

Integrated Surface and Groundwater Modeling for Watershed Management and Restoration Planning in Russian River Tributary Watersheds

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Acknowledgements

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 - CDFW
 - NMFS
 - CEMAR
 - UCCE

Background

- CDFW and NMFS have identified inadequate summer streamflows as a key limiting factor for coho survival
- Numerous natural and man-made factors control surface water and groundwater availability
- Knowledge of spatial and temporal variations in hydrologic conditions is incomplete
- Increasing water demands, ongoing drought, climate change

Approach

Why Develop a Numerical Hydrologic Model?

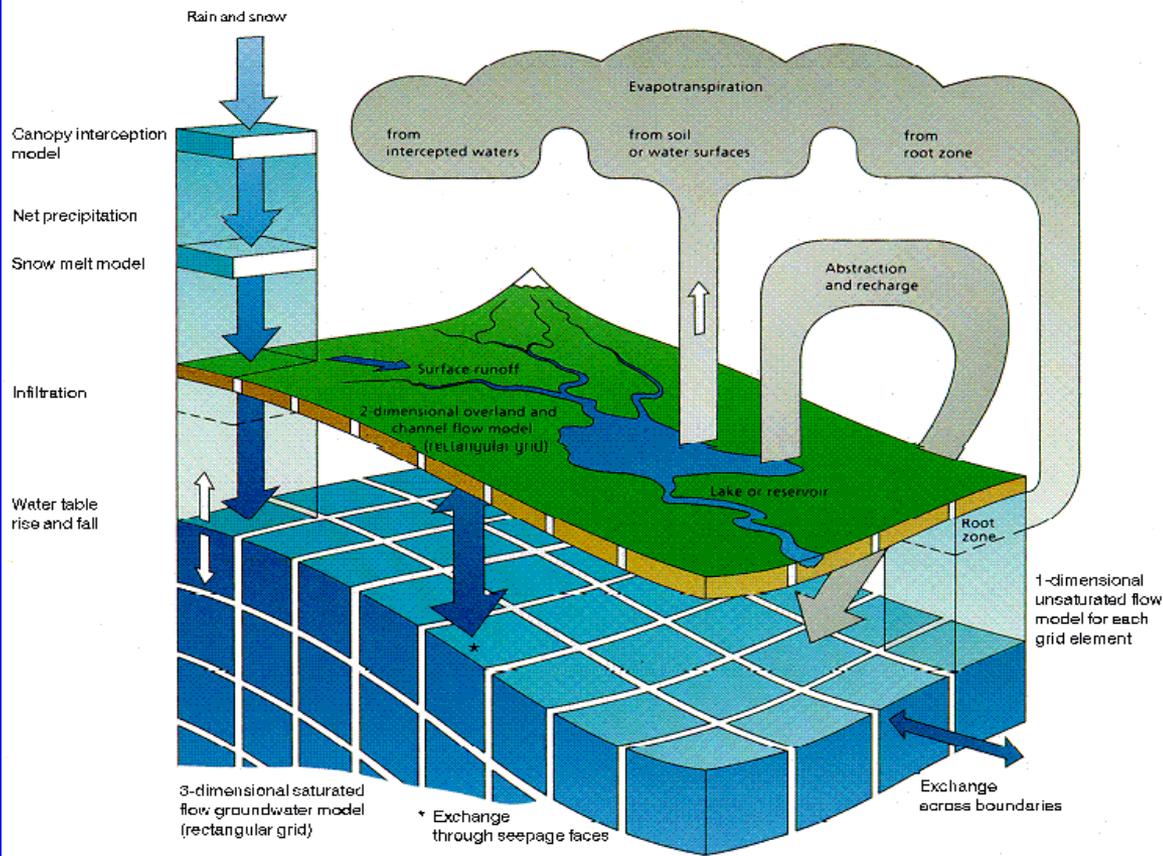
- Leverage monitoring data into a watershed-wide understanding of hydrologic conditions
- Evaluate cumulative impacts of land and water use management decisions and habitat restoration actions
- Test and optimize alternative management and restoration strategies



Model Overview

MIKE SHE

an Integrated Hydrological Modelling System



Precipitation

Evapotranspiration

Overland Flow

Unsaturated Flow

Groundwater Flow

River and Lakes

Irrigation

Sediment Transport

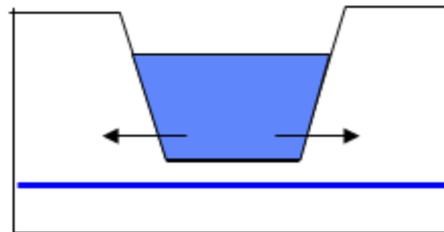
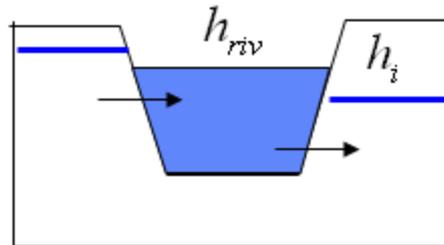
Water Quality

Model Overview

Water Level Gradient

Head difference between the river and the saturated zone is calculated as:

$$\Delta h = h_i - h_{riv}$$



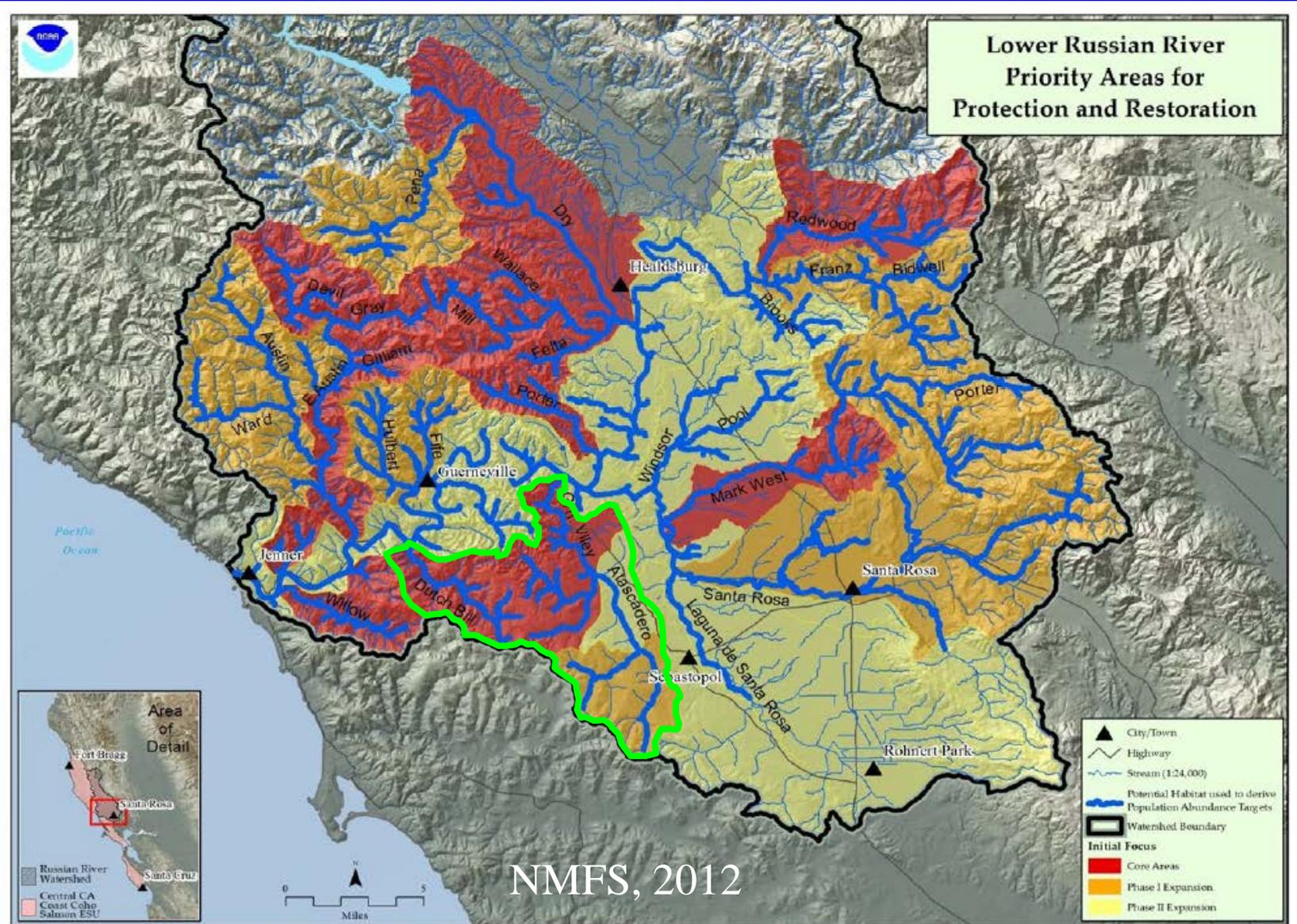
Conductance

Conductance calculated as the harmonic mean of the hydraulic conductivity of the aquifer and the river bed:

$$C_{i,sz-river} = \frac{1}{\frac{ds}{C_i \cdot da_i \cdot dx} + \frac{1}{C_{i,river} \cdot w_i \cdot dx}}$$

