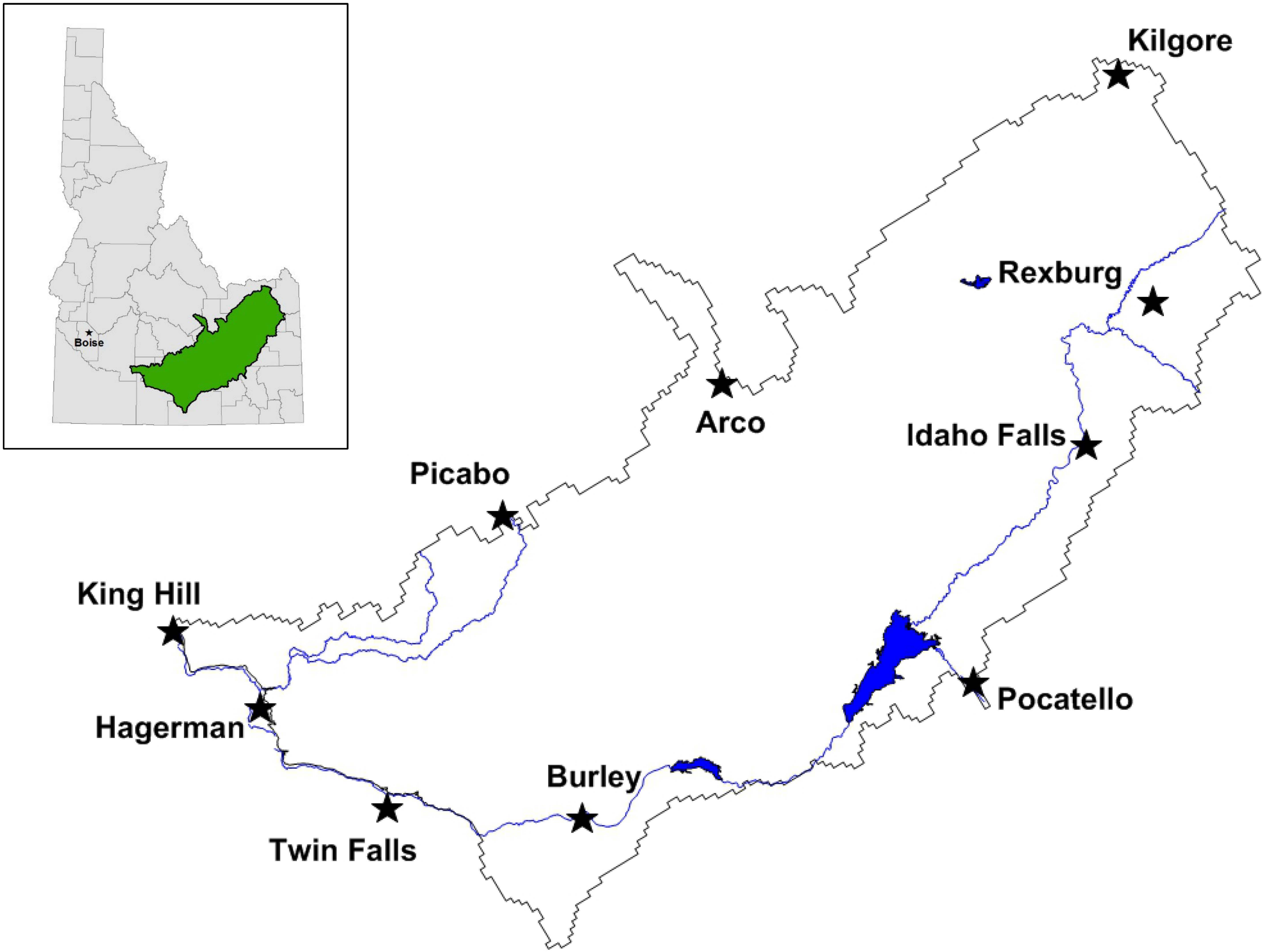
ESPA Storage Changes

Presented by Mike McVay, P.E., P.G.

January 10, 2024


Boise
Kilgore
Rexburg
Arco
Idaho Falls
Picabo
King Hill
Pocatello
Hagerman
Burley
Twin Falls

Aquifer Water Balance

Inflow – Outflow = ΔStorage

ESPA Inflows = Incidental recharge from SW irrigation, Canal Seepage, Perched River Seepage, Tributary Underflow, Precipitation.

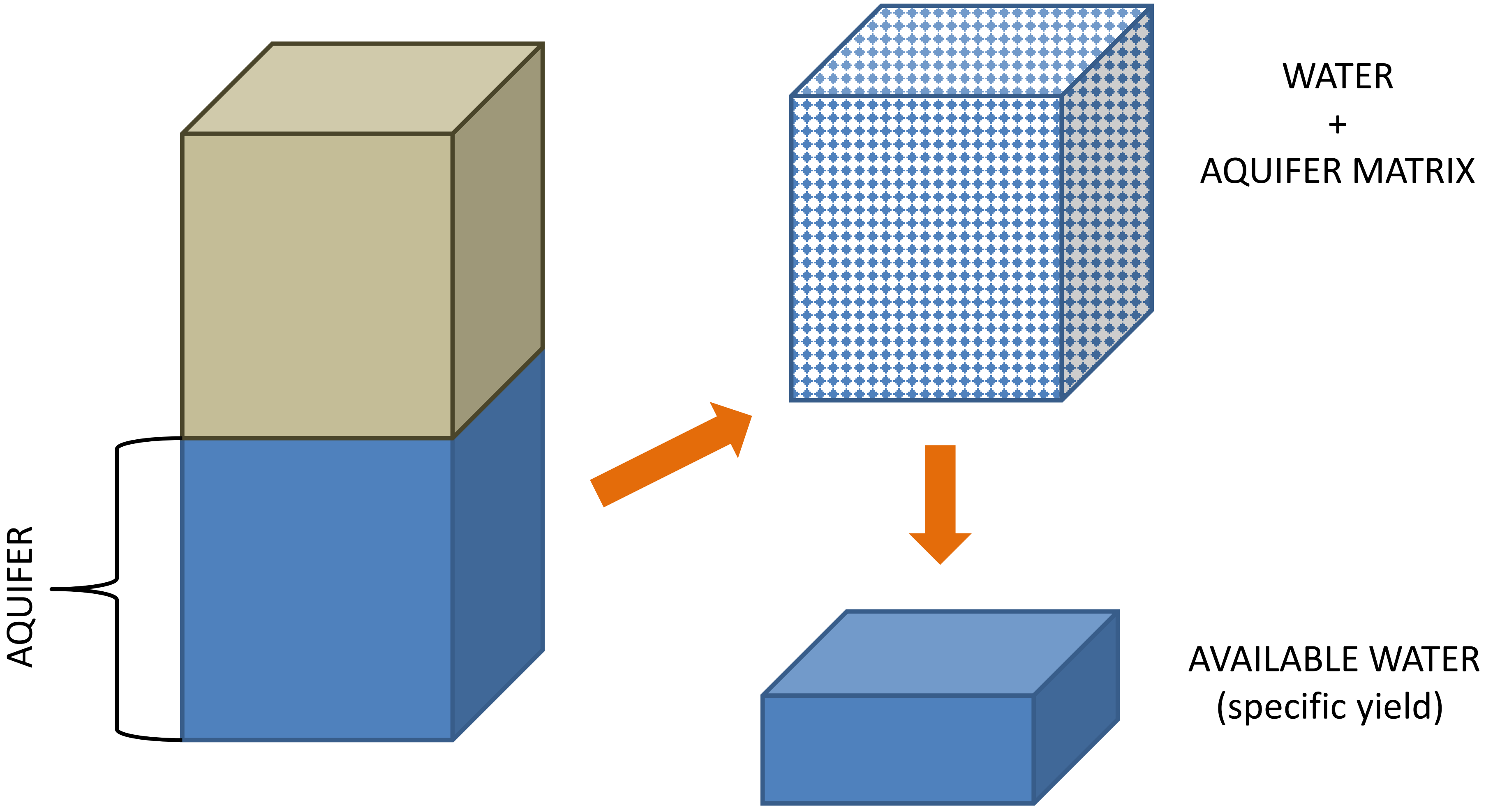
ESPA Outflows = Evapotranspiration, Spring Discharge, Well Pumping

- Requires large investment of time, money and effort.
- A more efficient method of calculating change-in-storage allows us to evaluate both aquifer conditions and aquifer management activities.
- Direct calculation of change-in-storage using water-level measurements.

Using Water-Level Data to Estimate Changes in Aquifer Storage

- Water-level changes are calculated for each of the wells.
- Changes at the wells are interpolated across the **ESPAM version 2.2** (ESPAM2.2) model area to create water-level change maps.
  - The resulting volume represents water and aquifer matrix.
- Specific Yield (Sy) is the ratio of the volume of water that drains from a saturated rock due to gravity to the total volume of the rock.

Specific Yield = Available Water



Using Water-Level Data to Estimate Changes in Aquifer Storage

- Water-level data are differenced to produce water-level changes at discrete points (at the wells).
- Changes at the wells are interpolated across the ESPAM2.2 model area to create water-level change maps.
  - The resulting volume represents water and aquifer matrix.
- ✓ The volumes calculated above are multiplied by the average, calibrated Sy from EPAM2.2 to calculate the change in volume of water.

Mass Measurements and Aquifer Storage Changes

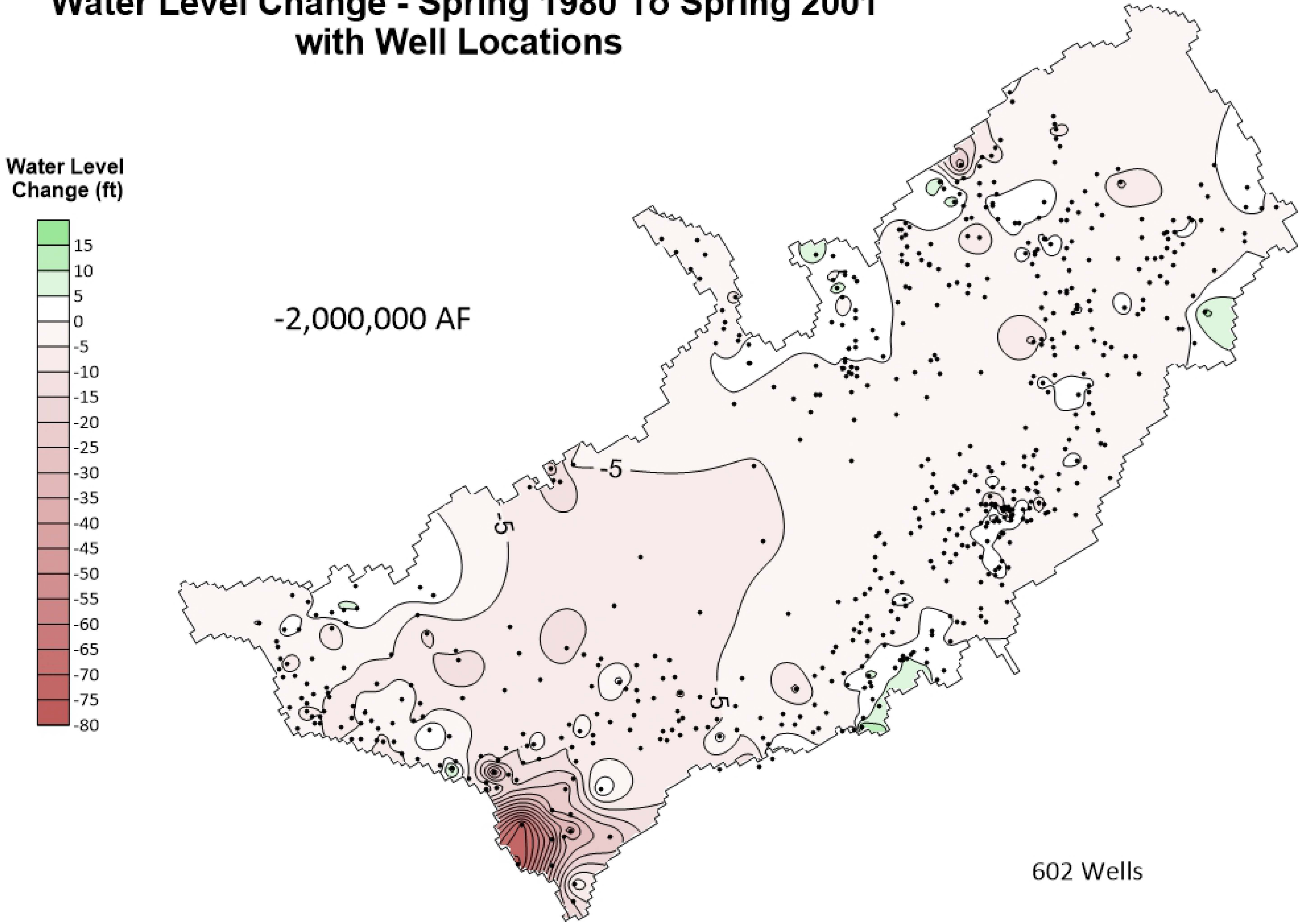
- Storage change calculations are based on data collected during mass measurement events.
- Mass measurement events are designed to collect as much data as possible during a brief window of time.
  - Provides a snapshot of the aquifer.
- Mass measurement events take place annually in the **spring**.

