

# Who gives a flux about the vadose zone?

*Why do we care and how do we monitor flow through unsaturated sediments?*

***Presented by:***

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# Gold Creek Return Flow Pilot Study

## Goal

Identify and quantify potential benefits of early season, aggressive irrigation on soil moisture, agricultural production, and local hydrology

## Objectives

- Quantify effects of early season irrigation on:
  - Soil moisture bank
  - Agricultural production
  - Aquifer levels and streamflows
- Quantify infiltration past the root zone



Evaluate feasibility of this approach for an agricultural operation, including challenges and benefits.

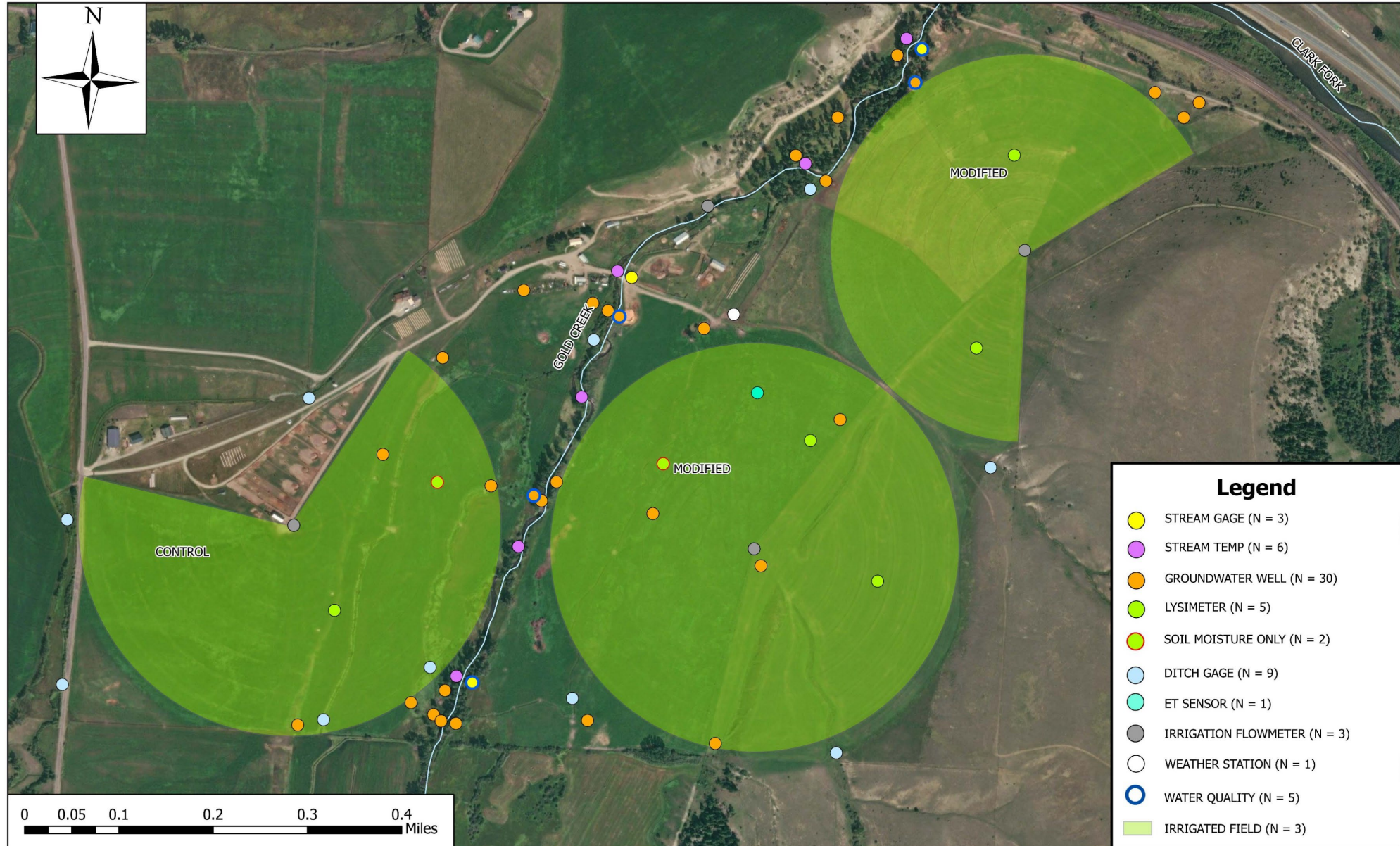
## Experimental treatment

- Run east side pivots as early as possible
- Maintain aggressive irrigation schedule
- Reduce irrigation once flows drop
- Do not alter west side pivot irrigation

## Monitoring

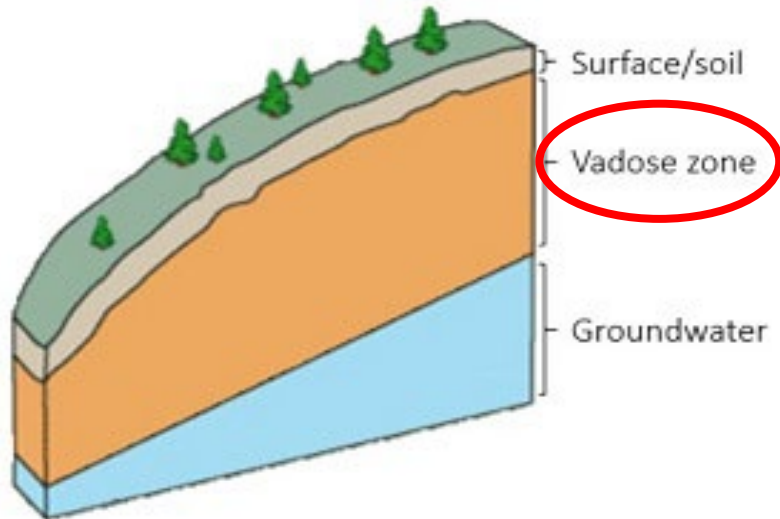
- Stream flows
- Groundwater
- Irrigation use & ditch seepage
- Stream temperature
- Water quality
- Agricultural productivity
- Evapotranspiration
- Weather station
- Soil variables:
  - Passive flux lysimeters
  - Soil moisture
  - Soil water potential
  - Infiltration

# GOLD CREEK RETURN FLOW STUDY MONITORING



# The *mysterious* vadose zone

“The unsaturated zone between the groundwater table and surface”



Source: National Institute of Environmental Health Sciences

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$$\begin{array}{ccccccc} \text{INs} & & \text{OUTs} & & \text{Storage} & & \\ \text{P} + \text{IRR} & = & \text{ET} + \text{R} + \text{DP} & + & \Delta\text{S} & & \\ \text{Precipitation} \quad \text{Irrigation} & & \text{Evapotranspiration} & & \text{Surface runoff} \quad \text{Deep percolation} & & \text{Soil water storage} \end{array}$$

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- Soil water balance
- Easy to monitor:
  - Precipitation
  - Irrigation
  - Surface runoff
  - Soil water storage
- Difficult to monitor:
  - Evapotranspiration
  - Deep percolation
  - Soil water storage
- Intrusive monitoring
- Highly dependent on:
  - Soil type
  - Soil thickness
  - Aquifer conditions
- Necessity for representative sites across study area

