Water Quality and Urban Growth in the Treasure Valley: *A Water Balance Perspective*

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TREASURE VALLEY WATER ATLAS

Conclusions, Observations, Conjectures

Conclusions, Observations

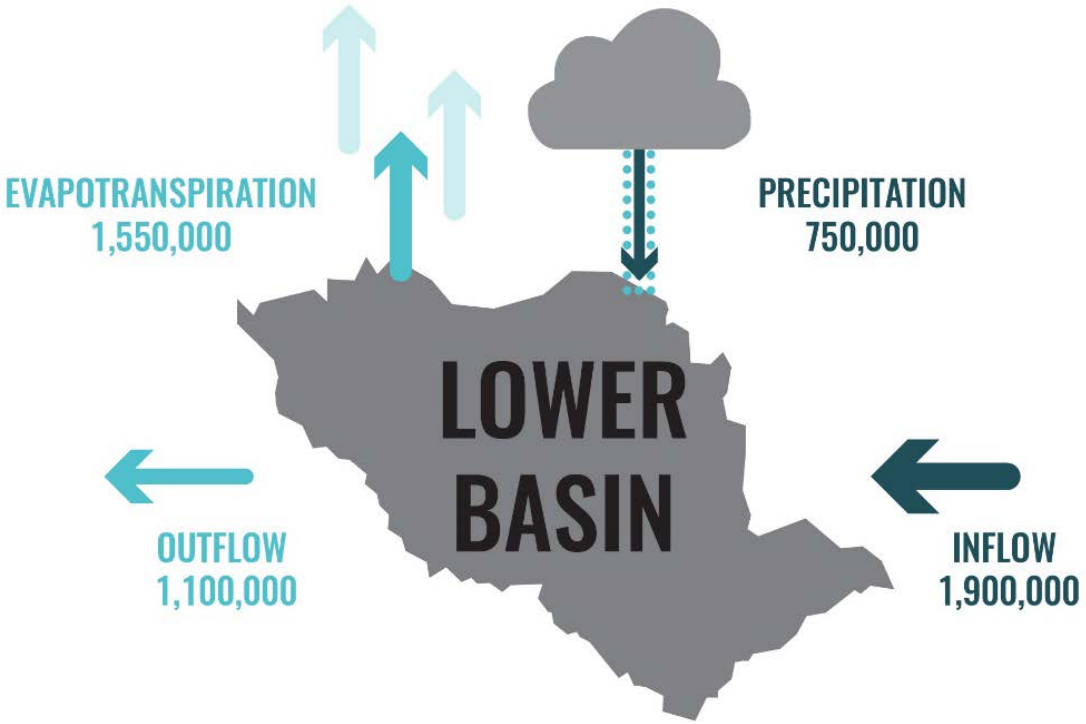
- Three Big Drivers of Change to Water Budget:
  - Climate change, Increased Irrigation Efficiency, Urbanization
- Urbanization Water Budget Impacts
  - Ag to Urban
  - Sage to Urban

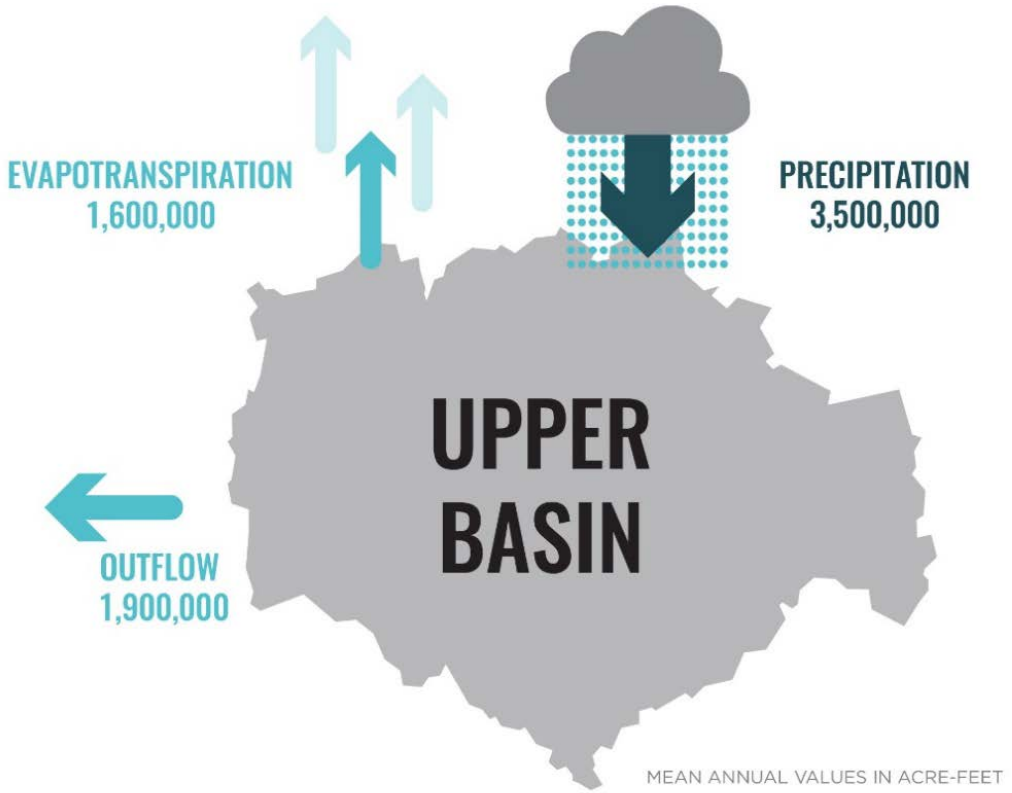
Conjectures

- Arsenic
- Uranium
- Nitrate

The Current System

Lower Basin vs. Upper Basin Water Balance



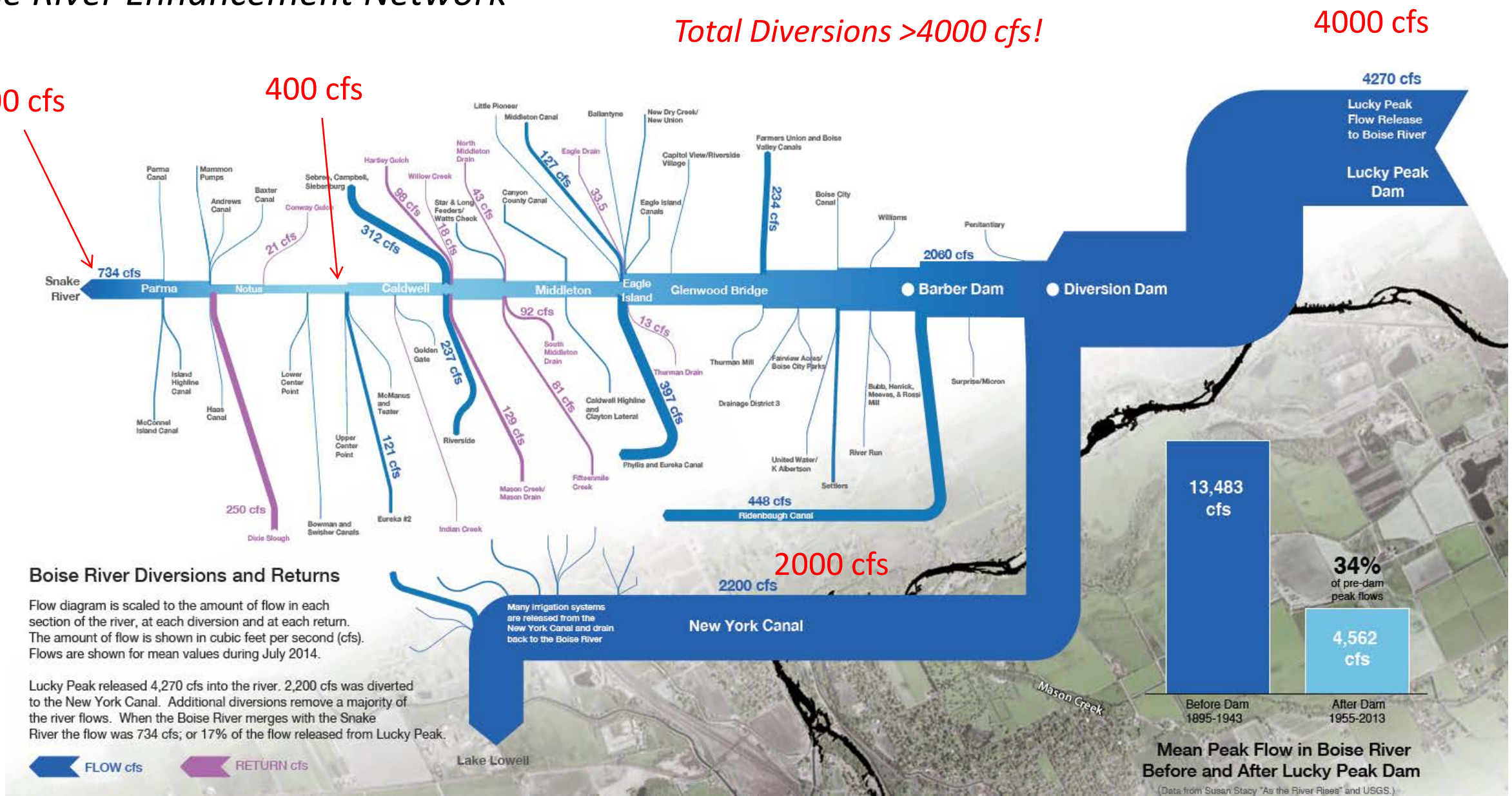


TREASURE VALLEY WATER ATLAS

Boise River Diversions and Returns

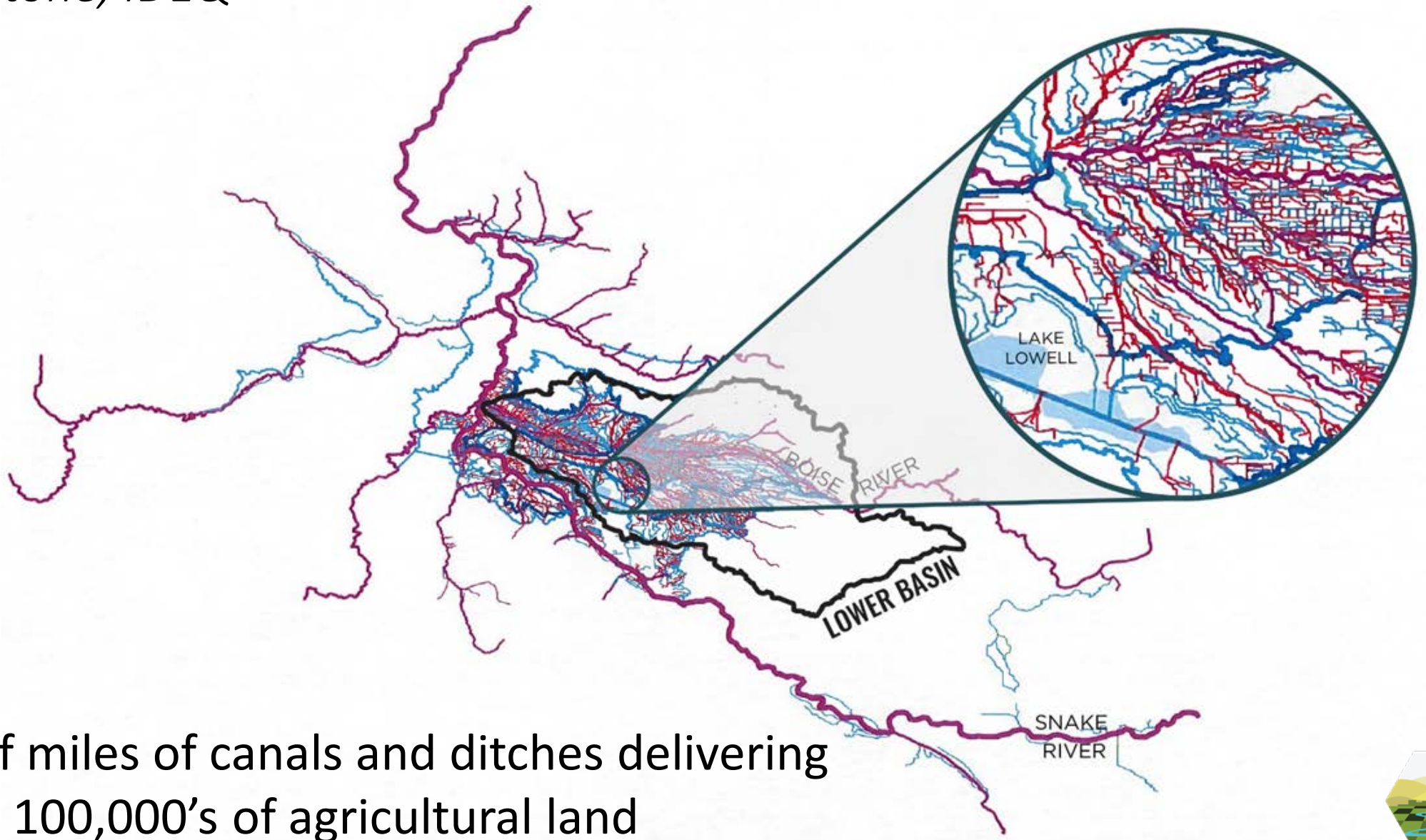
Boise River Enhancement Network

Total Diversions >4000 cfs!



Built Hydrologic System of Veins and Arteries

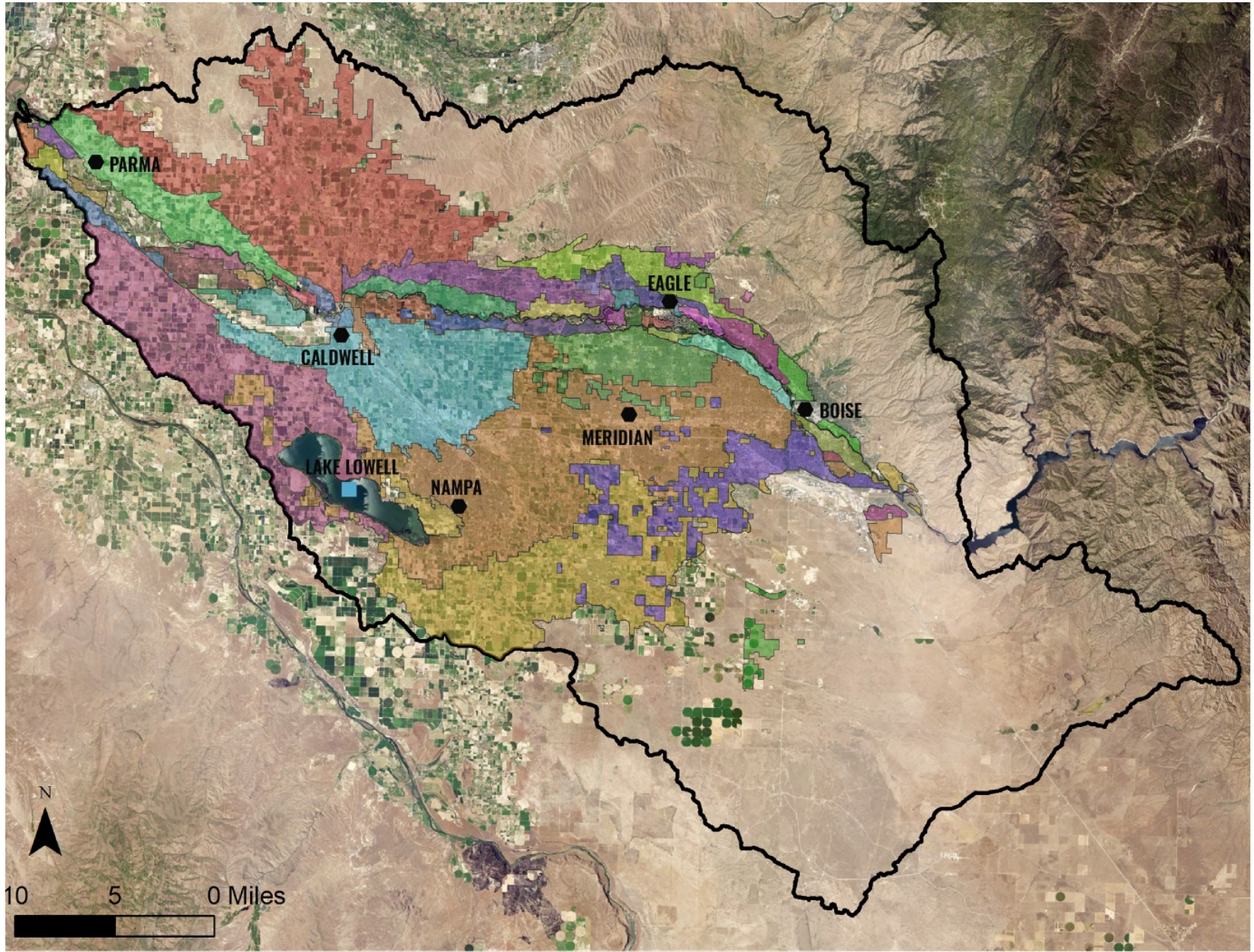
Hawk Stone, IDEQ



1000's of miles of canals and ditches delivering water to 100,000's of agricultural land

