The EAA Recharge Program Technical Briefing to the EAA Board of Directors

March 14, 2017

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Presentation Overview

- Purpose of Recharge Program
- The EAA Recharge Program – 1997
- Recharge as a component of optimization – program evolution
- The Edwards Aquifer and karst hydraulics
- Can we make enhanced recharge more effective?
- EAA Science Program contributions
- Conclusions
- Future discussions

Purpose of the EAA Recharge Program

- The Program was implemented by the EUWD.
    - To “enhance” recharge, given the technological and regulatory tools available at the time.

- Resulted in constructing four dams located in Medina County.

- What is the purpose today?
    - To provide additional recharge as part of a larger optimization strategy?
    - To contribute to springflow?
    - To bring added certainty to permit holders?

The EAA Recharge Program - 1997

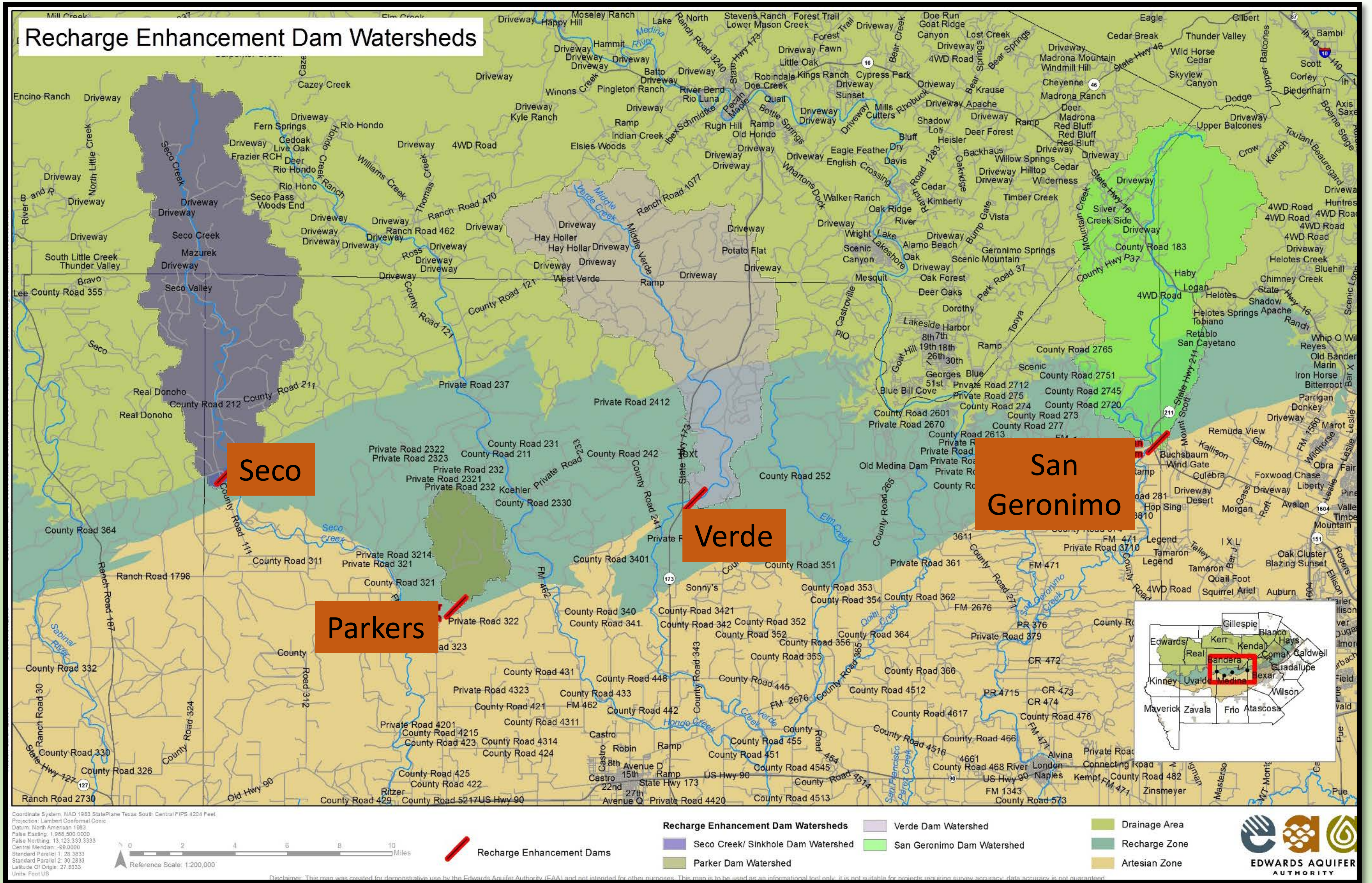
- In 1997, the Program consisted of four dams.
  - Constructed between 1974 and 1982.
    - Parkers Dam 1974
    - Middle Verde Dam 1978
    - San Geronimo Dam 1980
    - Seco Creek Dam 1982

- Average <u>total</u> recharge from dams equates to about 0.7-percent of annual average recharge.

- Average <u>enhanced</u> recharge from the dams equates to about 0.3-percent of annual recharge.

- Recharge statistics from dams through 2016:
    - Total R for POR = 210,785 AF (112,076 AF attributed to Seco)
    - Mean R for POR = 4,902 AF
    - Median R for POR = 1,028 AF*

**Median is likely more representative of what can be expected in any given year.*


Recharge Enhancement Dam Watersheds
Seco
Parkers
Verde
San Geronimo
Recharge Enhancement Dams
Recharge Enhancement Dam Watersheds
Seco Creek/ Sinkhole Dam Watershed
Parker Dam Watershed
Verde Dam Watershed
San Geronimo Dam Watershed
Drainage Area
Recharge Zone
Artesian Zone
Reference Scale: 1:200,000
EDWARDS AQUIFER AUTHORITY

Recharge and Optimization – Program Evolution

Recharge as defined in the EAA ACT:

Increasing the supply of water to the aquifer by naturally occurring channels or artificial means.

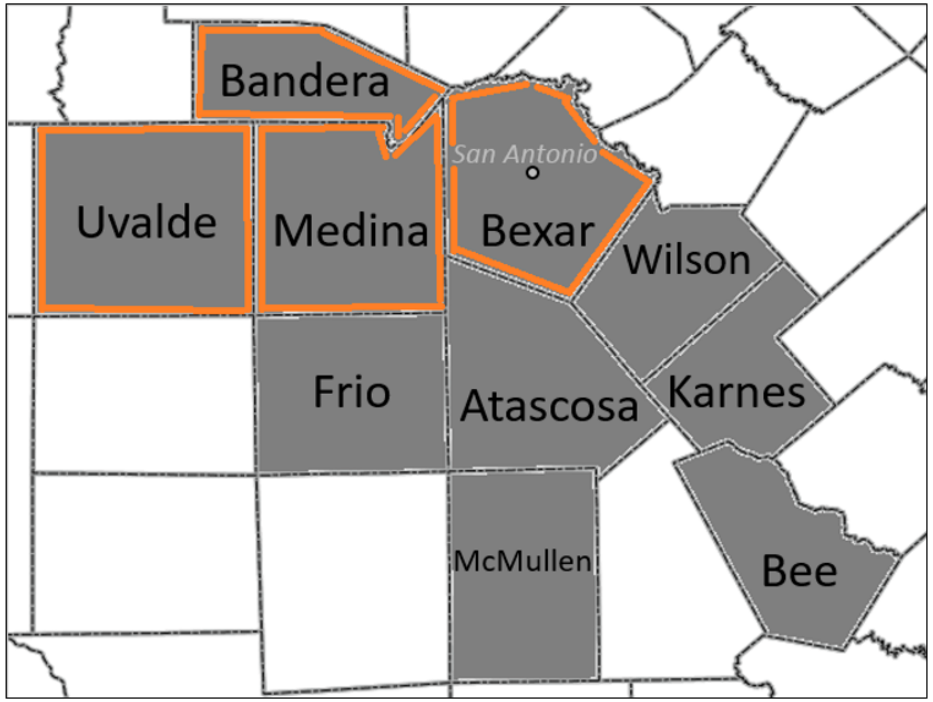
By this definition, the difference between today's recharge program and 1997 is the addition of Precipitation Enhancement.

Recharge and Optimization – Program Evolution

- Precipitation Enhancement Program
  - Average annual recharge 2004 - 2015 = 3,180 AF/yr.
  - PEP also contributes to demand reduction in affected areas.

- On average, EAA's Recharge Program contributes about 8,080 AF/year of additional recharge. (Average from dams + average from PEP)

- The drawback to both of these <u>tools</u> is a lack of effectiveness in dry years.



Gray: South Texas Weather Modification Association operation area. Counties highlighted in orange are part of the EAA.

Recharge and Optimization – Program Evolution

Optimization:

An act, process, or methodology of making something as fully perfect, functional, or effective as possible.

Perhaps a more effective way to view the Recharge Program is as a tool in the Optimization toolbox.

Water quality is also critical to the process of Optimization.