# Soil water balance stations

## INs

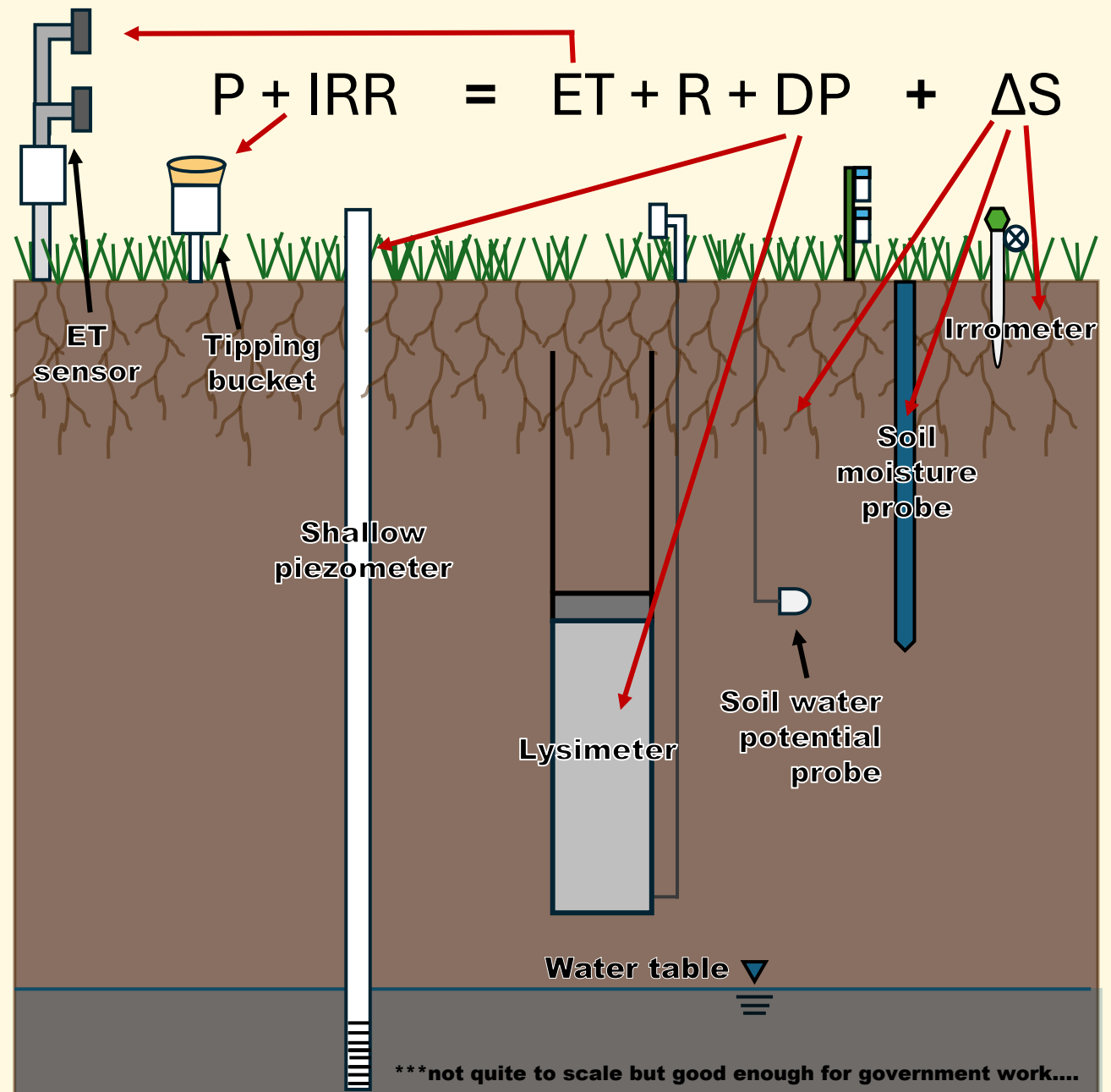
- **Precipitation & IRRigation**  
Tipping bucket installed below pivot nozzles, pivot flow meters and unirrigated background rain gauge

## OUTs

- **EvapoTranspiration**  
Moveable ET sensor
- **Runoff**  
Ditch gages
- **Deep Percolation**  
Lysimeters, shallow piezometers