Rationale for using Spring-Season Water Levels

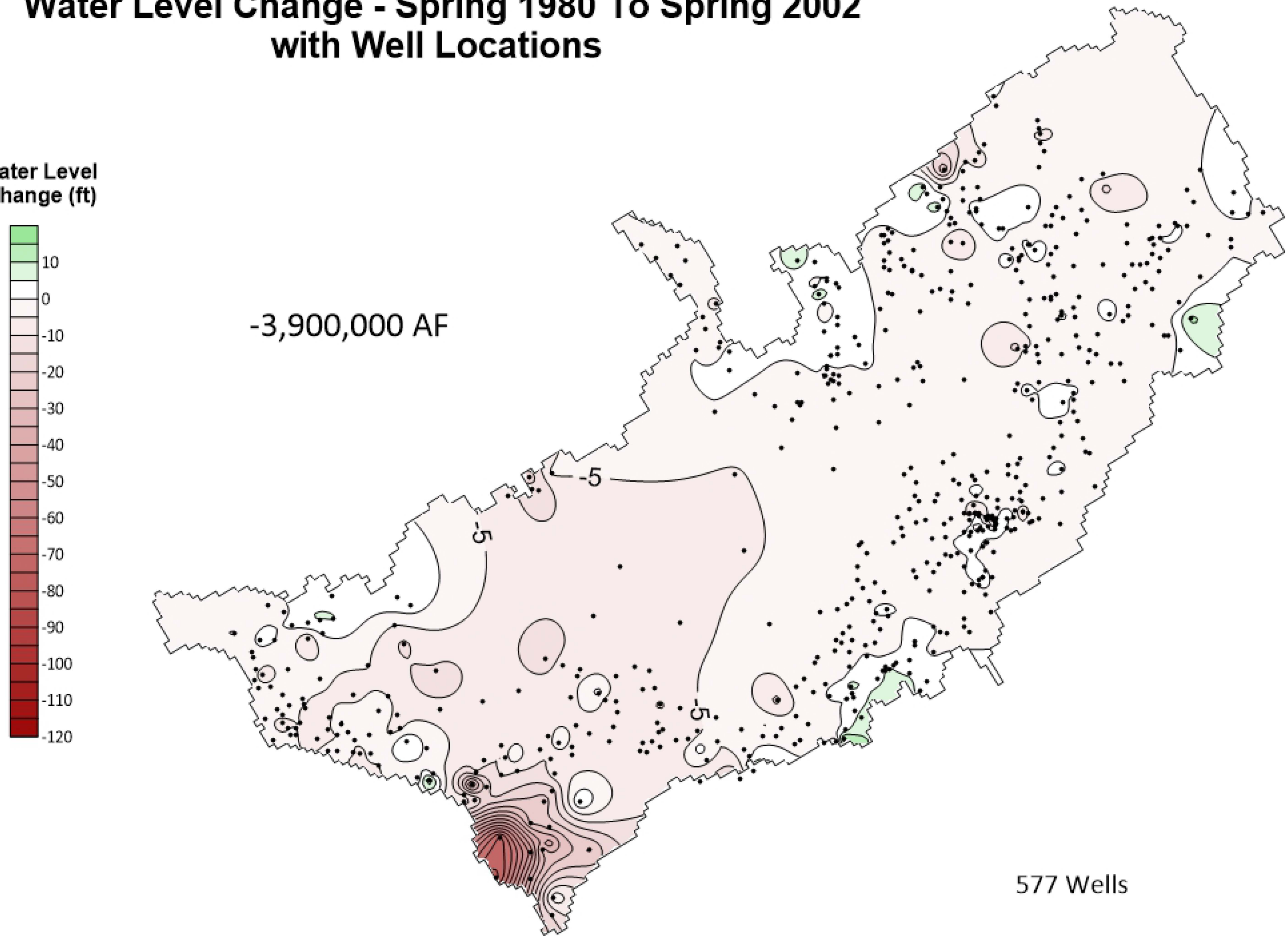
- Conducting measurement events in the spring:
  - Integrates the impacts due to irrigation-season activities into a resulting condition (annual aquifer storage change).
  - Maximizes the time between irrigation seasons.
  - Pre-irrigation measurements reduce the impact of local water use on water levels (unperturbed water table).

Mass Measurement Change Maps

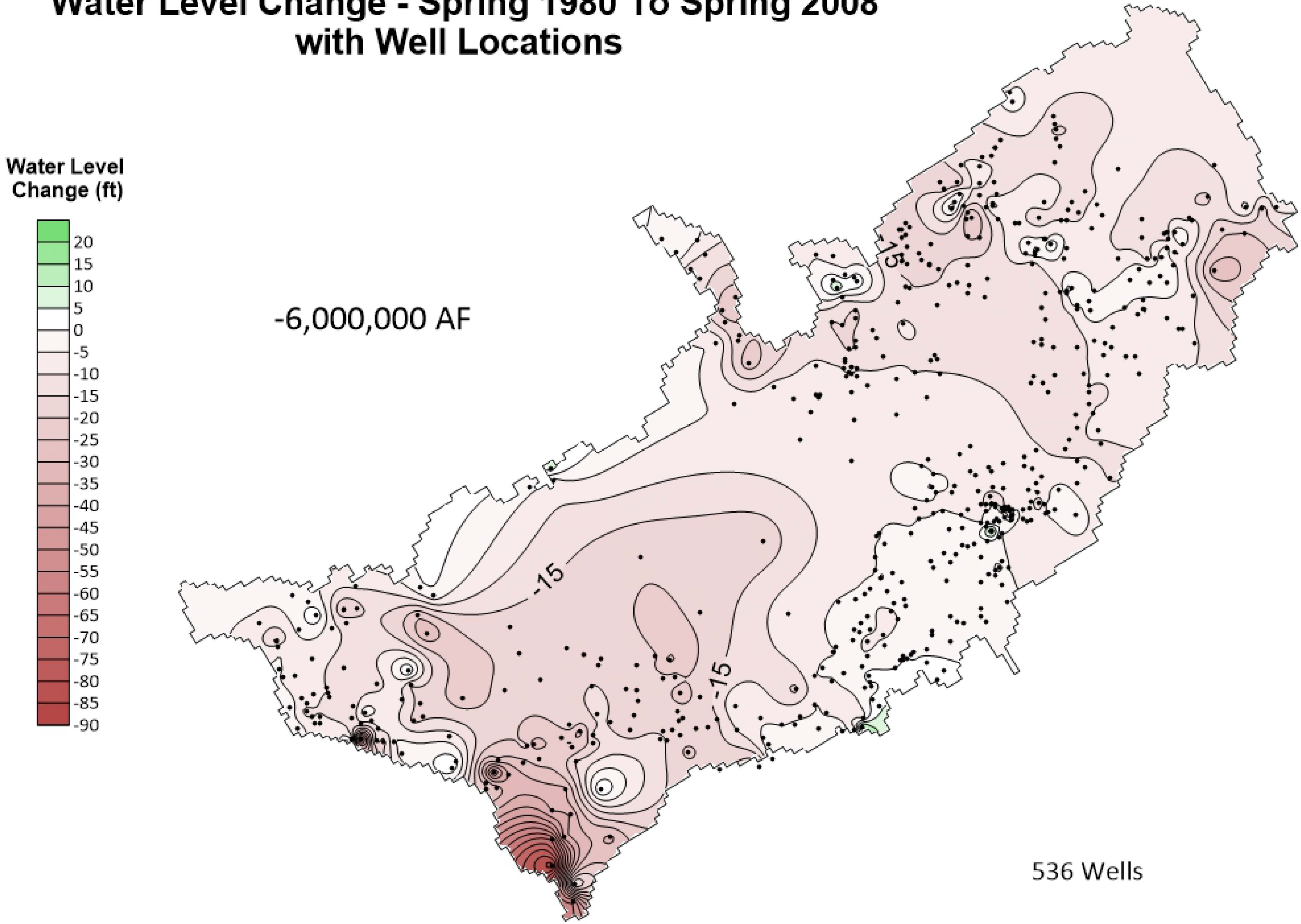
Water Level Change - Spring 1980 To Spring 2001 with Well Locations



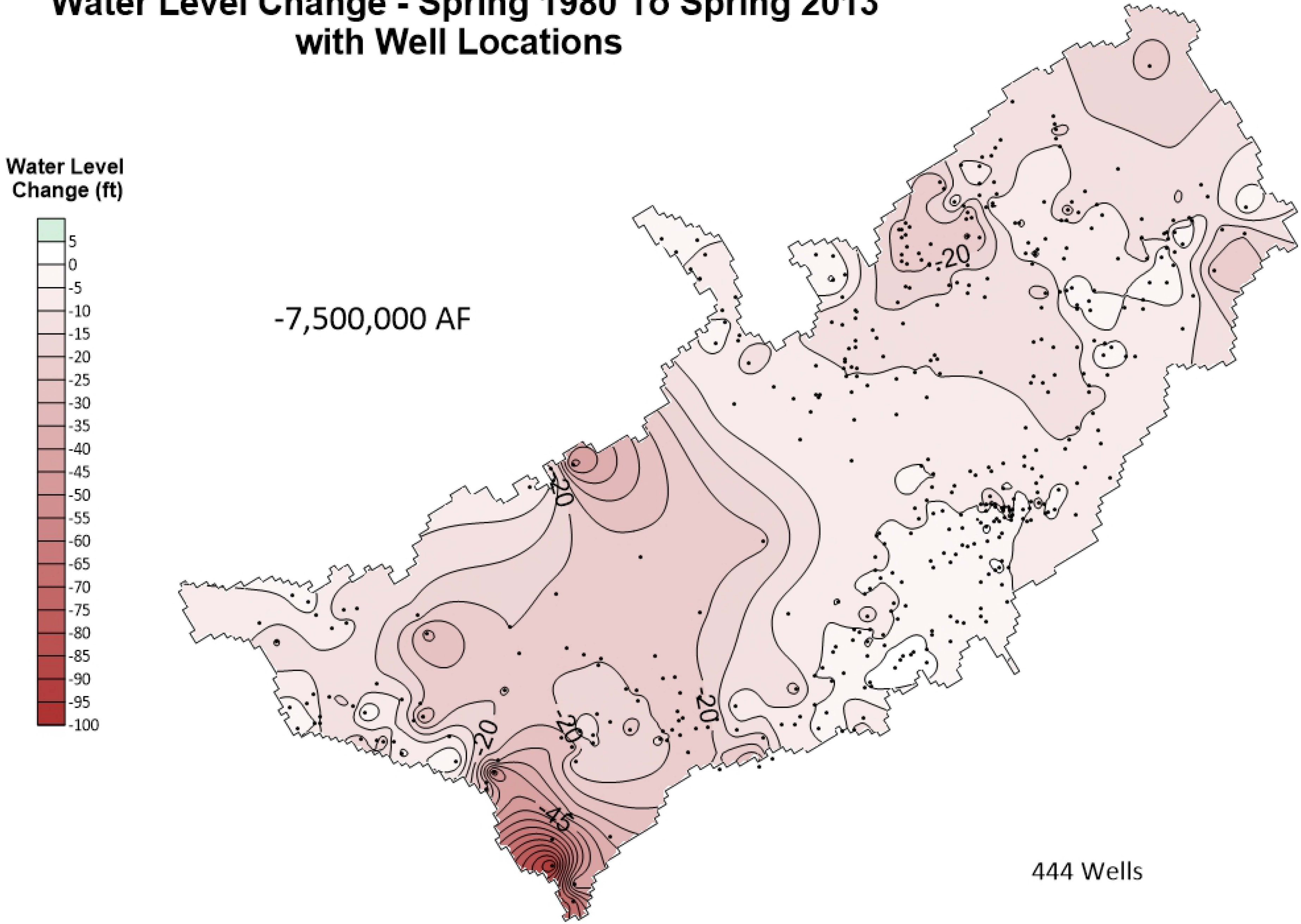
Water Level Change - Spring 1980 To Spring 2002 with Well Locations



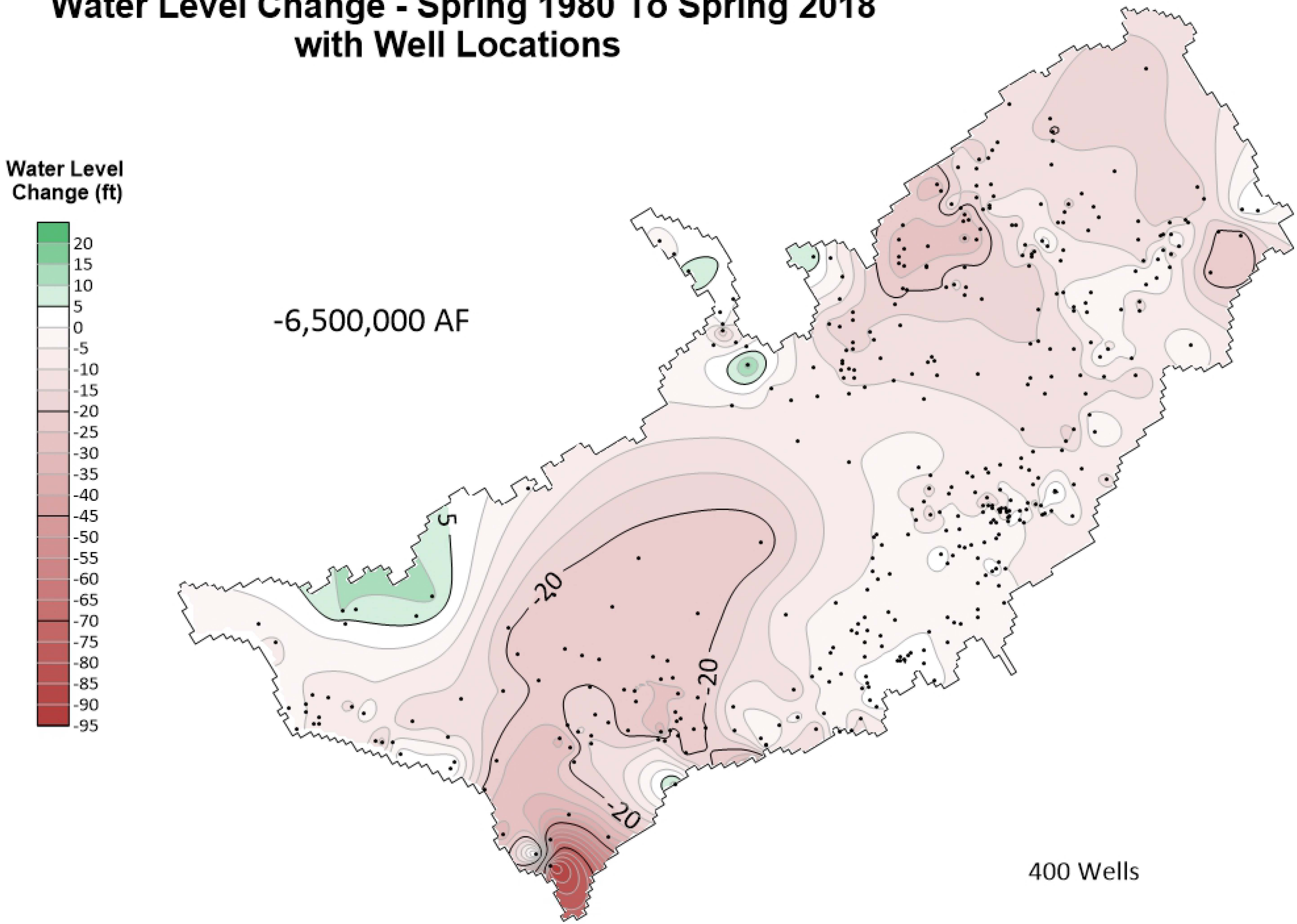
Water Level Change - Spring 1980 To Spring 2008 with Well Locations