TREASURE VALLEY WATER ATLAS

Over 30 Irrigation districts and canal companies



LEGEND

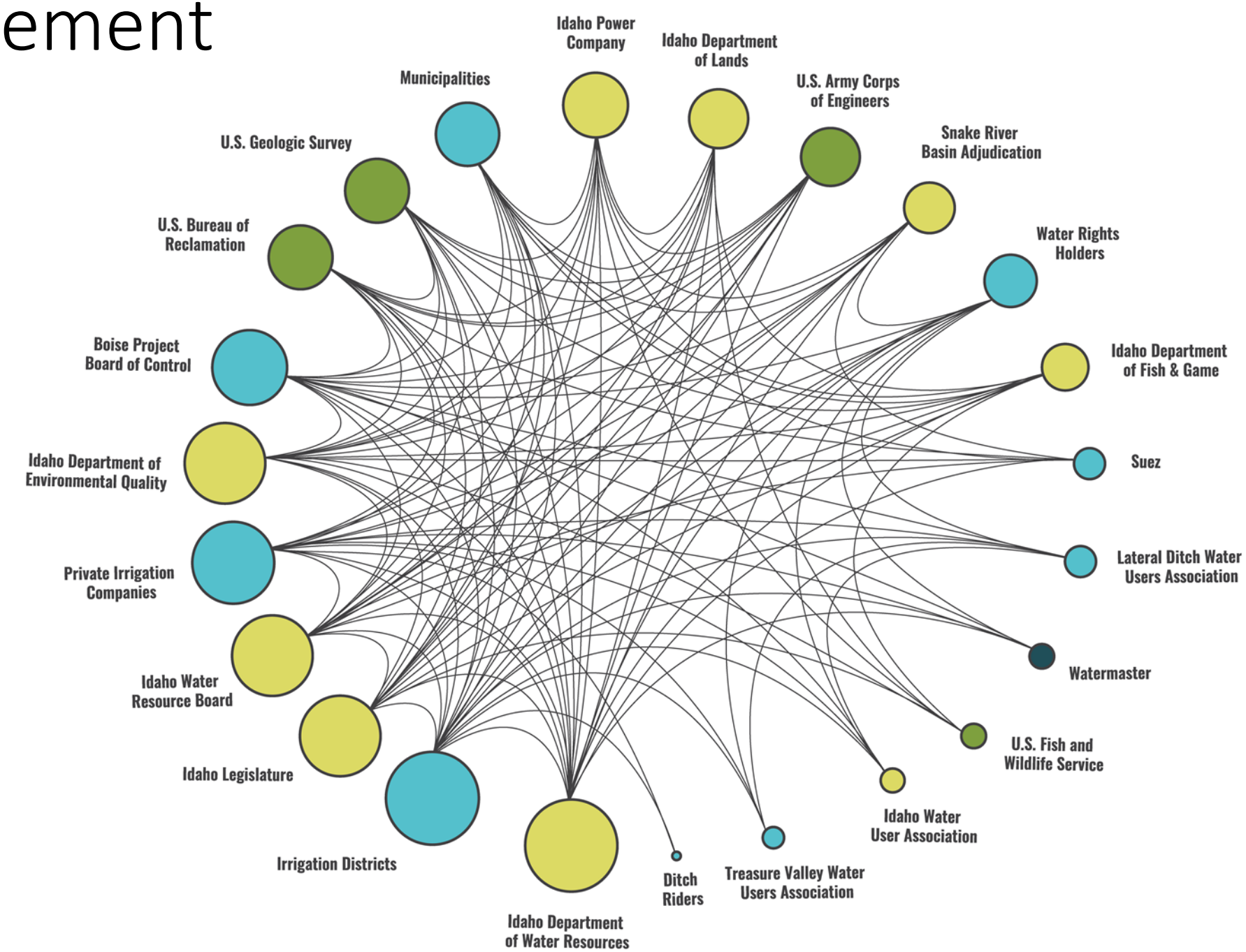
LBRB_irrigation_companies

Name

- BALLENTYNE DITCH CO
- BLACK CANYON IRRIGATION DIST
- BOISE CITY CANAL CO
- BOISE KUNA IRRIGATION DISTRICT
- BOISE PROJECT BOARD OF CONTROL
- BOISE VALLEY IRRIGATION DITCH CO
- CANYON COUNTY WATER CO LTD
- CANYON DITCH CO
- CANYON HILL IRRIGATION DISTRICT
- CAPITOL VIEW IRRIGATION INC
- EMMETT IRRIGATION DISTRICT
- EUREKA DITCH CO NO 2
- EUREKA WATER CO
- FAIRVIEW ACRES WATER USERS ASSOC INC
- FARMERS COOPERATIVE DITCH CO
- FARMERS UNION DITCH CO LTD
- FRANKLIN DITCH CO
- GOLDEN GATE IRRIGATION DISTRICT
- HAAS DITCH CO
- HART DAVIS DITCH CO INC
- ISLAND HIGHLINE DITCH CO
- LAKE RESERVOIR CO
- LEXINGTON HILLS INC
- LOWER CENTERPOINT DITCH CO
- MACE CATLIN DITCH CO
- MASON CREEK DITCH CO
- MC CONNEL ISLAND DITCH CO LTD
- MIDDLETON IRRIGATION ASSN INC; MIDDLETON MILL DITCH CO
- NAMPA & MERIDIAN IRRIGATION DISTRICT
- NEW DRY CREEK DITCH CO
- NEW UNION DITCH CO LTD
- NEW YORK IRRIGATION DISTRICT
- PIONEER DITCH CO LTD
- PIONEER DIXIE DITCH CO
- PIONEER IRRIGATION DISTRICT
- PLEASANT VALLEY IRRIGATION CO LTD
- POOR BOY DITCH CO INC
- RIVER FLAT DITCH CO
- RIVERSIDE IRRIGATION DISTRICT LTD
- SETTLERS IRRIGATION DISTRICT
- SIEBENBERG COOPERATIVE DITCH CO LTD
- SOUTH BOISE MUTUAL IRRIGATION CO LTD
- SOUTH BOISE WATER CO
- THURMAN MILL DITCH CO LTD
- UPPER CENTER POINT DITCH CO
- WARM SPRINGS DITCH CO
- WILDER IRRIGATION DISTRICT

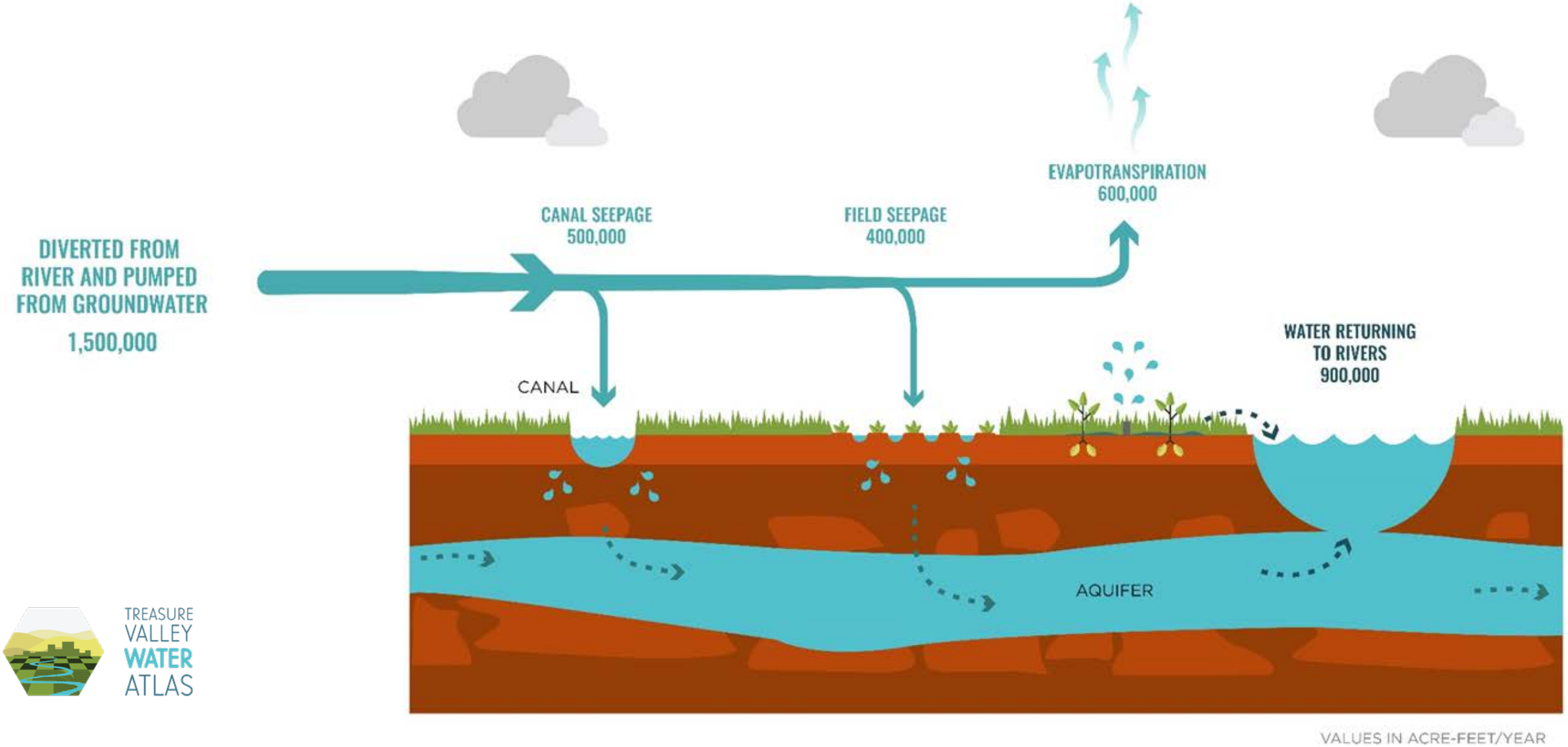
TREASURE VALLEY WATER ATLAS

Diffuse Management Structure



TREASURE VALLEY WATER ATLAS

What happens to the diverted water?

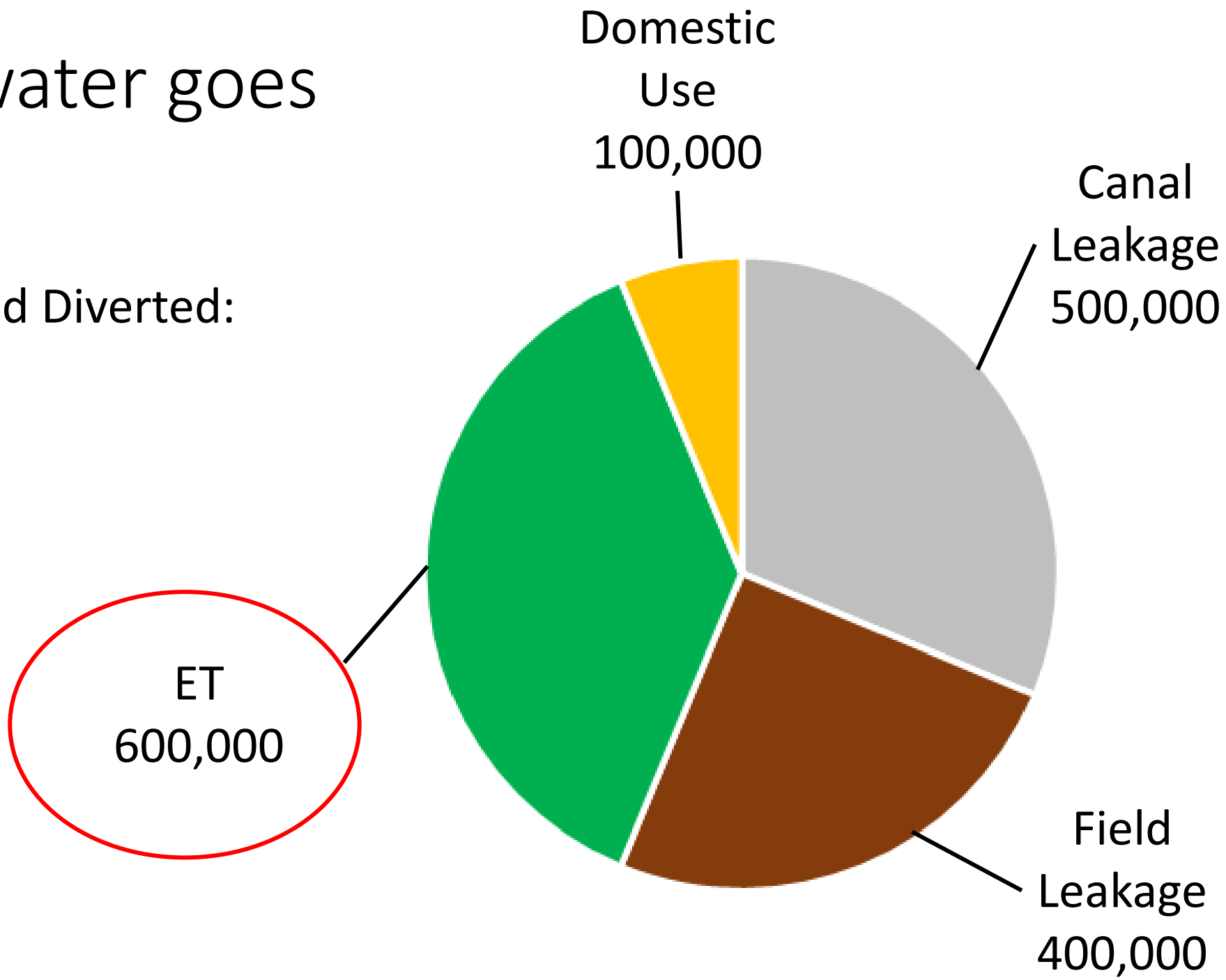


TREASURE VALLEY WATER ATLAS

Where all the water goes

Total Water Pumped and Diverted:

1,600,000 ac-ft



This is the consumptive use fraction!

Historical Perspective

Irrigation Radically Altered the Water Budget

Precipitation
11 inches

Evapotranspiration
10+ inches?

Groundwater
< 1 inch

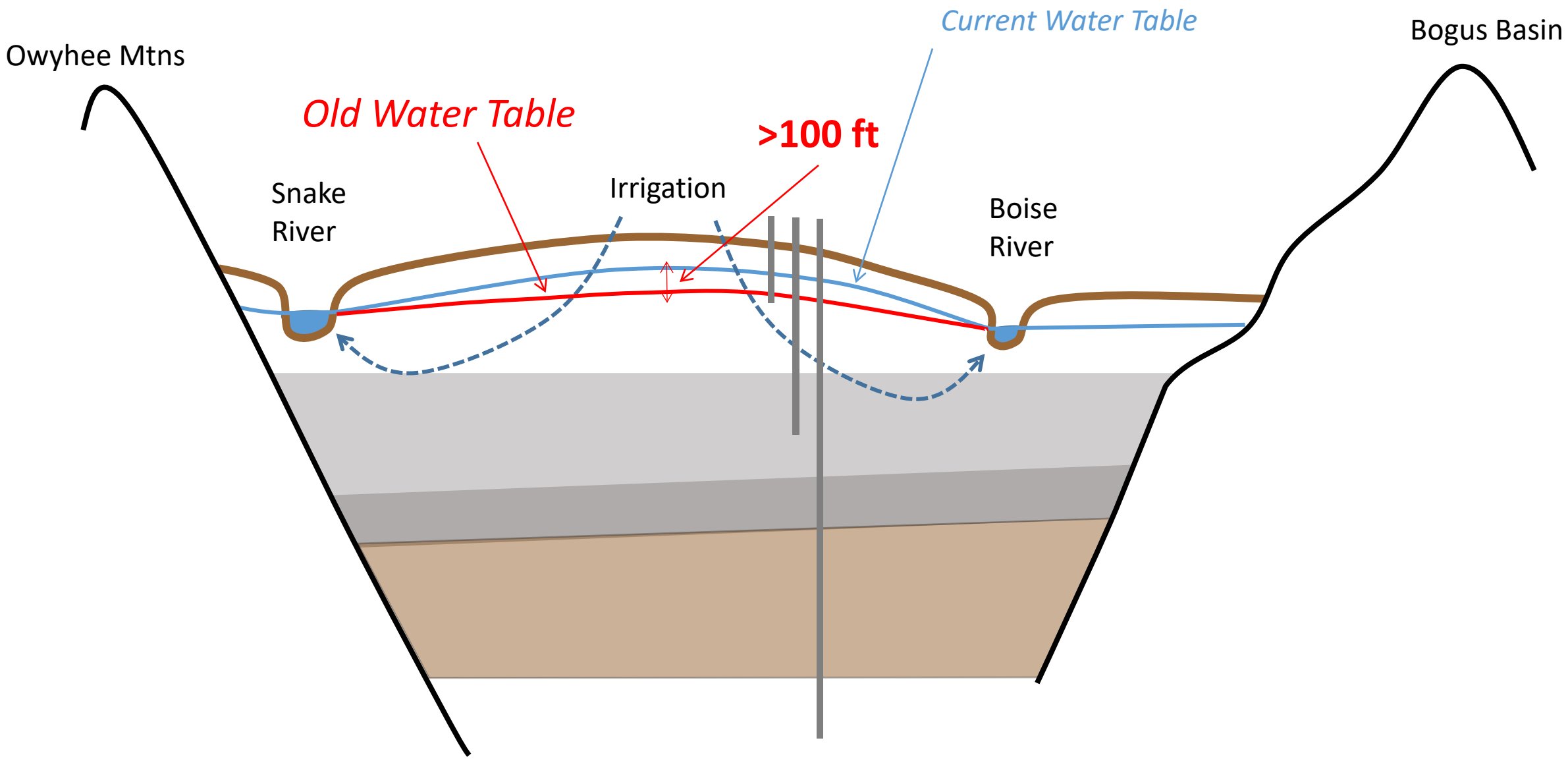
Precipitation
11 inches

Irrigation
29 inches?

