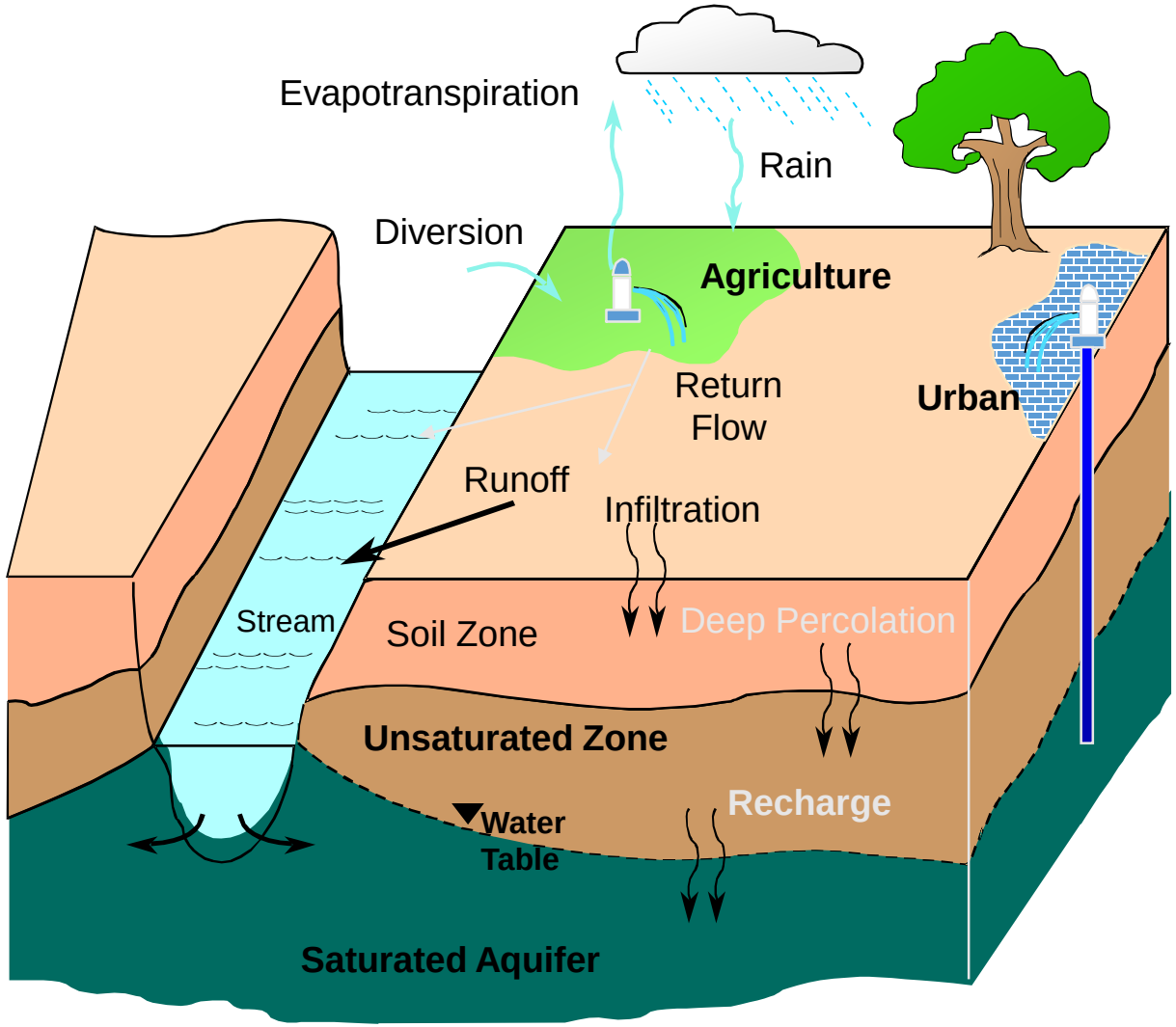
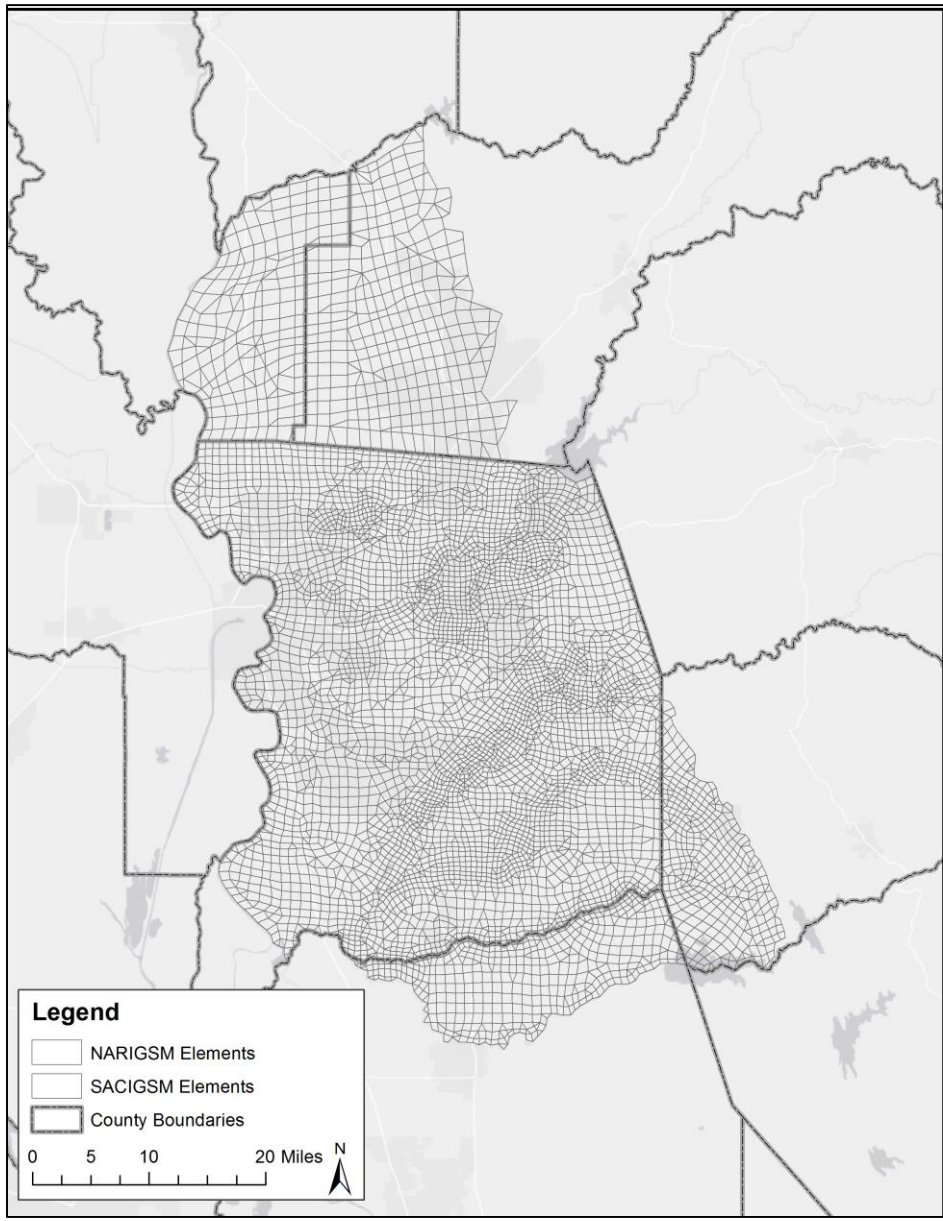
Modeling Code (Platform)

- Integrated Groundwater/Surface Water Model (IGSM) code
- A comprehensive numerical model that simulates various components of the hydrologic cycle and their interactions
- IGSM code developed by DWR and Reclamation to simulate Central Valley operations in early 1990s



Modeling Application

- Developed in 1993 for City and County of Sac to support Water Forum (SacIGSM)
- As part of the American River Water Resources Investigation in mid-1990s, linked to the North American River Basin (NARIGSM) Model
- Updated in SGA in 2007
- Updated in central Sac County in 2016
- Used by south Sacramento County for draft Groundwater Management Plan in 2011
- Today referred to as the Sacramento Integrated Water Resources Model (SacIRWM)