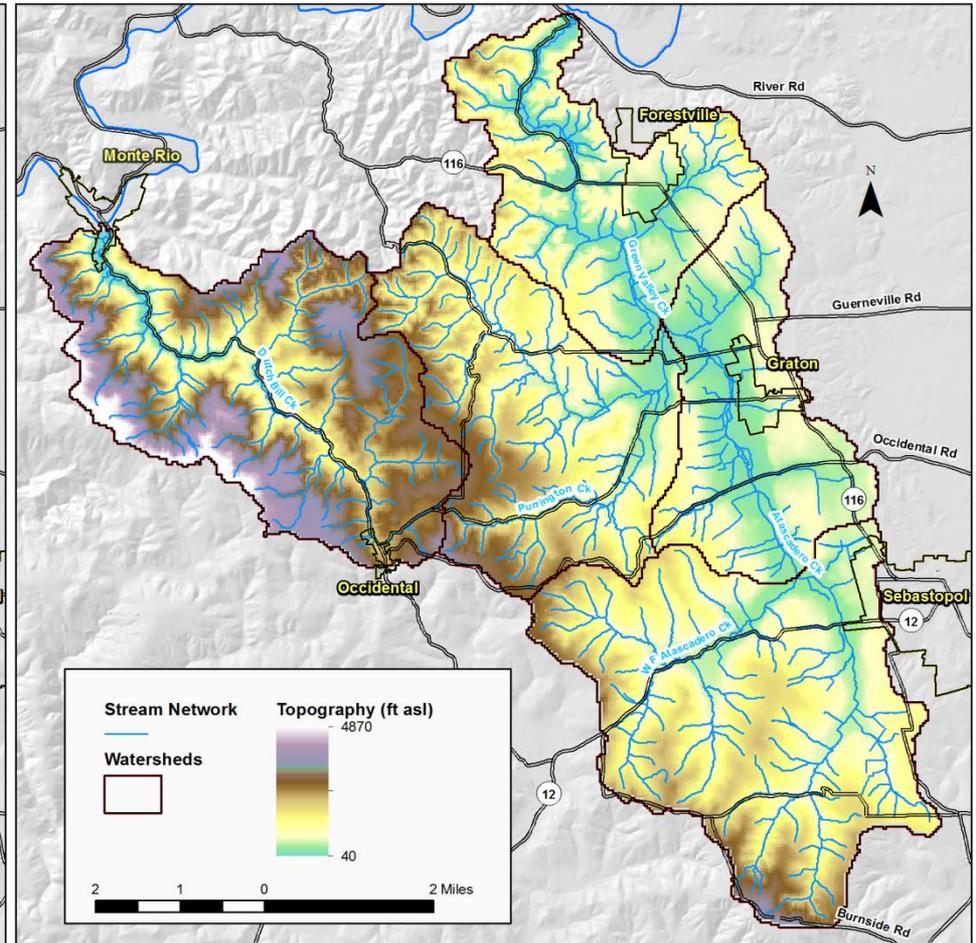
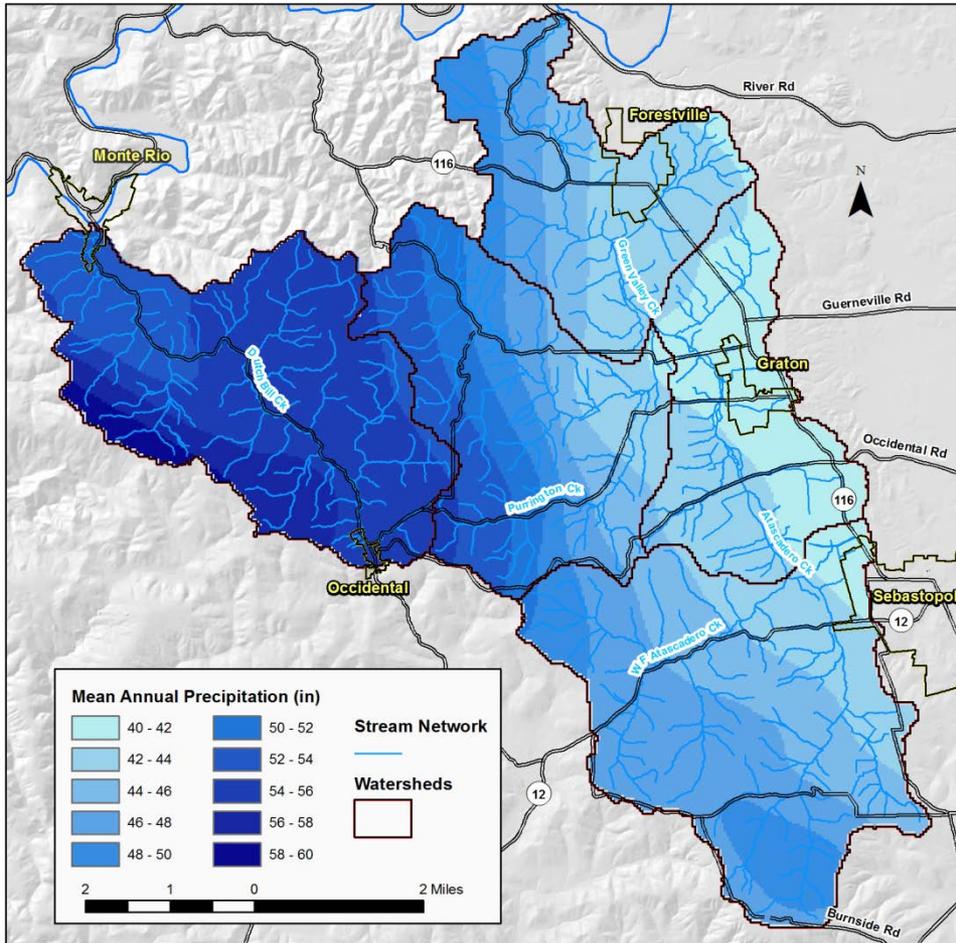
h_{riv}	river water level
h_i	head in grid cell i
C_i	hydraulic conductivity in saturated zone
$C_{i,river}$	leakage coefficient of river lining
da_i	saturated layer thickness
dx	SZ grid size
ds	Average flow length - distance
w_i	wetted perimeter in grid cell i

Study Area



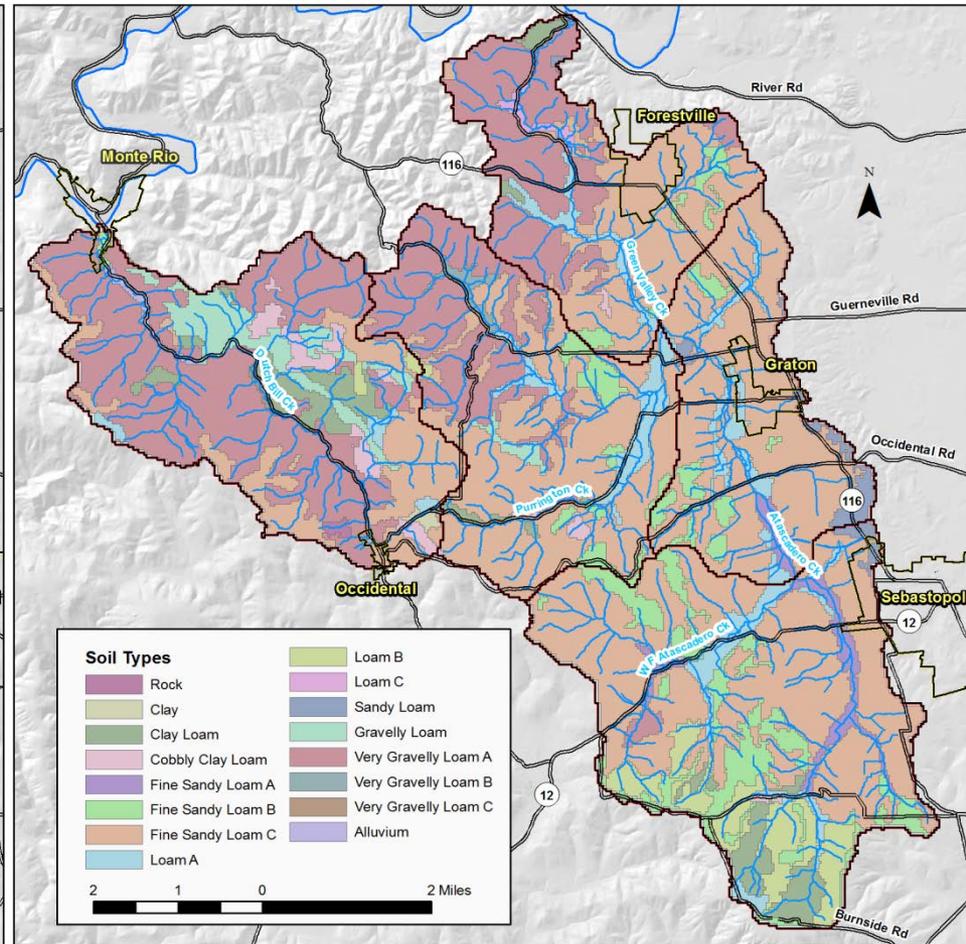
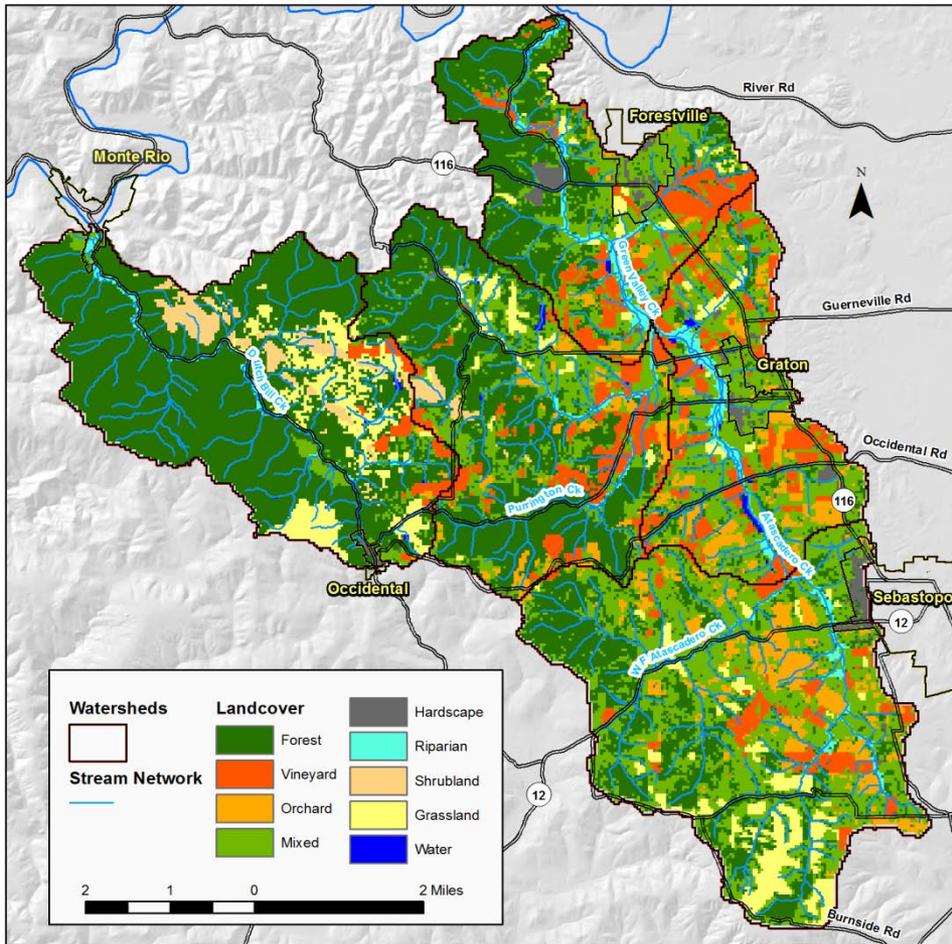
Climate

