Previous models of the Treasure Valley aquifer system

Presented to the Treasure Valley Modeling Technical Advisory Committee
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Introduction

- Treasure Valley Comprehensive Aquifer Management Program (CAMP) review of Treasure Valley groundwater models
- Treasure Valley Hydrologic Project (UI/IDWR)
- Treasure Valley Distributed Parameter Water Budget Data Base (BOR/IDWR)
- Transient Groundwater Model of the Treasure Valley Aquifer (BOR)
- IDWR recommendations for building on previous modeling efforts

CAMP Review of Models

- Cosgrove (2010)
  - Evaluated 7 models
    - Lindgren TV (1982)
    - USGS WSP (1991)
    - TVHP (2004)
    - UI M3 Eagle Area (2007)
    - PGG M3 Eagle Area (2008)
    - BOR Purdam Drain (2008)
    - BOR NY Canal (2009)

Evaluation of Ground Water Models in the
Treasure Valley, Idaho Area

Prepared for the Idaho Department of Water Resources
Boise, Idaho

by

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Western Water Consulting, Inc.
Idaho Falls, Idaho

June, 2010

http://www.idwr.idaho.gov/Browse/WaterInfo/EADA/contractor_findings/

CAMP Review of Models

- Cosgrove (2010) evaluated
  - model purpose;
  - areal extent;
  - method (finite difference, analytic element);
  - time discretization;
  - boundary conditions;
  - water budget

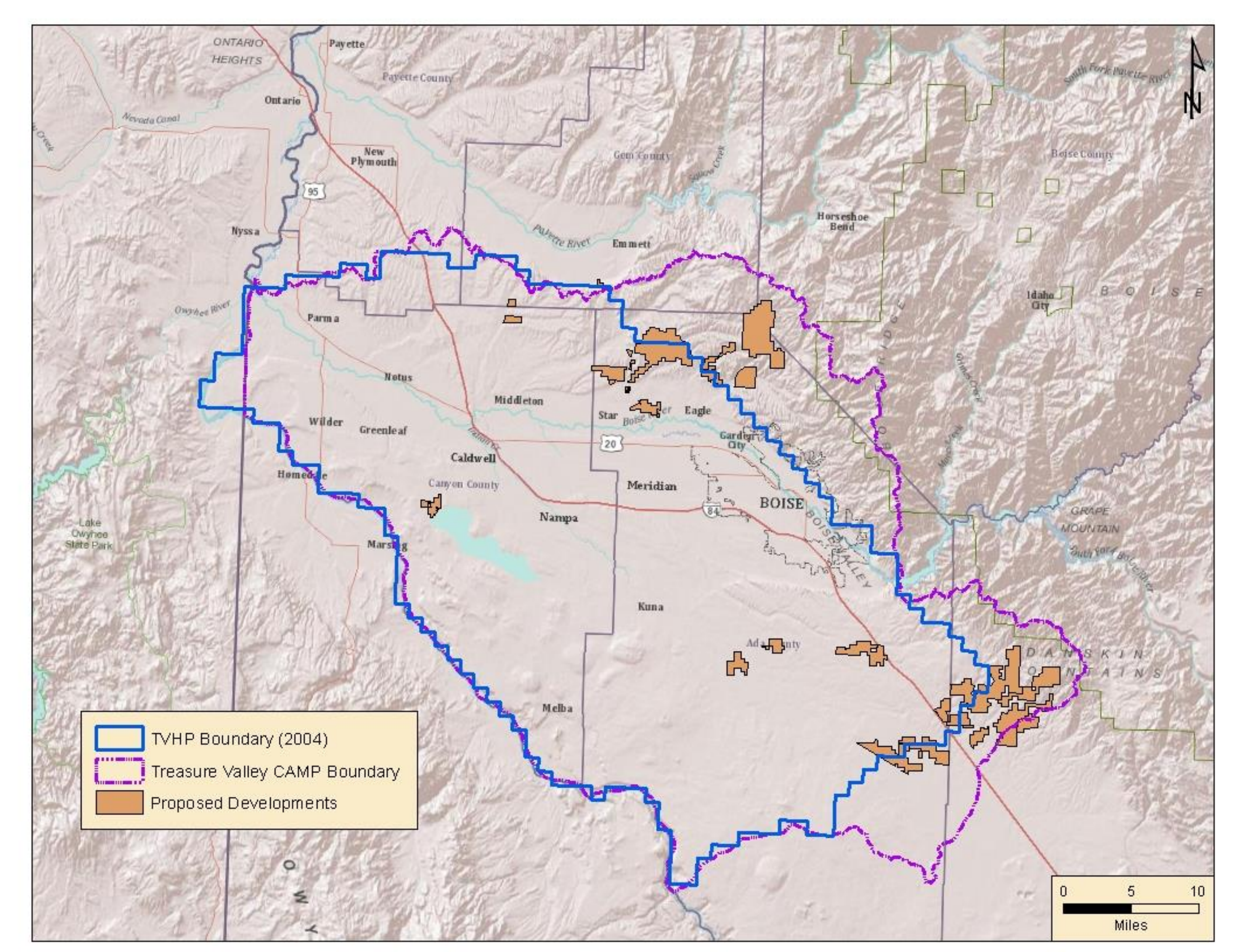
CAMP Review of Models

- Cosgrove (2010) concluded TVHP model is most rigorously developed model and recommended further development using TVHP as a starting point
  - Calibrate as a transient model
  - Extend northern model boundary to include Payette River
  - Extend southeast model boundary to include East Ada area

Treasure Valley Hydrologic Project (TVHP, 1996-2004)

- Characterized aquifer
  - Geologic cross sections and contour maps
  - Multi-level monitoring wells
  - Water level measurements (1996)
  - Geochemistry and isotope study
- Developed water budget for 1996 and 2000
- Simulation of groundwater flow
- Numerous reports available at http://www.idwr.idaho.gov/water-data/projects/treasure-valley/references.html

TVHP Model Extent



TVHP Model (Petrich, 2004)

- MODFLOW finite difference model
- Regional flow model
- Steady state model only
- Four layers
- 1-mile x 1-mile grid
- 5,448 active cells (1,362 mi^2 x 4 layers)

TVHP Model Layer Discretization

- Geologic strata were not used to define layers (Petrich, 2004)
  - transitions are neither apparent nor consistent over entire model domain
  - transitions may vary substantially in elevation
  - formations may be above saturated zone in part of model domain

TVHP Model Layer Discretization

Layers defined by elevation surface based on Boise and Snake River elevations (Petrich, 2004)

