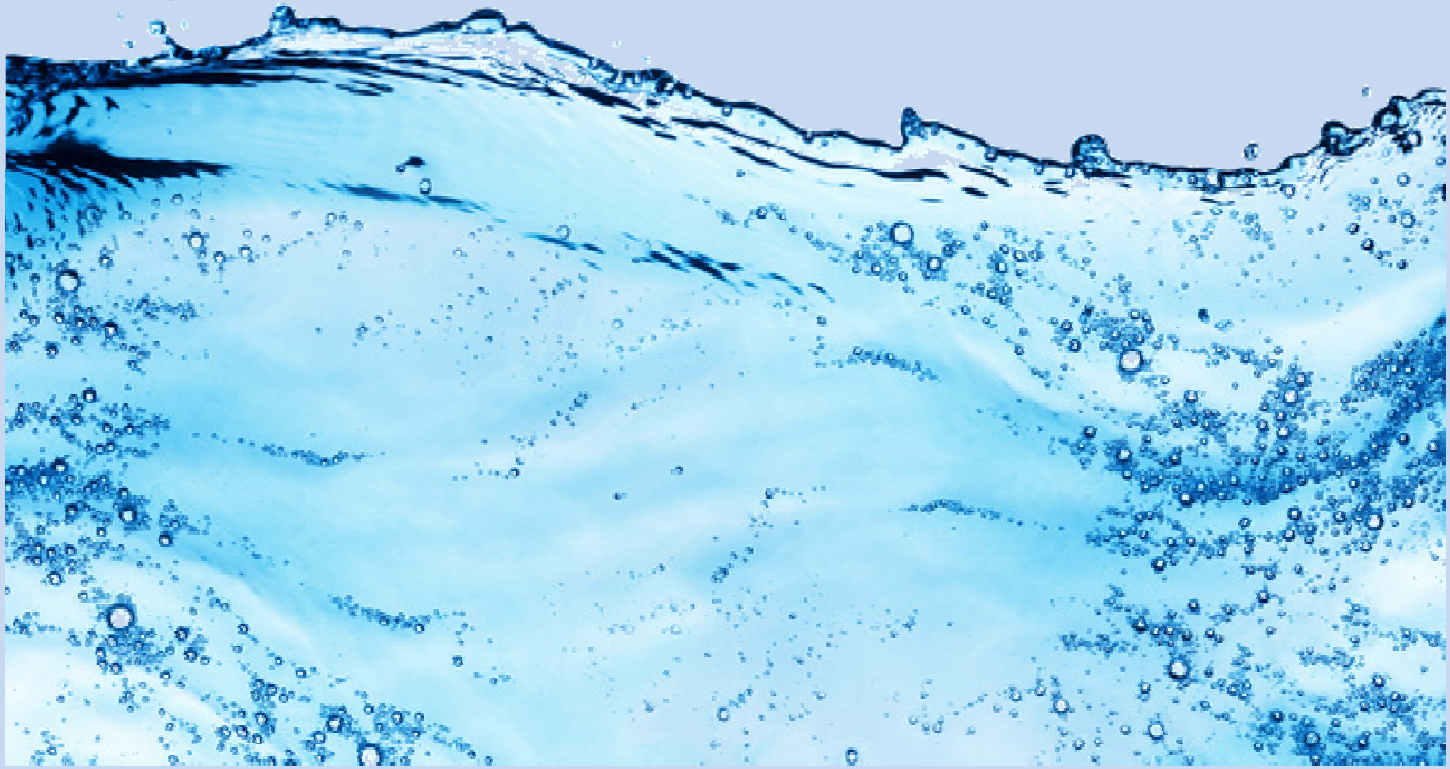
Groundwater in Clarkdale—today and in the future



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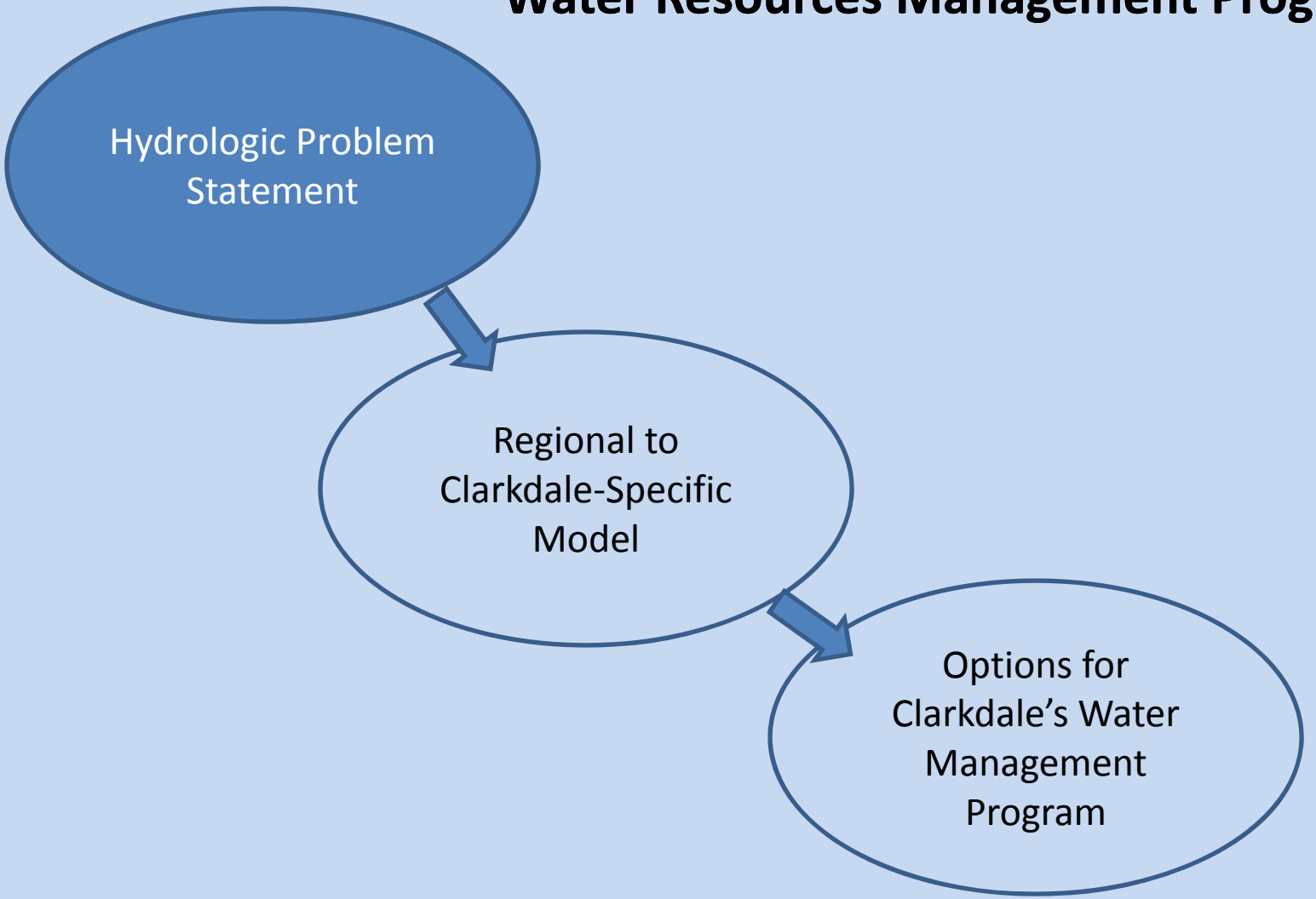
Water Resources Management Program



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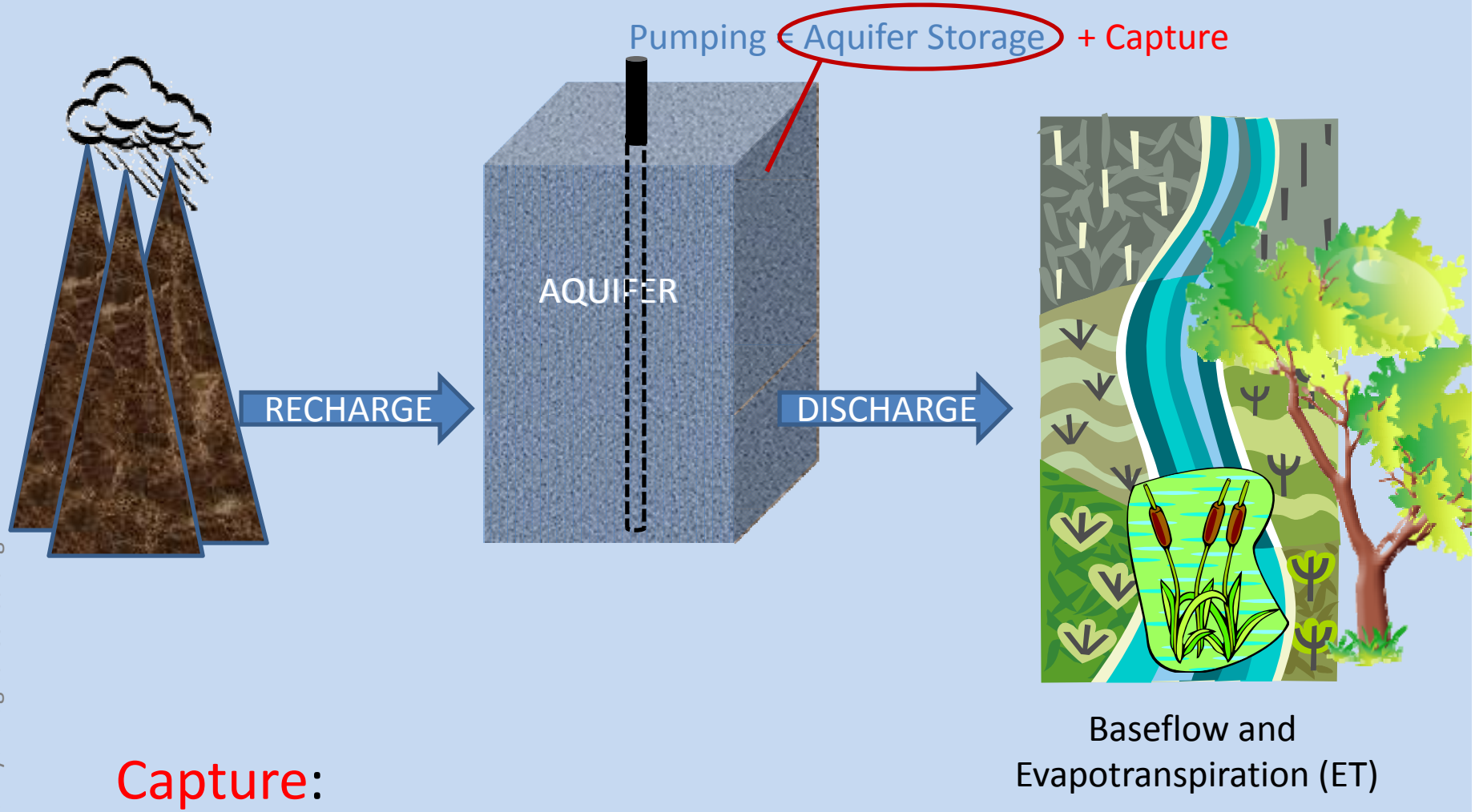
How Does Pumping Groundwater Affect the Verde River?

