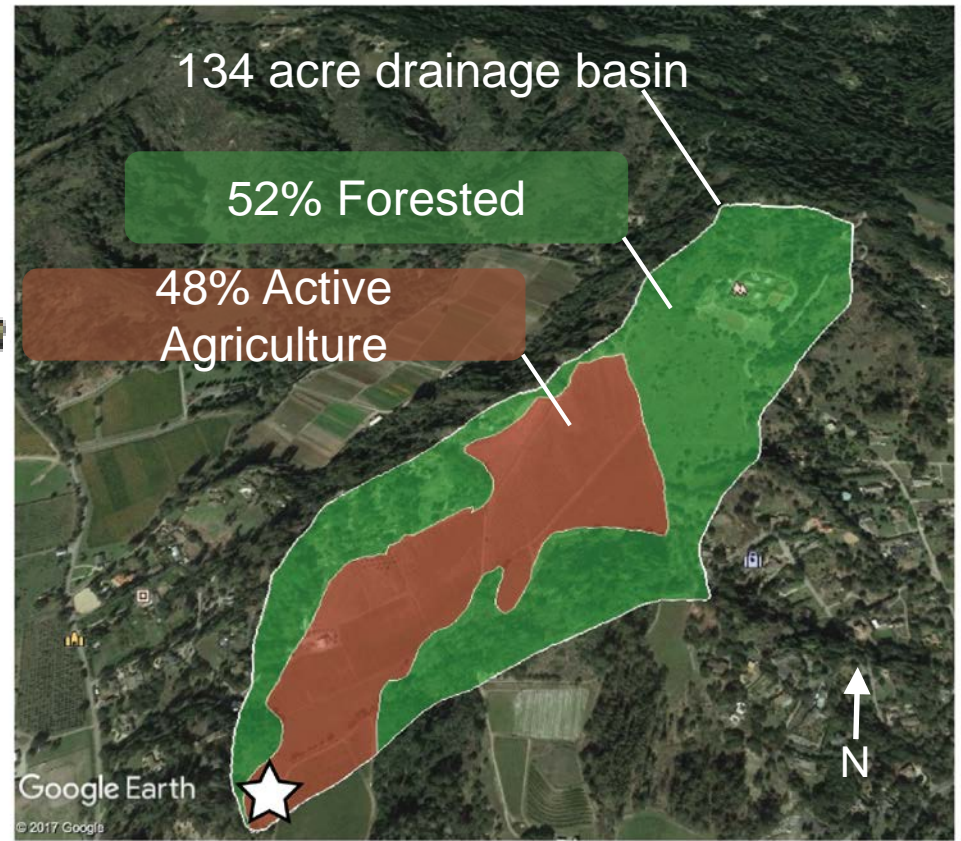
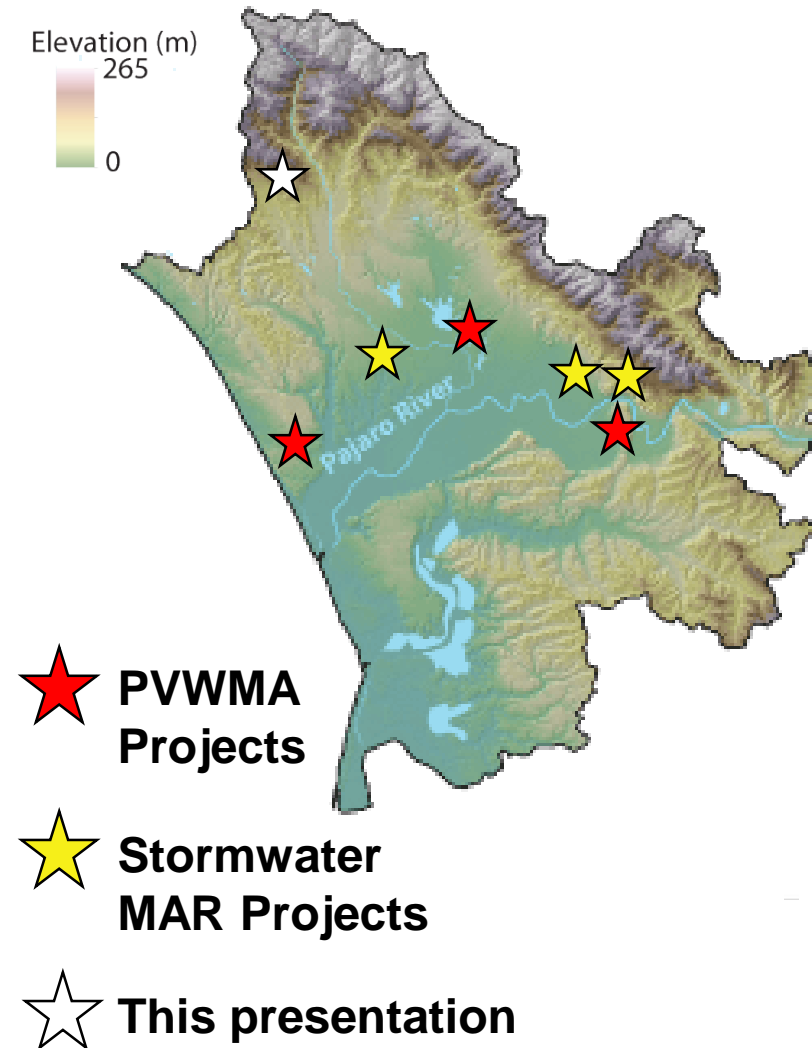
Managed recharge projects distributed throughout the basin are aimed at addressing these issues

UCSC projects are part of the Recharge Net Metering program (ReNeM)

Also a part of our efforts to combine field observations with modeling results of runoff and infiltration



Managed recharge projects distributed throughout the basin are aimed at addressing these issues



1 kilometer

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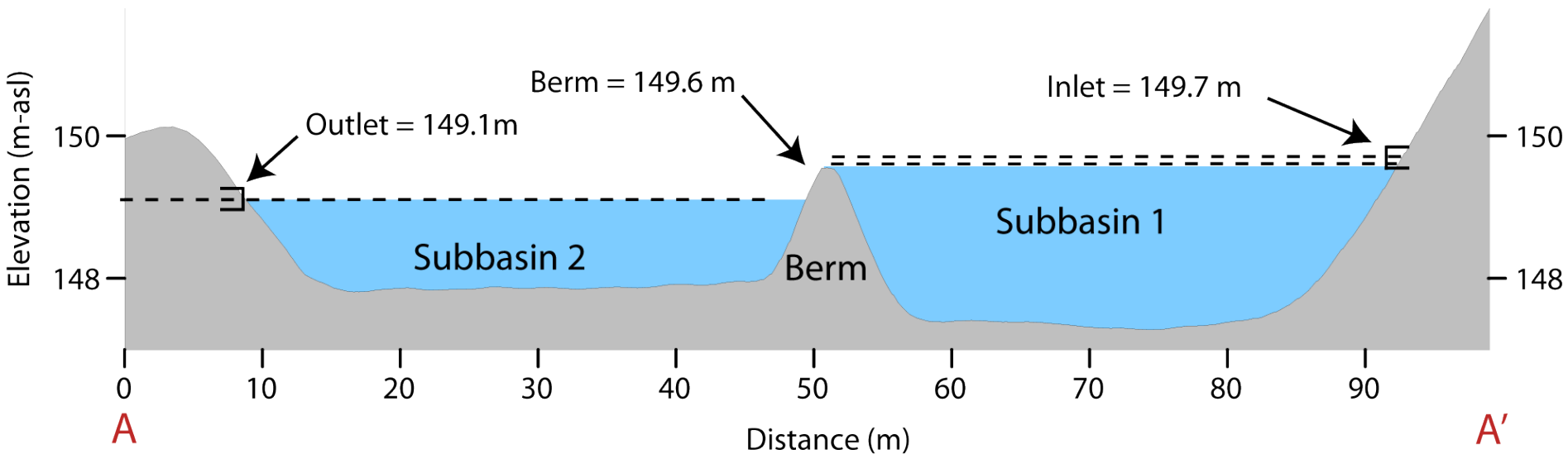
Ongoing work and future plans

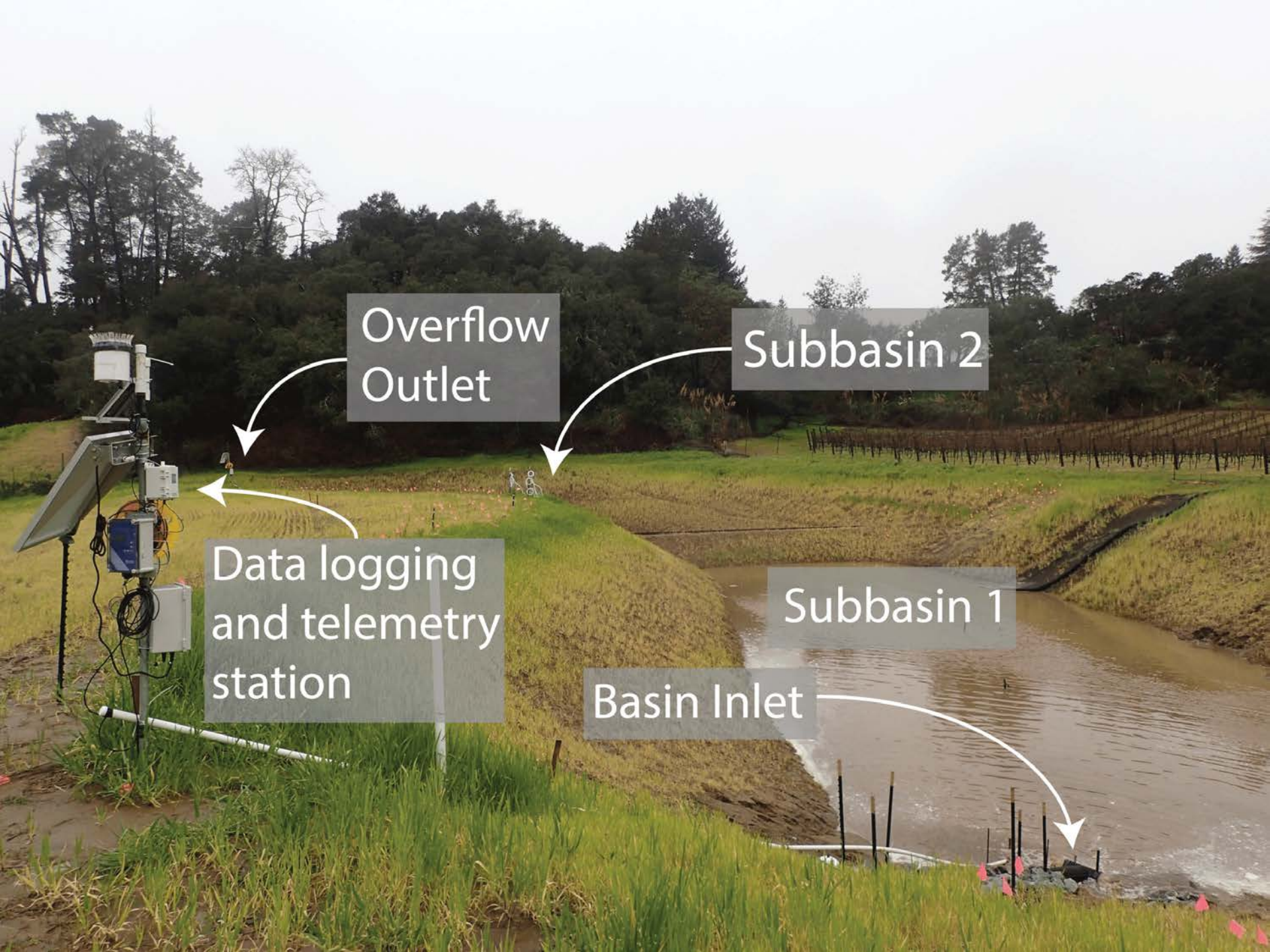


Orientation routes excess flows back to canal



Both subbasins are instrumented for mass balance measurements





Overflow
Outlet

Subbasin 2

Data logging
and telemetry
station

Subbasin 1

Basin Inlet

Talk Outline

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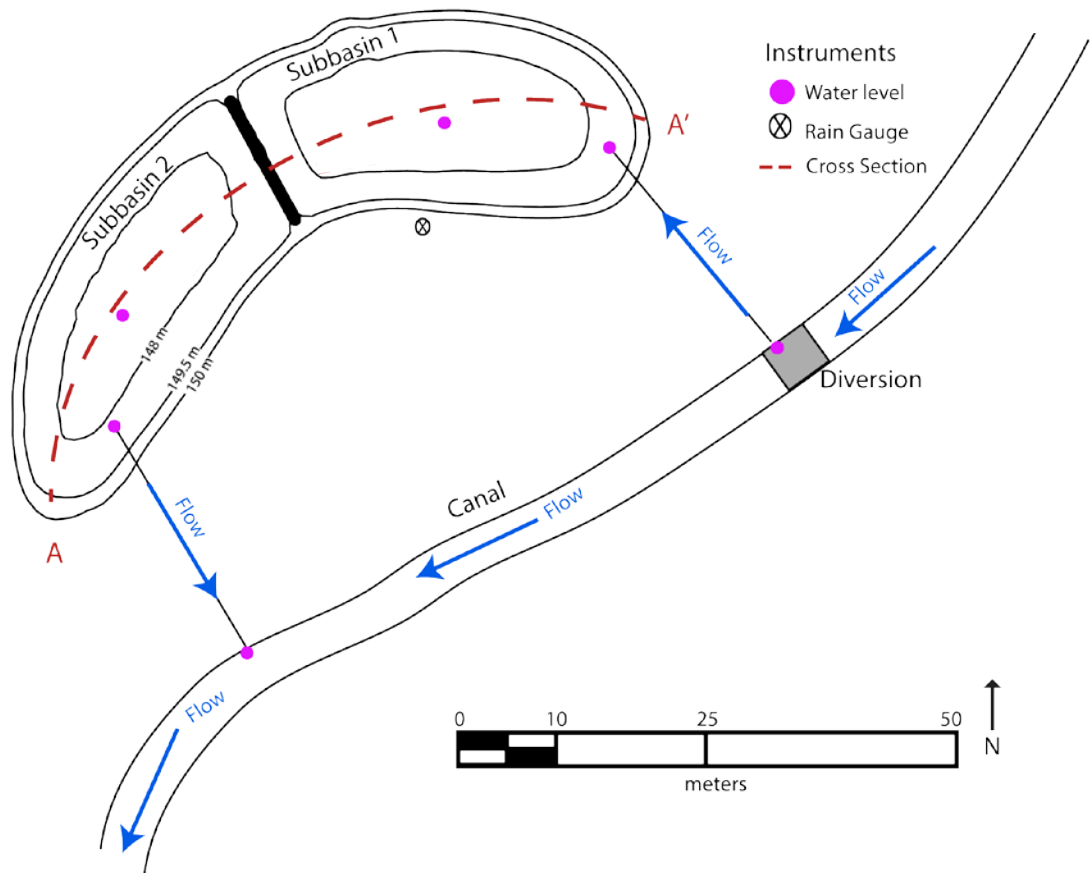
Water quality improvements