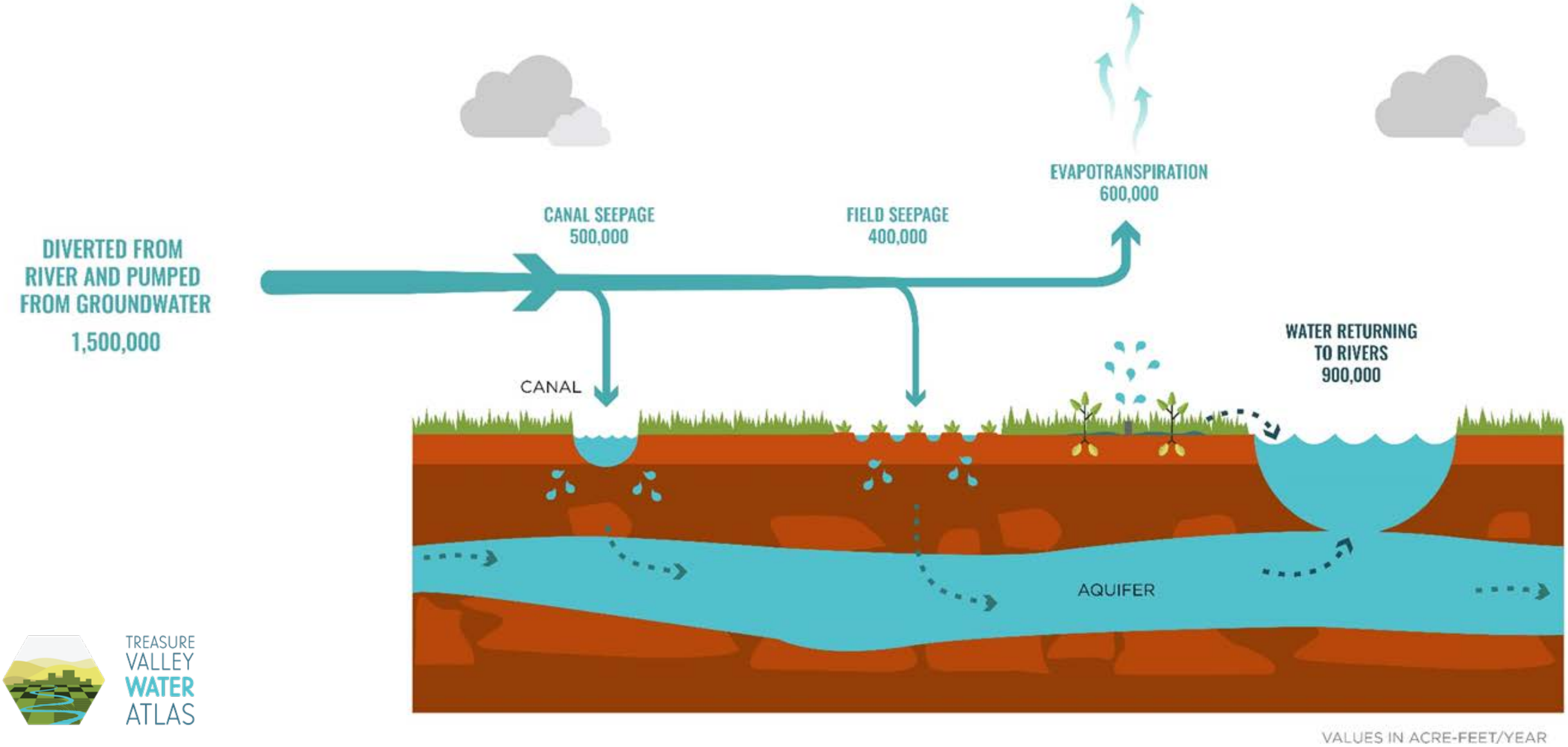
Evapotranspiration
20 inches?

Groundwater
20 inches?

Increased Recharge = Elevated GW Levels



If we change any ‘arrow’ there will be cascading impacts



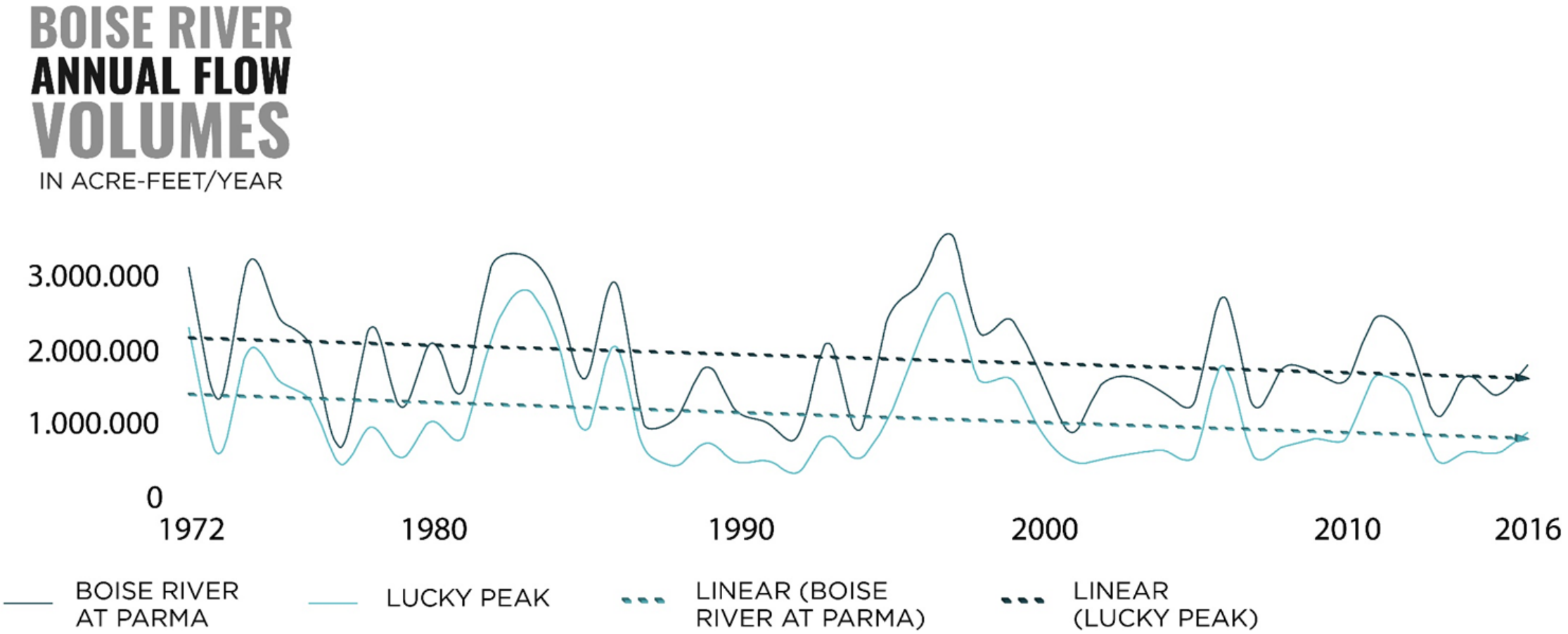
TREASURE VALLEY WATER ATLAS

Big Three Changes on Horizon

- Climate Change
- Changing Irrigation Practices
- Urbanization
  - Ag to Urban
  - Sage to Urban

Boise River Flow Declines

(Climate Change Signal?)



TREASURE VALLEY WATER ATLAS

Changing Irrigation Practices

Traditional
(Inefficient)

Newer
(Apply ½ as much water)

Irrigation Practices

Current:

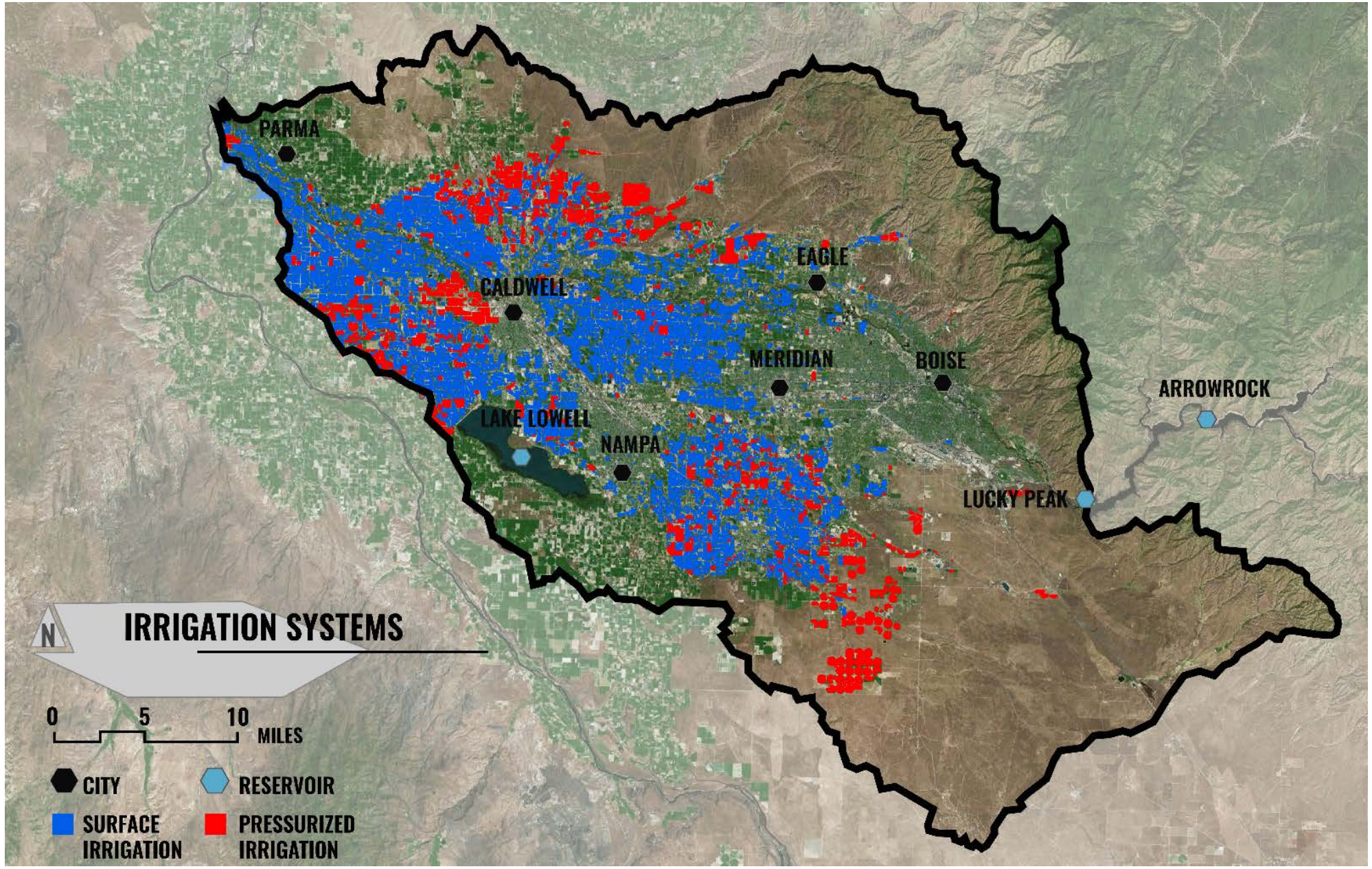
80% Surface

20% Pressurized

In 25 Years:

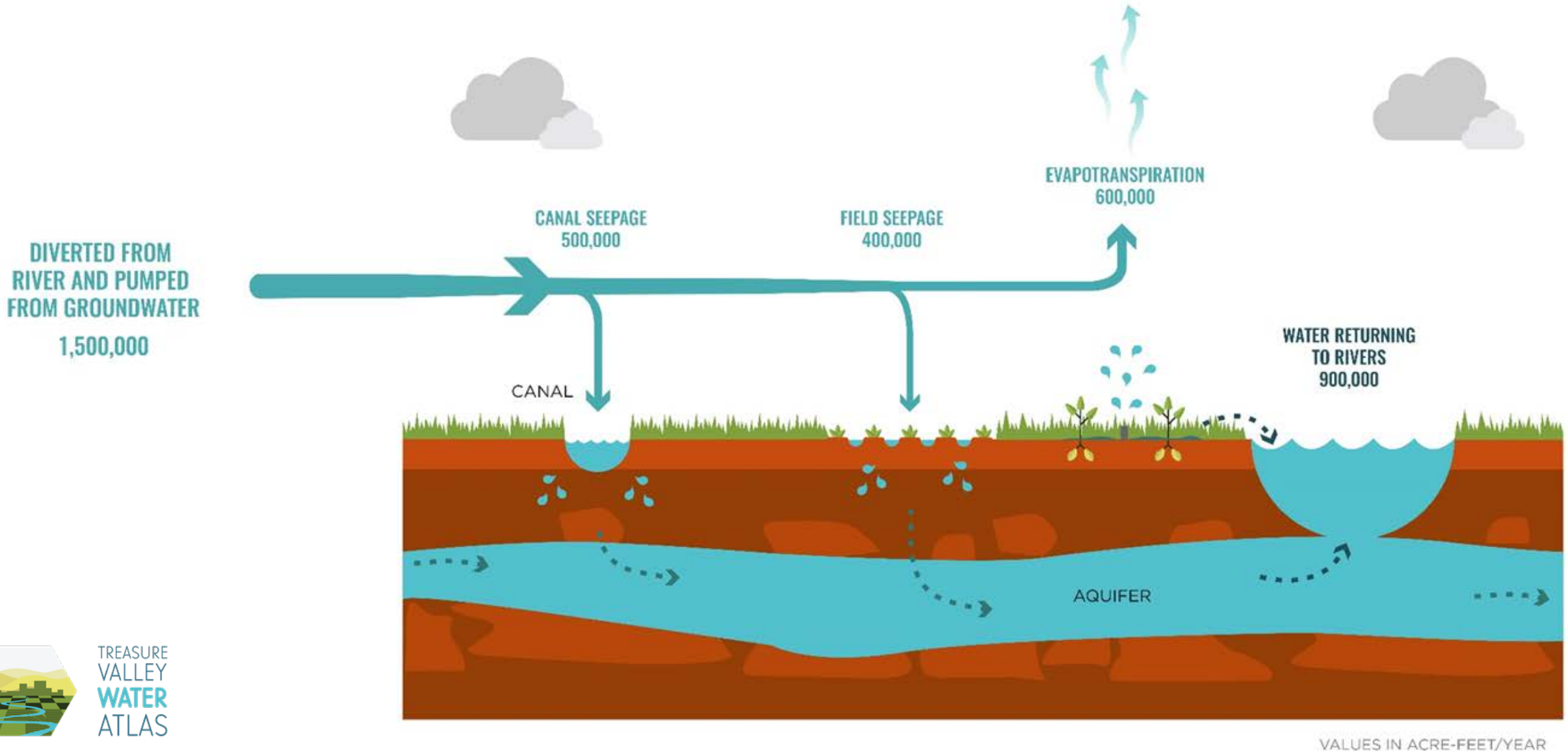
20% Surface

80% Pressurized



TREASURE VALLEY WATER ATLAS

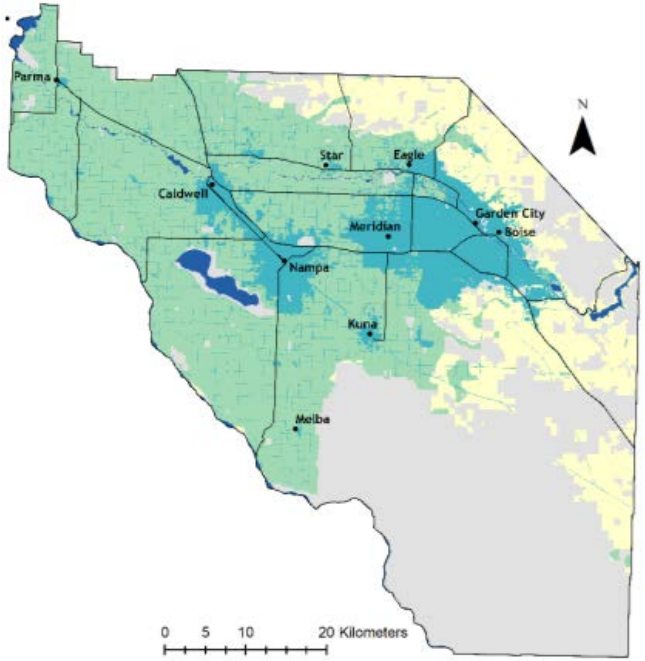
What happens to the diverted water?