Natural Conditions: RECHARGE = DISCHARGE



Capture:

Increased RECHARGE + Decreased DISCHARGE

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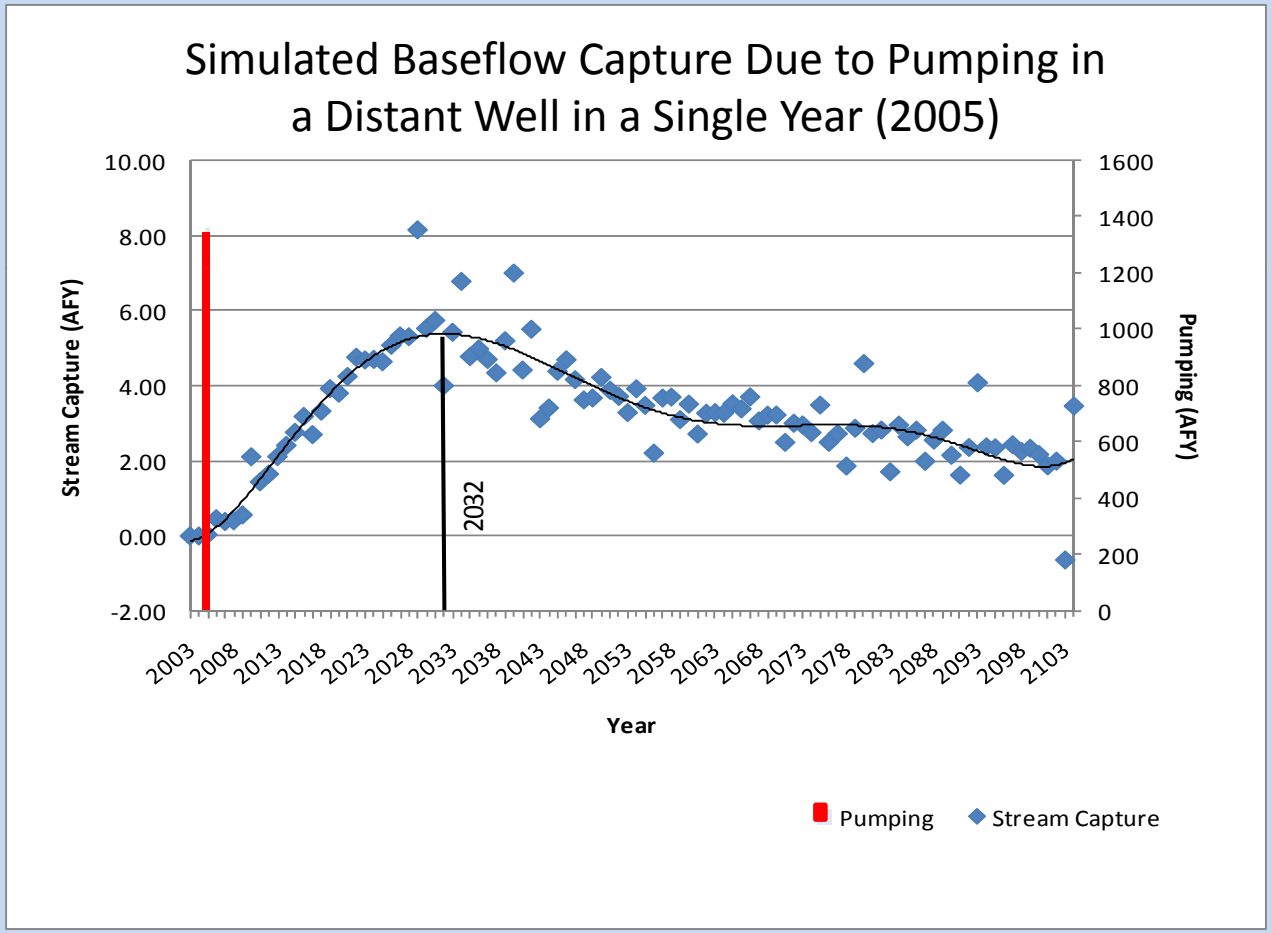
Effects of Pumping May Continue for a Long, Long Time... Even After Pumping Stops



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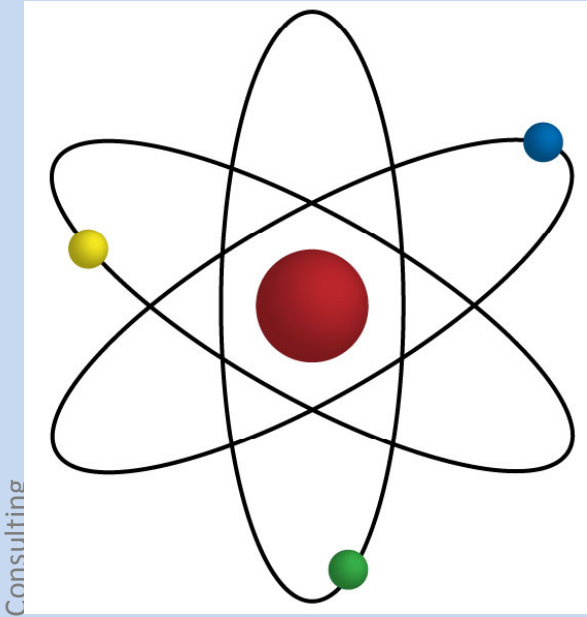
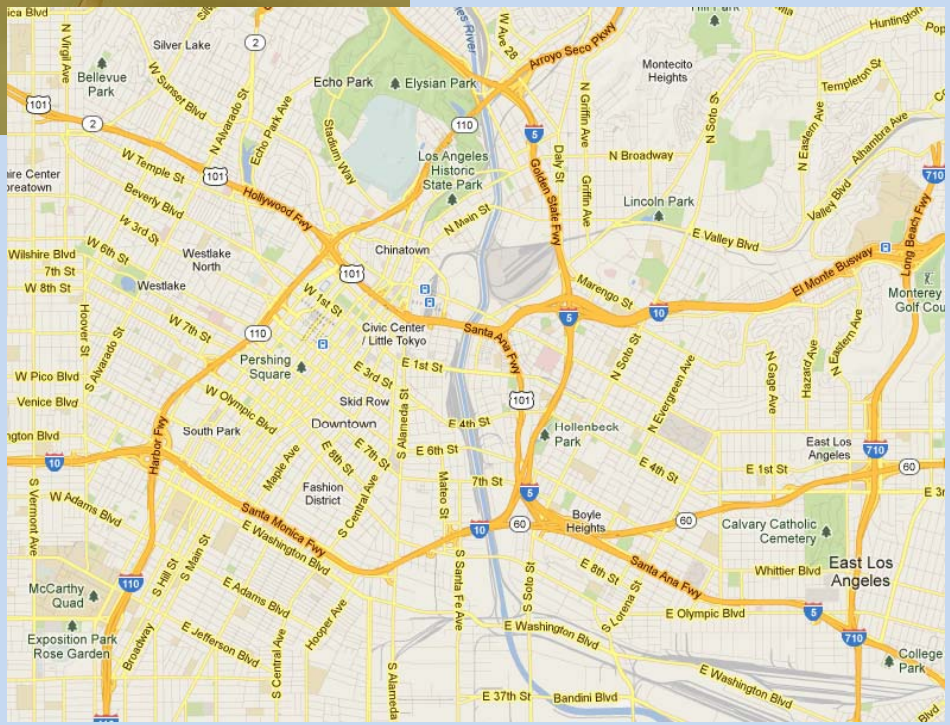
Hydrologic Tools for Understanding Water Systems

GROUNDWATER MODELS

MODEL: A Description or Analogy Used to Help Visualize Something that Cannot be Directly Observed.

-- Merriam-Webster Dictionary definition no. 11





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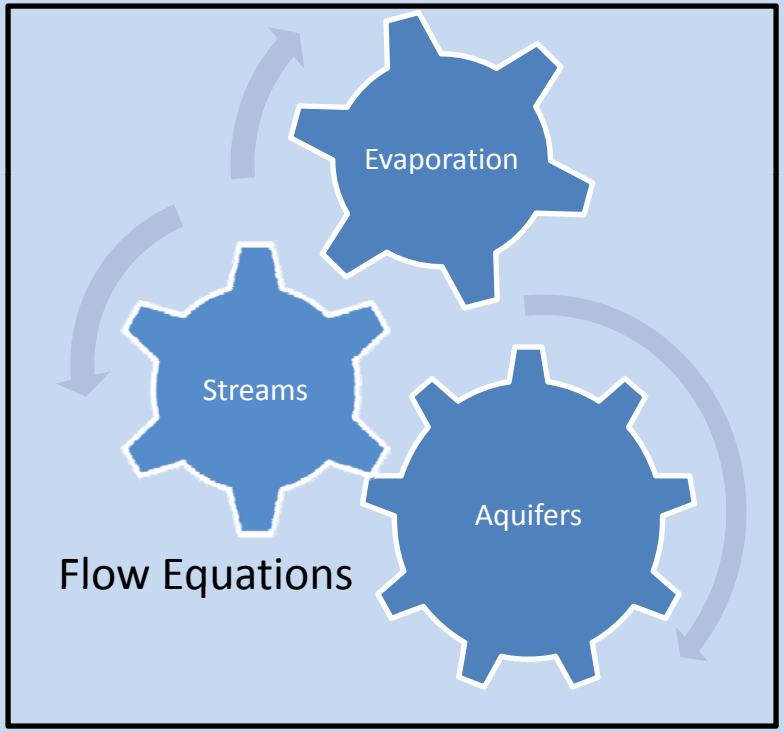
GROUNDWATER MODEL: A Computer Program that Uses Flow Equations to Make Sense of a Complex Natural System.

Numerical Model

INPUT

Pumping,
Stream Diversions,
Evaporative
Demand



OUTPUT

Groundwater
Conditions,
Baseflow,
Evaporative
Consumption

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Why Use a Groundwater Model?

- To test the outcome of actions that can't easily be tested in real life:
  - future changes in pumping
  - new wells
  - changing climate
  - new recharge projects