Ongoing work and future plans

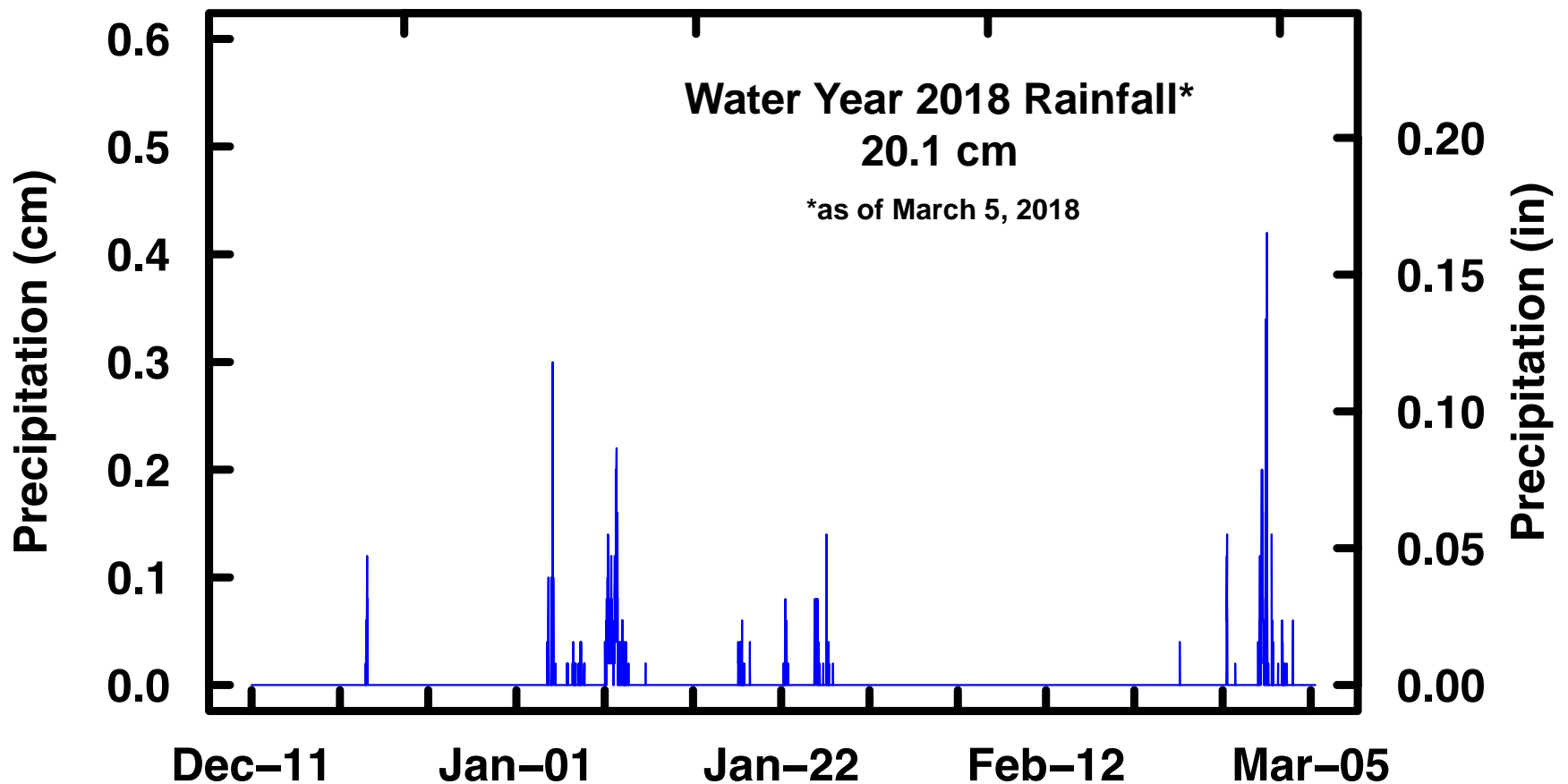


Quantification of initial recharge

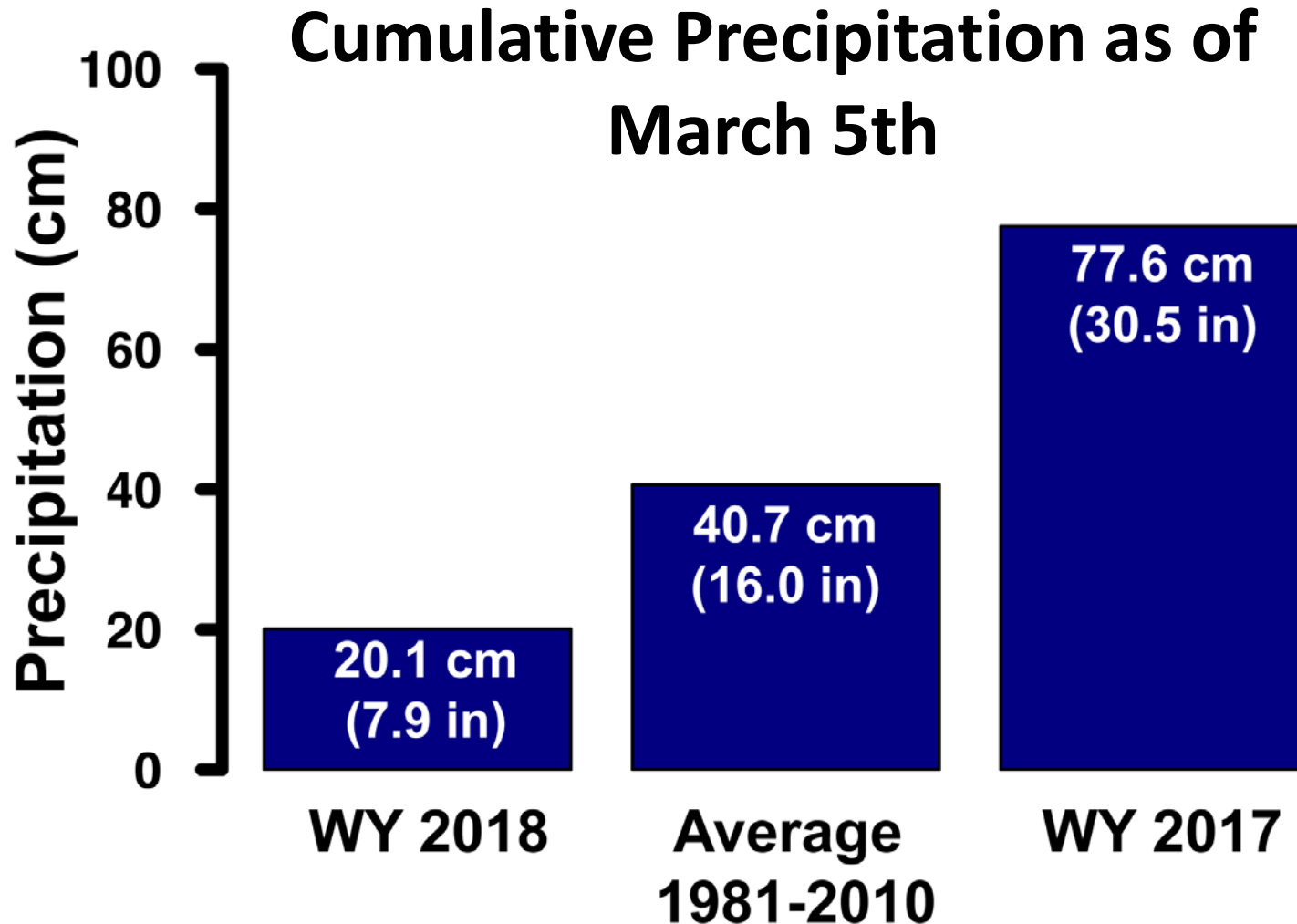
How does inflow and infiltration vary with precipitation?