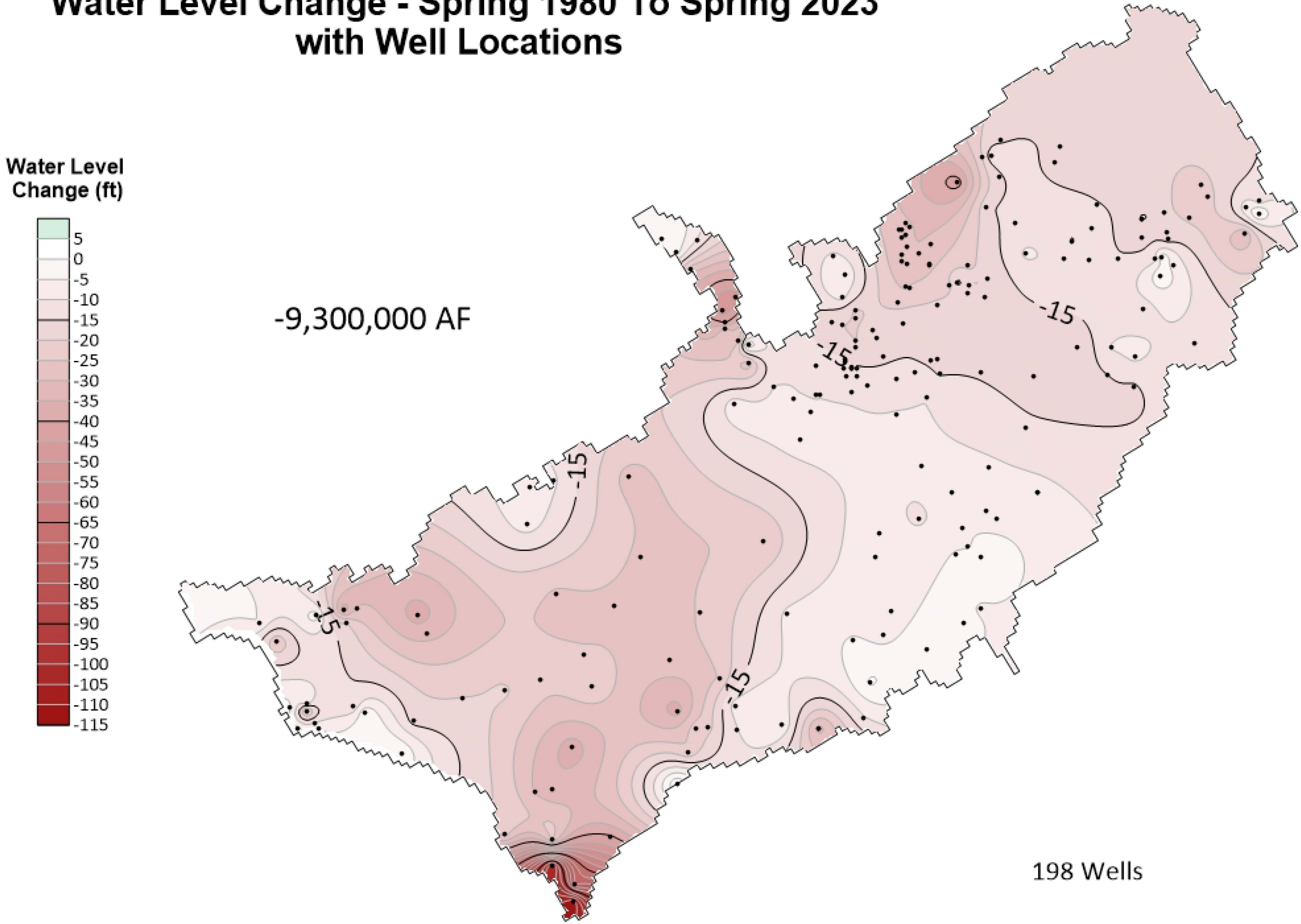
Water Level Change - Spring 1980 To Spring 2013 with Well Locations