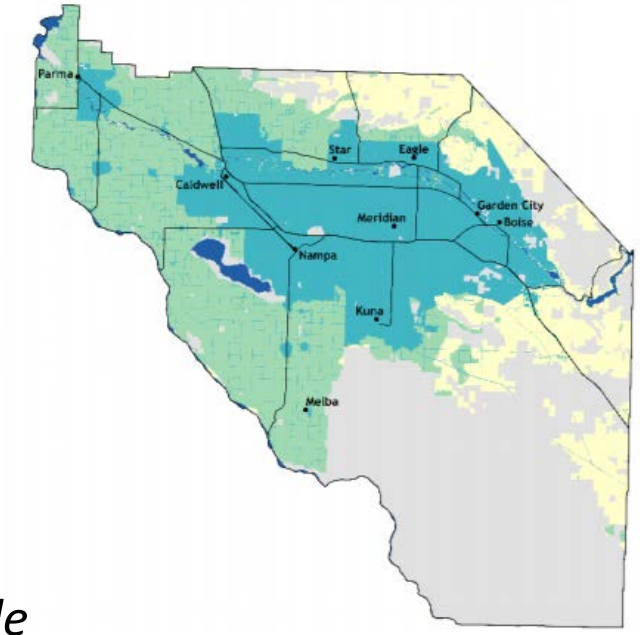
TREASURE VALLEY WATER ATLAS

Urban Growth Projections

Current (2011)

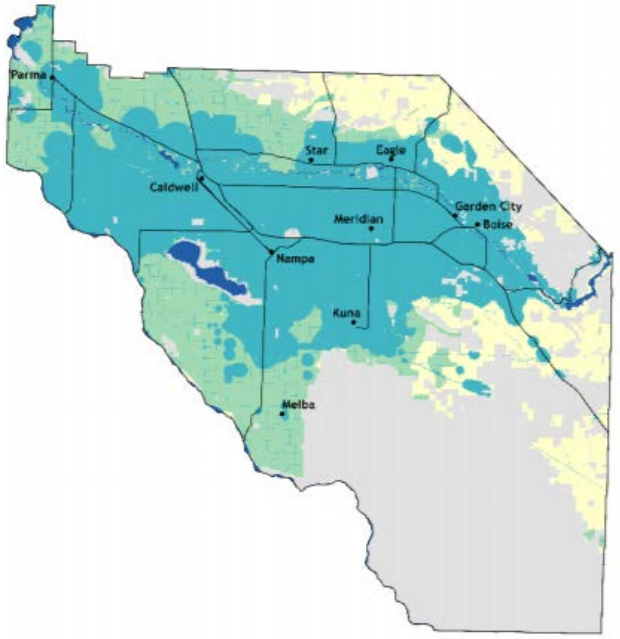


High Density Urbanization



2100: 1.5 Million People

Low Density Urbanization



Urban

Ag Land

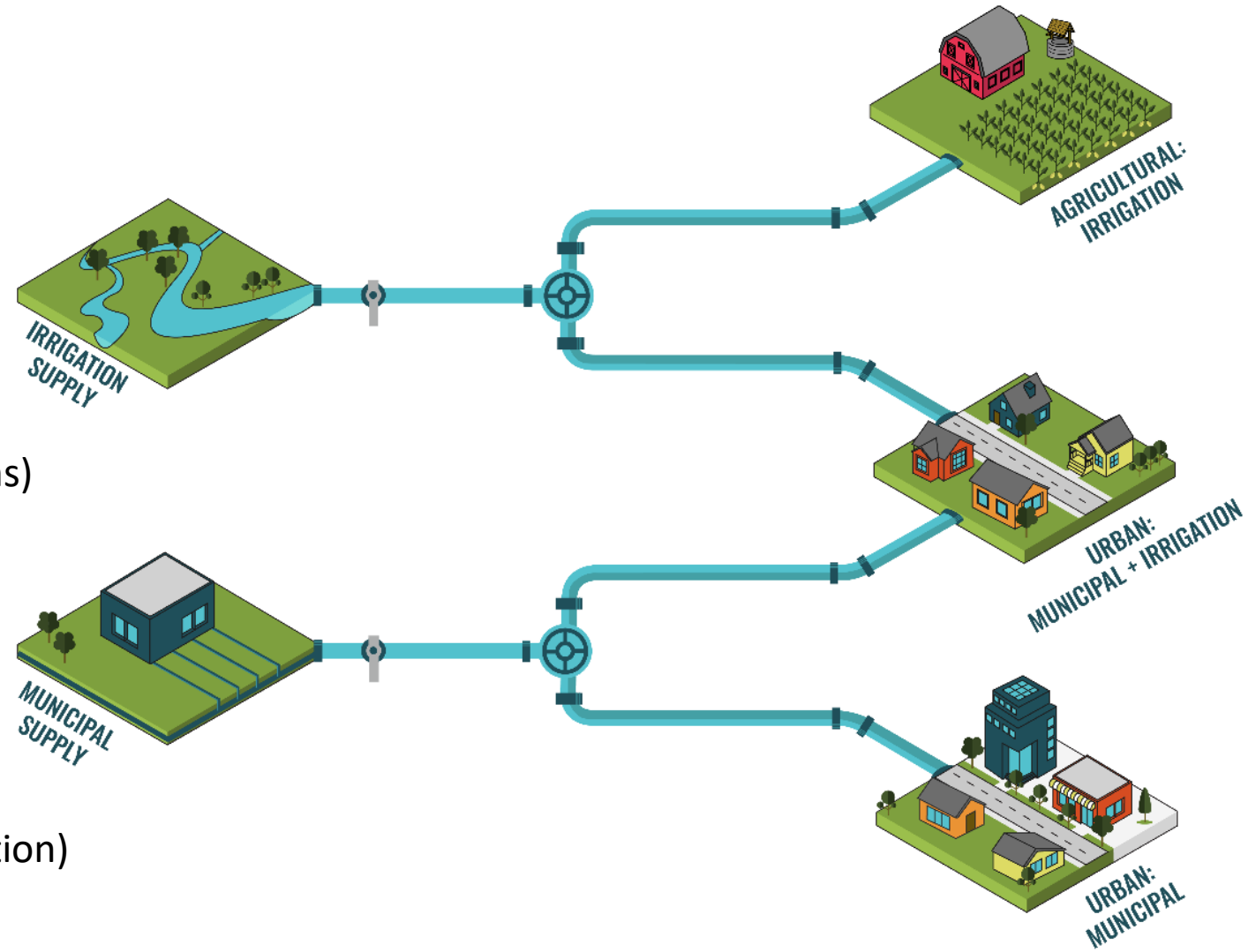
Jenna Narducci, Master's Thesis, Boise State

https://www.boisestate.edu/hes/projects/modeling-urban-growth-in-the-treasure-valley-idaho/

We have a unique approach to water rights during urbanization

Farm Water Rights → Subdivision Water Rights

A Unique Approach to Urban Water Supply

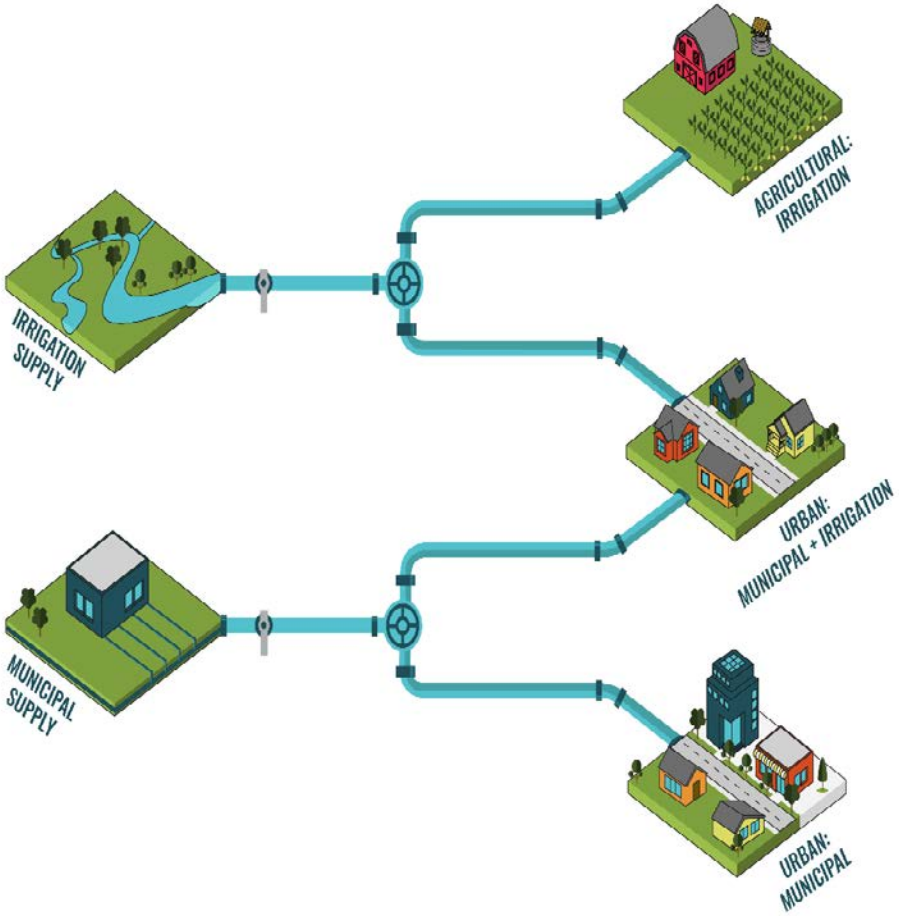


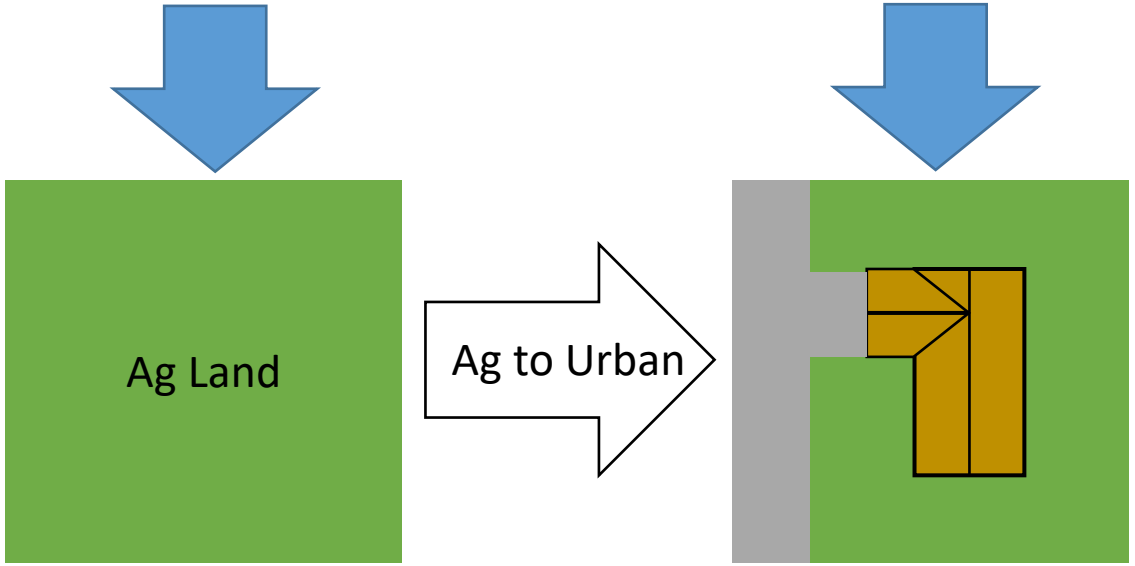
(Boise River Diversions)

(Groundwater Extraction)

TREASURE VALLEY WATER ATLAS

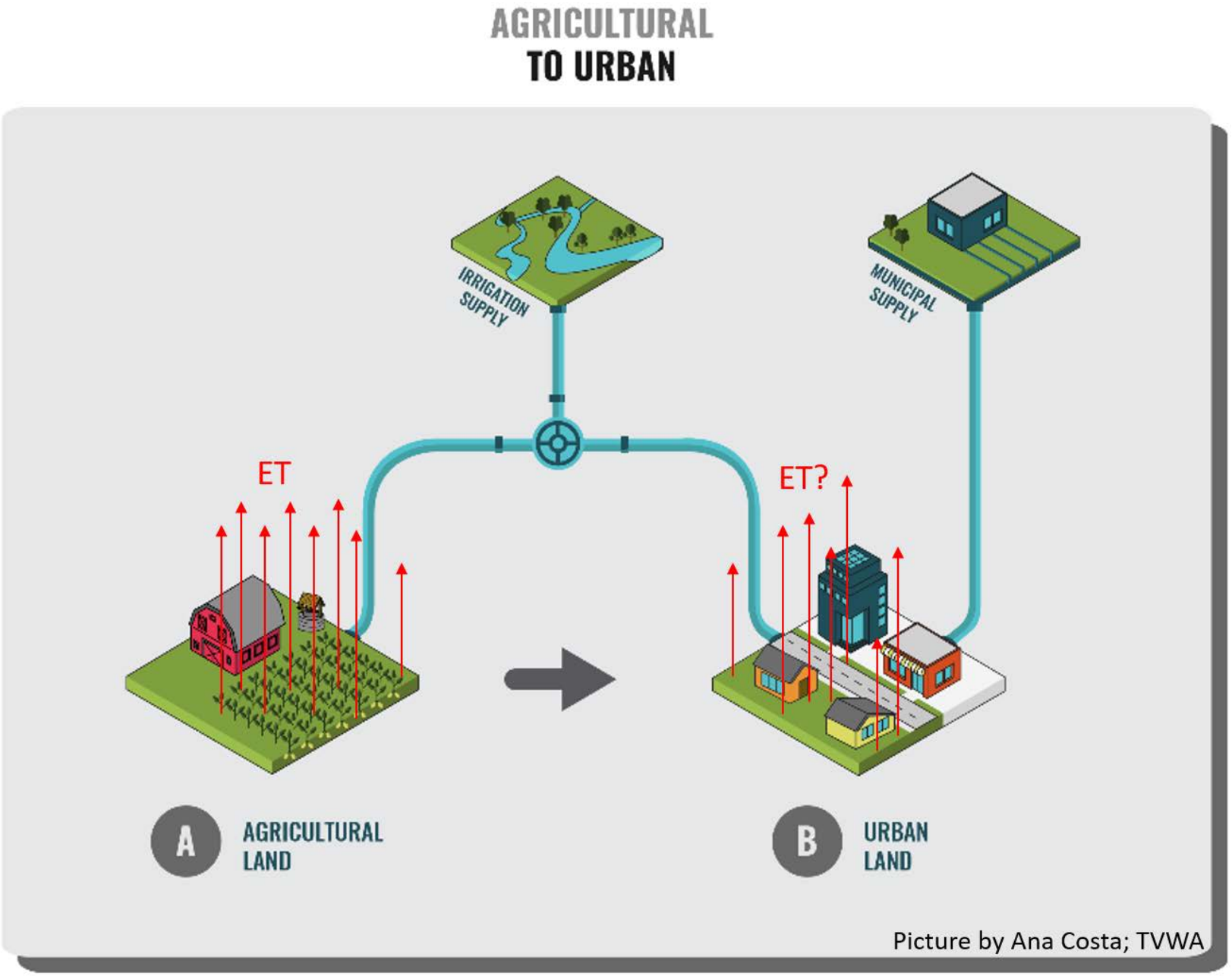
A Unique Approach to Urban Water Supply





Change in Consumptive Use?
More/Less Infiltration?

More or Less ET?