Topography

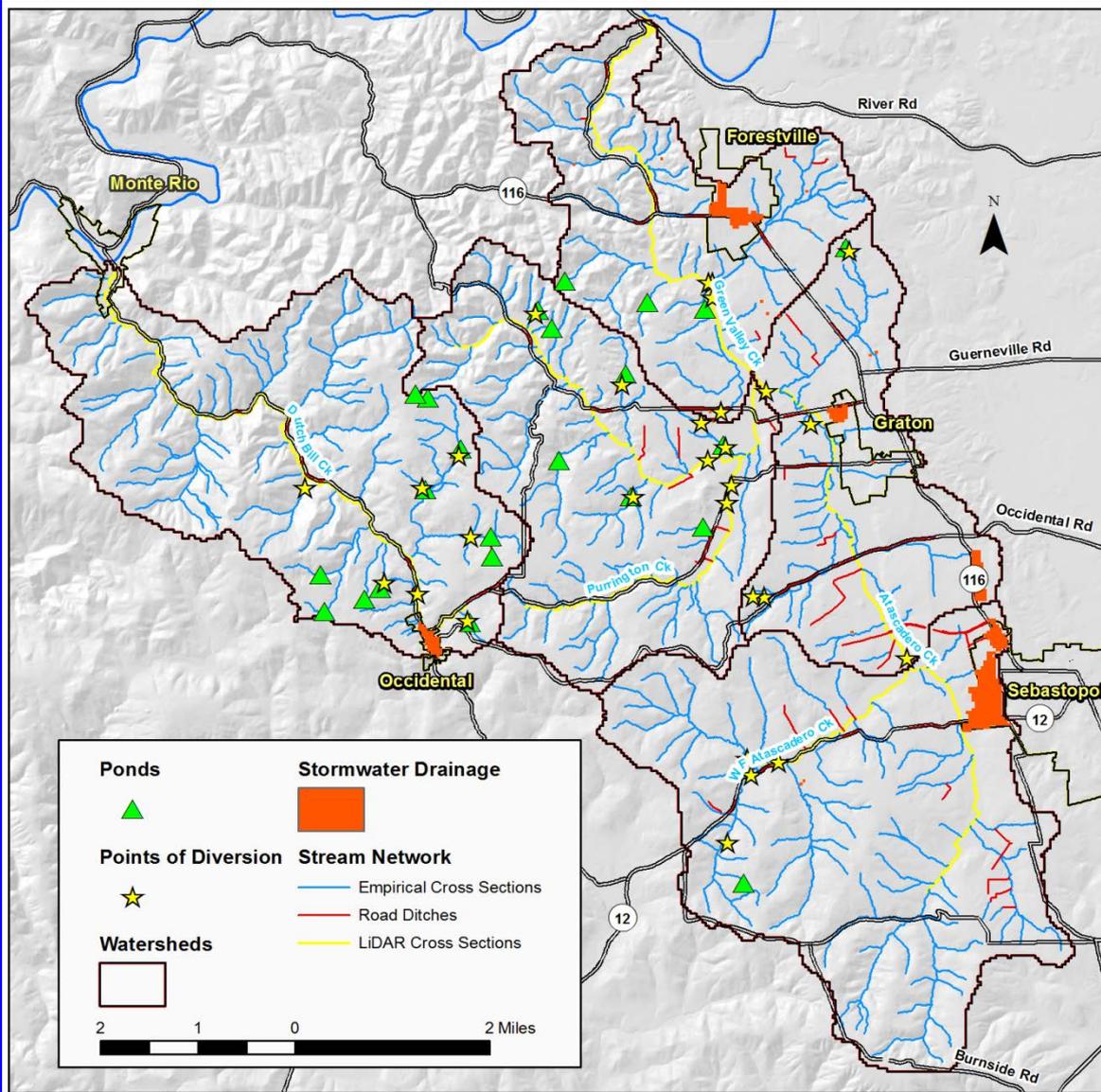


Land Cover

Soils



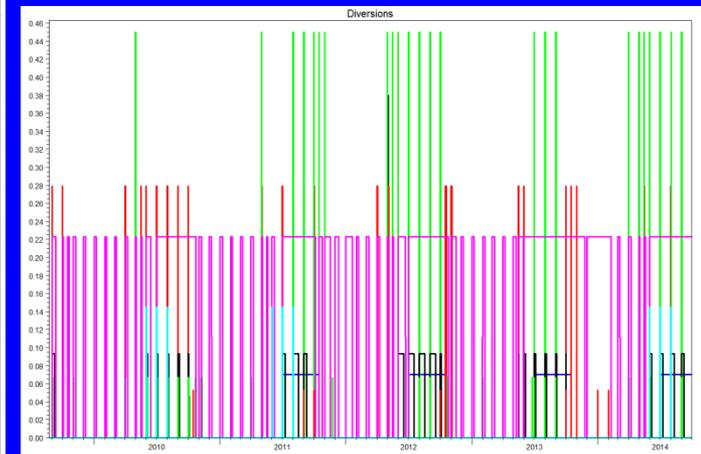
Surface Water



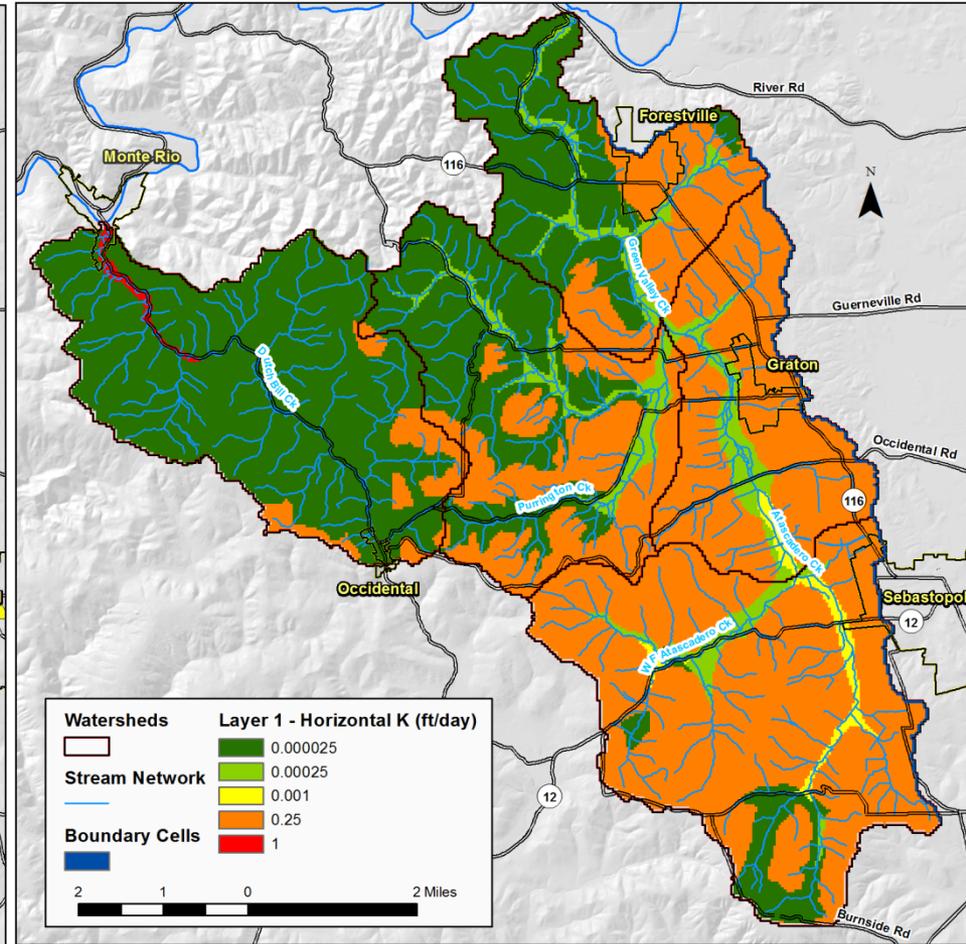
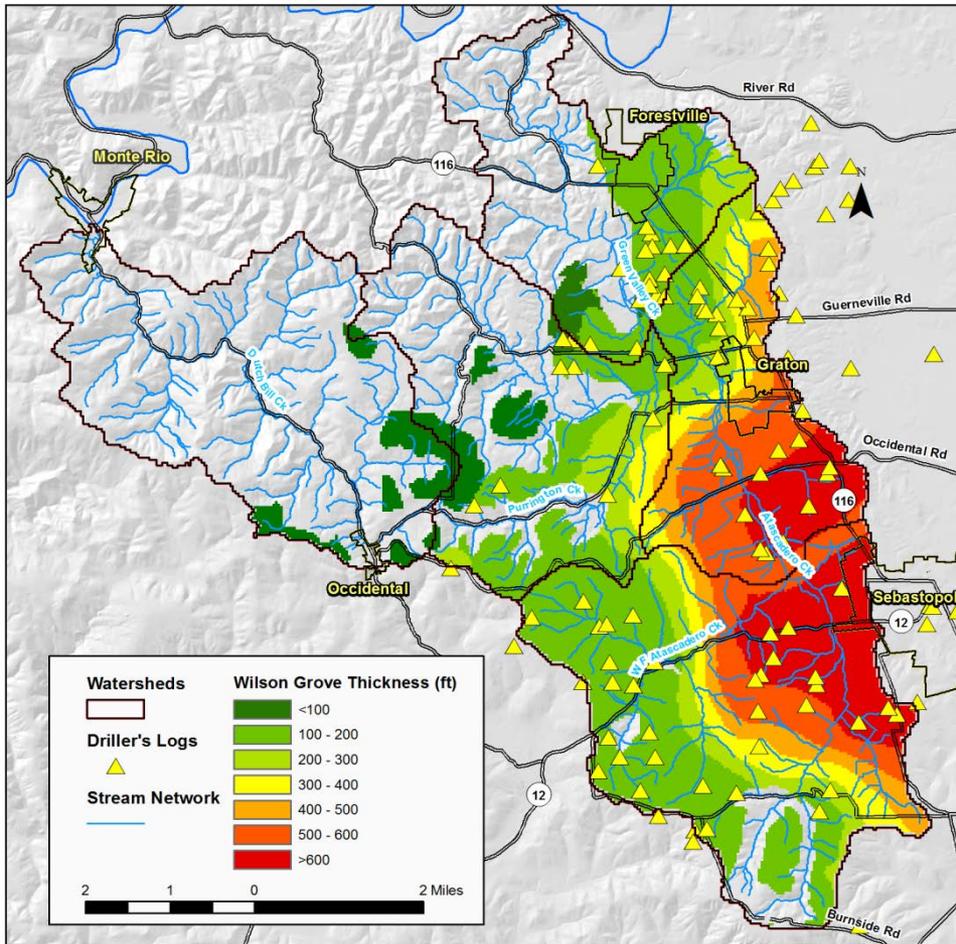
Cross Sections