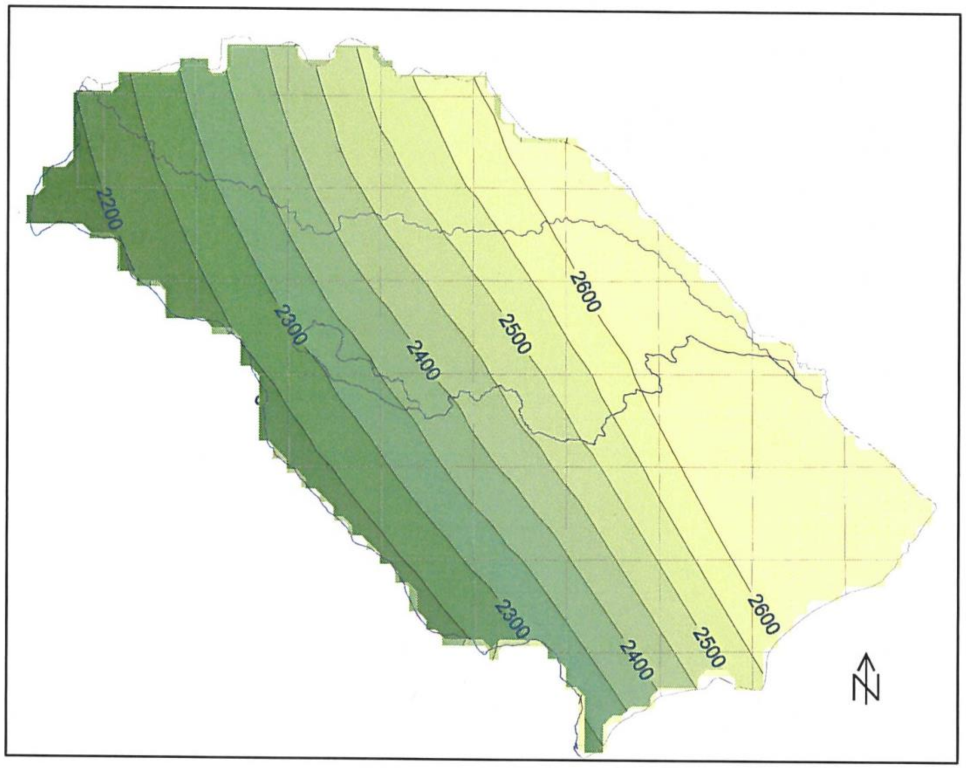


Figure 3-3: Elevation (ft) of uniform layer surface (i.e., layer "datum").

TVHP Model Layer Discretization

- Layers defined by elevation surface based on Boise and Snake River elevations (Petrich, 2004)
  - Layer 1 extends to a depth of 200 feet below this datum and is assumed to include most of the coarser-grained Snake River sediments
  - Layer 2 extends 200 feet below Layer 1 and roughly corresponds to the unconformity separating the Chalk Hills formation and overlying sediments in some areas
  - Layers 3 and 4 are each 400 feet thick and generally represent the Idaho Group sediments

TVHP Boundary Conditions

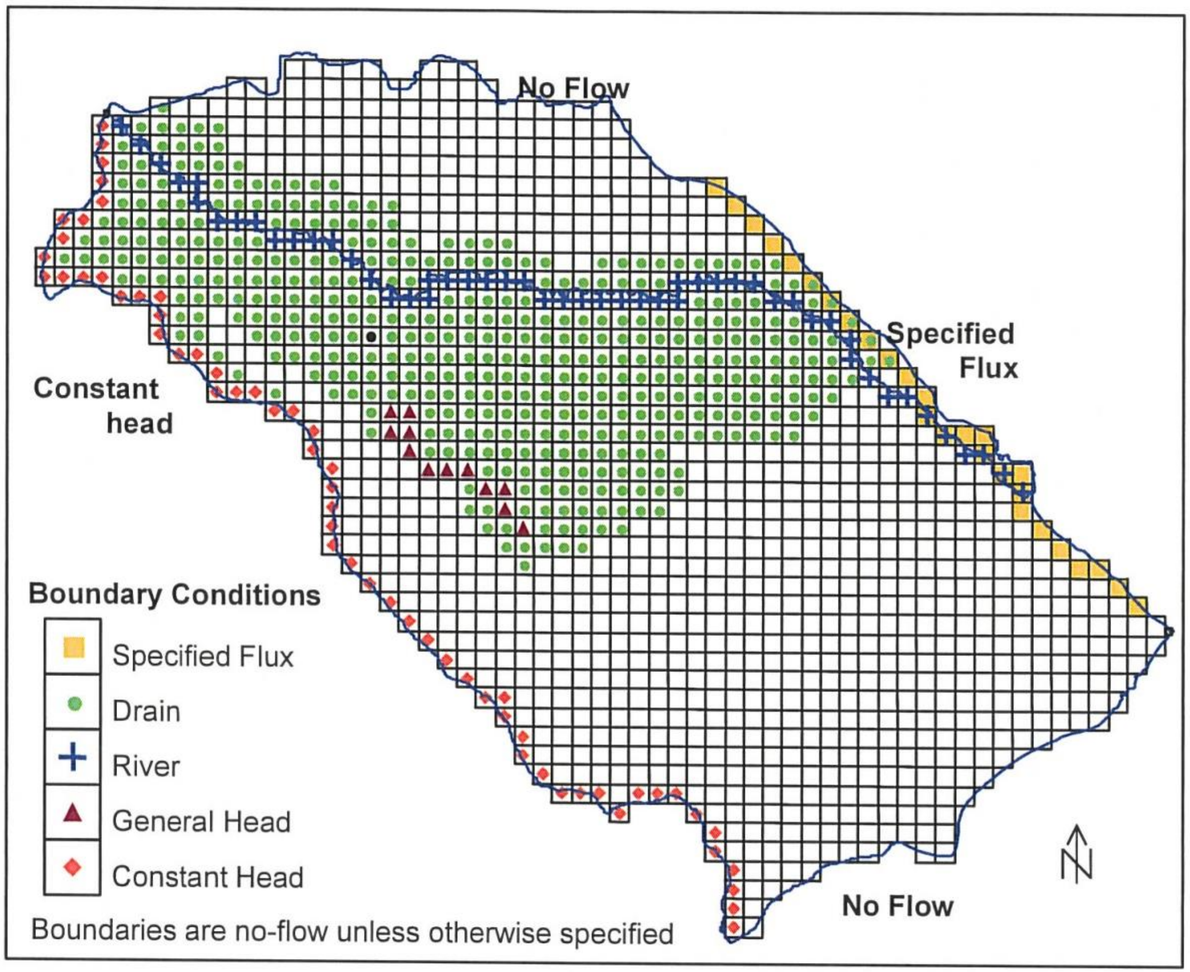


Figure 3-5: Model grid and boundary conditions.