Recharge and Optimization – Program Evolution

The Optimization Toolbox:

- SAWS ASR: ≈50,000 AF in storage (EAHCP).
- VISPO: ≈40,000 AF of irrigation water taken out of use in severe drought.
- Collaboration to develop a new ASR in Edwards Saline Zone (≈7,000 AF).
- Edwards Aquifer Protection Program – maintaining historical recharge.
  - 145,000 acres and growing, designed to maintain water quantity and quality.
- State Resource Concern Program – contributing to water quality.
  - Riparian health, sediment control.
  - Brush management, re-seeding operations.

Recharge and Optimization – Program Evolution

The Optimization Toolbox:

- Benefits resulting from the EAA Act:
  - Staff estimates the Act is responsible for a savings of 2.6 million AF of water between 1997 and 2014*.
  - This equates to about 152,900 AF/yr for the period.
  - We witnessed the impacts of the Act on springflow and aquifer levels in the recent drought.
  - Highly effective tool for maintaining aquifer levels and springflows, this tool was not available to the EUWD.

***The EAA Act: A Success Story, numbers based on savings from pumping growth predicted to occur without the Act, increased population, Act related cap, permit system, and conservation measures.**

Recharge and Optimization - Summary

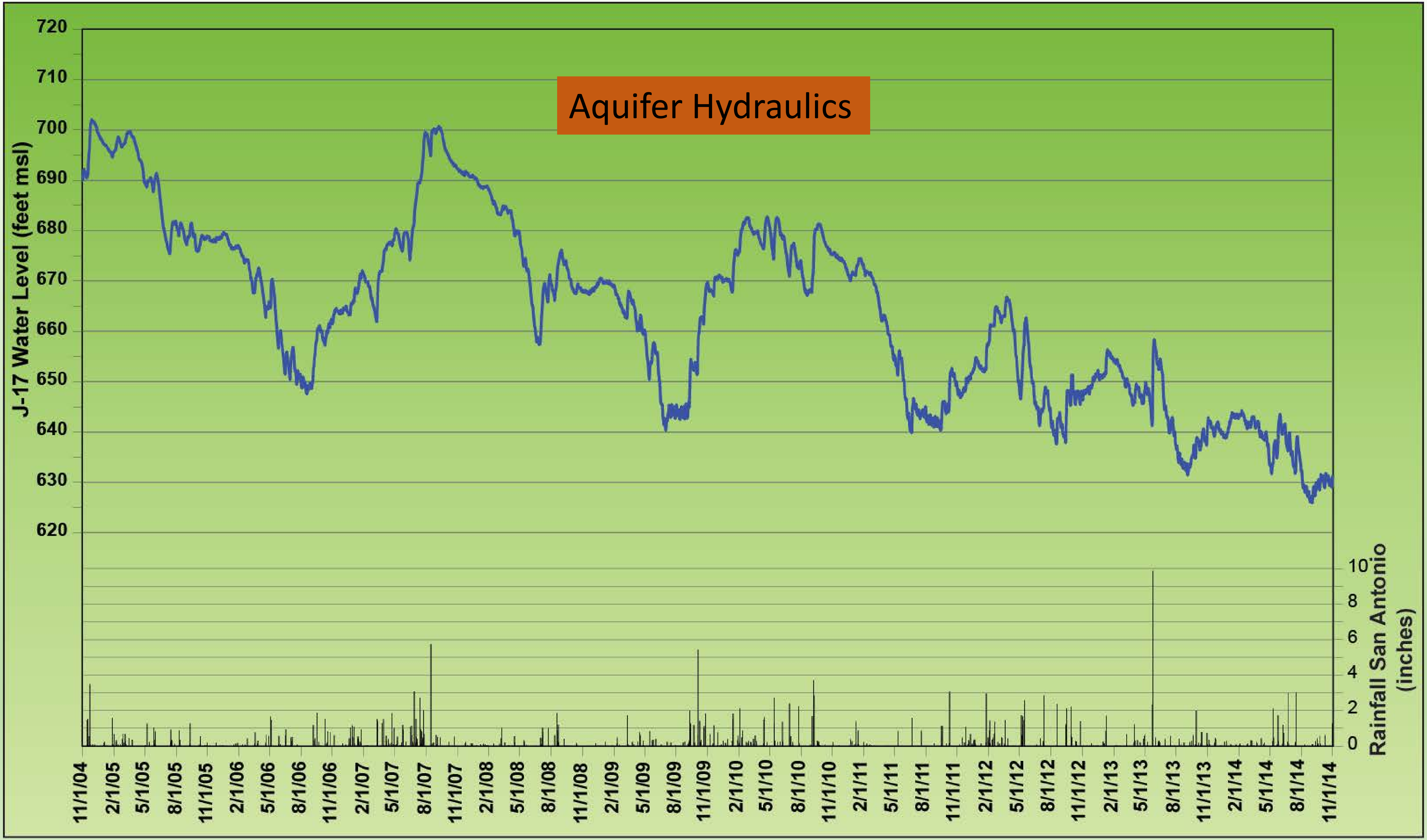
- Average Recharge from Dams
  - 4,902 AF/yr (total R) or 3,298 AF/yr (enhanced R)
  - *Note: Without Seco – the average drops to 2,296 AF/yr*
- Recharge from PEP average = 3,180 AF/yr
- Benefits from Optimization tools:
  - EAHCP ASR contributions about 50,000 AF*
  - VISPO about 40,000 AF*
  - Potential new ASR estimated at 7,000 AF*
  - EAA Act average of about 150,000 AF/yr*
  - Maintaining natural/historical recharge through the EAPP.
  - Maintaining water quality through SRC and other EAA programs.

*Initiatives that result in significant demand reduction.

Aquifer Hydraulics

- The Edwards Aquifer
  - Karst, rapid response to recharge.
    - Annual recharge estimates range from 43,700 AF to 2,485,700* AF for POR.
  - Karst, rapid response to discharge (and drought).
    - Aquifer will drain from "full" to Stage III in about two-years, without adequate rainfall.
    - Difficult to count on a firm yield during persistent drought.
    - For the POR, springflow averages just over half of total discharge.