USGS
science for a changing world

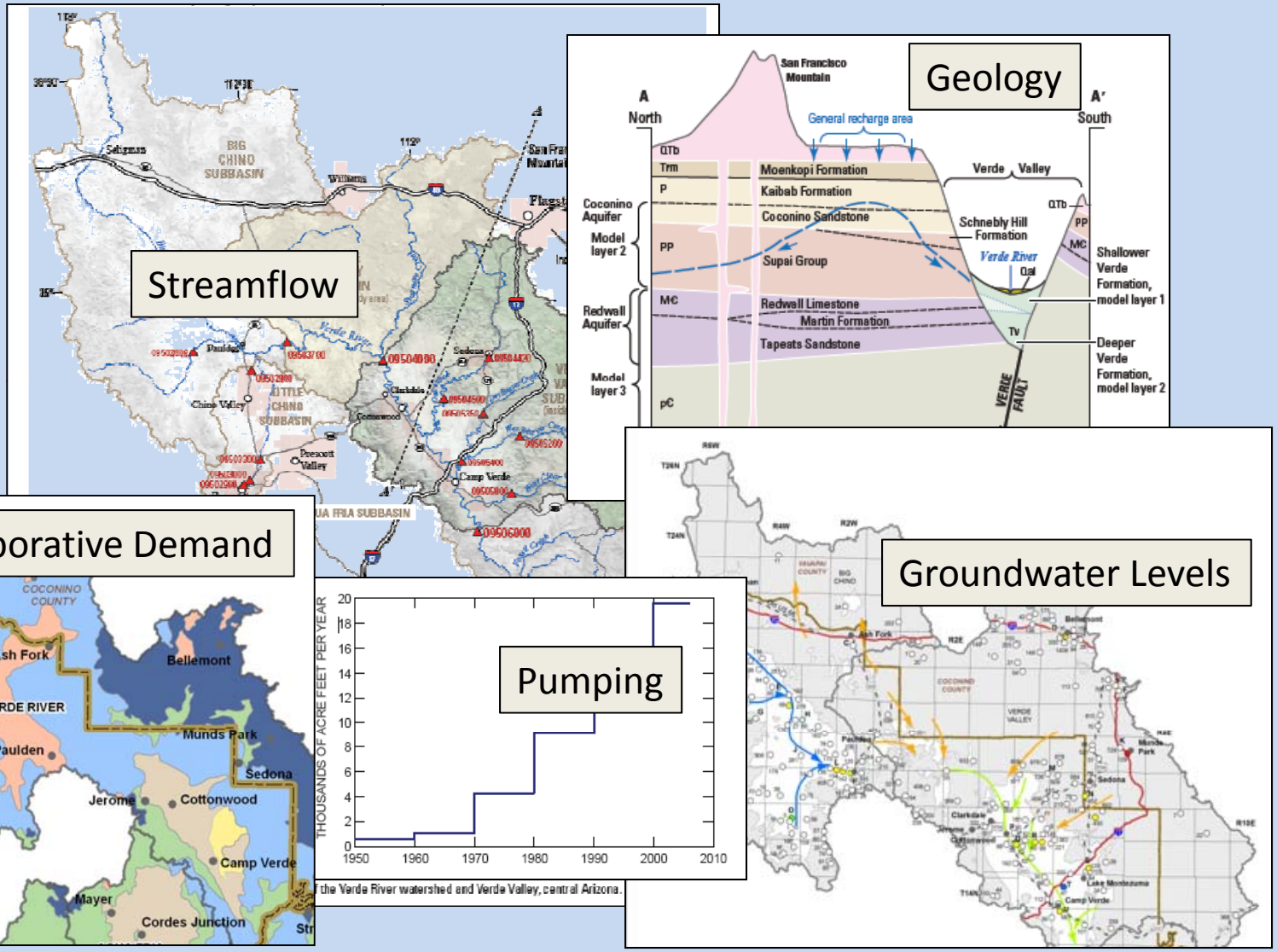
Prepared in cooperation with the Arizona Department of Water Resources and Yavapai County

Regional Groundwater-Flow Model of the Redwall-Muav, Coconino, and Alluvial Basin Aquifer Systems of Northern and Central Arizona

Scientific Investigations Report 2010-5180, v. 1.1

U.S. Department of the Interior
U.S. Geological Survey

What We Know About Our System



Source: SIR 2013-5029

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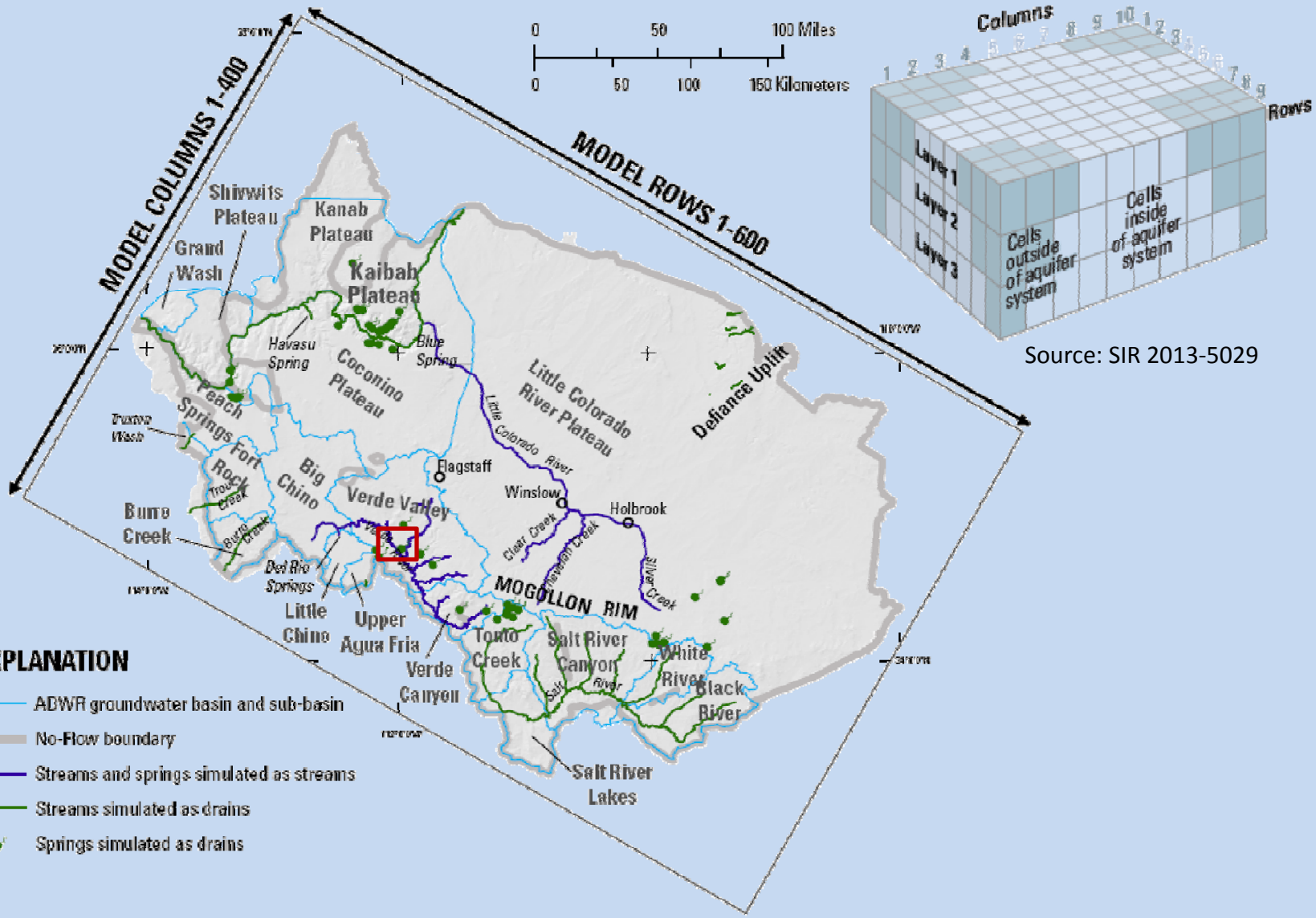

Source: SIR 2013-5029

Figure 11. Boundary conditions for the Northern Arizona Regional Groundwater-Flow Model.

Source: SIR 2010-5180

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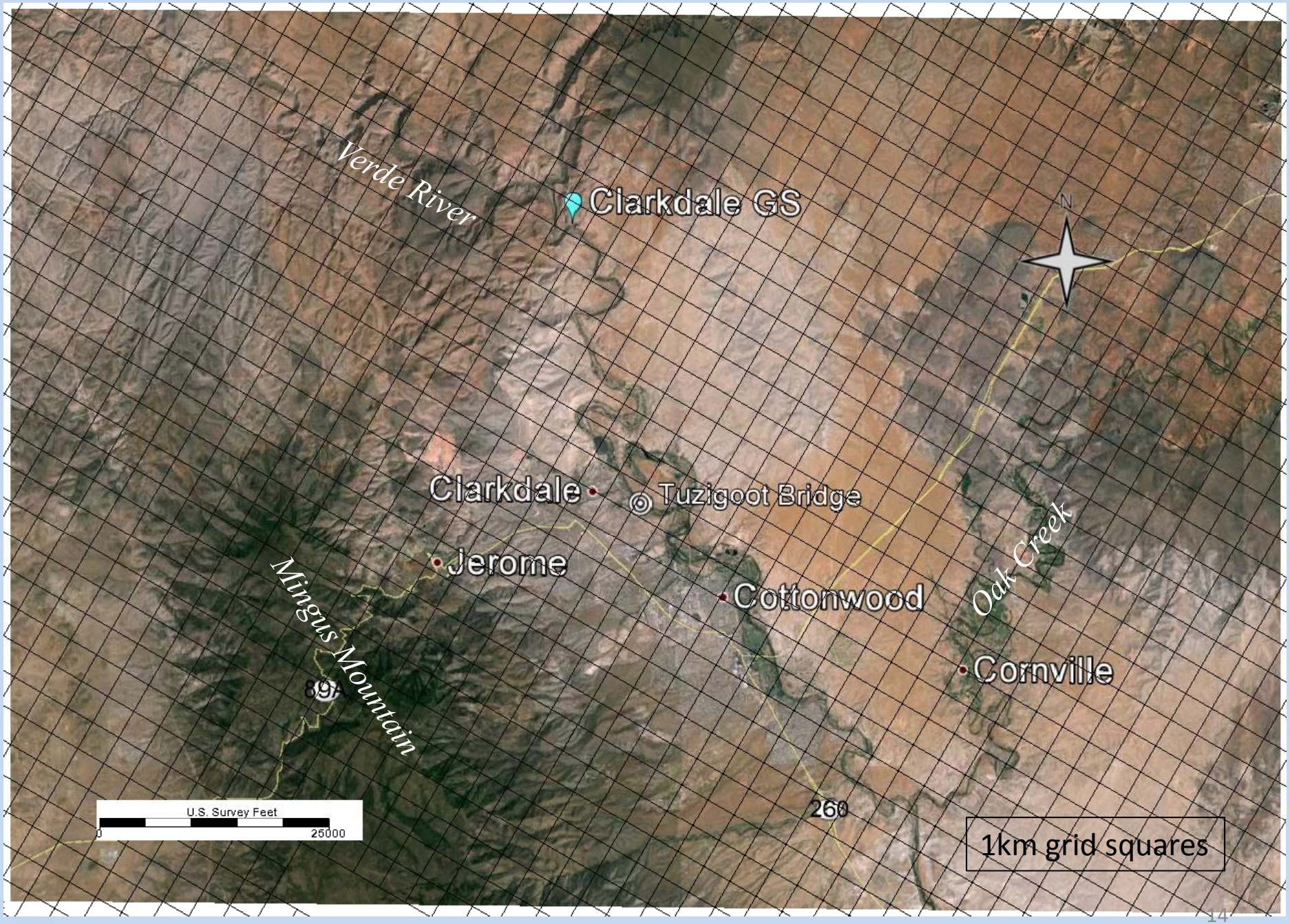
MODELING THE CLARKDALE AREA


Verde River
Clarkdale GS
N
Clarkdale
Tuzigoot Bridge
Jerome
Cottonwood
Oak Creek
Mingus Mountain
Cornville
89A
260
U.S. Survey Feet
0
25000
1km grid squares

Future Simulation (2006 to 2076)

- No Change in Pumping from 2006-2076*

  * Clarkdale pumping updated 2006-2012, then constant to 2076.