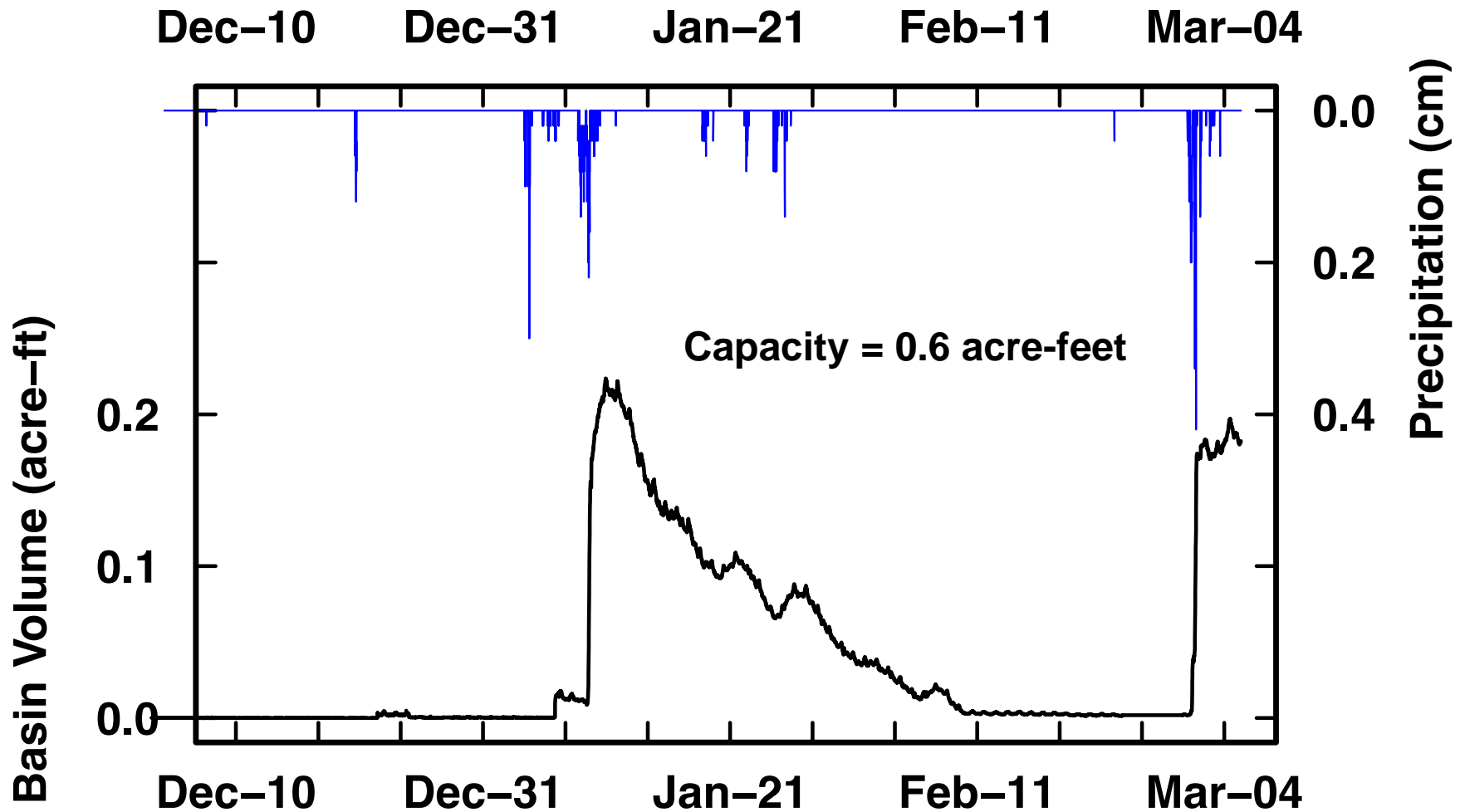
Another dry winter in California

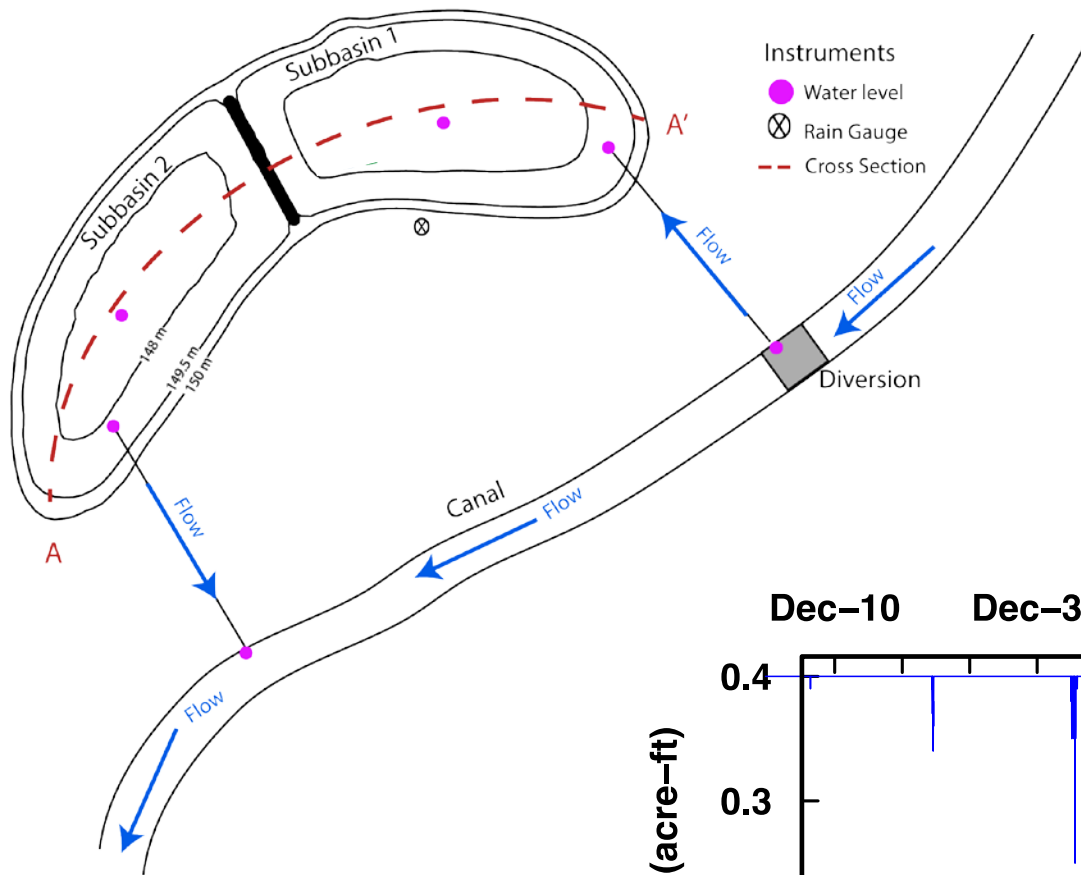


Another dry winter in California



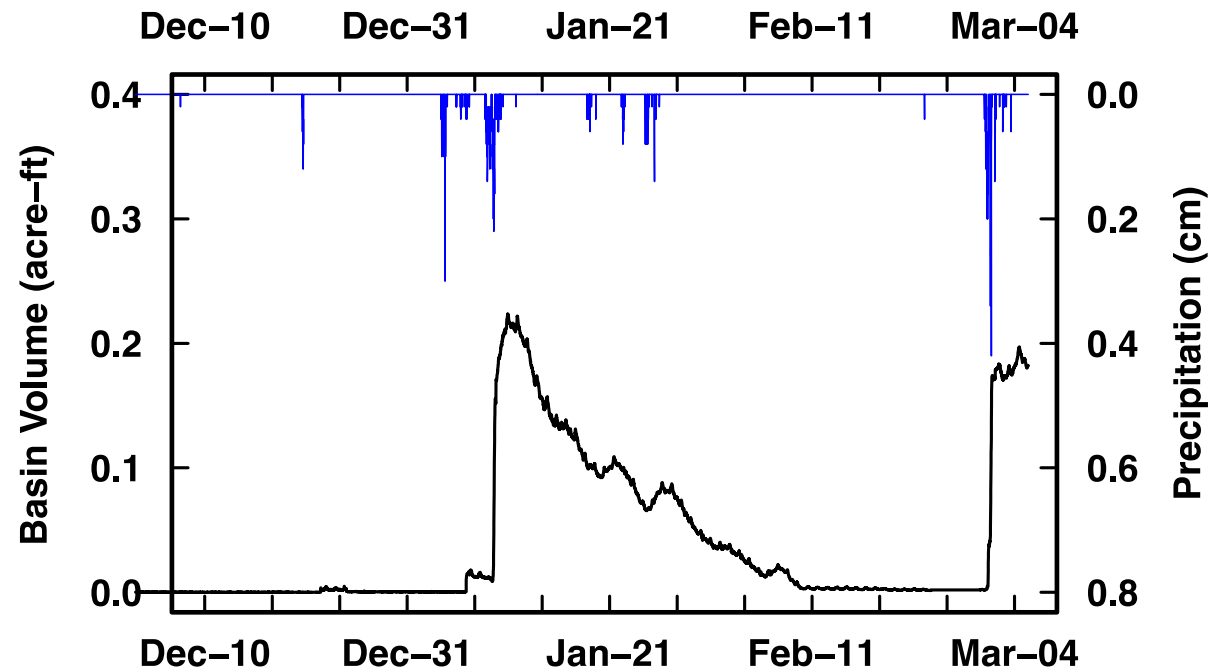
Basin volume response to events



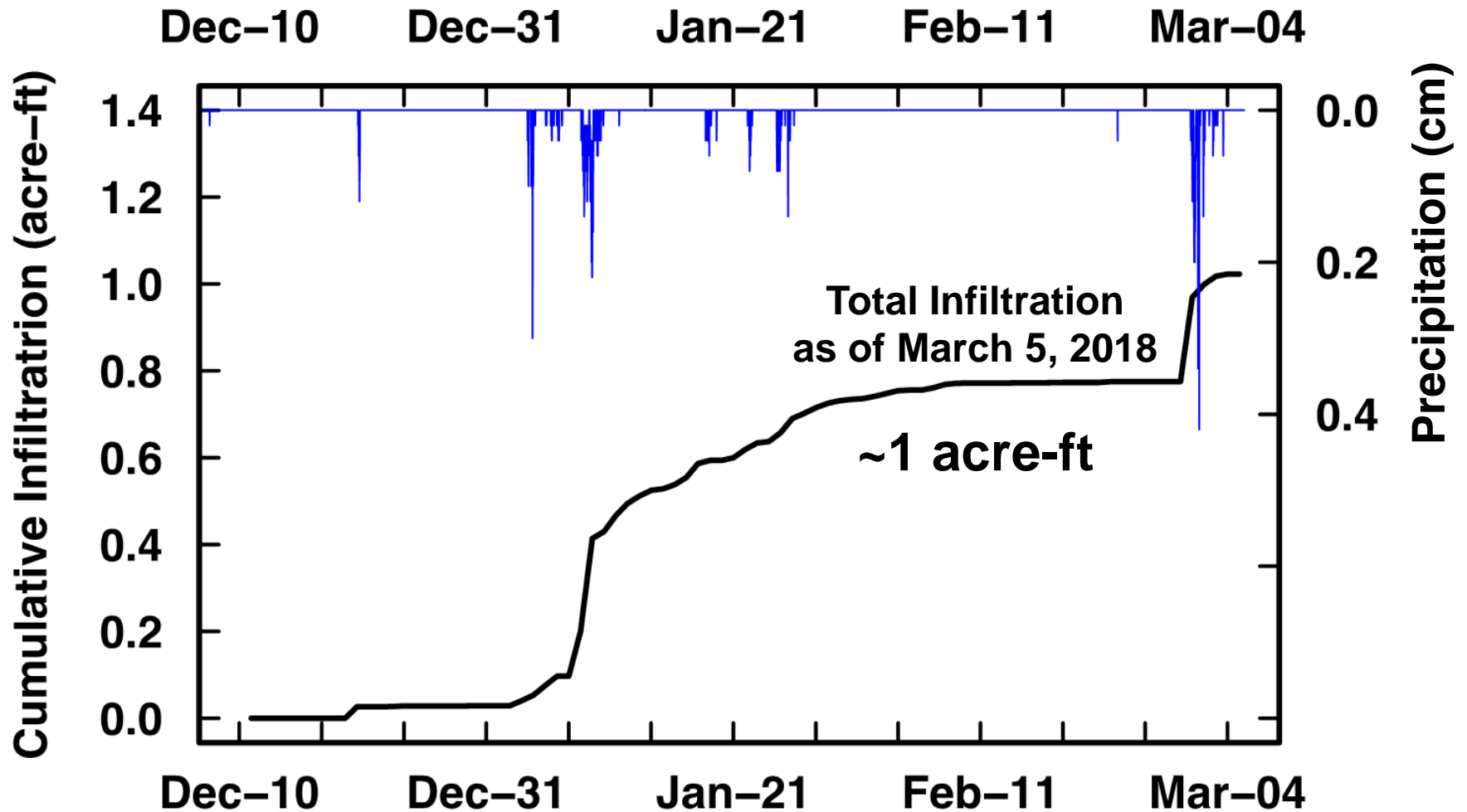


System is designed to divert a fraction of runoff in the canal

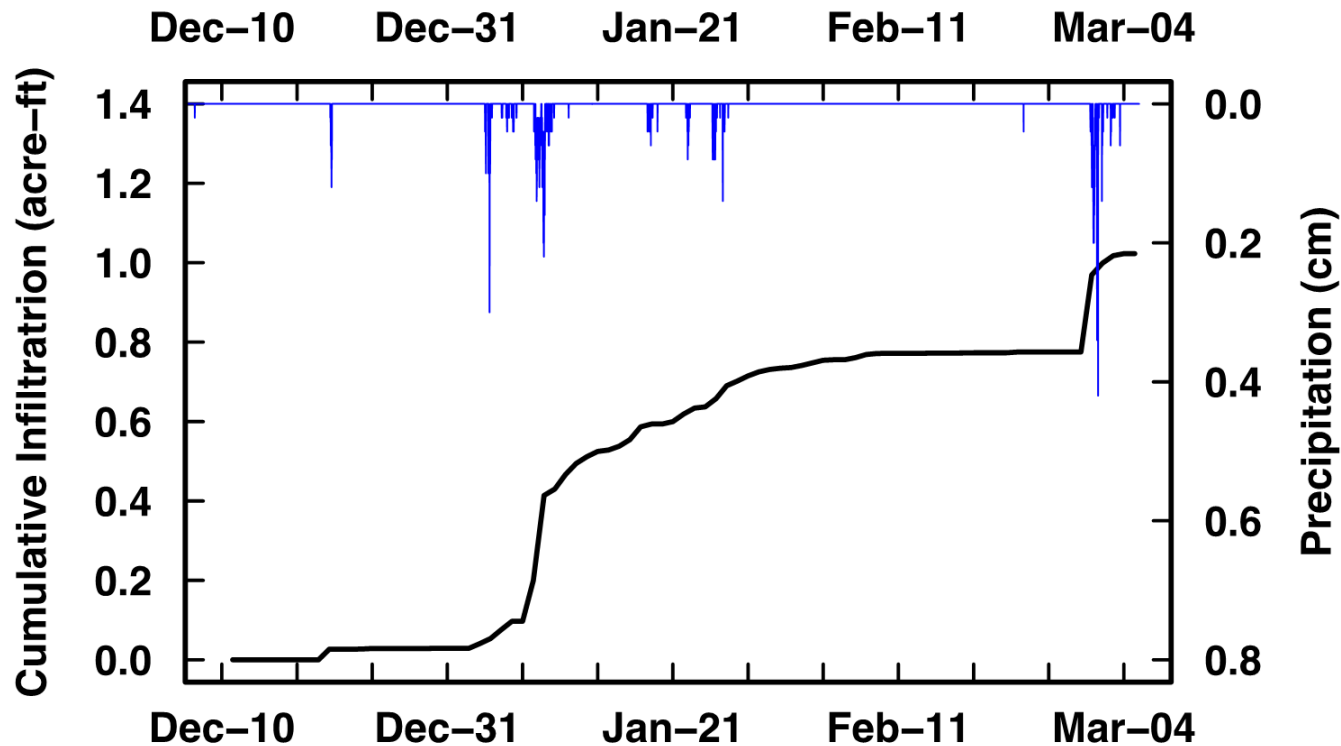
Diversion amount will increase as system stabilizes in future years



Infiltration response to events

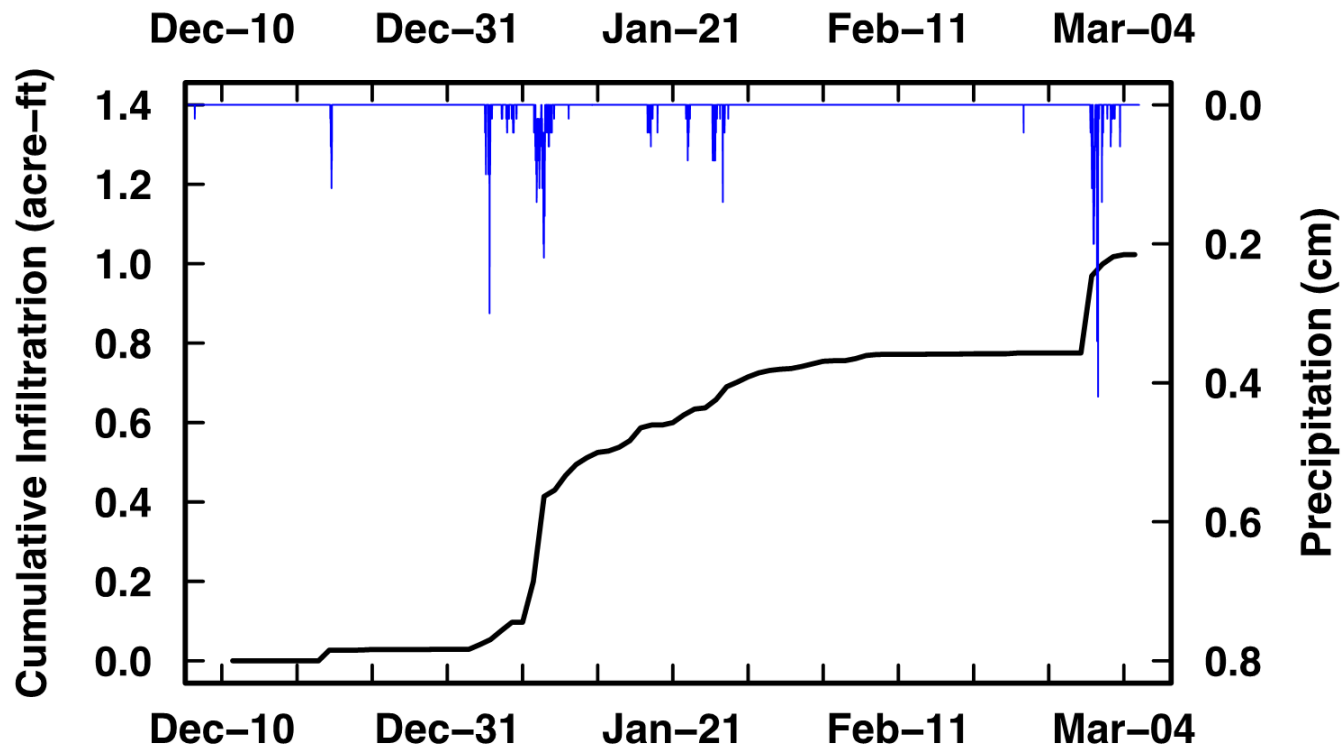


Quantification of initial recharge benefit



System has infiltrated a modest amount of water in a dry year

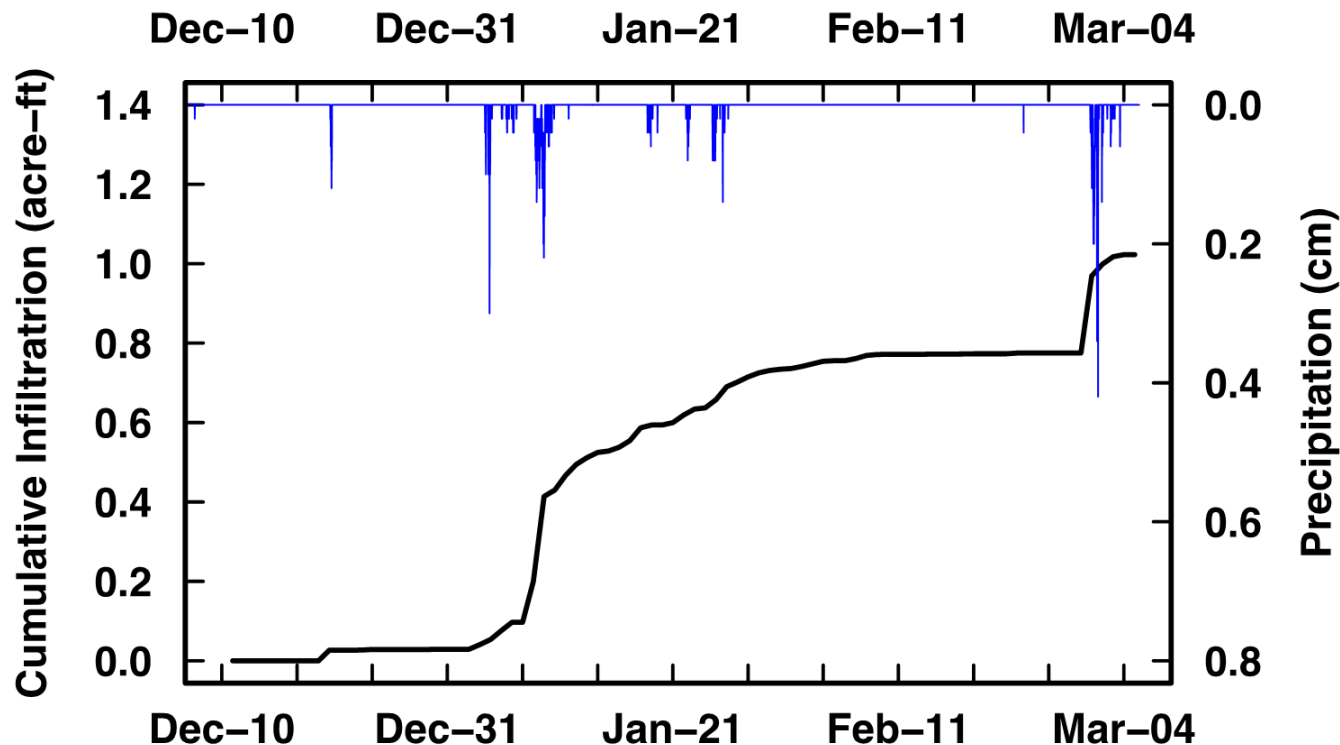
Quantification of initial recharge benefit



System has infiltrated a modest amount of water in a dry year

System is performing as expected in first season of operation

Quantification of initial recharge benefit



System has infiltrated a modest amount of water in a dry year

System is performing as expected in first season of operation

Unused basin volume and generated runoff present an opportunity to increase infiltration

Talk Outline

Background and setting

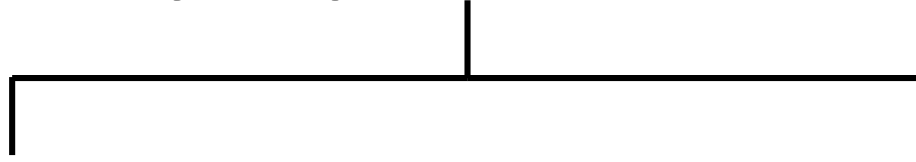
System design

Quantification of initial infiltration benefit

Water quality improvements

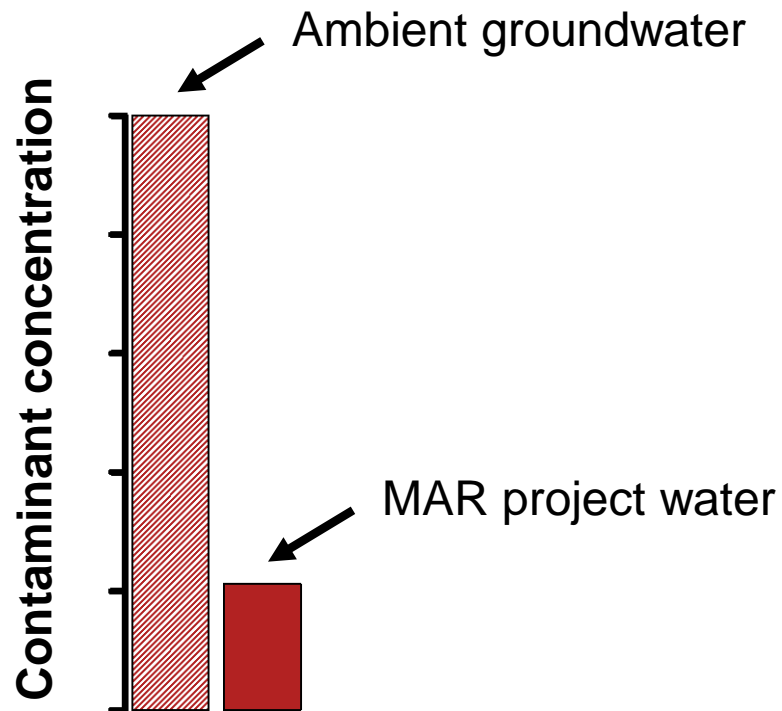
Ongoing work and future plans

Water quality improvements during MAR



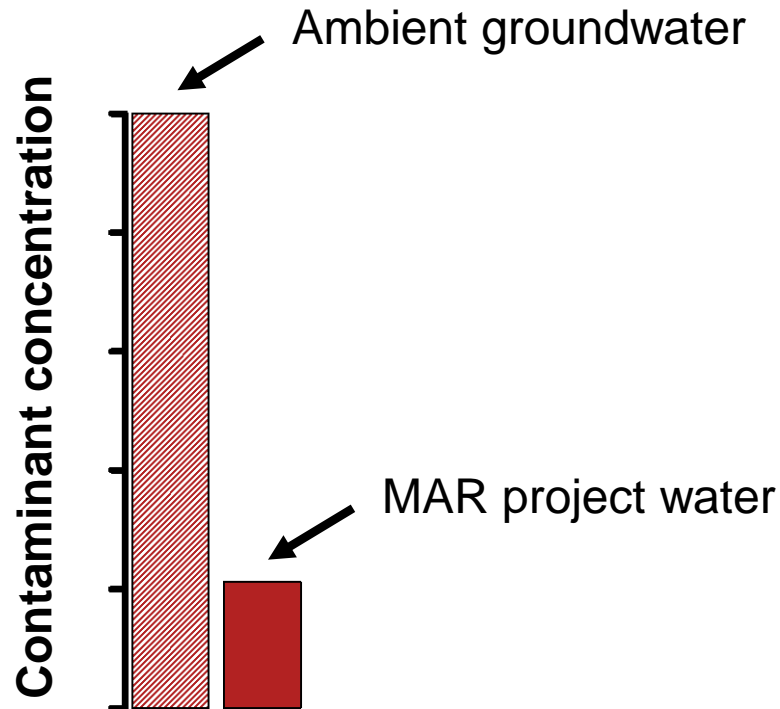
Water quality improvements during MAR

Dilution

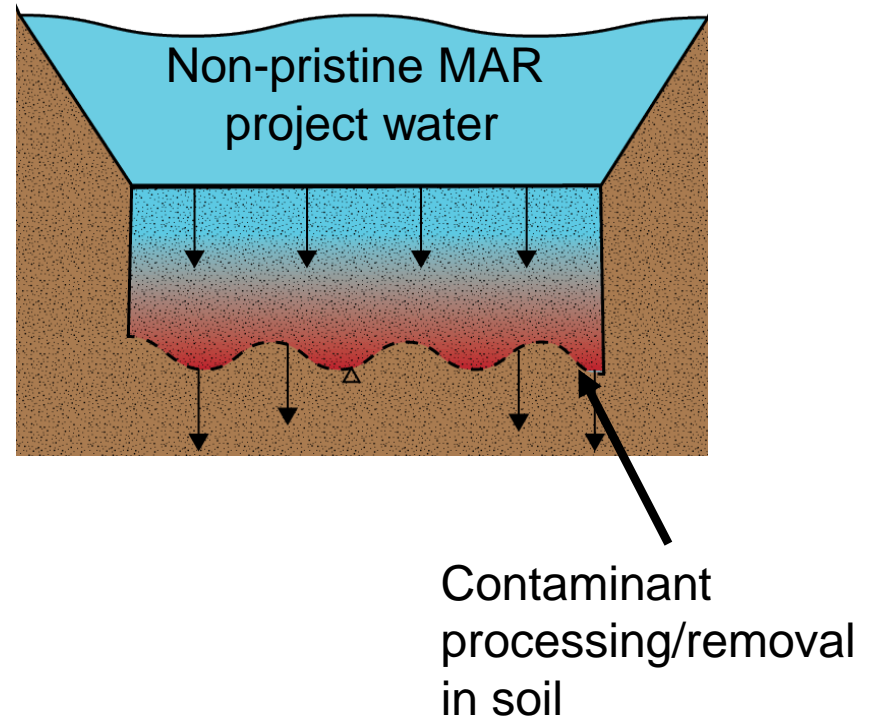


Water quality improvements during MAR

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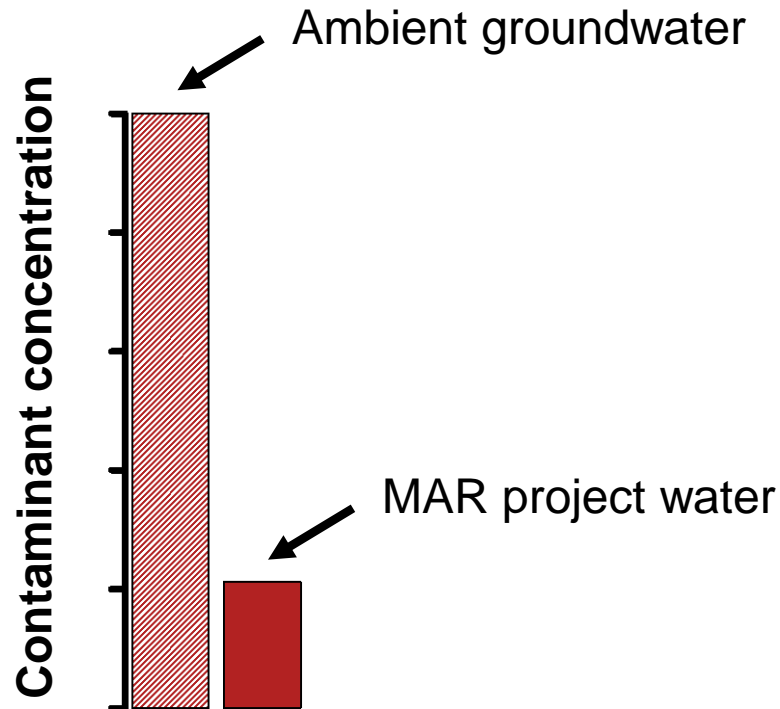