**Indicator of natural recharge efficiency*



Aquifer Hydraulics
J-17 Water Level (feet msl)
720
710
700
690
680
670
660
650
640
630
620
Rainfall San Antonio (inches)
10
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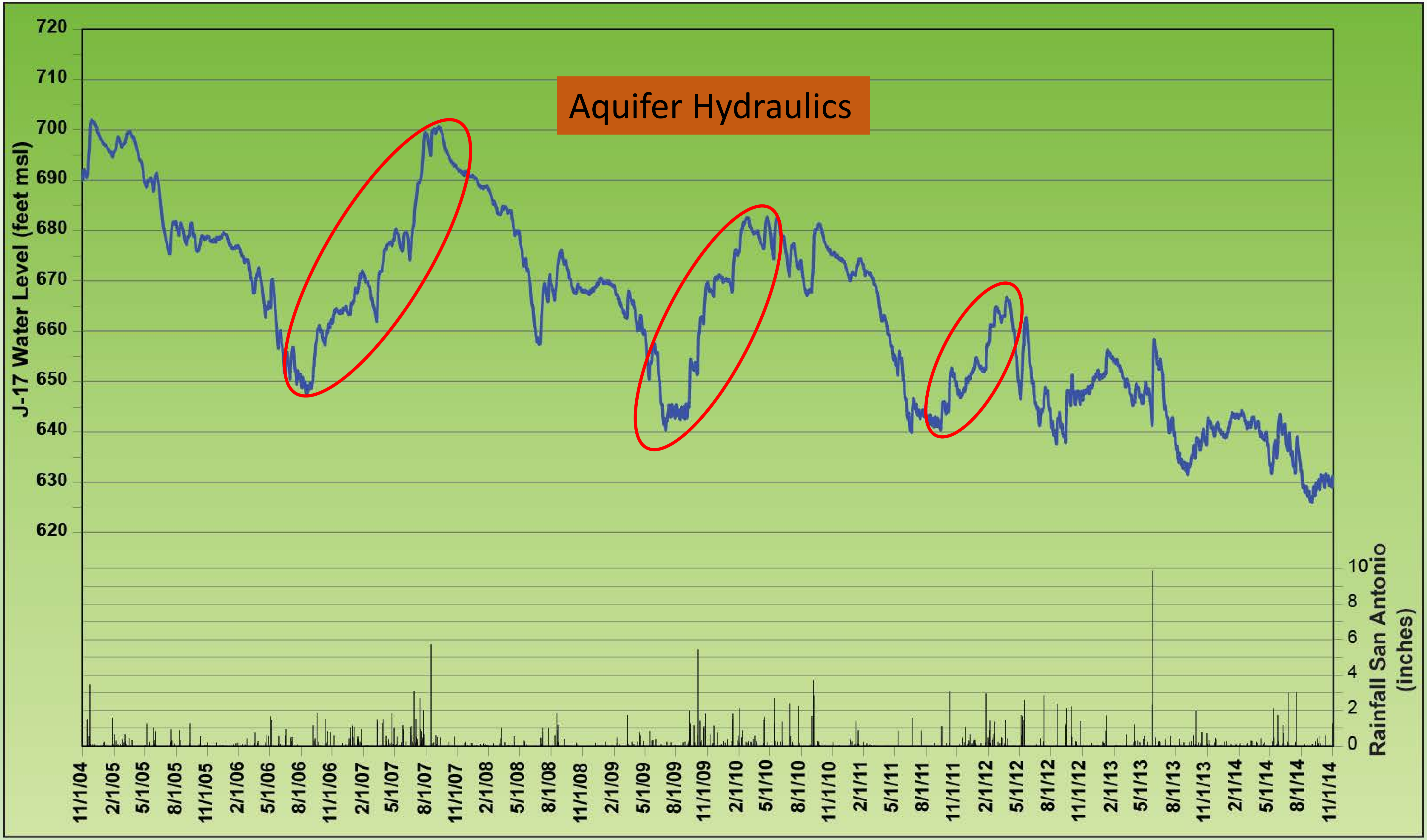
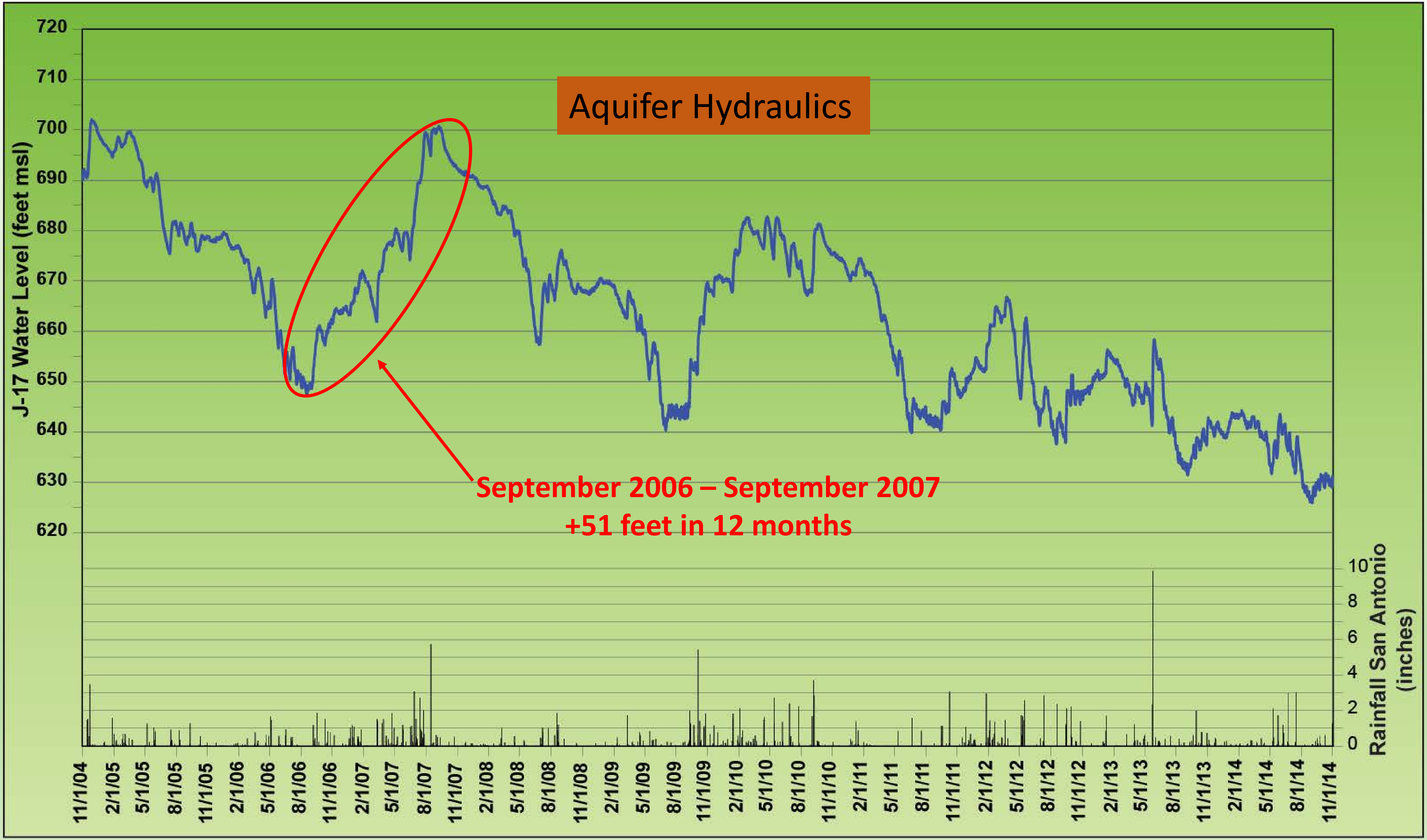
Aquifer Hydraulics





Aquifer Hydraulics
September 2006 – September 2007
+51 feet in 12 months
J-17 Water Level (feet msl)
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710
700
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Rainfall San Antonio (inches)
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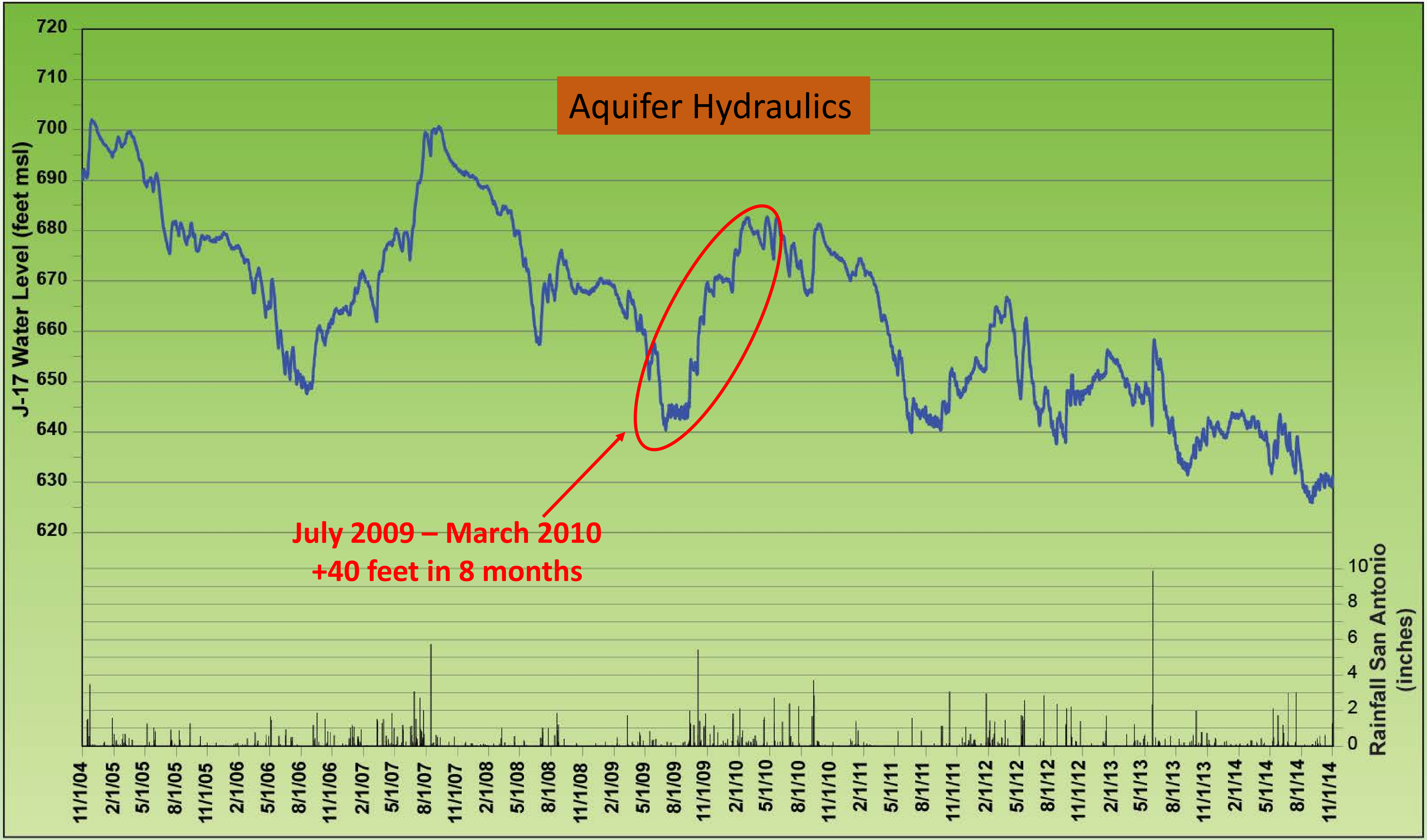