- Repeat Historic (1910-1970) Recharge 2016 to 2076

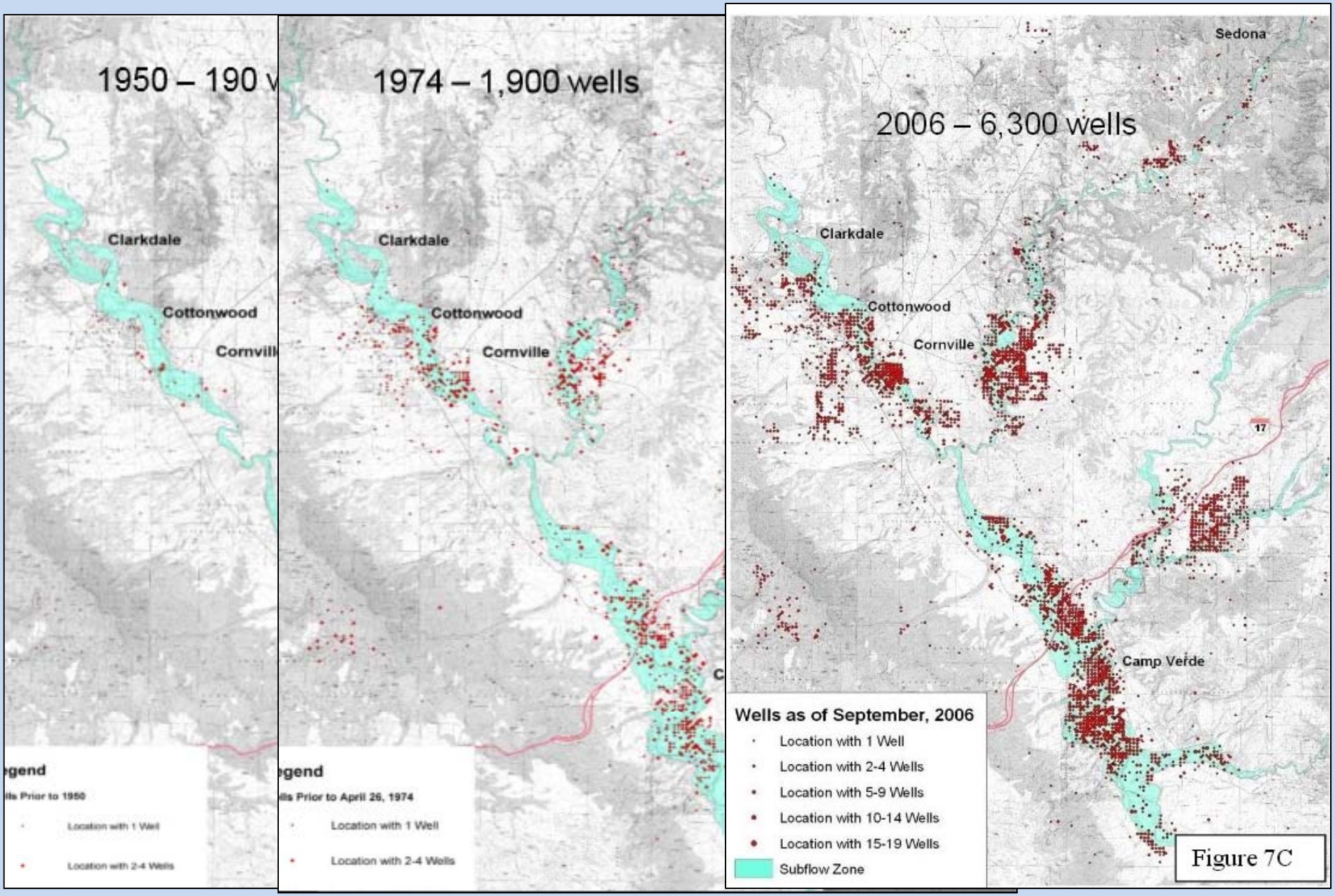
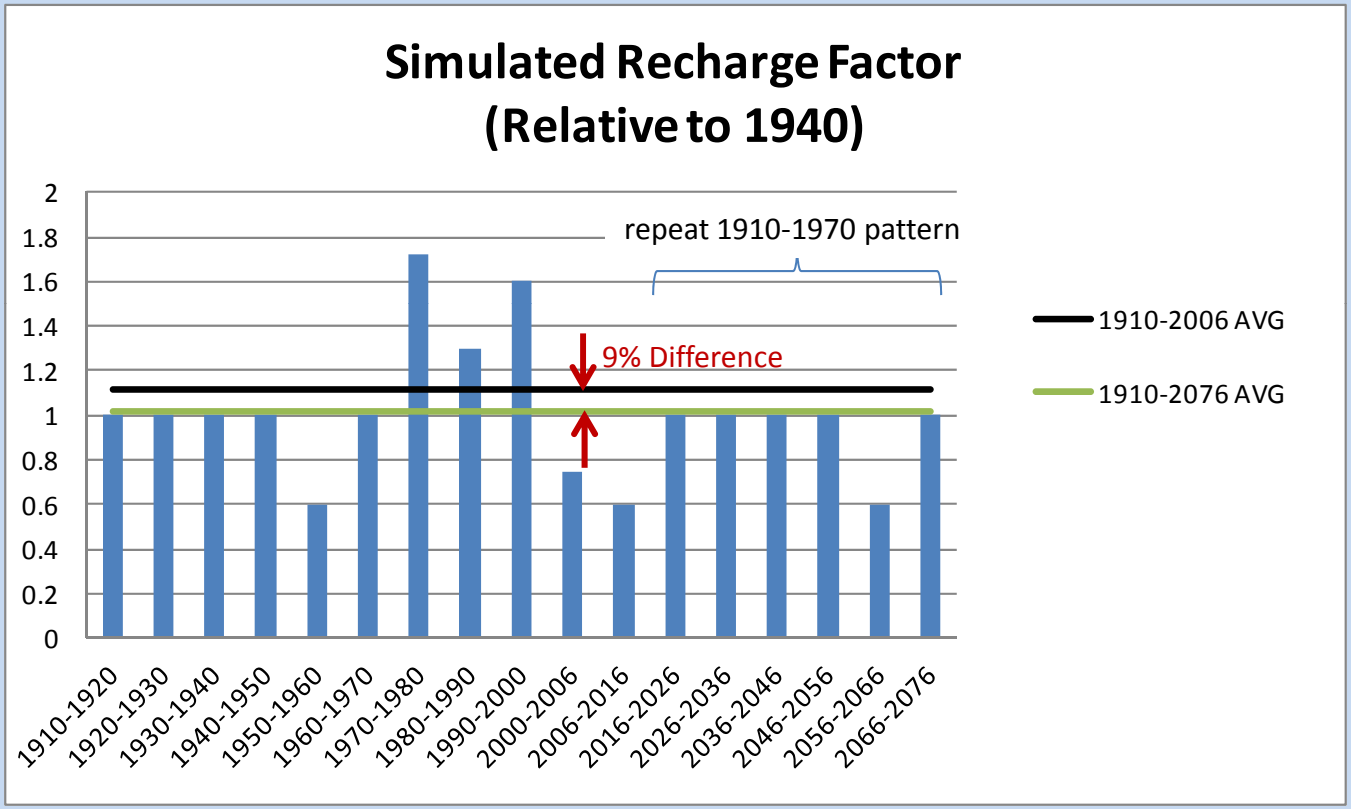

1950 – 190
Clarkdale
Cottonwood
Cornvill
gend
ls Prior to 1950
Location with 1 Well
Location with 2-4 Wells
1974 – 1,900 wells
Clarkdale
Cottonwood
Cornville
gend
ls Prior to April 26, 1974
Location with 1 Well
Location with 2-4 Wells
2006 – 6,300 wells
Sedona
Clarkdale
Cottonwood
Cornville
17
Camp Verde
Wells as of September, 2006
Location with 1 Well
Location with 2-4 Wells
Location with 5-9 Wells
Location with 10-14 Wells
Location with 15-19 Wells
Subflow Zone

Figure 7C



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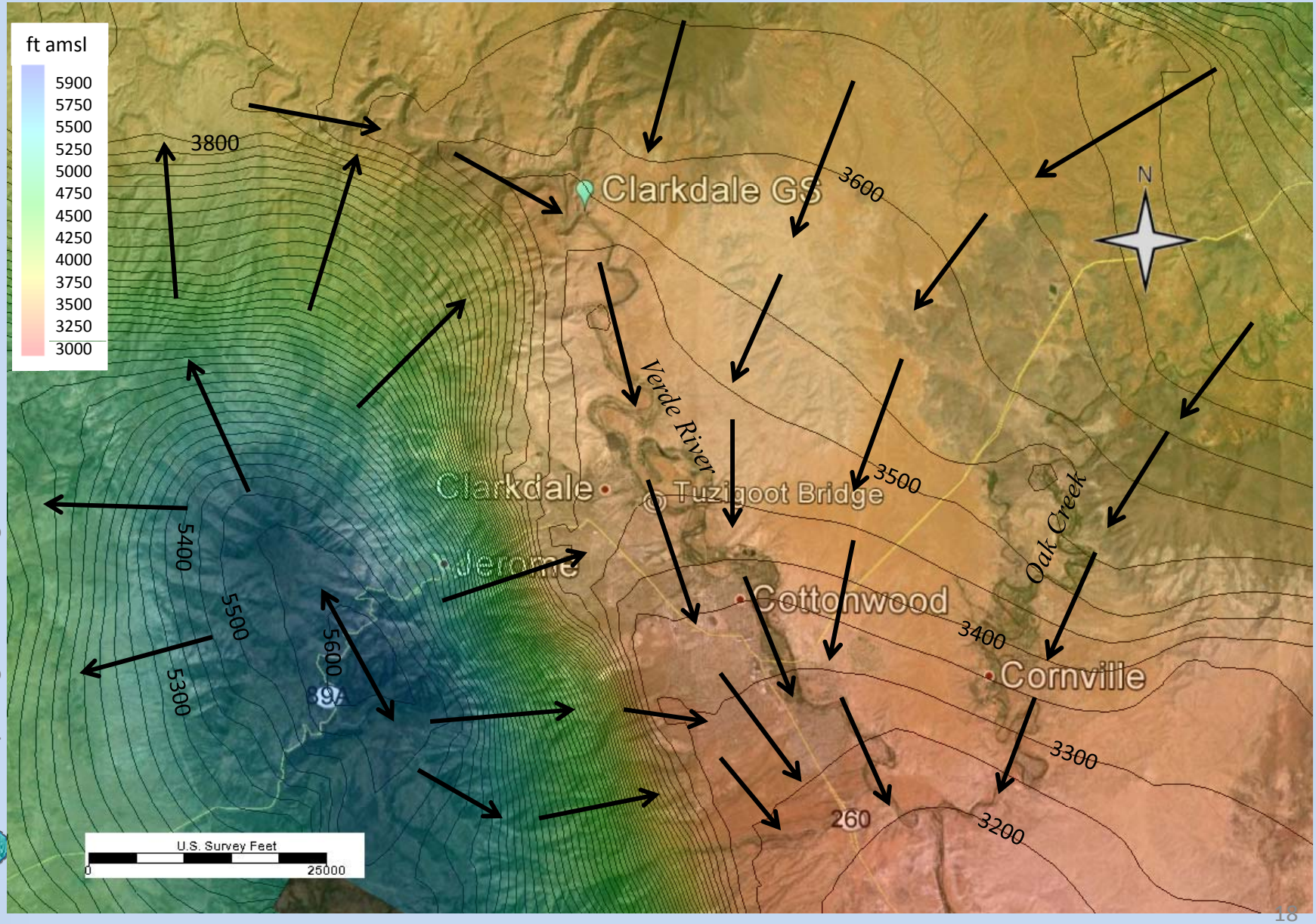
Simulated Heads and Flow Paths – 1910 (Predevelopment)

contour interval = 50 ft.



