Integrated Hydrologic Modeling for Flow Availability Analysis and Streamflow Enhancement Planning

Matt O'Connor, PhD, CEG
Jeremy Kobor, MS, PG

GOLD RIDGE RESOURCE CONSERVATION DISTRICT

COAST RANGE WATERSHED INSTITUTE

Pepperwood PRESERVE
Inspiring conservation through science

REGIONAL PARKS SONOMA COUNTY

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SONOMA RESOURCE CONSERVATION DISTRICT

FRIENDS OF THE MARK WEST WATERSHED · CALIFORNIA ·

Mark West Creek

To be completed early 2021

Sonoma RCD
Pepperwood Preserve
Friends of the Mark West Watershed
Sonoma County Regional Parks

WCB funding

Mill Creek

To be completed early 2021

Sonoma RCD
Trout Unlimited

WCB funding

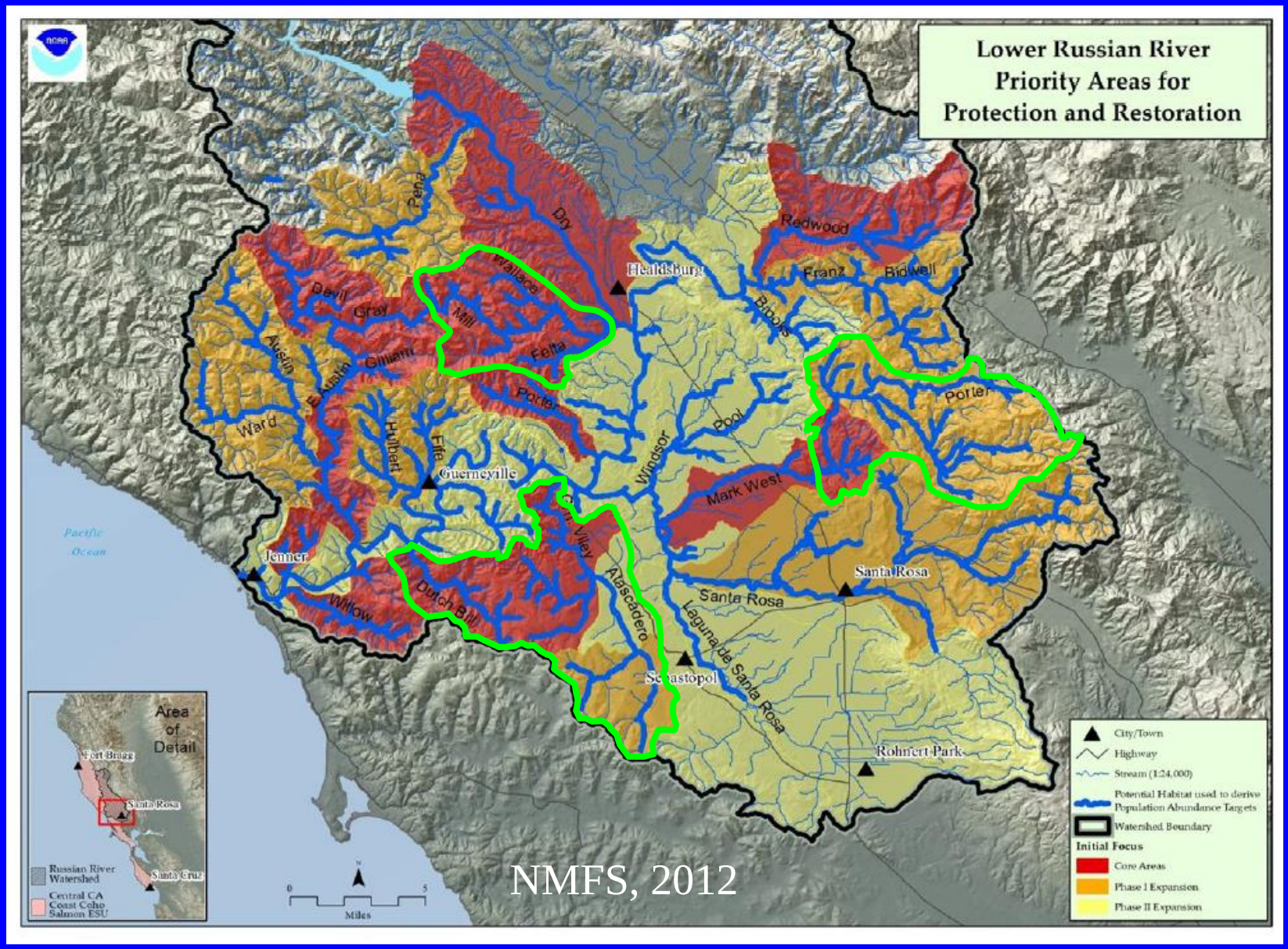
Green Valley, Atascadero & Dutch Bill Creeks

Completed 2016

Gold Ridge RCD

FRGP funding

Study Areas



NMFS, 2012

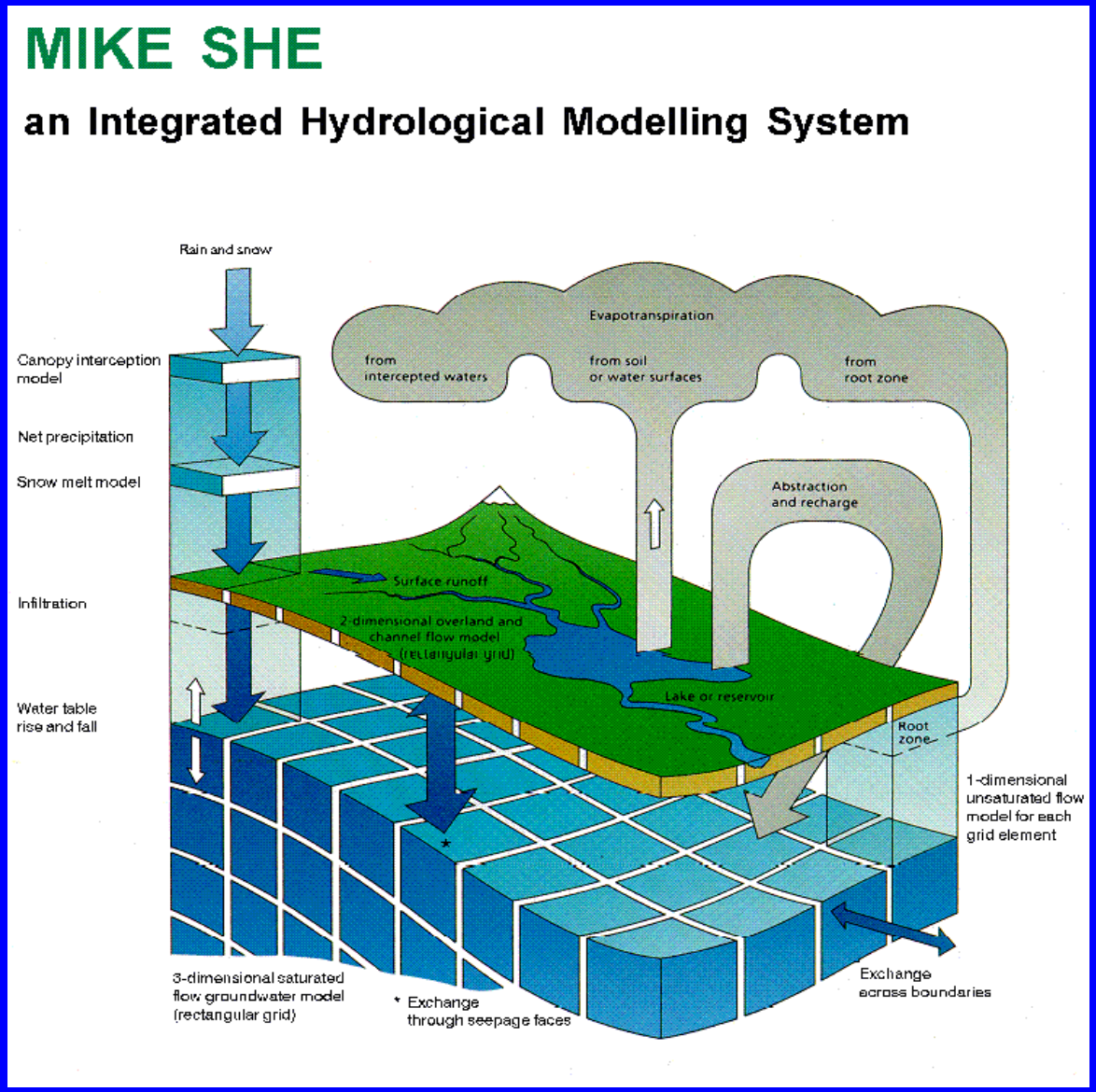
Motivation

- Address insufficient summer streamflow as a key limiting factor for coho recovery
  - Controlling processes are complex
  - Incomplete knowledge (we can't monitor everywhere)
- Effective recovery efforts require prioritization
  - Recovery plans identify hundreds of river miles as high priority where should projects be developed for maximum benefits?
  - Unclear which strategies will be effective in which areas water use modifications, recharge enhancement, geomorphic adjustments, and/or flow releases?
- Many challenges
  - Increasing water demands, drought, climate change…

Approach

- Numerical Hydrologic Model ≈ MANAGEMENT TOOL
  - Data synthesis and comprehensive and objective description of hydrologic conditions and processes
- Utilize hydrologic simulation model to:
  - Predict location and quantity of surface flows relative to salmonid requirements under different climate conditions
  - Evaluation of cumulative effects of land and water use on stream flow
  - Prioritize reaches for restoration based on flow availability-based habitat indices
  - Predict effectiveness of various strategies to maintain or enhance summer stream flow

Model Overview



Precipitation

Evapotranspiration

Overland Flow

Unsaturated Flow

Groundwater Flow

River and Lakes

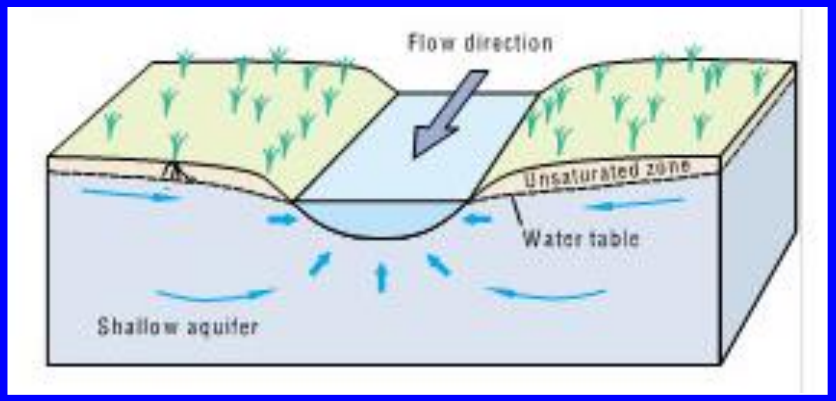
Irrigation/Water Use

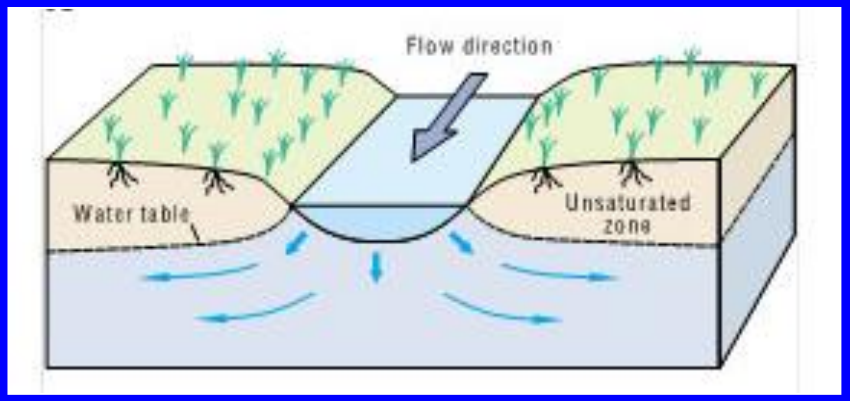
Sediment Transport

Temperature and Water Quality

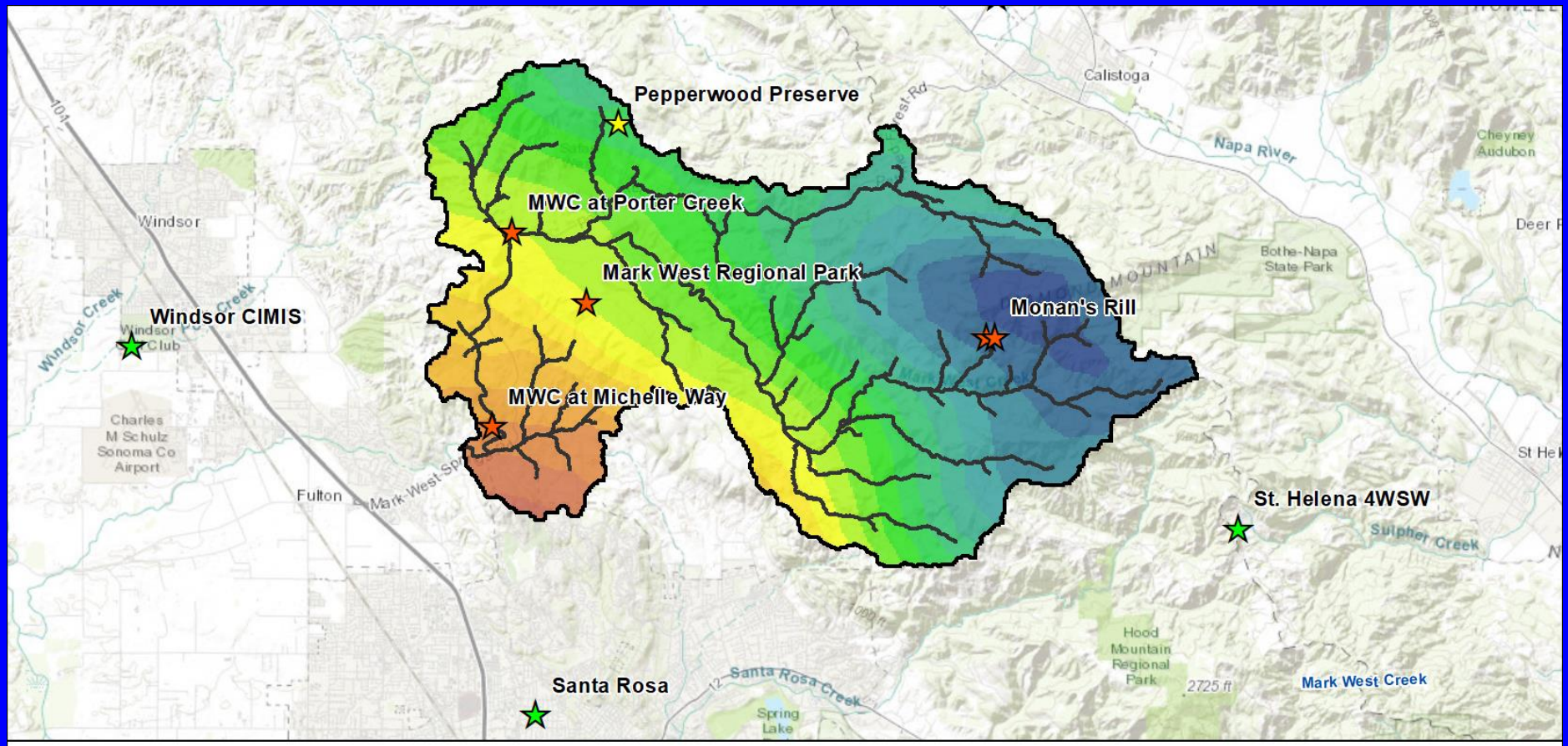
Surface Water/Groundwater Interaction

- Physically-based representation
  - Simulates aquifer hydraulic heads and stream stages
  - Simulates exchanges based on head gradients and aquifer and stream bed hydraulic conductivities
  - Gaining and losing reaches can vary spatially and temporally