Aquifer Hydraulics
J-17 Water Level (feet msl)
720
710
700
690
680
670
660
650
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620
July 2009 – March 2010
+40 feet in 8 months
Rainfall San Antonio (inches)
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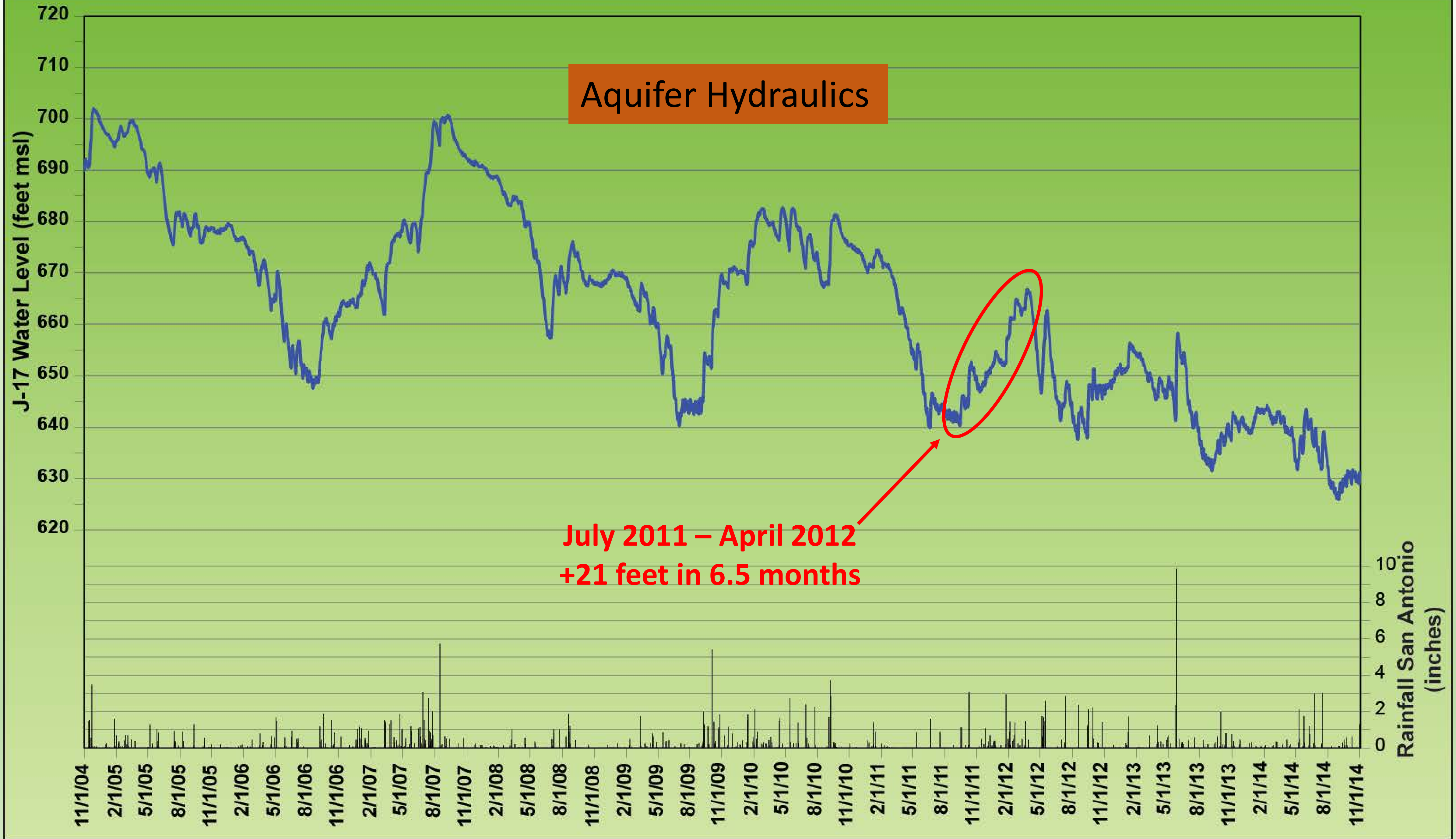
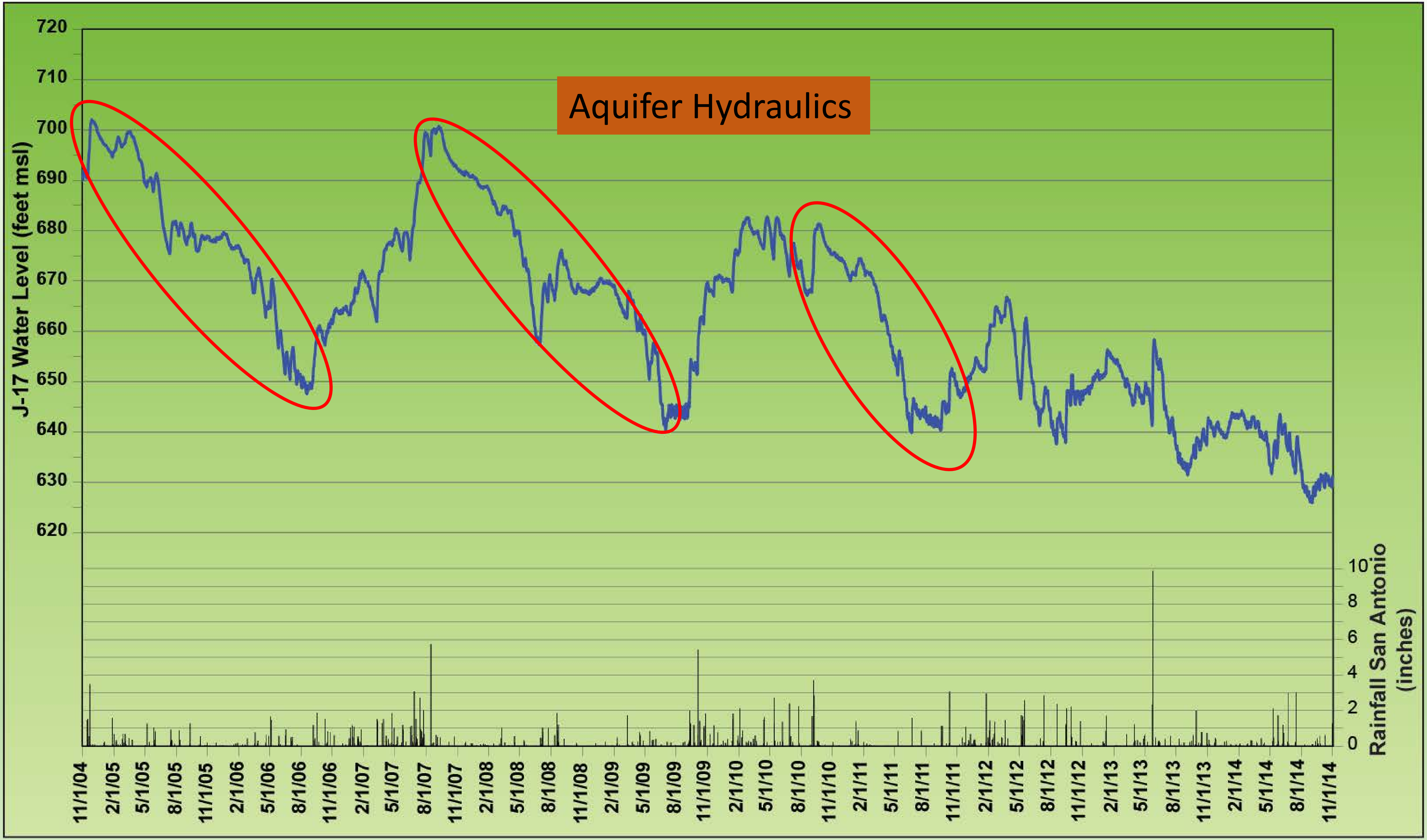
Aquifer Hydraulics





Aquifer Hydraulics
J-17 Water Level (feet msl)
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Rainfall San Antonio (inches)
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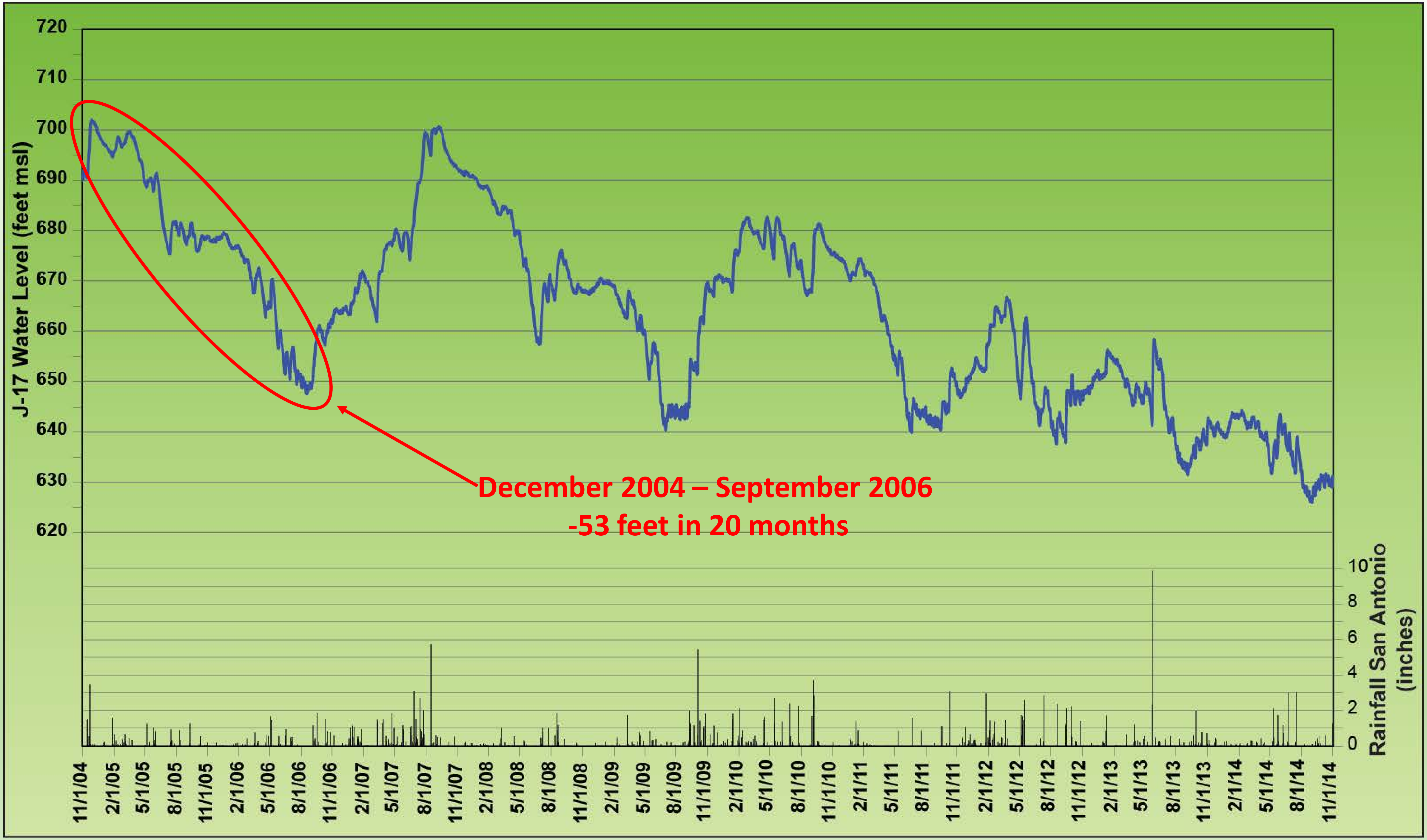
J-17 Water Level (feet msl)
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Rainfall San Antonio (inches)
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December 2004 – September 2006
-53 feet in 20 months