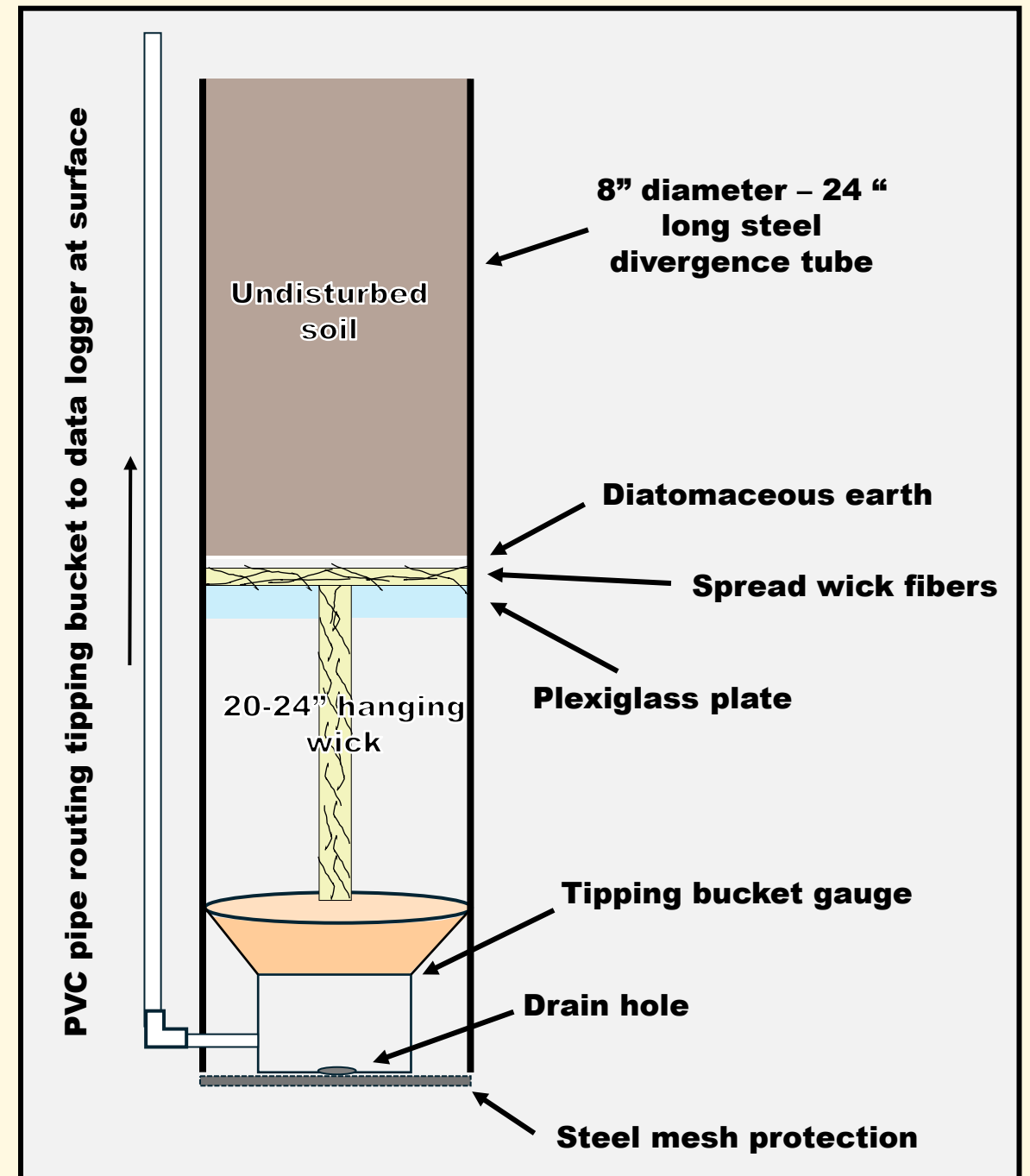
## $\Delta S$

- **Change in Storage**  
Soil moisture probe, irrometer & soil water potential (gradient)



# Passive flux wick lysimeters

- Literature based design
- Rigorous lab tested
- Wick maintains soil tension in profile
- Driven divergence tube ensures minimally disturbed soil
- Installed roughly 6"-12" below ground surface
- Sampling depth roughly 30"-36" below ground surface (below observed root zone)
- Total depth 6' – 7'
- **Borderline reckless faith** in tipping bucket gauges