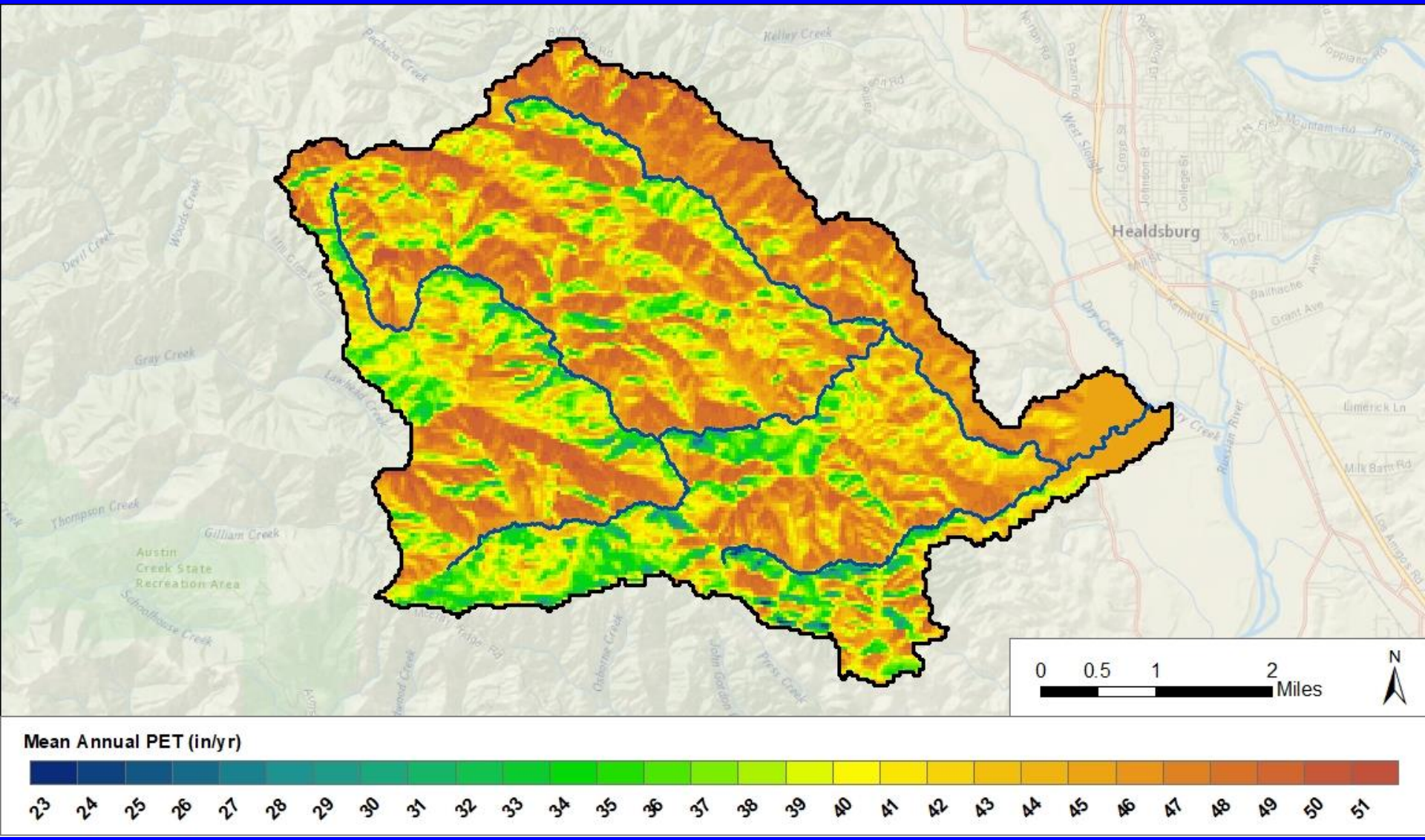




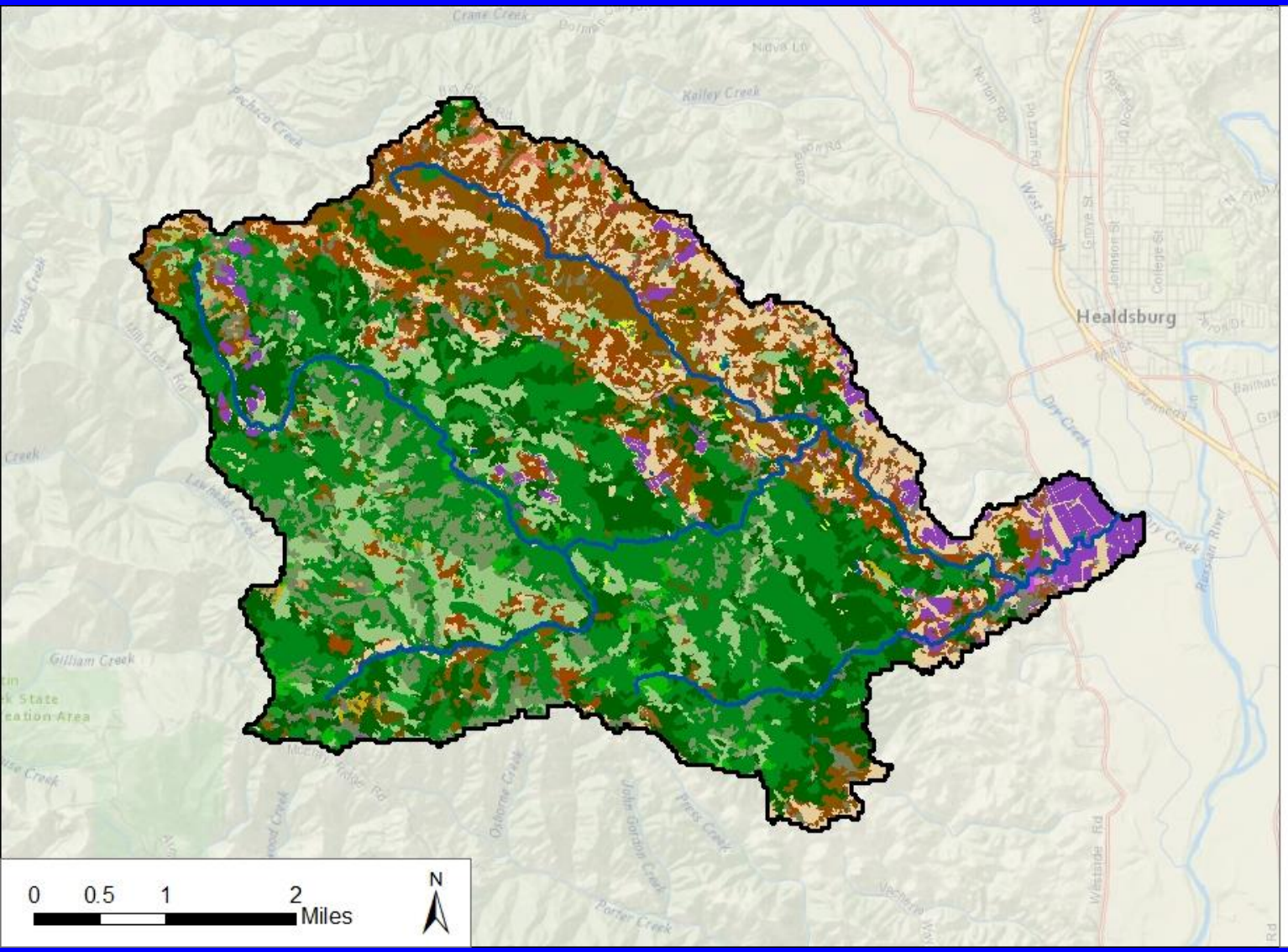
Mark West Creek Rainfall



Mill Creek Potential Evapotranspiration (PET)



Mill Creek Land Cover



Conifer
- Sargent's Cypress
- Douglas Fir & Tanoak
- Douglas Fir
- Coastal Redwood

Hardwood
- Bigleaf Maple
- Pacific Madrone
- Tanoak
- Mixed Oak Forest
- Coast Live Oak
- Oregon White Oak
- California Black Oak
- Valley Oak
- Interior Live Oak
- California Bay

Riparian Forest
- Vancouverian Riparian Forest

Shrub
- Chamise
- Mixed Chaparral
- Coyote Shrub

Herbaceous
- Annual & Perennial Grassland

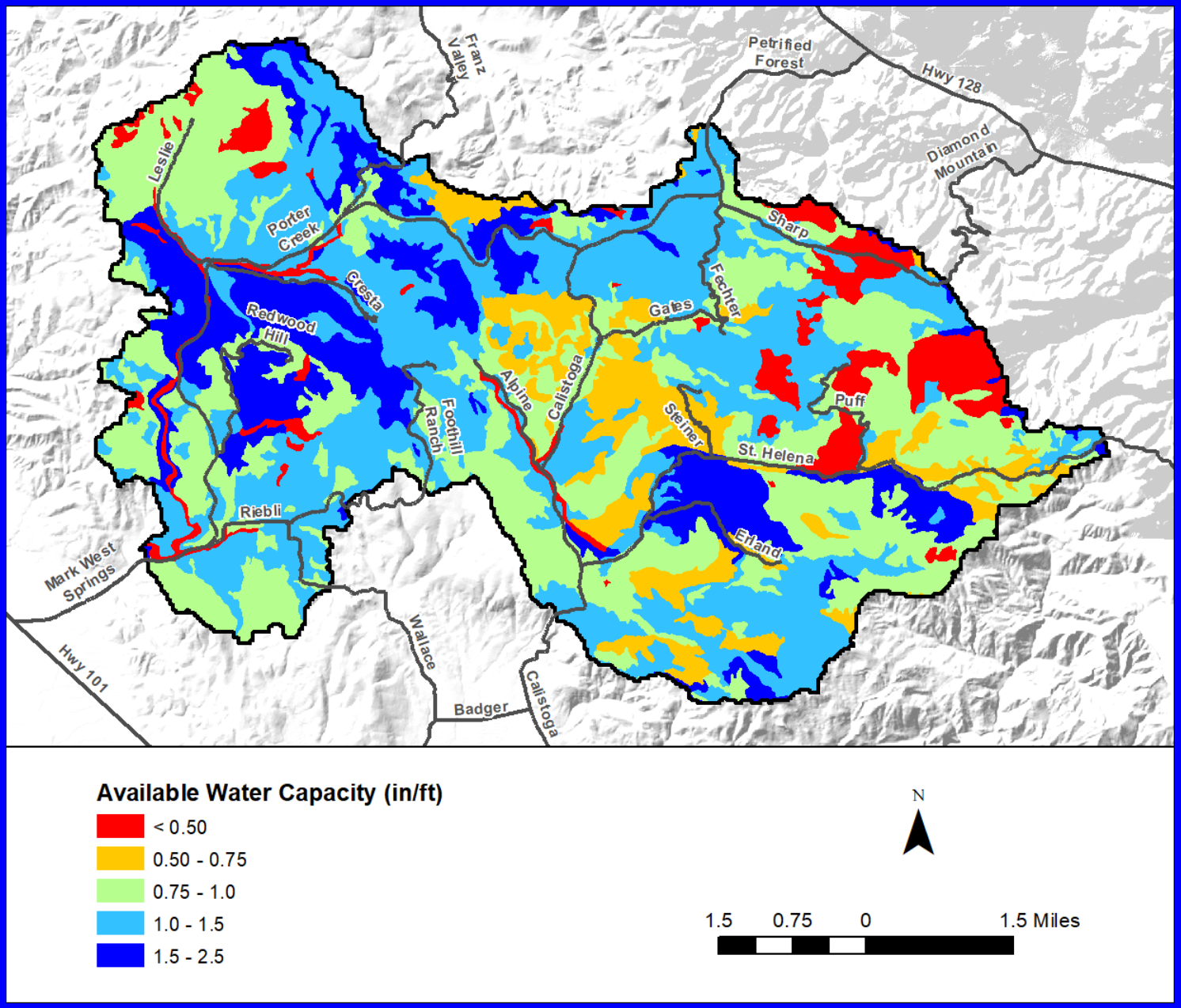
Agriculture
- Annual Cropland
- Orchard or Grove
- Vineyard