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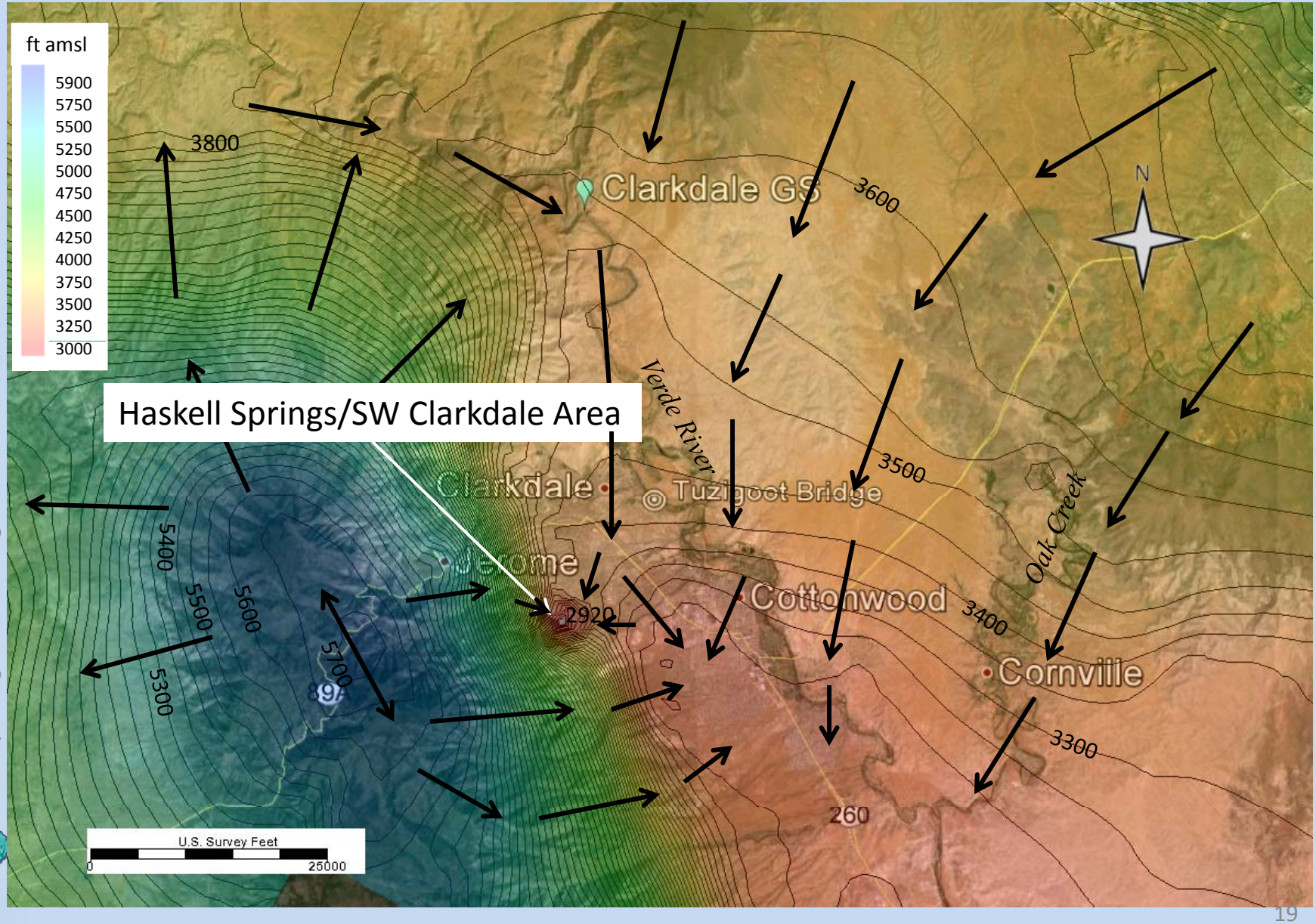
Simulated Heads and Flow Paths – 2006

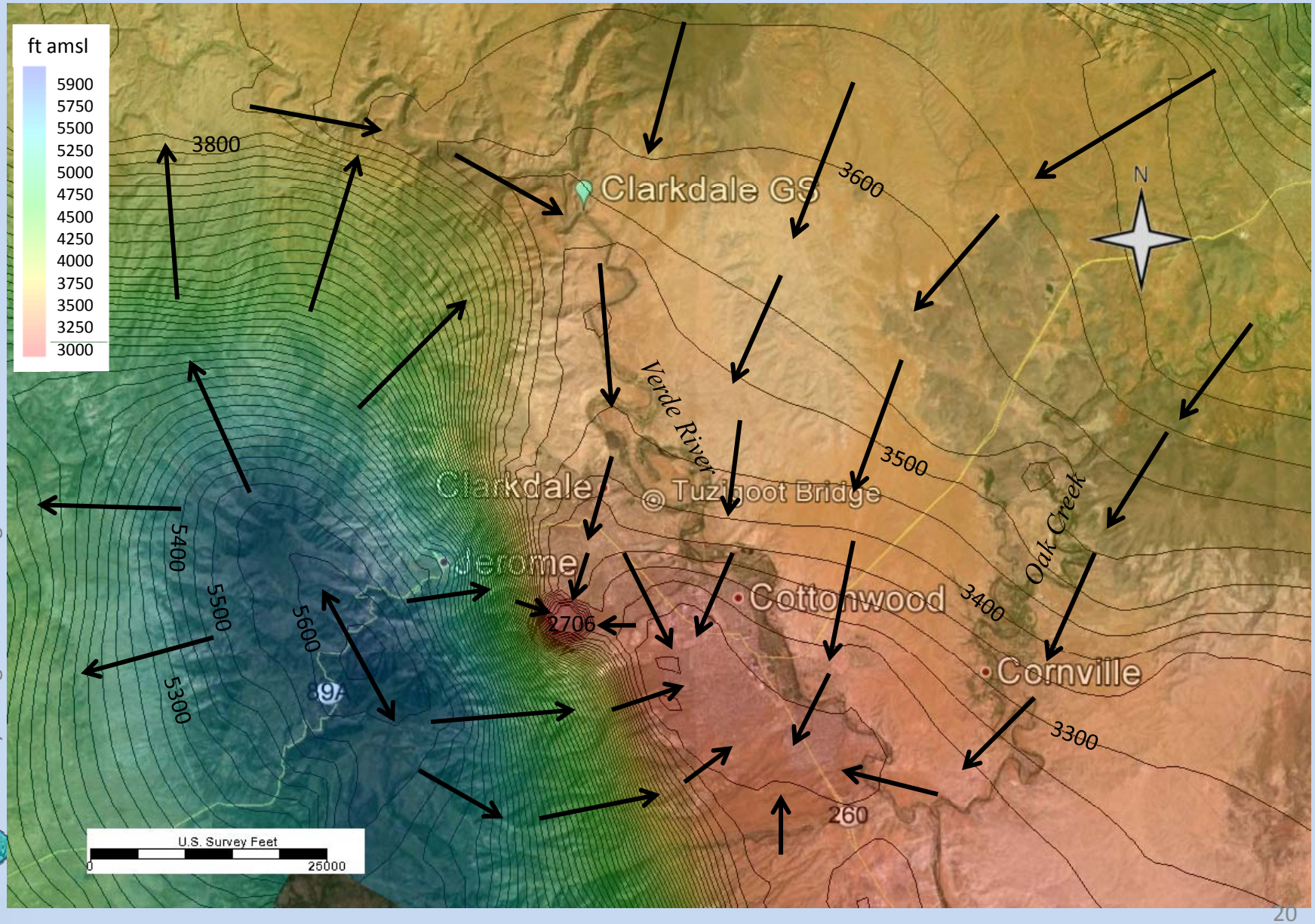
contour interval = 50 ft.



Lacher Hydrological Consulting

Simulated Heads and Flow Paths – 2030

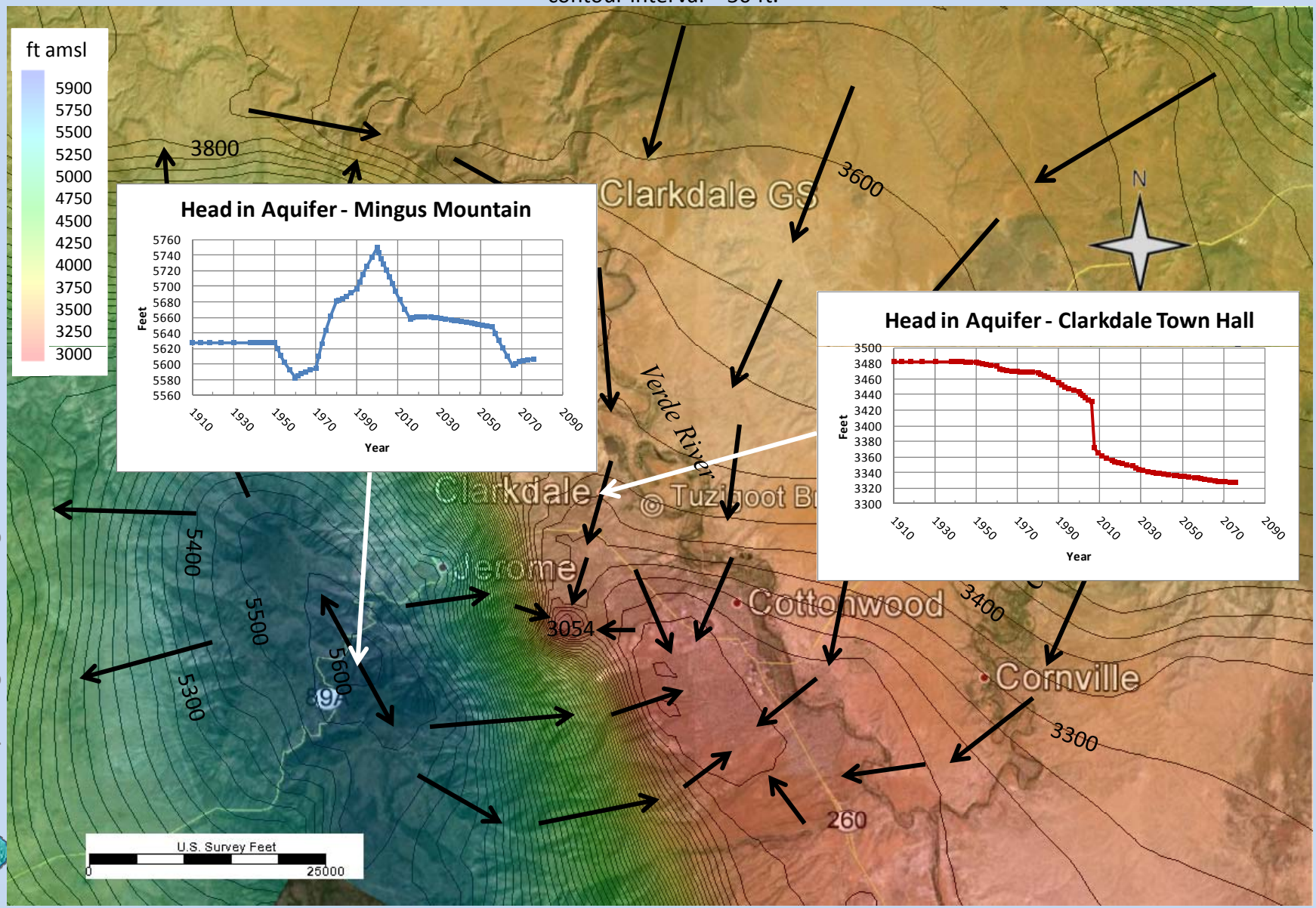
contour interval = 50 ft.