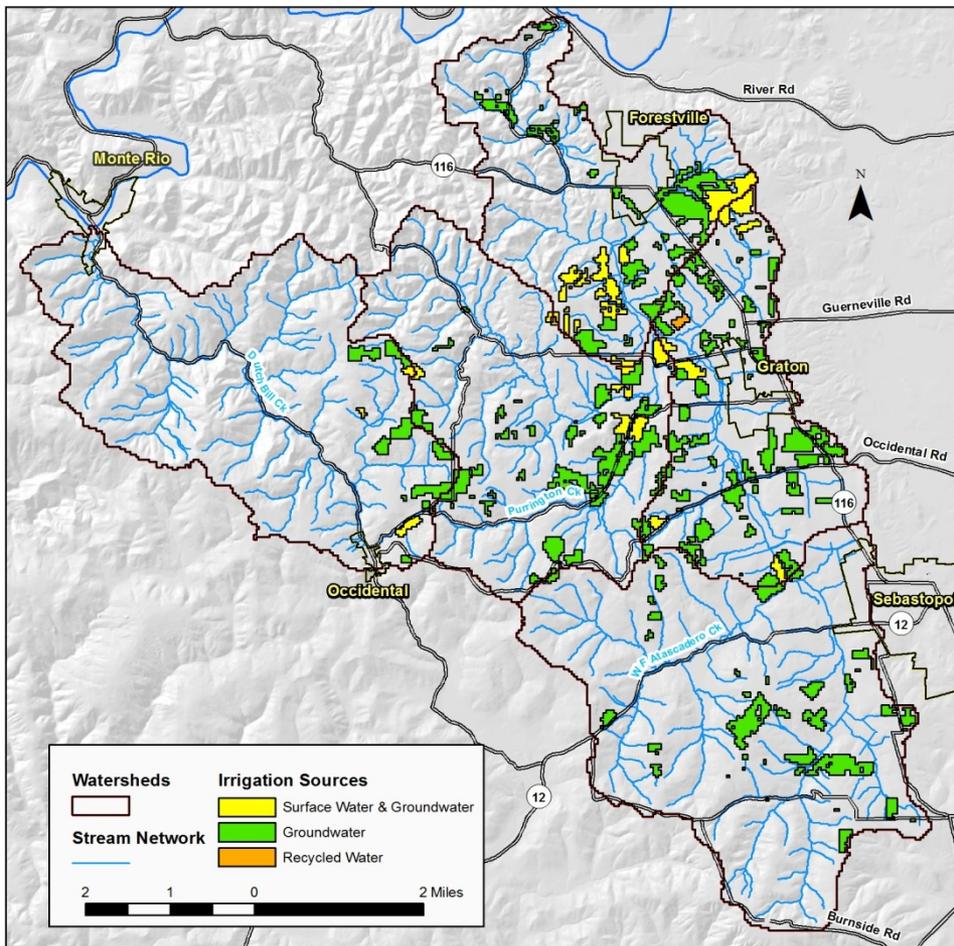
Timeseries



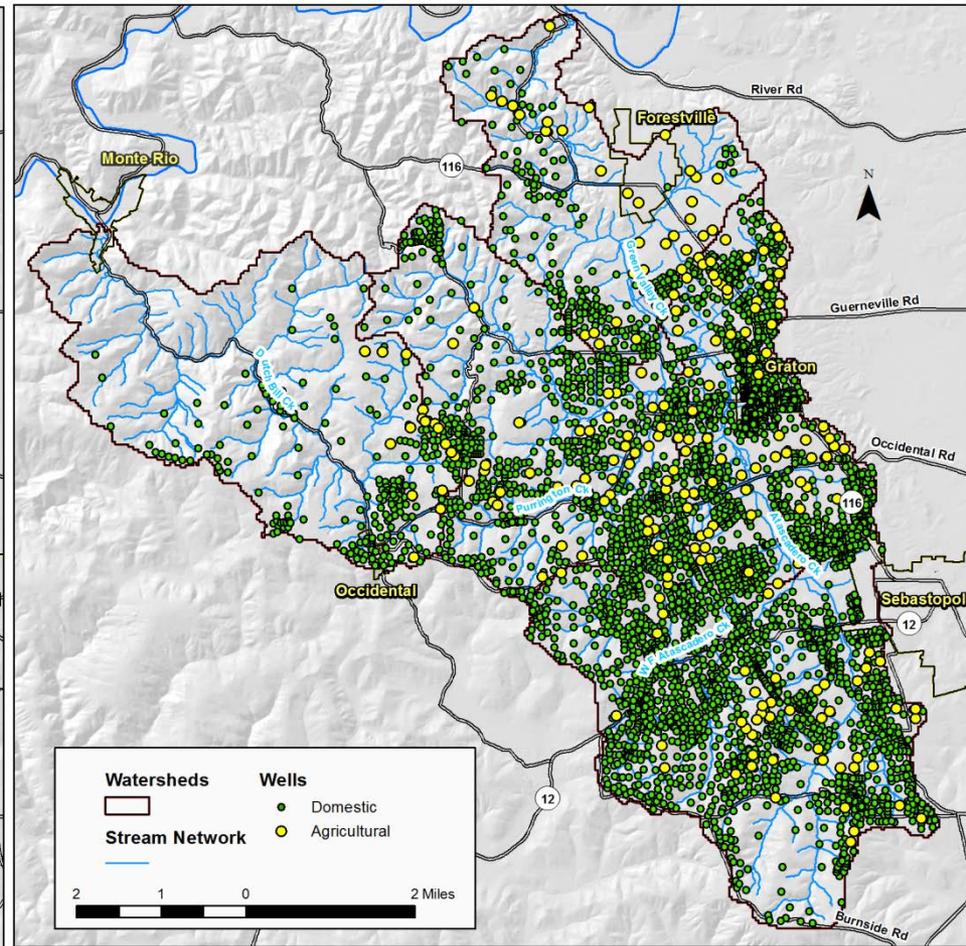
Groundwater



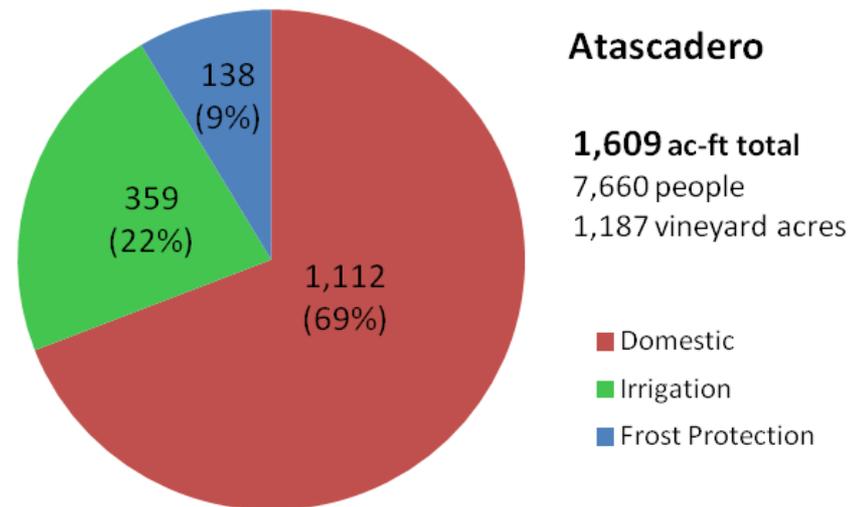
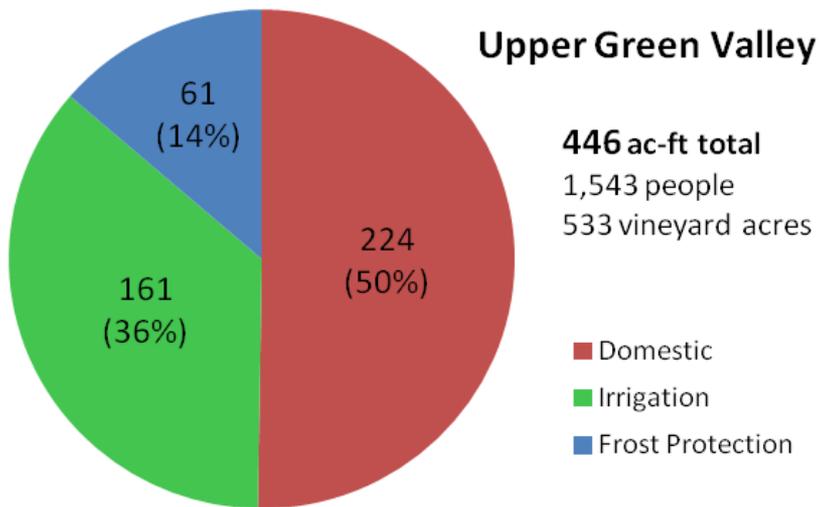
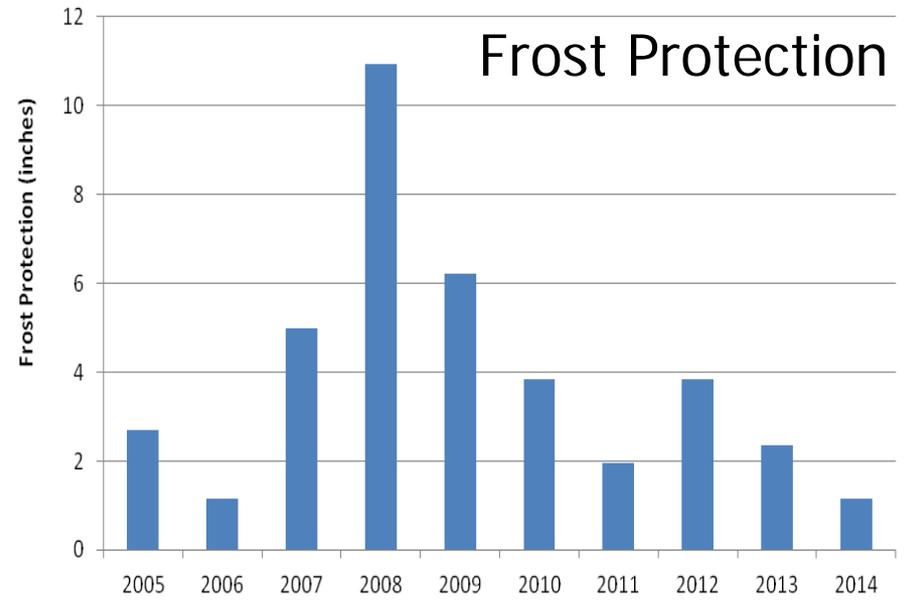
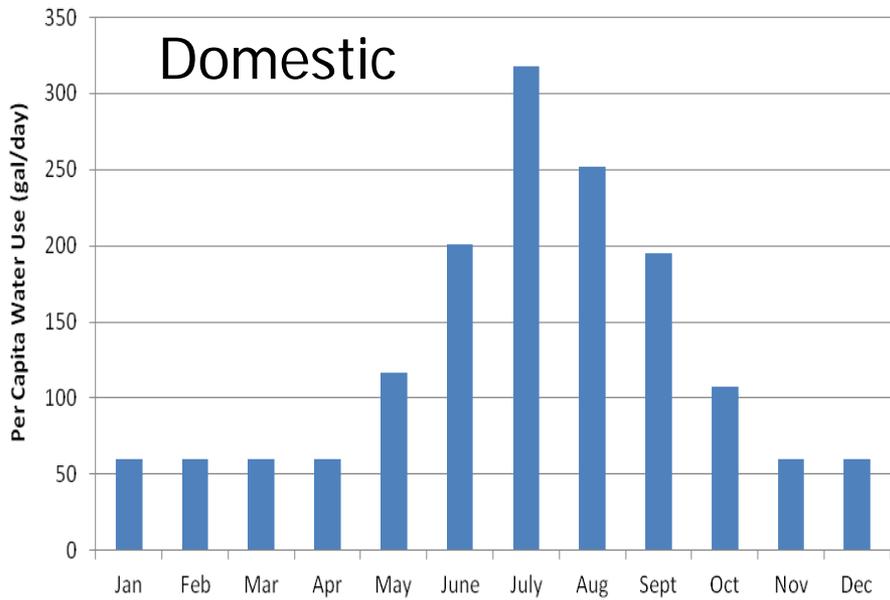
Irrigation