Water Level Change - Spring 1980 To Spring 2018 with Well Locations

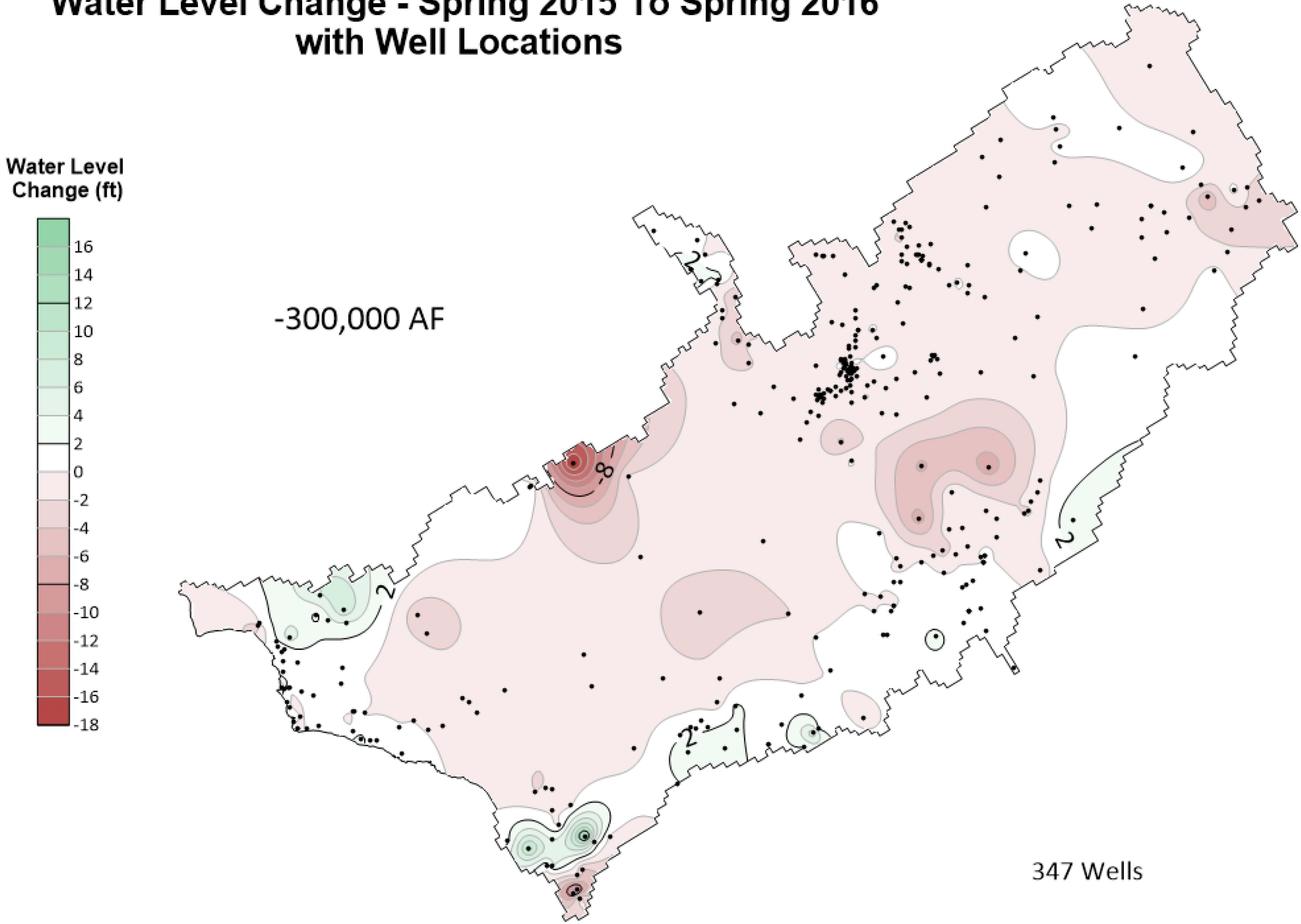


Water Level Change - Spring 1980 To Spring 2023 with Well Locations

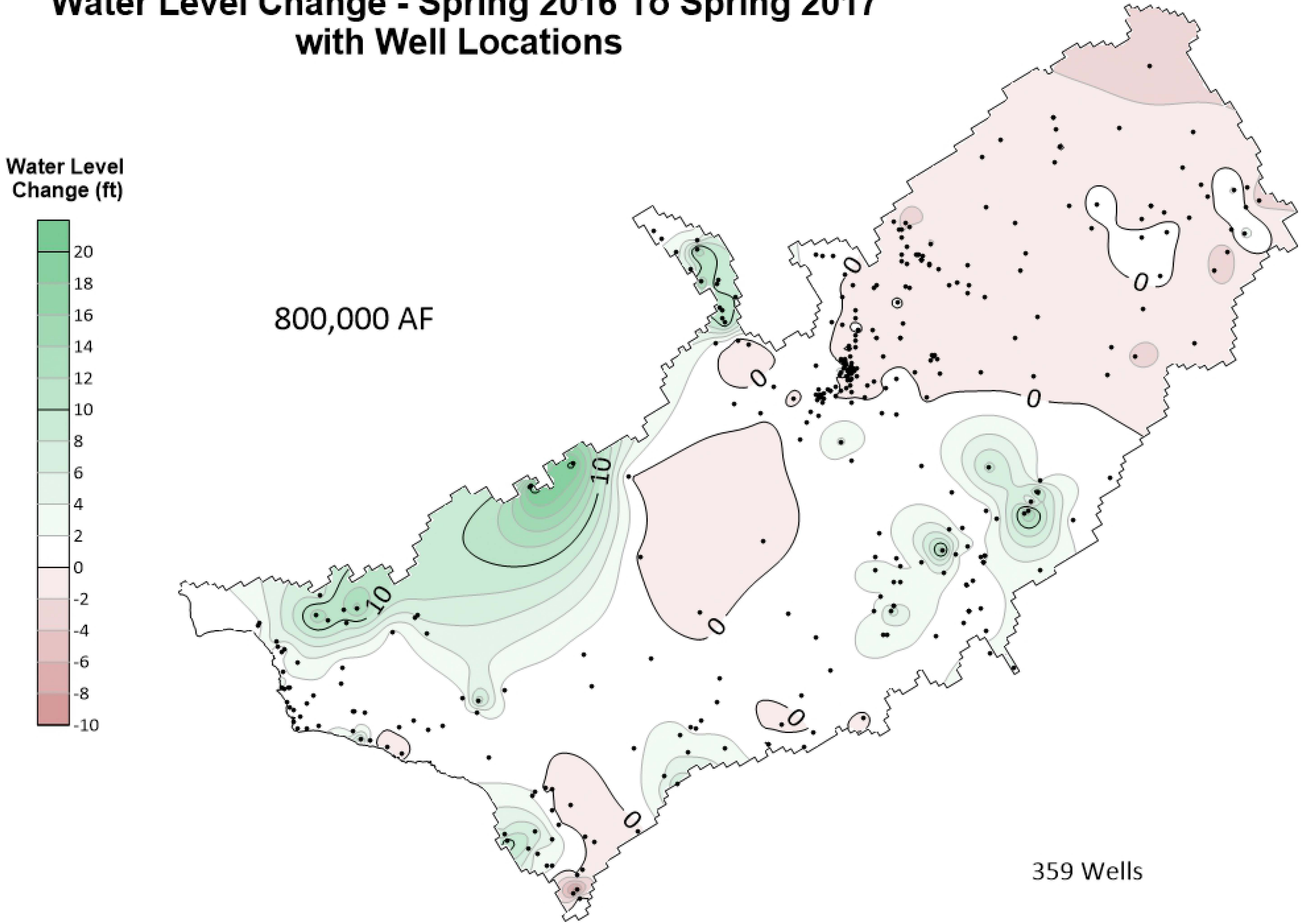


Annual Measurement Change Maps: 2015 – 2023

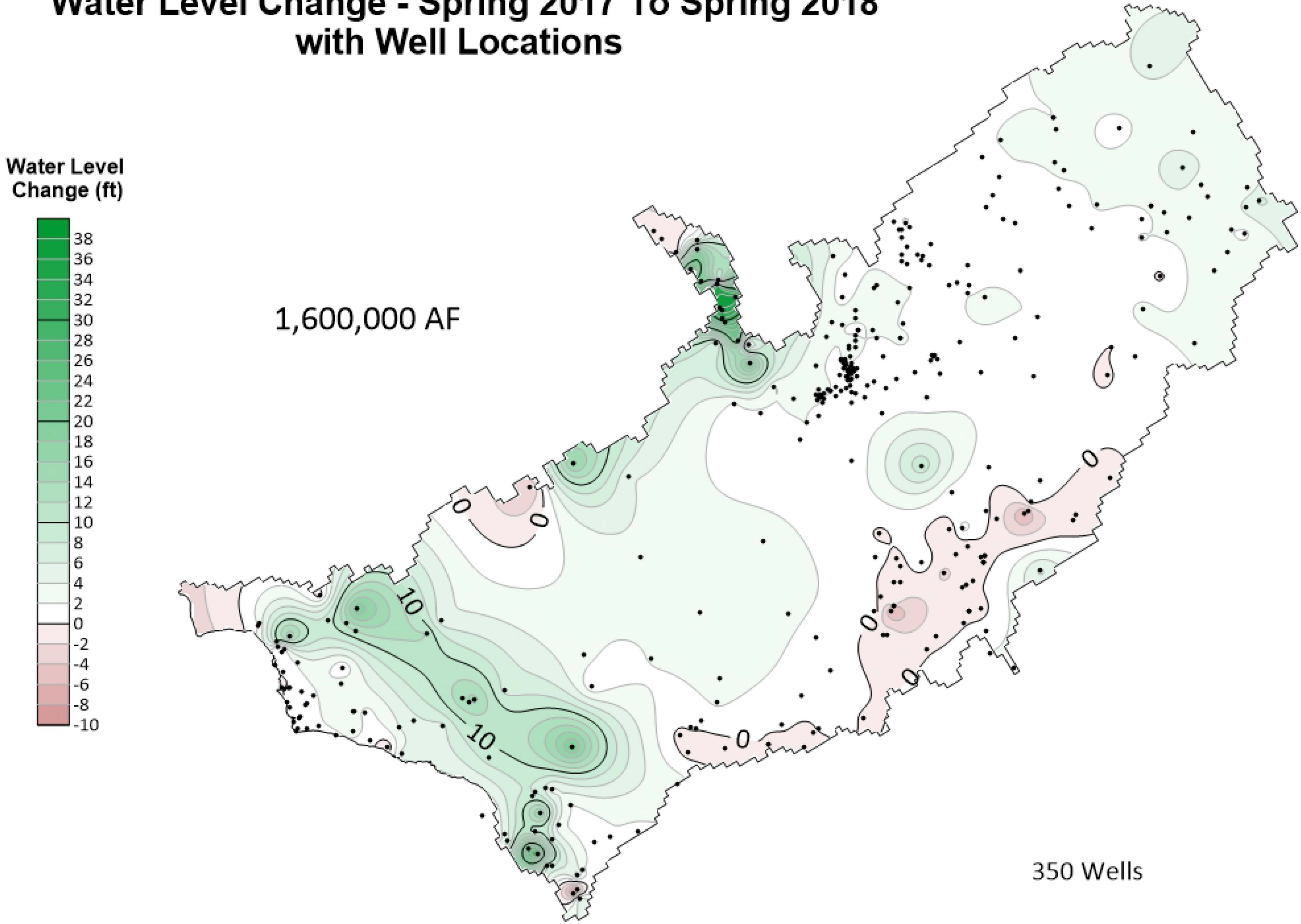
Water Level Change - Spring 2015 To Spring 2016 with Well Locations



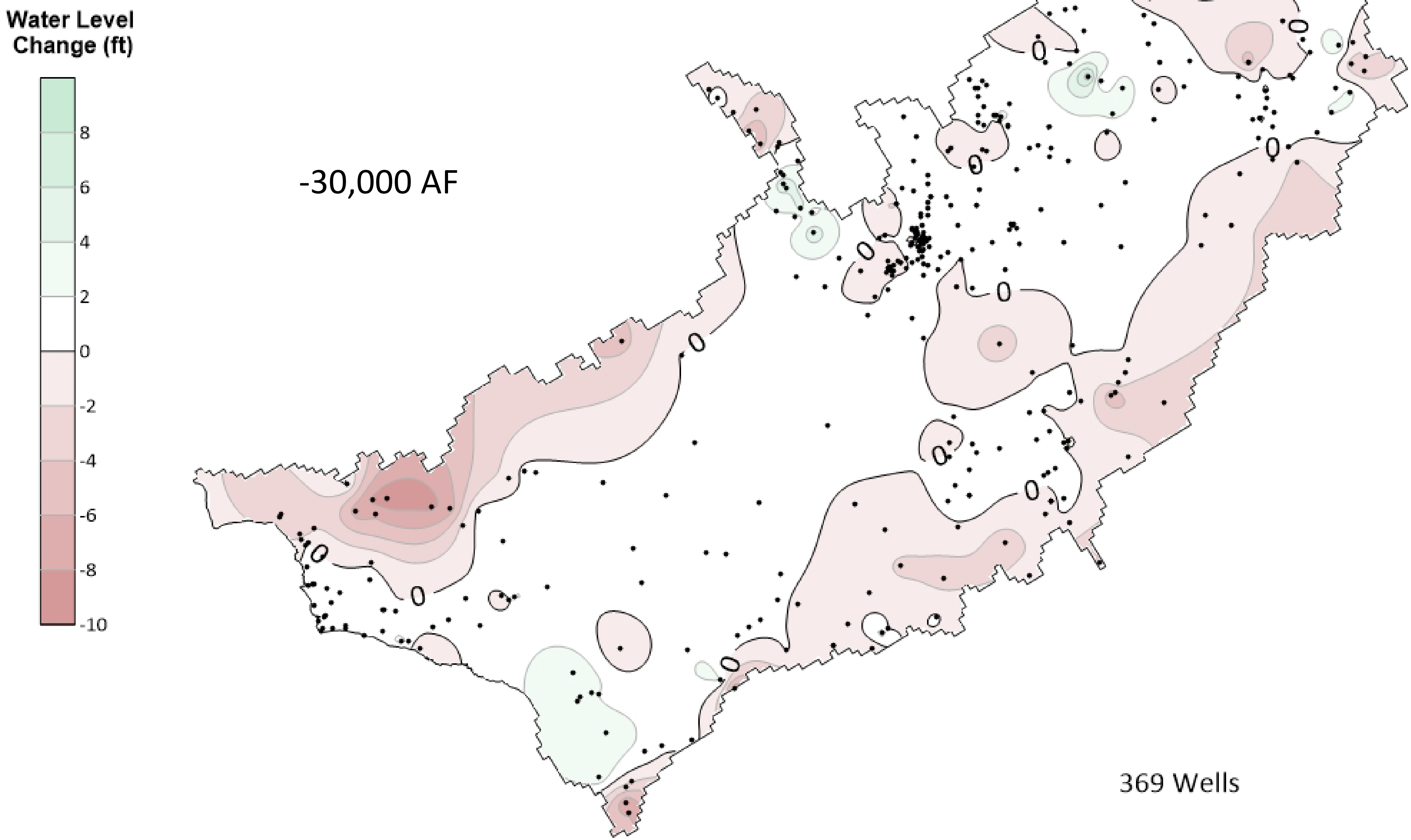
Water Level Change - Spring 2016 To Spring 2017 with Well Locations



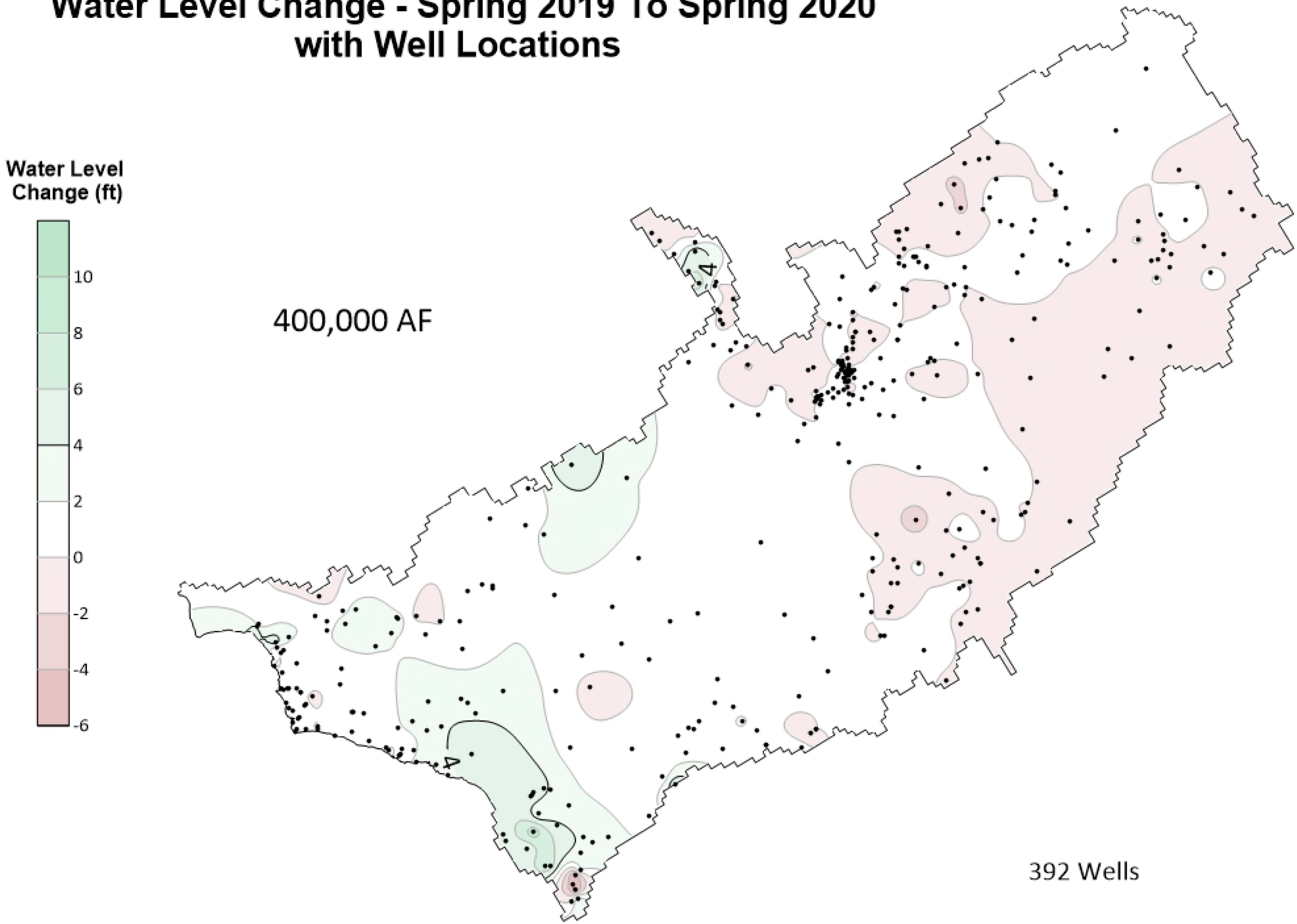
Water Level Change - Spring 2017 To Spring 2018 with Well Locations



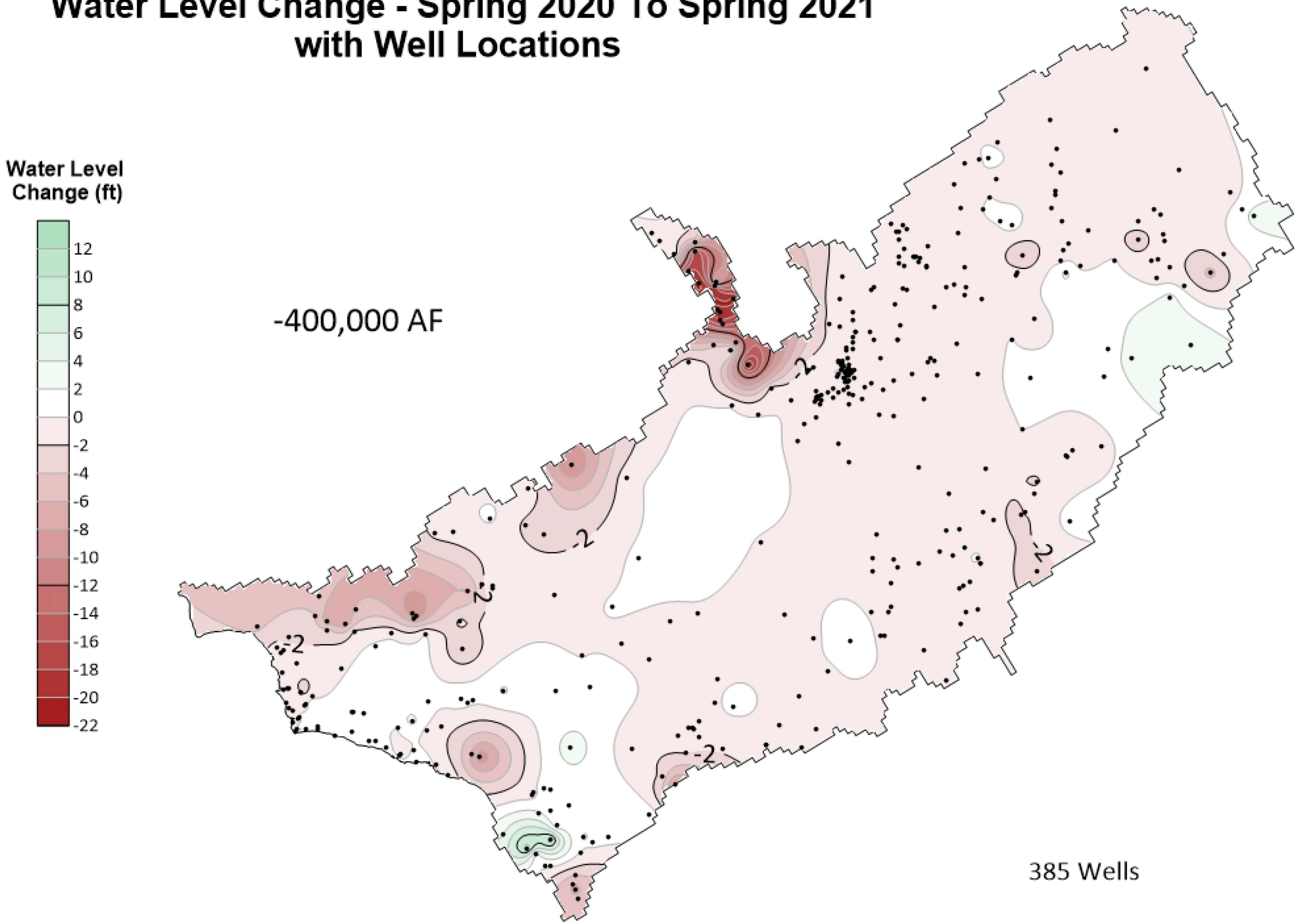
Water Level Change - Spring 2018 To Spring 2019 with Well Locations