TVHP Calibration (Petrich, 2004)

- Water budget for calendar year 1996
- 200 steady state water level targets, average of spring and fall 1996 measurements
- Flux data for rivers and drains had not been compiled at time of model calibration
- One vertical gradient observation target from Caldwell multi-level monitoring well
- Five synthetic vertical gradient targets based on anecdotal water level information

TVHP Calibration (Petrich, 2004)

Calibrated Kh at 44 pilot points in Layers 1, 2, 3/4

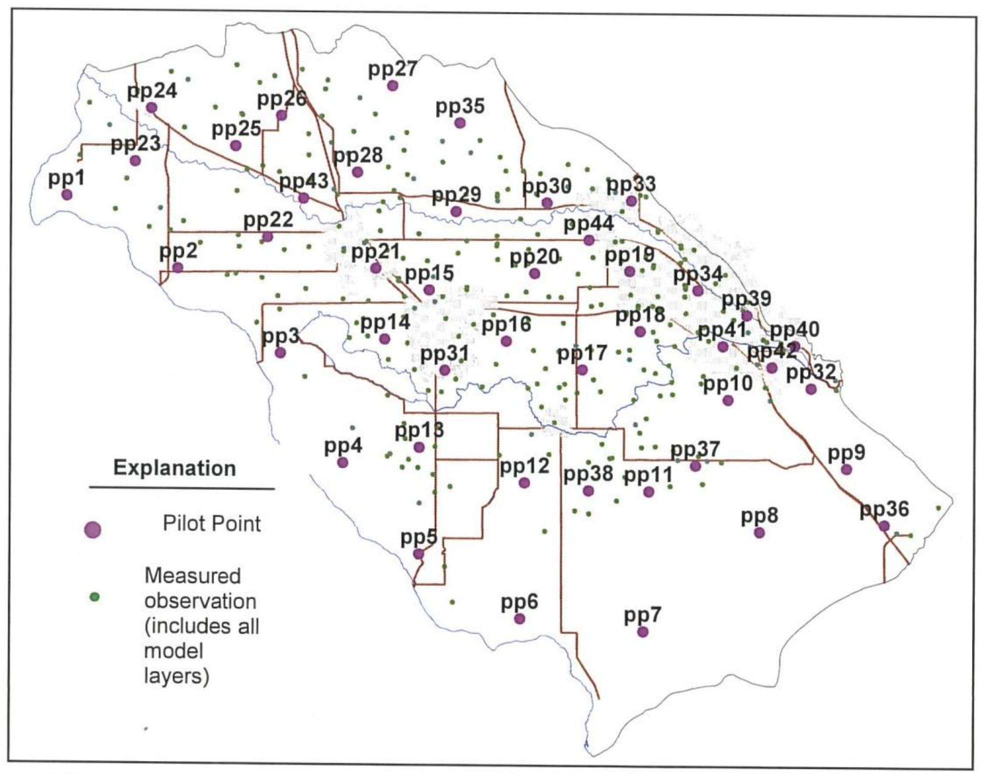


Figure 5-6: Distribution of pilot points.

TVHP Calibration (Petrich, 2004)

Calibrated Kv at 44 pilot points in Layers 1, 2, 3/4

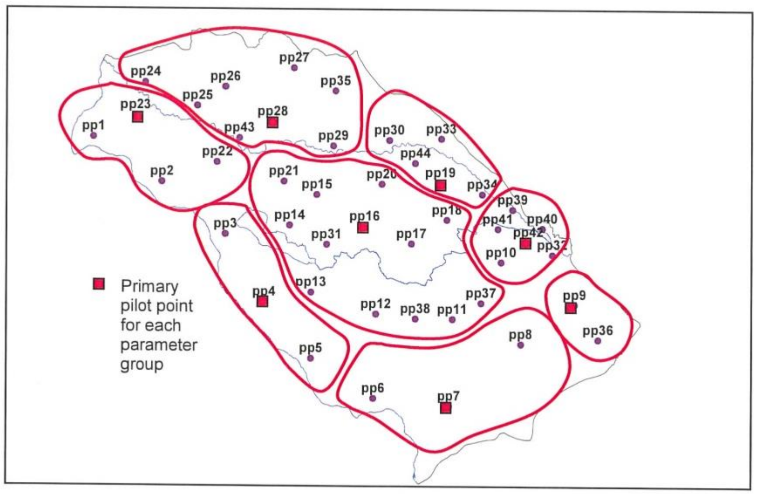


Figure 5-7: Tied K_v parameters in layer 1.

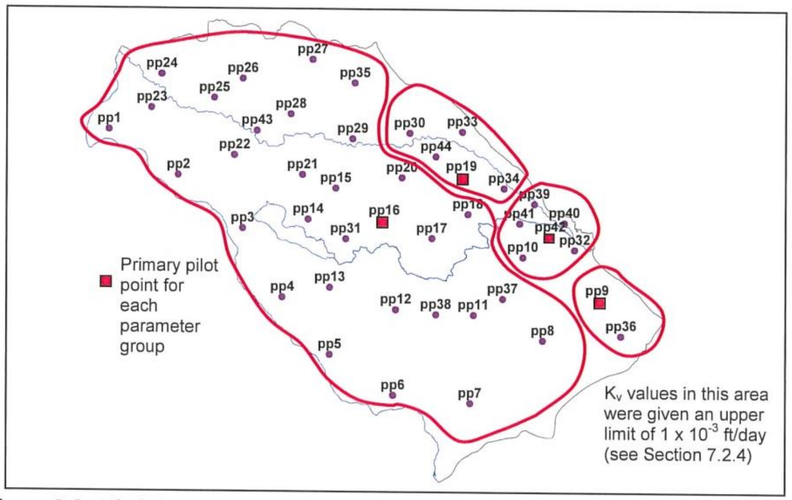


Figure 5-8: Tied K_v parameters in layers 2 and 3.

TVHP Calibration (Petrich, 2004)