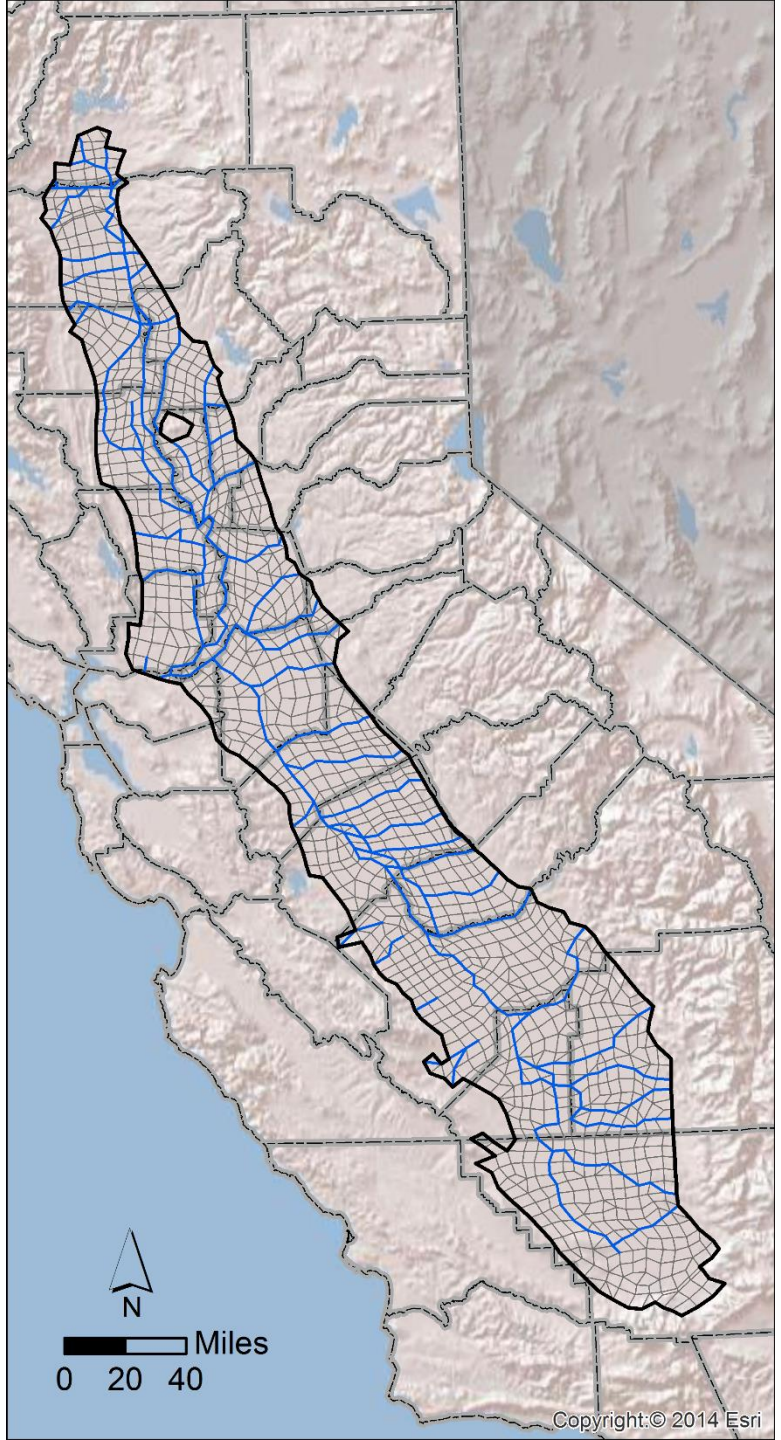


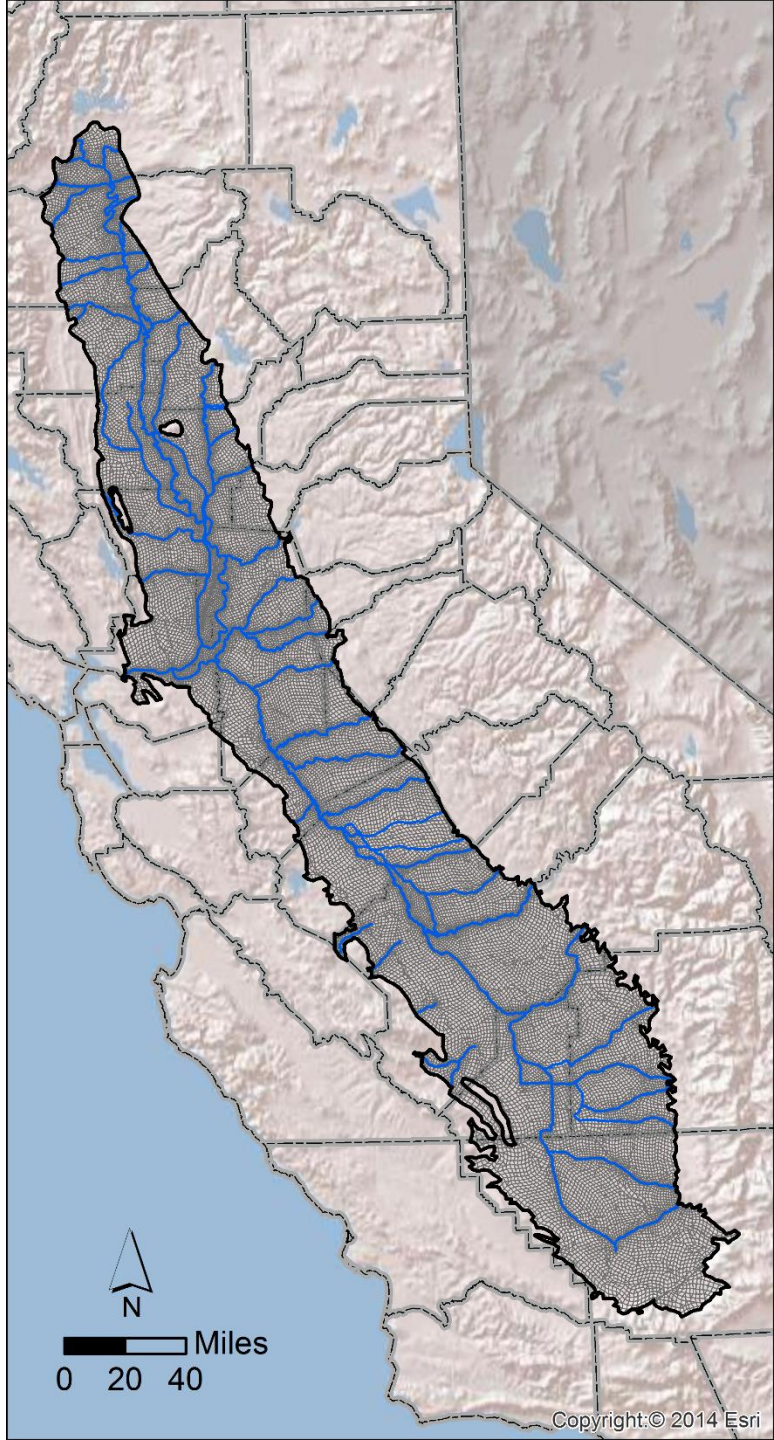
Recent DWR Modeling Efforts

- DWR developed its own version of original IGSM code in the early 2000's and has continuously updated it since
  - Now referred to as Integrated Water Flow Model (IWFM)
  - Latest Version (2015.0.475) released in 2016
- Current Commitment to IWFM
  - The ***Department shall provide*** the California Central Valley Groundwater-Surface Water Simulation Model (C2VSIM) and the ***Integrated Water Flow Model*** (IWFM) for use by Agencies in developing the water budget (Article 5. Subarticle 2§ 354.18. Water Budget)
- Currently updating 2 applications of IWFM expected by end of 2017
  - Central California Valley Simulation Model (C2VSim)
  - Sacramento Valley Simulation Model (SacSim)