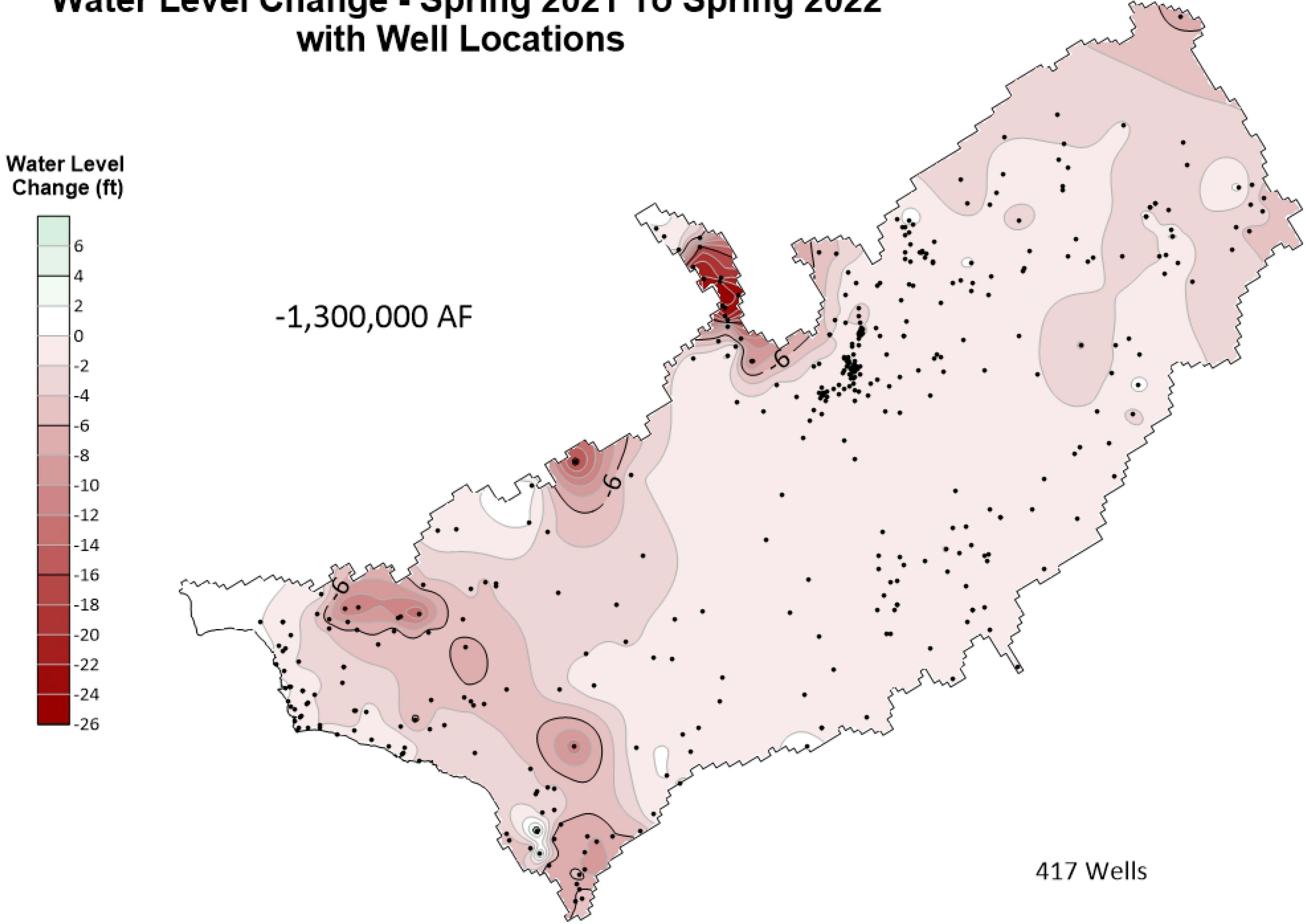
Water Level Change - Spring 2019 To Spring 2020 with Well Locations



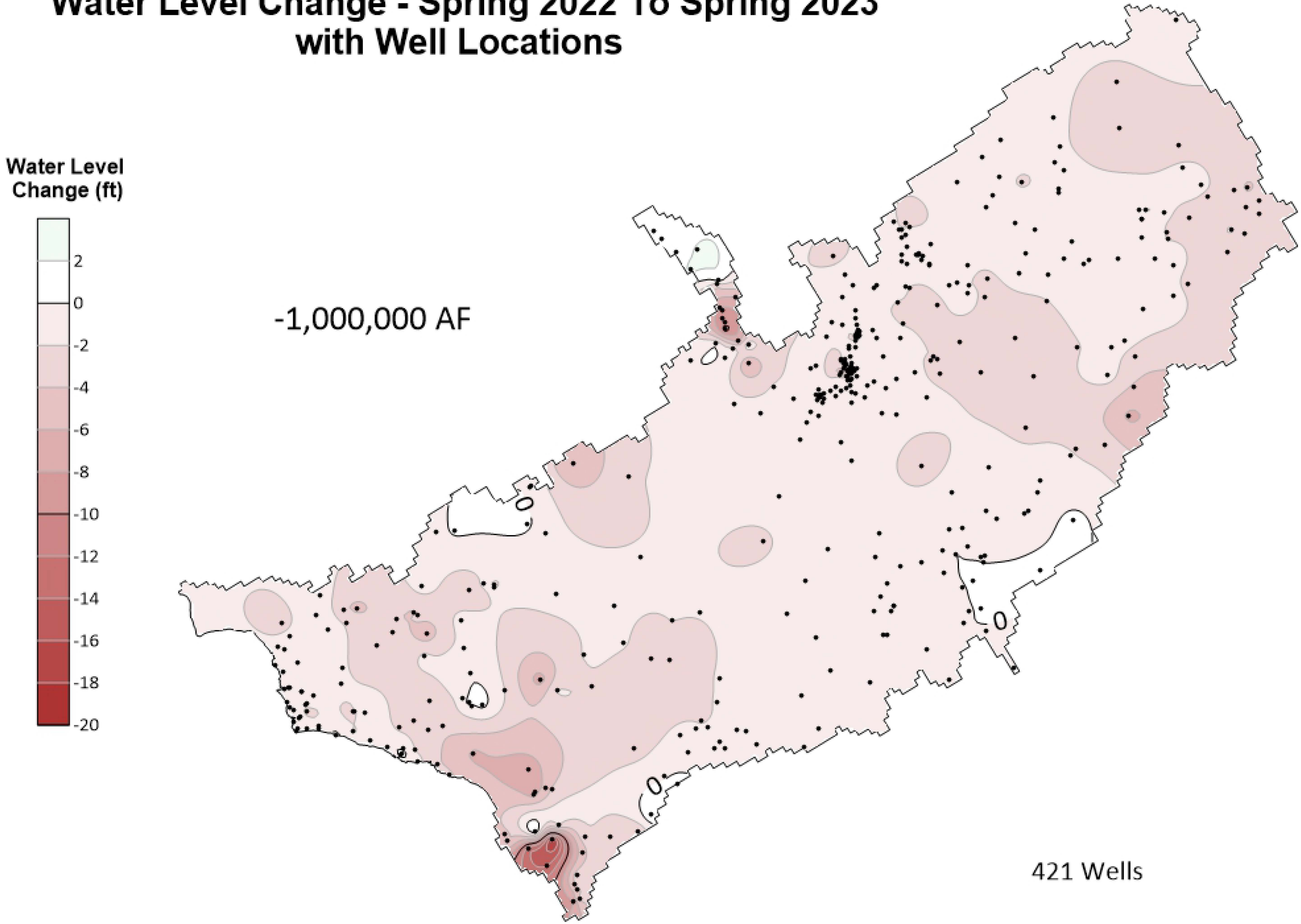
Water Level Change - Spring 2020 To Spring 2021 with Well Locations



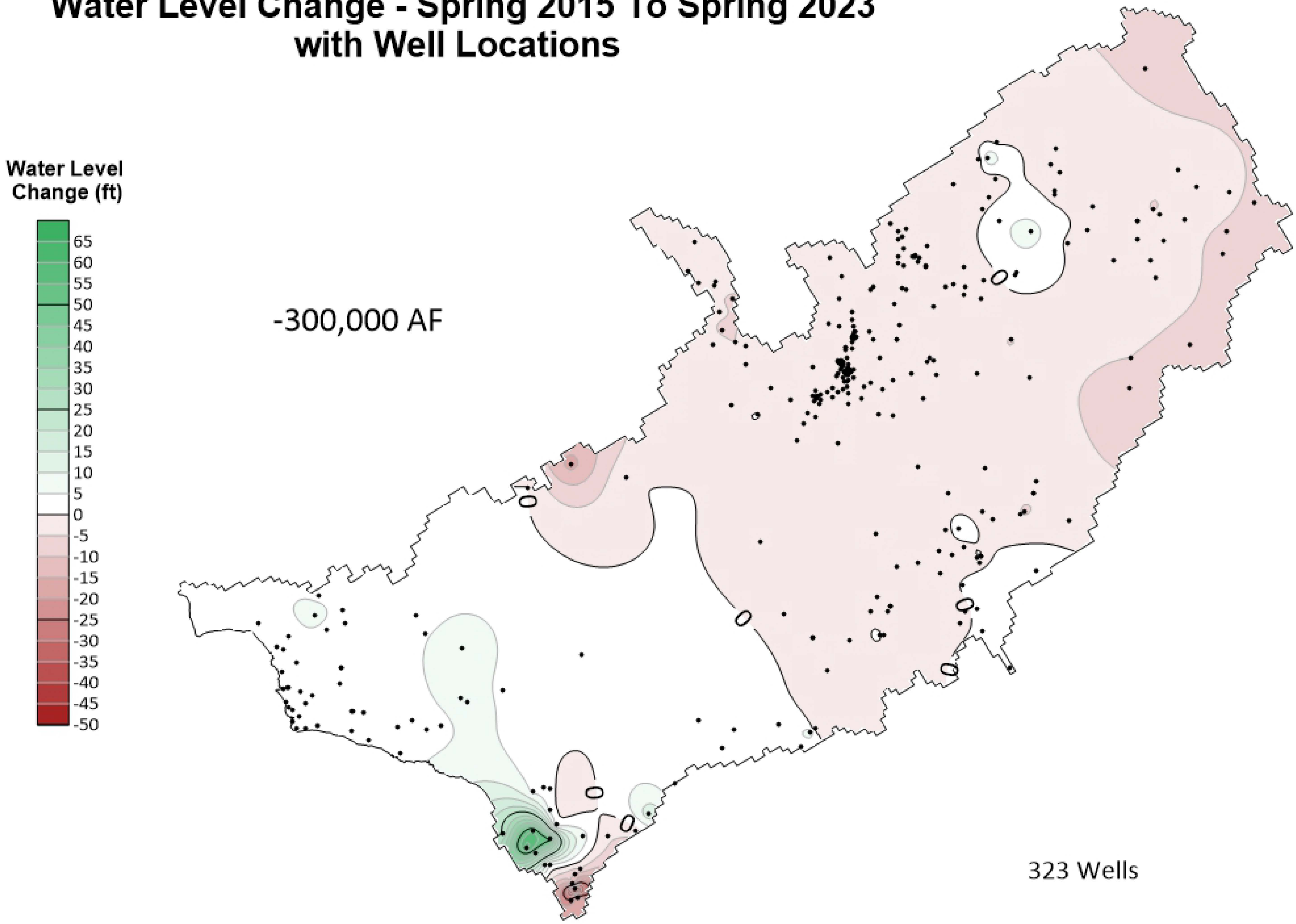
Water Level Change - Spring 2021 To Spring 2022 with Well Locations