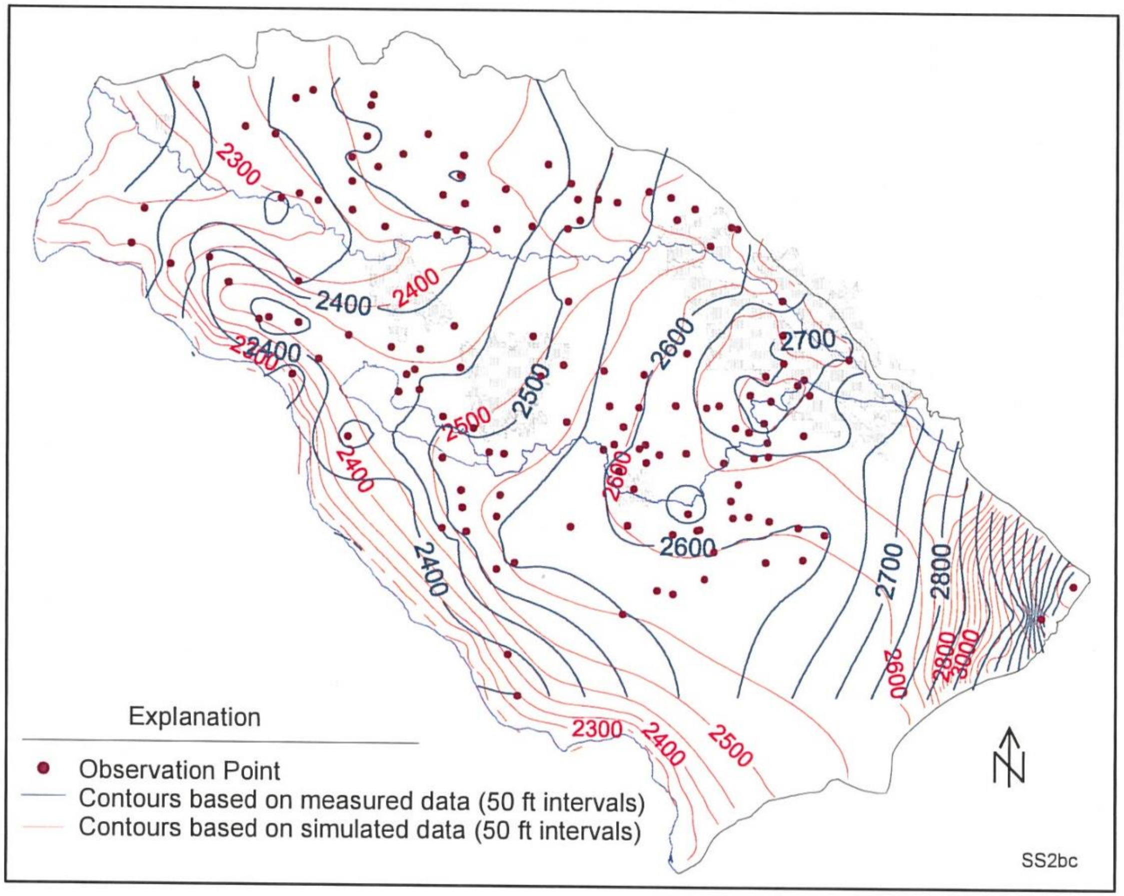


Figure 7-2: Simulated and observed potentiometric contours, layer 1.

TVHP Calibration (Petrich, 2004)

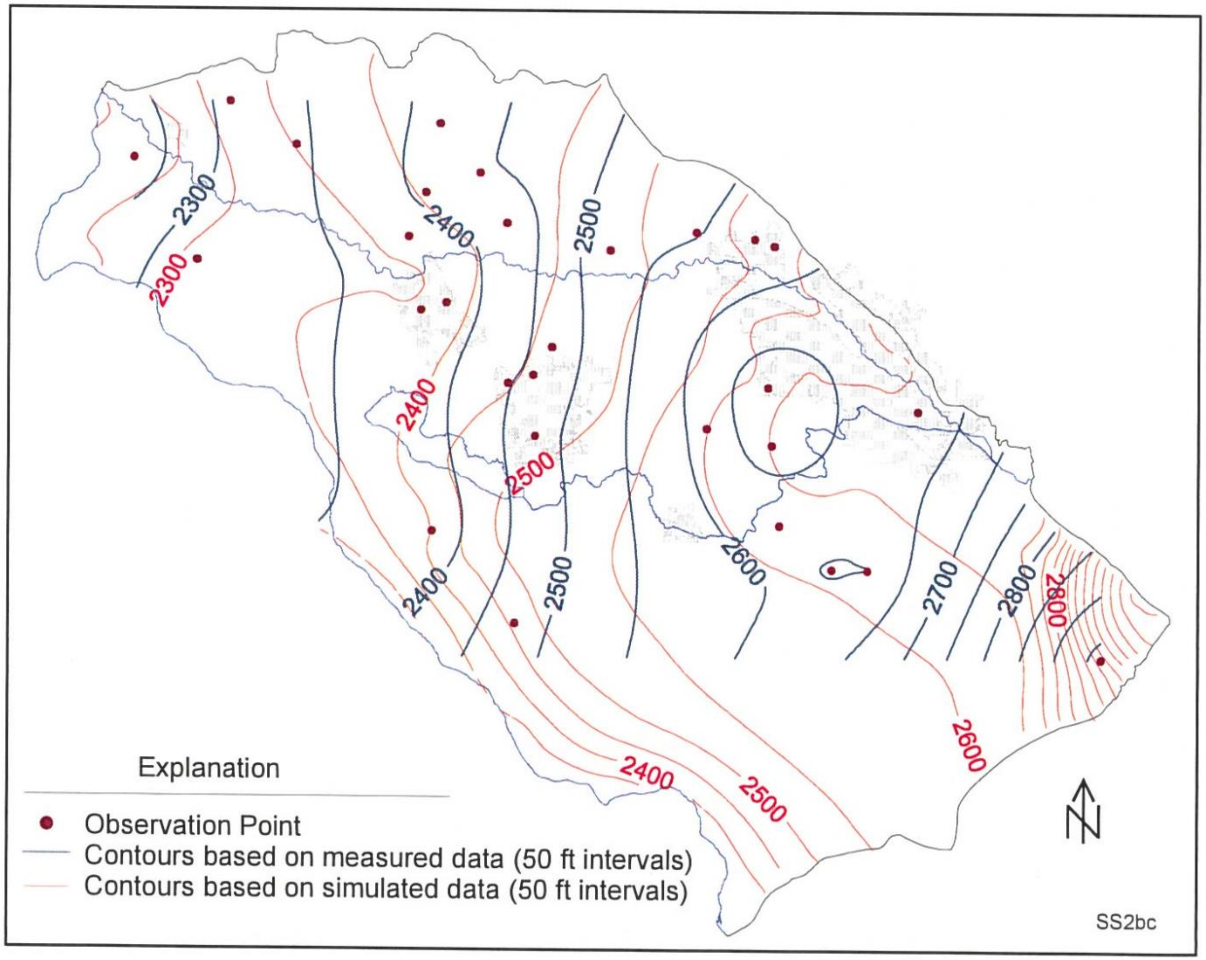


Figure 7-3: Simulated and observed potentiometric contours, layer 2.

TVHP Calibration (Petrich, 2004)