C2VSim

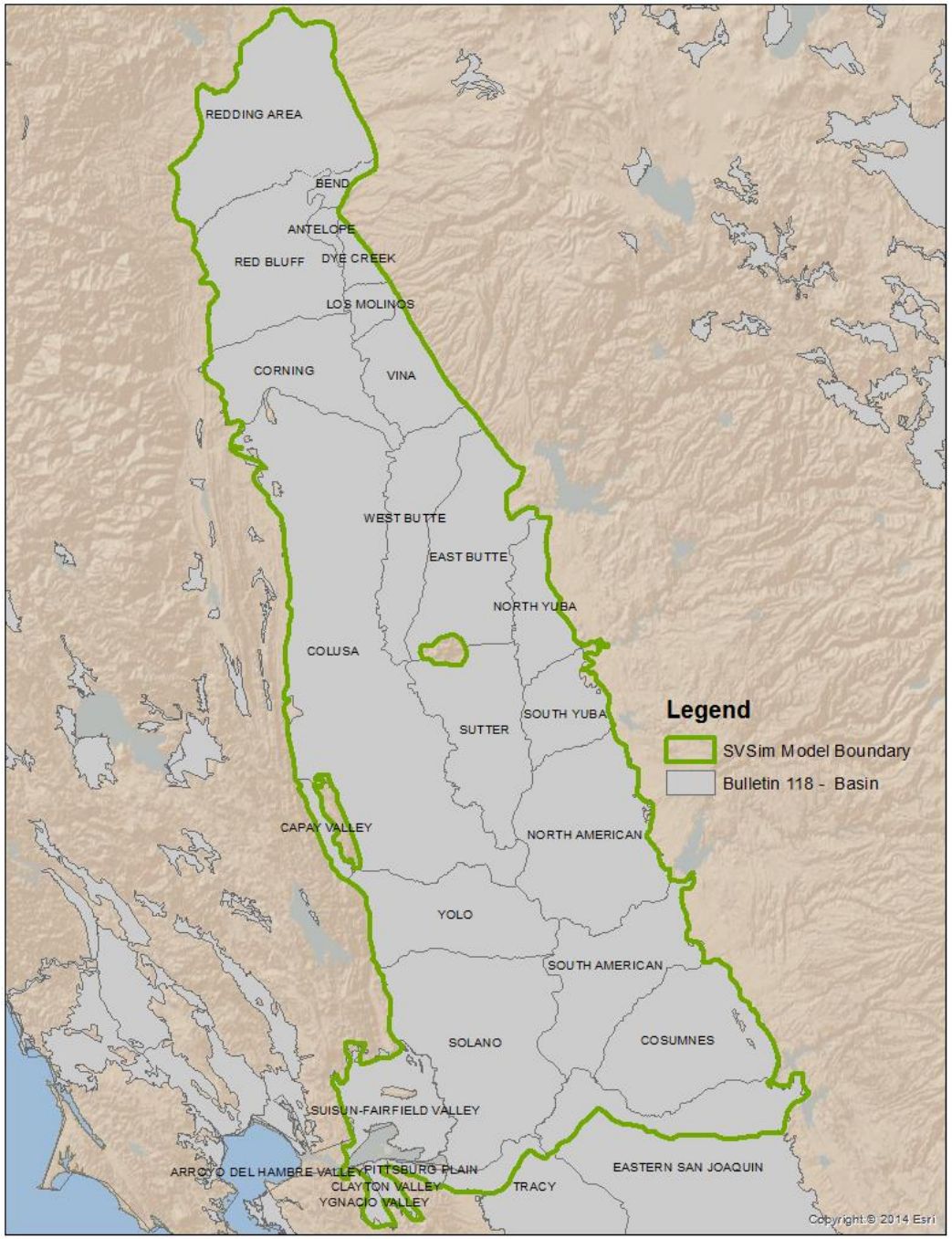
- Has been in use for many years by DWR and Reclamation
- Coarse Grid (IGSM) – 1989
- Fine Grid (IWFM) – 2011
- 3 aquifer layers now (moving to 4 layers)
- Simulation Period: 1922-2009 now (moving to 2015)
- Updated data through 2015





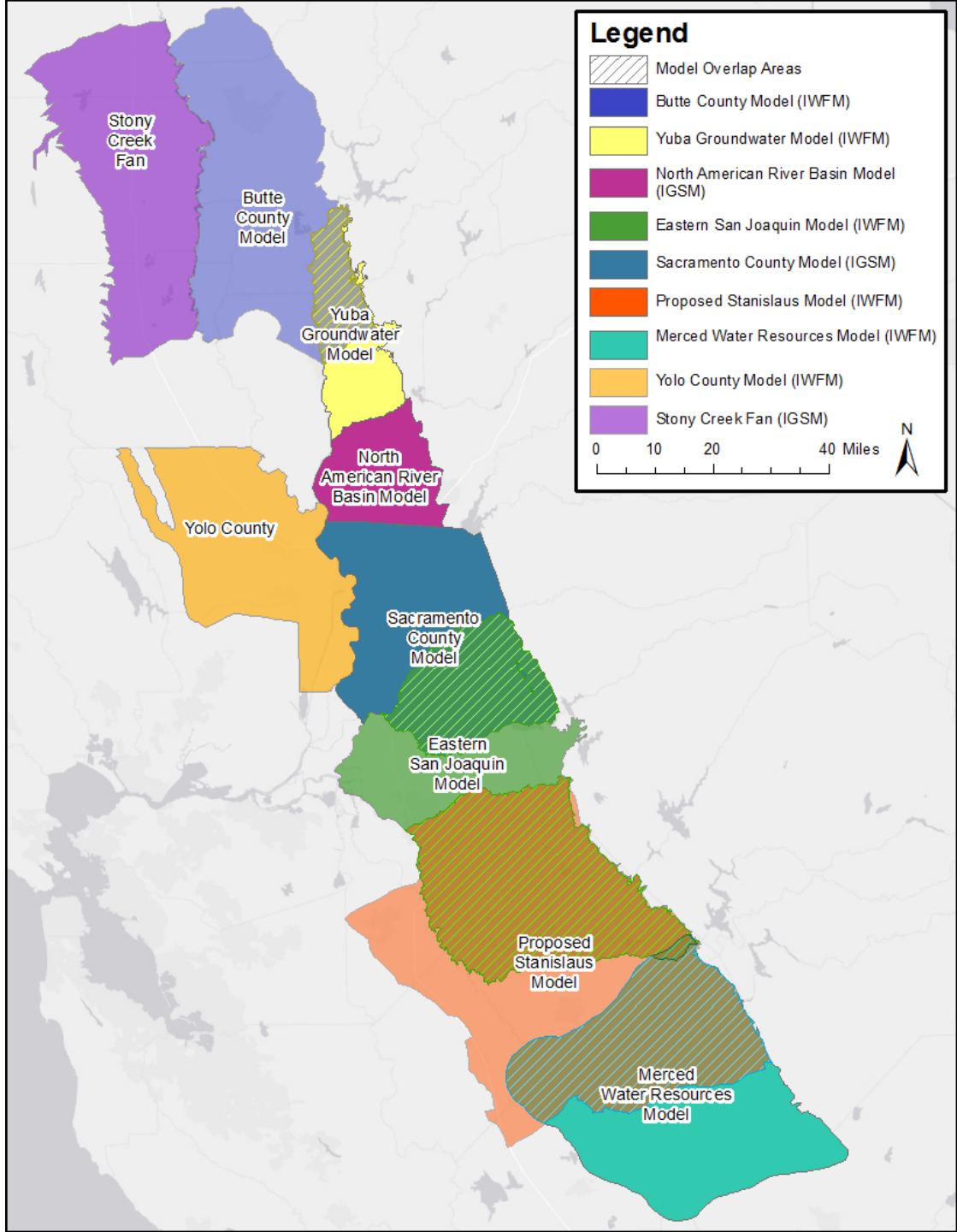
SacSim

- **<u>Primary Goal (support Groundwater Substitution Transfers):</u>**
  - Enhance DWR's C2VSim model to ensure that it meets essential modeling requirements for evaluating the impacts of groundwater substitution transfers on stream depletion in the Sacramento Valley
- **<u>Secondary Goal (support SGMA):</u>**
  - Develop a tool for estimating water budgets, simulating SW-GW interactions and land subsidence, and evaluating different SGM scenarios in the Sacramento Valley by DWR and GSAs