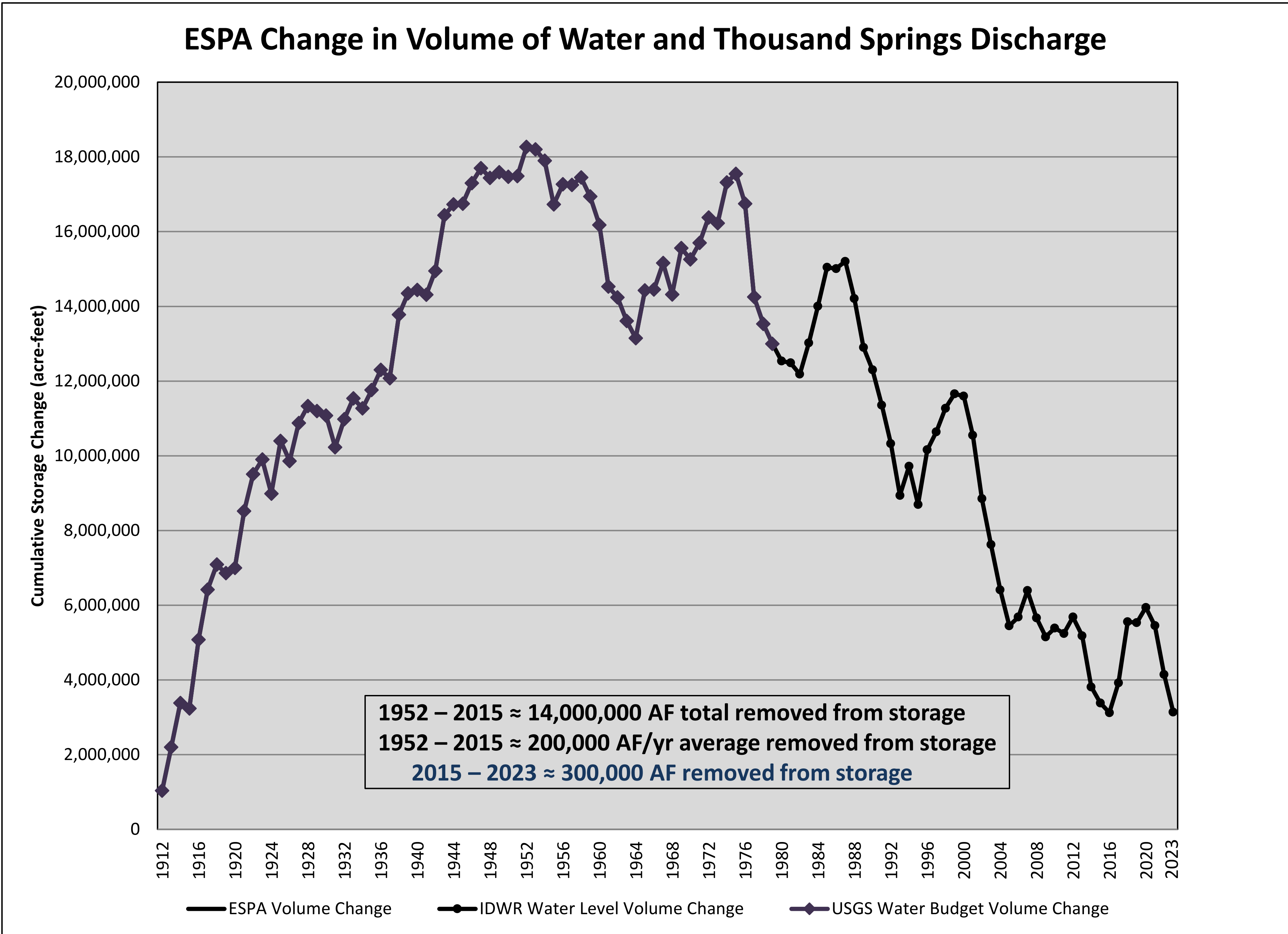


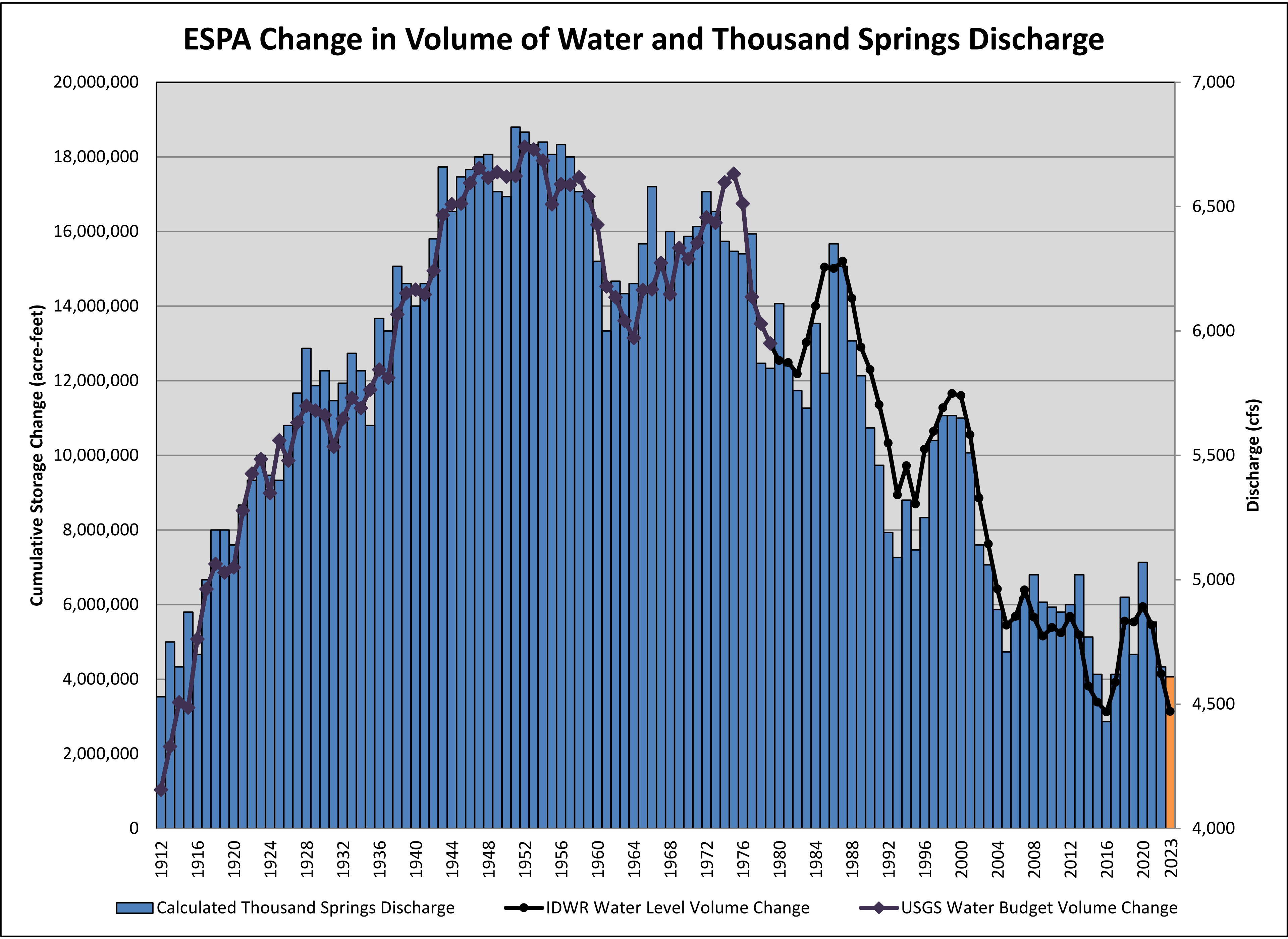
Water Level Change - Spring 2022 To Spring 2023 with Well Locations



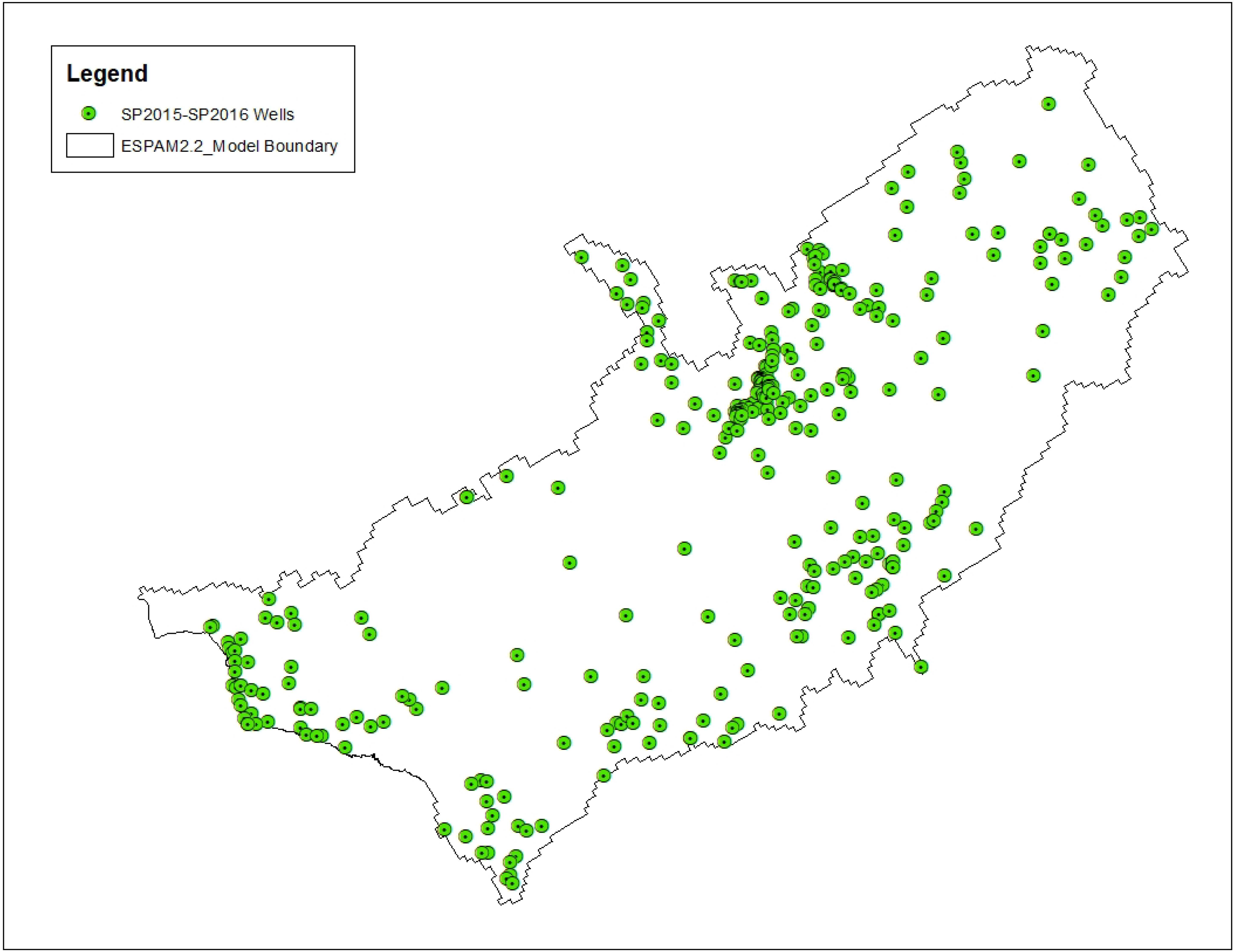
Water Level Change - Spring 2015 To Spring 2023 with Well Locations