Contaminant removal during infiltration

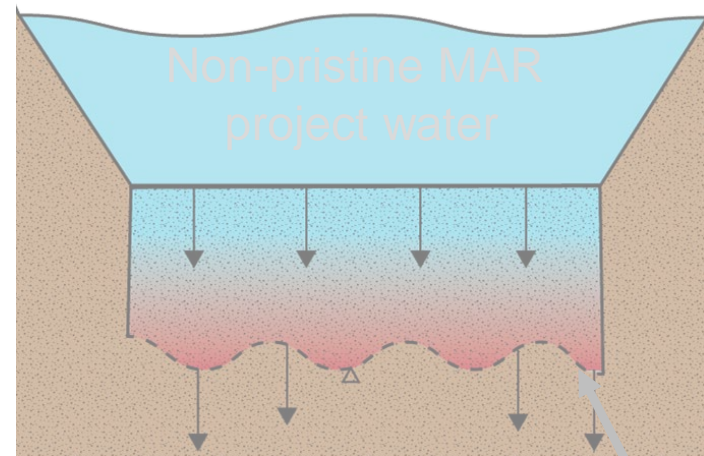


Water quality improvements during MAR

Dilution

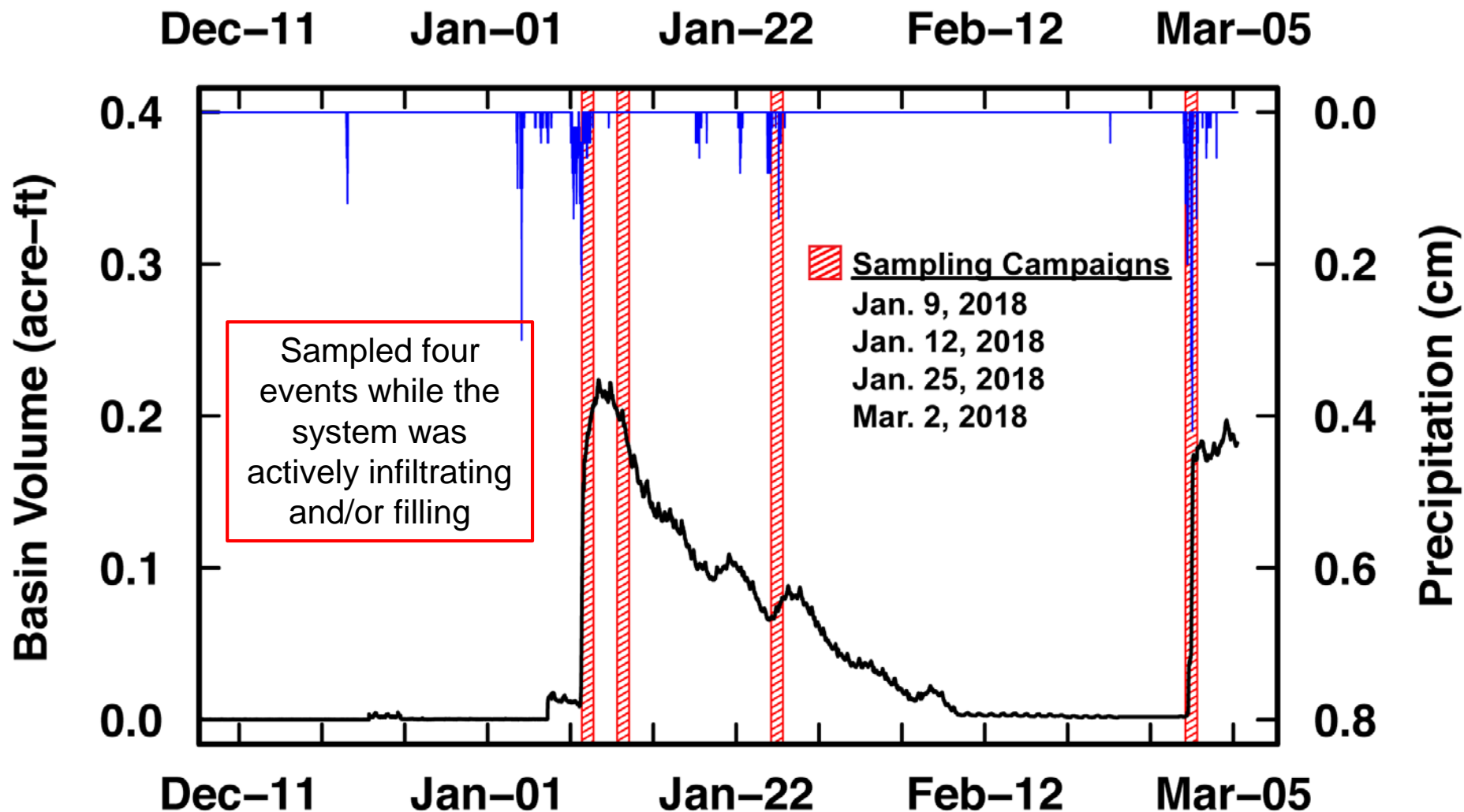


Contaminant removal during infiltration

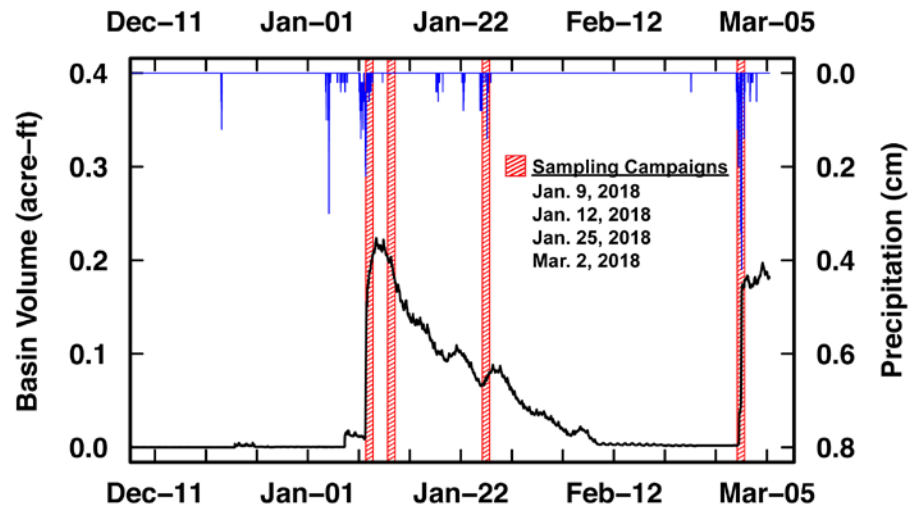


Contaminant processing/removal in soil

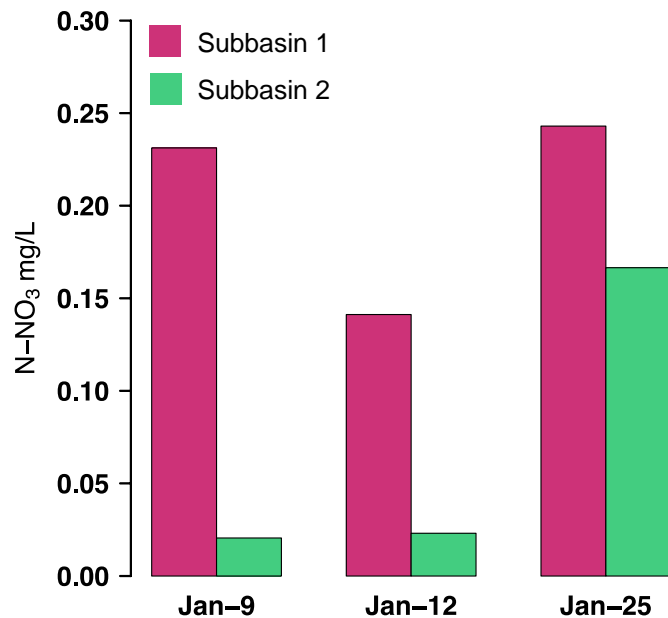
Sampling storm events



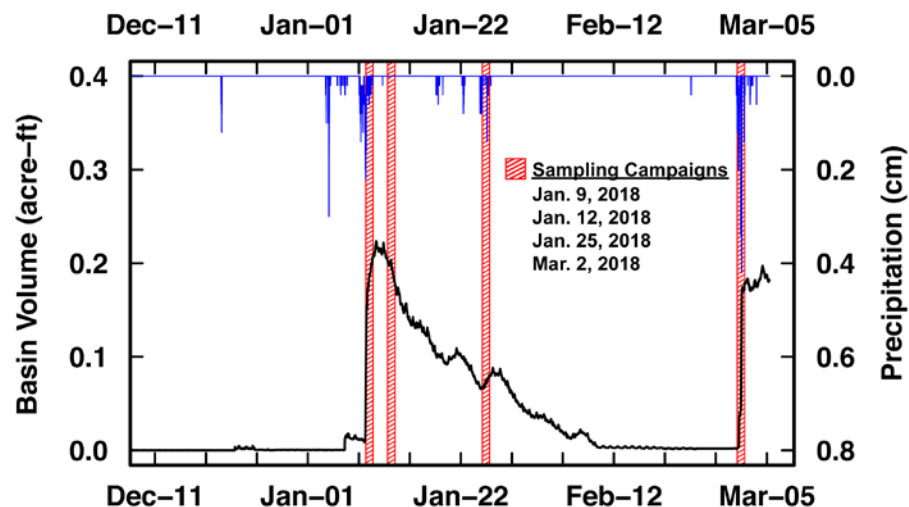
Sampling storm events



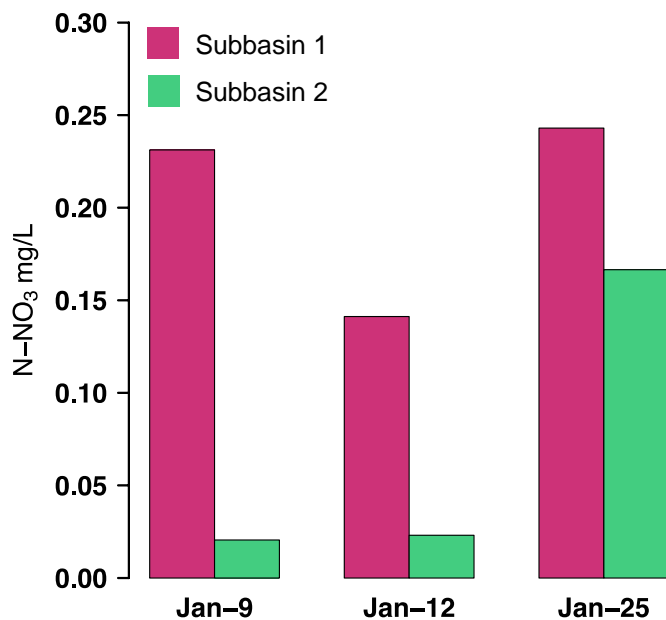
Basin N-NO₃ Concentration mg/L



Sampling storm events

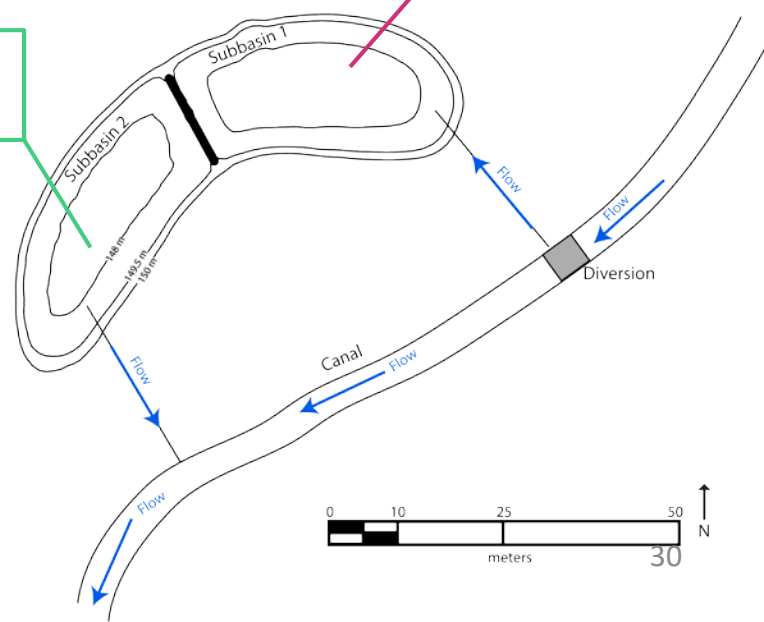


Basin N-NO₃ Concentration mg/L

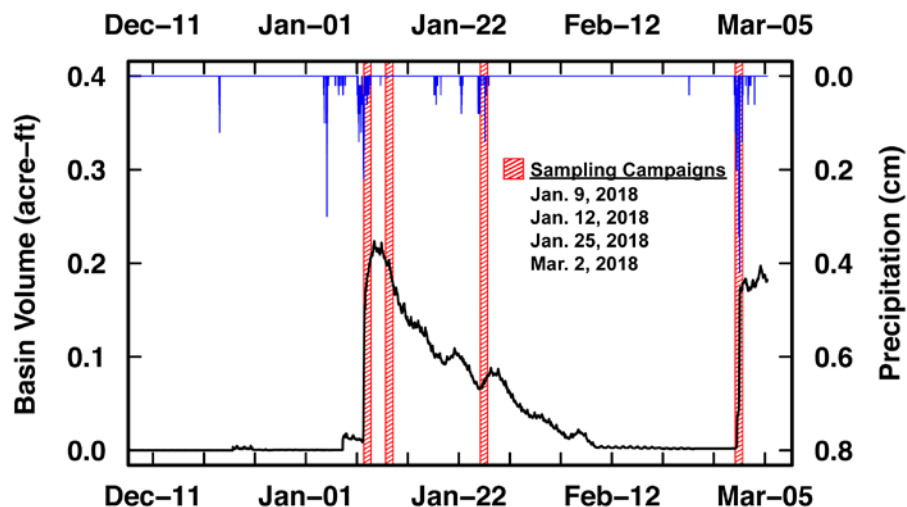


Subbasin 2 fed primarily by precipitation

Subbasin 1 fed by field runoff and precipitation



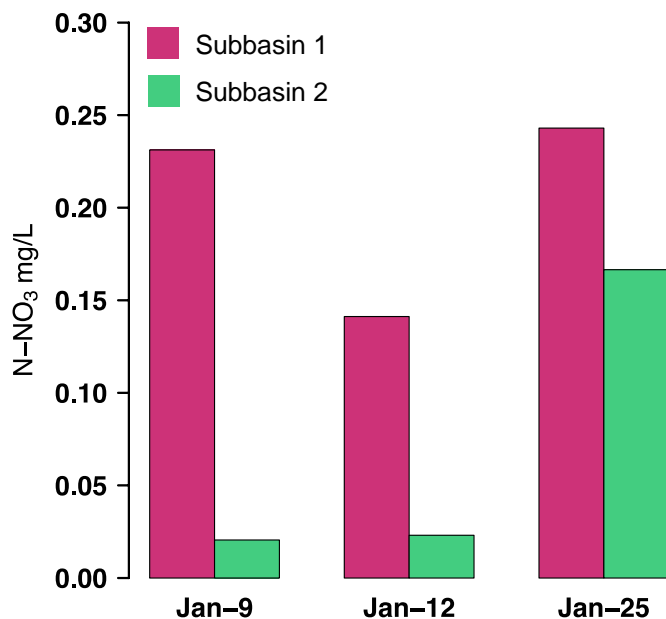
Sampling storm events



N-NO₃ concentrations are well below California MCL –10 mg/L

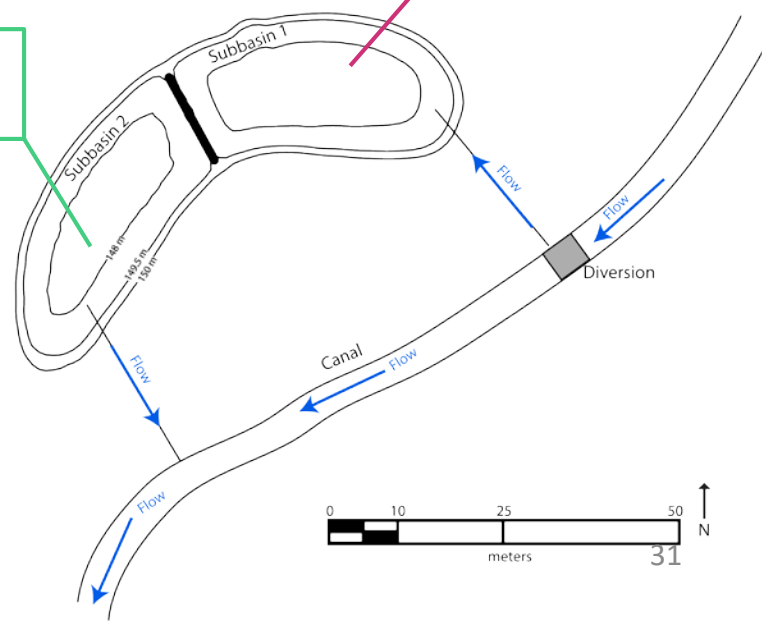
Other indicators show high water quality as well (eg TDS, NaCl, metals)