Picture by Ana Costa; TVWA

TREASURE VALLEY WATER ATLAS

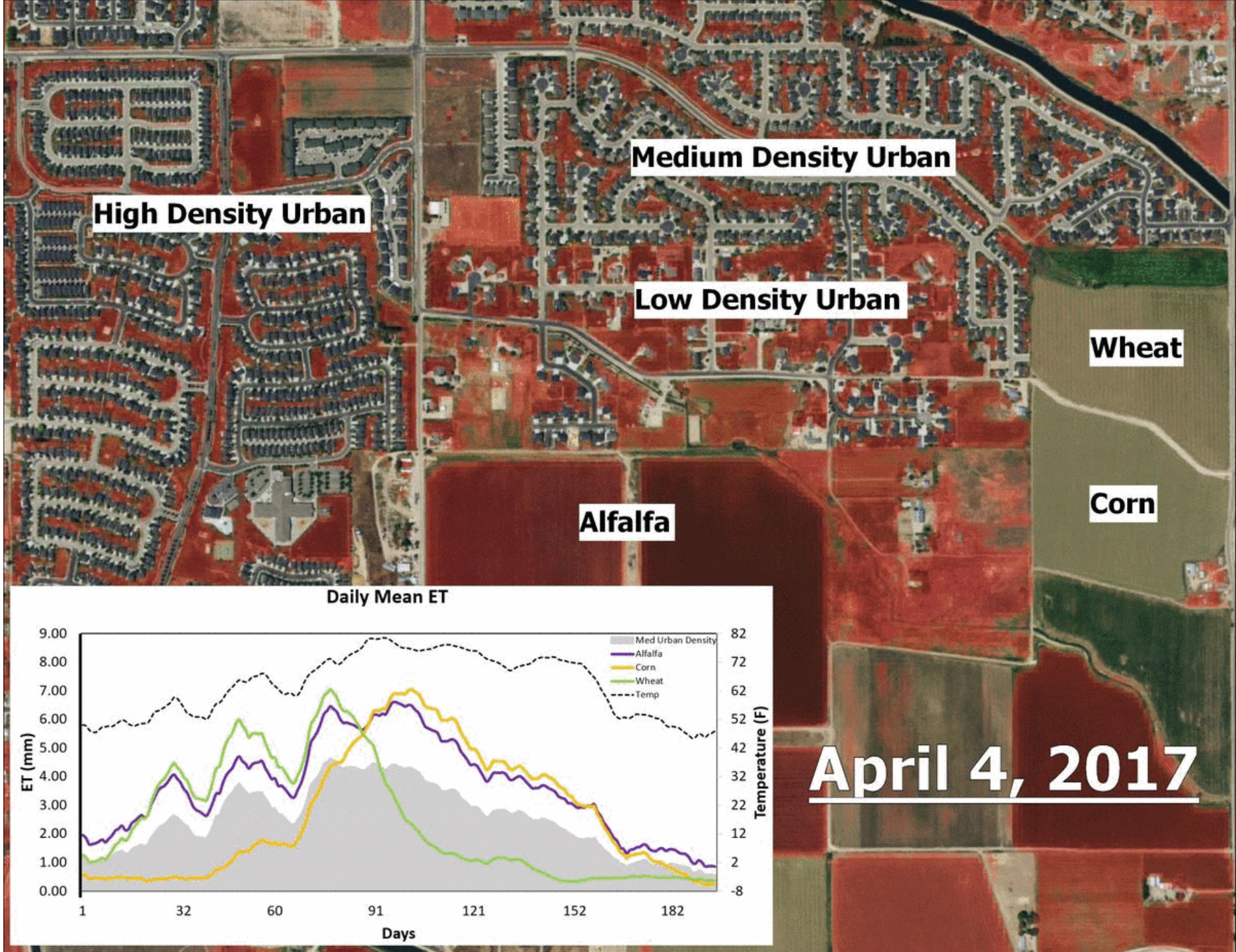
Satellite-Based ET Estimates for Different Land Use Types