J-17 Water Level (feet msl)
720
710
700
690
680
670
660
650
640
630
620
September 2007 – July 2009
-61 feet in 22 months
Rainfall San Antonio (inches)
10
8
6
4
2
0
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11/1/14

J-17 Water Level (feet msl)
720
710
700
690
680
670
660
650
640
630
620
October 2010 – July 2011
-41 feet in 20 months
Rainfall San Antonio (inches)
10
8
6
4
2
0
11/1/04
2/1/05
5/1/05
8/1/05
11/1/05
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5/1/06
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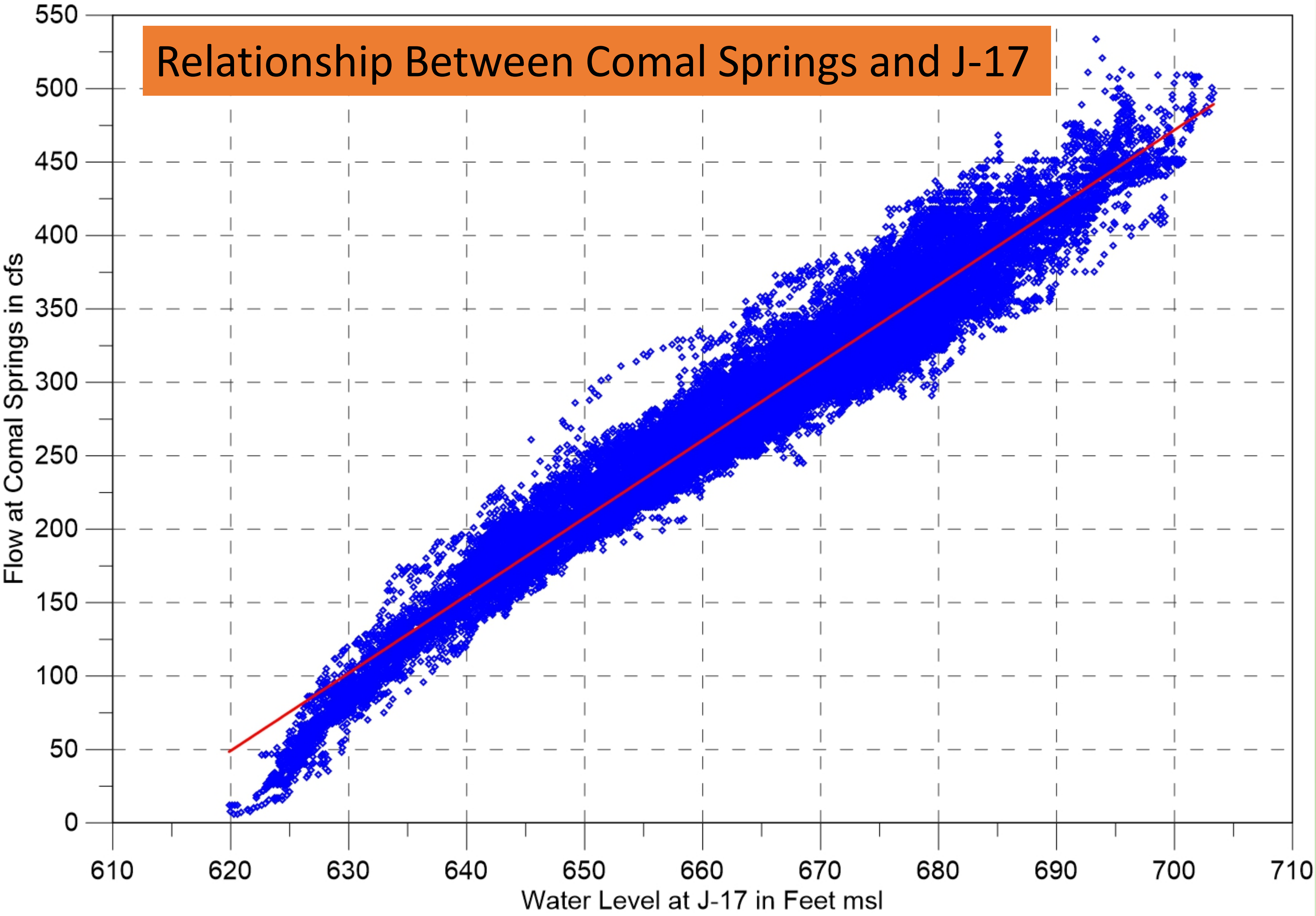
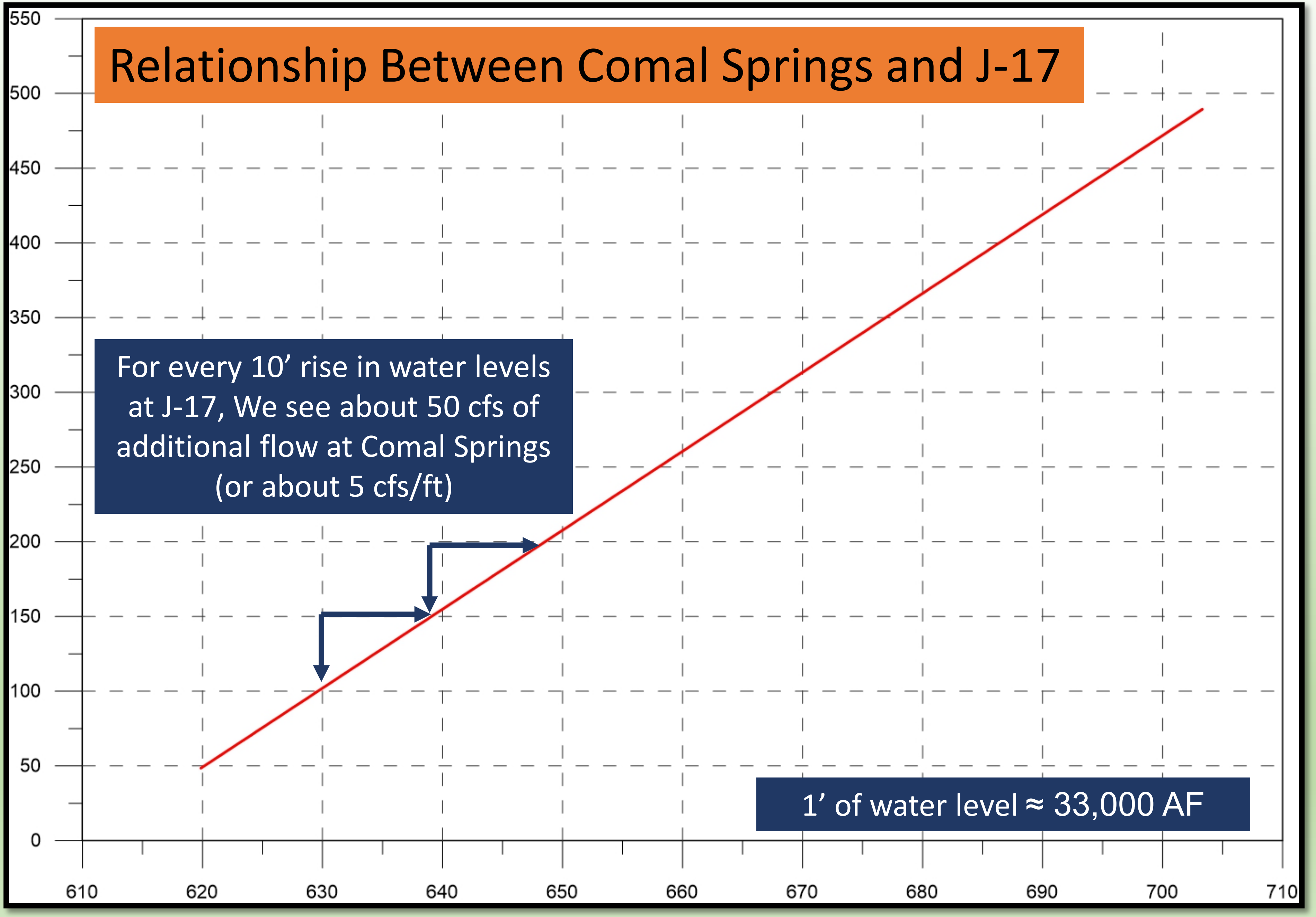


Relationship Between Comal Springs and J-17
Flow at Comal Springs in cfs
0
50
100
150
200
250
300
350
400
450
500
550
610
620
630
640
650
660
670
680
690
700
710
Water Level at J-17 in Feet msl



Relationship Between Comal Springs and J-17
For every 10’ rise in water levels at J-17, We see about 50 cfs of additional flow at Comal Springs (or about 5 cfs/ft)
1’ of water level ≈ 33,000 AF
550
500
450
400
350
300
250
200
150
100
50
0
610
620
630
640
650
660
670
680
690
700
710

Aquifer Hydraulics

The aquifer responds rapidly to both recharge and discharge.