# Installation: Divergence tube



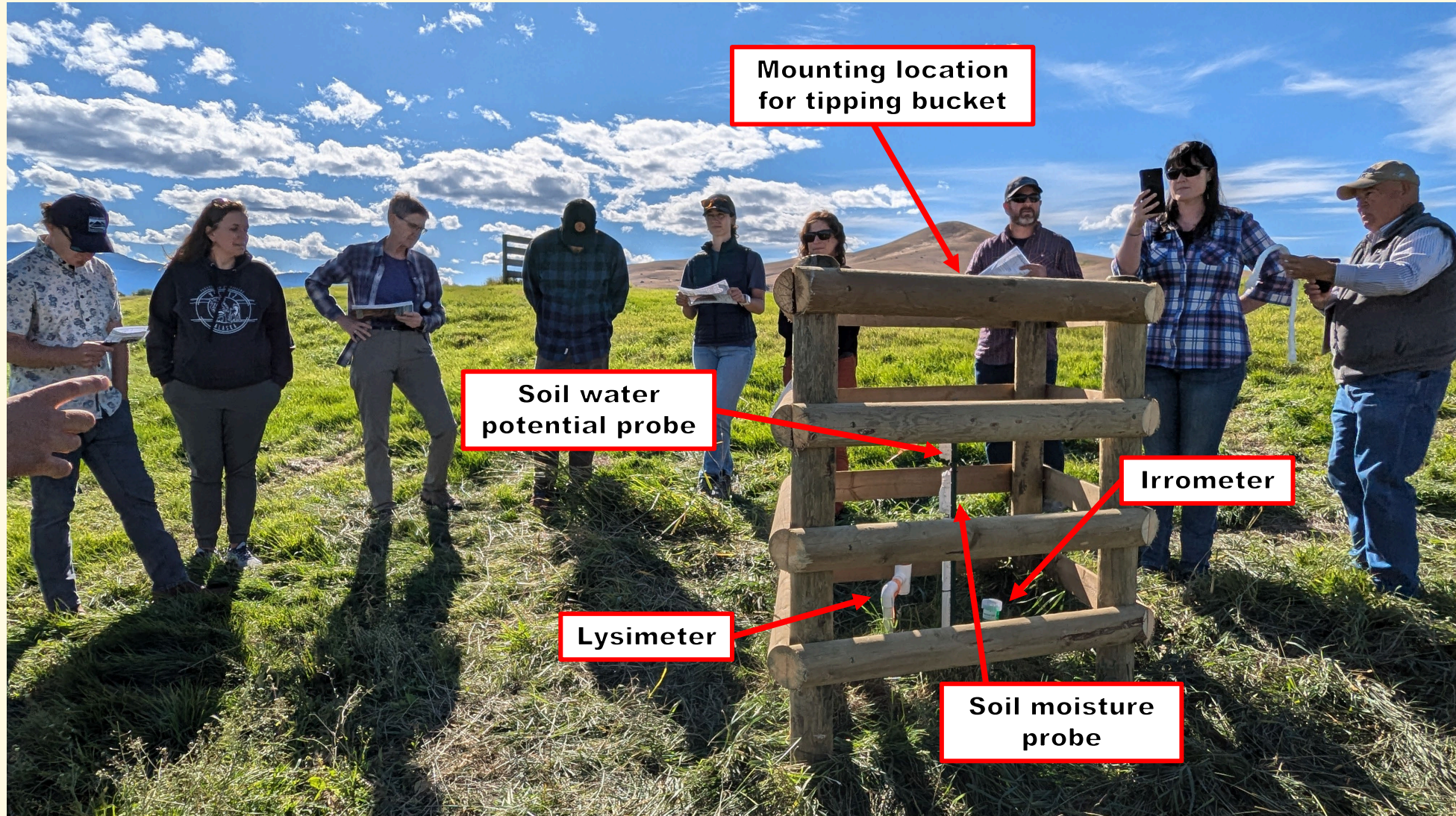
# Installation: The pit