Curtis Crandall, MS Thesis,
Boise State University

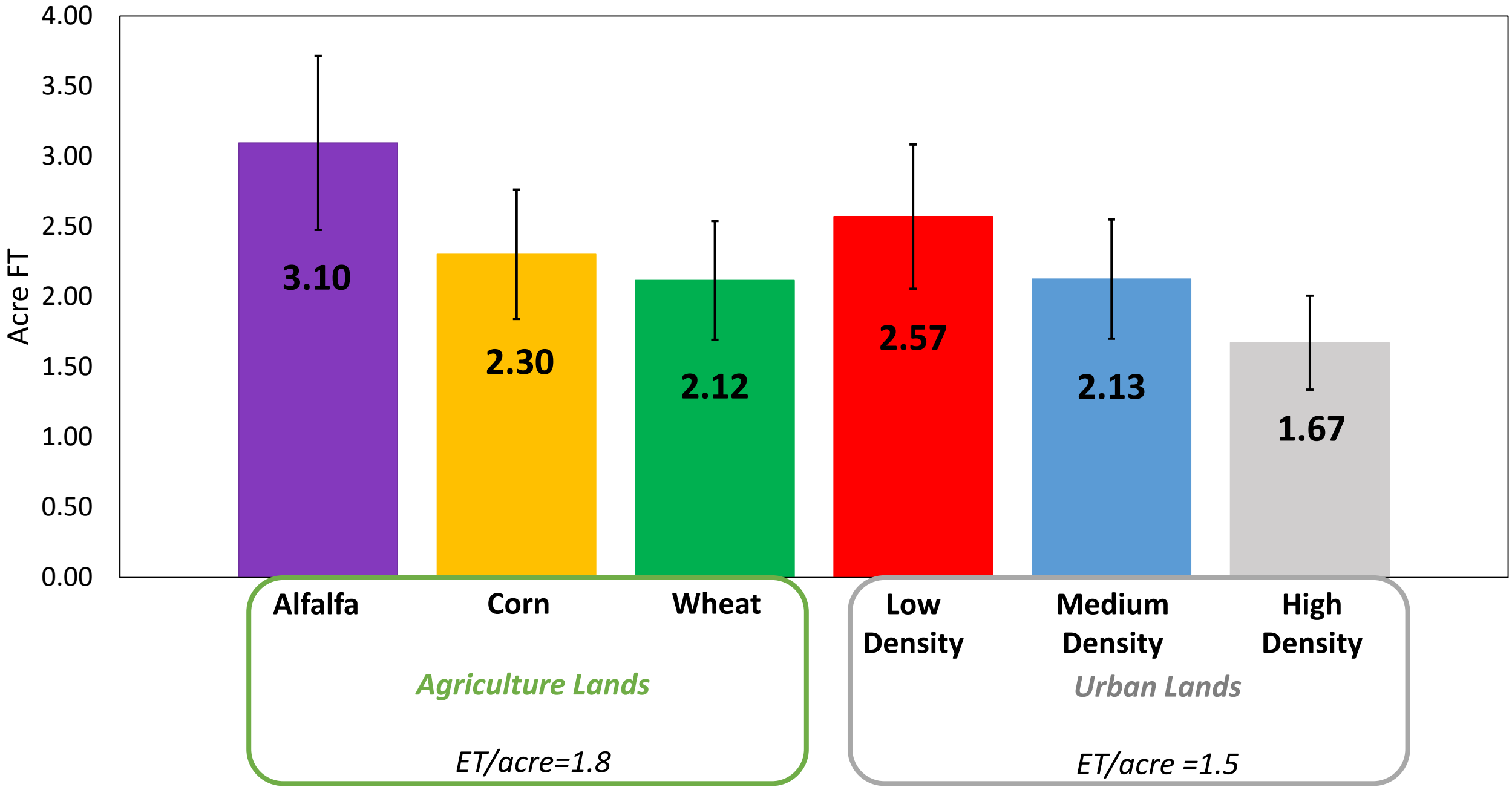
2017 ET Weekly Time Lapse

ET Intensity

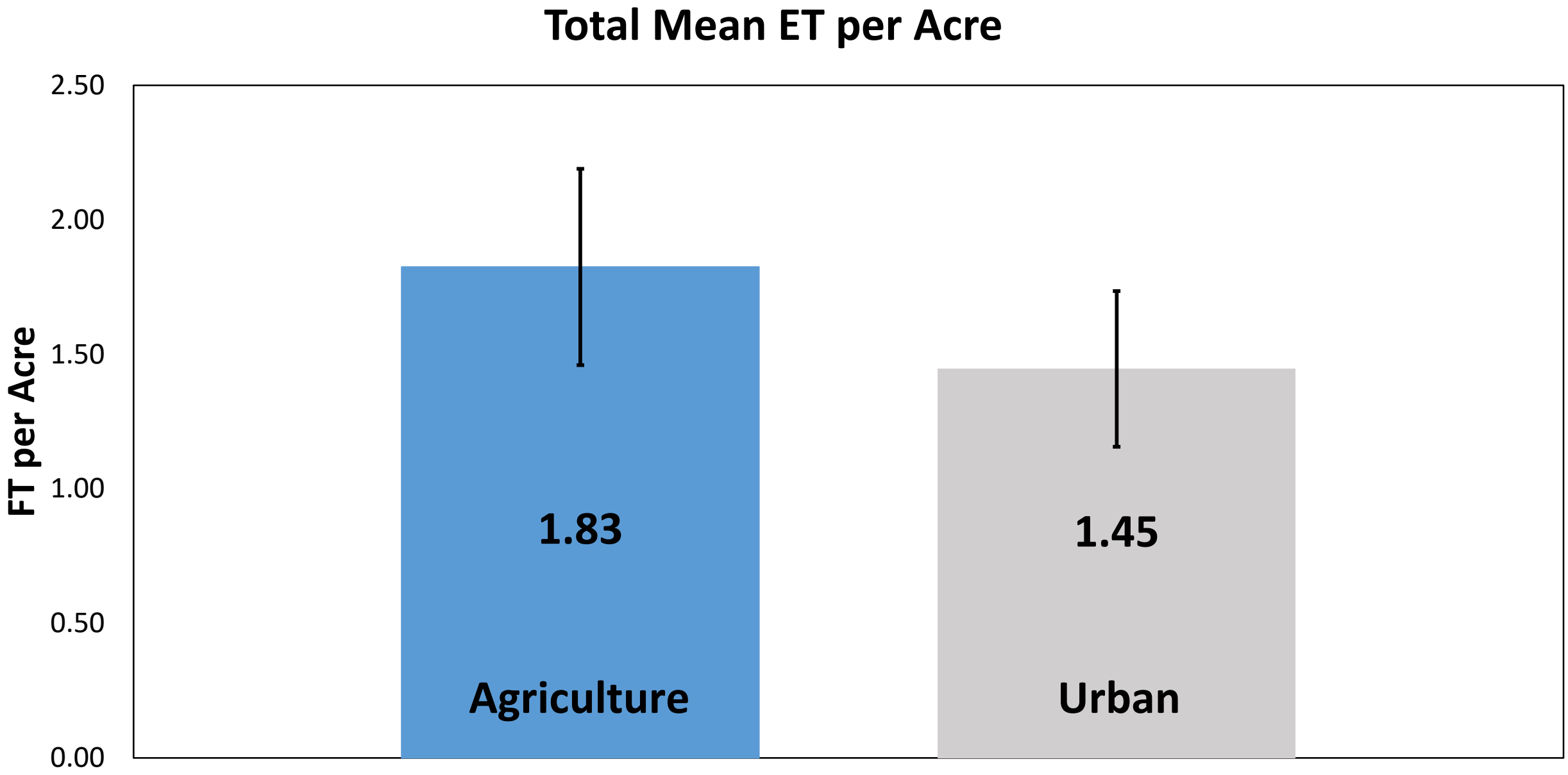
Low High



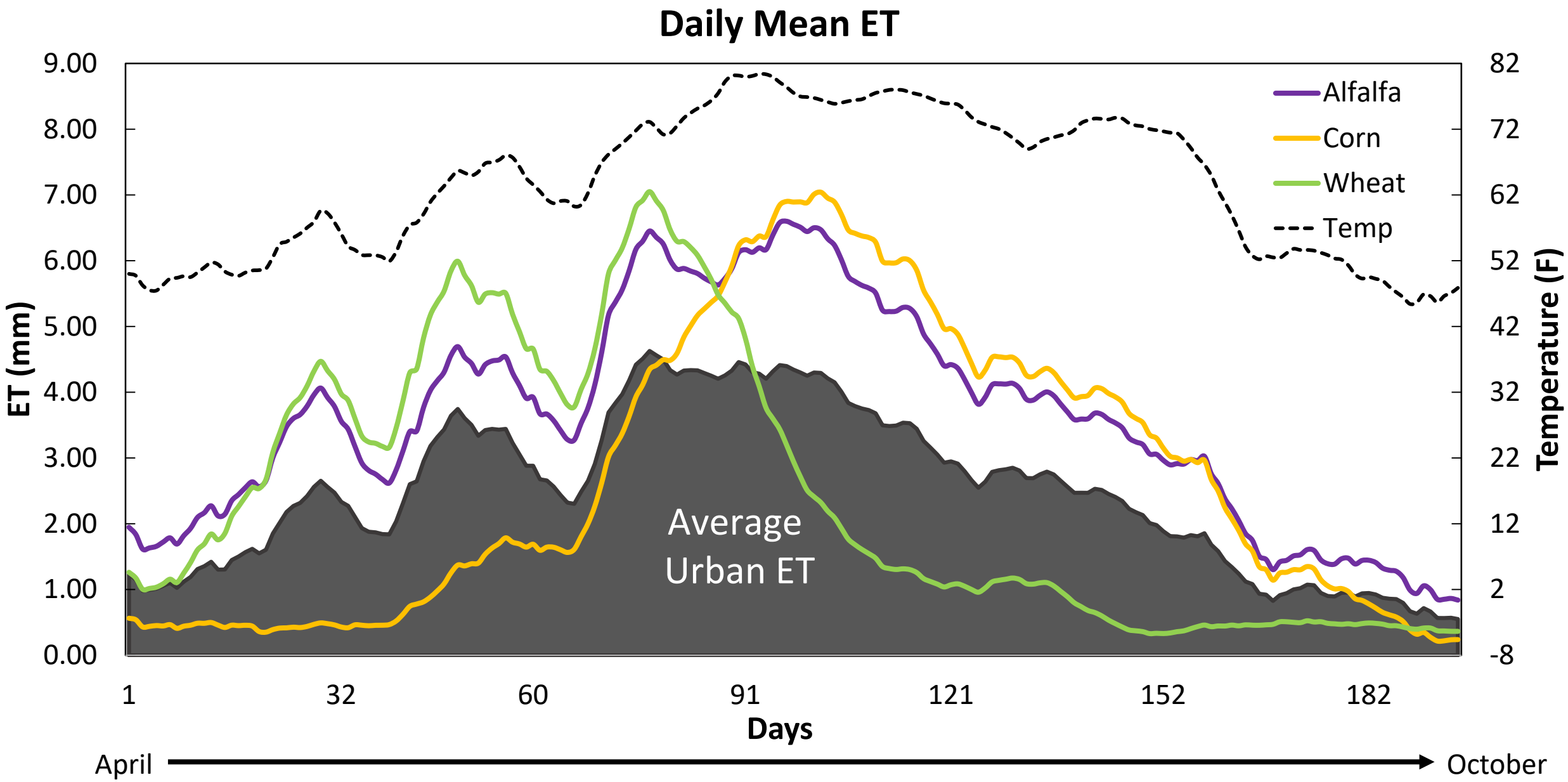
Total Mean ET per Acre



Total Basin ET

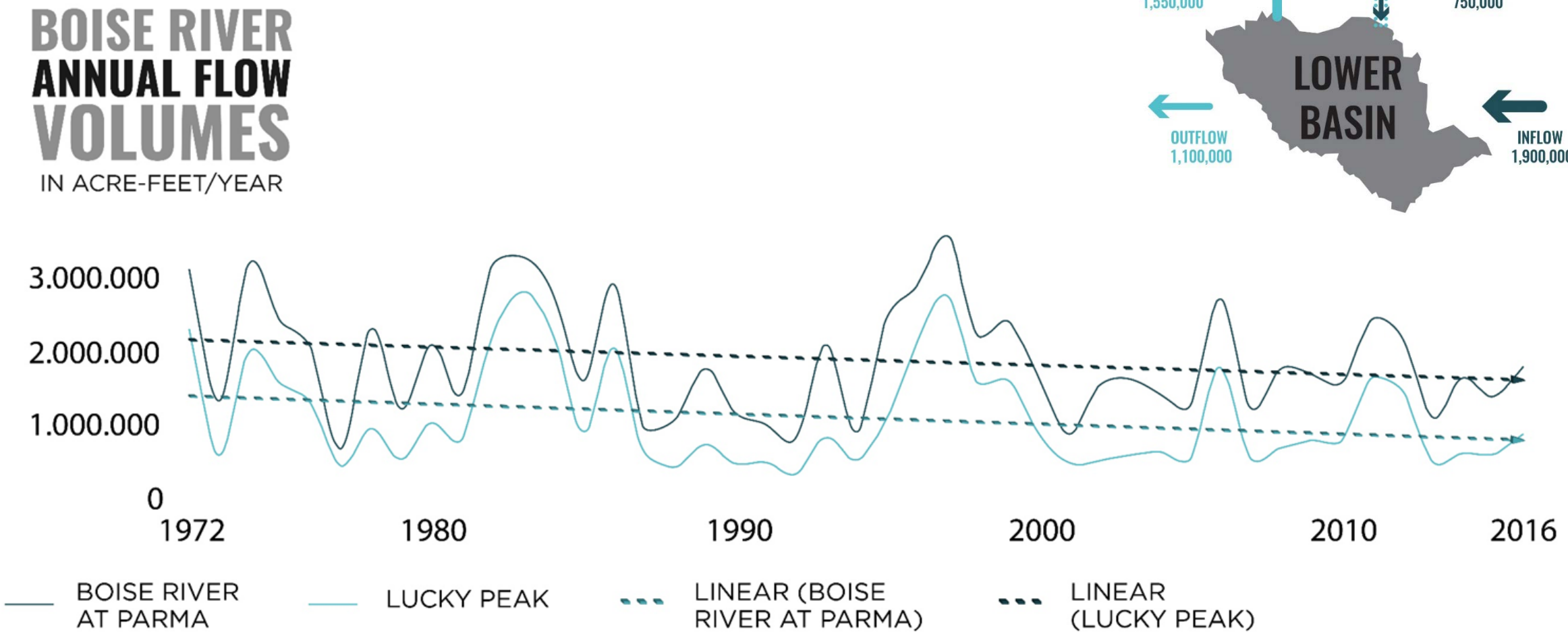


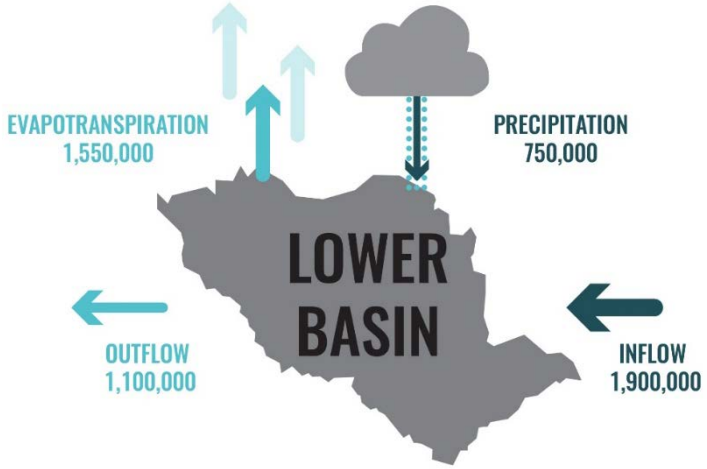
Agricultural Vs. Mean Urban



40 Years of Urbanization

No Change in Lucky Peak – Parma (No ET Change)





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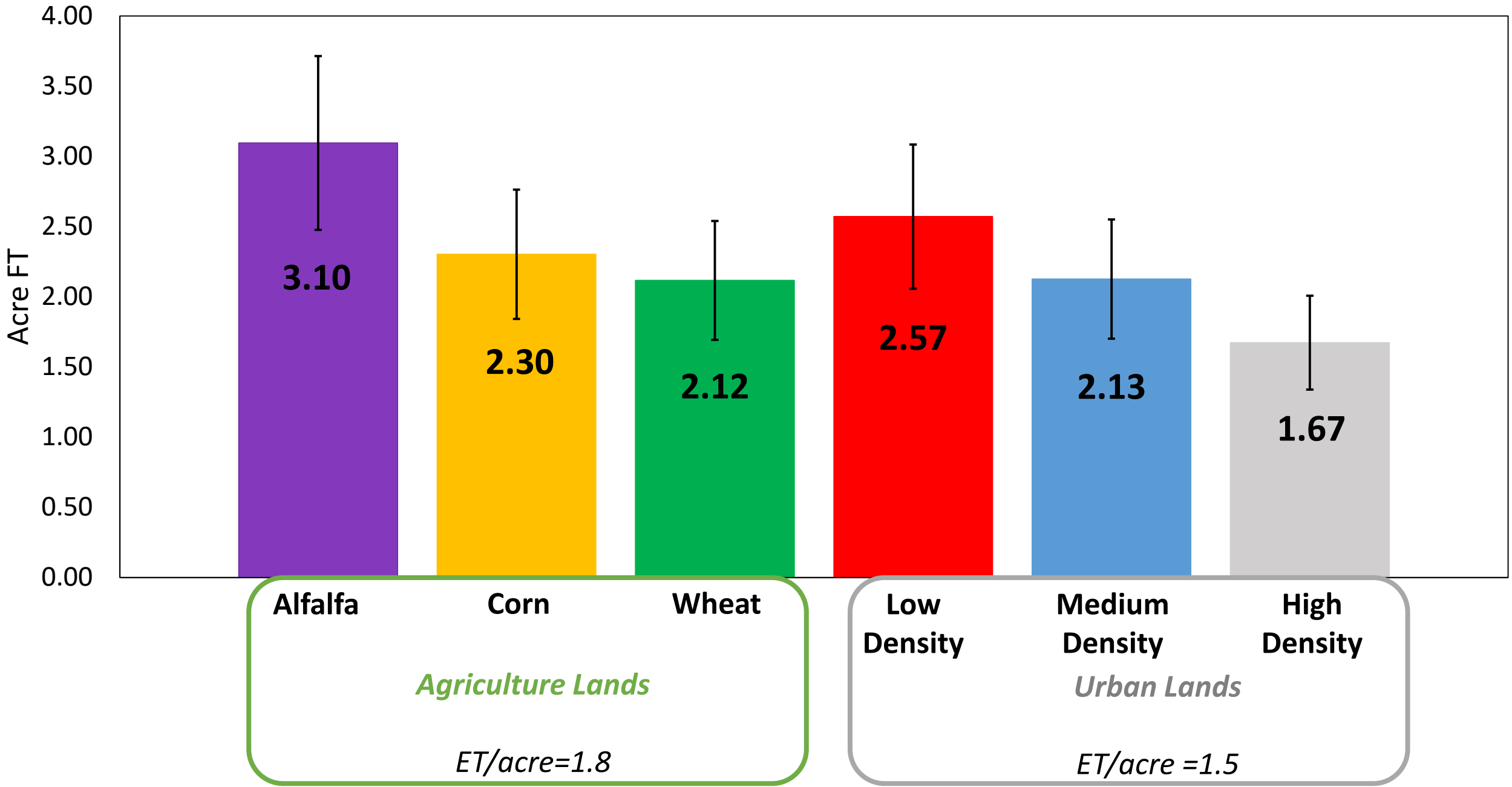
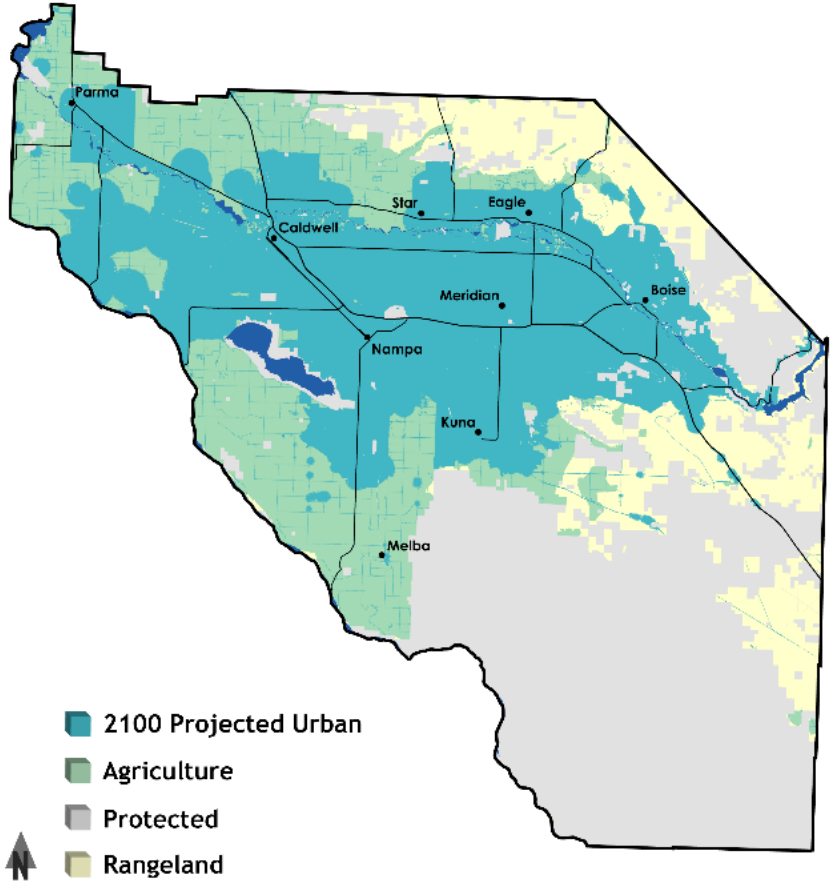


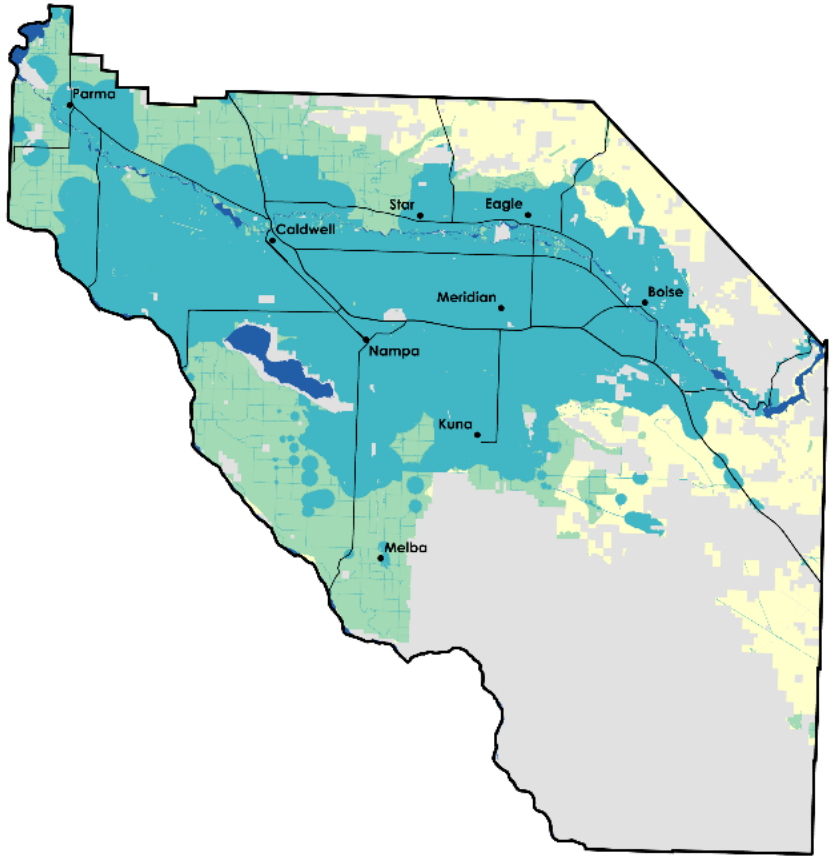
Implications

BUSINESS AS USUAL



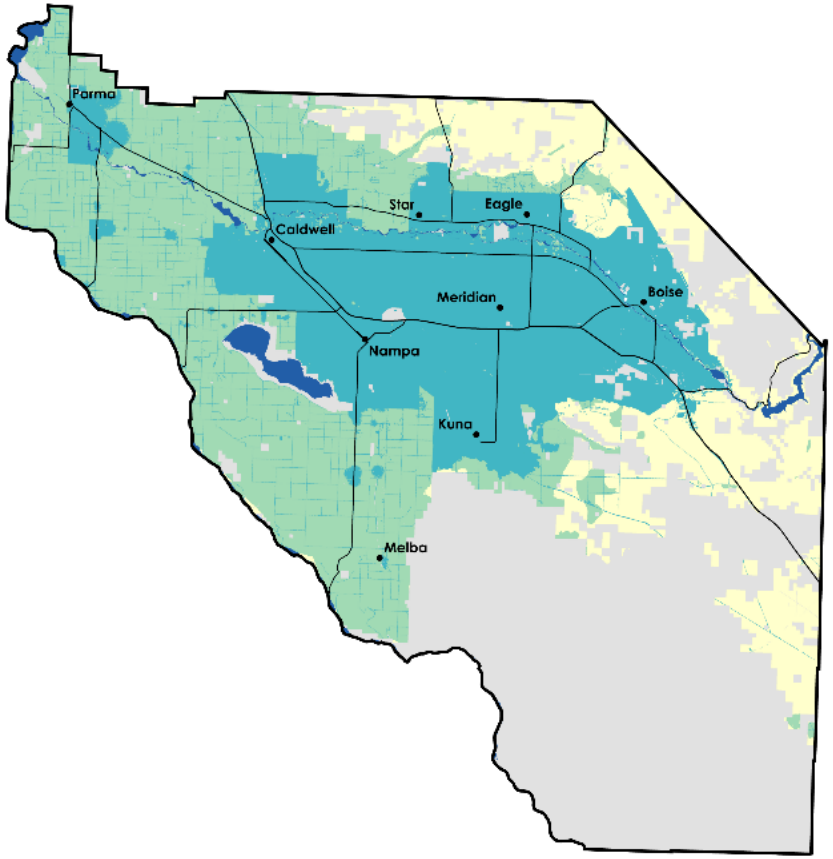
29% increase in ET

DECREASED DENSITY



52% increase in ET

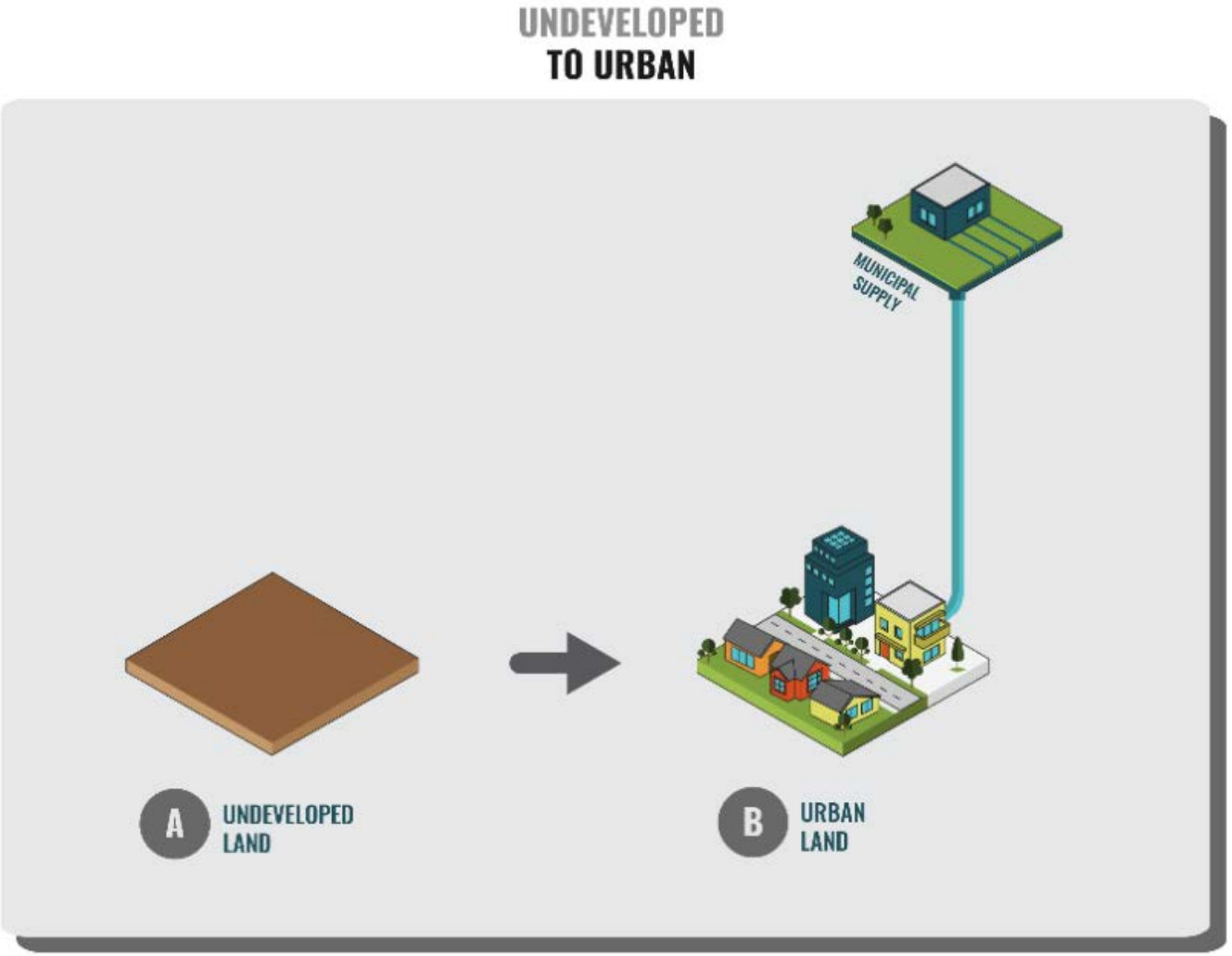
INCREASED DENSITY



2% increase in ET

Urbanizing Undeveloped Land

- Undeveloped land is currently not consuming irrigation water
- Highest potential increase in future ET and water demand