Non-native Forest and Shrub
- Non-native Shrub

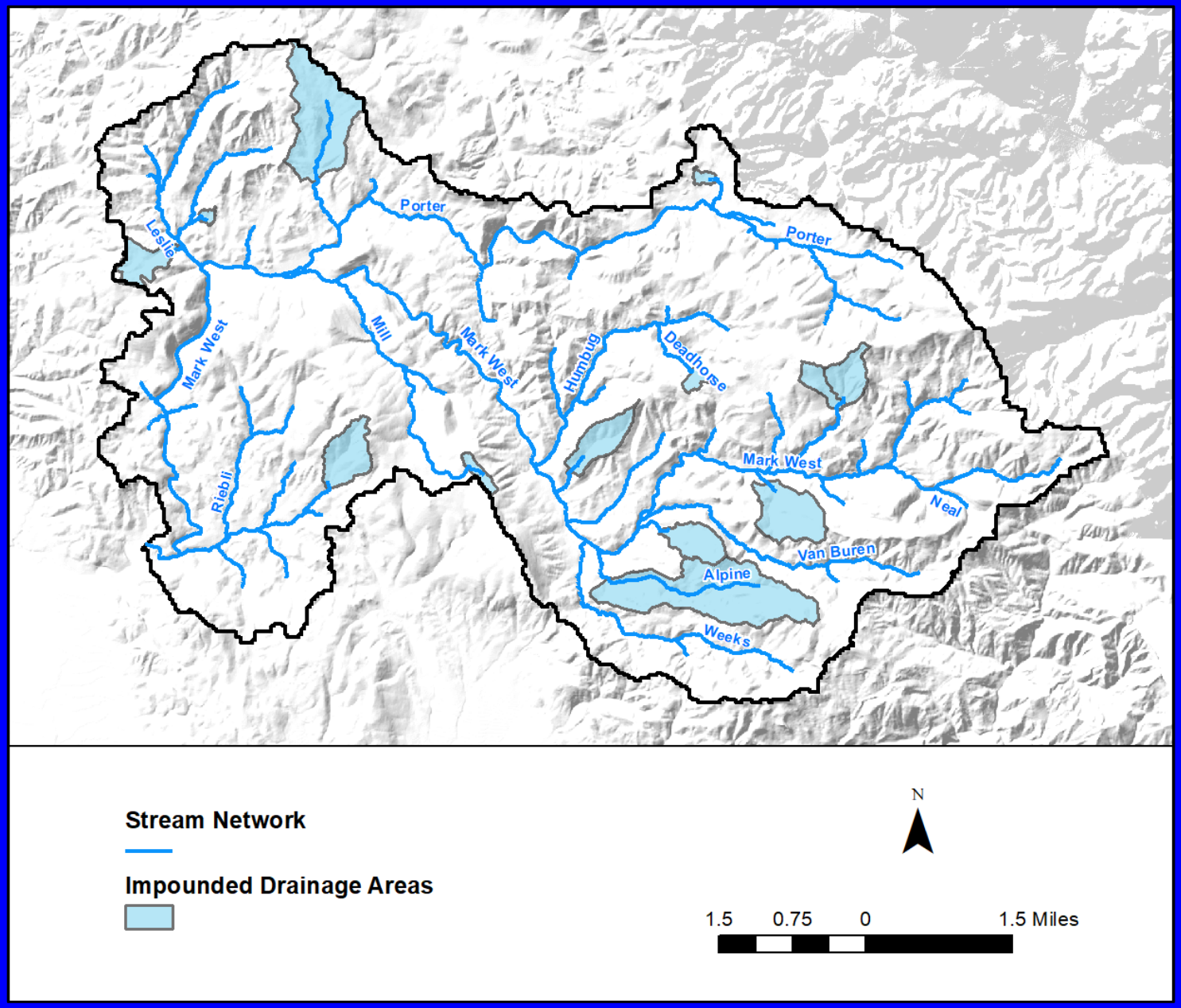
Other Map Classes
- Water

Developed and Built Up
- Developed

Mark West Creek Soils

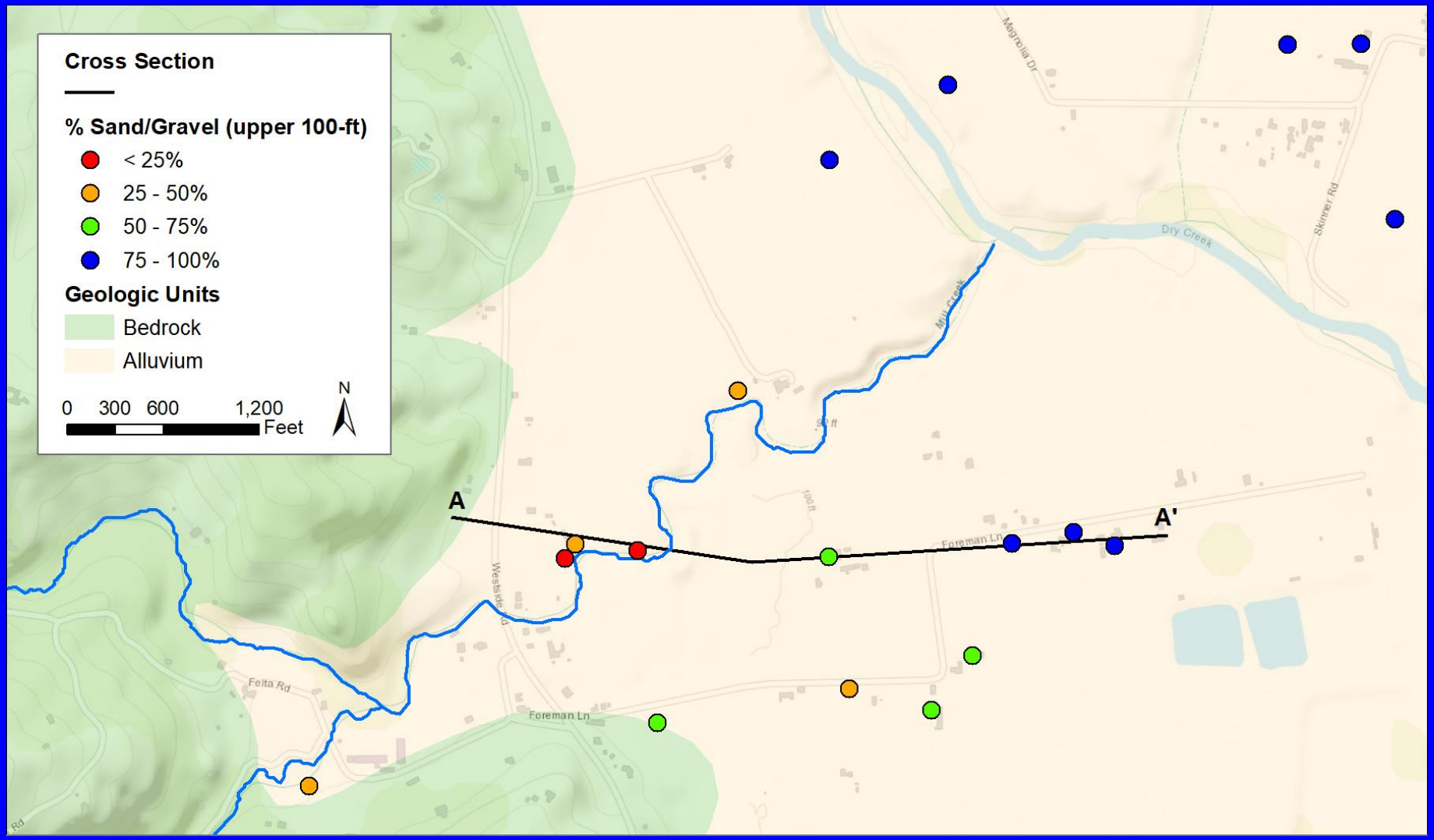


Mark West Creek Surface Water



Lower Mill Hydrogeology

Alluvium Texture



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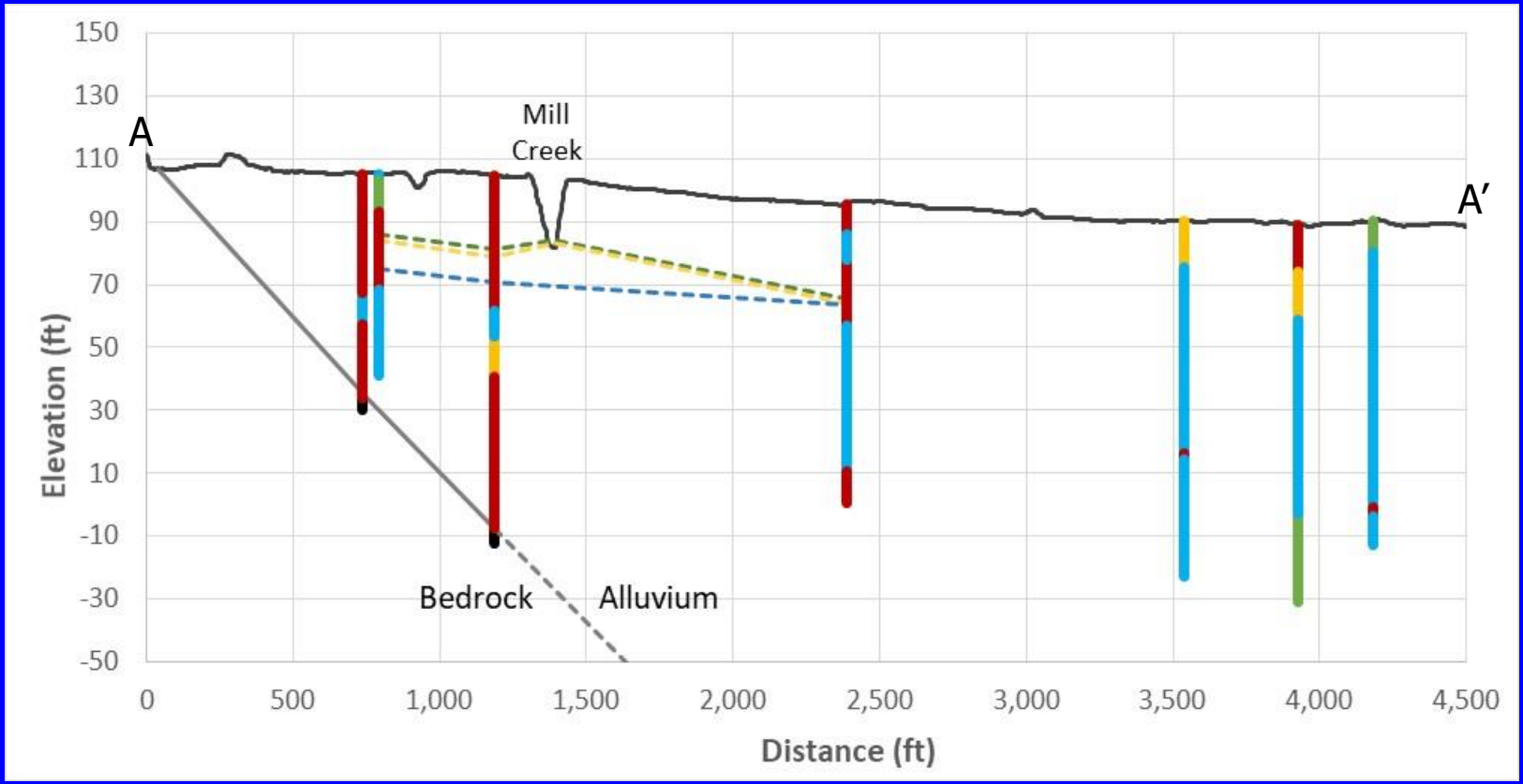
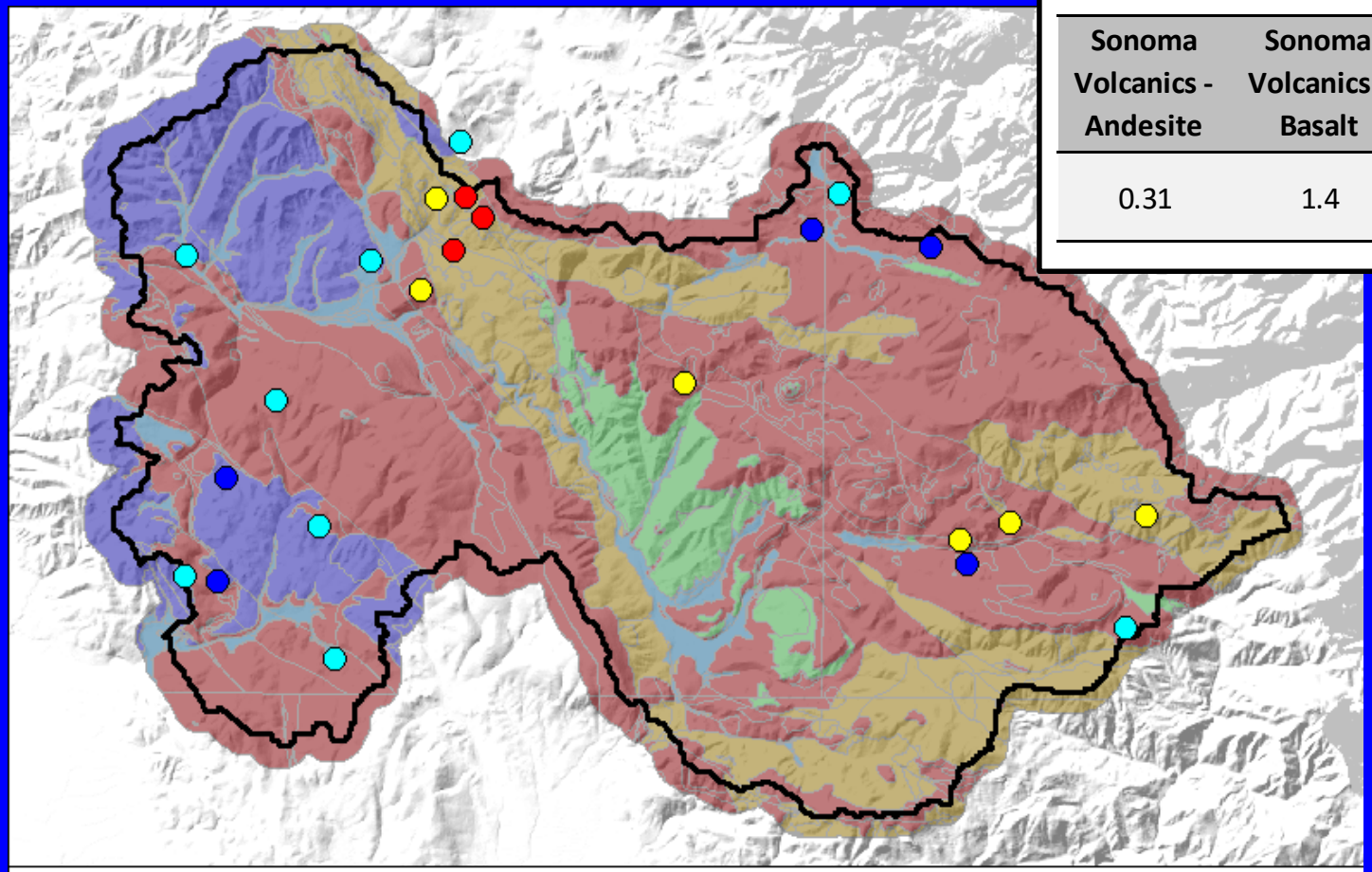


- Topography
- Sand & Gravel
- Sand & Gravel with Clay
- Clay with Sand & Gravel
- Clay
- Bedrock
- Groundwater Elevations (April 2018)
- Groundwater Elevations (August 2018)
- Groundwater Elevations (October 2018)

Mark West Creek Hydrogeology

Sonoma Volcanics - Andesite	Sonoma Volcanics - Basalt	Sonoma Volcanics - Tuff	Franciscan
0.31	1.4	23	0.048



Hydrogeologic Units

- Alluvium
- Sonoma Volcanics
- Glen Ellen Formation
- Humbug Creek deposits
- Franciscan Complex

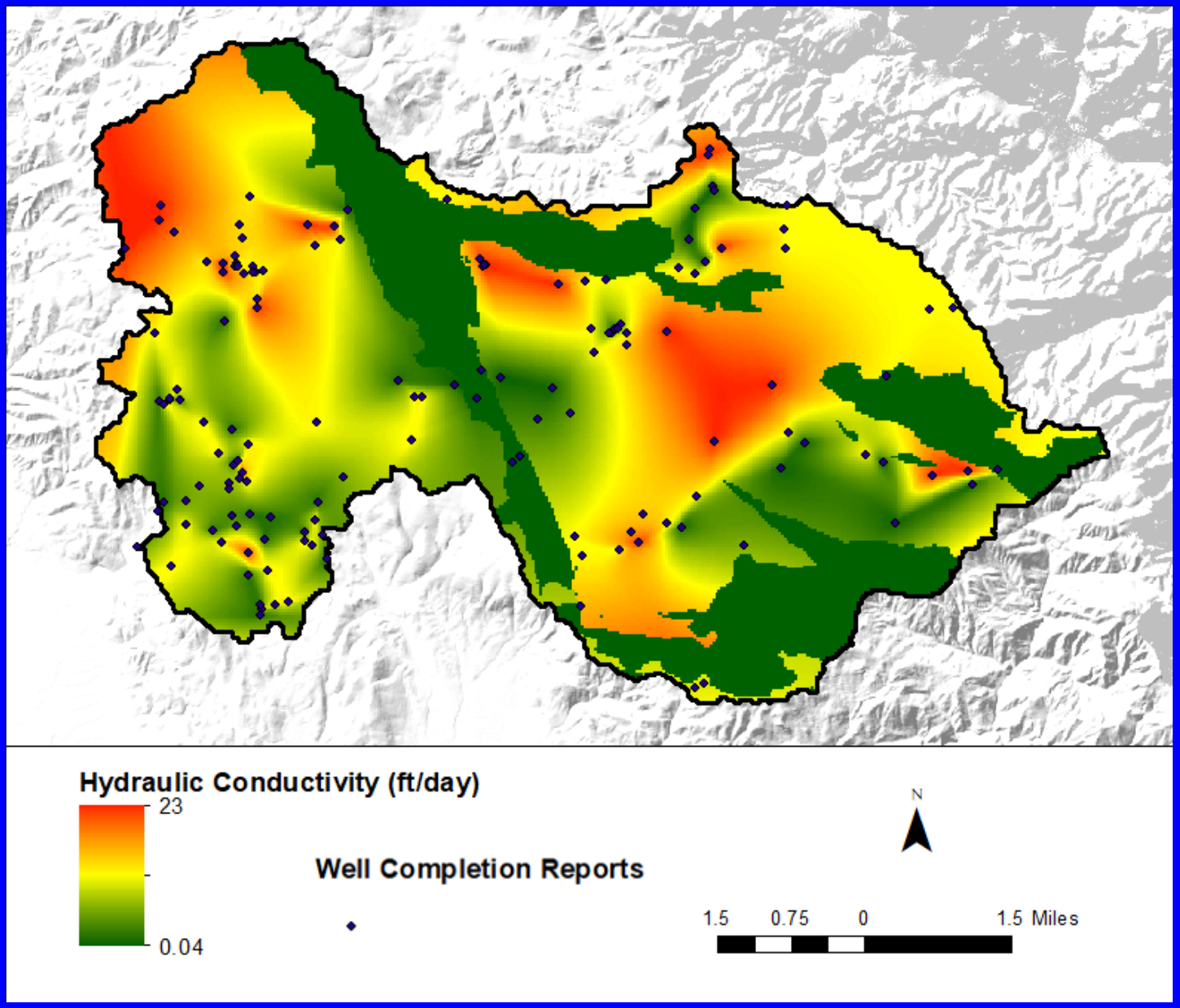
Hydraulic Conductivity (ft/day)

- 0.01 - 0.1
- 0.1 - 1
- 1 - 10
- 10 - 100

N

1.5 0.75 0 1.5 Miles

Mark West Creek Hydrogeology



Water Use

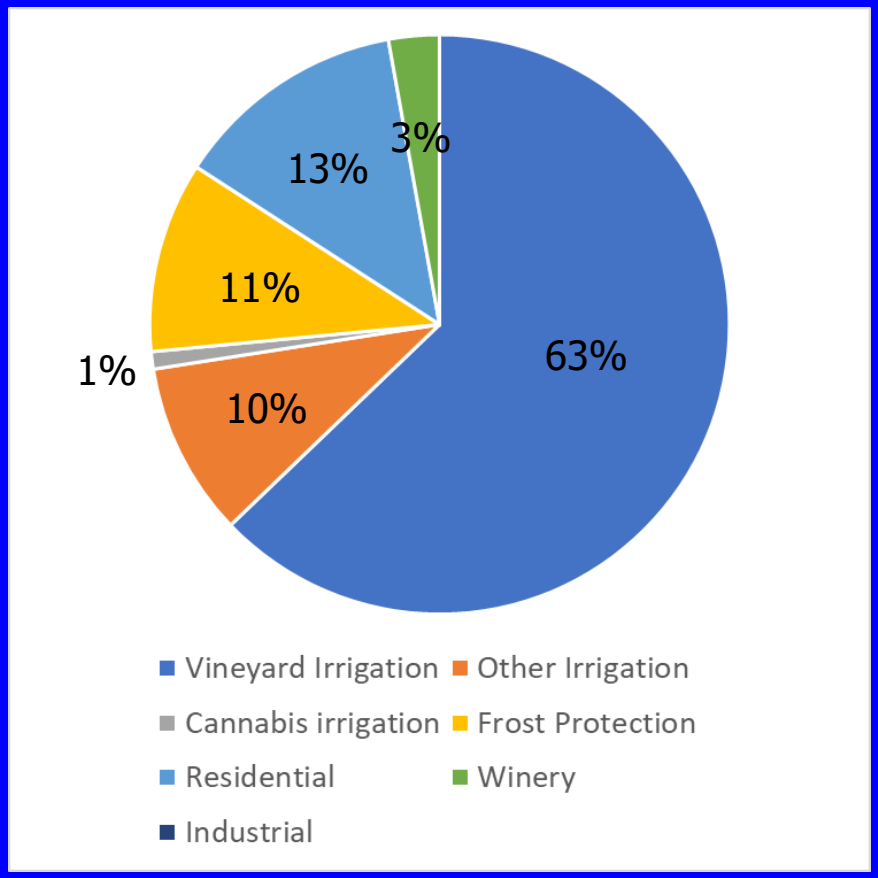
- Residential – Census Data, Per Capita Use (Info Order, City of Windsor) – 0.08 ac-ft/yr/person
- Irrigation – Sonoma Veg Map, Healdsburg WWTP Recycled Water Deliveries, Info Order – 0.32 ac-ft/yr/acre
- Frost Protection – Ag Commissioner's Registration Database, Hourly Climate Data – 0 to 0.24 ac-ft/yr/acre
- Cannabis Irrigation – Permit Sonoma, Aerial Photography, NCRWQCB – 1.3 to 1.5 ac-ft/yr/acre