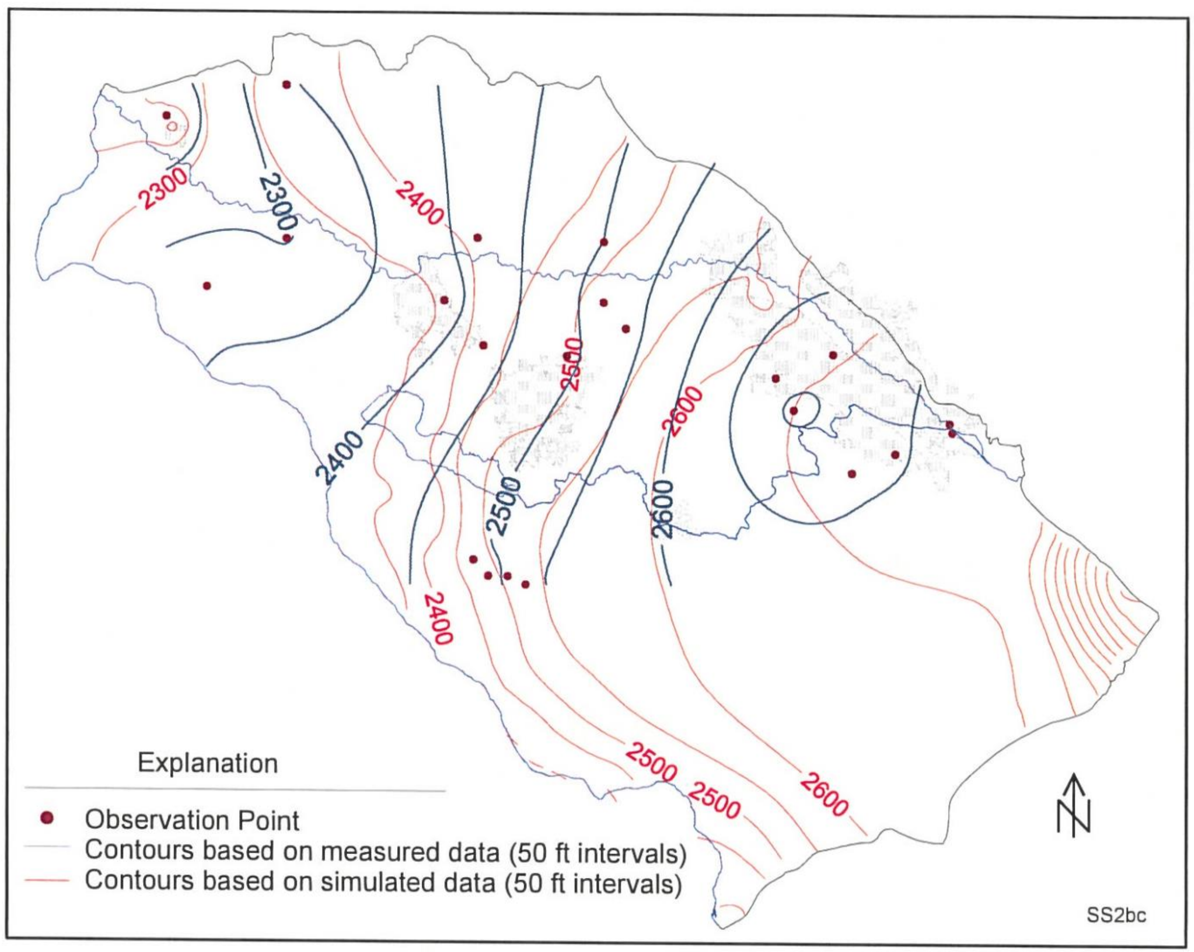


Figure 7-4: Simulated and observed potentiometric contours, layer 3.

TVHP Calibration (Petrich, 2004)

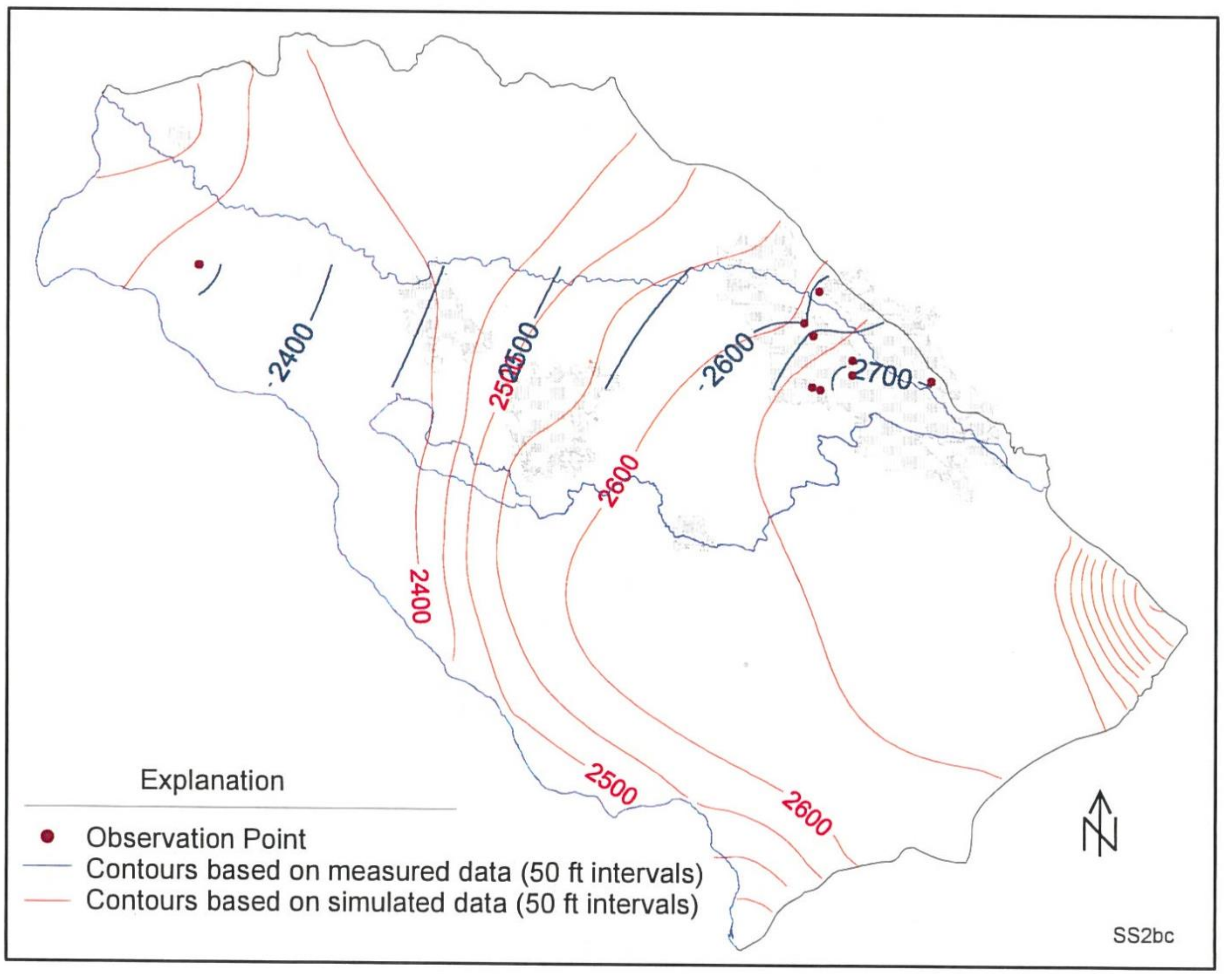


Figure 7-5: Simulated and observed potentiometric contours, layer 4.