Lacher Hydrological Consulting

Simulated Heads and Flow Paths – 2076

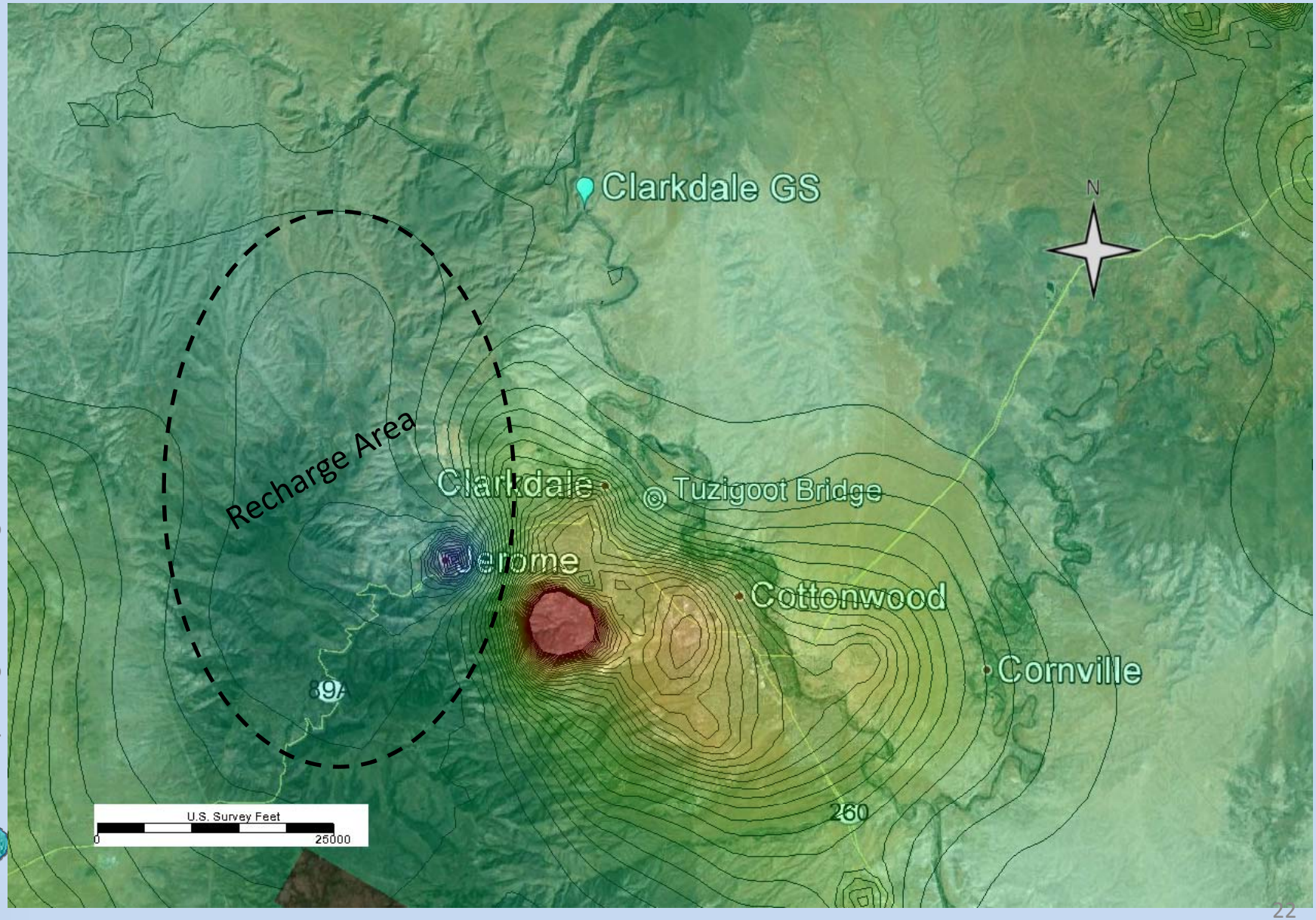
contour interval = 50 ft.



Lacher Hydrological Consulting

Simulated Head Change 1910 to 1970

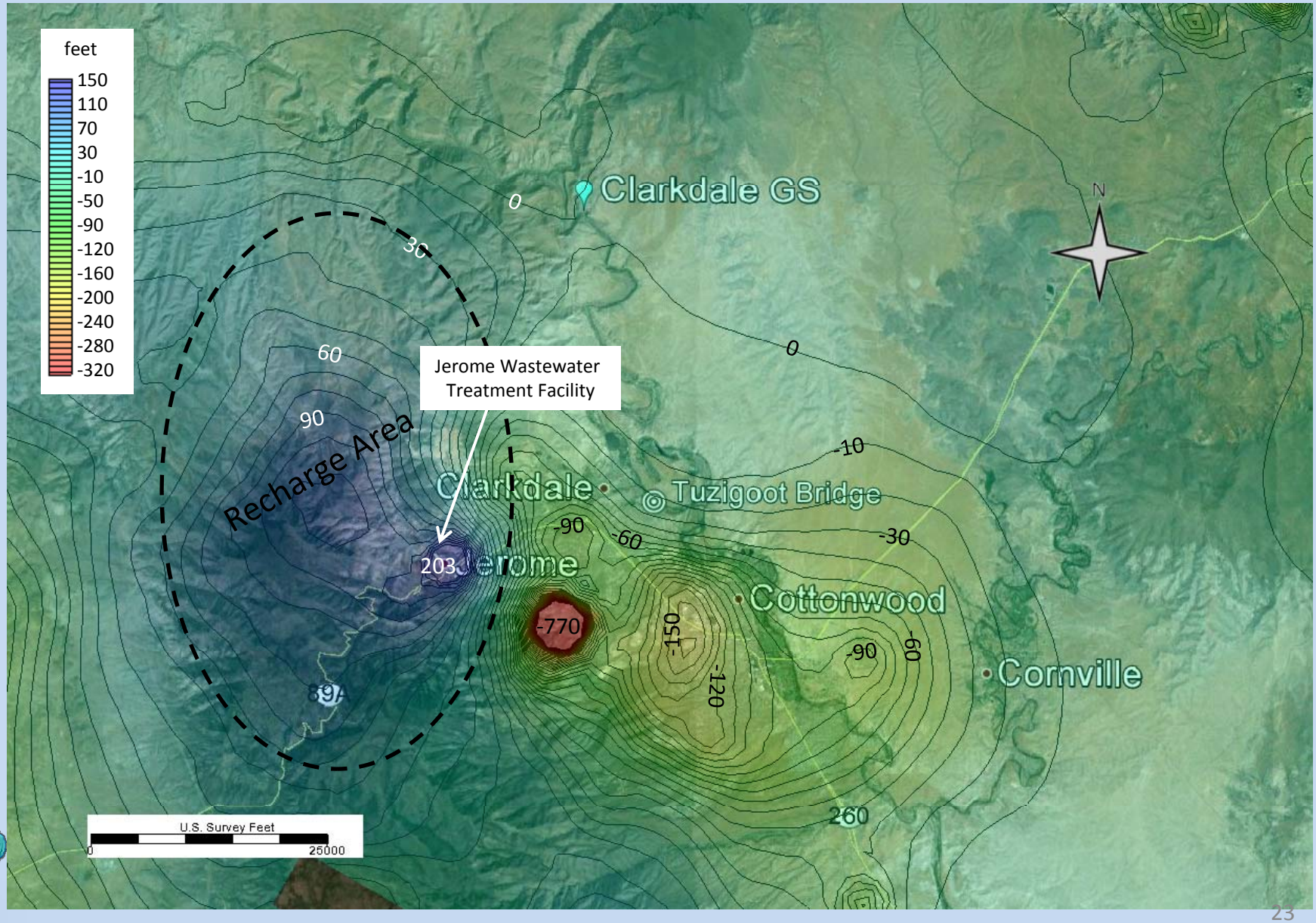
contour interval = 10 ft.



Lacher Hydrological Consulting

Simulated Head Change 1910 to 2006

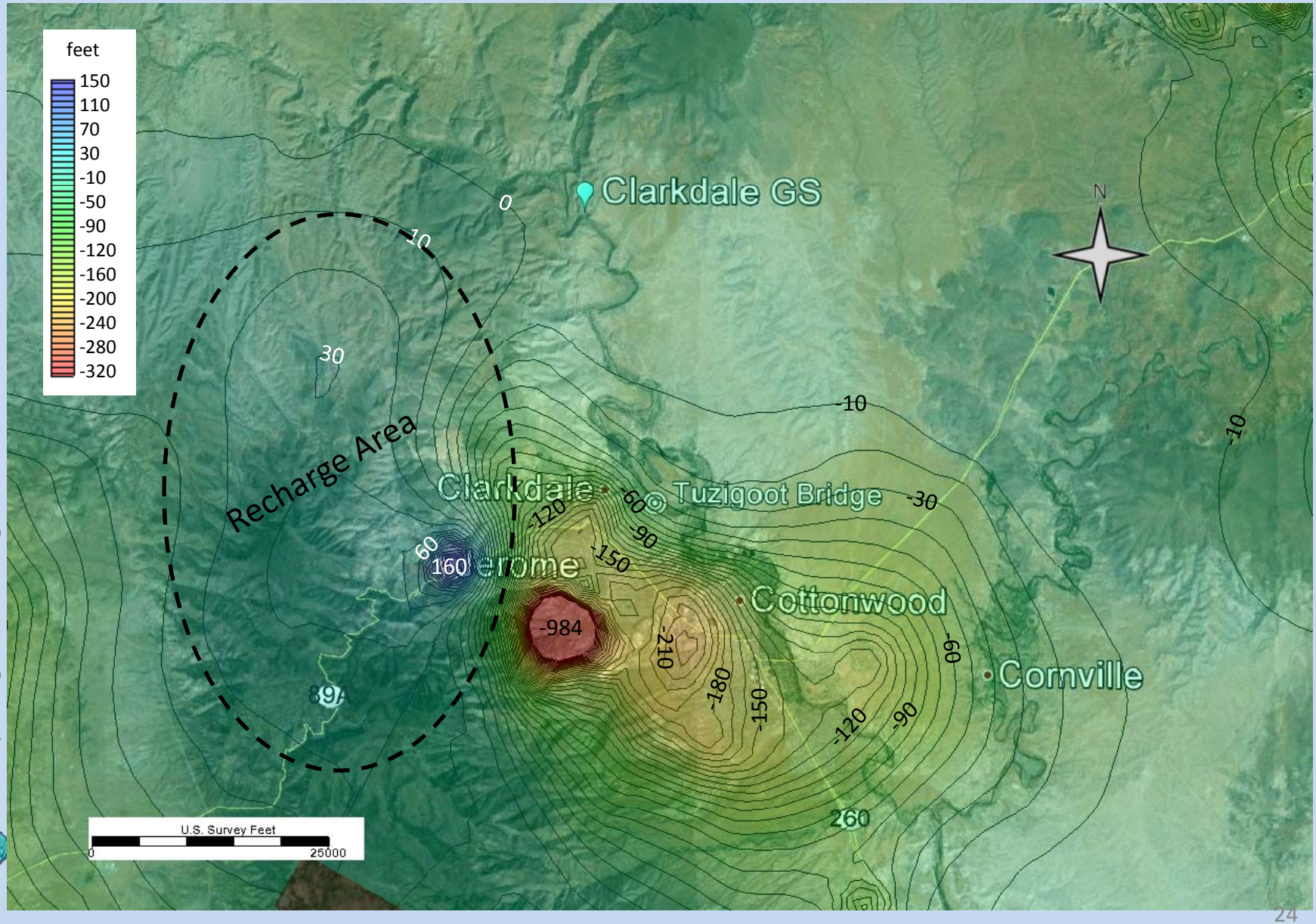
contour interval = 10 ft.