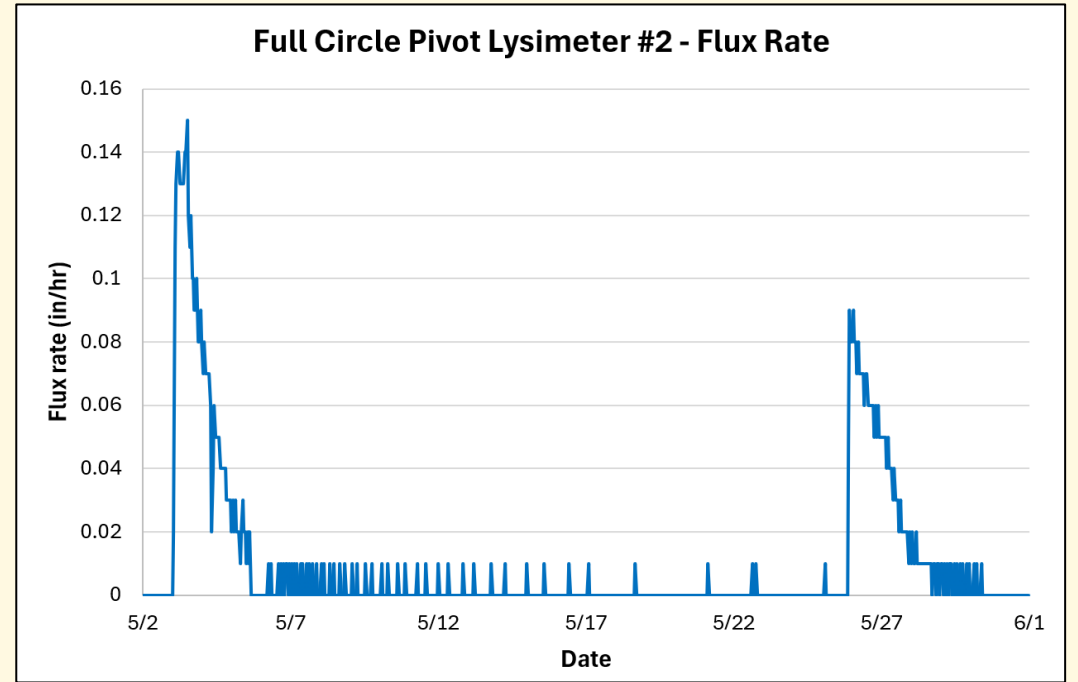
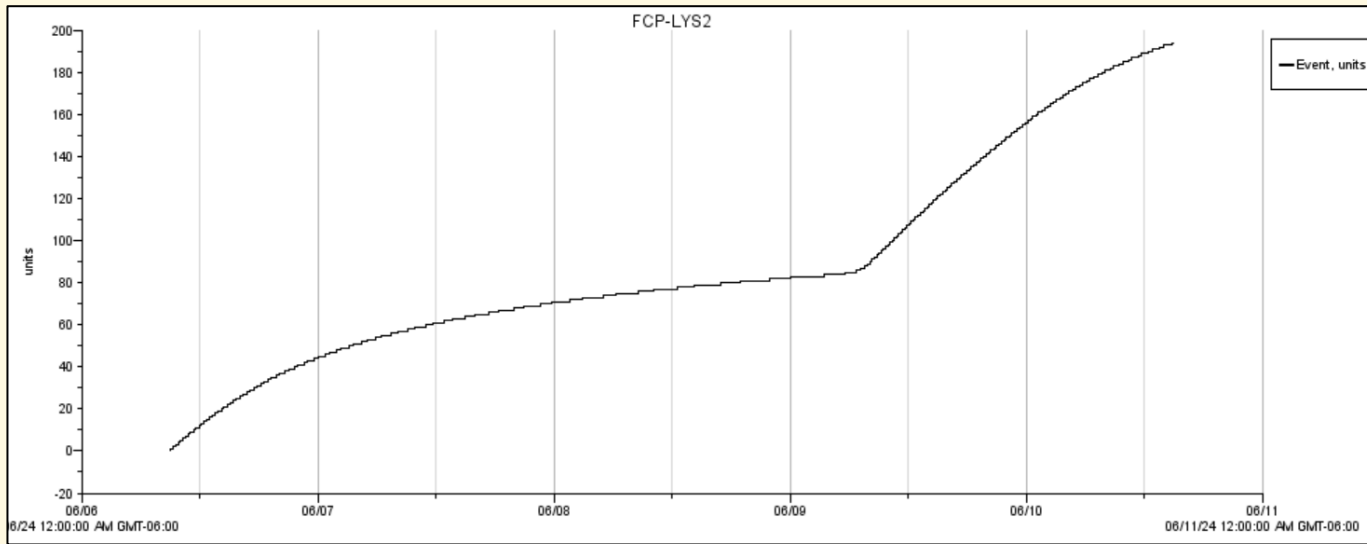
# Installation: Lysimeter