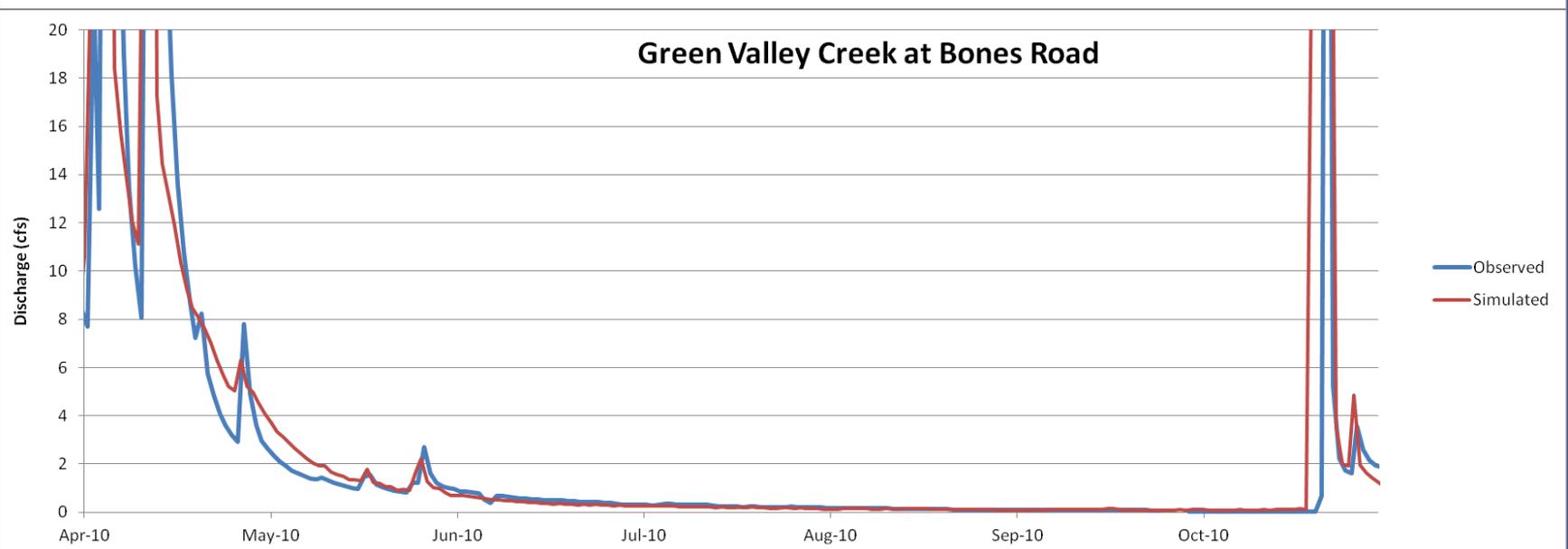
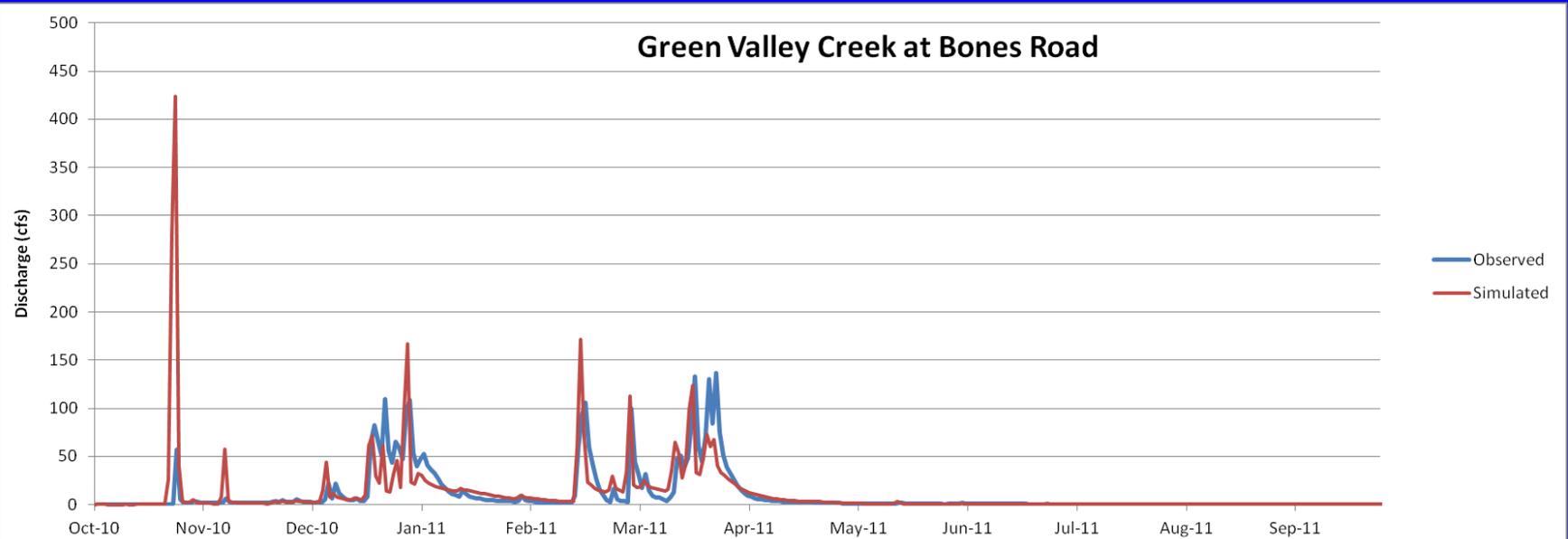
Wells