Lacher Hydrological Consulting

Simulated Head Change 1910 to 2030

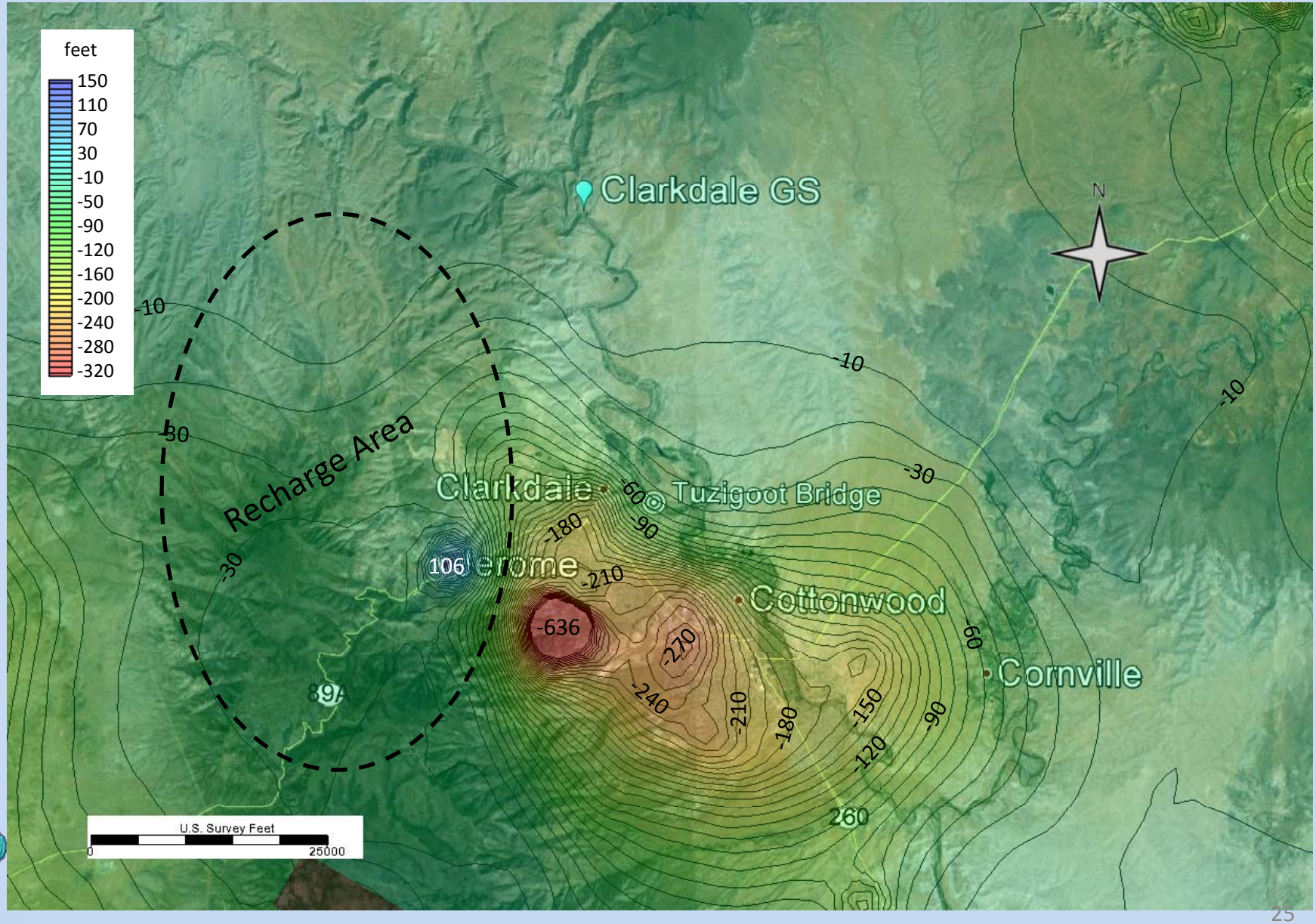
contour interval = 10 ft.



Lacher Hydrological Consulting

Simulated Head Change 1910 to 2076

contour interval = 10 ft.



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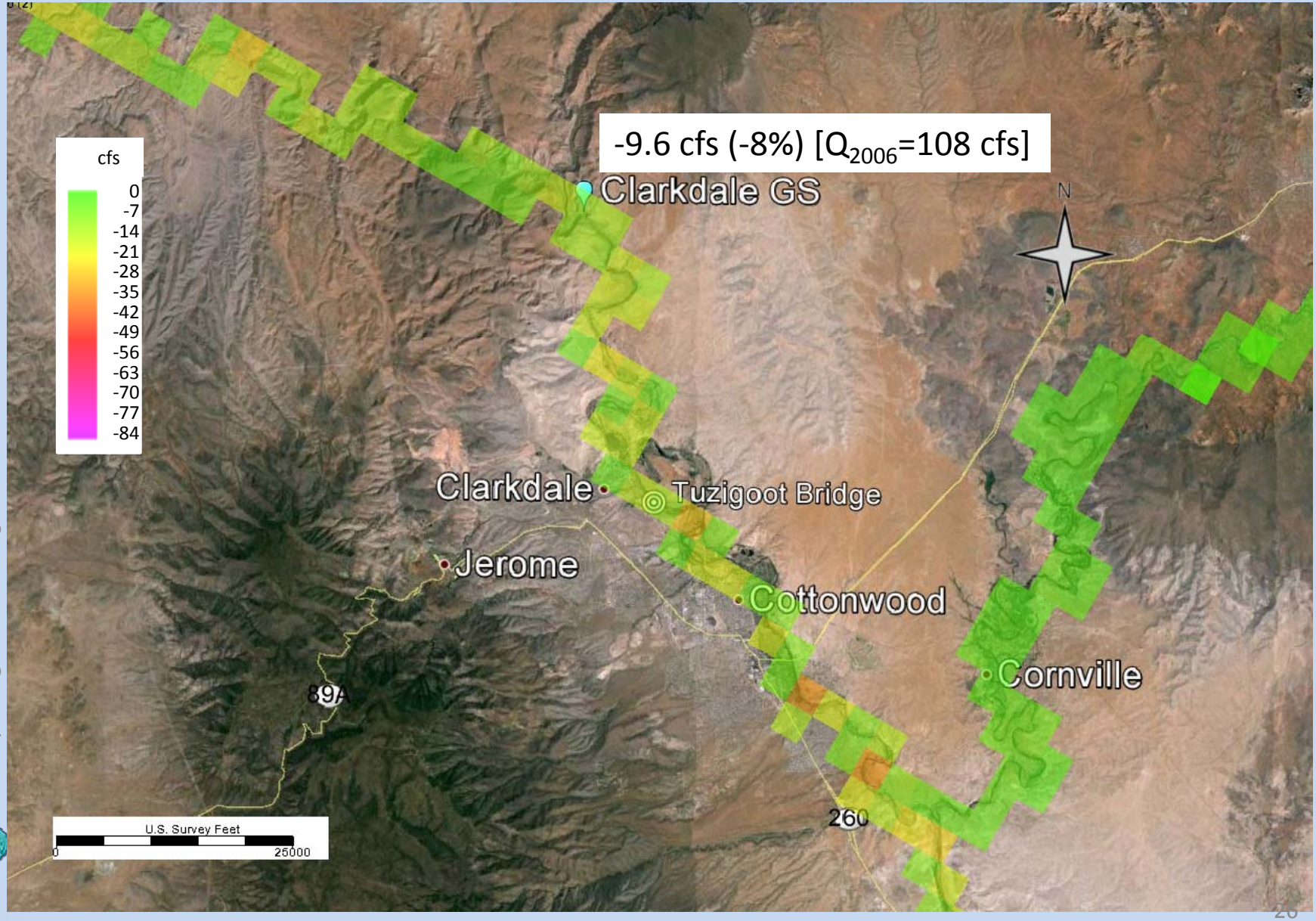
Simulated Change in Baseflow - 1910 to 2006

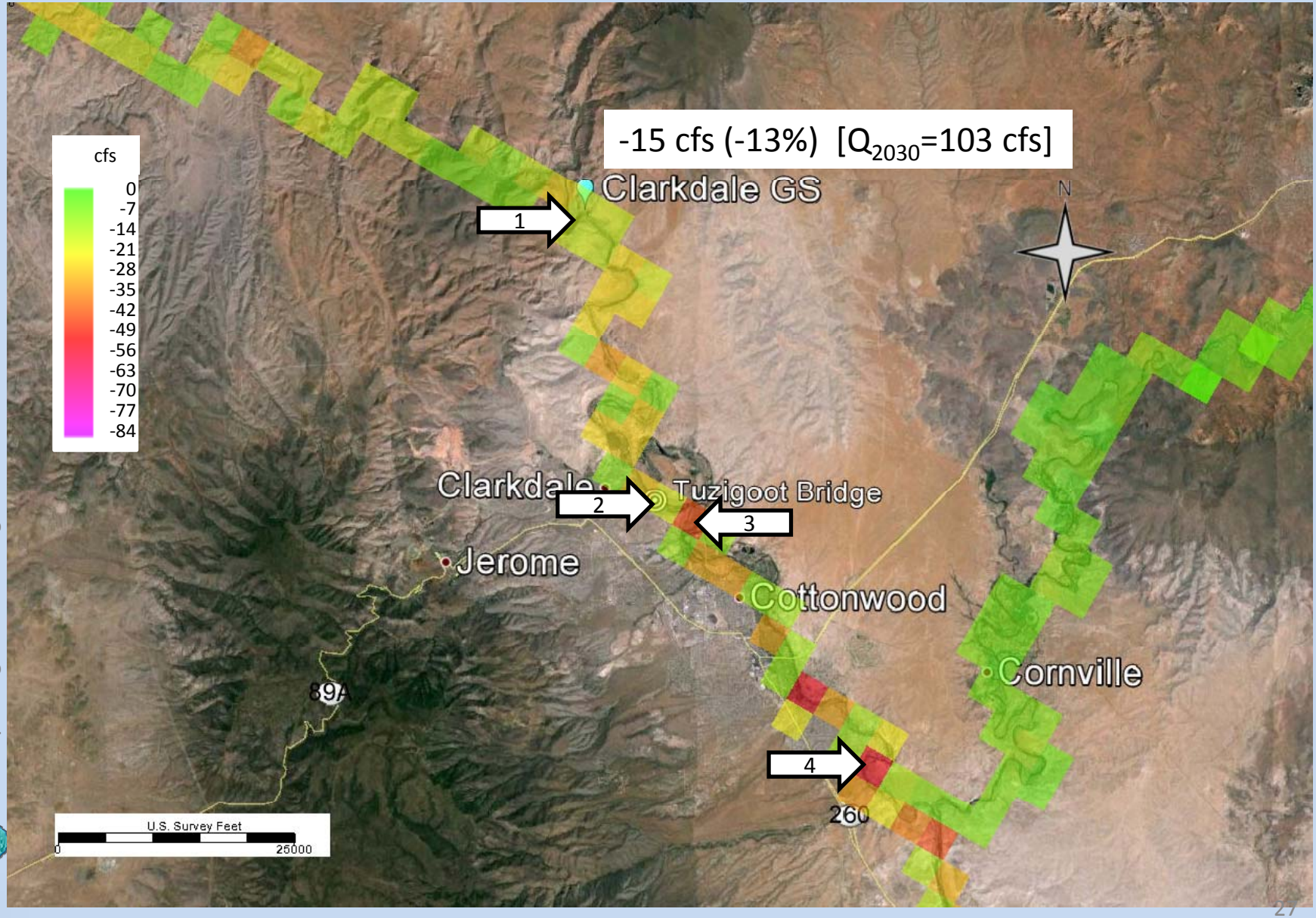
contour interval = 1 cubic-foot per second (cfs)