Basin N-NO₃ Concentration mg/L

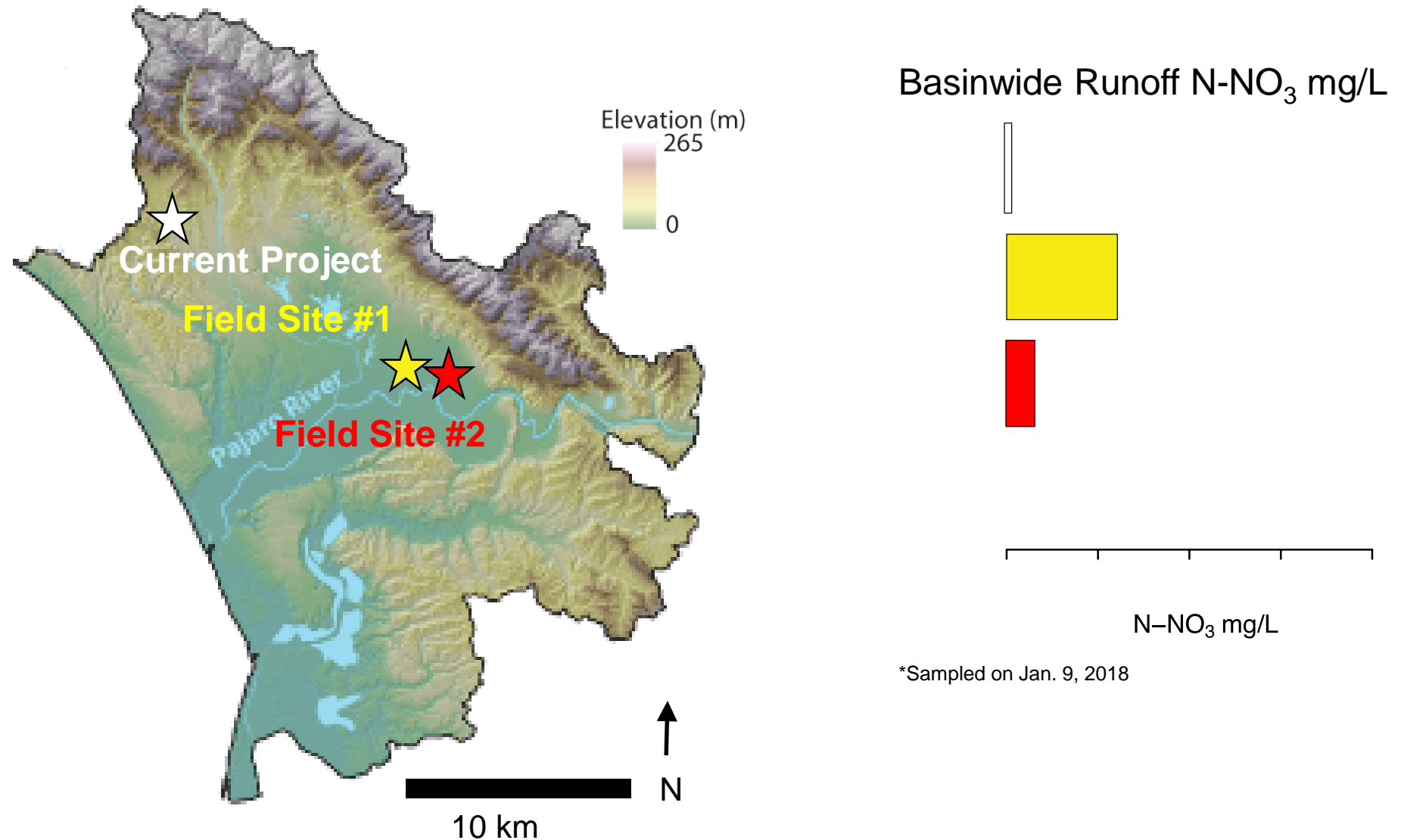


Subbasin 2 fed primarily by precipitation

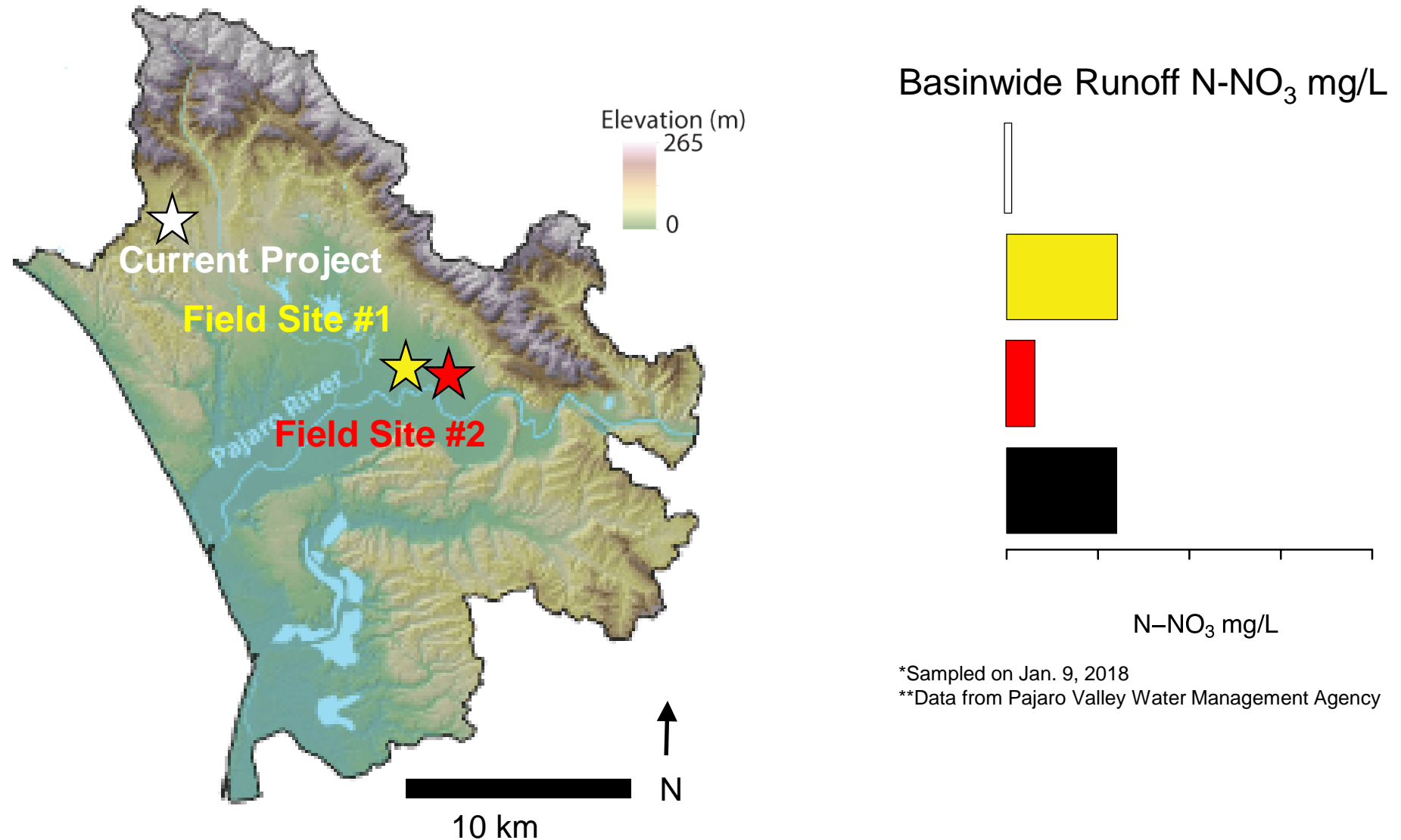
Subbasin 1 fed by field runoff and precipitation



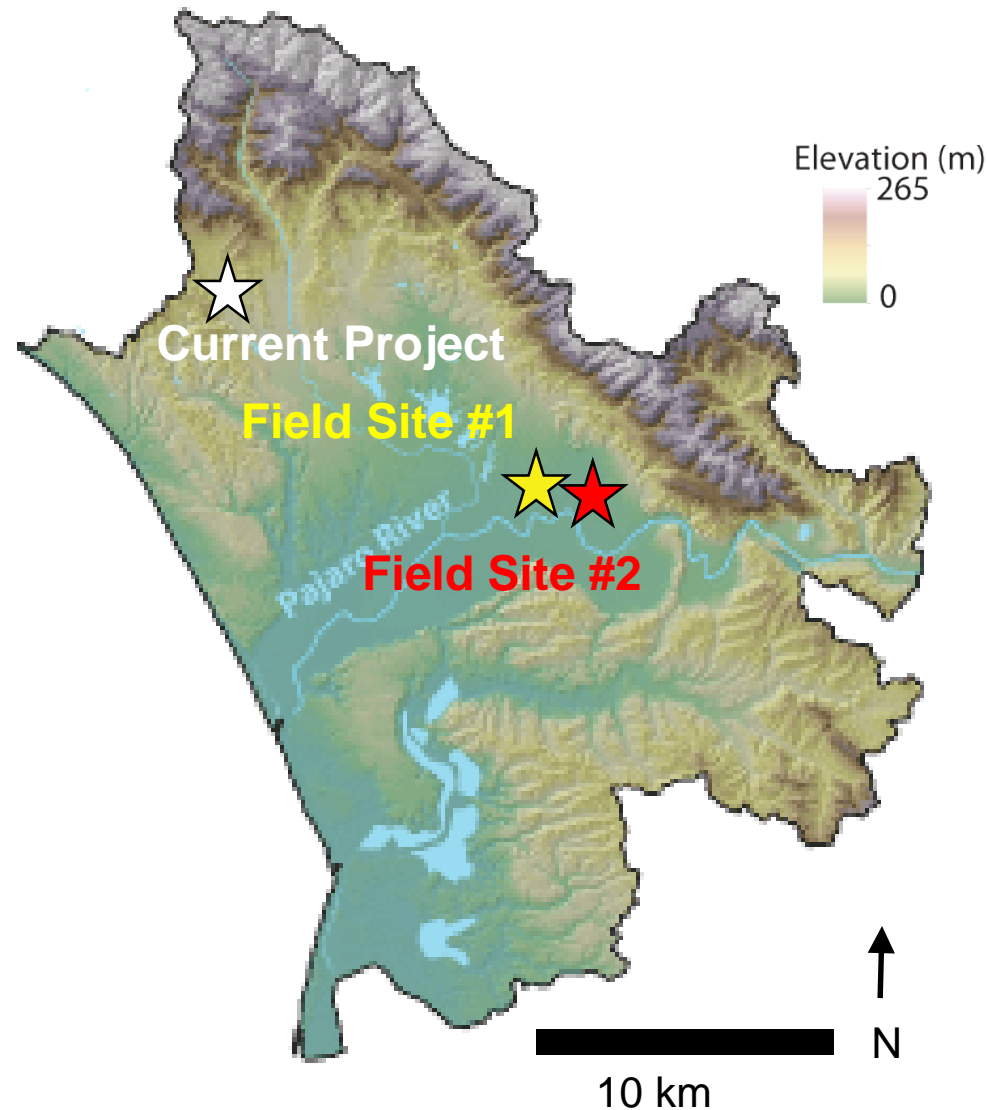
Sampling storm events—Across the groundwater basin



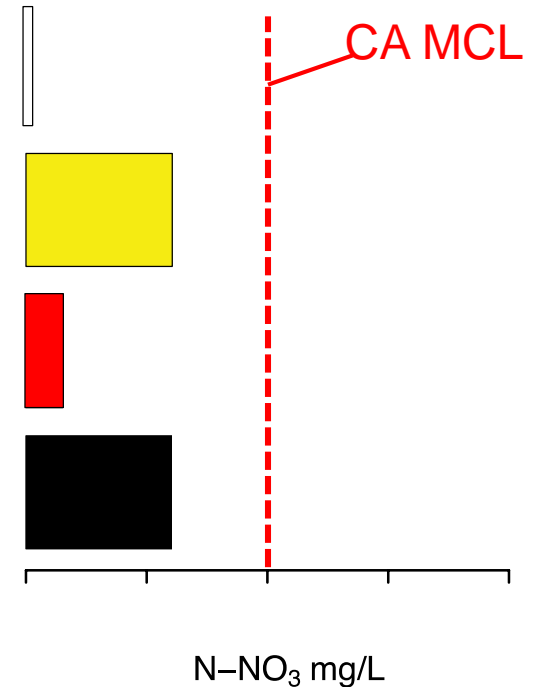
Sampling storm events—Across the groundwater basin



Sampling storm events—Across the groundwater basin



Basinwide Runoff N-NO₃ mg/L

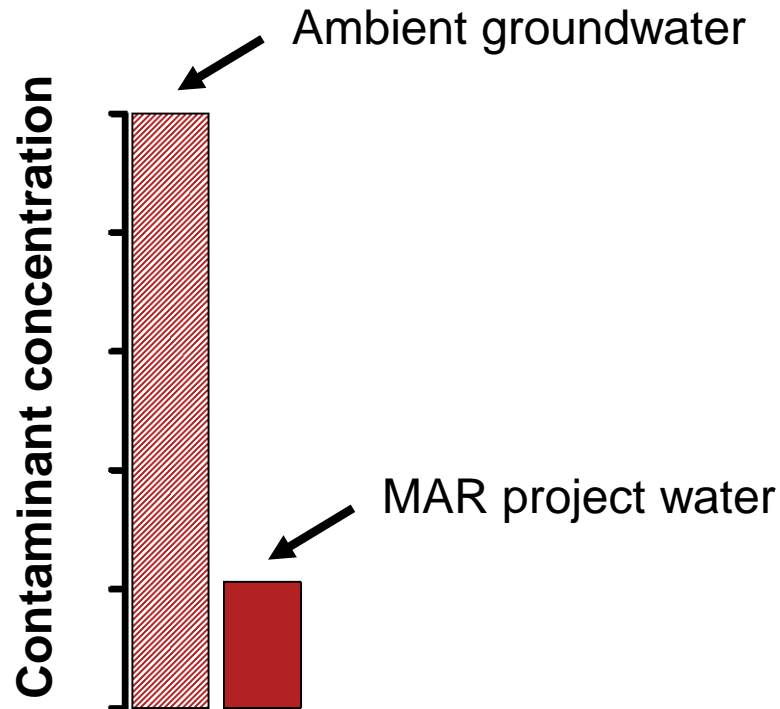


*Sampled on Jan. 9, 2018

**Data from Pajaro Valley Water Management Agency

Water quality improvements during MAR

Dilution



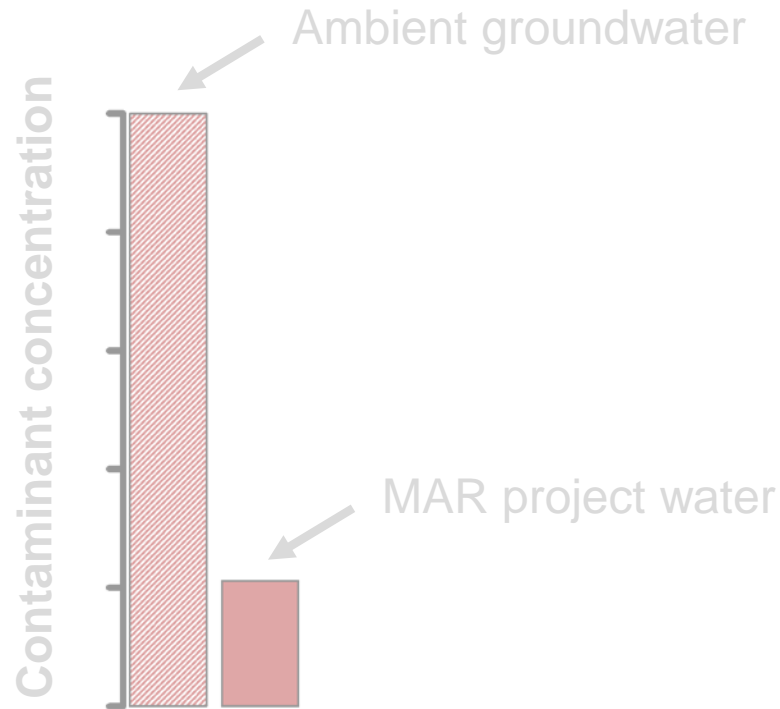
--Current project generates high quality water for infiltration

--Other projects areas around the basin have the potential to generate high quality water for infiltration

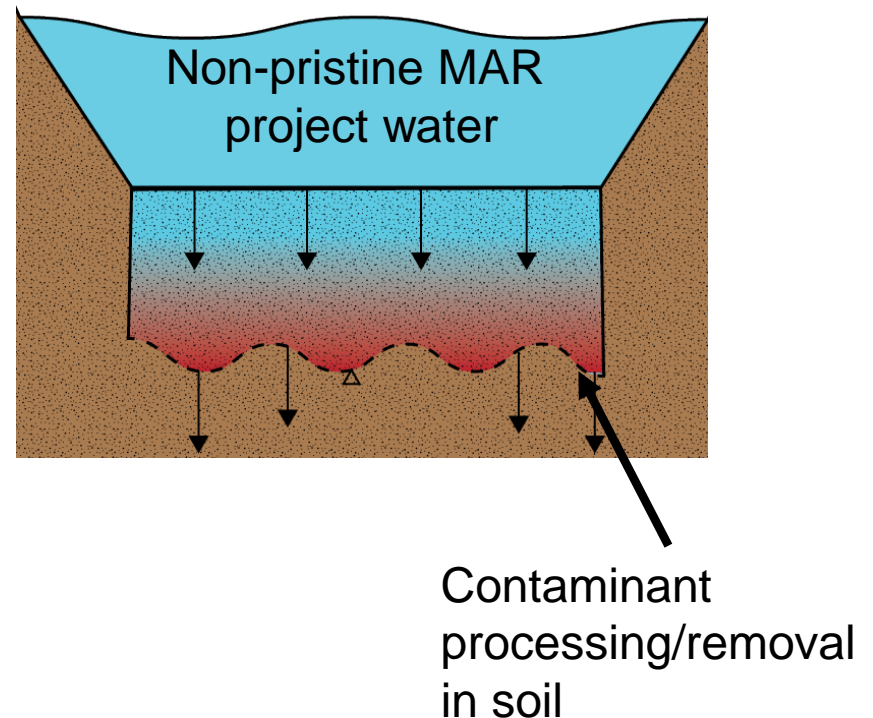
--Nitrate and other water quality indicators are likely to vary by storm events throughout the year