Water Use

Mill Creek

Total Use – 257 ac-ft/yr

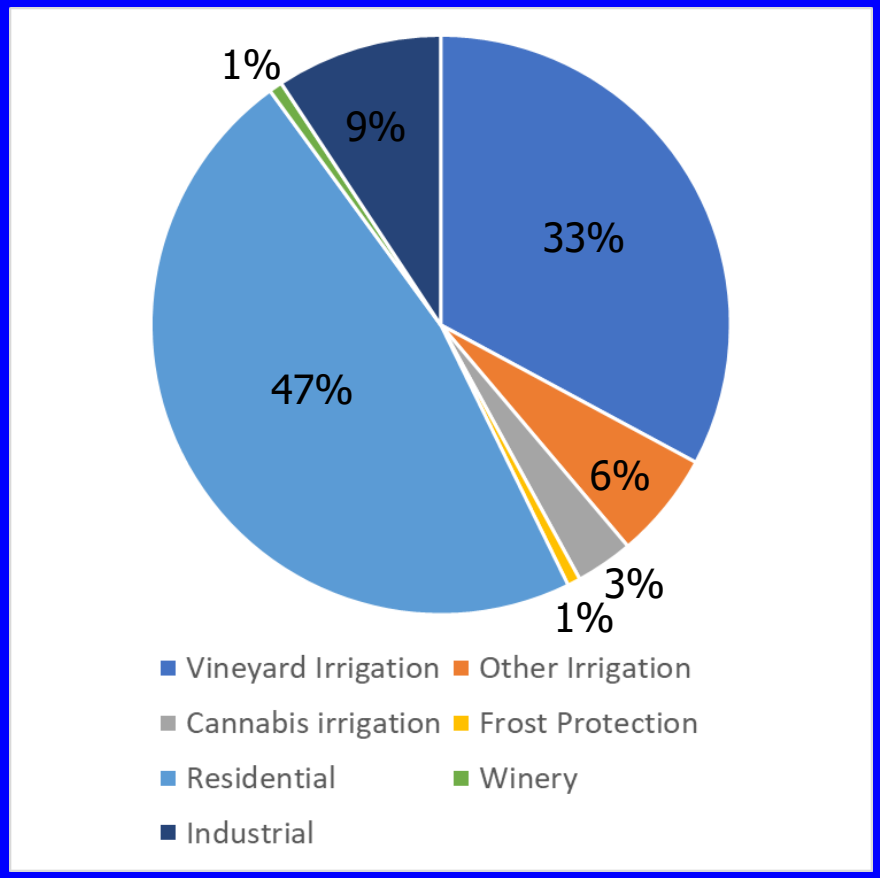
11.3 ac-ft/mi^2



Mark West Creek

Total Use – 431 ac-ft/yr

10.7 ac-ft/mi^2



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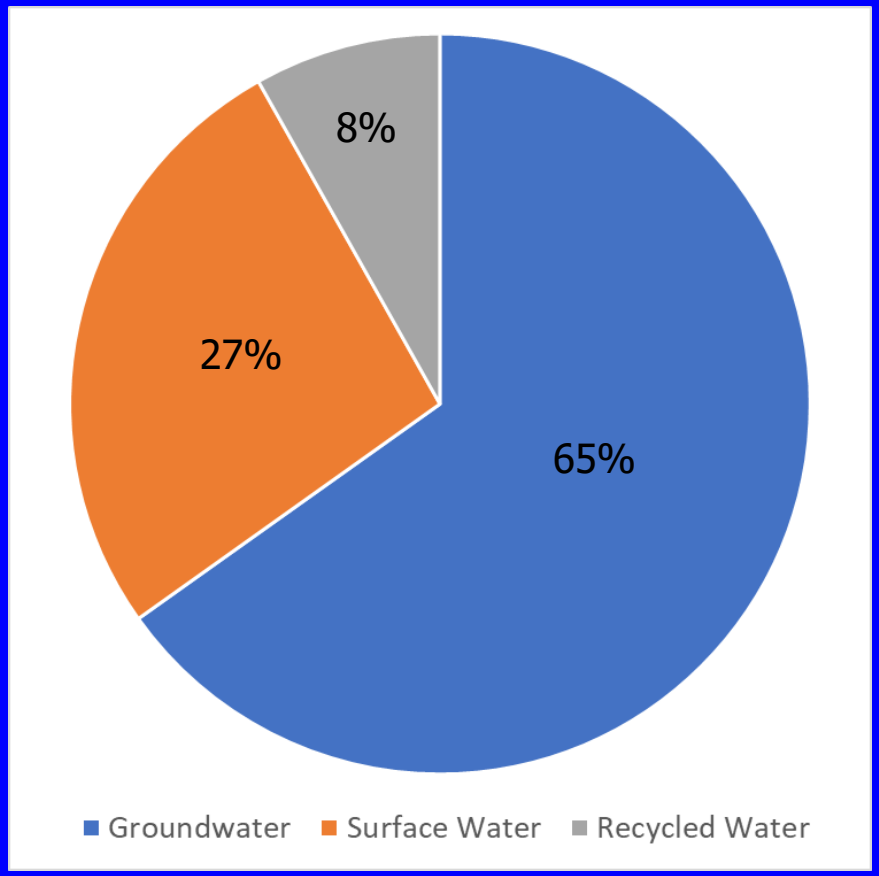

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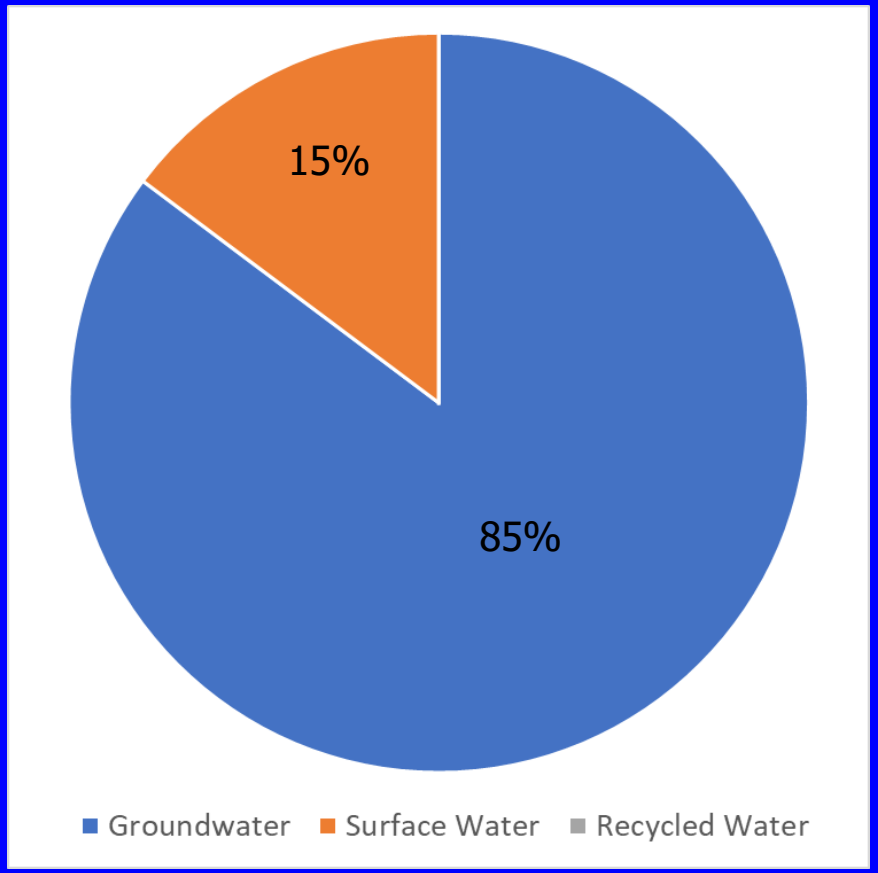
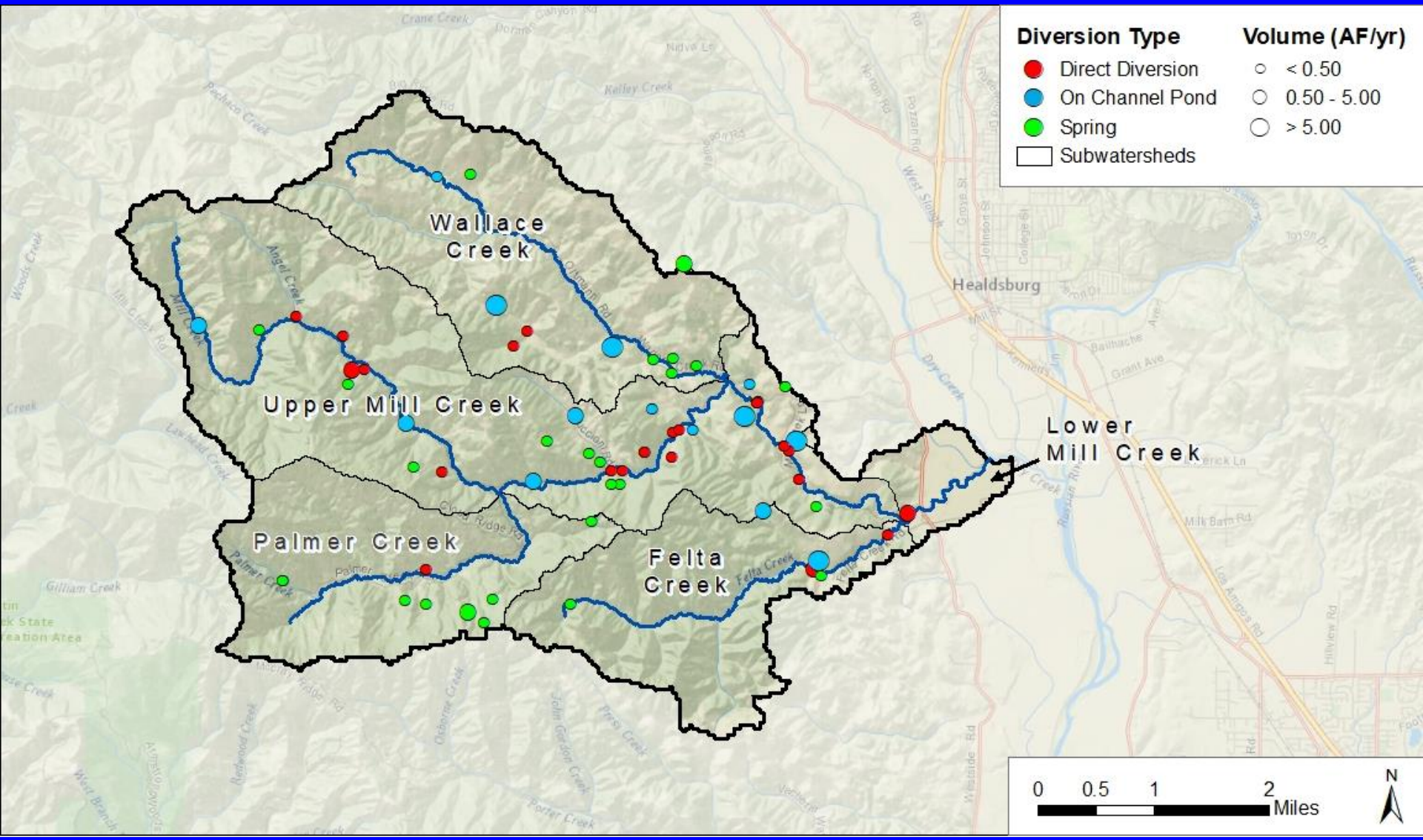


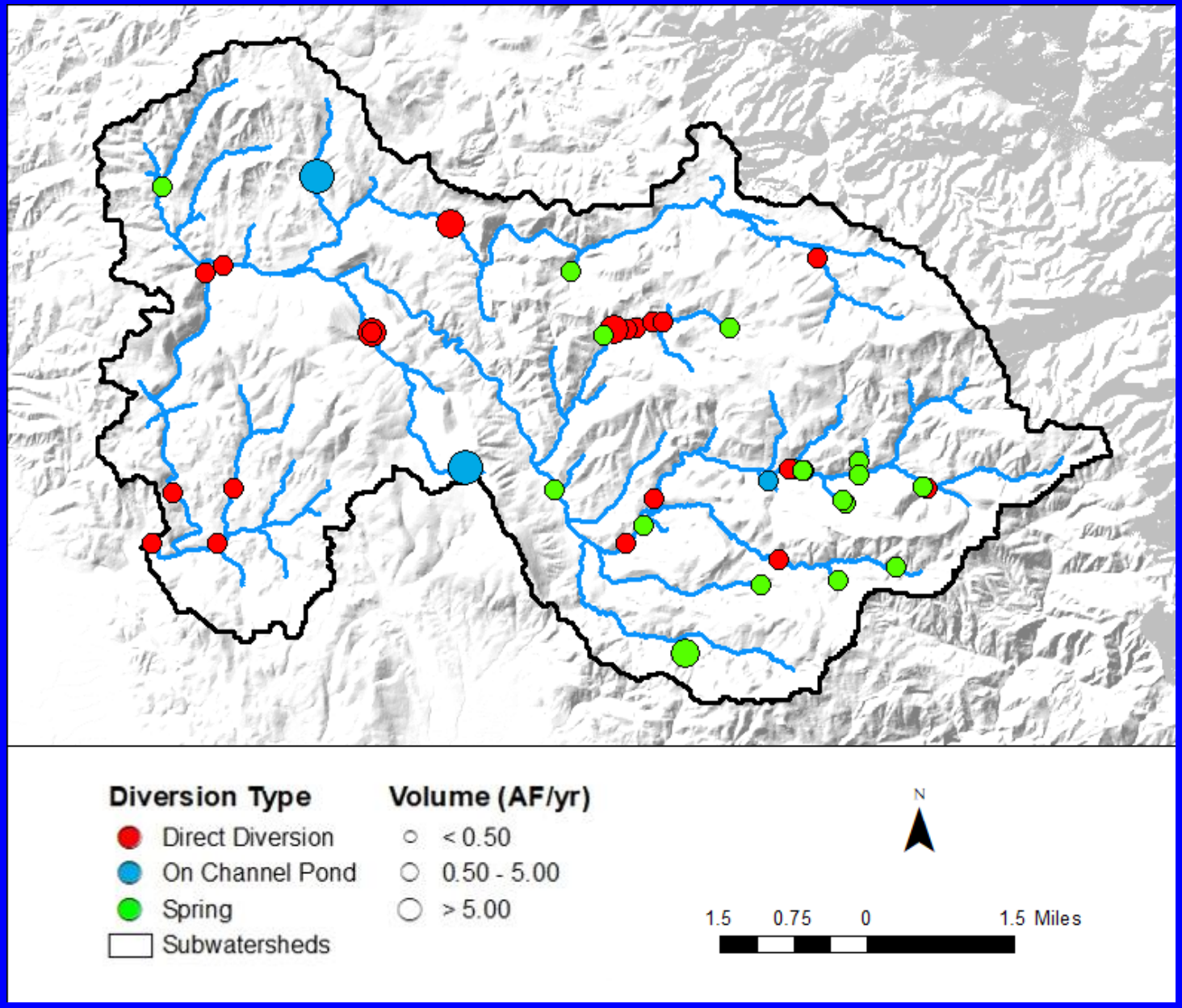
Surface Diversions

- Data Sources
  - eWRIMS & Water Board Information Order
- Rates
  - ~30% have reasonable metered rates
  - Others based on typical rates
    - 2.7 gpm domestic; 9.0 gpm vineyards
- Volumes
  - ~72% have reasonable reported volumes
  - Others based on typical volumes for associated uses
- Schedules
  - Based on storage assumptions in relation to rates and demand volumes
    - Springs/Ponds – minimal storage - active every day
    - Residential Direct Diversions – 3,000 gallons – active once per week
    - Agricultural Direct Diversions – 8,000 – 20,000 gallons – active once per week