Selected Conclusions from TVHP Model

- Conductivity is generally higher in upper aquifer zones and in eastern and central portion of the valley
- Flux between model layers is small, especially in the lower layers
- 10% increase or decrease in recharge resulted in minimal changes in water levels at steady state
- Predicted water level declines due to a 20% increase in groundwater withdrawal were modest in Layers 1 & 2 and greater in Layers 3 & 4

Selected Recommendations from TVHP Model

- Expand monitoring in areas showing recent water level declines
- Better define discharge rates to surface water channels to constrain model discharge
- Better define temporal discharge and return rates for transient simulations
- Install additional multi-level wells to expand vertical gradient data
- Enhance water level monitoring in areas that lack data

Bureau of Reclamation studies

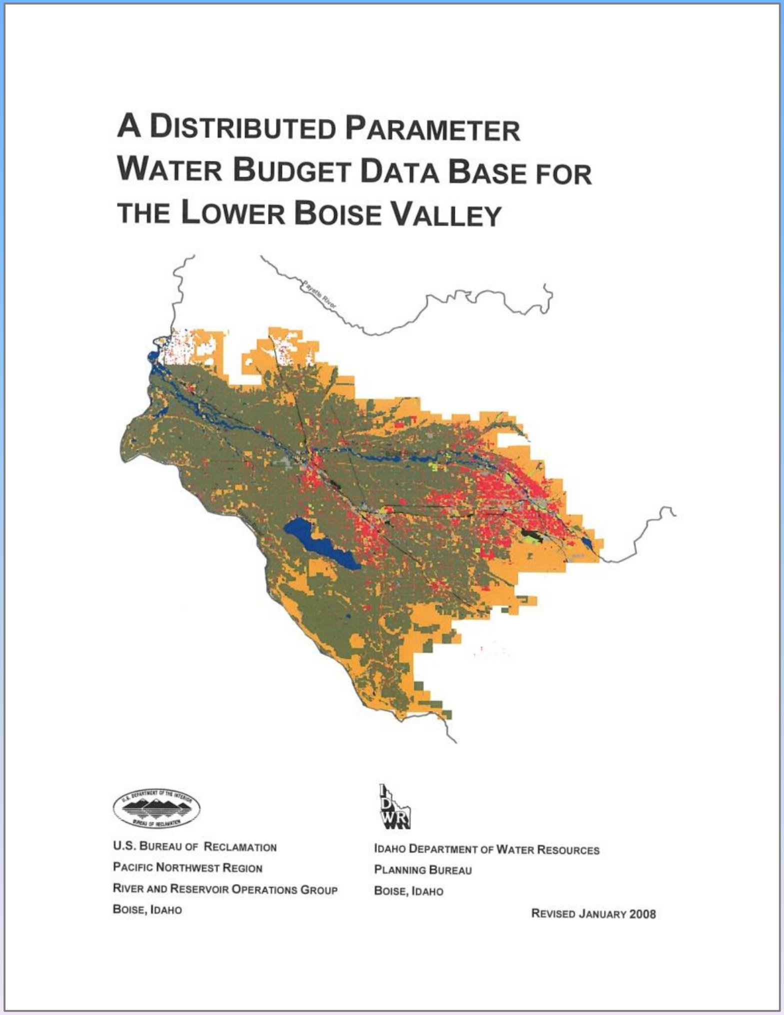
- Since TVHP, BOR has implemented some recommendations from TVHP and the CAMP model evaluation
  - Distributed Parameter Water Budget for Lower Boise Valley (BOR/IDWR, 2008)
  - Transient Groundwater Model of the Treasure Valley Aquifer (BOR, 2013)

Distributed Parameter Water Budget for Lower Boise Valley (BOR, 2008)

- Average monthly water budget data based on 1967-1997 data
  - Assumed little change in total irrigated acreage between the completion of Lucky Peak Dam and 1997
- Spatial distribution of irrigated lands, dry lands, water bodies, and DCMI lands based on 1994 Boise Valley land use
- Quantifies groundwater discharge to drains and base flow discharge to Boise River & Snake River
- Average groundwater discharge to drains was estimated based on limited measured data

Distributed Parameter Water Budget

- R.D. Schmidt and others, 2008
- http://www.idwr.idaho.gov/WaterInformation/Projects/nac/Publications/PDFs/A_Distributed_Parameter_Water_Budget_Data_Base_for_the_Lower.pdf



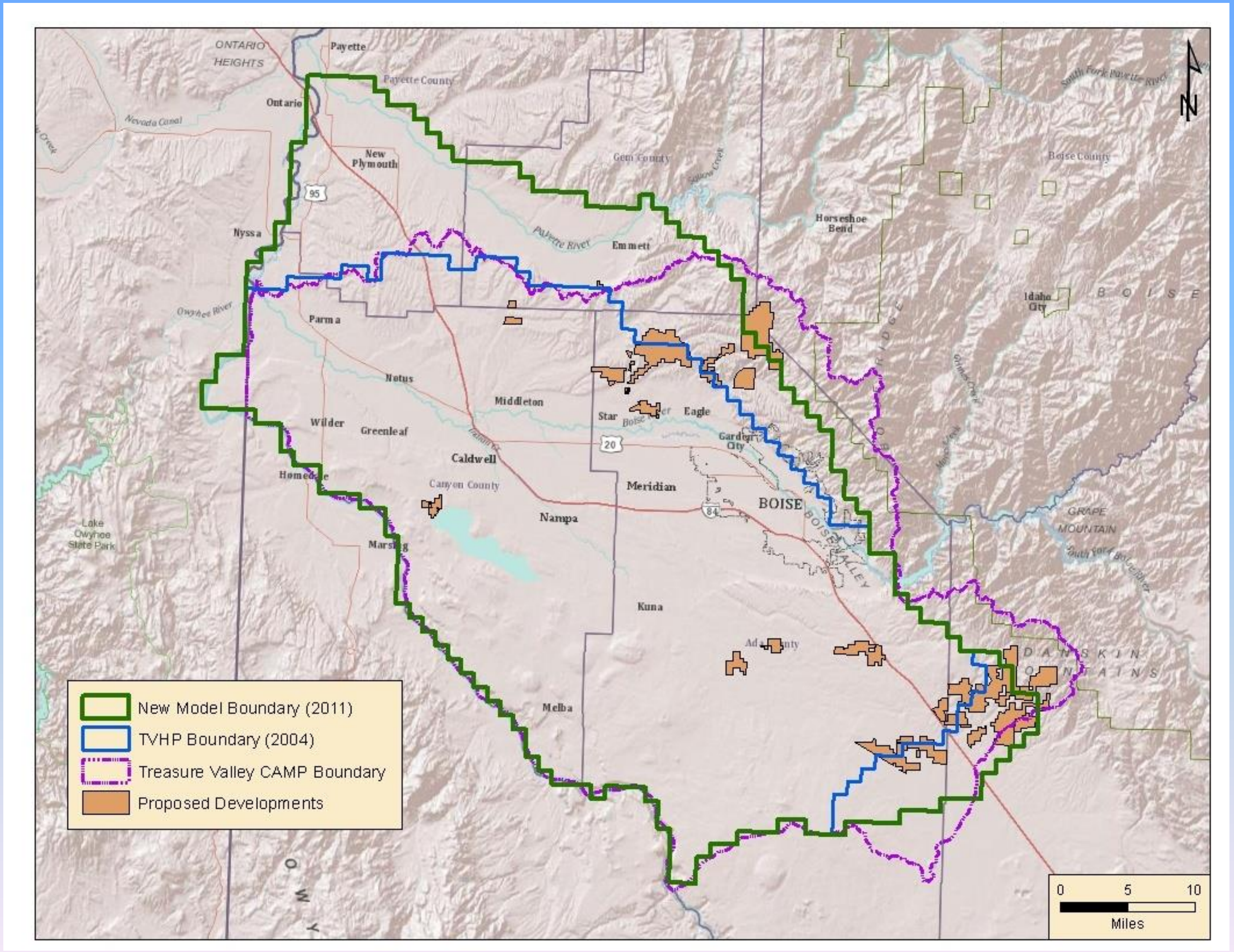
Transient Groundwater Model of the Treasure Valley Aquifer (BOR, 2013)