Water quality improvements during MAR

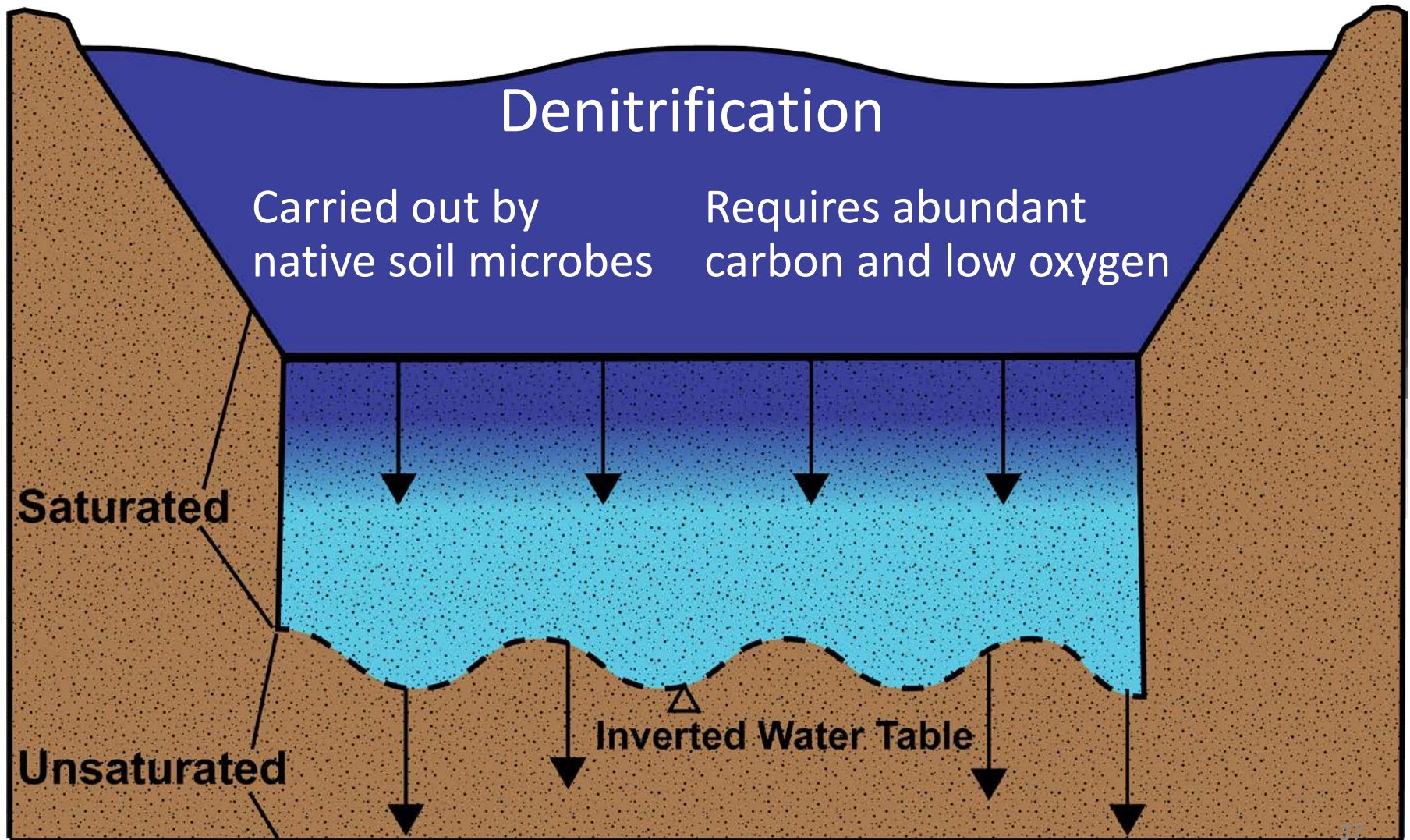
Dilution



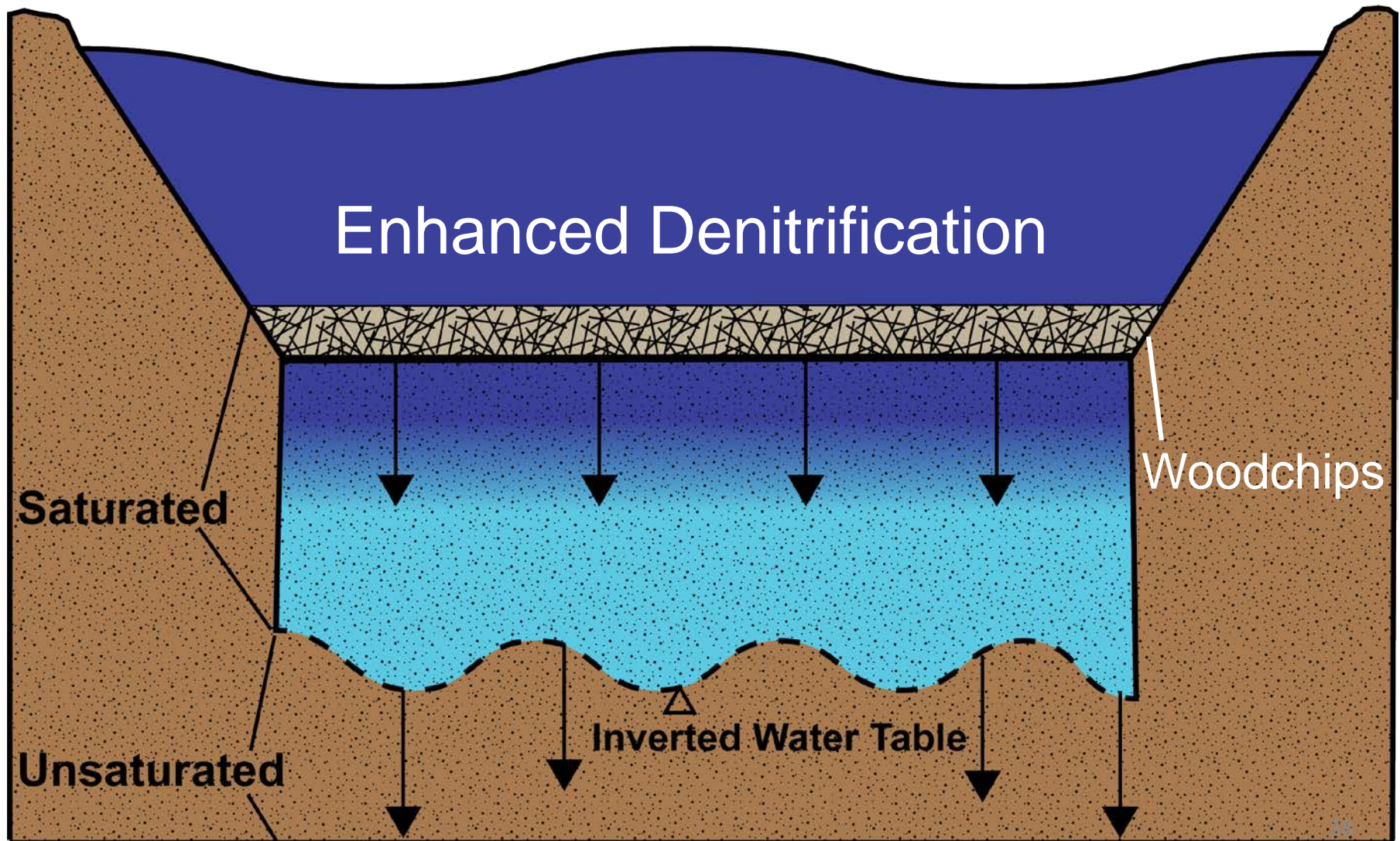
Contaminant removal
during infiltration



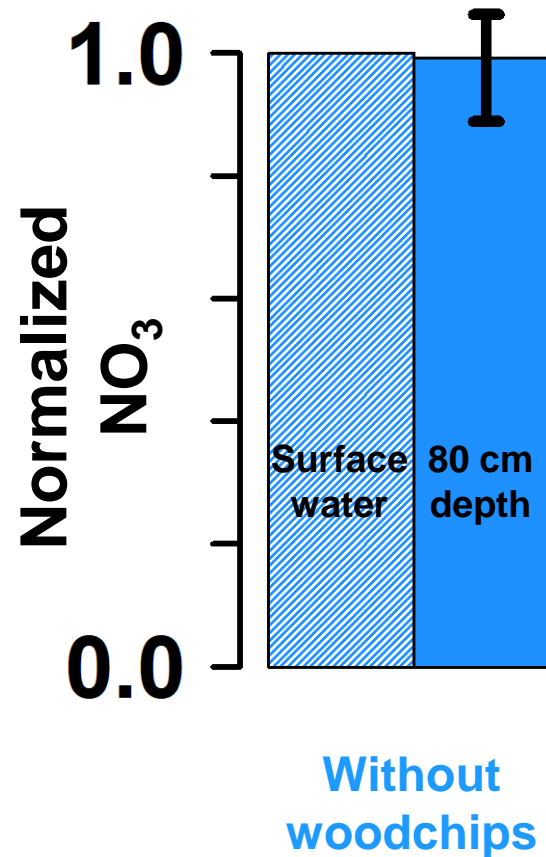
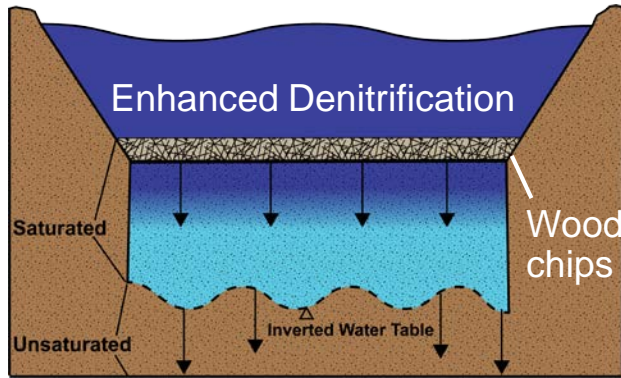
Improving water quality during infiltration



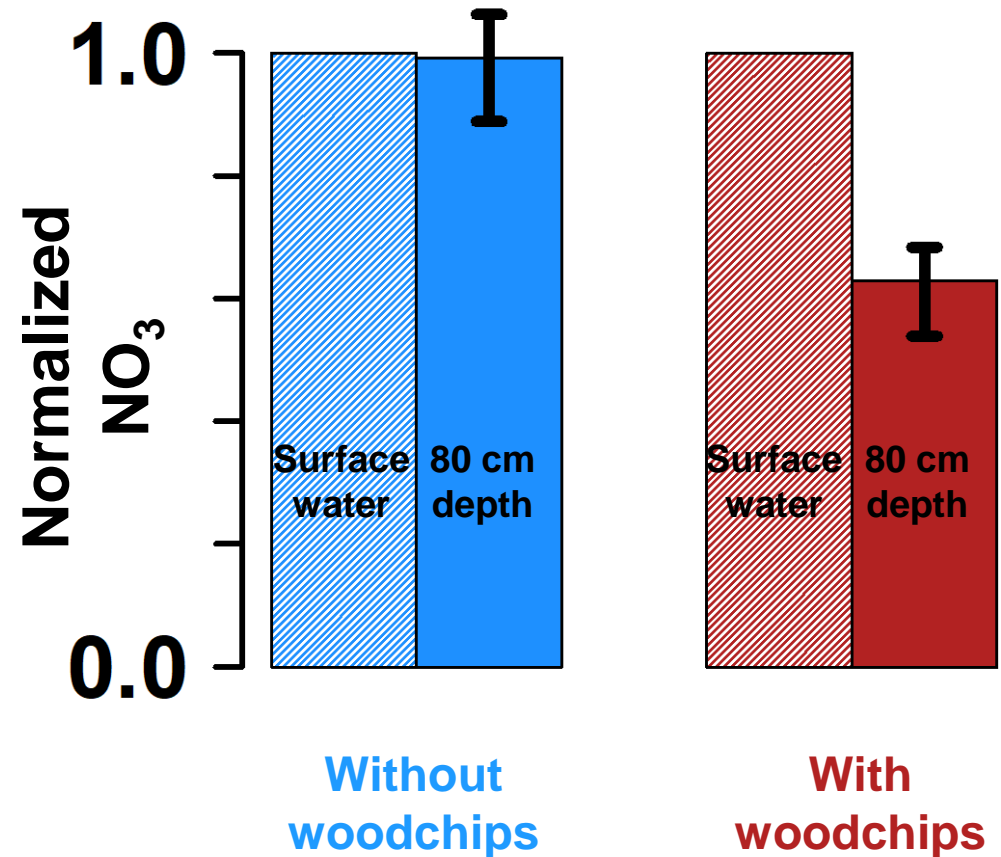
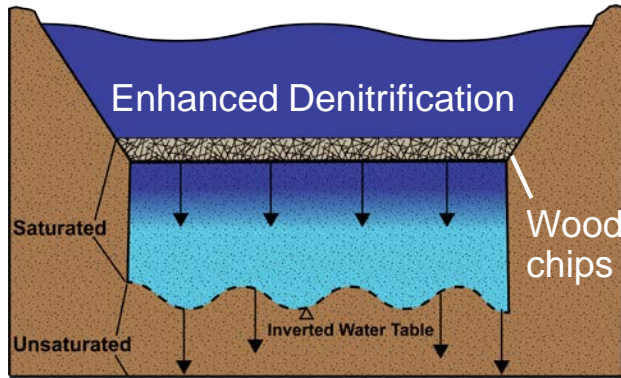
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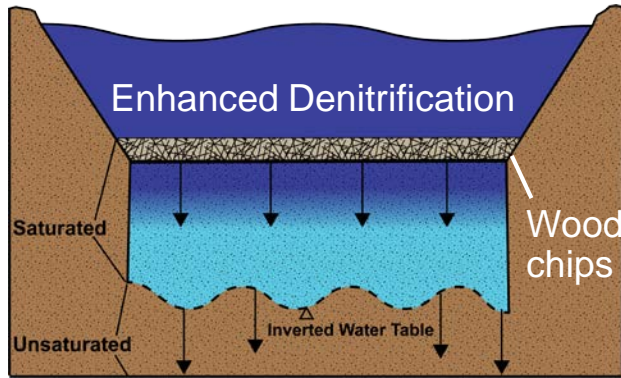
Improving water quality during infiltration



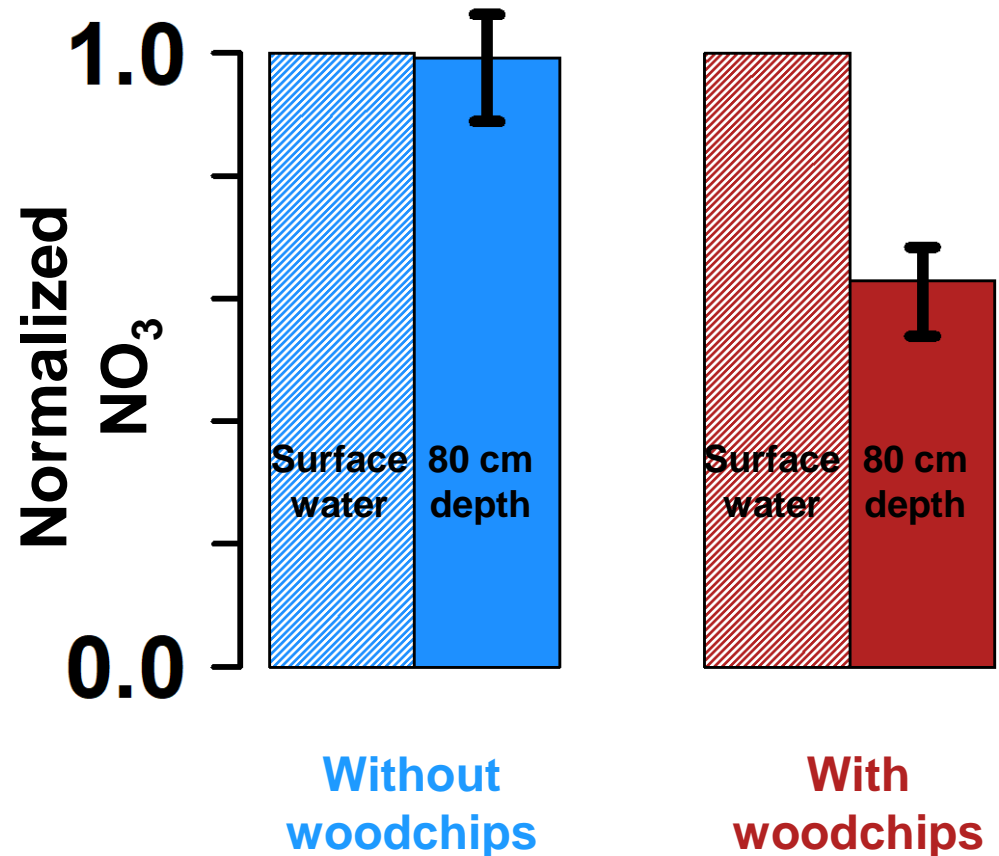
Improving water quality during infiltration



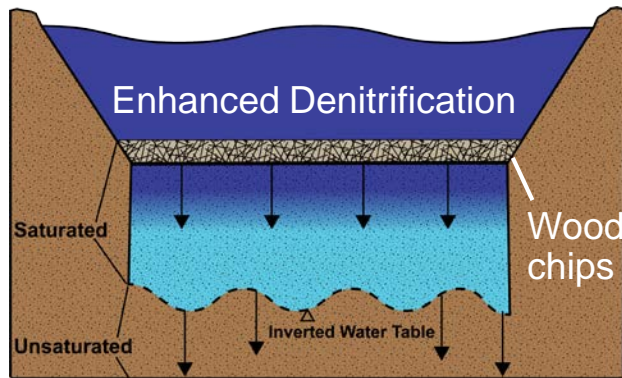
Improving water quality during infiltration



An average of **~40%** removal of nitrate was observed during infiltration in the presence of **woodchips** compared to **<1% without woodchips**