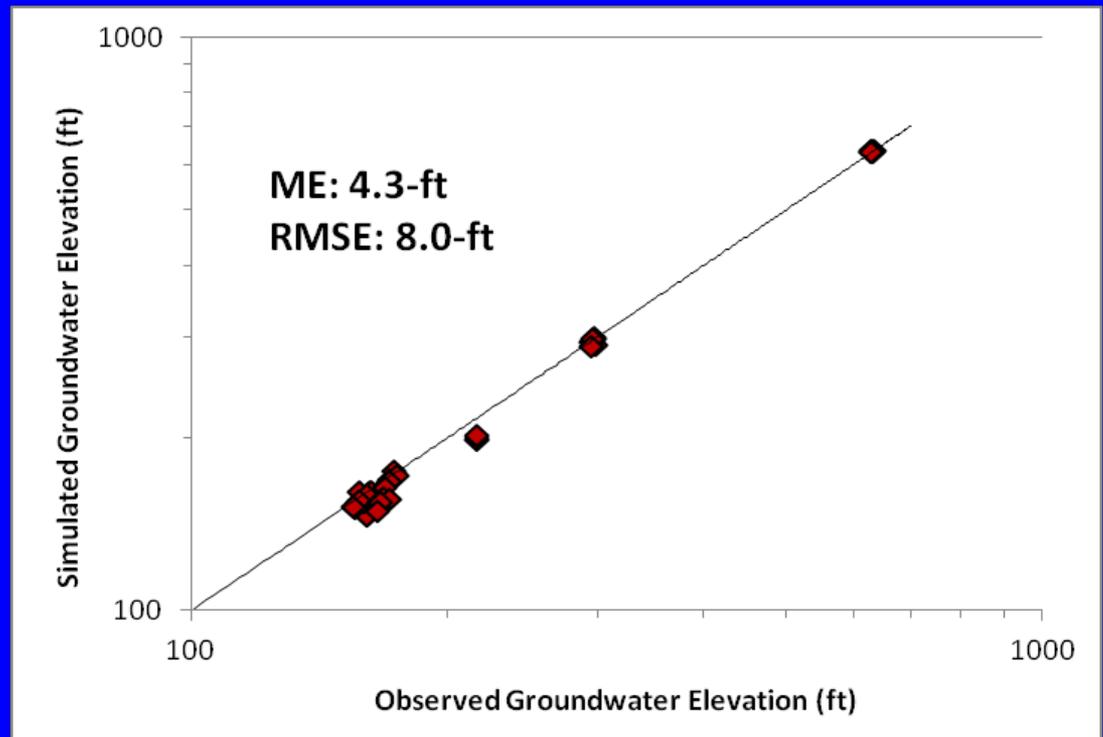
Water Use



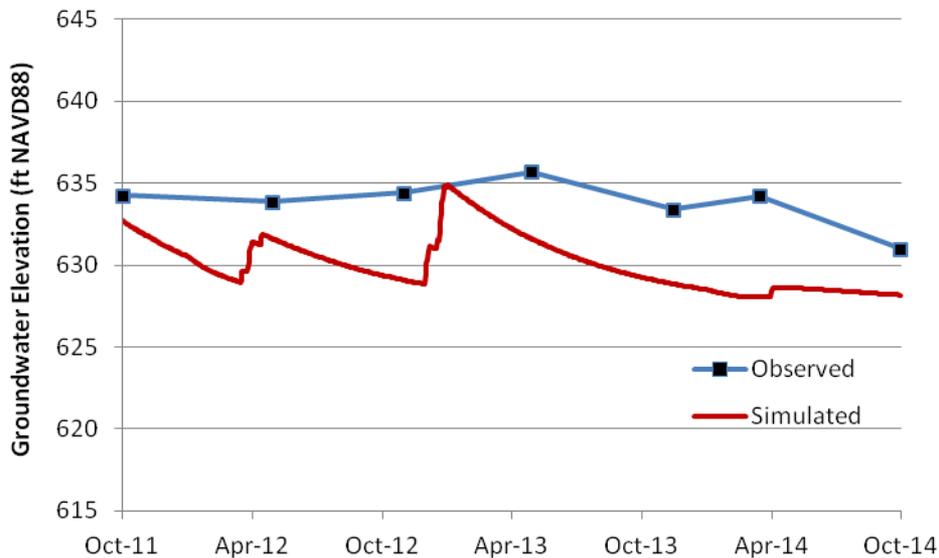
Surface Water Calibration



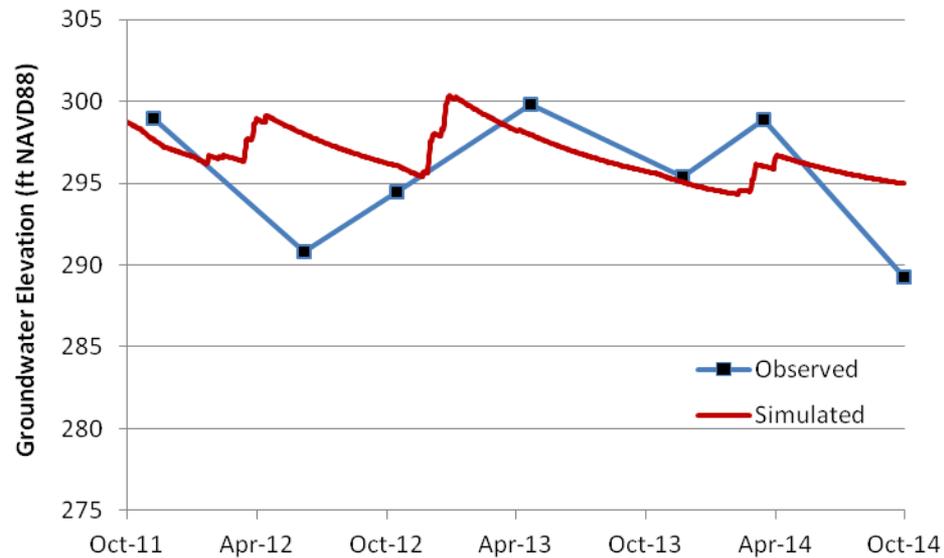
Groundwater Calibration



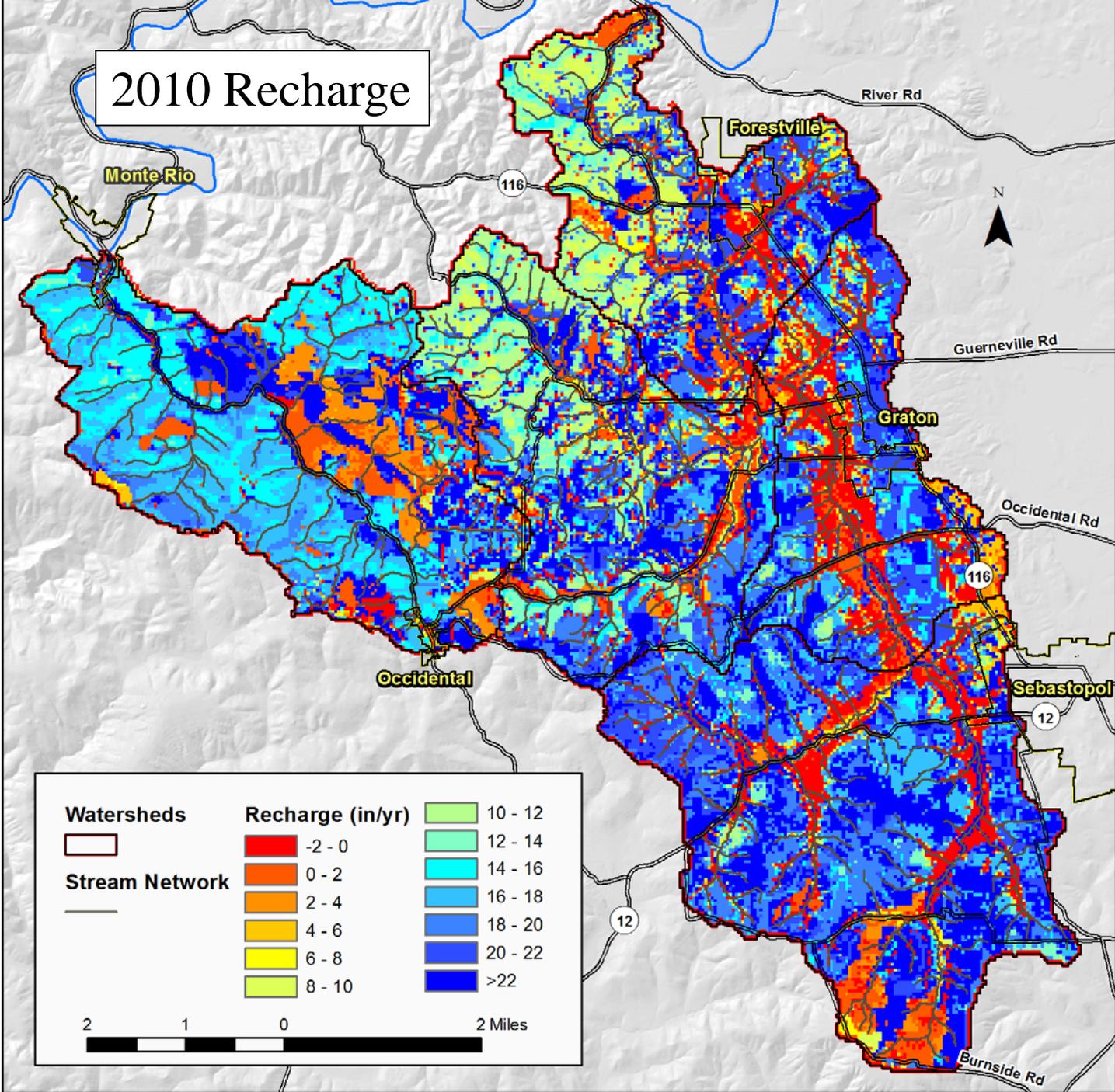
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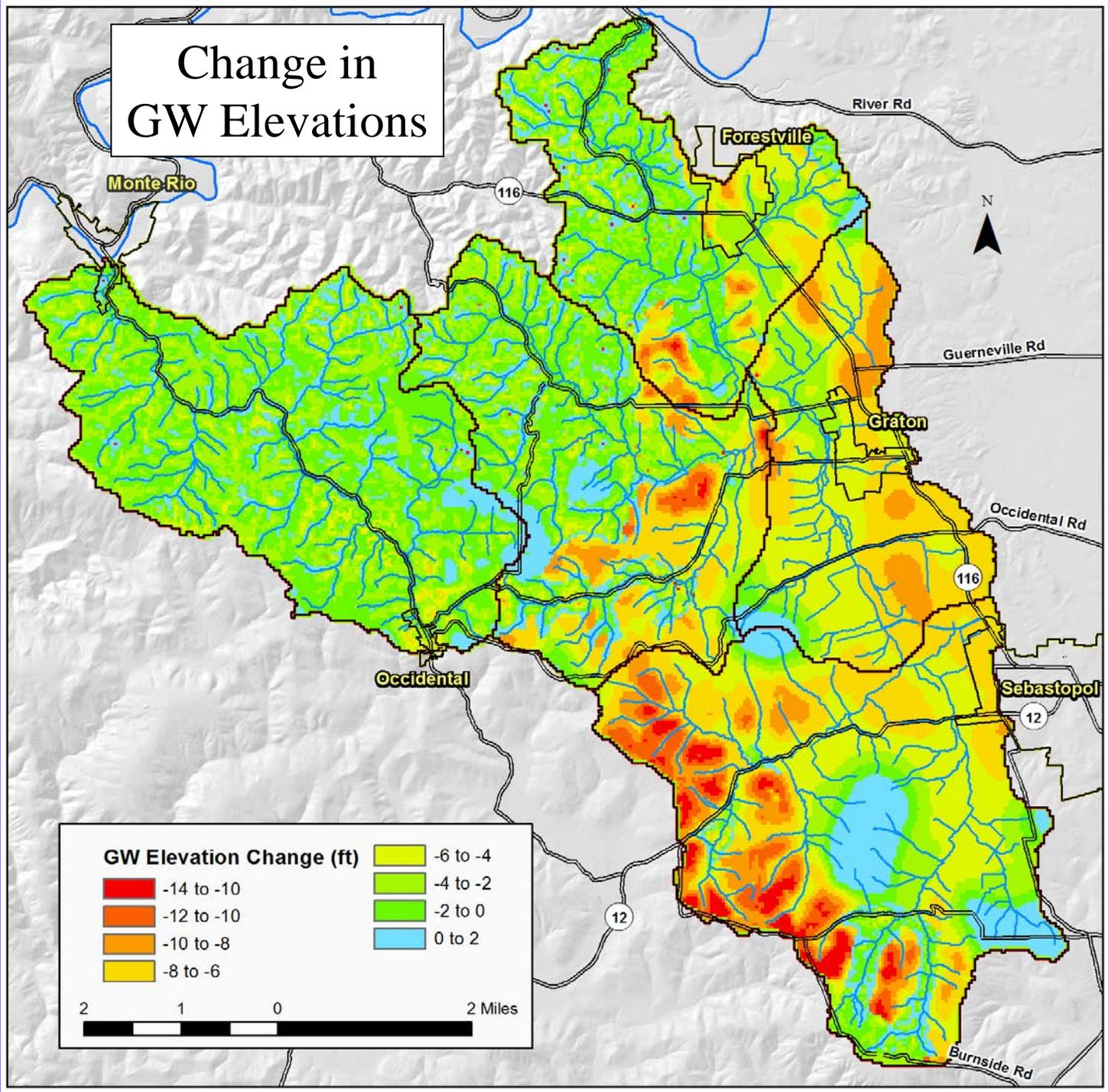
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2010 Recharge