Lacher Hydrological Consulting

Simulated Change in Baseflow - 1910 to 2030

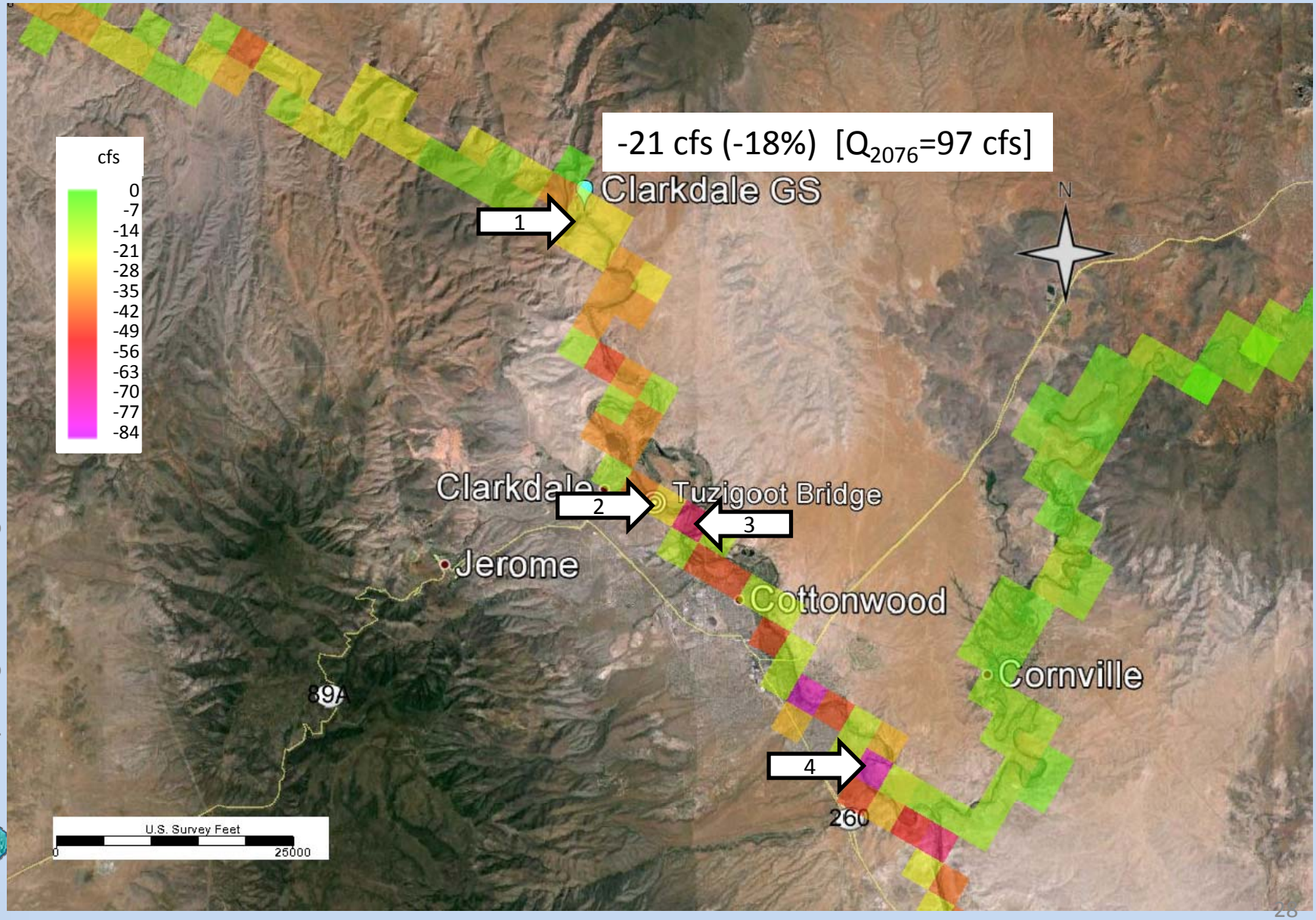
contour interval = 1 cubic-foot per second (cfs)



Lacher Hydrological Consulting

Simulated Change in Baseflow - 1910 to 2076

contour interval = 1 cubic-foot per second (cfs)



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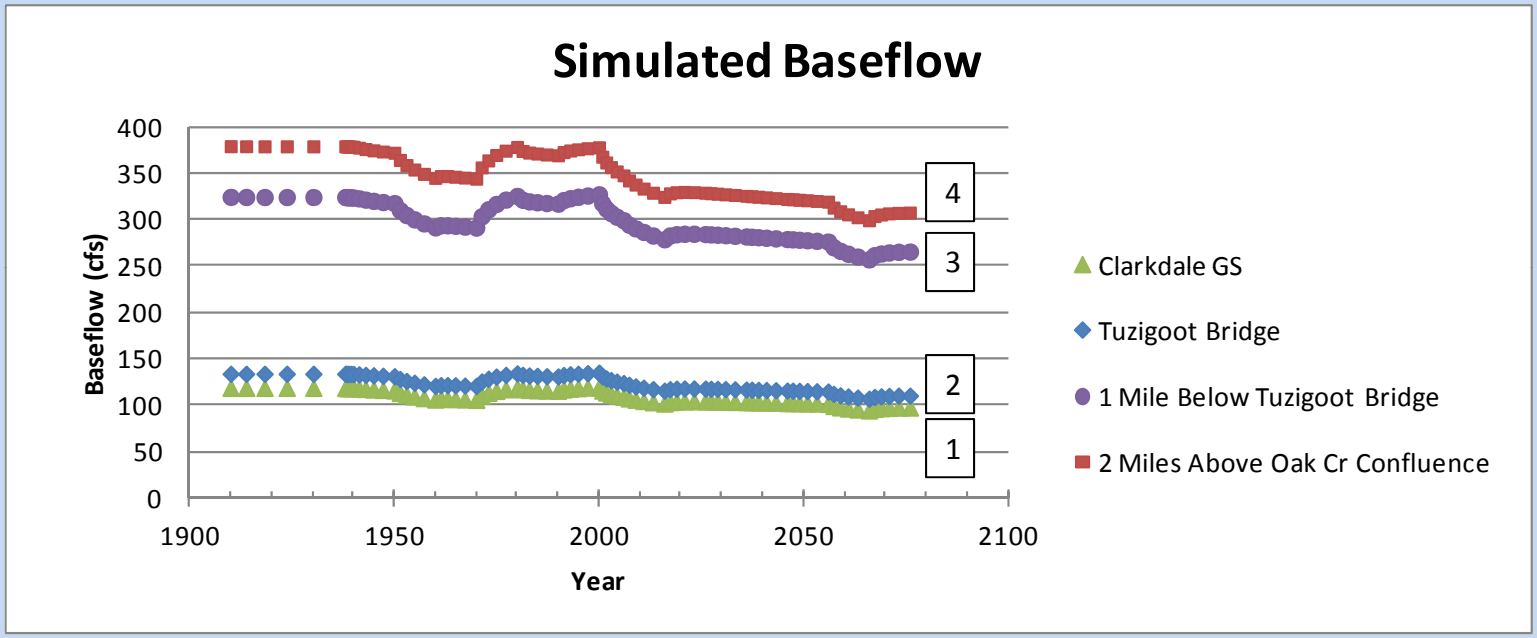

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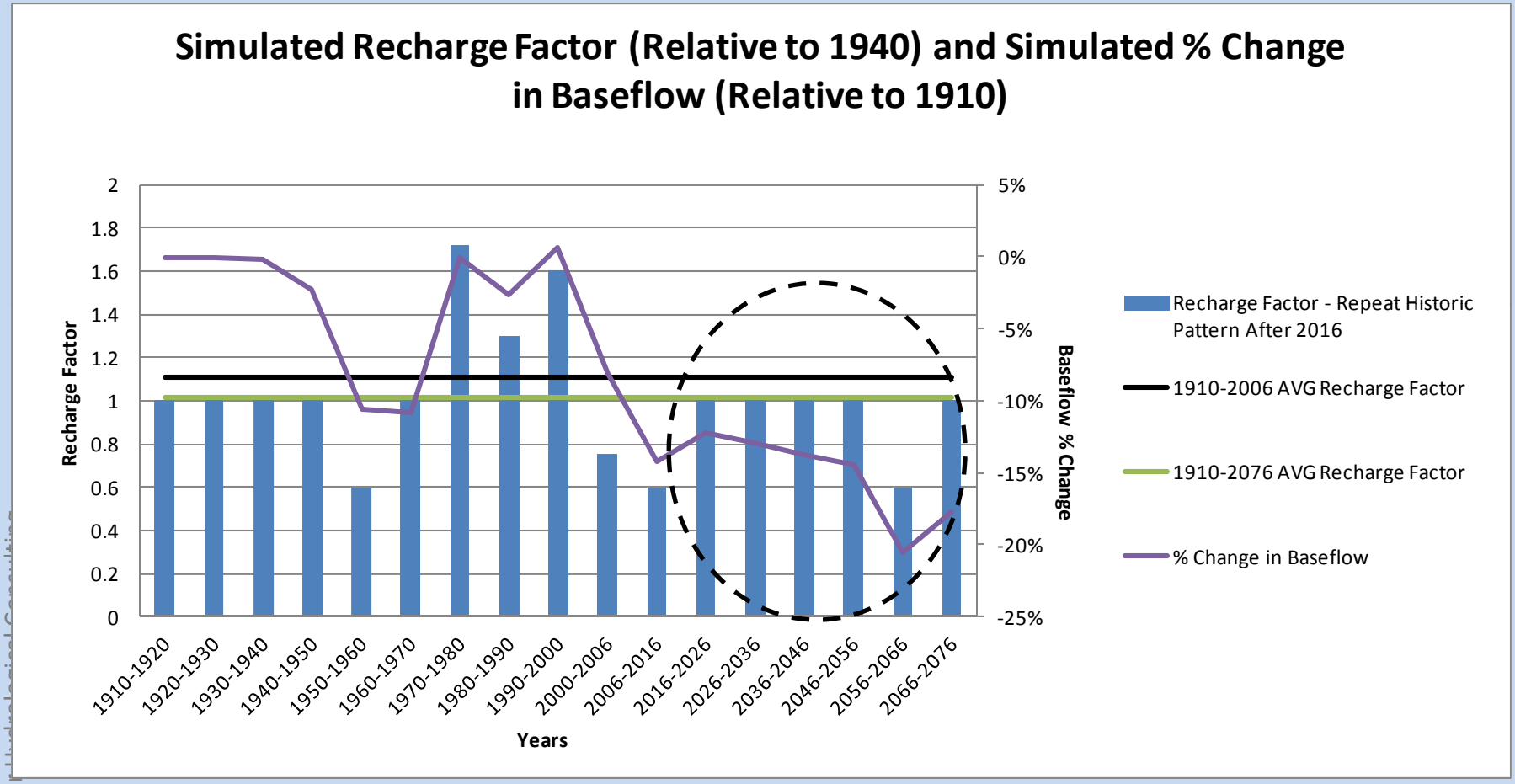
Simulated Recharge Factor (Relative to 1940) and Simulated % Change in Baseflow (Relative to 1910)
Recharge Factor
Baseflow % Change
Years
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
5%
0%
-5%
-10%
-15%
-20%
-25%
1910-1920
1920-1930
1930-1940
1940-1950
1950-1960
1960-1970
1970-1980
1980-1990
1990-2000
2000-2006
2006-2016
2016-2026
2026-2036
2036-2046
2046-2056
2056-2066
2066-2076
Recharge Factor - Repeat Historic Pattern After 2016
1910-2006 AVG Recharge Factor
1910-2076 AVG Recharge Factor
% Change in Baseflow

Take-Aways

- Baseflows in the middle Verde have declined by about 8% over the past century and are likely to decline at least 10% more by 2076.
- Baseflows are sensitive to recharge and pumping, but pumping impacts will become more significant in the future (even without increased pumping).
- Haskell Springs/SW Clarkdale area is hydrologically sensitive.

Thank you!

Lacher Hydrological Consulting