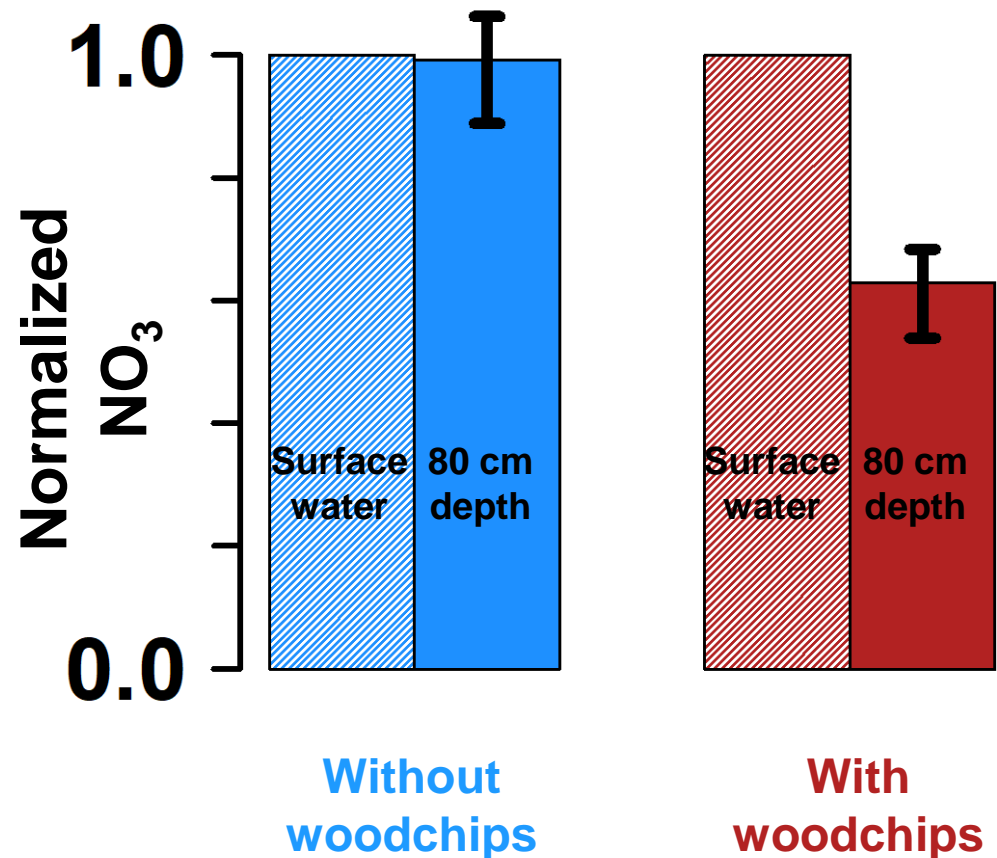


Improving water quality during infiltration

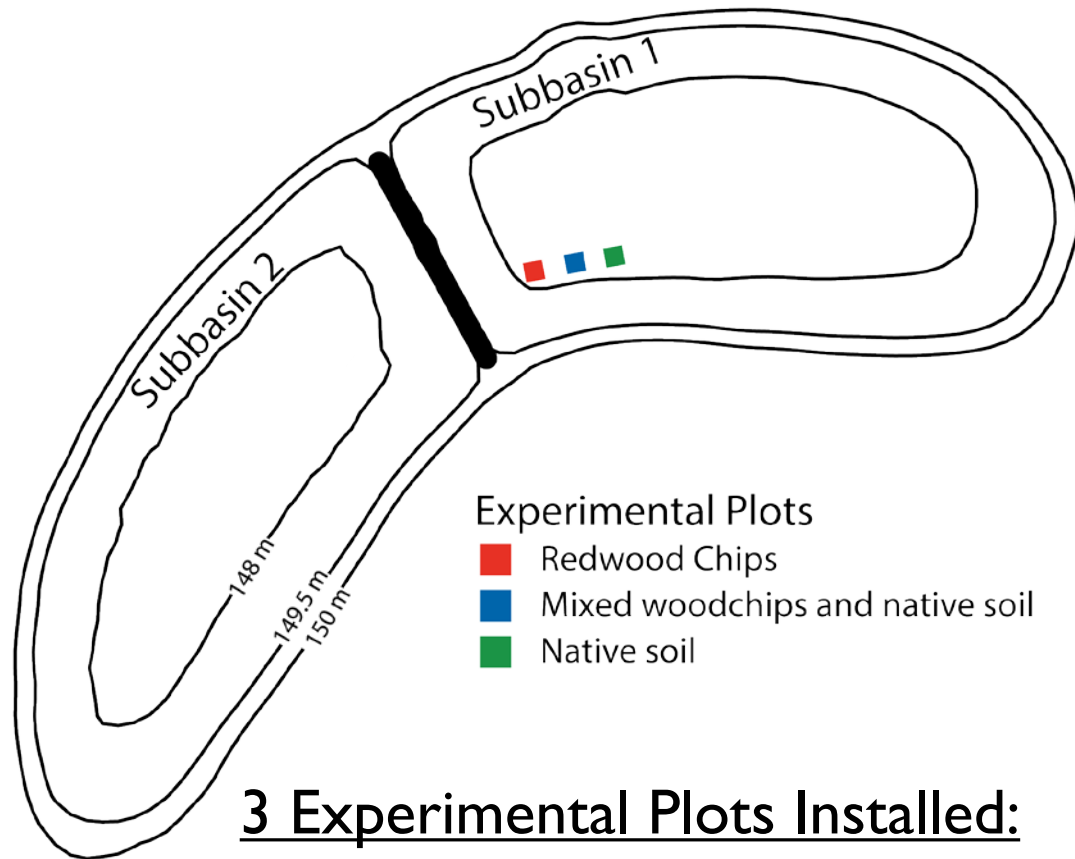


Controlled infiltration studies suggest that denitrification can be enhanced during infiltration, **but does this happen under field conditions?**

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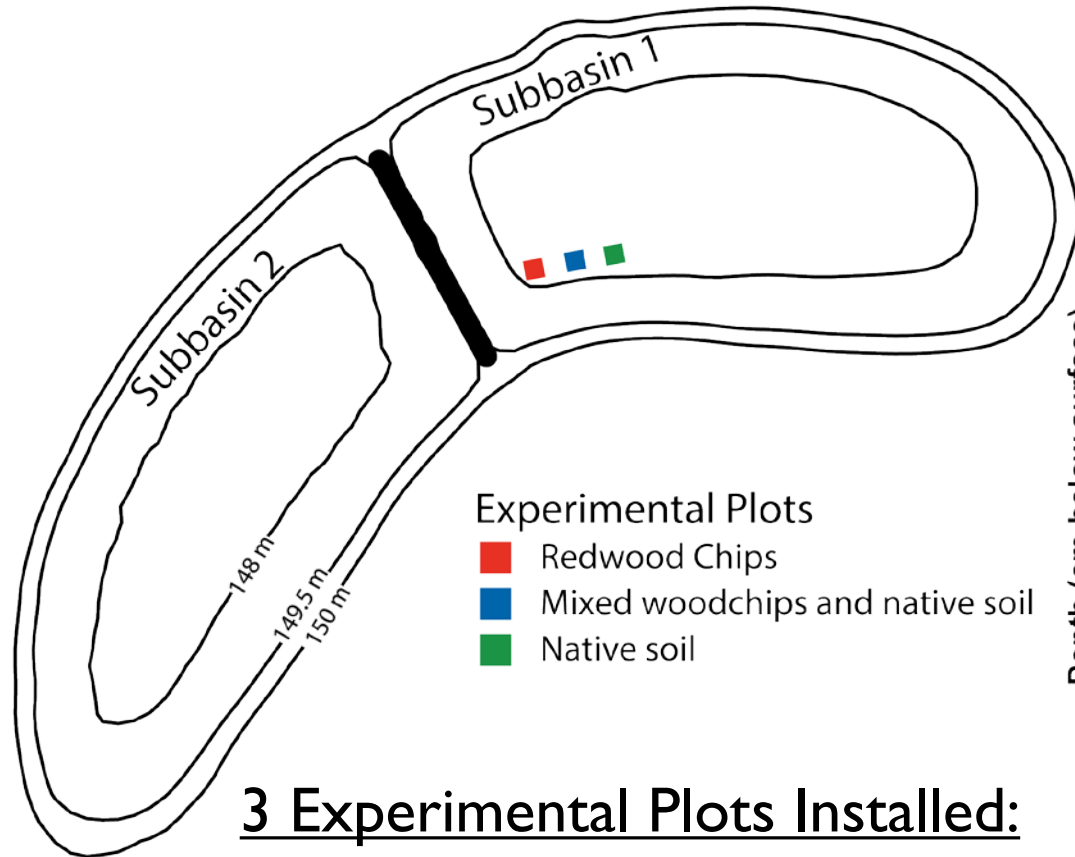
Experimental plots will facilitate testing of enhanced nitrate removal during operation



3 Experimental Plots Installed:

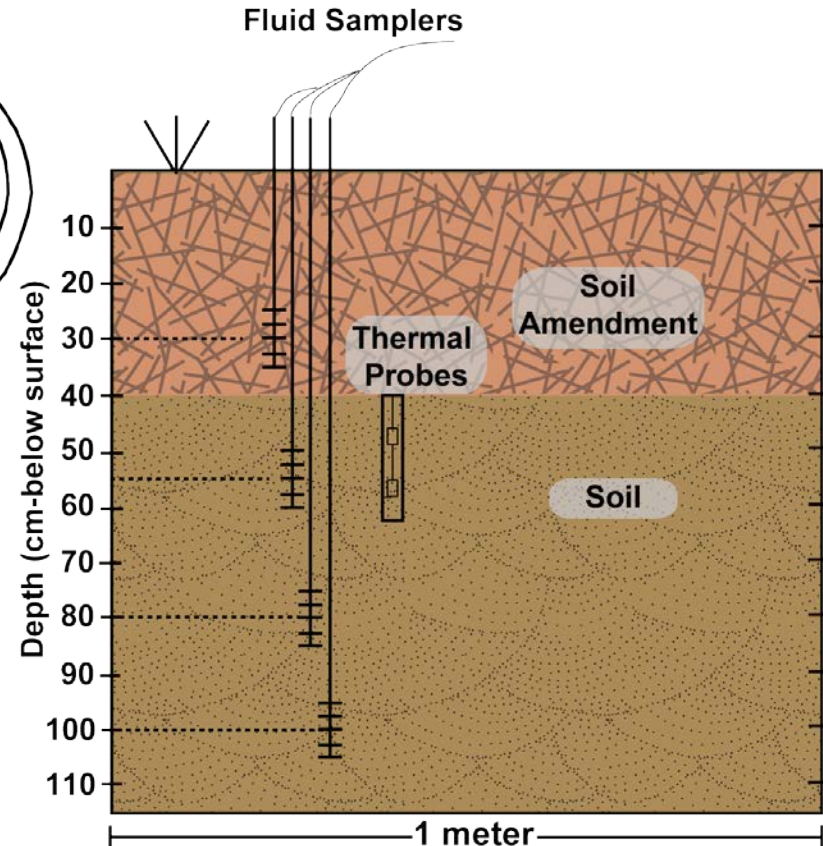
- Native Soil (control)
- Woodchips
- Woodchips:Soil Mixture (1:1)

Experimental plots will facilitate testing of enhanced nitrate removal during operation

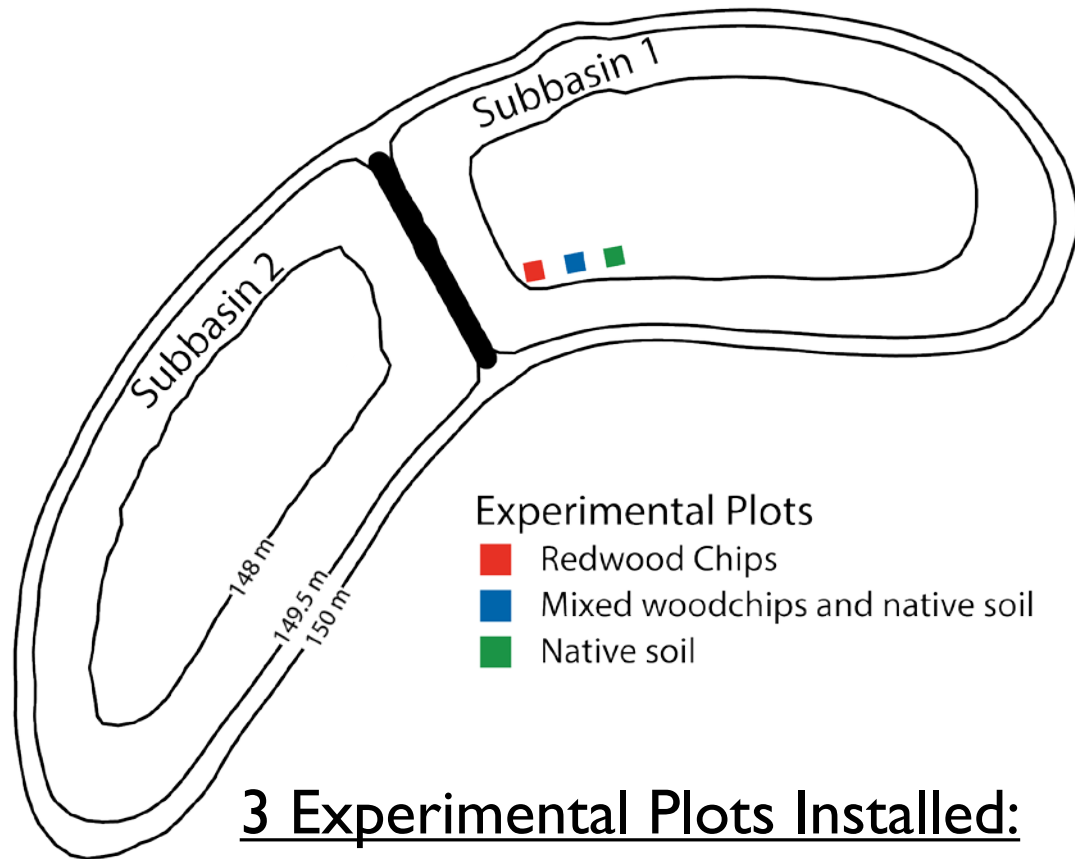


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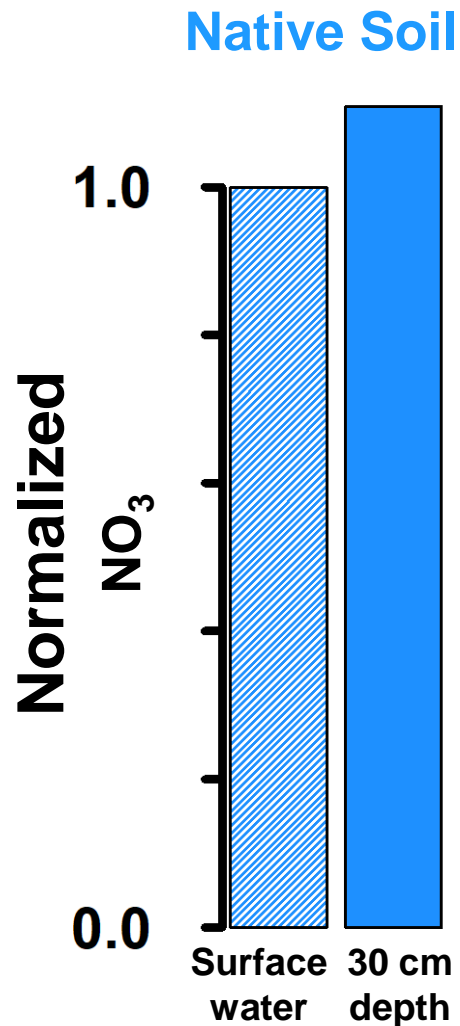
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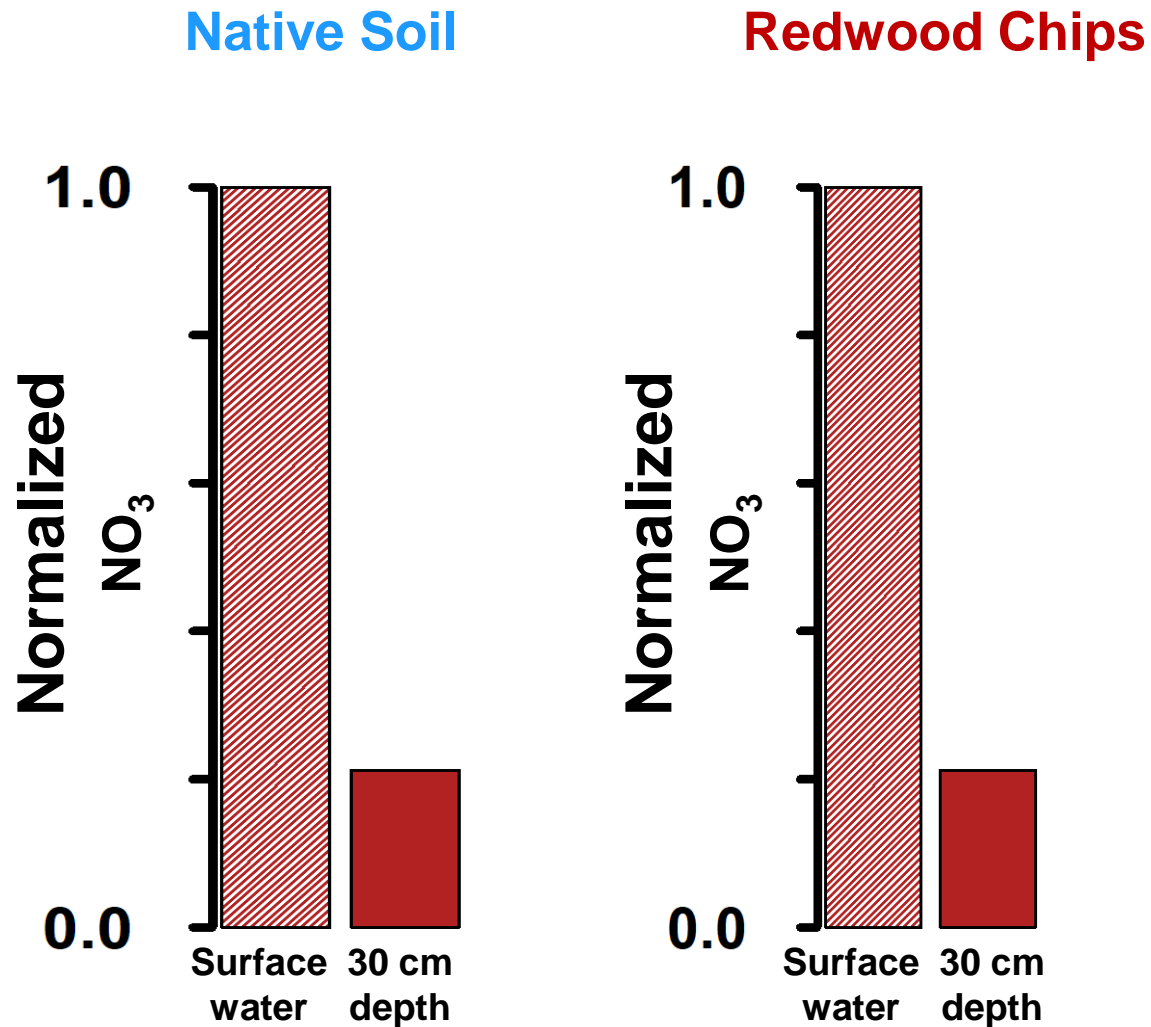
Can woodchips enhance nitrate removal during infiltration under field conditions?

Can a woodchip soil mixture provide similar nitrate removal benefit to woodchips?