Springflows are proportional to water level, the system drains faster at high levels.

This brings us to the issue of Firm Yield.

Firm Yield can be thought of as reliable storage over a 5 to 10-year period.

Firm Yield – The dependable supply of water available during a repeat of the drought of record (1947-1956) 10 years.

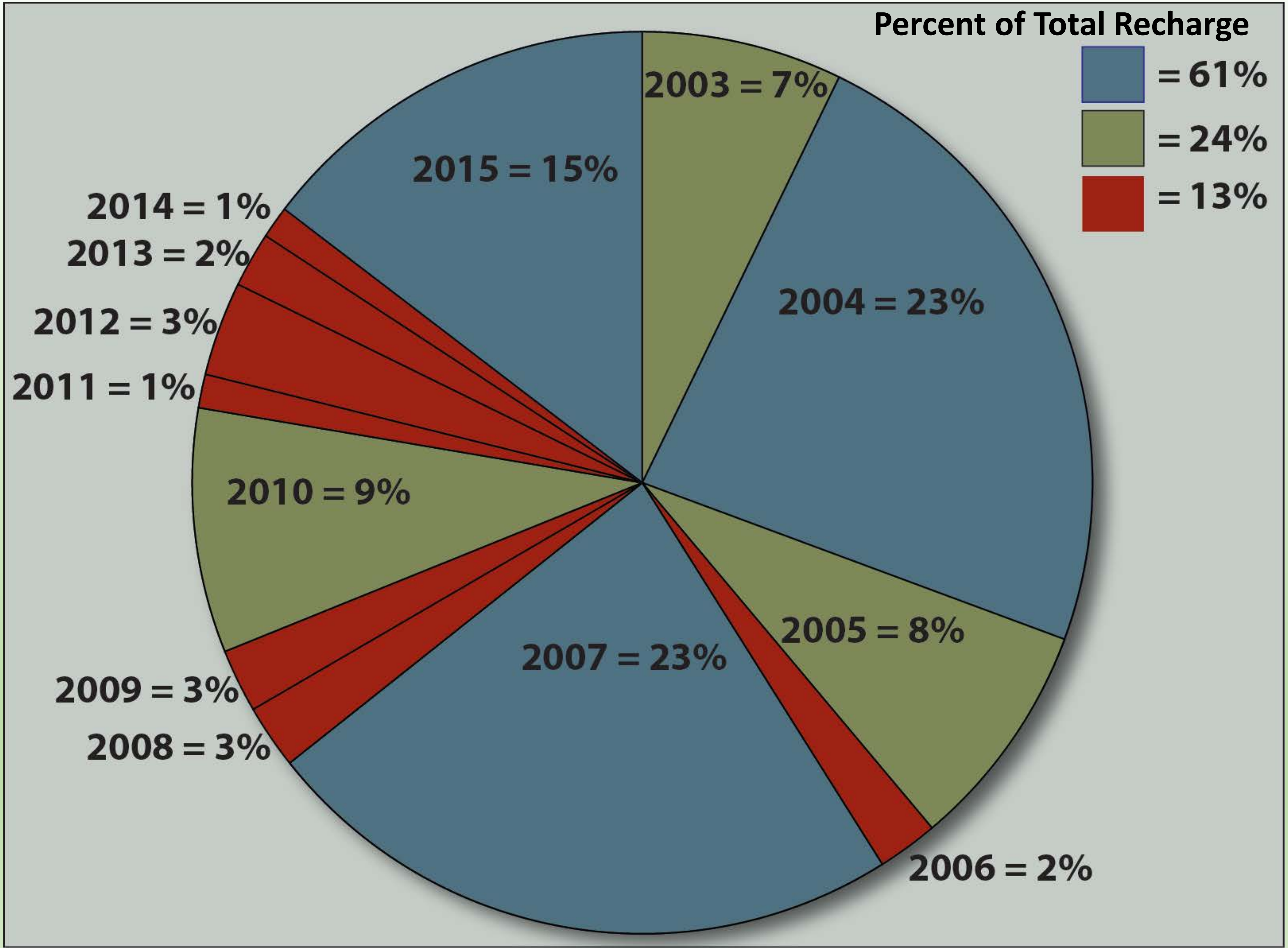
Aquifer Hydraulics

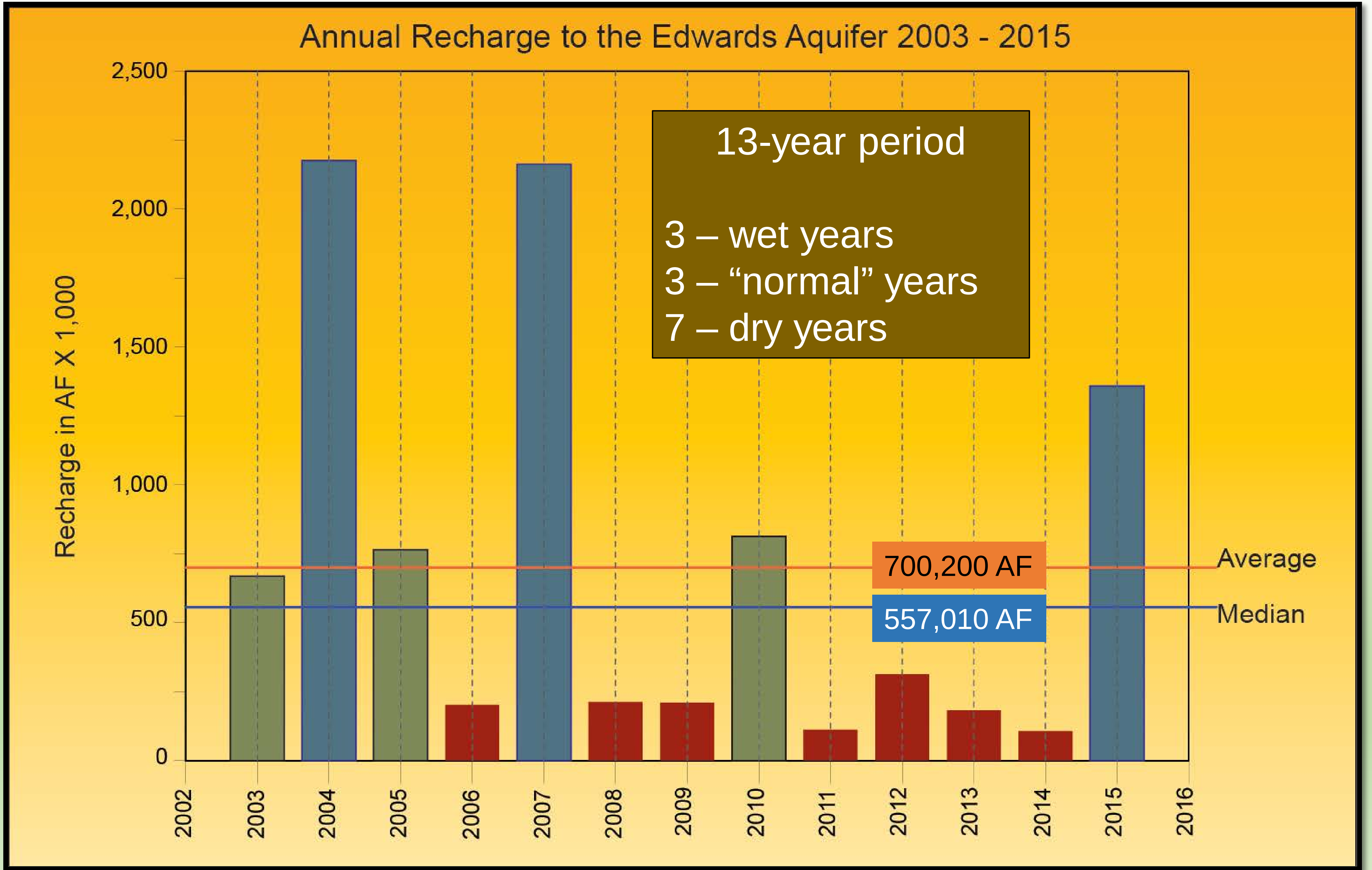
13-year period ending December 31, 2015

We will typically have a wet year in most 10-year Periods.