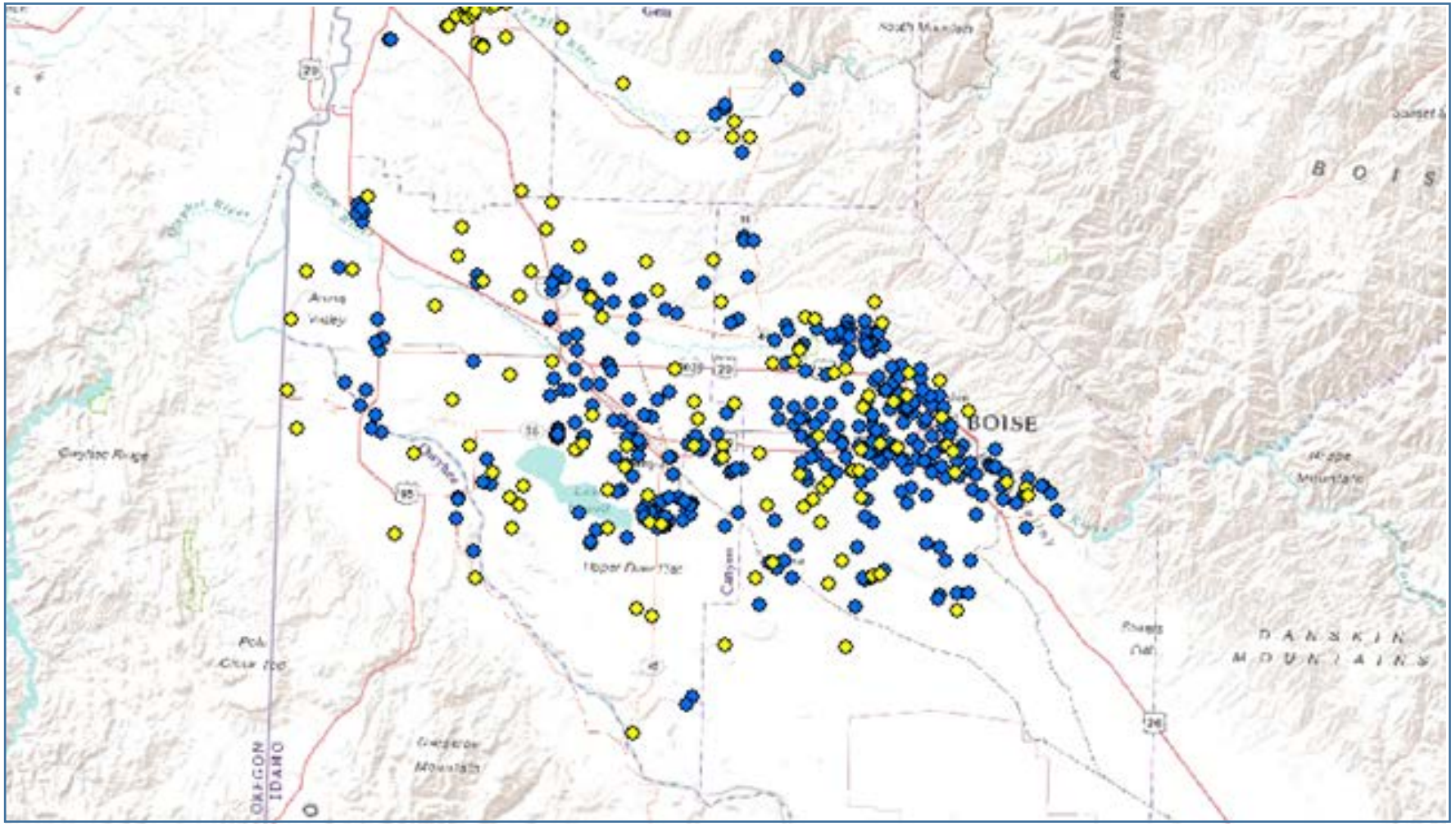
Conjectures

Treasure Valley Groundwater Wells

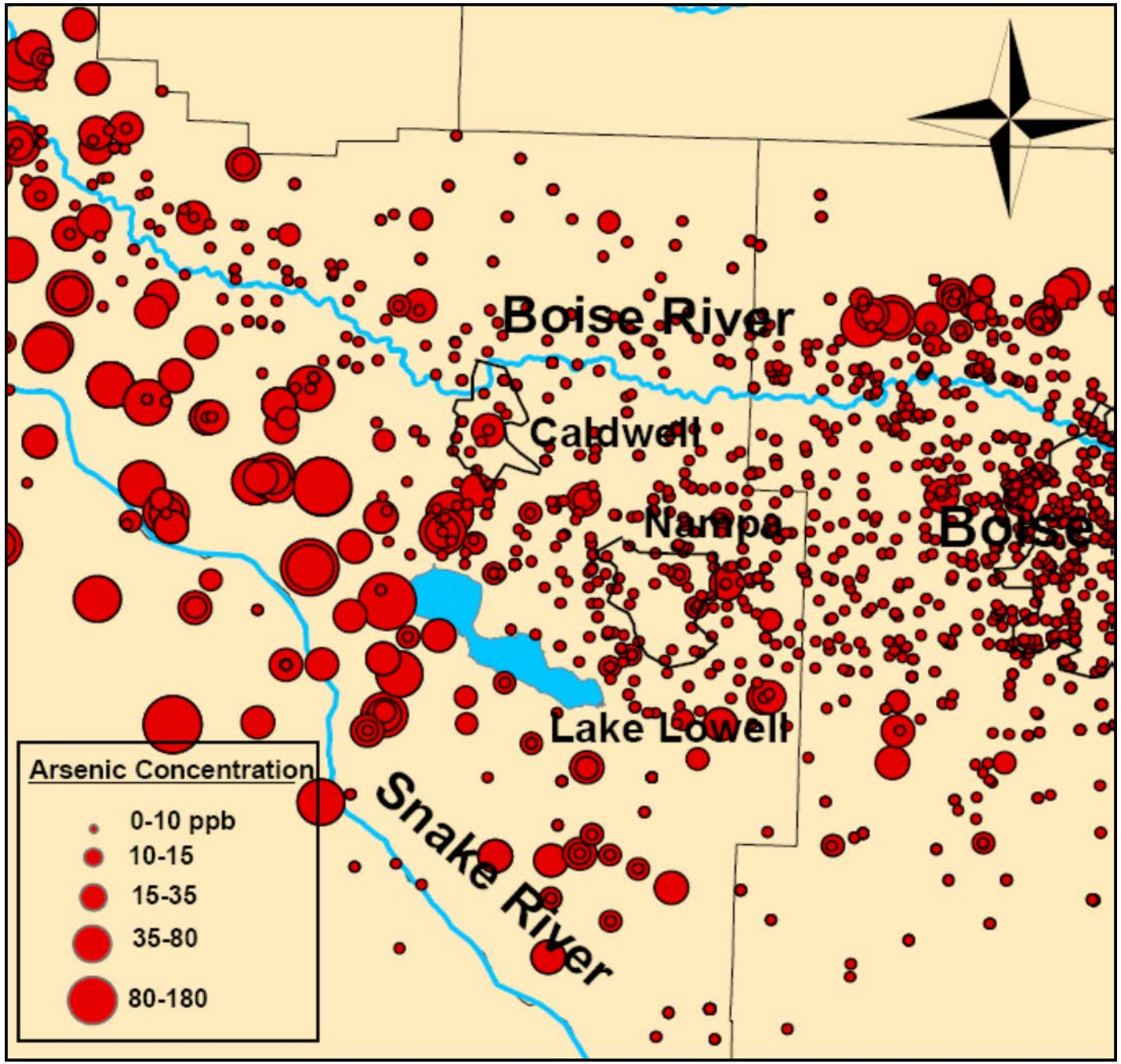
Three Important Contaminants in Treasure Valley:

- Arsenic
- Uranium
- Nitrate

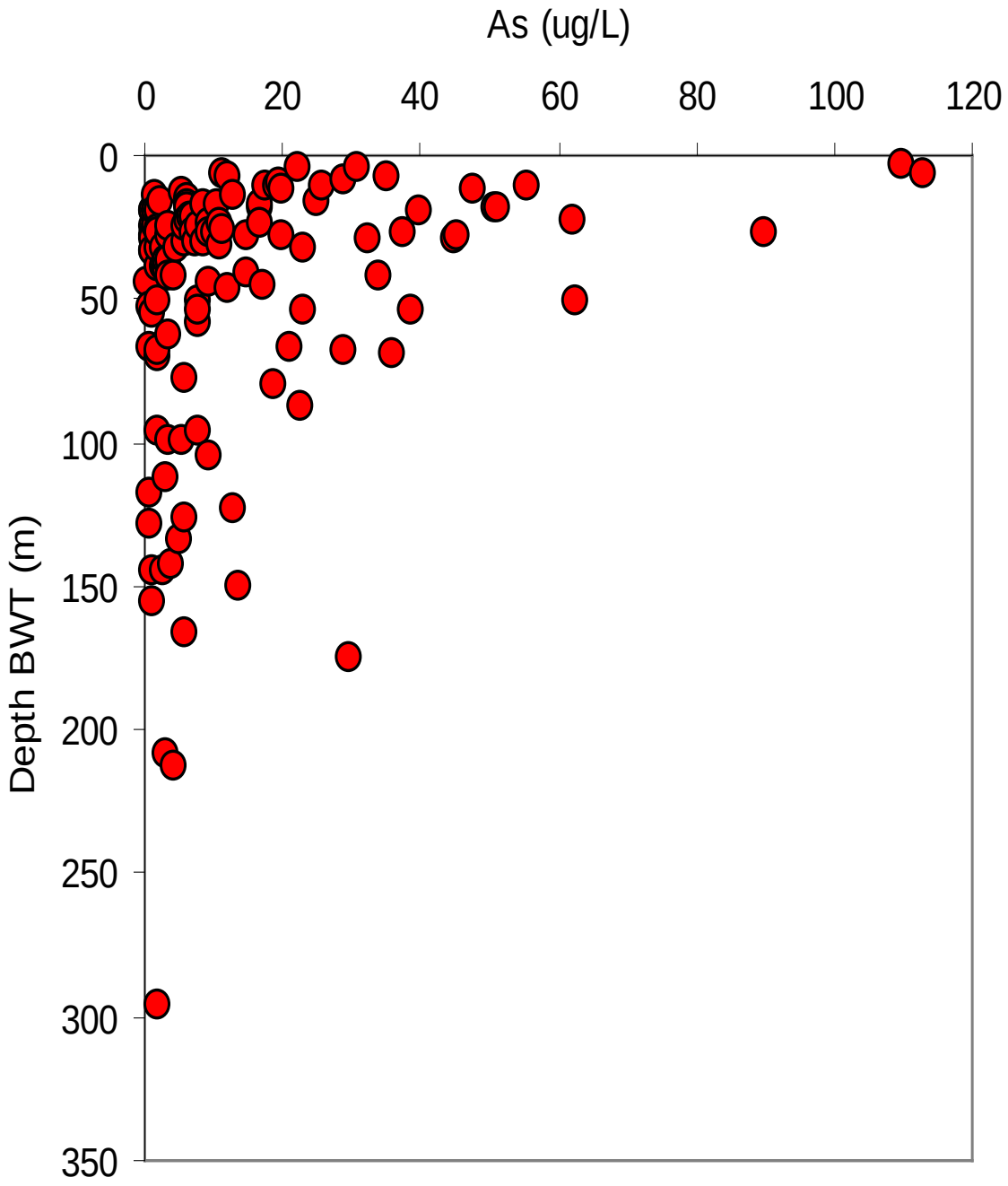
Map of known Arsenic and Uranium Contaminated Wells