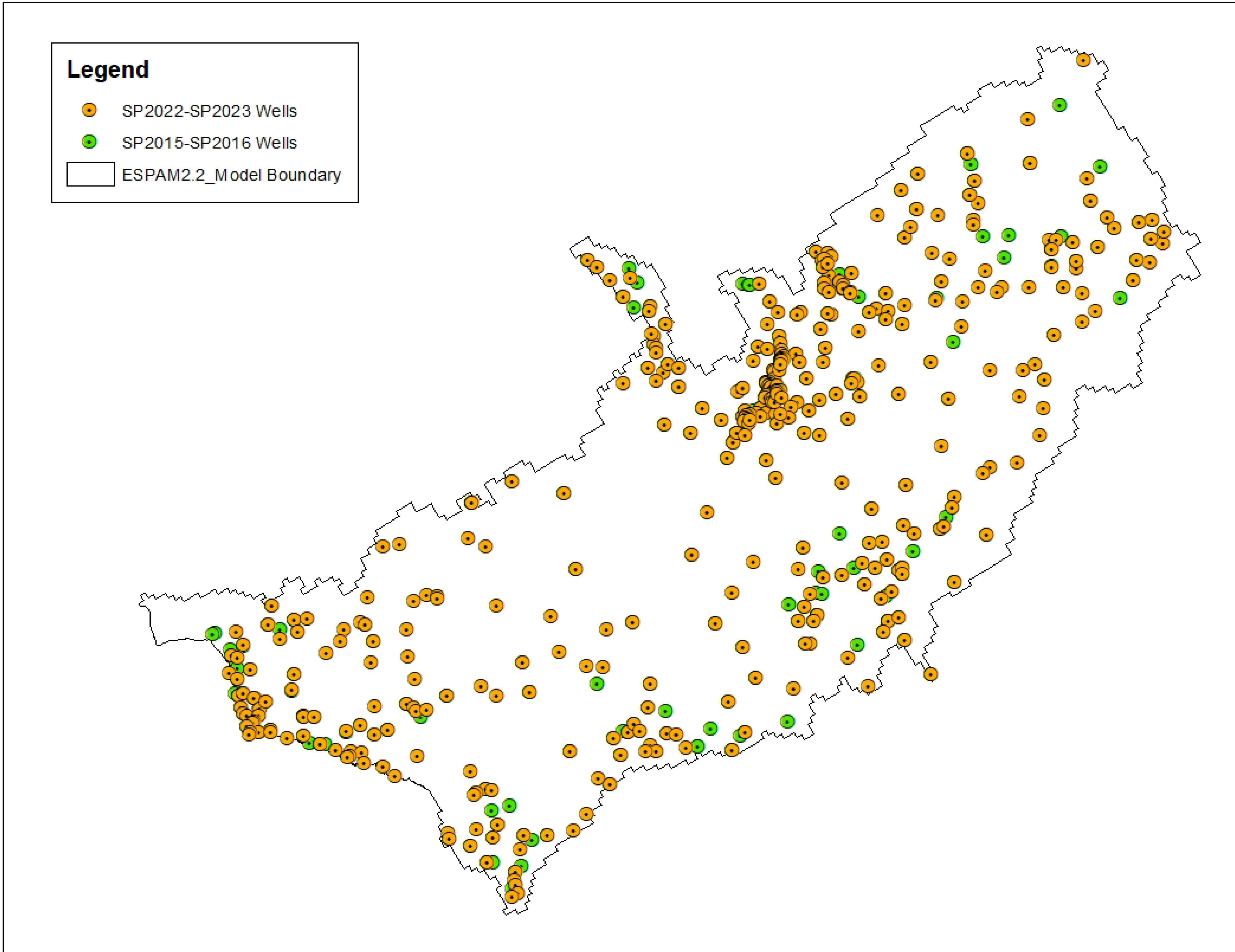


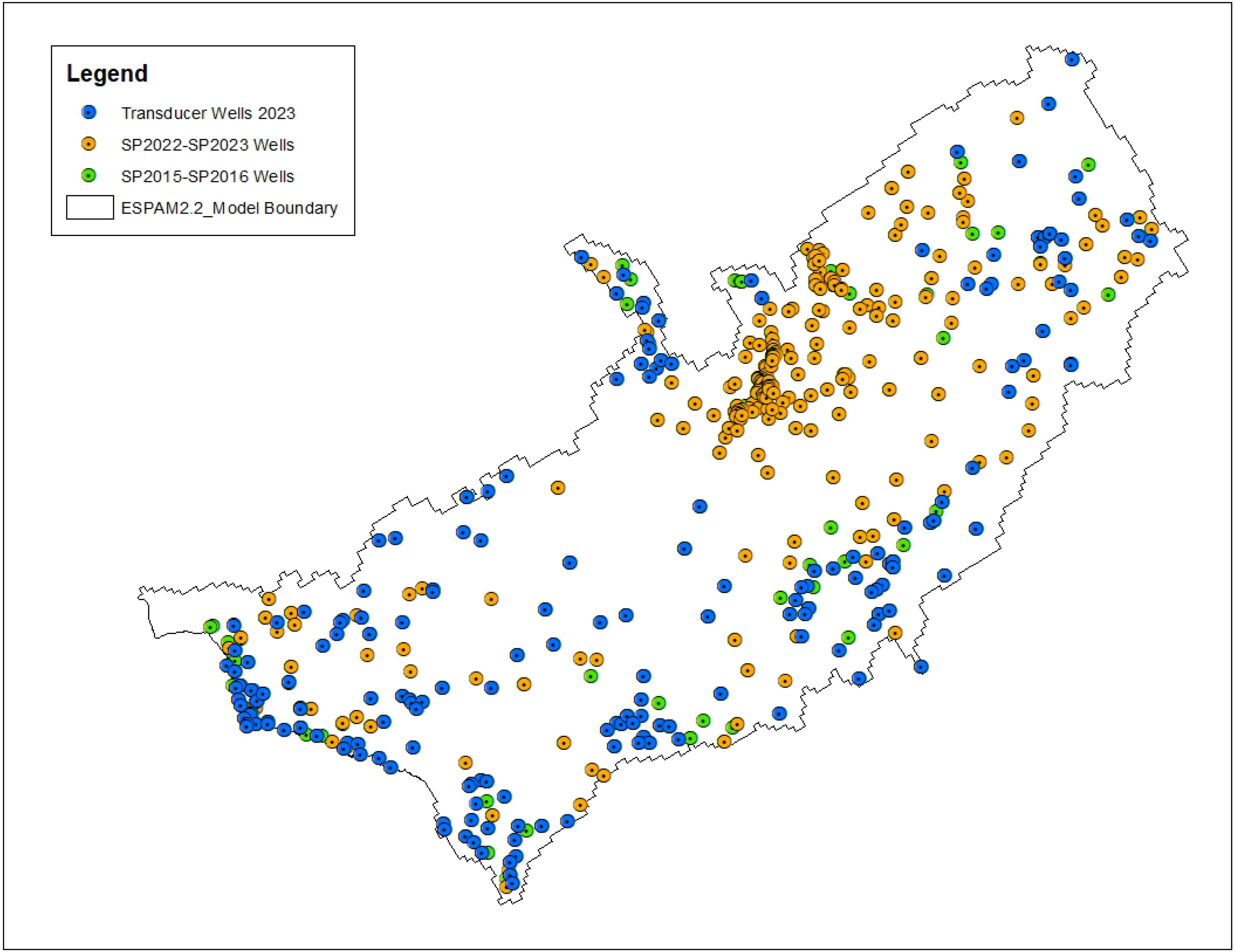

ESPA Change in Volume of Water and Thousand Springs Discharge
Cumulative Storage Change (acre-feet)
20,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
2023
1952 – 2015 ≈ 14,000,000 AF total removed from storage
1952 – 2015 ≈ 200,000 AF/yr average removed from storage
2015 – 2023 ≈ 300,000 AF removed from storage
ESPA Volume Change
IDWR Water Level Volume Change
USGS Water Budget Volume Change


ESPA Change in Volume of Water and Thousand Springs Discharge
Cumulative Storage Change (acre-feet)
Discharge (cfs)
0
2,000,000
4,000,000
6,000,000
8,000,000
10,000,000
12,000,000
14,000,000
16,000,000
18,000,000
20,000,000
4,000
4,500
5,000
5,500
6,000
6,500
7,000
1912
1916
1920
1924
1928
1932
1936
1940
1944
1948
1952
1956
1960
1964
1968
1972
1976
1980
1984
1988
1992
1996
2000
2004
2008
2012
2016
2020
2023
Calculated Thousand Springs Discharge
IDWR Water Level Volume Change
USGS Water Budget Volume Change

Water-Level Monitoring Network Continues to Expand


Legend
SP2015-SP2016 Wells
ESPAM2.2_Model Boundary


Legend
SP2022-SP2023 Wells
SP2015-SP2016 Wells
ESPAM2.2_Model Boundary

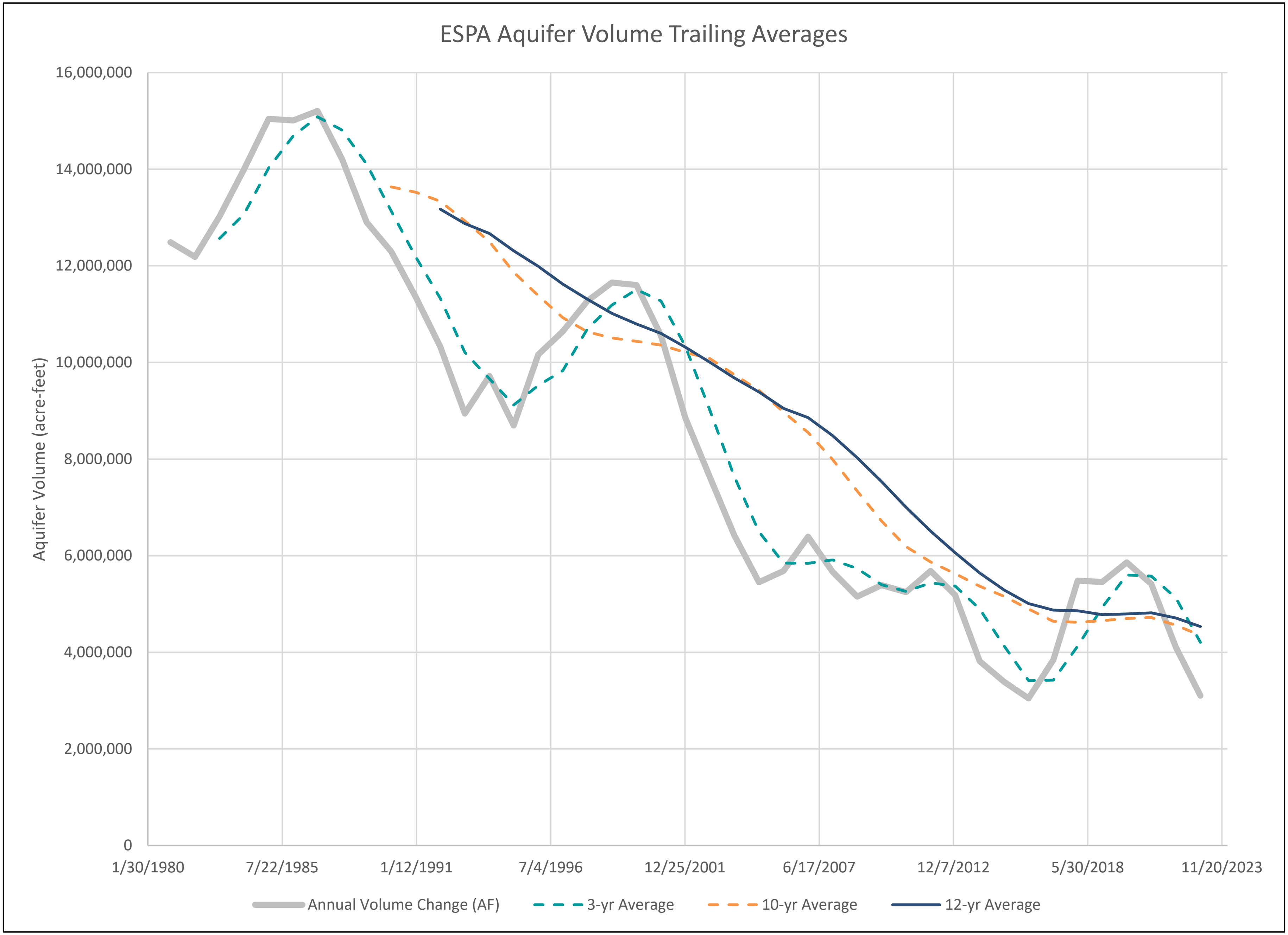

Legend
Transducer Wells 2023
SP2022-SP2023 Wells
SP2015-SP2016 Wells
ESPAM2.2_Model Boundary

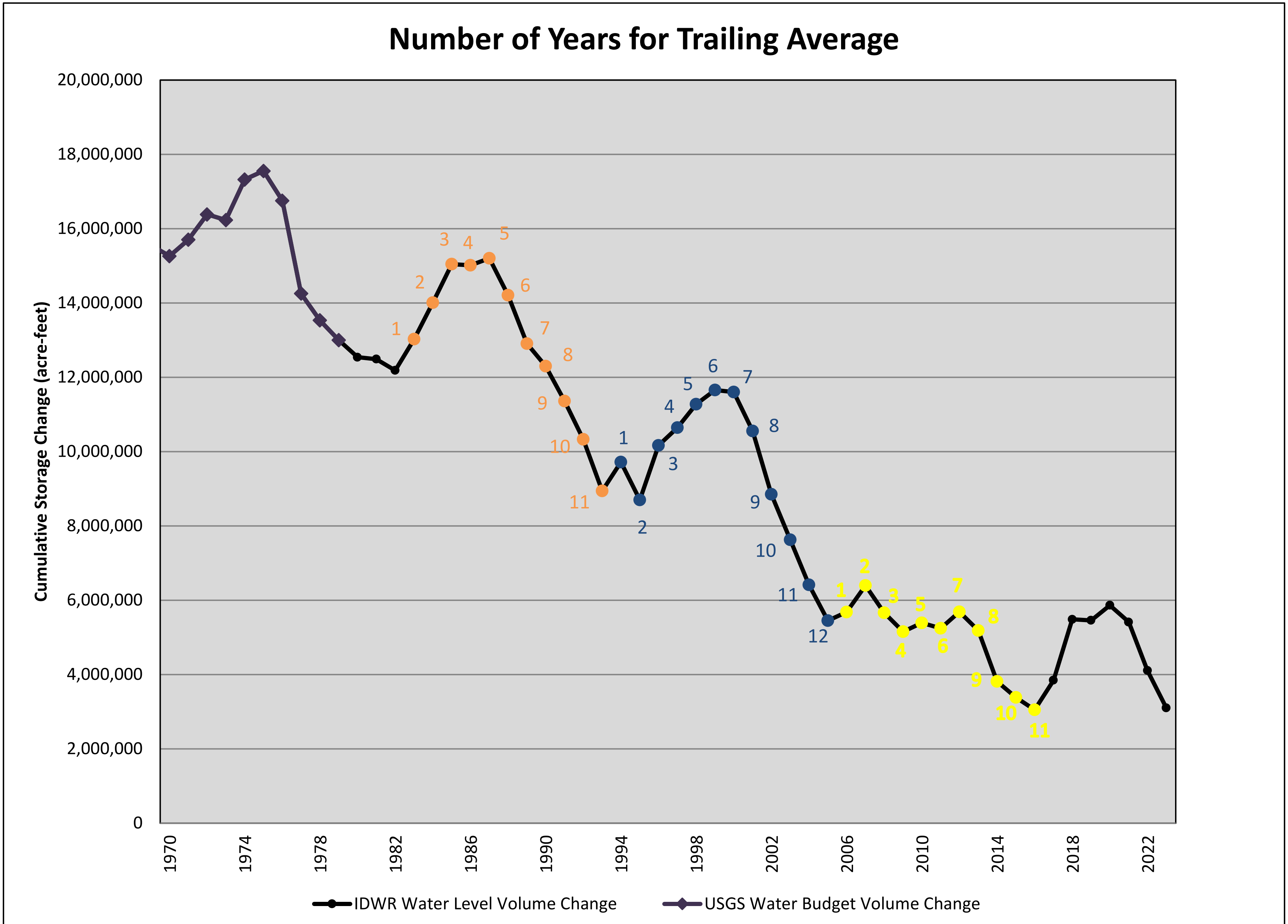
Storage Change Summary

- The aquifer lost 1,000,000 acre-feet from 2022 to 2023.
- The aquifer has lost approximately 300,000 acre-feet of storage since 2015.
- The increase in precipitation in 2016 – 2017 helped us get a good start to a long-term solution.
  - Undulations due to weather are to be expected – 2021 and 2022 were dry years
  - The ESPA leaks, and aquifer-storage gains are fleeting.
  - Perseverance through the dry times is vital to success.