Mill Creek Diversions



Mark West Creek Diversions



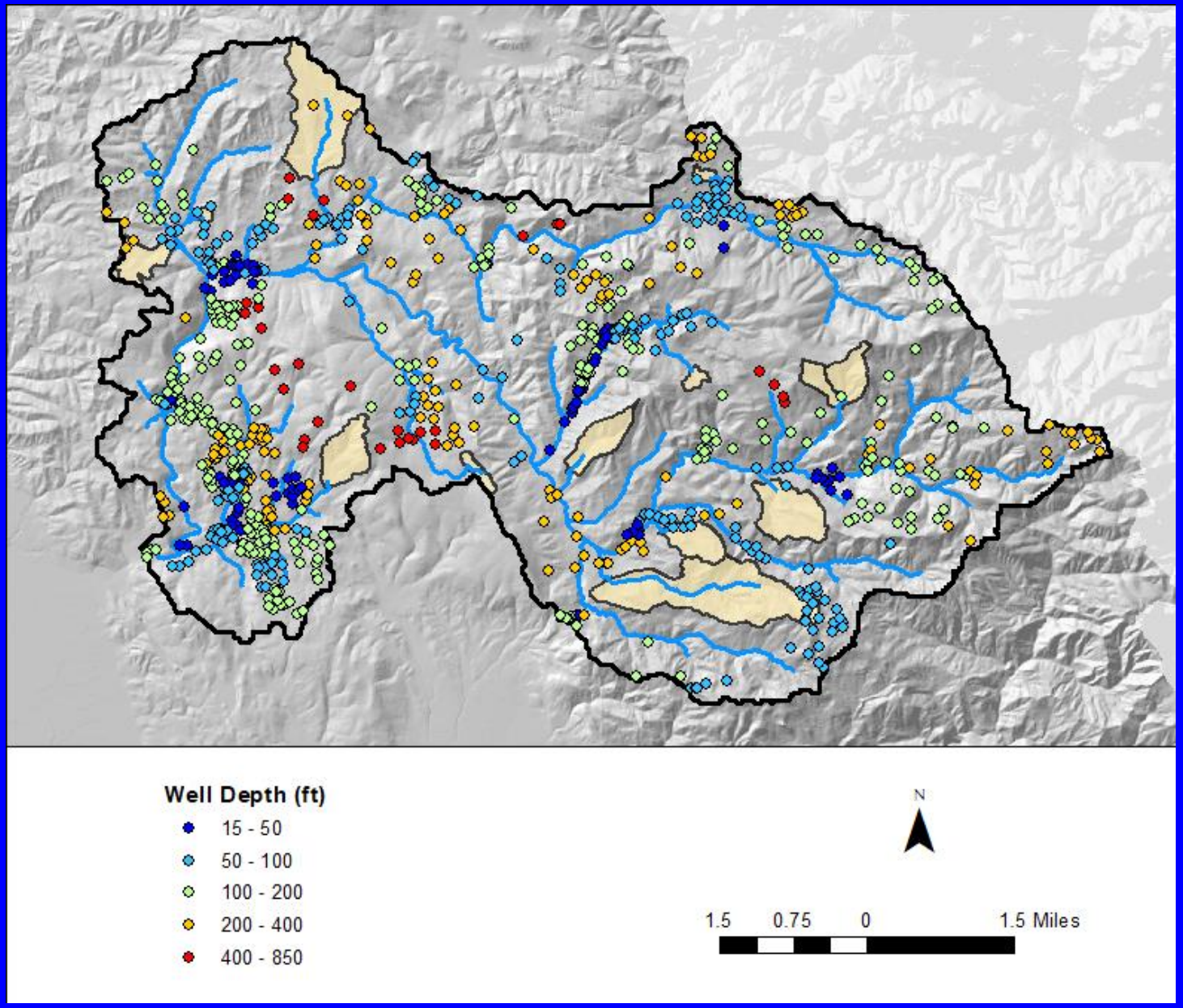
Surface Diversions Summary

- Number of Diversion Points
  - Mill Creek – 66
  - Mark West Creek – 46
- Annual Diversion Volumes
  - Mill Creek – 69 ac-ft/yr
  - Mark West Creek – 65 ac-ft/yr
- Maximum Summer Diversion Rate
  - Mill Creek – 1.7 cfs (0.7 cfs direct diversion)
  - Mark West Creek 0.5 cfs (0.2 cfs direct diversion)

Wells

- Data Sources
  - Informational Order, DWR Well Completion Reports, PRMD Well Yield Certifications (pump tests)
- Locations
  - Used actual locations reported in Informational Order or WCRs (~58%)
  - If no location reported, used parcel centroids
- Completion Details
  - Used known screened intervals locations reported in WCRs (~32%)
  - If no WCR available – used screened intervals from nearest well with similar geology

Mark West Creek Wells

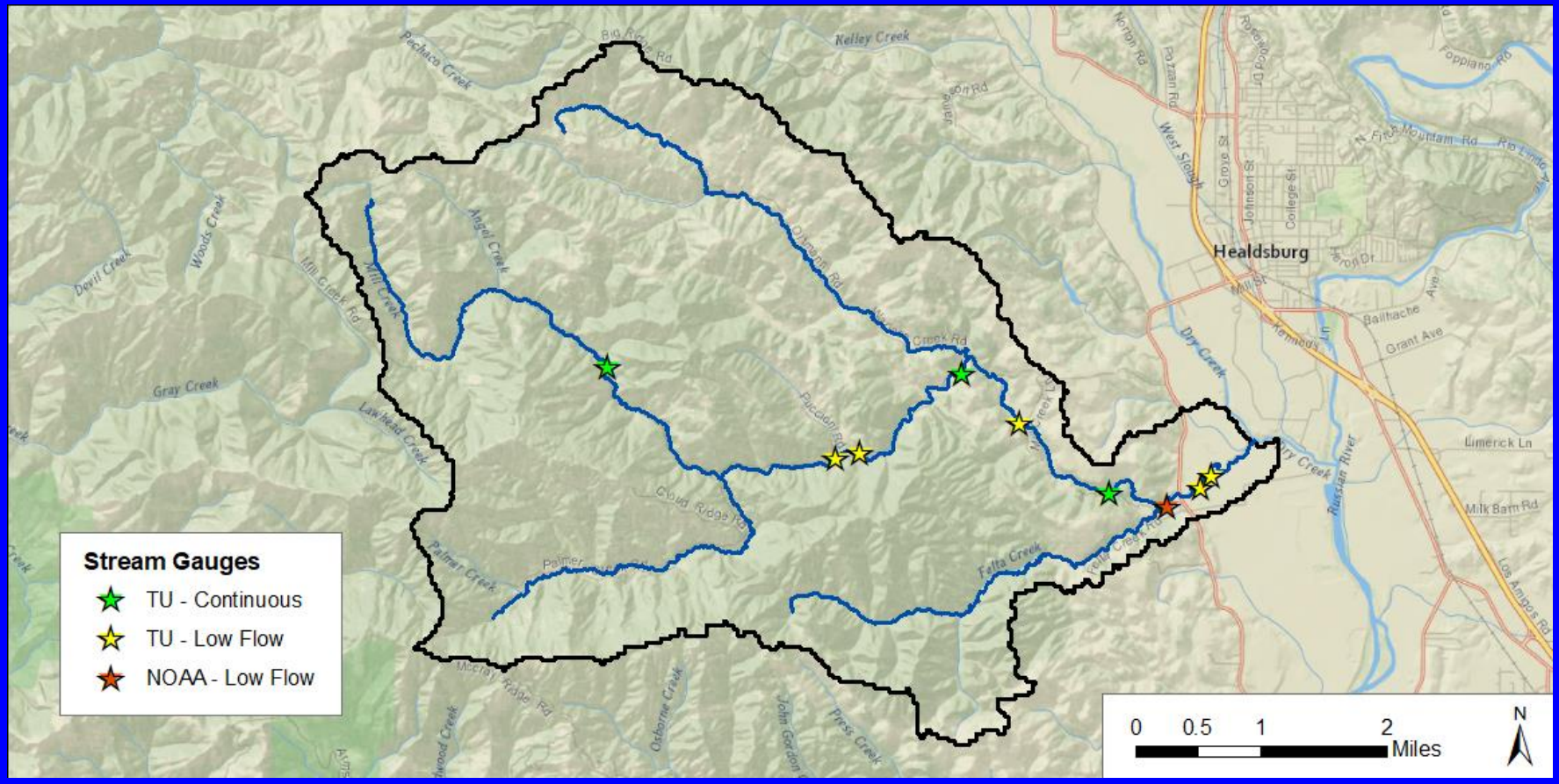


Well Summary

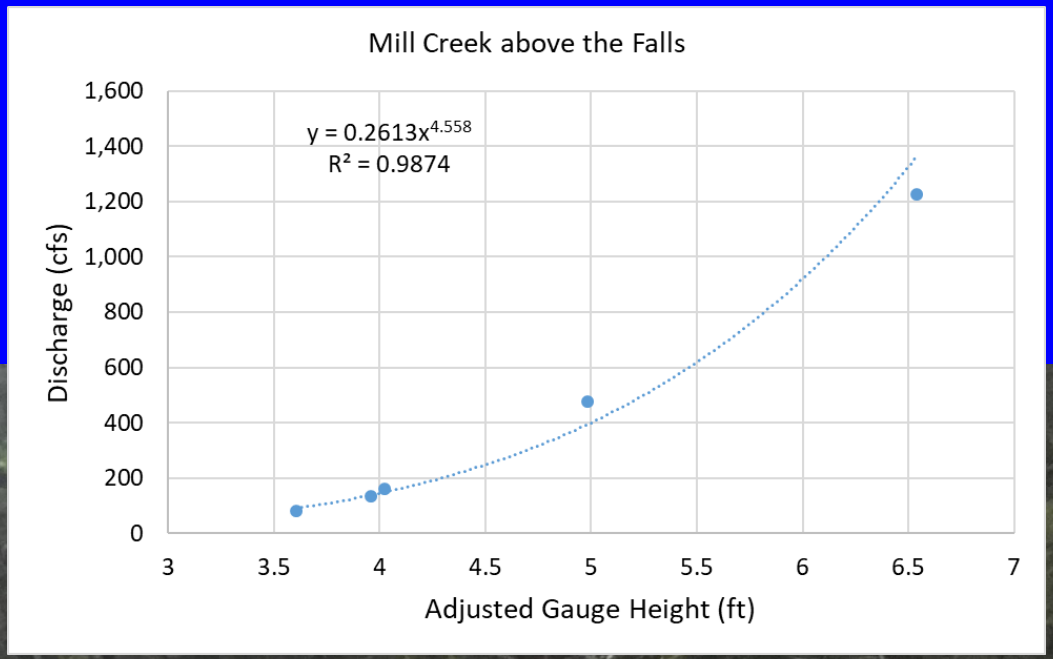
- Number of Wells
  - Mill Creek – 204
  - Mark West Creek – 792
- Annual Pumping Volumes
  - Mill Creek – 167 ac-ft/yr
  - Mark West Creek – 366 ac-ft/yr

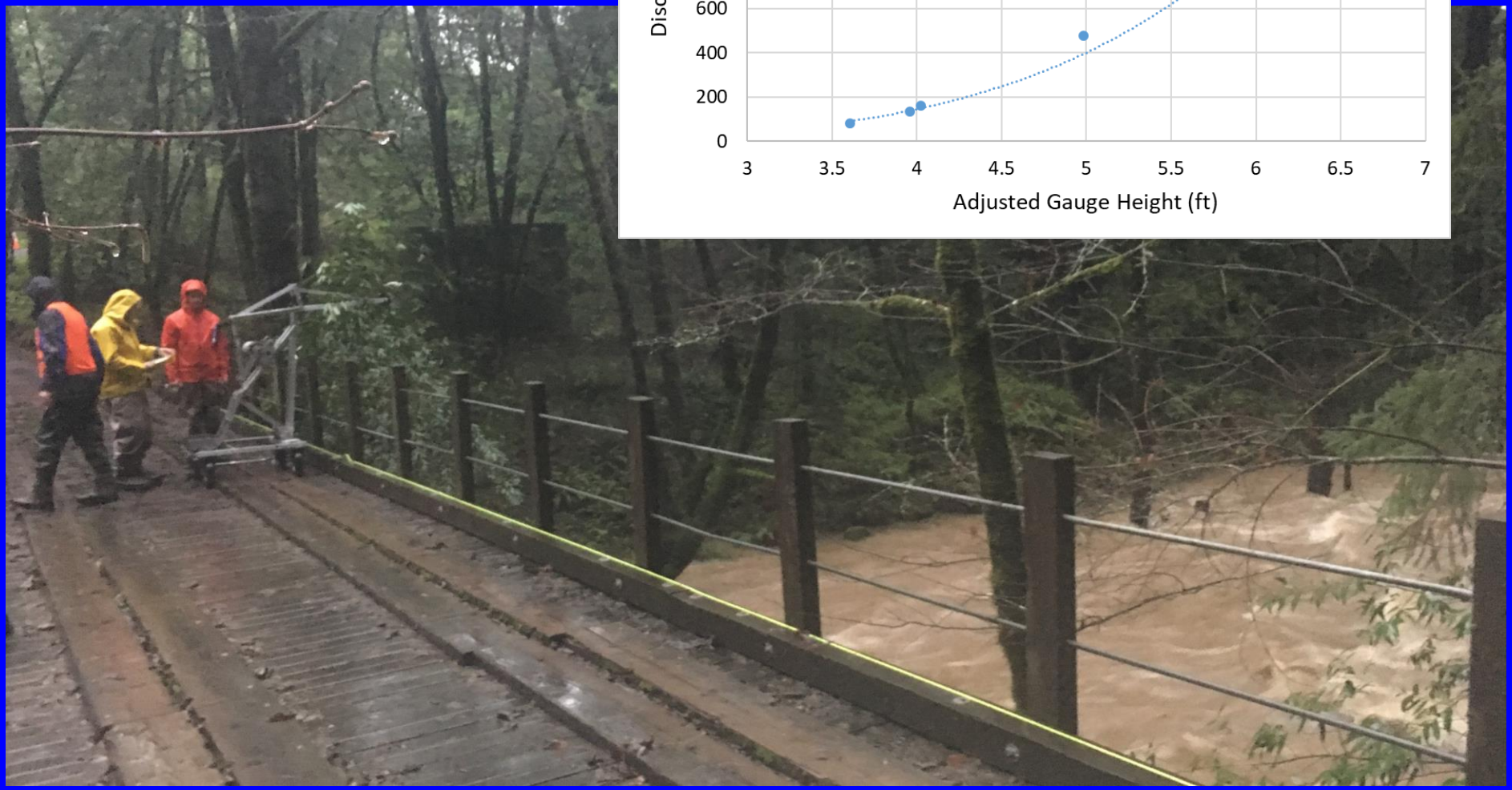
Calibration Data

- 19 streamflow gauges in Mill and Mark West (TU, NOAA, CEMAR)
- 29 monitored wells (this project)
- SeaGrant wet/dry mapping