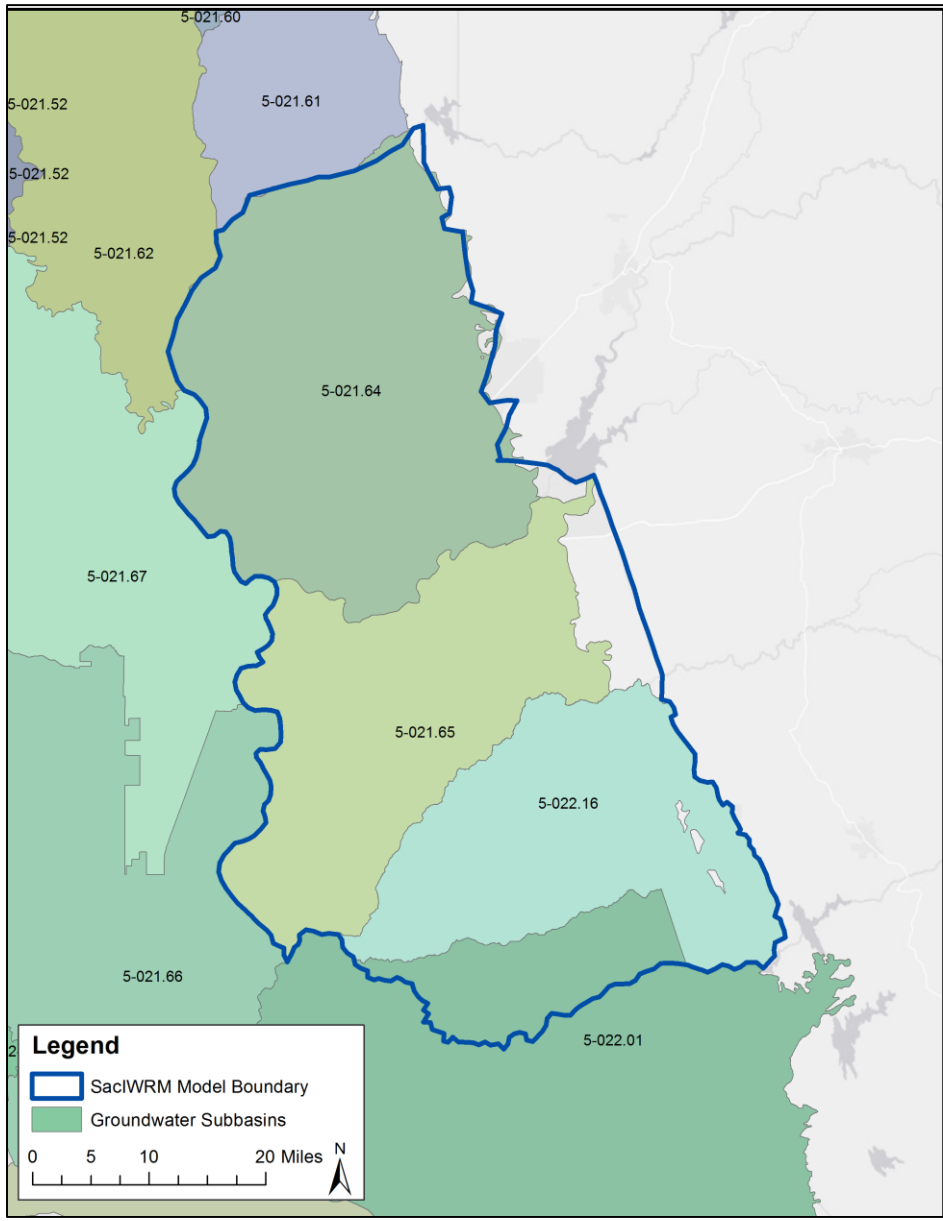
Why Use IWFM?

- Widely used in Central Valley and by adjacent basins to North American
- Designed for developing total water budget consistent with SGMA requirements
- Designed for analysis of management scenarios
- DWR to support GSAs on C2VSim use and application per regulations
- Documentation and training available from DWR



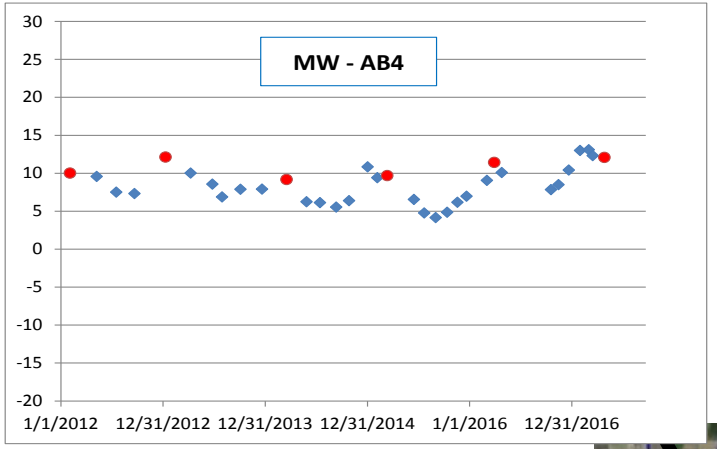
Possible Option for Moving Forward in Region

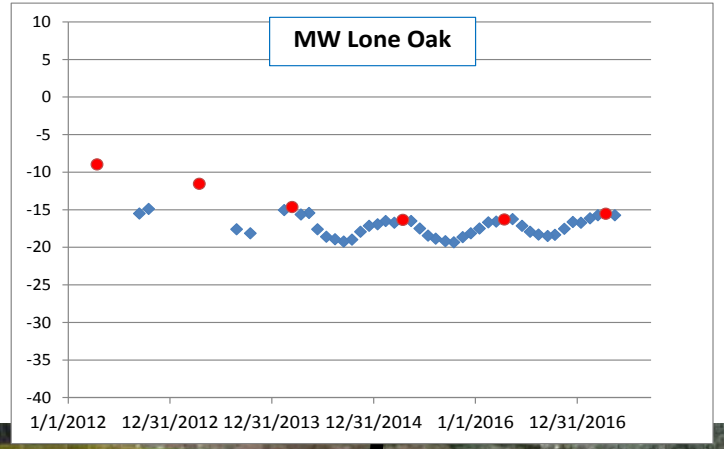
- Develop a unified IWFM application for North American, South American, and Cosumnes groundwater subbasins
- Use relevant datasets from existing SacIRWM, NARIGSM and Roseville models
- Use relevant datasets from the basin-scale C2VSim and SVSIM currently being upgraded by the DWR
- Work directly with representatives from each subbasin to ensure a wide acceptance of the modeling approach, assumptions, data, and results among the stakeholders