Trailing-Average Index Examples

Aquifer Volume Index

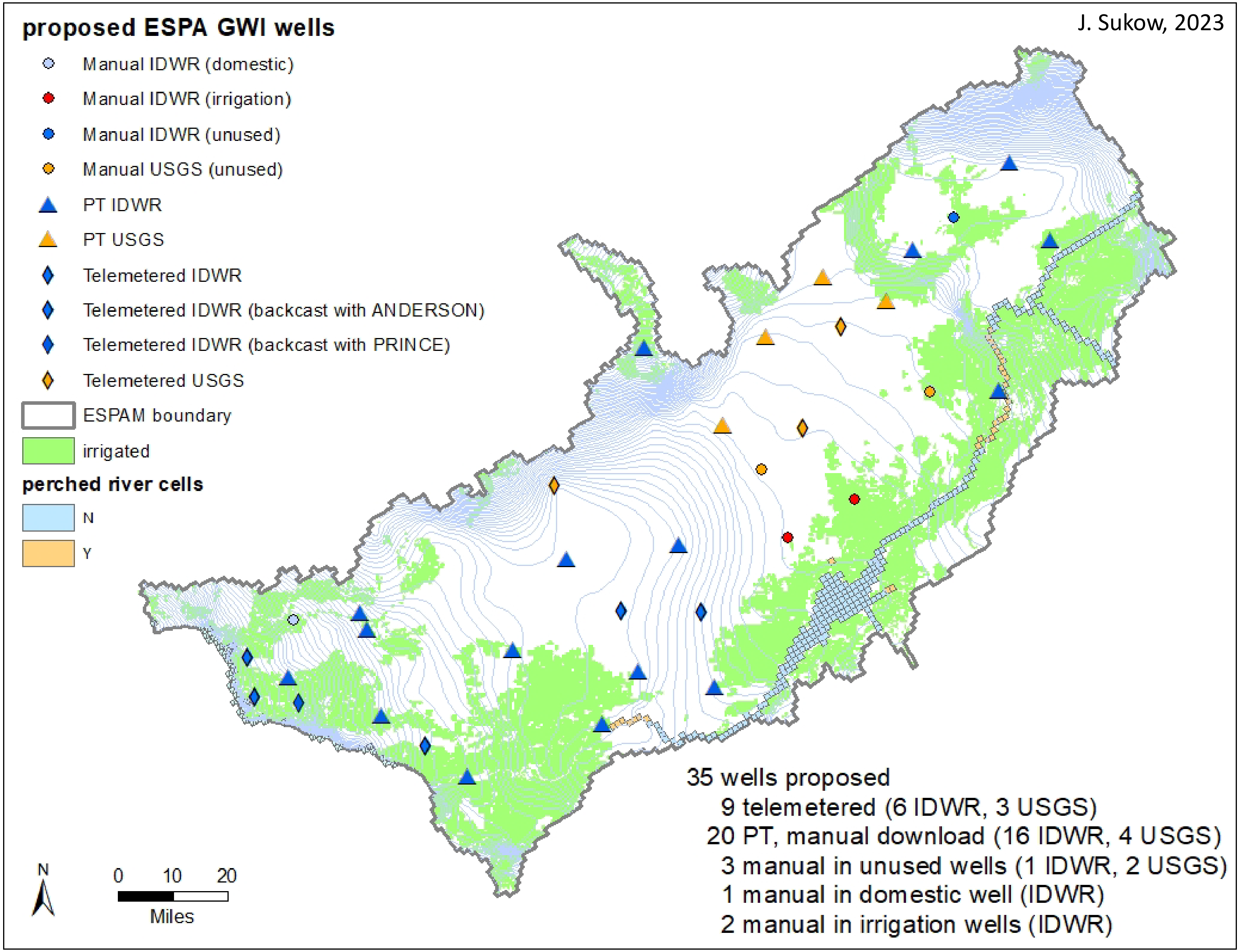

ESPA Aquifer Volume Trailing Averages
Aquifer Volume (acre-feet)
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1/30/1980
7/22/1985
1/12/1991
7/4/1996
12/25/2001
6/17/2007
12/7/2012
5/30/2018
11/20/2023
Annual Volume Change (AF)
3-yr Average
10-yr Average
12-yr Average

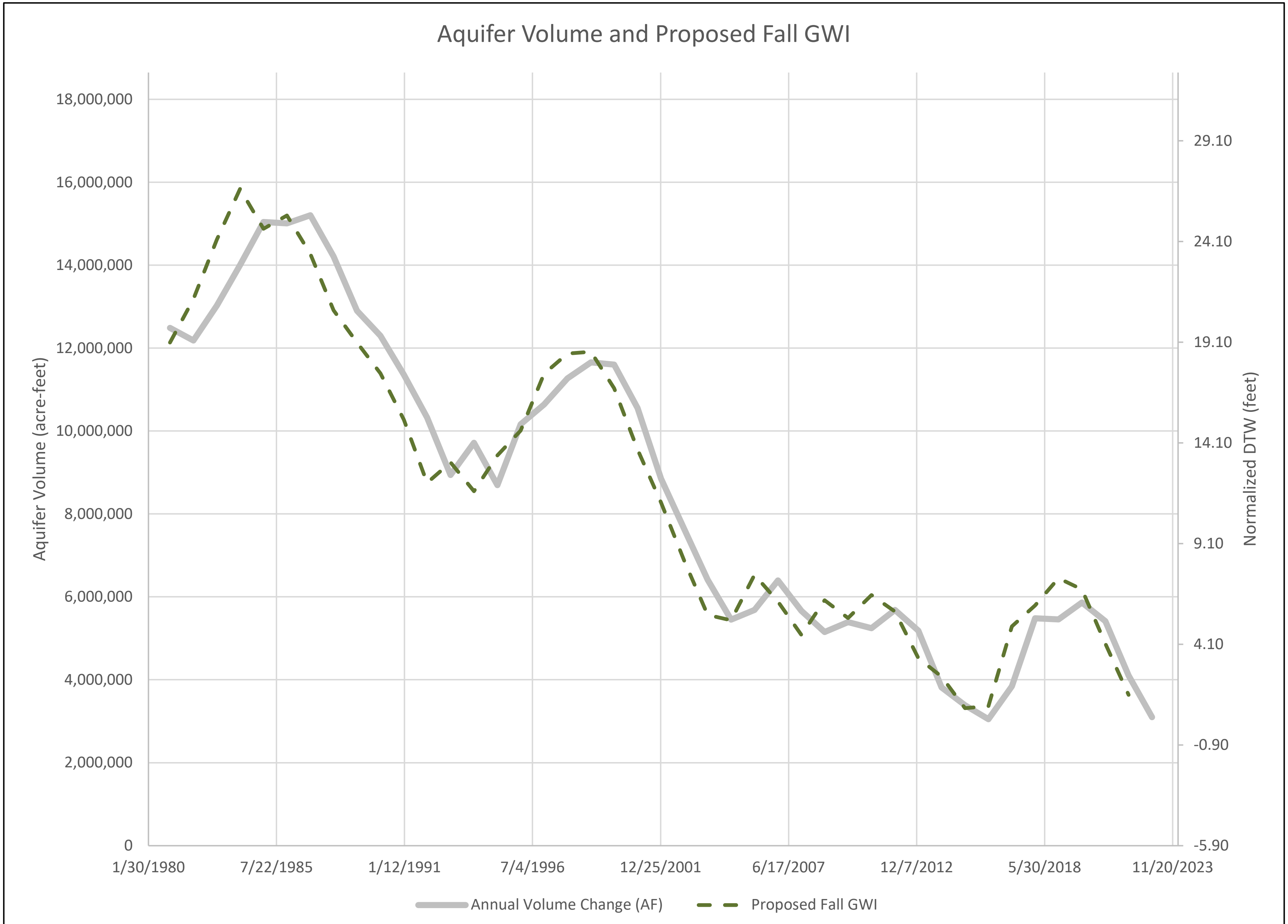


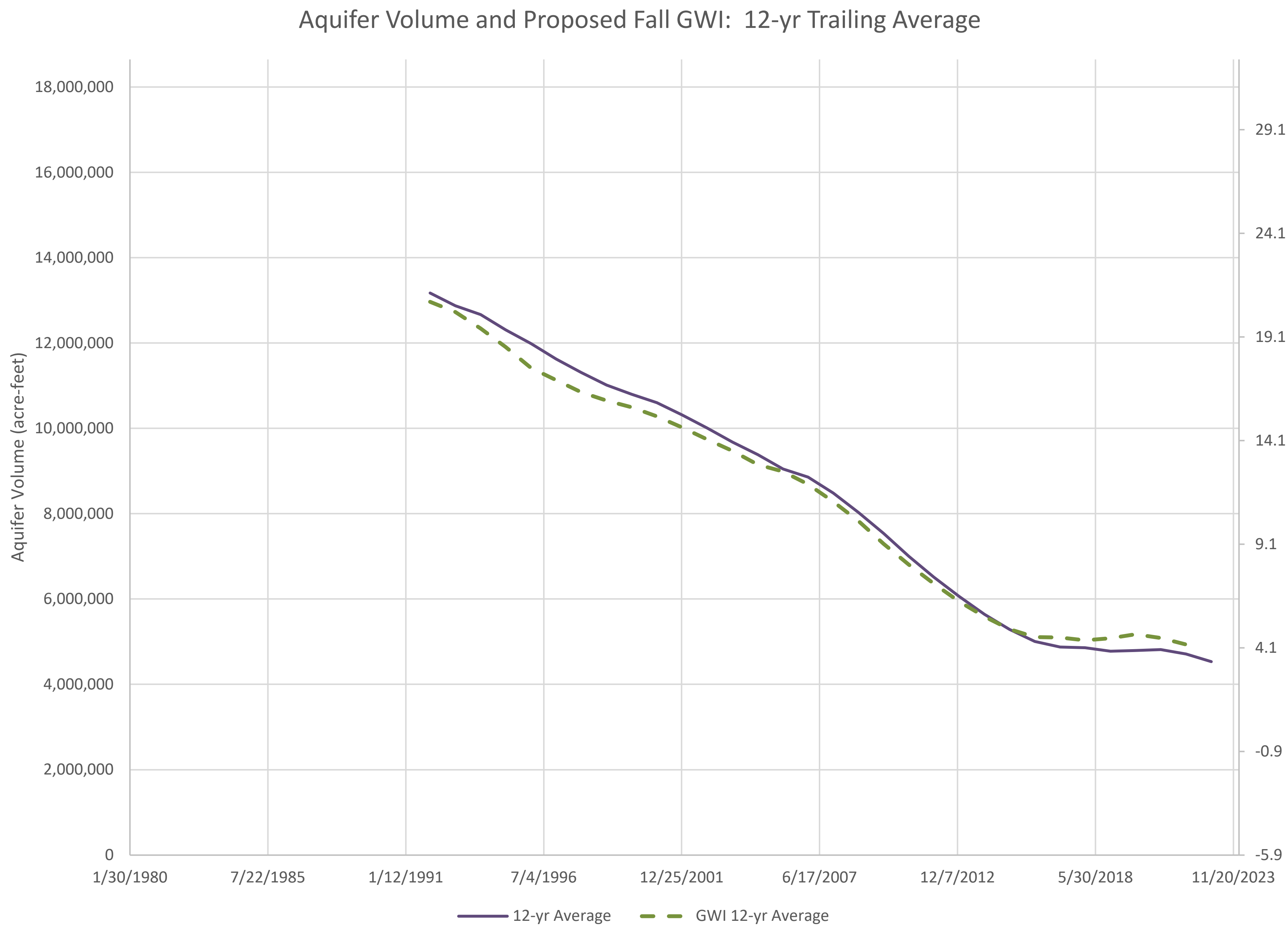
Number of Years for Trailing Average
Cumulative Storage Change (acre-feet)
20,000,000
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
1970
1974
1978
1982
1986
1990
1994
1998
2002
2006
2010
2014
2018
2022
1 2 3 4 5 6 7 8 9 10 11
1 2 3 4 5 6 7 8 9 10 11 12
1 2 3 4 5 6 7 8 9 10 11
IDWR Water Level Volume Change
USGS Water Budget Volume Change

Groundwater Index (GWI) with Fall Water Levels

Proposed GWI Wells




Aquifer Volume and Proposed Fall GWI
Aquifer Volume (acre-feet)
Normalized DTW (feet)
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
29.10
24.10
19.10
14.10
9.10
4.10
-0.90
-5.90
1/30/1980
7/22/1985
1/12/1991
7/4/1996
12/25/2001
6/17/2007
12/7/2012
5/30/2018
11/20/2023
Annual Volume Change (AF)
Proposed Fall GWI



Aquifer Volume and Proposed Fall GWI: 12-yr Trailing Average
Aquifer Volume (acre-feet)
18,000,000
16,000,000
14,000,000
12,000,000
10,000,000
8,000,000
6,000,000
4,000,000
2,000,000
0
29.1
24.1
19.1
14.1
9.1
4.1
-0.9
-5.9
1/30/1980
7/22/1985
1/12/1991
7/4/1996
12/25/2001
6/17/2007
12/7/2012
5/30/2018
11/20/2023
12-yr Average
GWI 12-yr Average

Discussion