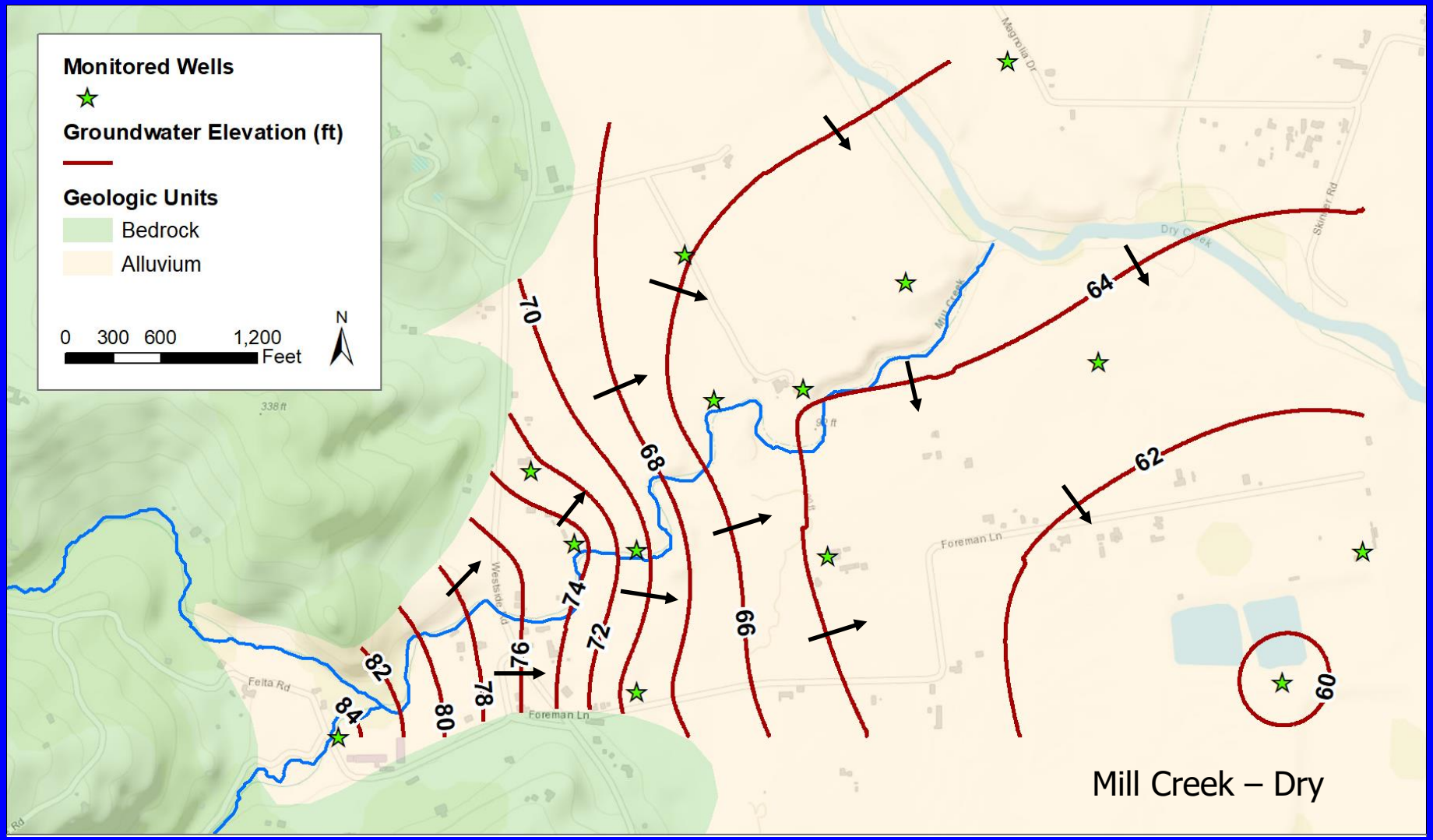
Streamflow Gauging



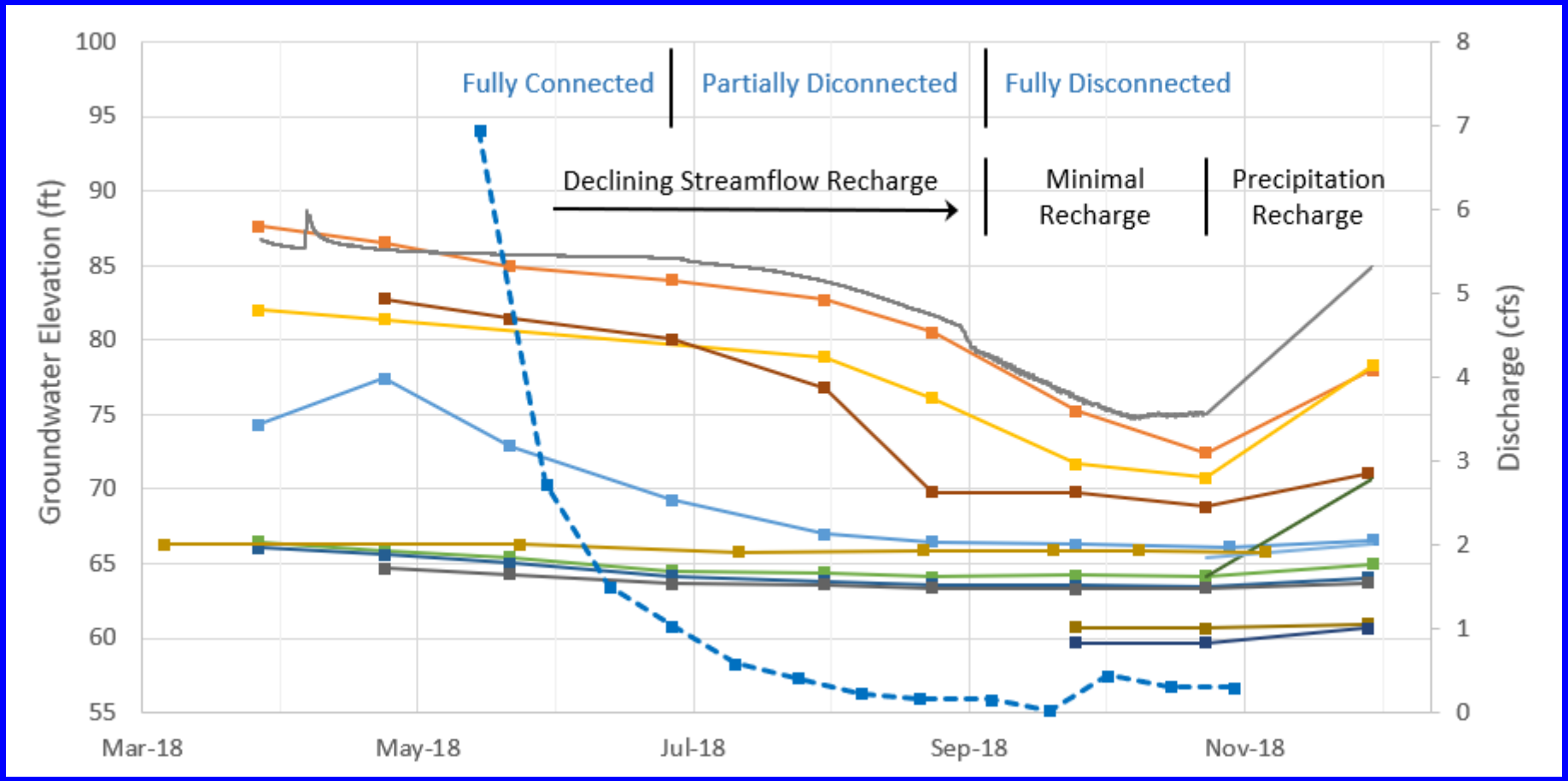


Lower Mill Groundwater Monitoring

Groundwater Contours - October 24, 2018

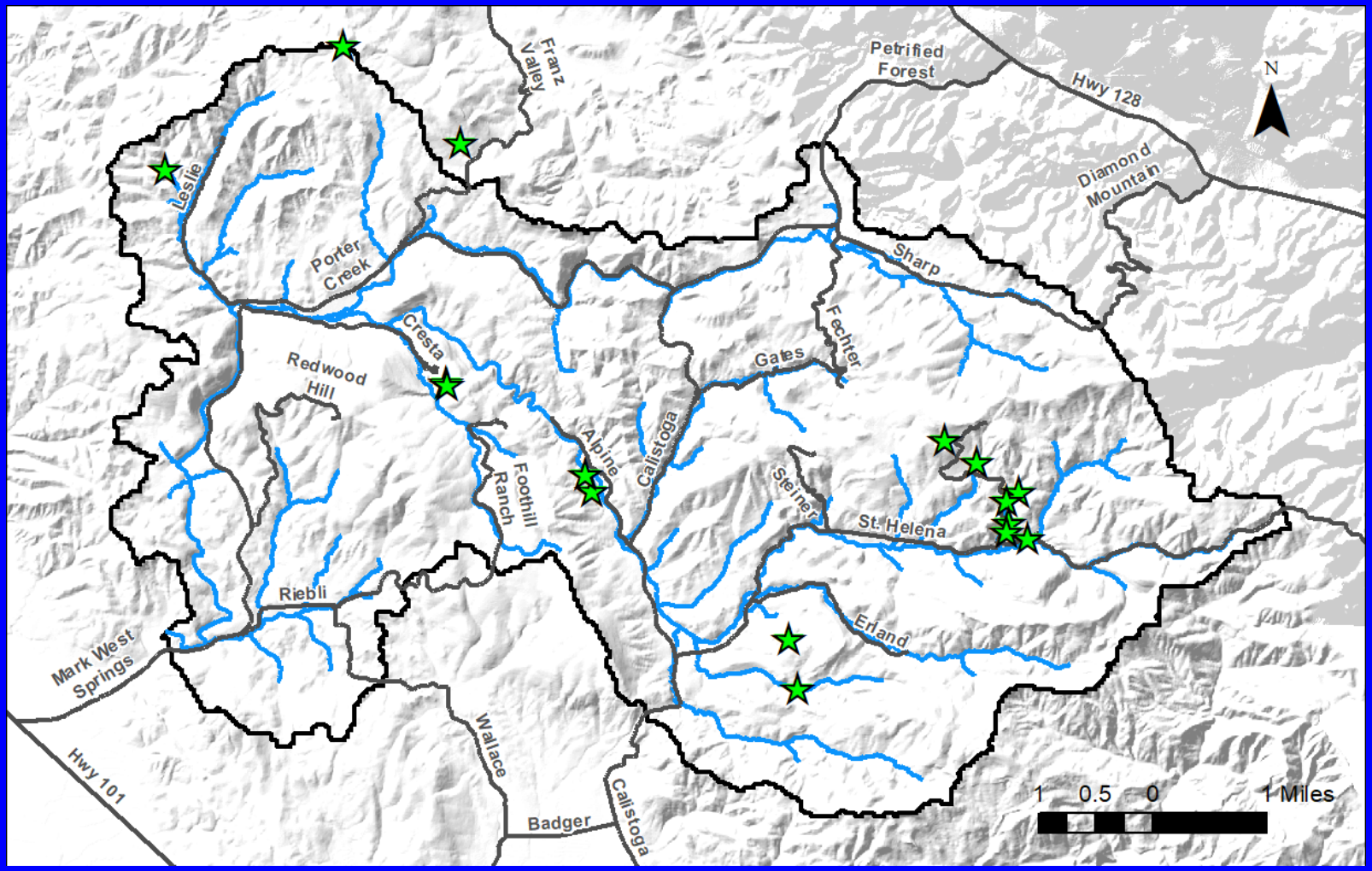


Lower Mill Groundwater Monitoring

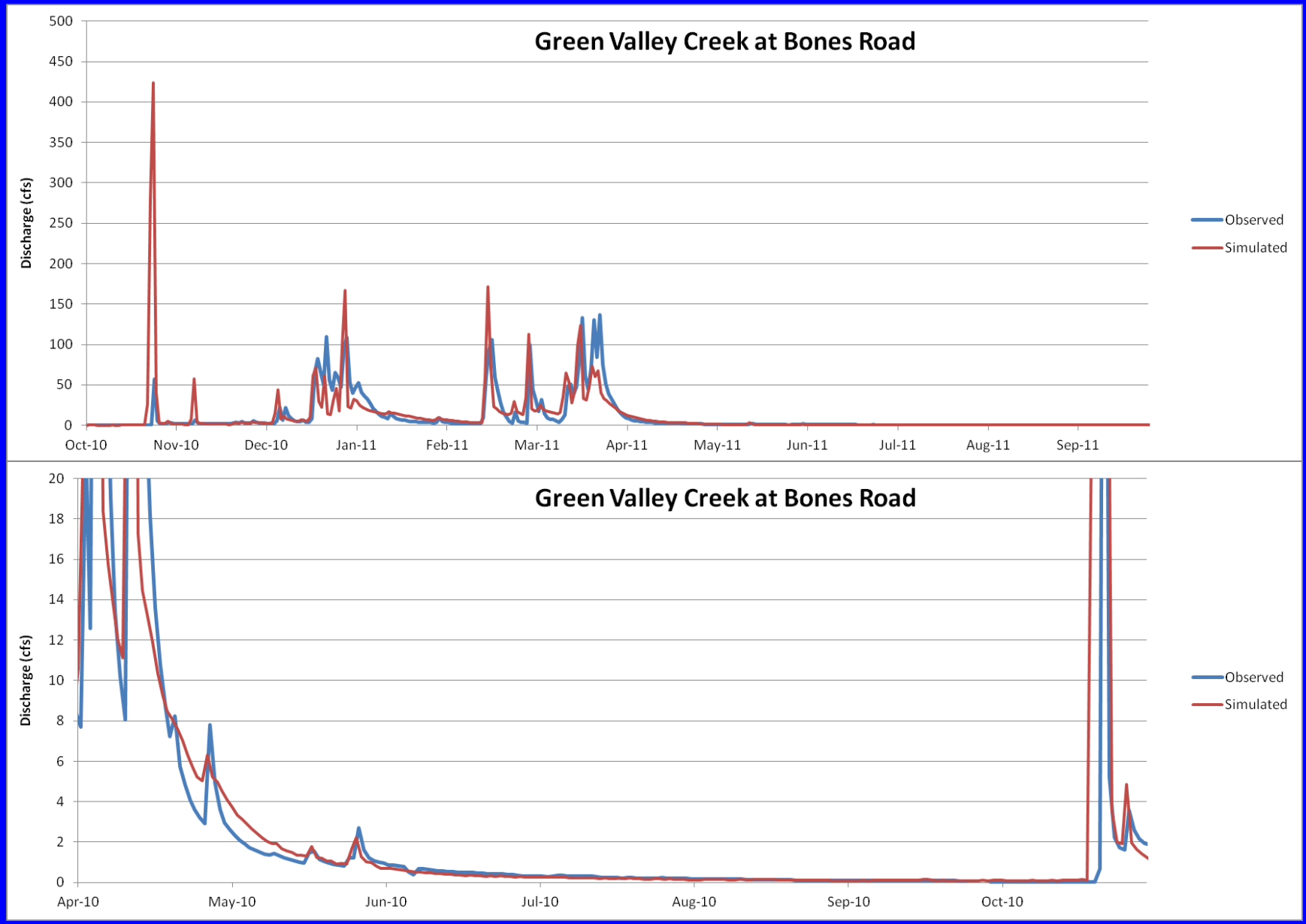


Mark West Creek Groundwater Monitoring

- 15 Wells (tuff, basalt, andesite, Franciscan)
  - Monitored every 5 weeks since June 2018