Change in GW Elevations

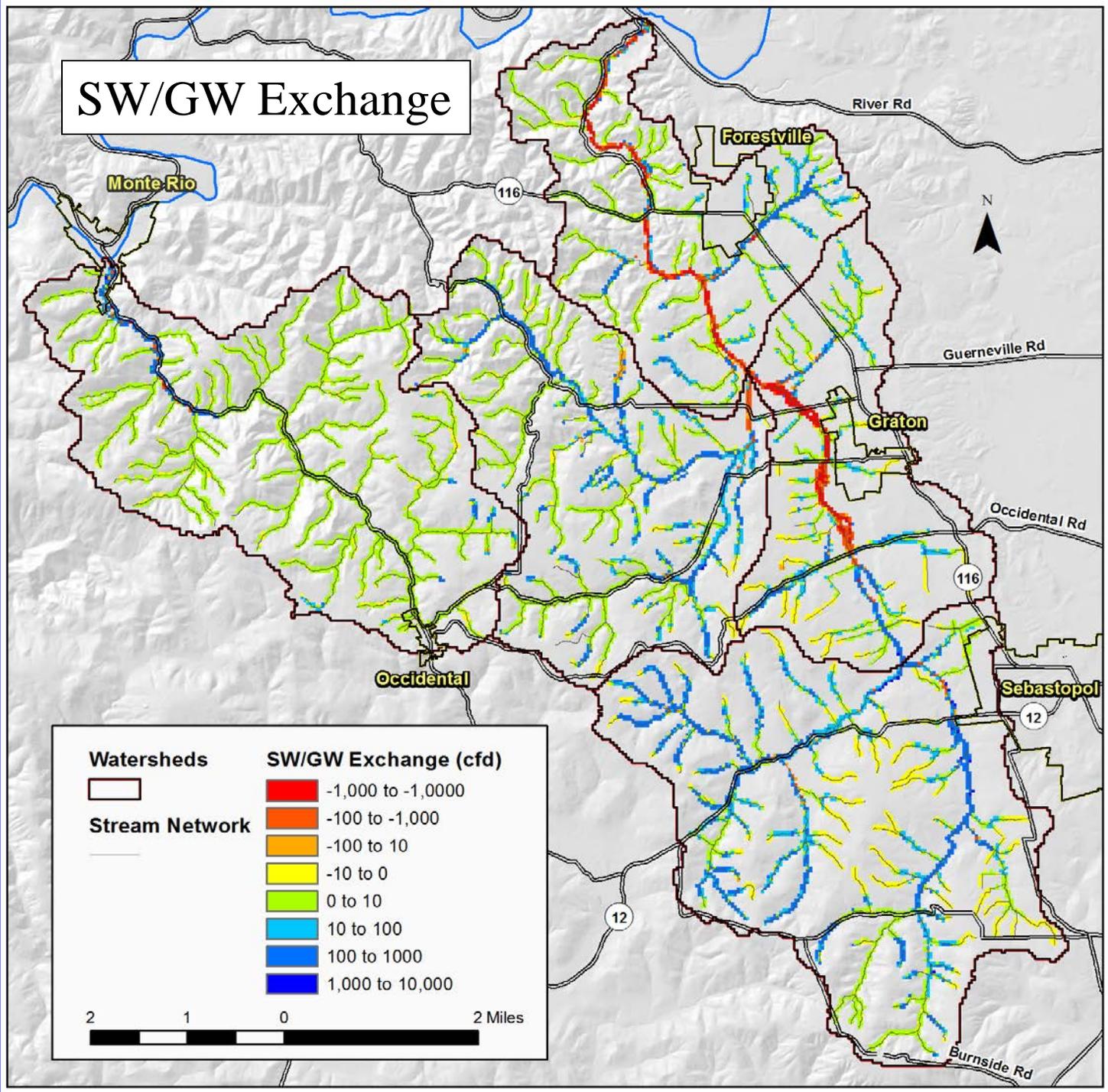


GW Elevation Change (ft)

	-14 to -10		-6 to -4
	-12 to -10		-4 to -2
	-10 to -8		-2 to 0
	-8 to -6		0 to 2

2 1 0 2 Miles

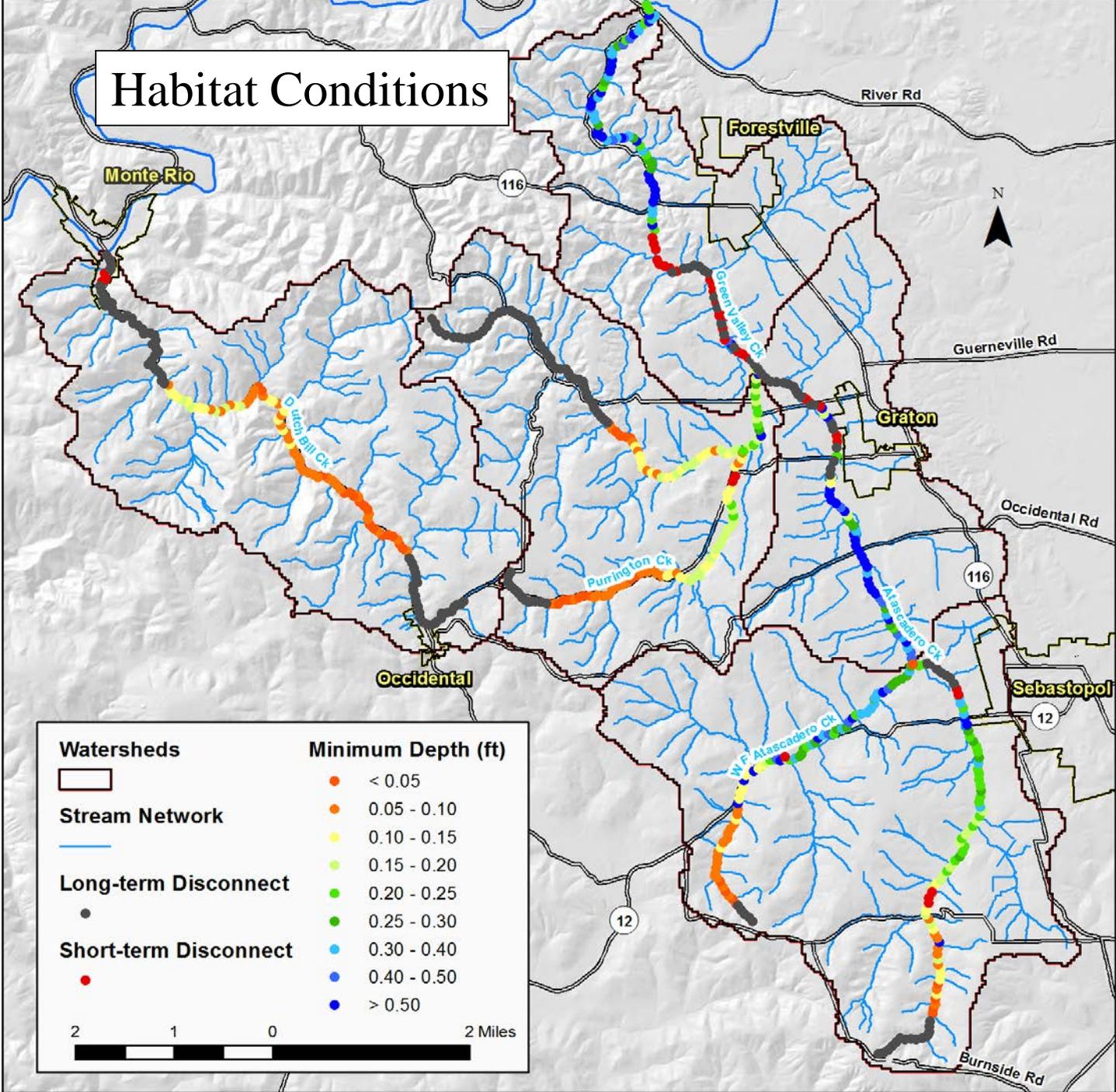
SW/GW Exchange



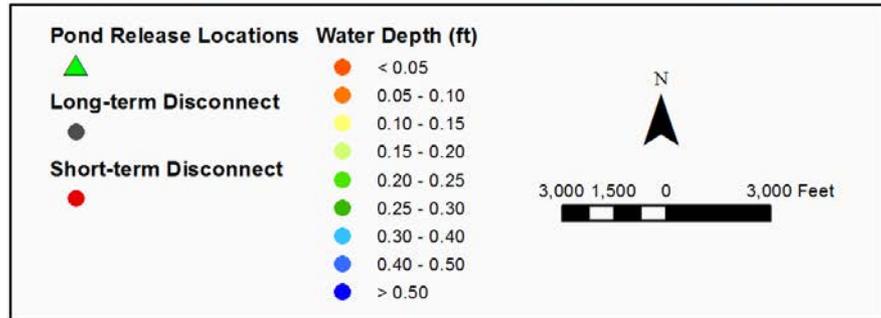
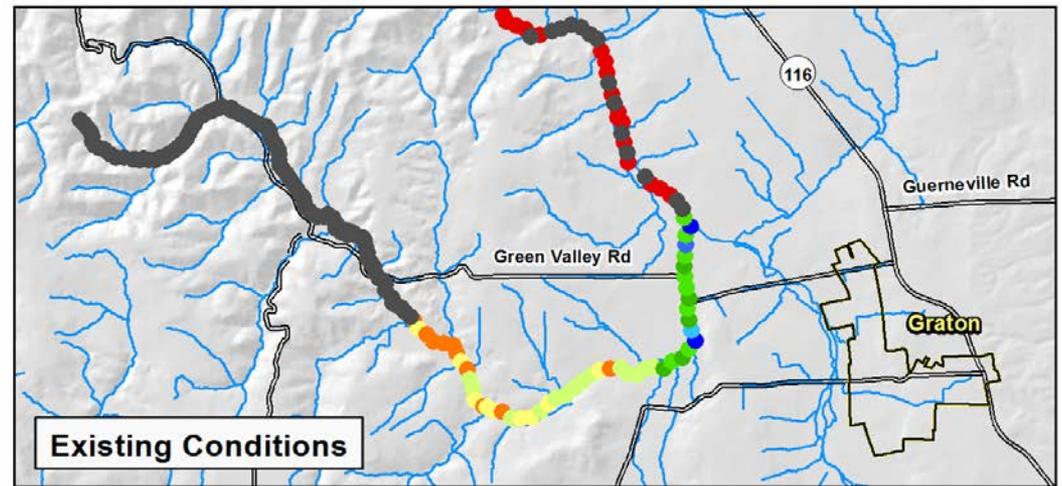
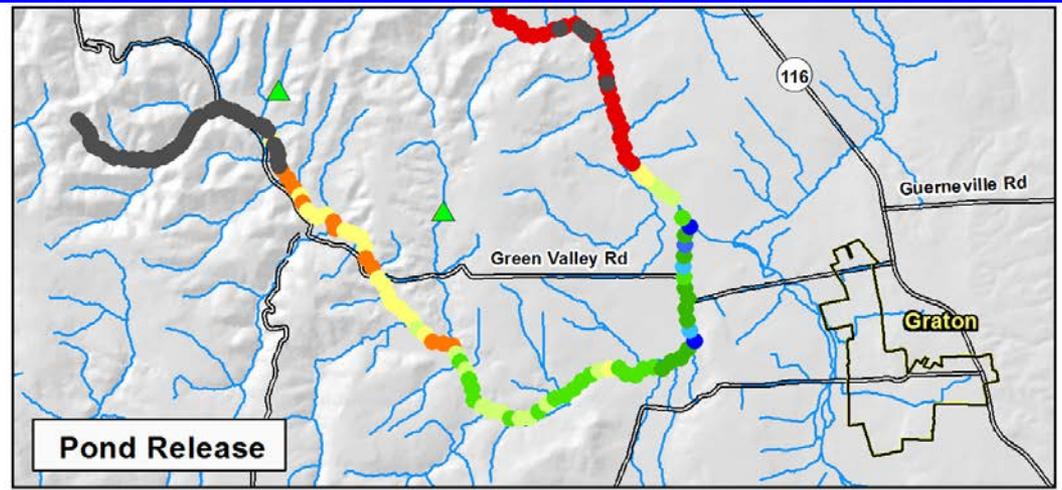
Watersheds	SW/GW Exchange (cfd)
	 -1,000 to -1,0000
Stream Network	 -100 to -1,000
	 -100 to 10
	 -10 to 0
	 0 to 10
	 10 to 100
	 100 to 1000
	 1,000 to 10,000