- Part of a larger research project, "*Evaluating Water Management Responses to Global Climate Change Using Coupled Hydrologic and Economic Models*"
- Modeling effort incorporated some of recommendations from CAMP model review
  - Transient model
  - Expanded model area and modification of some boundary conditions

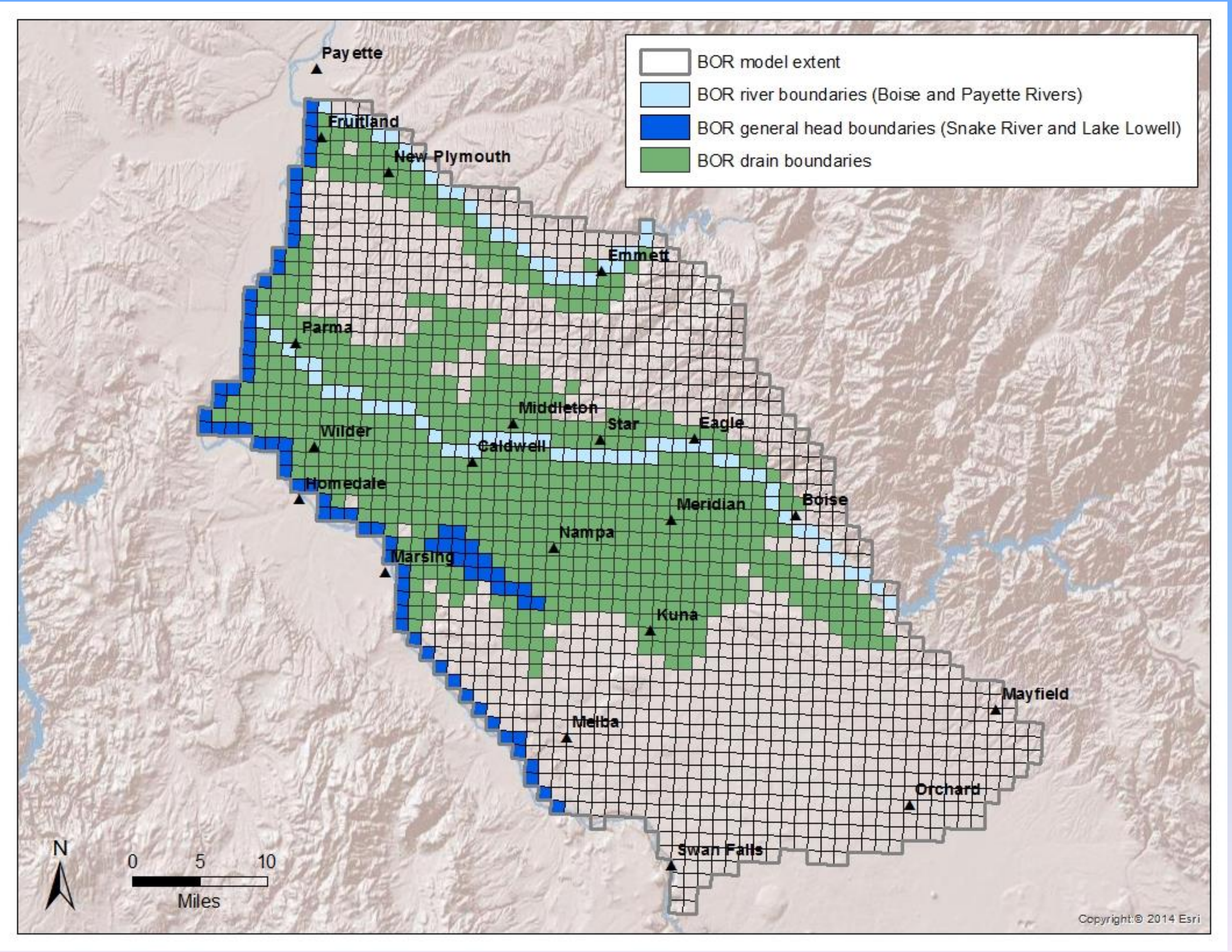
Transient Groundwater Model of the Treasure Valley Aquifer (BOR, 2013)

- Transient calibration using average monthly water budget (1967-1997)
- 20-year simulation calibrated to average monthly targets during last 5 years of simulation
- Expanded model boundaries based on recommendations from CAMP evaluation
- Changed Snake River from constant head to general head boundary
- Added drain boundary condition to approx. 180 cells within TVHP boundary
- Added flux calibration targets for Snake, Boise, and Payette rivers, Lake Lowell, and 20 drain areas
- Calibrated to monthly average head targets at 38 well locations