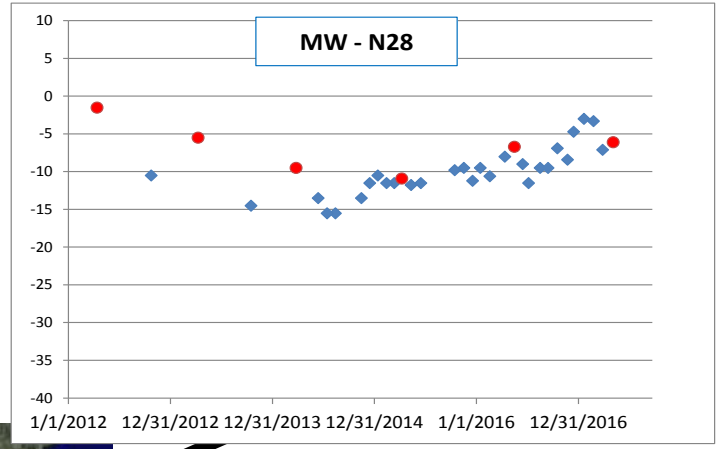


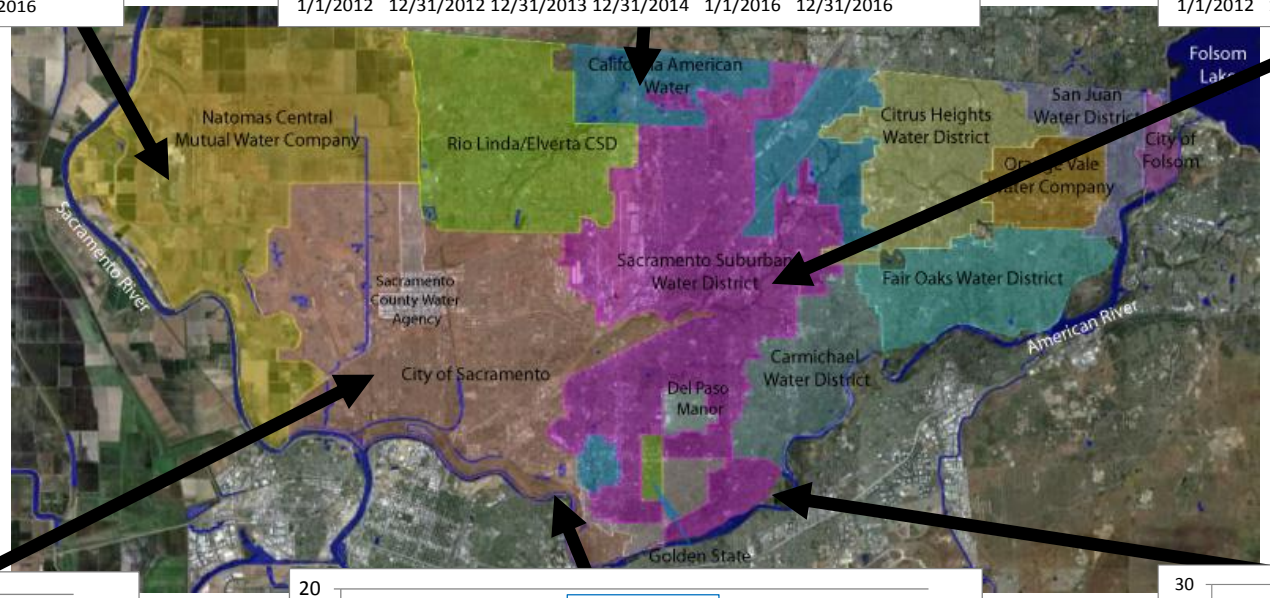
Next Steps

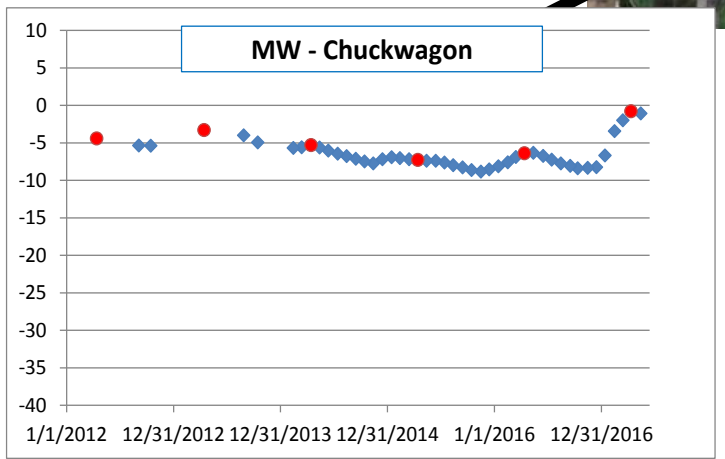
- Decide on modeling platform
- Decide on modeling application
- If decide to move forward :
  - Model scope, schedule and budget will be refined
  - Would then be split into three “modules” so that each subbasin could apply for grant funds for their portion of the update
  - Each subbasin would manage their portion of the update independently

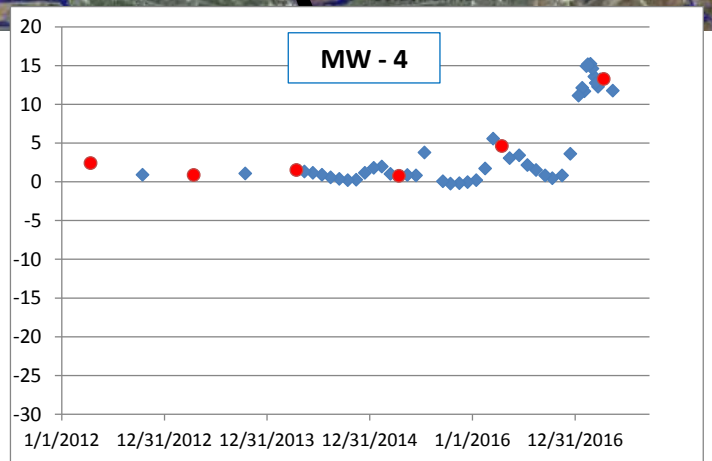

MW - AB4
30
25
20
15
10
5
0
-5
-10
-15
-20
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016

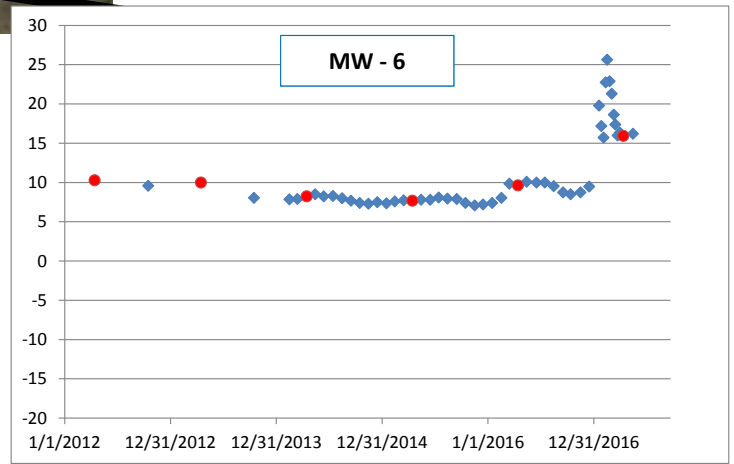

MW Lone Oak
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016


MW - N28
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016


Natomas Central Mutual Water Company
Rio Linda/Elverta CSD
Citrus Heights Water District
San Juan Water District
City of Folsom
Folsom Lake
Sacramento River
Sacramento County Water Agency
Sacramento Suburban Water District
Fair Oaks Water District
American River
City of Sacramento
Del Paso Manor
Carmichael Water District
Golden State


MW - Chuckwagon
10
5
0
-5
-10
-15
-20
-25
-30
-35
-40
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016


MW - 4
20
15
10
5
0
-5
-10
-15
-20
-25
-30
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016


MW - 6
30
25
20
15
10
5
0
-5
-10
-15
-20
1/1/2012
12/31/2012
12/31/2013
12/31/2014
1/1/2016
12/31/2016

- http://www.abc10.com/news/local/california/valley-sinking-due-to-groundwater-depletion/436087226