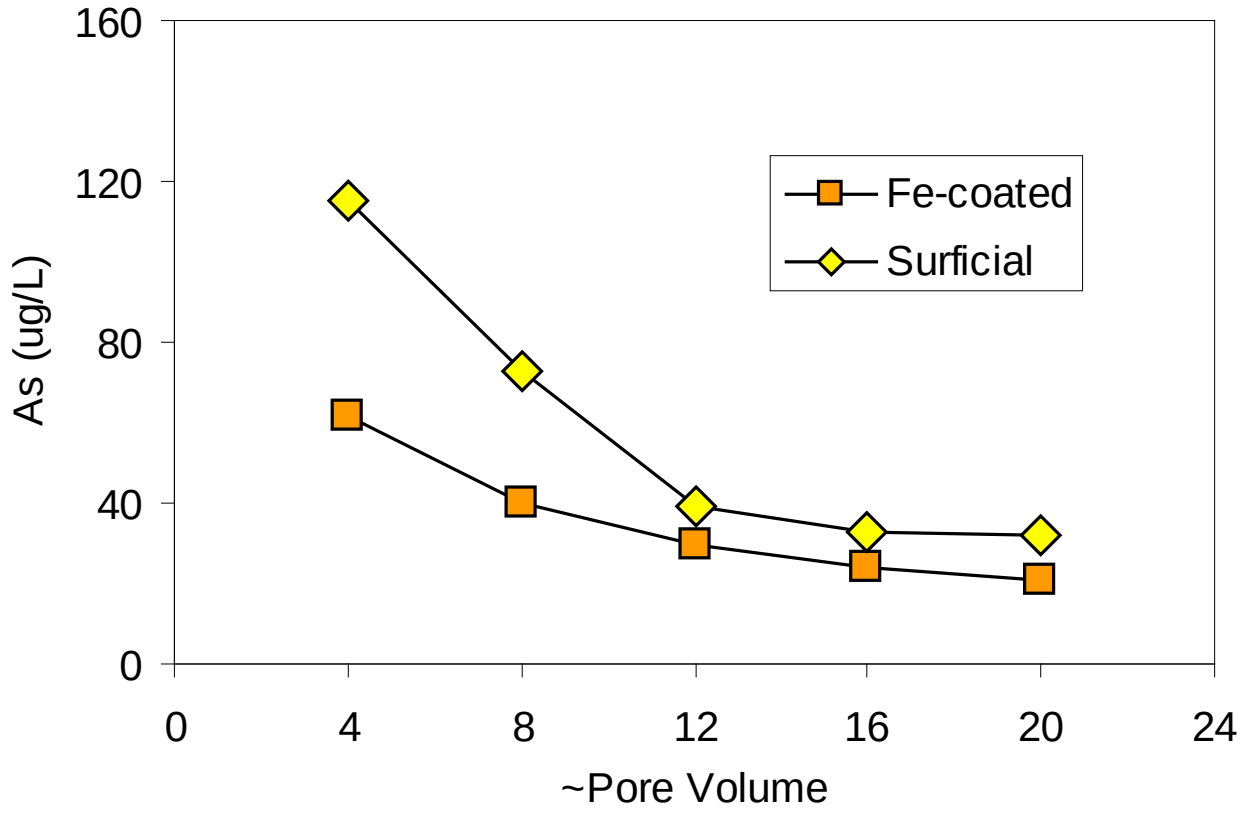
Arsenic in Groundwater Wells

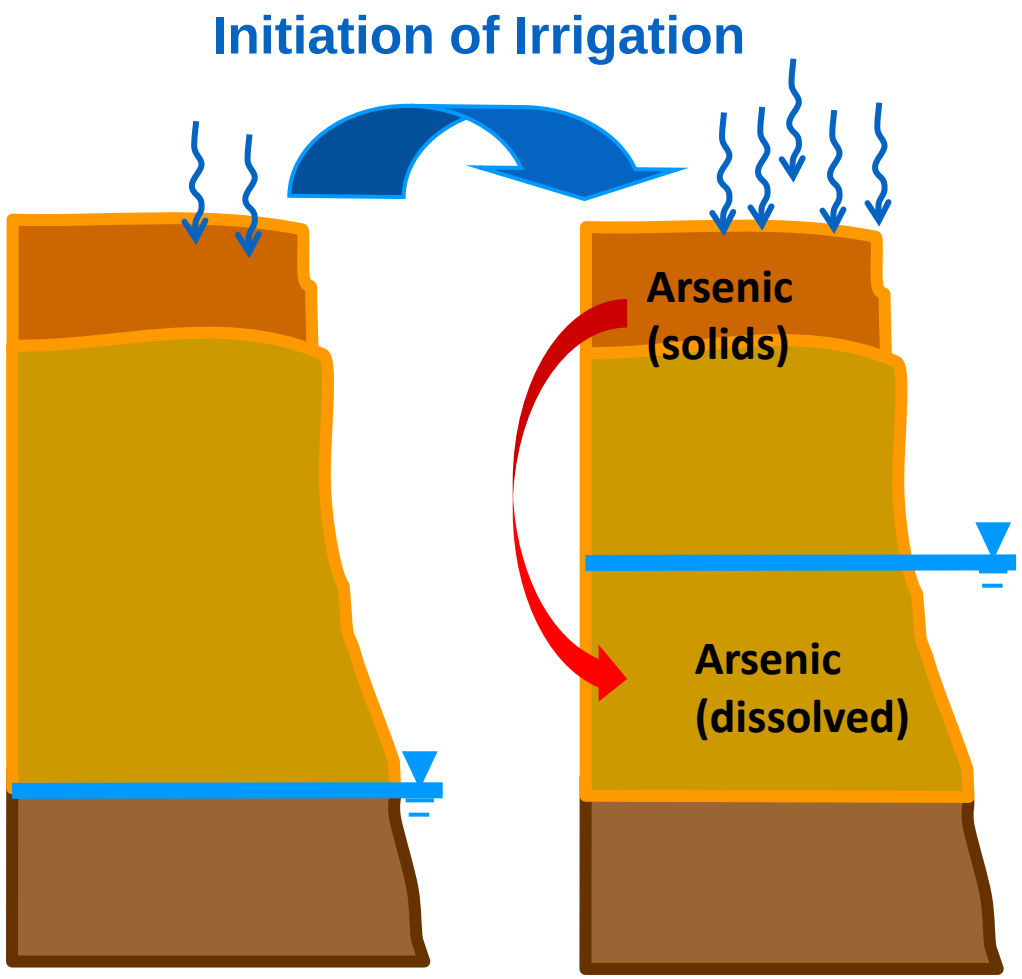


Arsenic Concentrations Highest In Wells Closest to Water Table

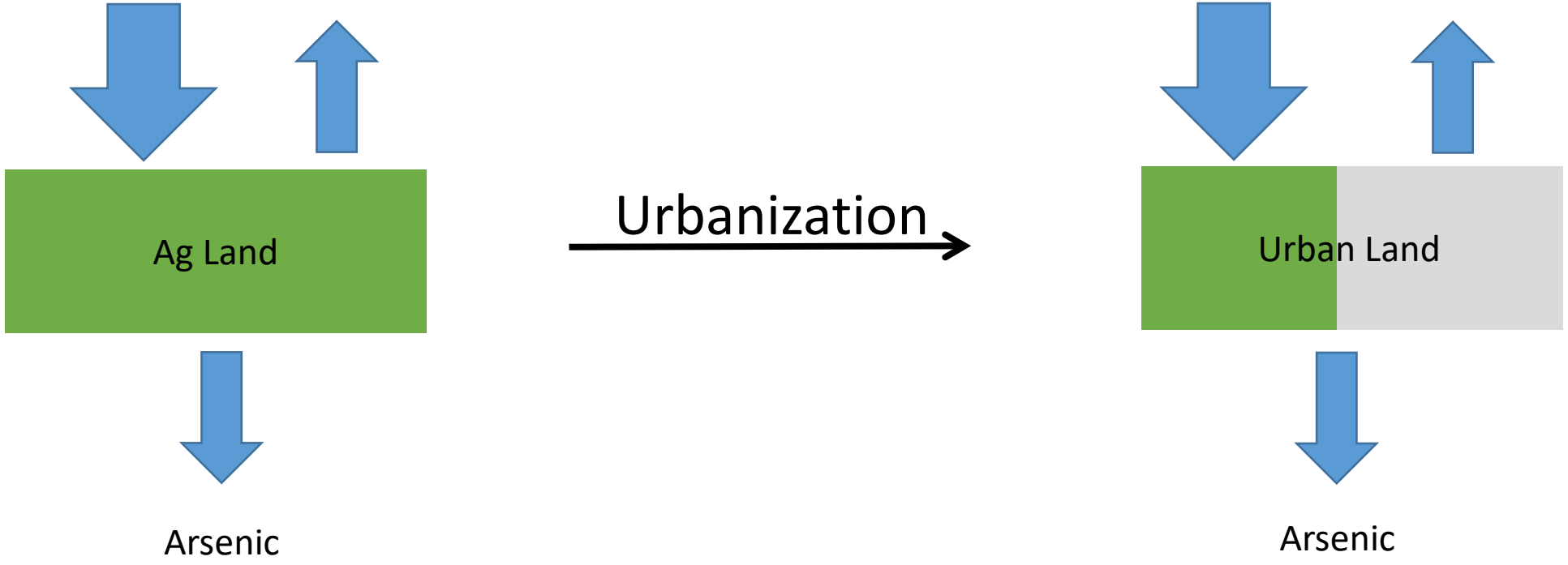


How Irrigation Leads to Arsenic Contamination

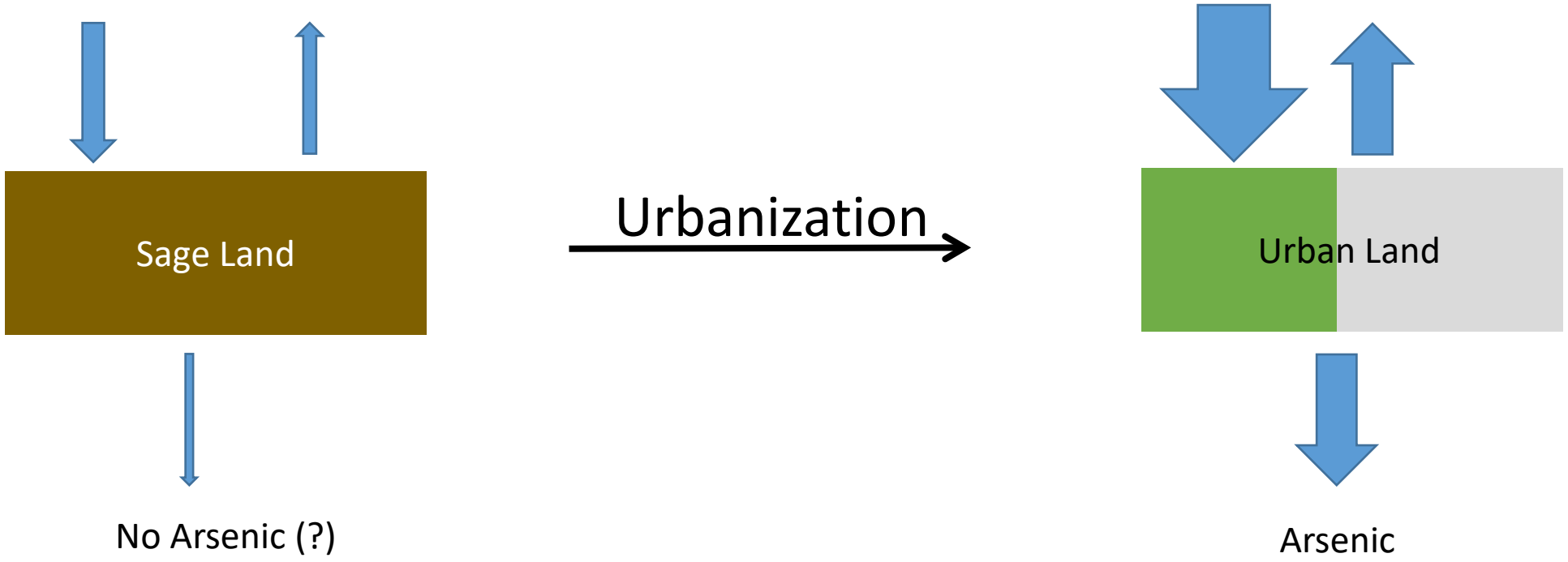




Urbanization of Ag Lands = No Arsenic Change?



Urbanization of undeveloped = More Arsenic?



Precipitation
11 inches

Evapotranspiration
10+ inches?

Groundwater
< 1 inch

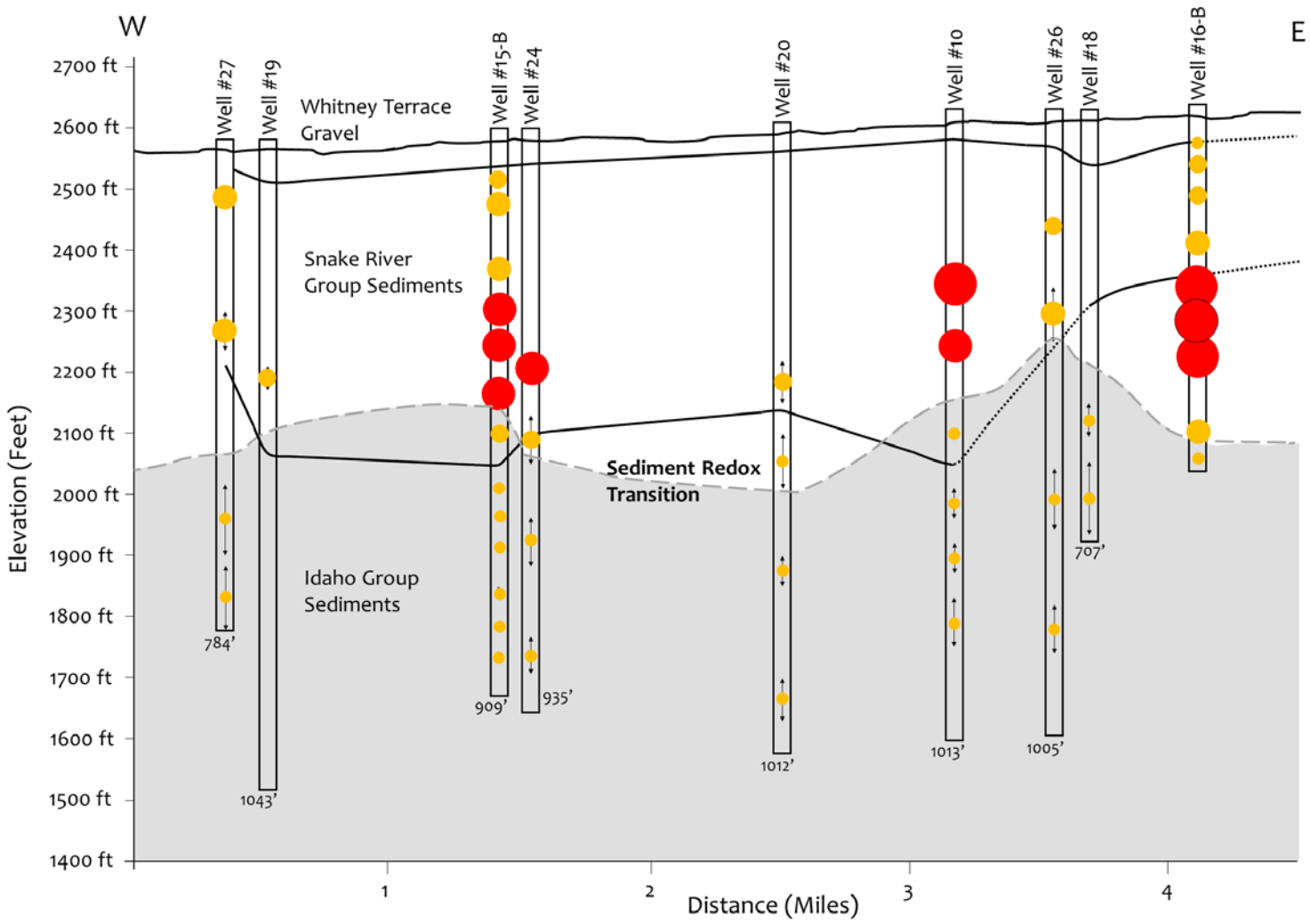
Precipitation
11 inches

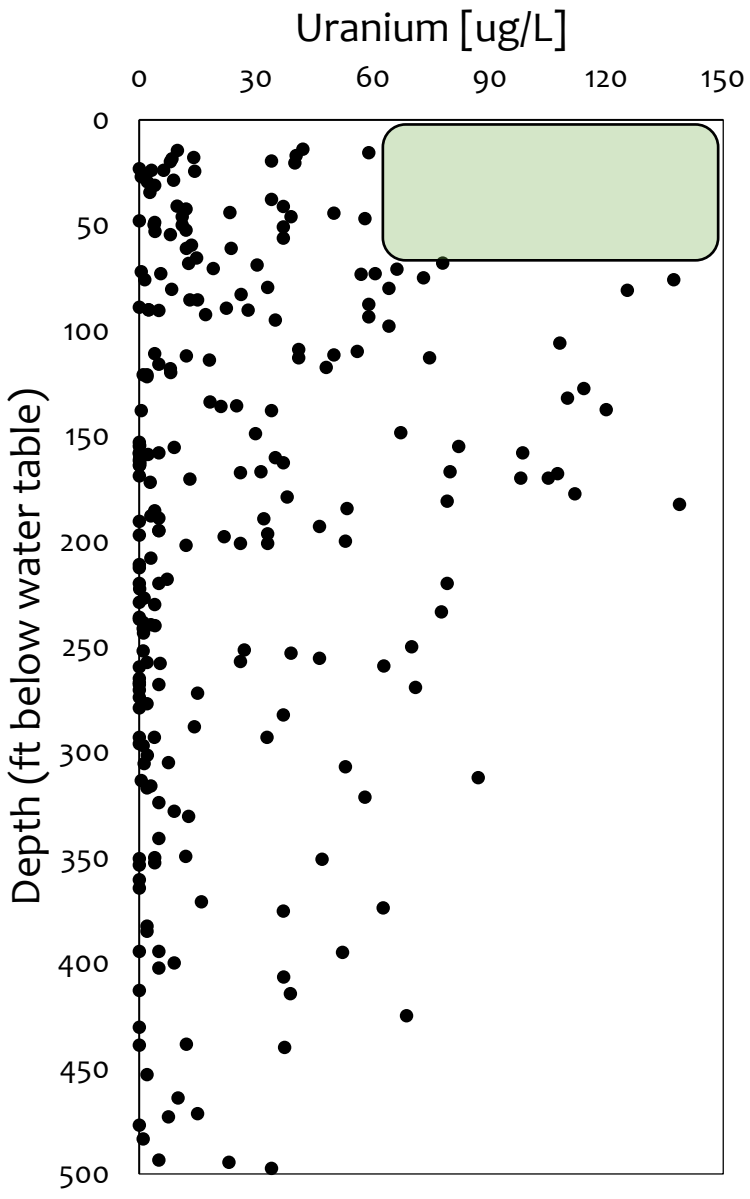
Irrigation
29 inches?

Evapotranspiration
20 inches?

Groundwater
20 inches?

Uranium


W
E
Well #27
Well #19
Well #15-B
Well #24
Well #20
Well #10
Well #26
Well #18
Well #16-B
Whitney Terrace Gravel
Snake River Group Sediments
Sediment Redox Transition
Idaho Group Sediments
784'
1043'
909'
935'
1012'
1013'
1005'
707'
2700 ft
2600 ft
2500 ft
2400 ft
2300 ft
2200 ft
2100 ft
2000 ft
1900 ft
1800 ft
1700 ft
1600 ft
1500 ft
1400 ft
Elevation (Feet)
1
2
3
4
Distance (Miles)


Uranium [ug/L]
0
30
60
90
120
150
0
50
100
150
200
250
300
350
400
450
500
Depth (ft below water table)

Urbanization Impacts on Uranium

- Geologic source at depth, not leached from the surface
- Controlled by alkalinity and oxic conditions

With Urbanization, No Change?

- No obvious mechanism of change

Urbanization Impacts on Nitrate

- No geologic source, always comes from the surface
- Generally the source is infiltration from Ag-fertilizer

With urbanization, could go up or down?

- Urban fertilizer use?

How Will We Detect GW Quality Change?

IDWR Statewide Monitoring Program is great…

….Except:

- Well sampling is on 5 year rotation, we need better temporal data
- Treasure Valley has few robust vertical monitoring well nests, Meridian has some, they should be monitored regularly

Conclusions, Observations, Conjectures

Conclusions, Observations

- Three Big Drivers of Change to Water Budget:
  - Climate change, Increased Irrigation Efficiency, Urbanization
- Ag to Urban: Surprisingly, little change in water budget
- Sage to Urban: Significant changes to water budget

Conjectures

- Arsenic: Largely same (Ag to Urban), Worse (Sage to Urban)?
- Uranium: No obvious mechanism of changes?
- Nitrate: Depends (on urban watering/fertilizer practices)?