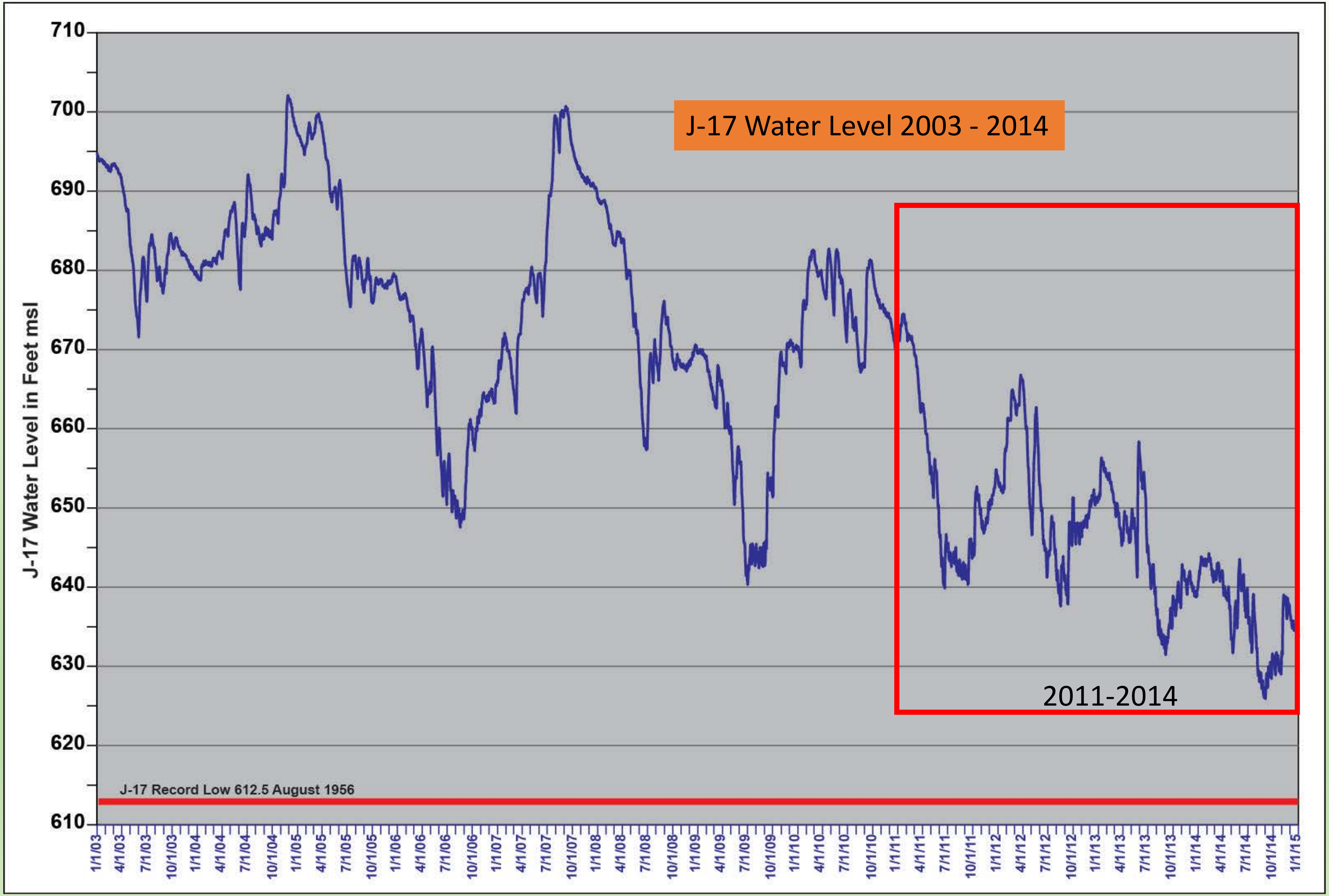
But, consecutive dry years have significant impacts on water levels.

What if 2015 had been dry?





Annual Recharge to the Edwards Aquifer 2003 - 2015
Recharge in AF X 1,000
2,500
2,000
1,500
1,000
500
0
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
13-year period
3 – wet years
3 – "normal" years
7 – dry years
700,200 AF
557,010 AF
Average
Median



J-17 Water Level 2003 - 2014
2011-2014
J-17 Record Low 612.5 August 1956
J-17 Water Level in Feet msl
710
700
690
680
670
660
650
640
630
620
610
1/1/03
4/1/03
7/1/03
10/1/03
1/1/04
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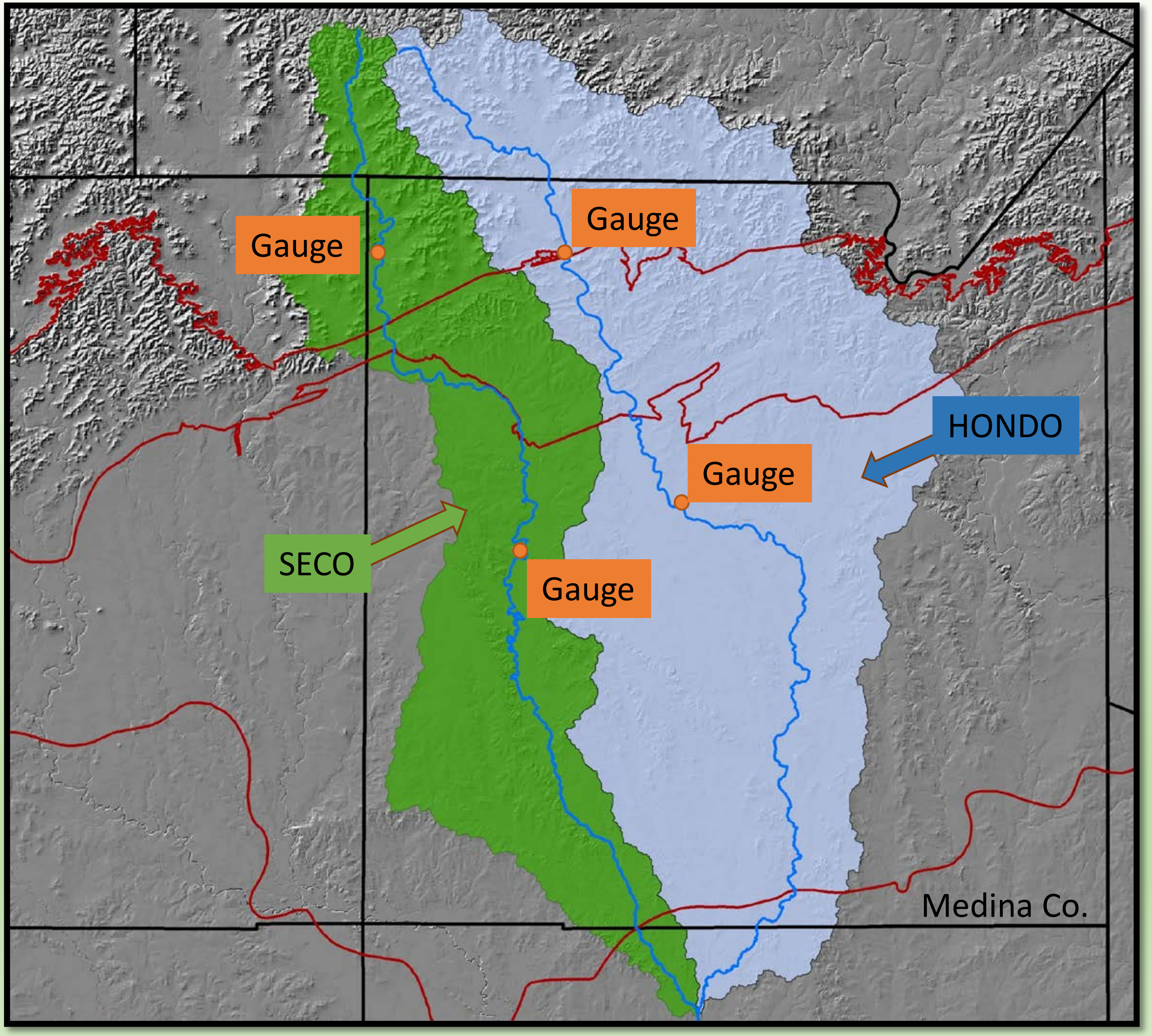
Aquifer Hydraulics

Natural efficiency of the system:

Seco Creek vs Hondo Creek watersheds

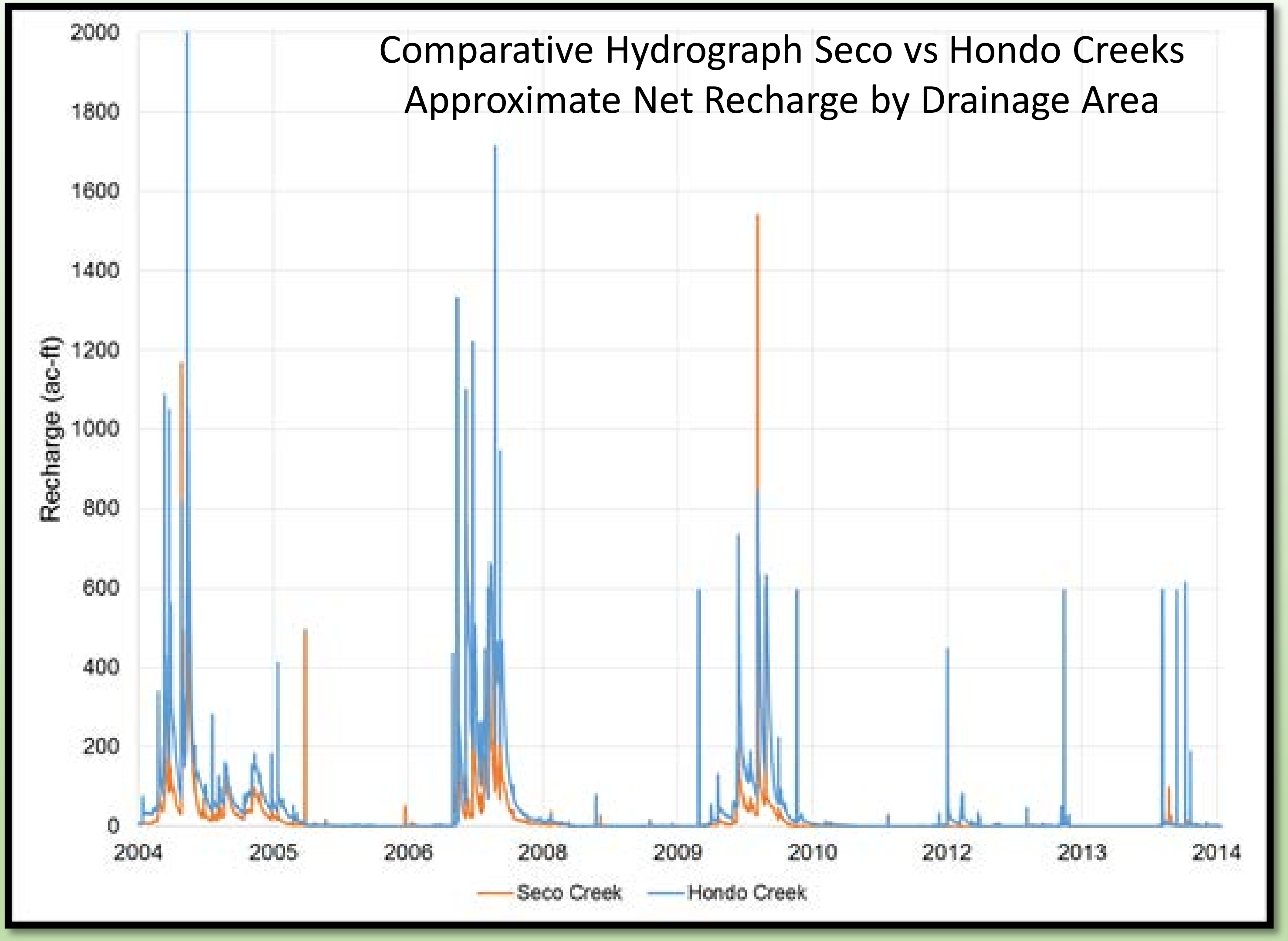
Seco Creek Drainage Area = 226,129 acres
Hondo Creek Drainage Area = 426,443 acres



Aquifer Hydraulics

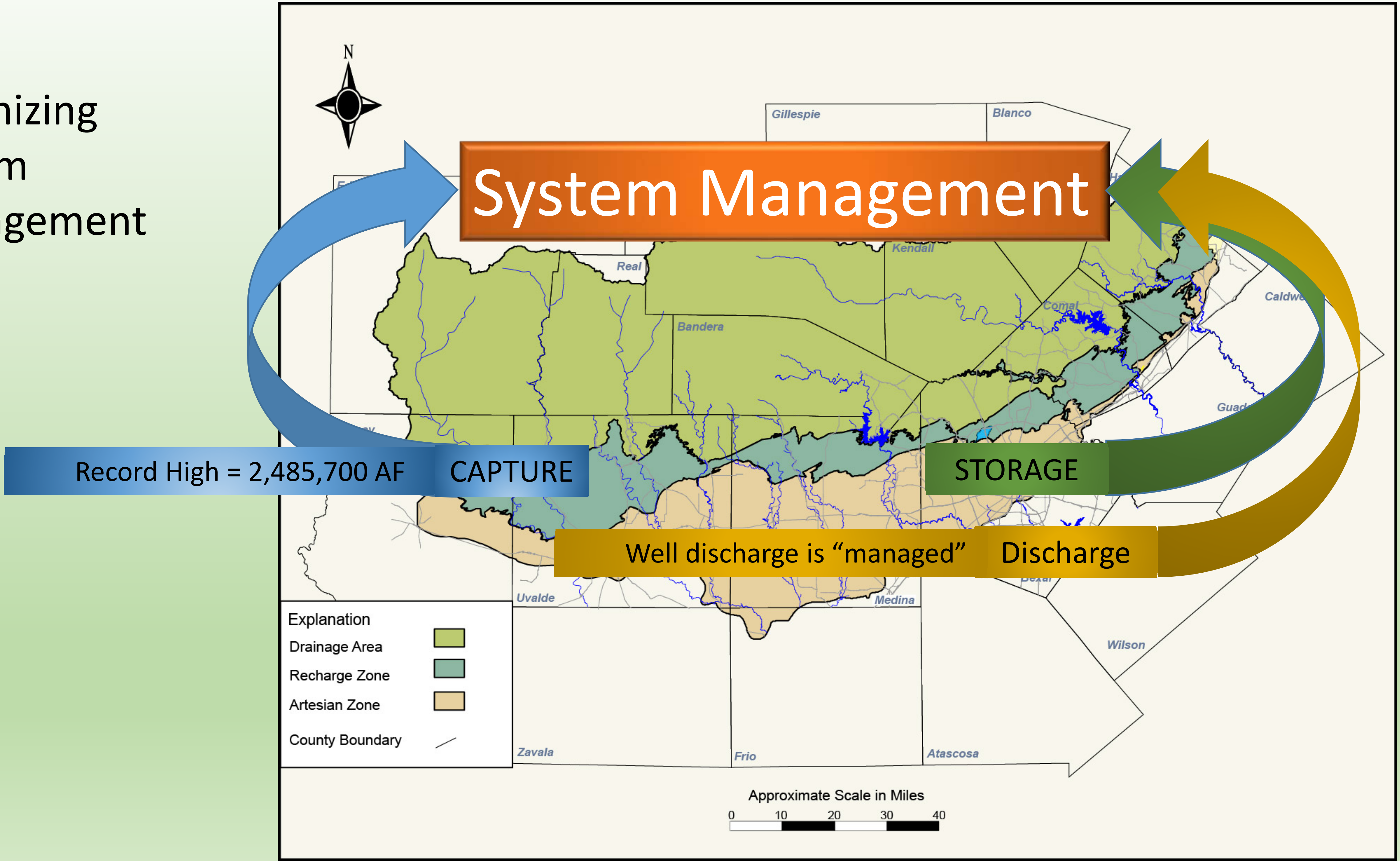
Analyses of these two basins indicate similar recharge efficiencies, with Hondo being slightly more efficient.

In wet years about 10-percent of average daily flows pass by the downstream gauge, which is important for moving sediment past the recharge zone.



Aquifer Hydraulics

Optimizing System Management



Can We Make the Recharge Program More Effective?

Yes – if we can effectively increase the residence time of water in the system.

Goal – Increase Firm Yield

HOW?

Currently, ASR appears to be the most effective tool.

EAA’s Science Program Impacts on Recharge

- Continual efforts to better understand the system:
  - Interformational Flow Study
    - Refining the water balance, reducing uncertainties
      - Trinity Aquifer contributions
      - Diffuse recharge study
      - Do we have unknown losses?
  - Modeling Program
    - Utilizing the results of research efforts to make the model match the geology
    - Improving both the surface water models and groundwater models

Better information will lead to better system management

Summary

- The aquifer will accept a very high percentage of rainfall as recharge.

- The system also acts to flush/transport sediments during peak flows, maintaining natural efficiency.

- The Recharge Program – is effectively a tool in the Optimization toolbox.

- The ACT, ASR, and VISPO, are also tools that help provide certainty for the region.

- Other programs are designed to protect natural recharge and water quality.

Conclusions

- The traditional recharge program is limited by:
  - The nature of the system and climate.
  - Totals 8,080 AF/yr (dams + PEP) on average (note: dry years = 0).
- Other Optimization tools bring added certainty to the region.
  - The Act, SAWS ASR, VISPO, New ASR(s), EAPP, SRC – All contribute to managing the system more effectively.

Conclusions

- Re-conceptualizing Recharge, as a tool in the Optimization Toolbox while continuing to:
  - Collaborate with others to achieve long term storage (firm yield)
  - Maintain/protect natural recharge
  - Maintain/protect water quality

Better management of storage will help to bring more certainty to permit holders and the region during critical drought scenarios.

Additional Topics – for future presentation

- Technical Briefing
  - Overview of the current EAA Recharge Program
- AMP Committee Briefings
  - EAA's Role in Regional Water Planning.
  - Updating Recharge Enhancement Feasibility studies – capacities, costs, & risks.
  - Alternative strategies to maximize beneficial use of the aquifer.
- Board
  - Develop consensus on Program goals and priorities.