Past Subsidence Surveys in SGA Area

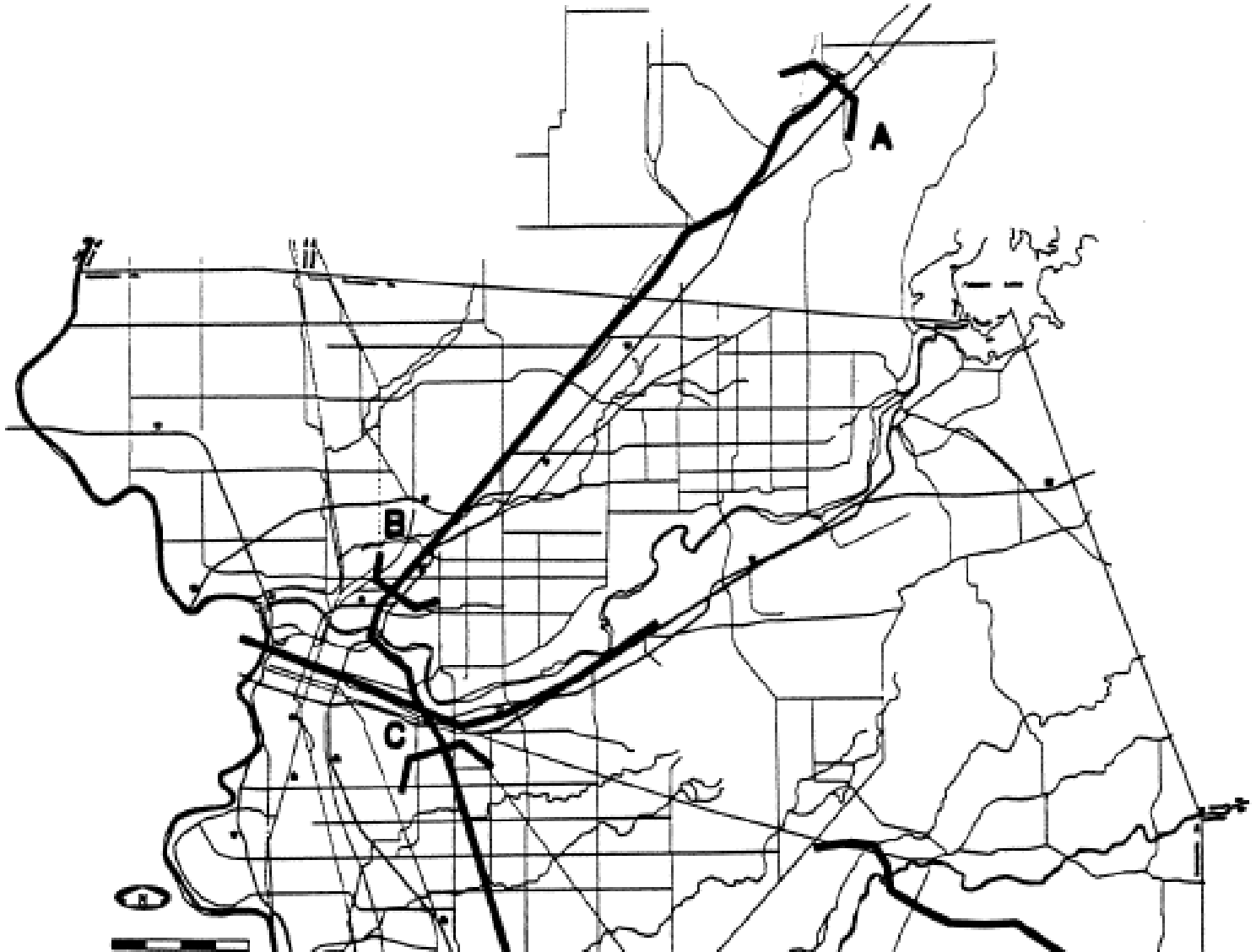
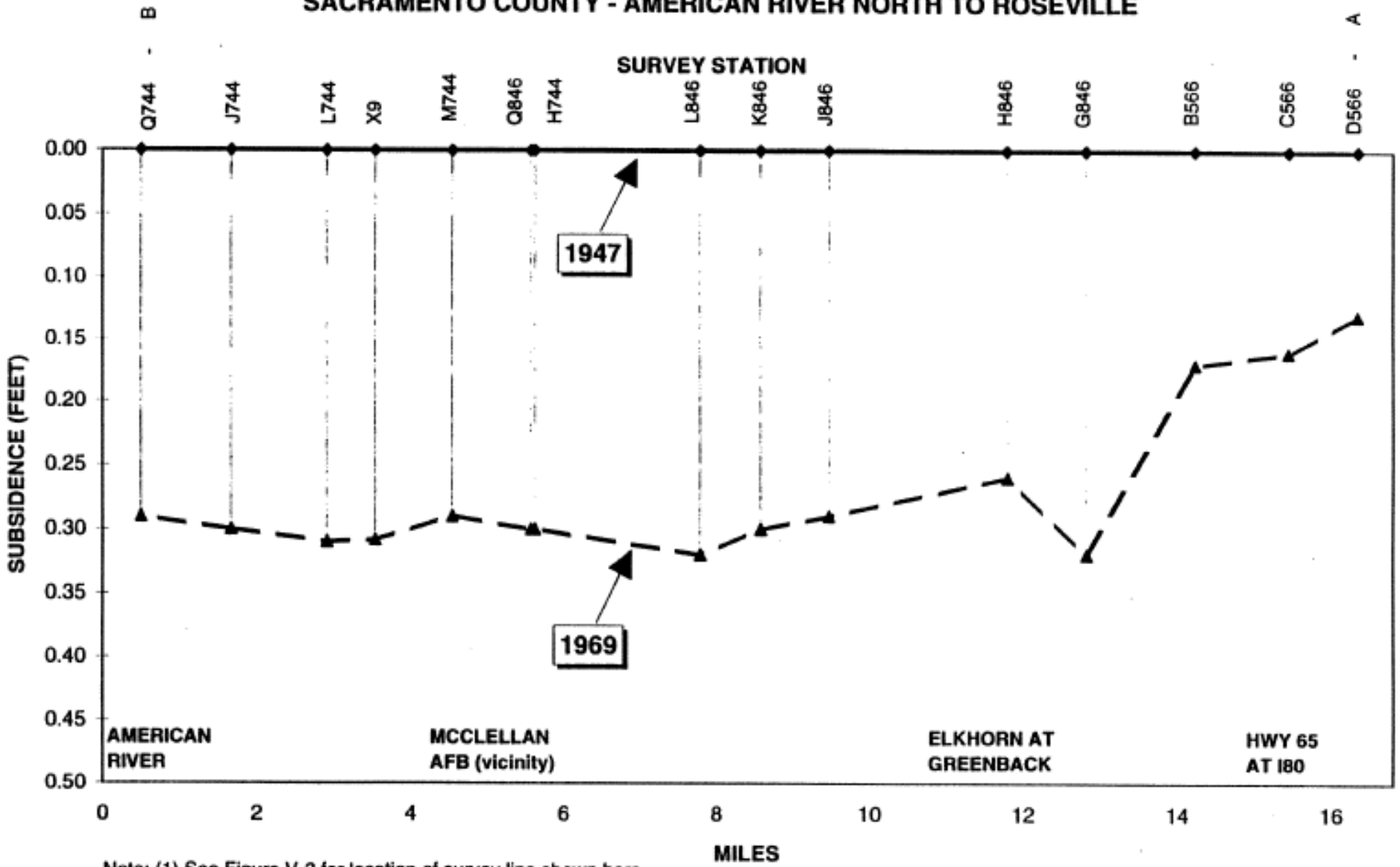