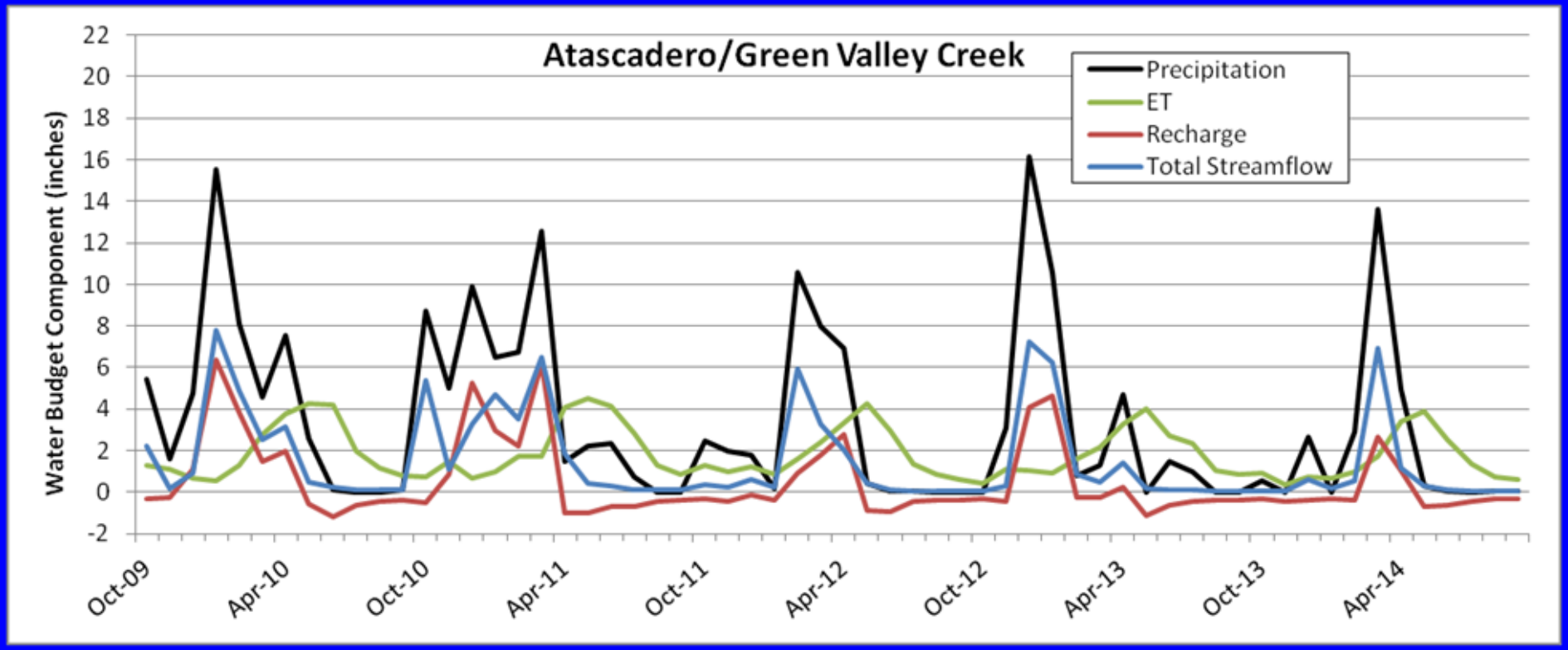


Green Valley Calibration

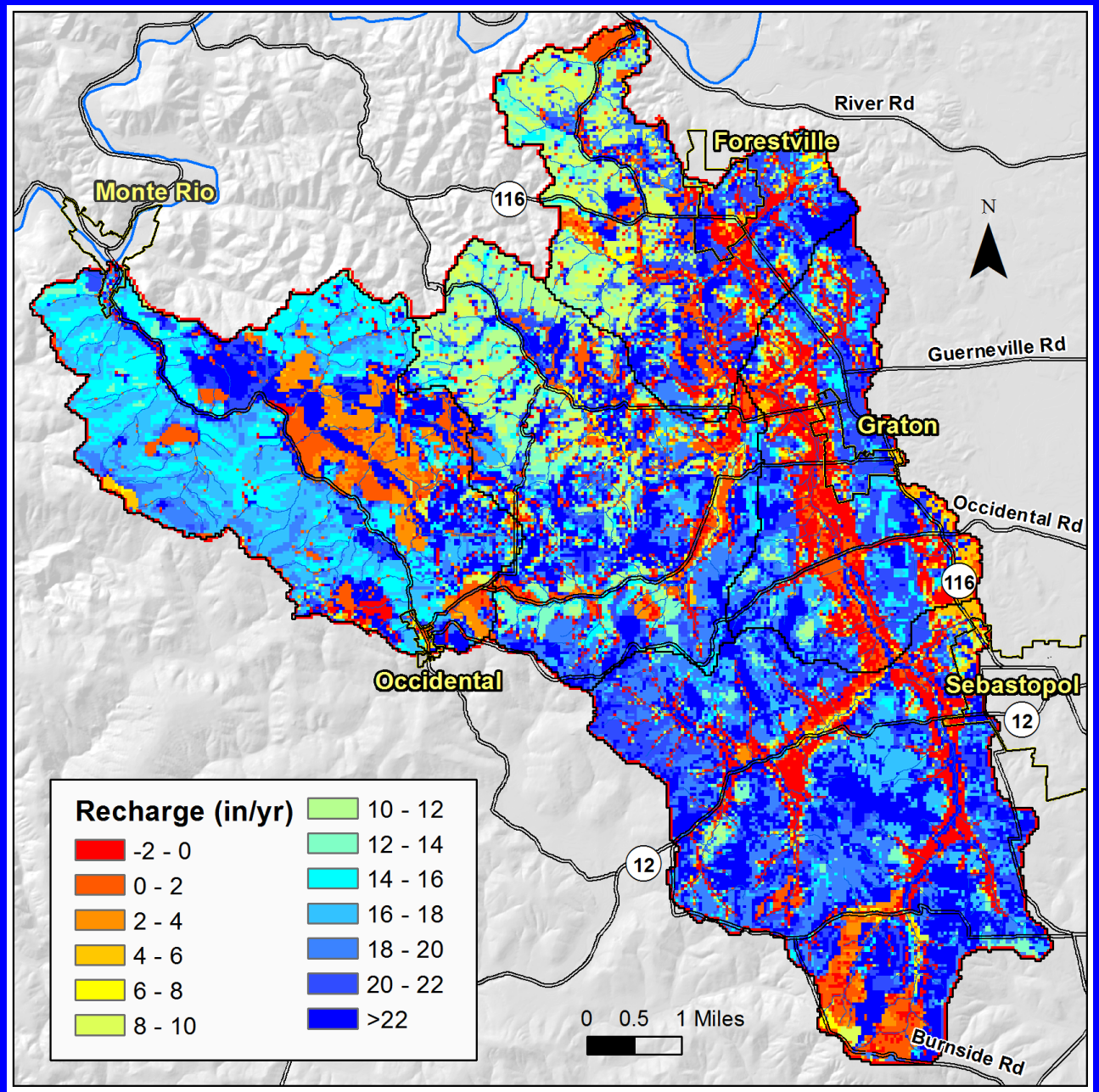


Green Valley/Atascadero & Dutch Bill Results

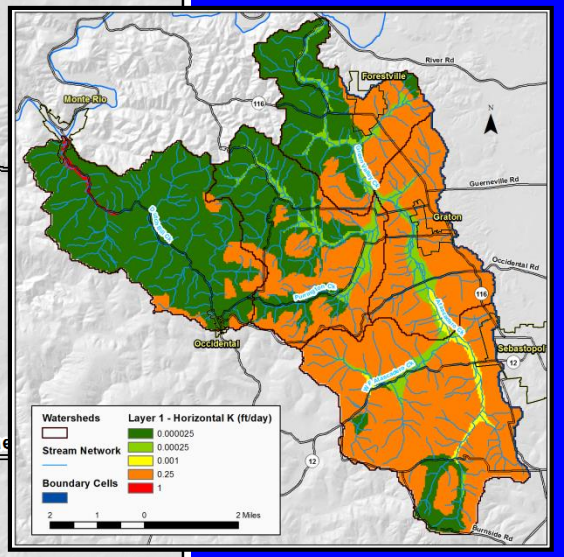
Monthly Water Balance 2009-2014
Green Valley Creek



Groundwater Recharge



SW/GW Exchange Average Water Year



River Rd

Forestville

Monte Rio

116

Graton

Occidental Rd

Occidental

Sebastopol

12

Burnside Rd

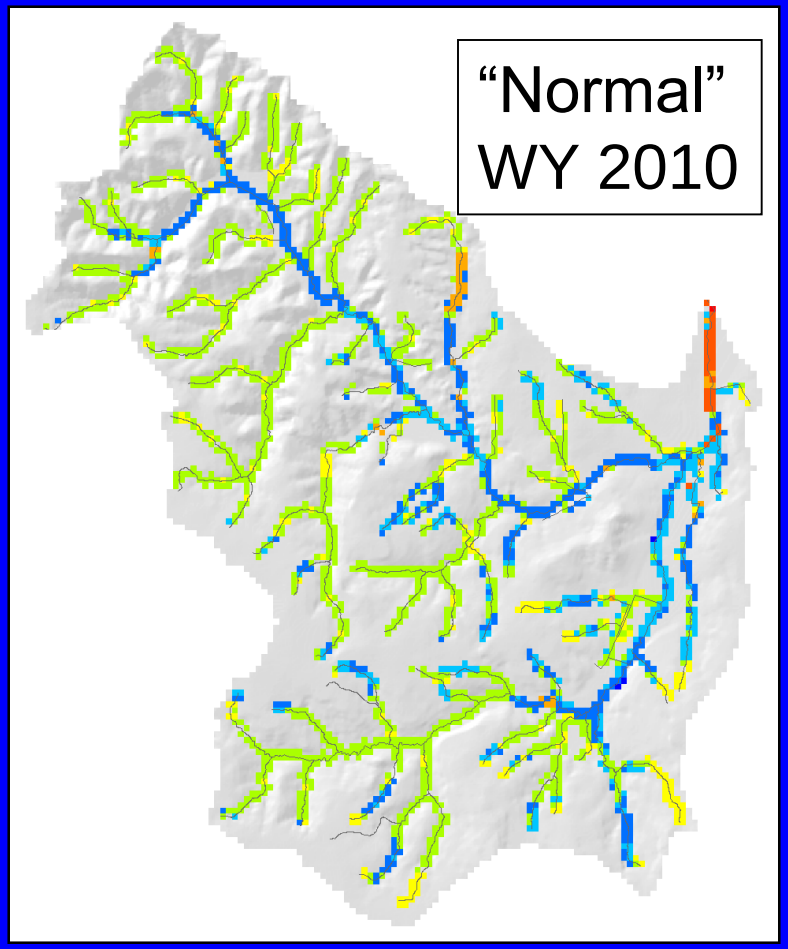
Watersheds

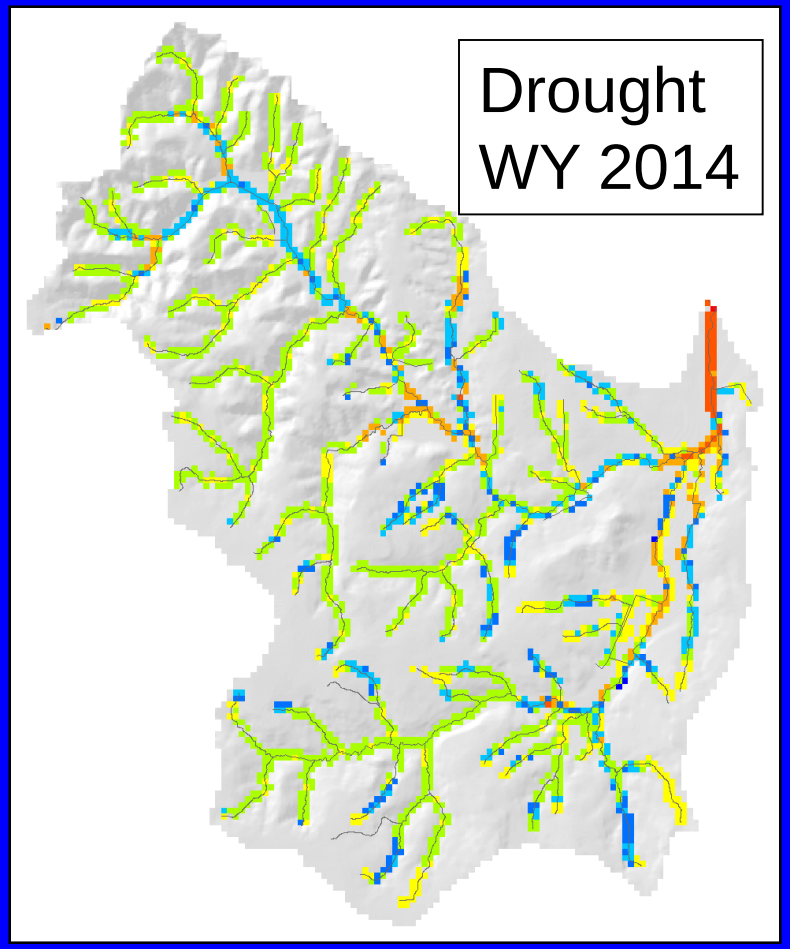
Stream Network

SW/GW Exchange (cfd)

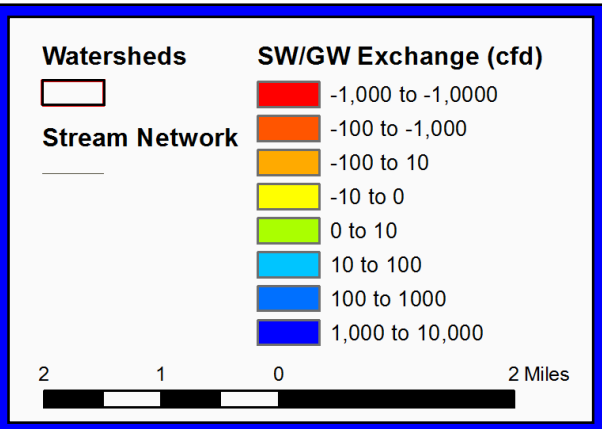
- -1,000 to -1,0000
- -100 to -1,000
- -100 to 10
- -10 to 0
- 0 to 10
- 10 to 100
- 100 to 1000
- 1,000 to 10,000