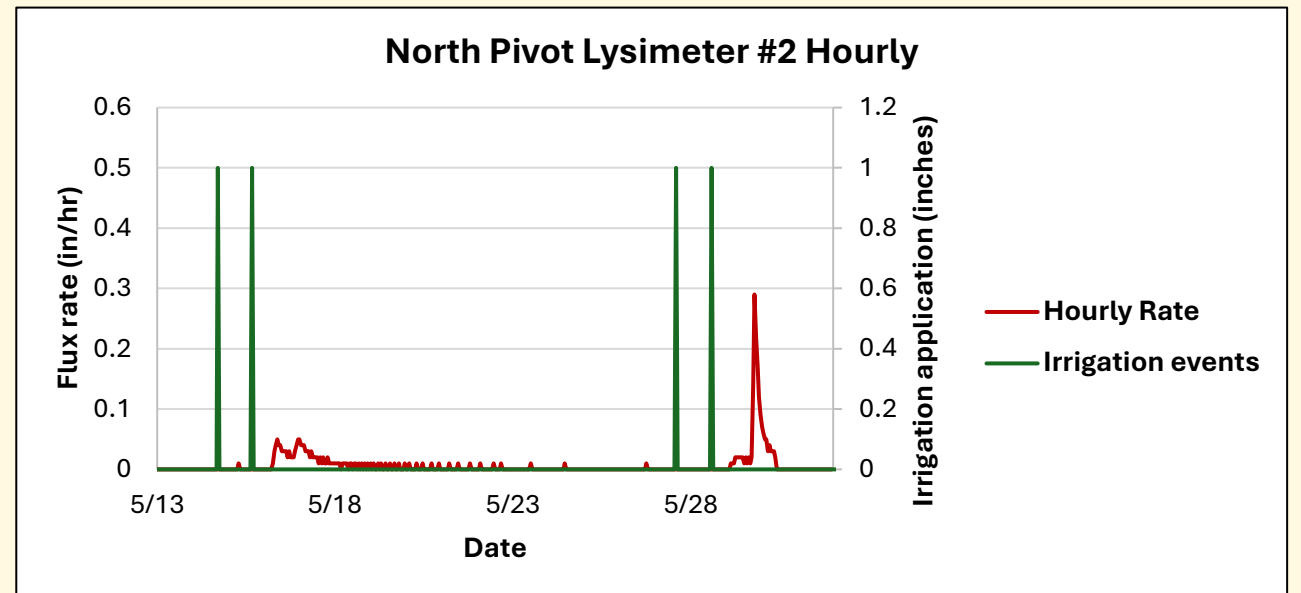
# Installation: Enclosures



# The Data



- Event based dataset
- Ultimately pair with:
  - Irrigation
  - Precipitation
  - ET
  - Compared site to site



# Work to be done...

- Control year complete, WY24
- Modified irrigation schedule in WY25, 26
- Routine monitoring
- Continued improvement of monitoring with operating ranch
- Deployment of ET sensor throughout study area
- Testing of “office” lysimeter



# The people that make it possible....



# Buried in data...



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