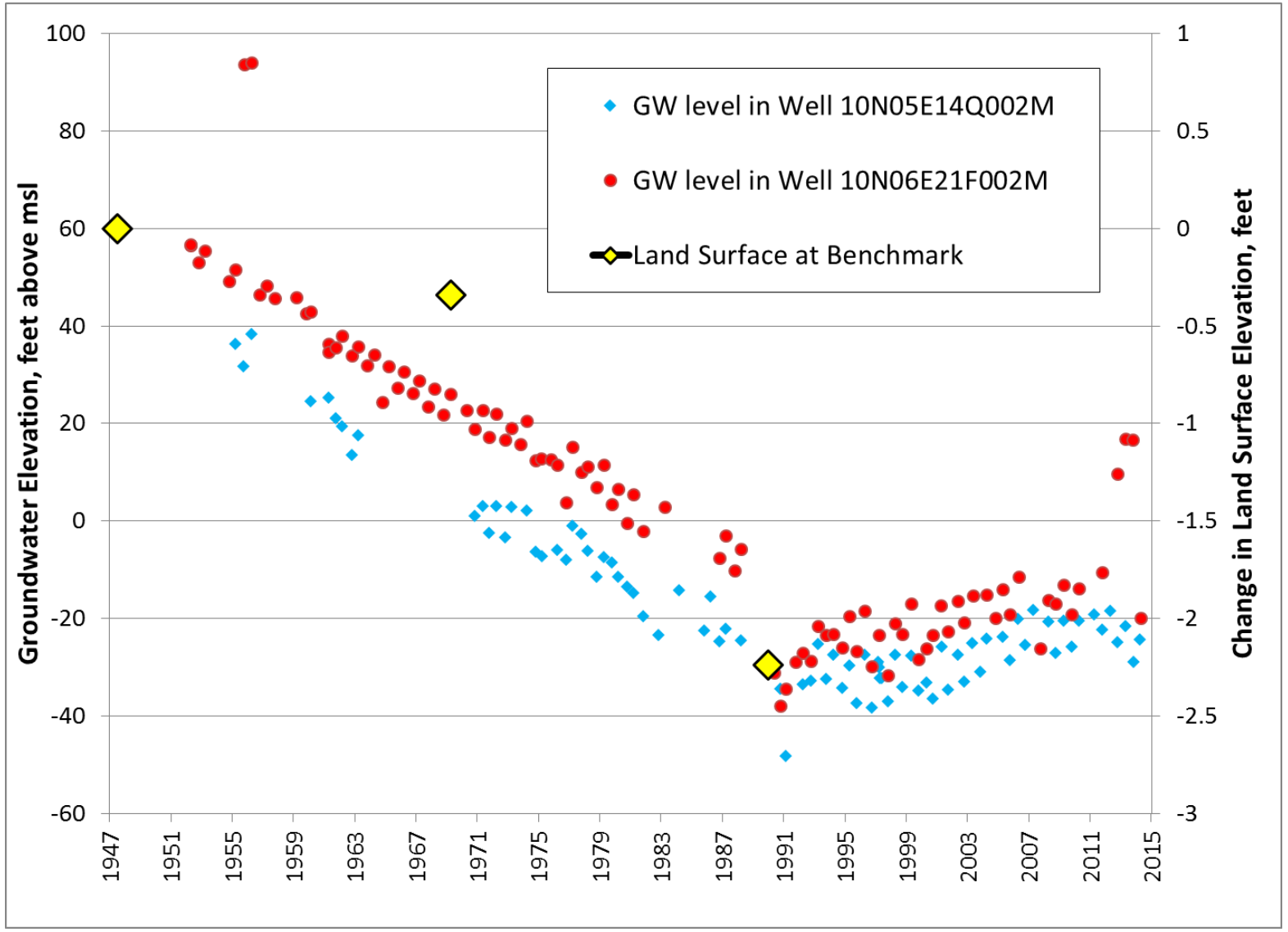
FIGURE 19

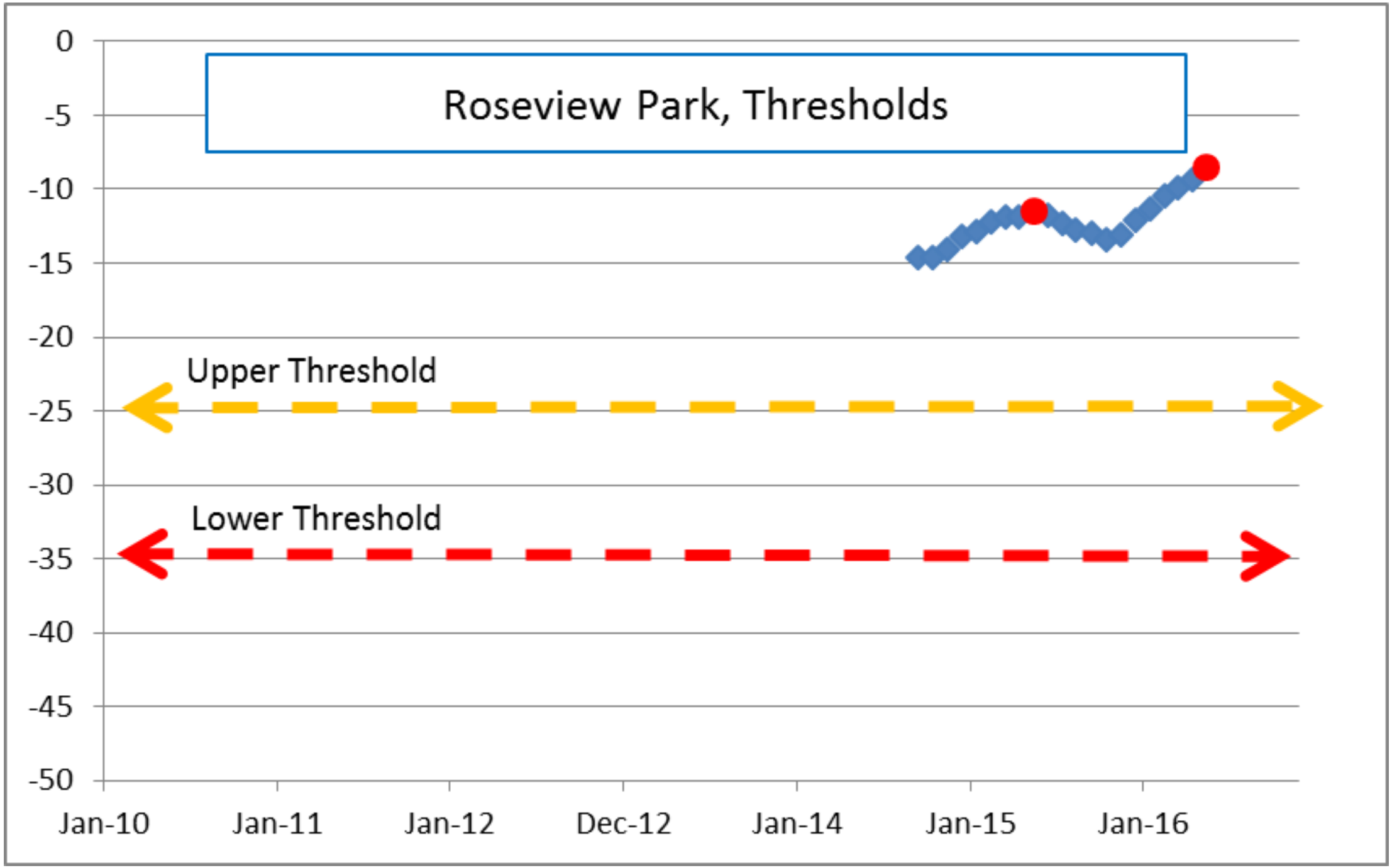
PROFILE OF LAND SUBSIDENCE OCCURRING BETWEEN 1947 AND 1969
SACRAMENTO COUNTY - AMERICAN RIVER NORTH TO ROSEVILLE



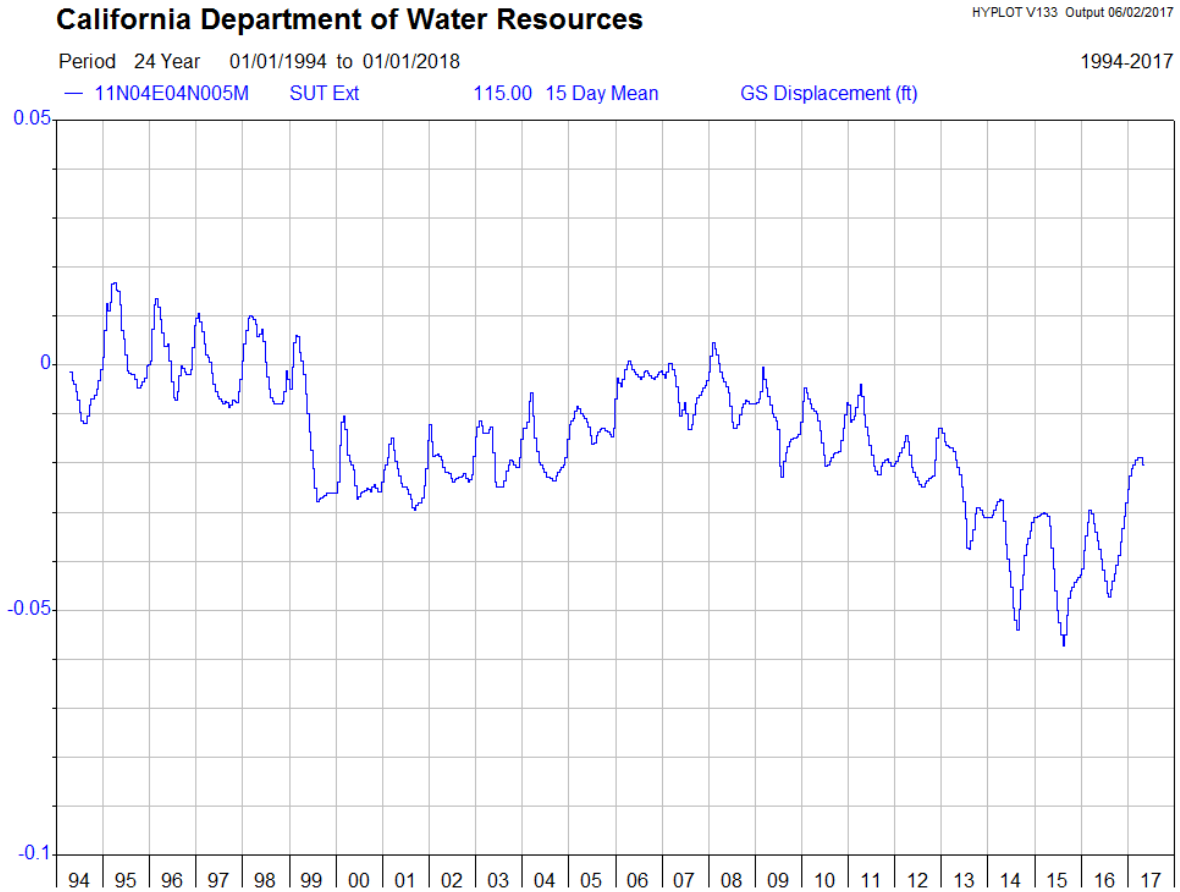
Note: (1) See Figure V-3 for location of survey line shown here.