2 1 0 2 Miles

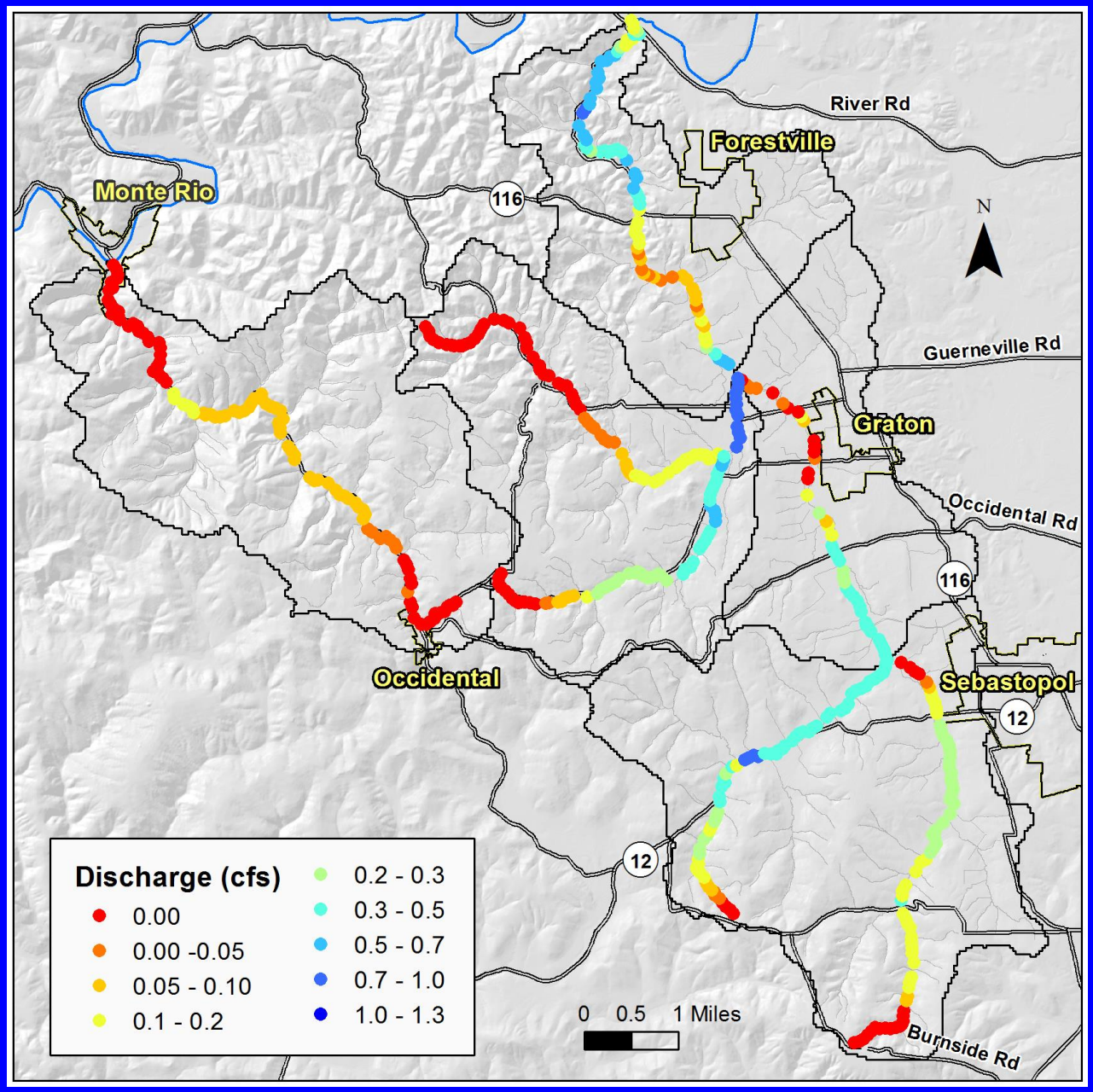




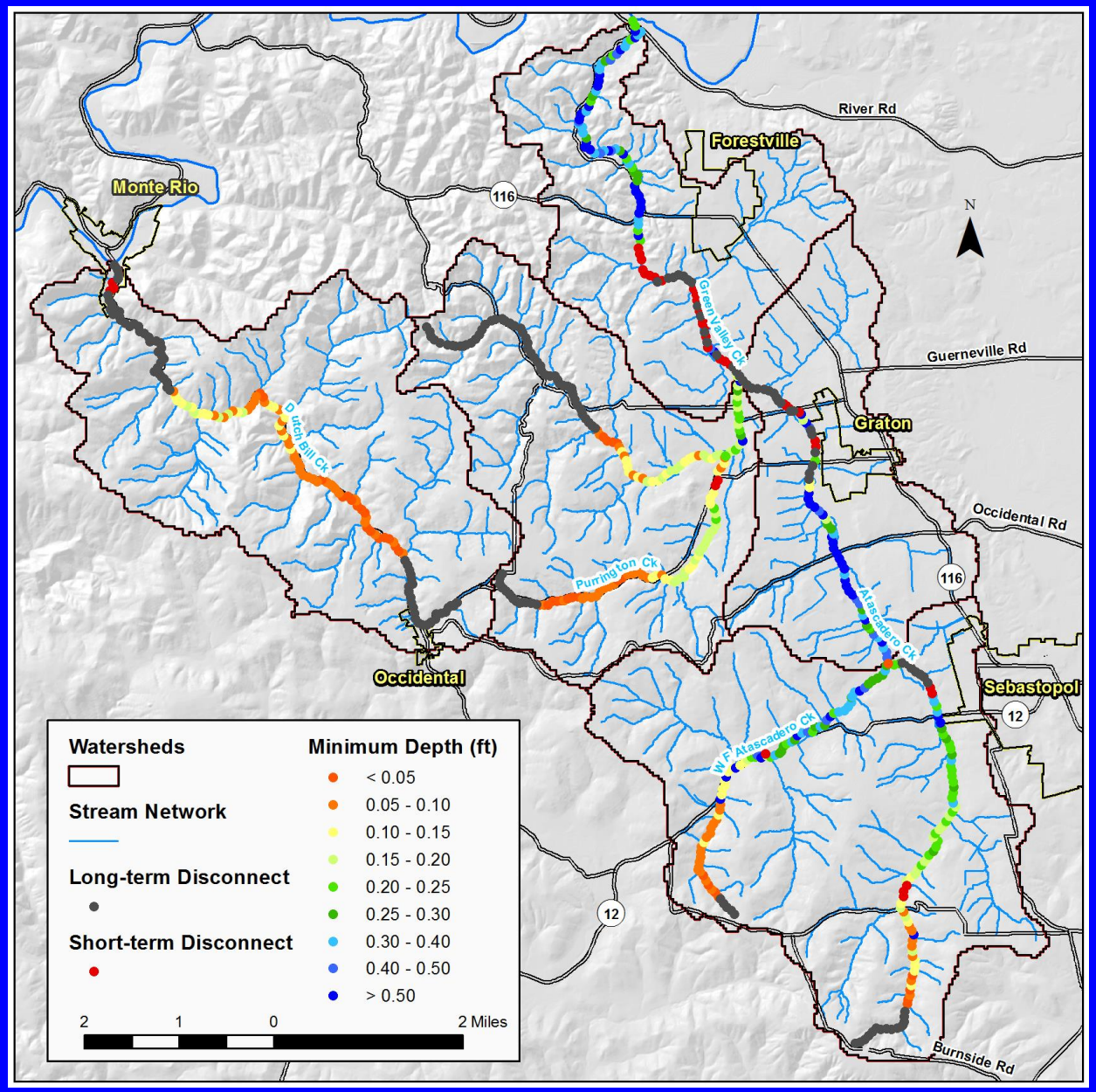
Upper Green Valley Cr. SW/GW Exchange



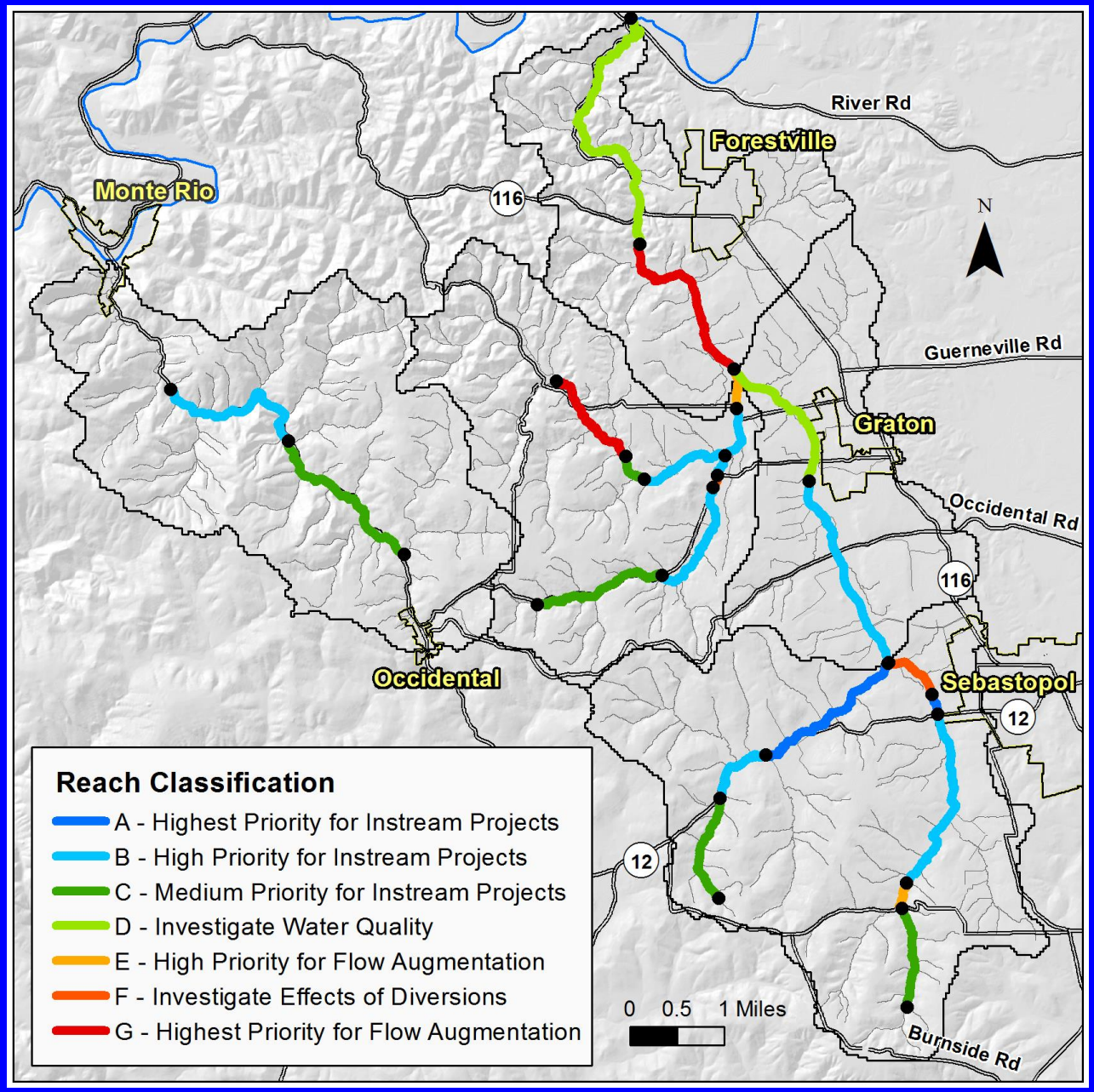
Minimum Stream Flow



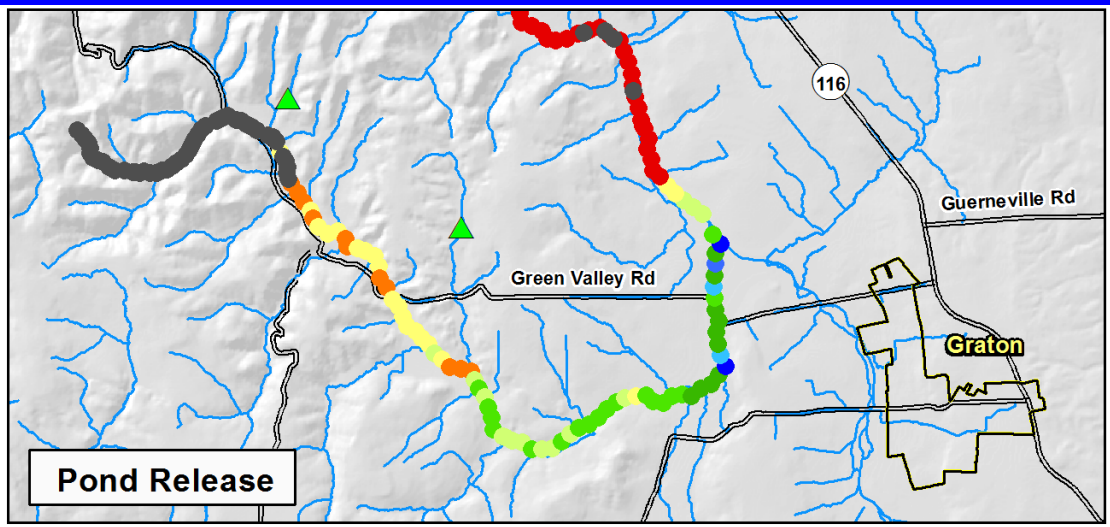
Flow Depths and Pool Disconnection

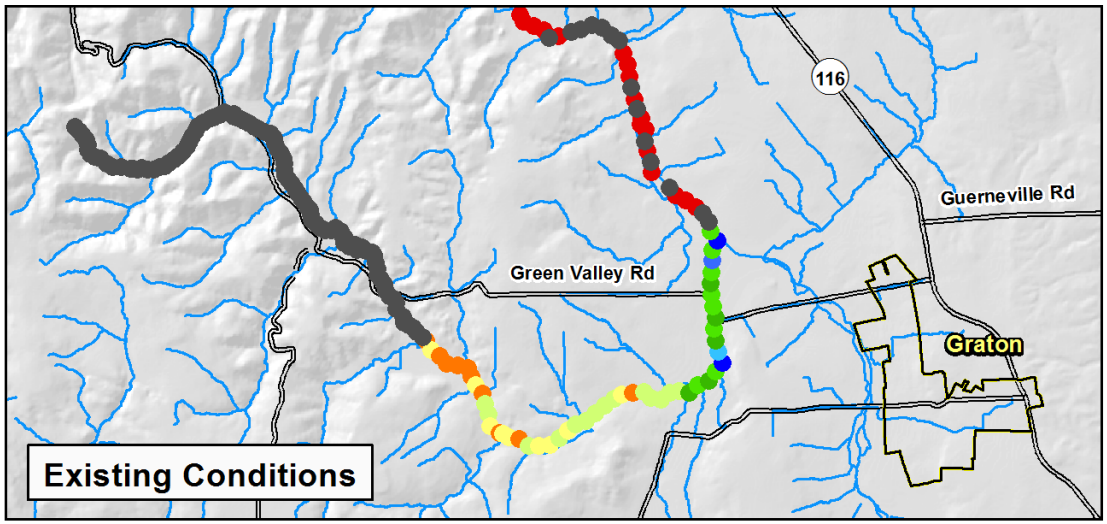


Restoration Recommendations



Flow Augmentation Scenario





Pond Release Locations

Long-term Disconnect

Short-term Disconnect

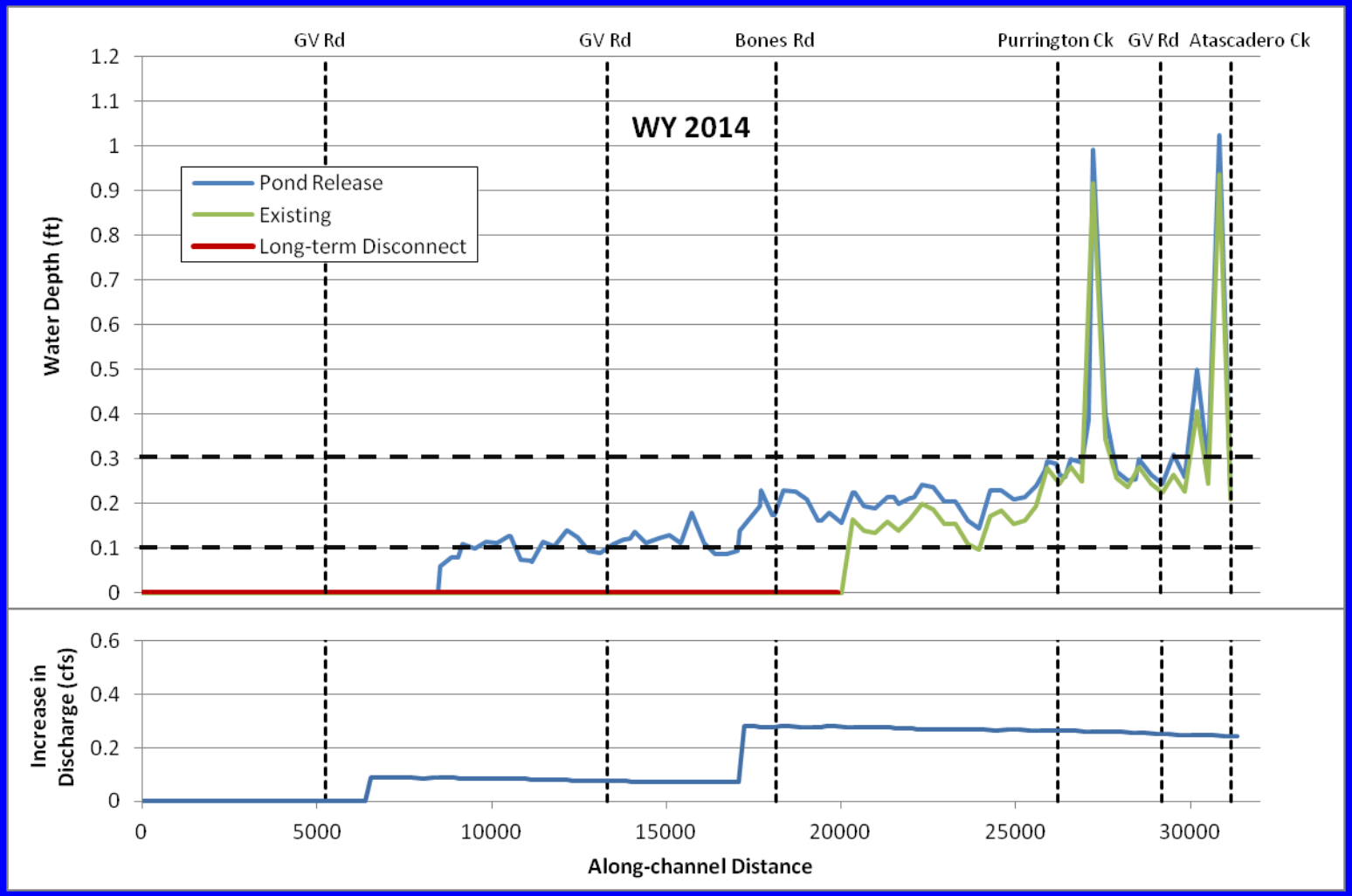
Water Depth (ft)

- < 0.05
- 0.05 - 0.10
- 0.10 - 0.15
- 0.15 - 0.20
- 0.20 - 0.25
- 0.25 - 0.30
- 0.30 - 0.40
- 0.40 - 0.50
- > 0.50

N

3,000 1,500 0 3,000 Feet

Flow Augmentation Scenario



Mill/Mark West Scenario Concepts

- Climate Change – lots of downscaled GCM datasets
- Future Build-out
- Flow Enhancement Concepts
  - Replacement or timing adjustments to diversions and/or high-impact wells (storage, lower-impact wells, recycled water)
    - 415 ac-ft/yr of recycled water is available from Healdsburg WWTP - existing pipeline along Foreman Lane
  - Pond Bypasses/releases
  - Channel Morphology (excavation/aggradation)
  - Forest Management
  - Infiltration basins/Stormwater management
  - Headwater Stream Sediment Plugs

Project Schedule

- Fully Calibrated Model – Summer 2019
- Scenario Analysis – Spring 2020
- Restoration Recommendations – Fall 2020
- Workshops – Fall 2020
- Final Report – 1/1/2021


Questions/Discussion