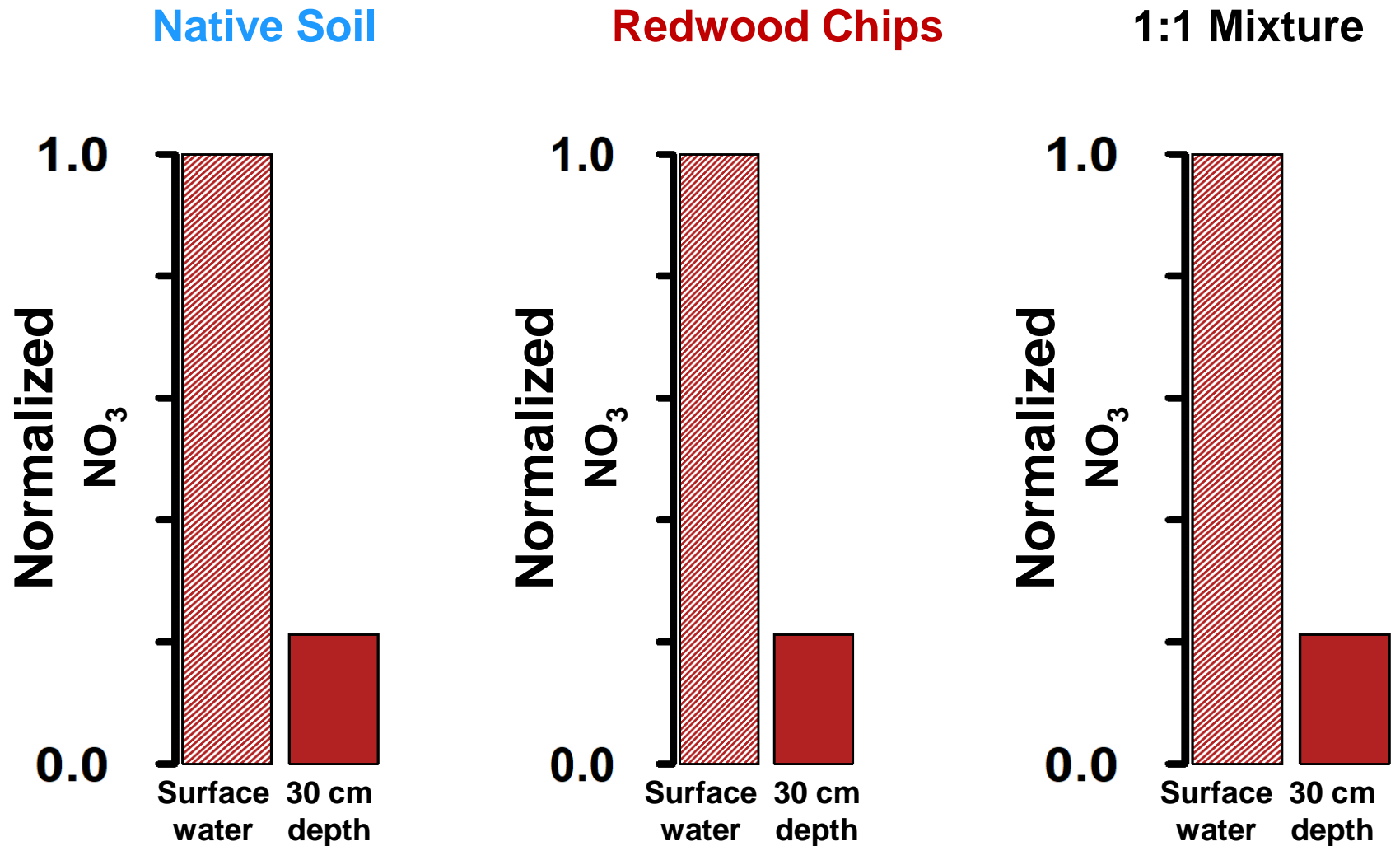
Native soil plots show little evidence of nutrient cycling during infiltration



~80% removal of nitrate within the woodchip layer



Similar removal in soil:woodchip mixture,
suggesting feasible implementation on a larger
scale

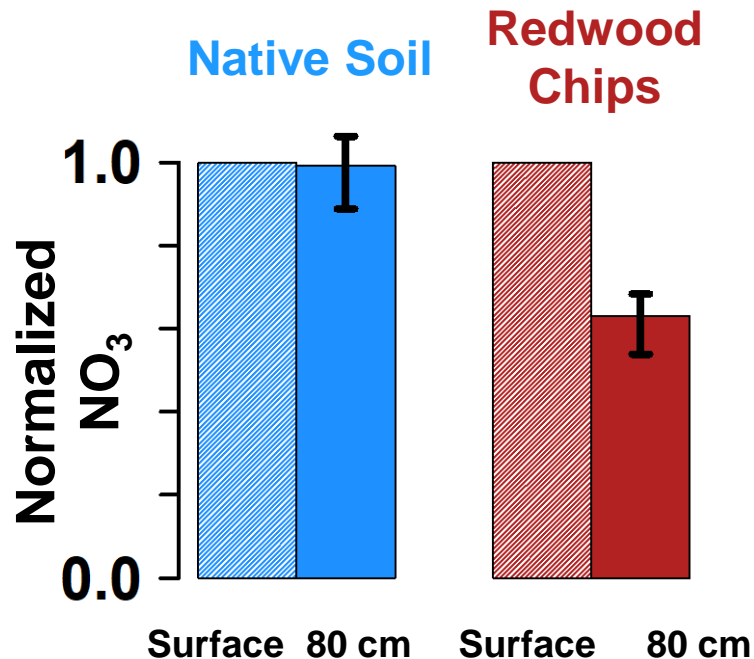


Improving water quality during infiltration

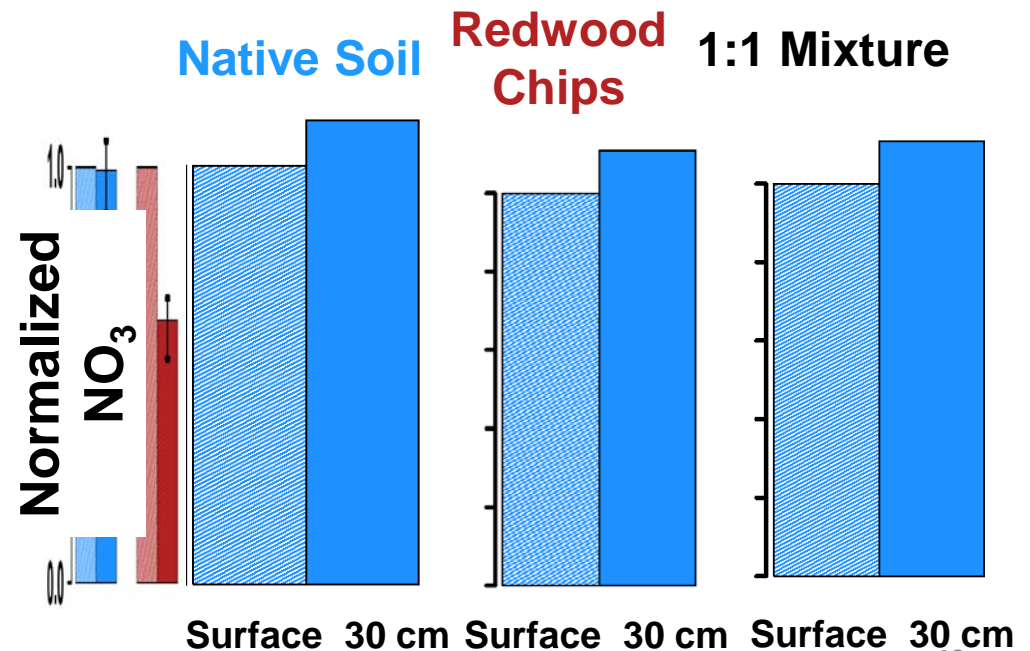
Water quality can be effectively improved during infiltration using woodchips

Soil woodchip mixture may offer a viable implementation technique

Controlled Infiltration Experiments

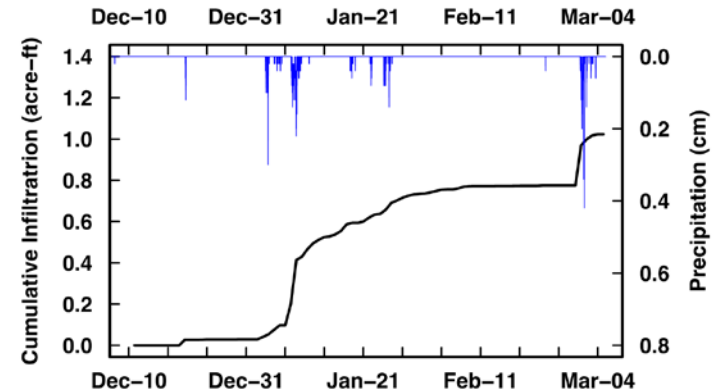


Field Results



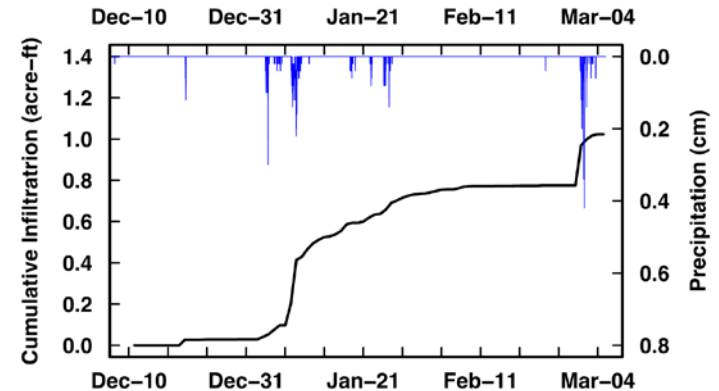
Simultaneously addressing water quantity and quality with MAR

System has collected and infiltrated ~1 acre-ft of water in a dry winter so far

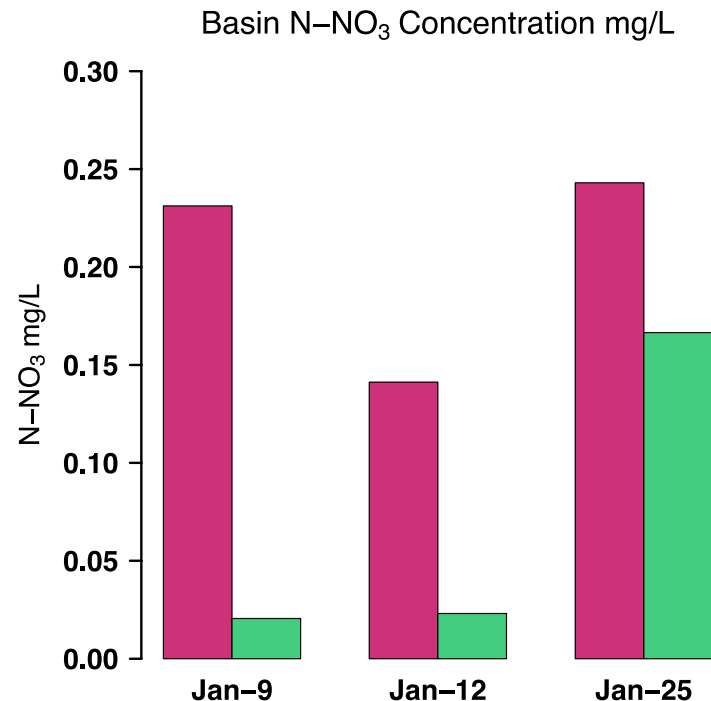


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Initial runoff water quality is high

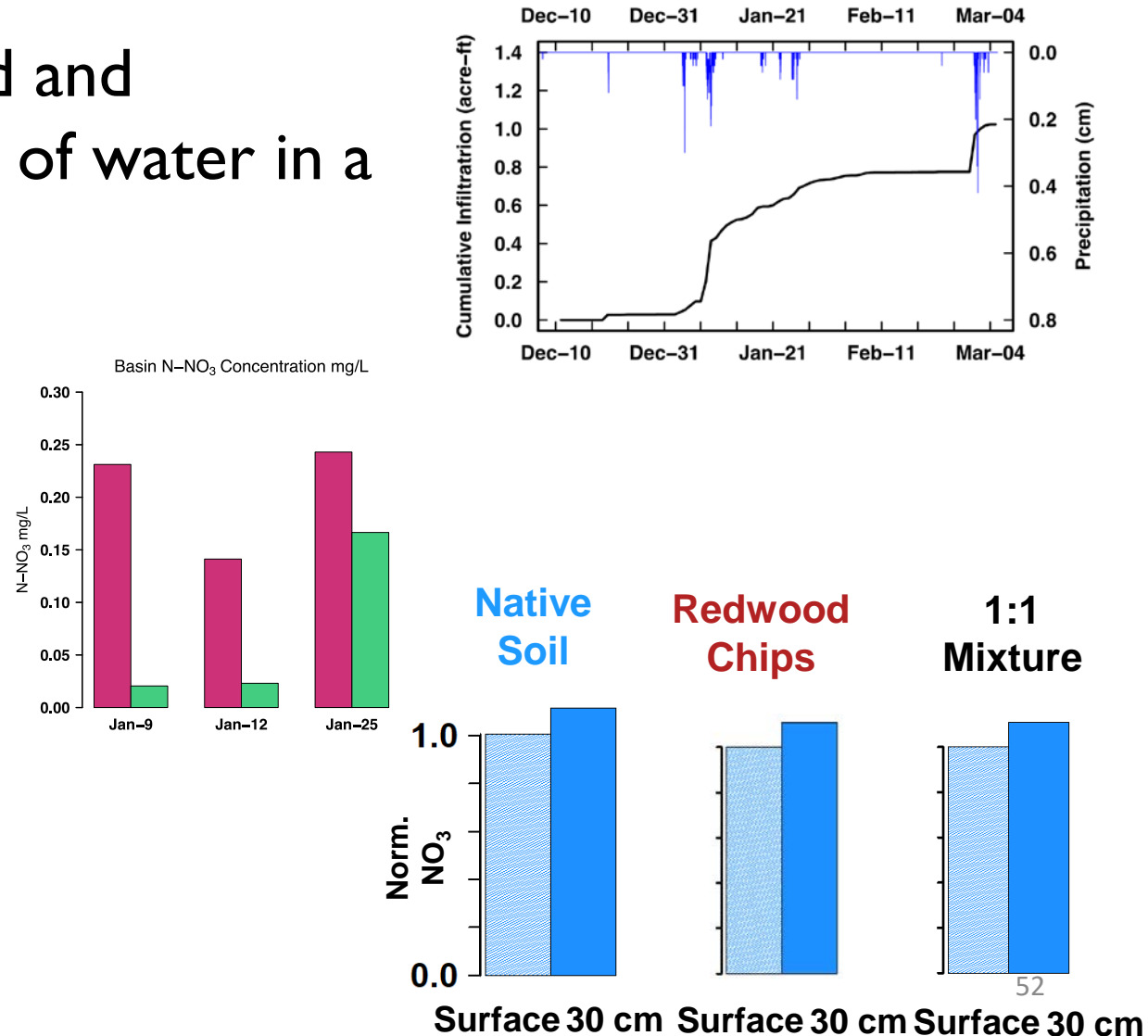


Simultaneously addressing water quantity and quality with MAR

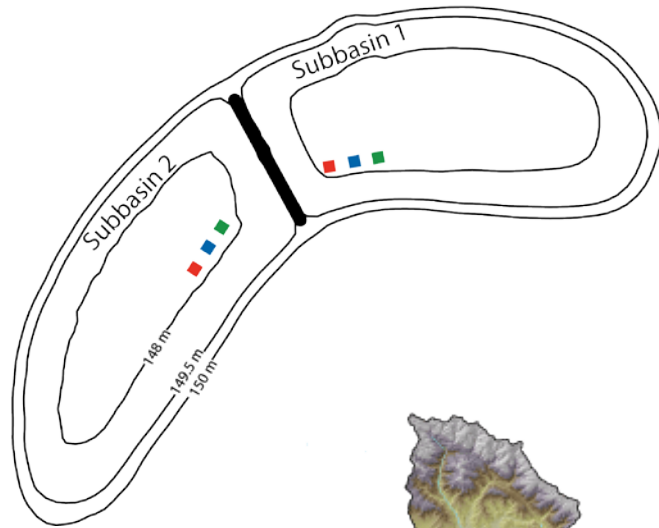
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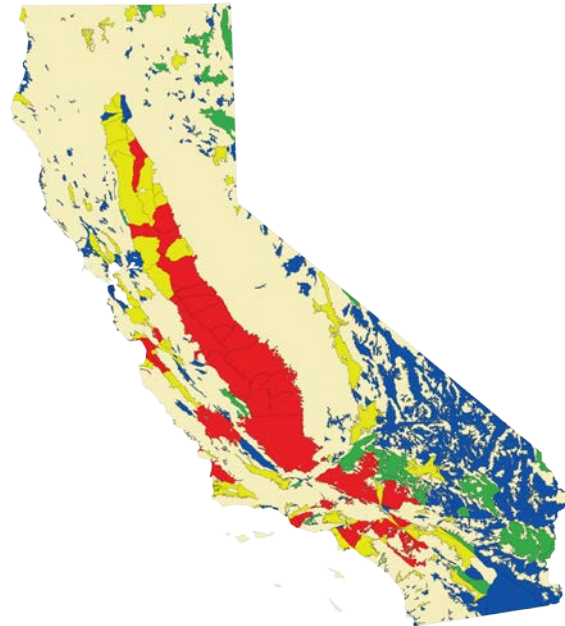
Nitrate removal can be enhanced during infiltration



Providing a pilot for future projects



Methods and data from this project can inform future projects across the basin and throughout the state



Thank you!

Acknowledgements

Sarah Farola, Paige Borges,
Jenny Pensky, Araceli Serrano,
Dan Sampson, Stephen and
Pamela Storrs, Kelli Camara, Bill
Rice, Sarah Beganskas, Mark
Burnett, Ryan Nyberg, Walker
Weir, Tyler Stewart, Dom van
den Dries, Rob Franks,

Contact:
ggorski@ucsc.edu



GORDON AND BETTY
MOORE
FOUNDATION



 **The Recharge Initiative**
Replenish • Recover • Restore

Sampling storm events