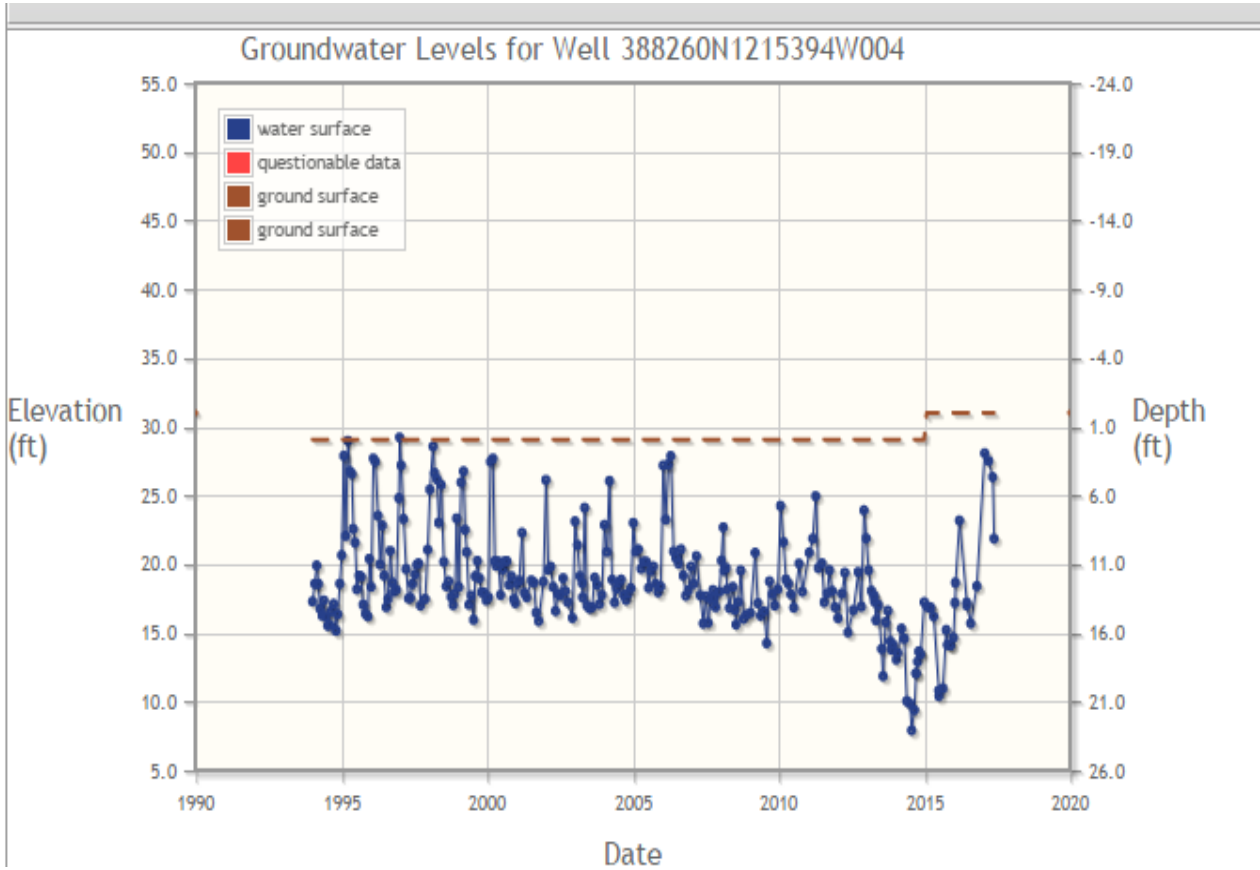
Historical Subsidence Information in SGA Area

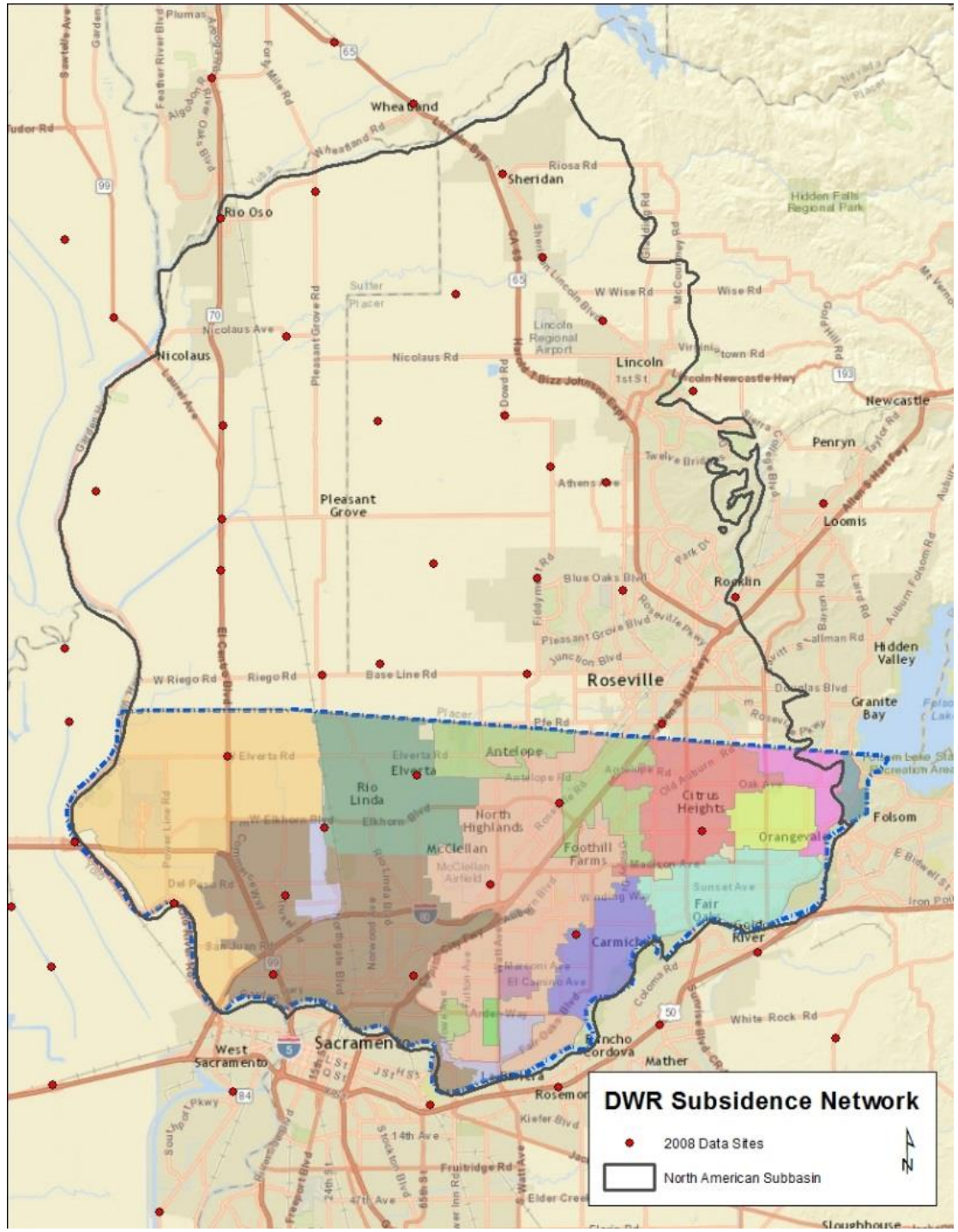



Roseview Park, Thresholds
0
-5
-10
-15
-20
-25
-30
-35
-40
-45
-50
Upper Threshold
Lower Threshold
Jan-10
Jan-11
Jan-12
Dec-12
Jan-14
Jan-15
Jan-16

Sutter Extensometer






DWR Subsidence Network
2008 Data Sites
North American Subbasin
N
Sacramento
West Sacramento
Roseville
Rocklin
Lincoln
Pleasant Grove
Rio Oso
Nicolaus
Sheridan
Wheatland
Penryn
Newcastle
Loomis
Granite Bay
Folsom
Citrus Heights
Antelope
Elverta
Rio Linda
North Highlands
McClellan
Foothill Farms
Orangevale
Fair Oaks
Carmichael
Rancho Cordova
Mather
Hidden Valley