2 1 0 2 Miles

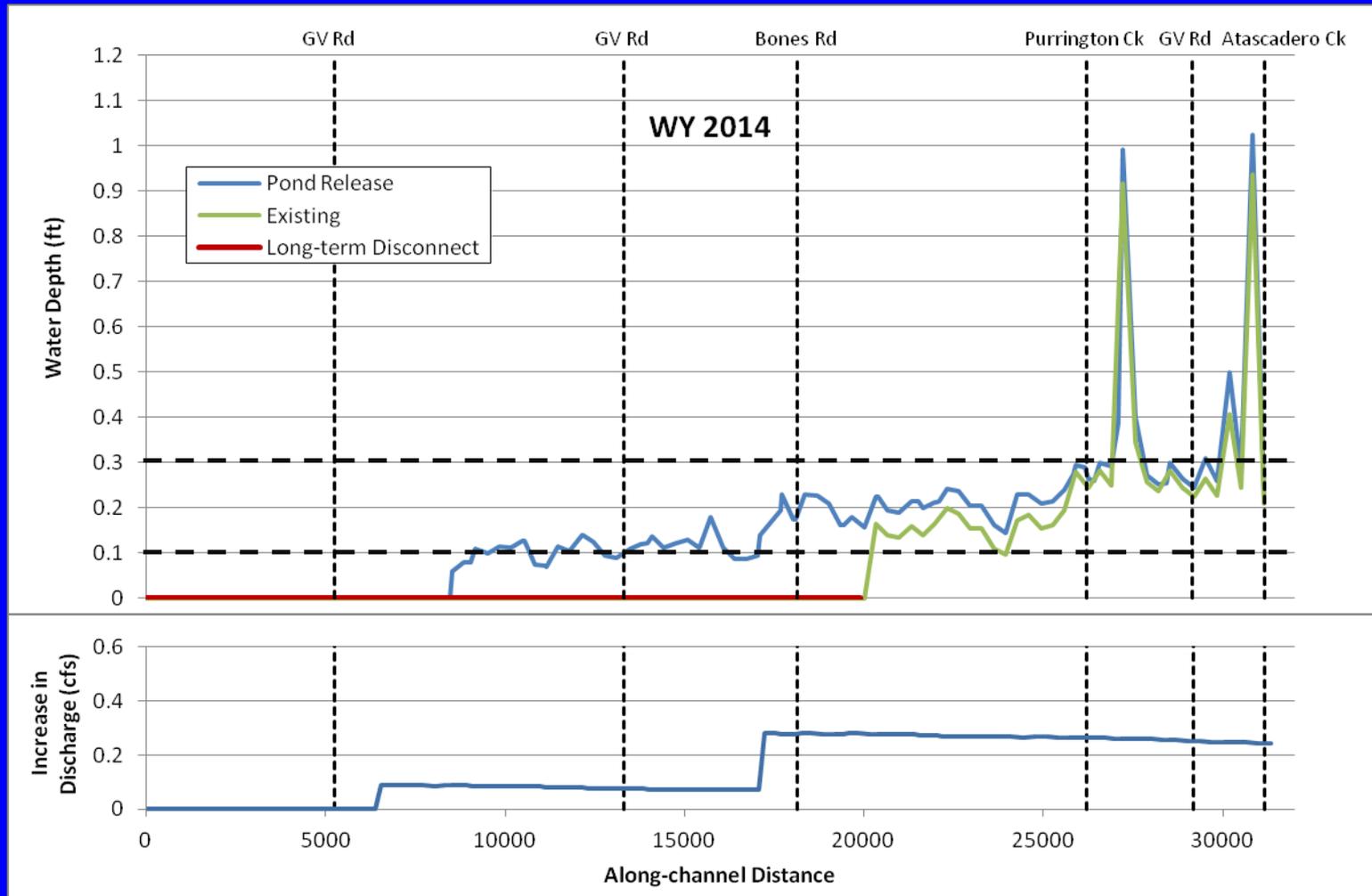
Habitat Conditions

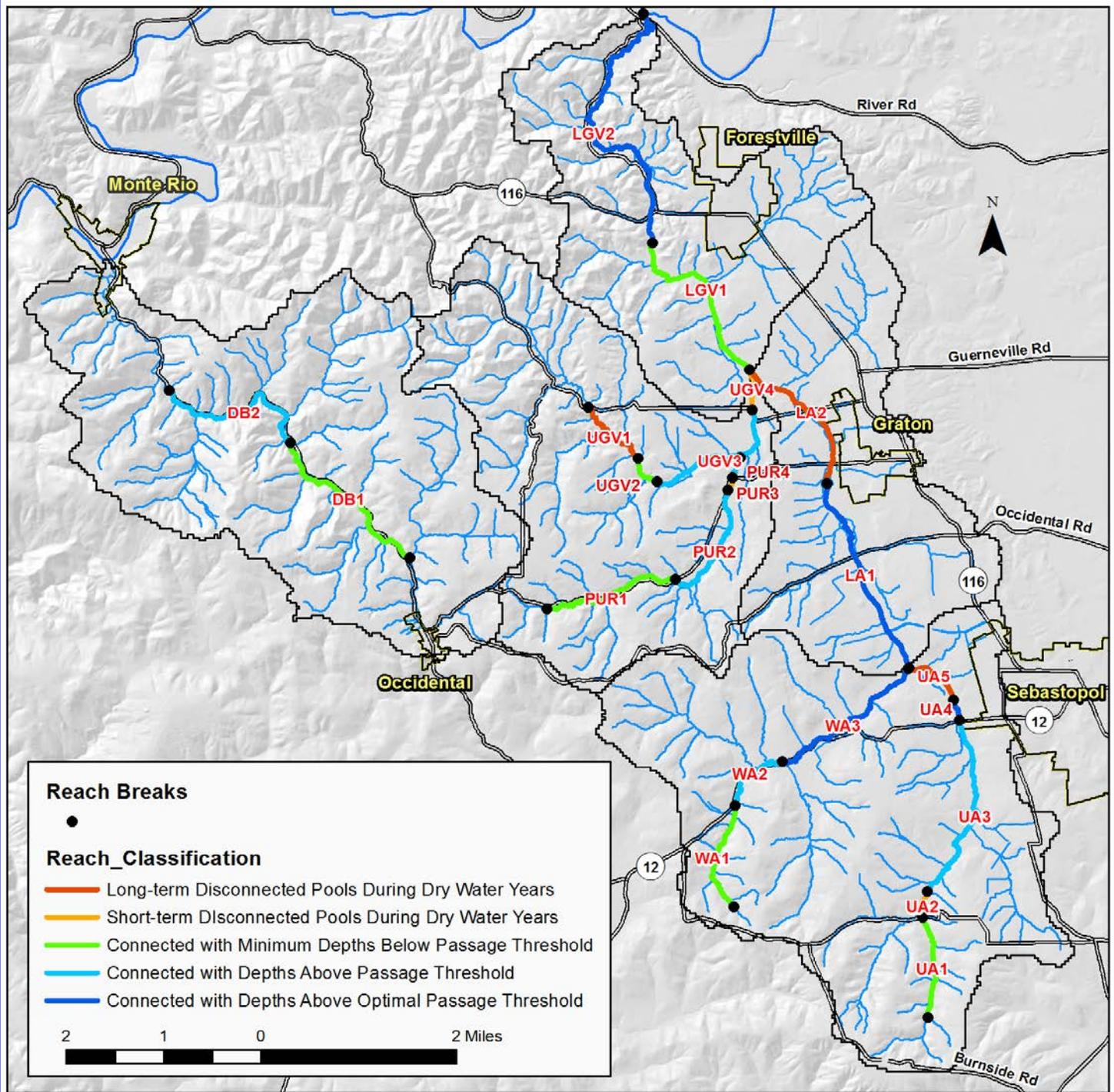


Flow Augmentation Scenario



Flow Augmentation Scenario





Monte Rio

LGV2

Forestville

River Rd

116

N

LGV1

Guerneville Rd

DB2

UGV4

Graton

LA2

DB1

UGV1

UGV3

PUR4

UGV2

PUR3

Occidental Rd

PUR2

LA1

116

Occidental

Sebastopol

WA3

UA5

UA4

12

WA2

UA3

12

WA1

UA2

UA1

Burnside Rd

Potential Applications

- Conjunctive use of surface and groundwater
- Water rights and degree of connectivity between wells and streams
- Floodplain management
- Climate change impacts and future demands
- Water supply reliability
- Irrigation efficiency

Thank You!



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