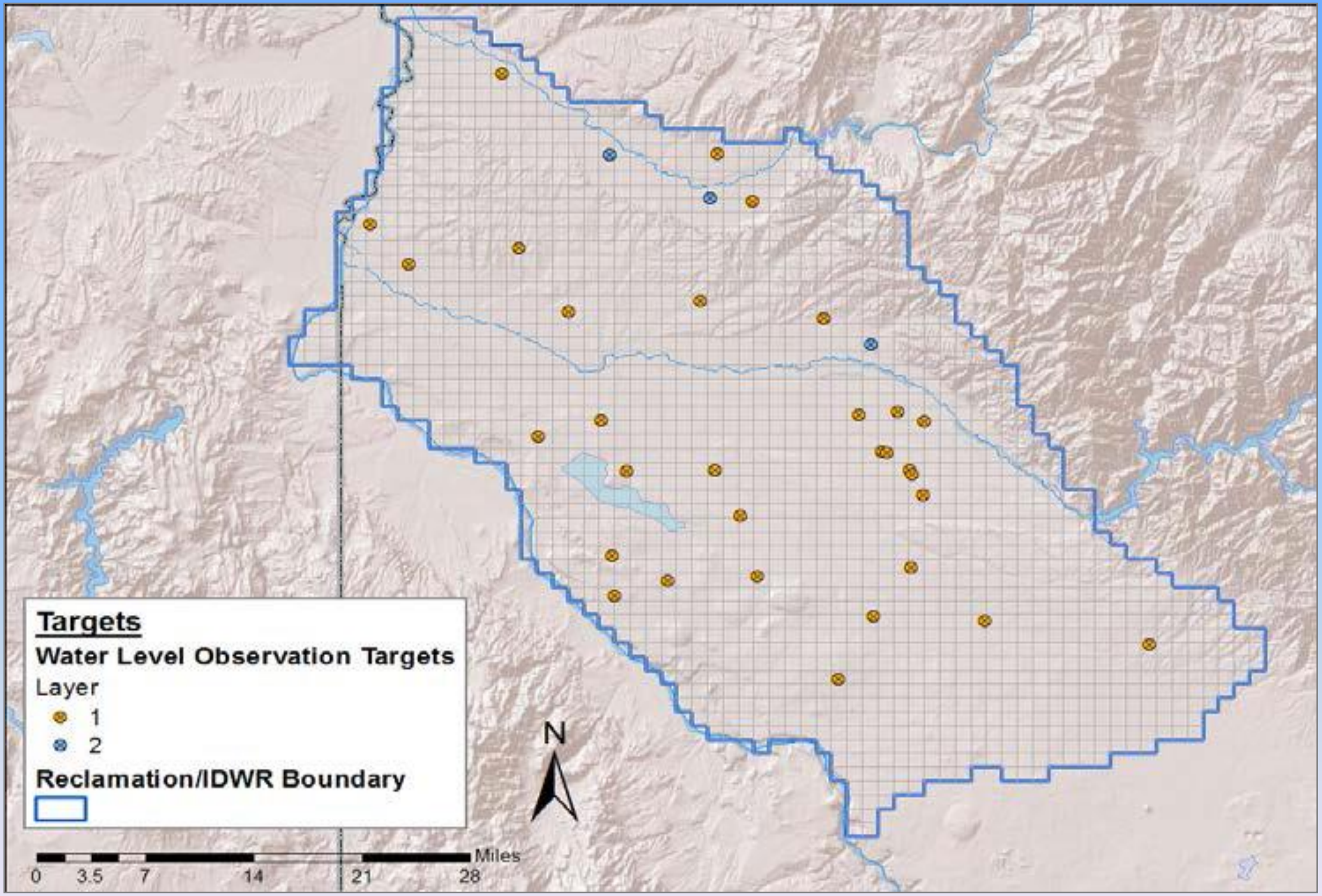
BOR (2013) model boundary



BOR (2013) boundary conditions



BOR (2013) head calibration targets



BOR (2013) head calibration targets

Figure 3-8: Location of observation hydrographs plotted in Figure 3-9.

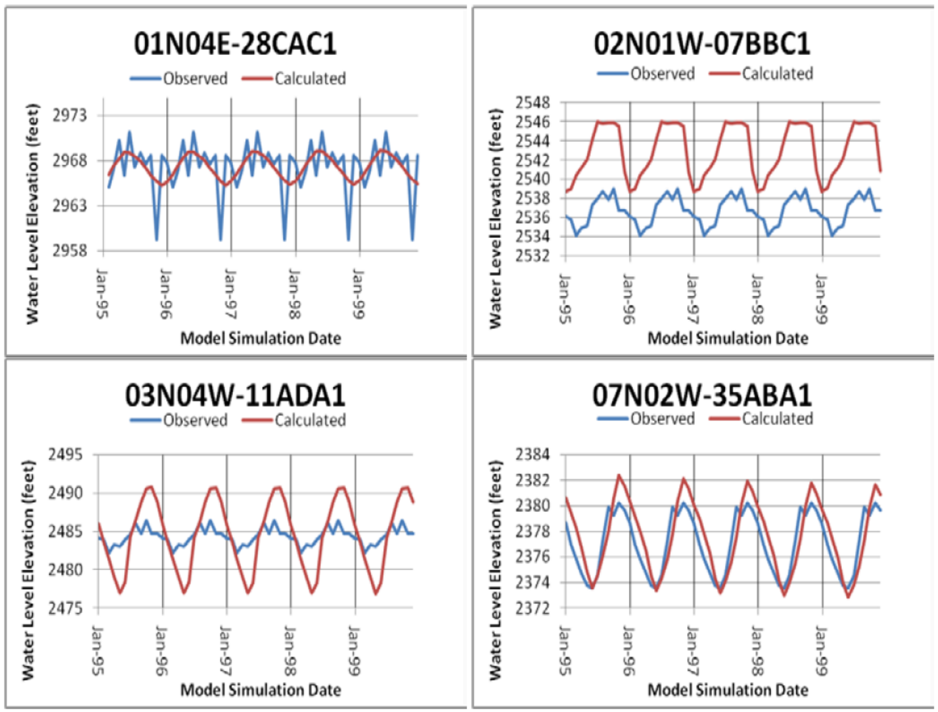


Figure 3-9: Observed and calculated water levels at target locations shown in Figure 3-8 in which the seasonal timing is matched.

BOR (2013) head calibration targets

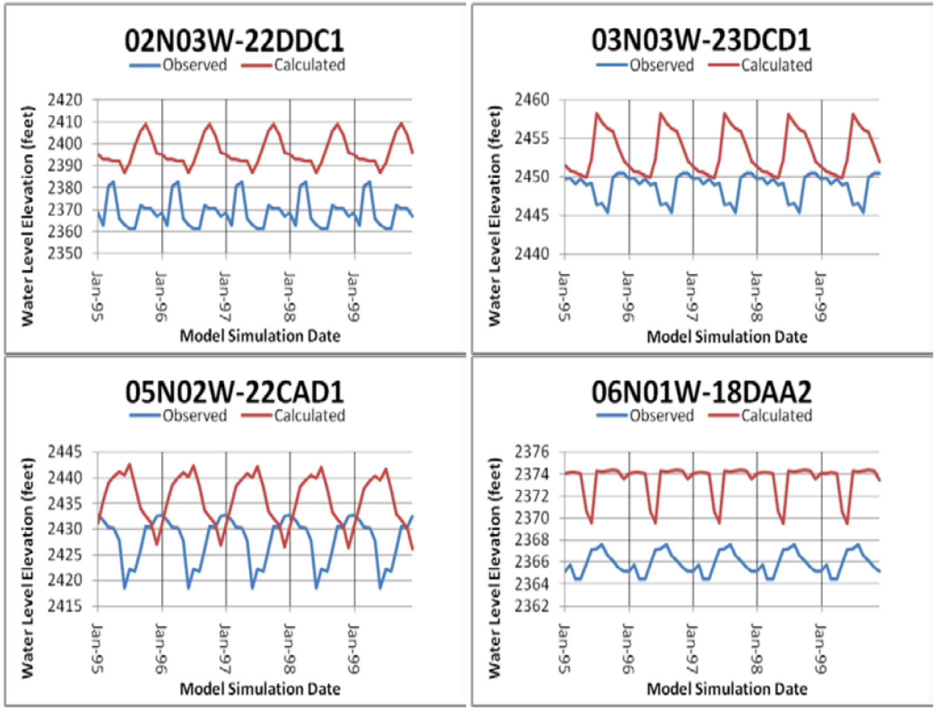
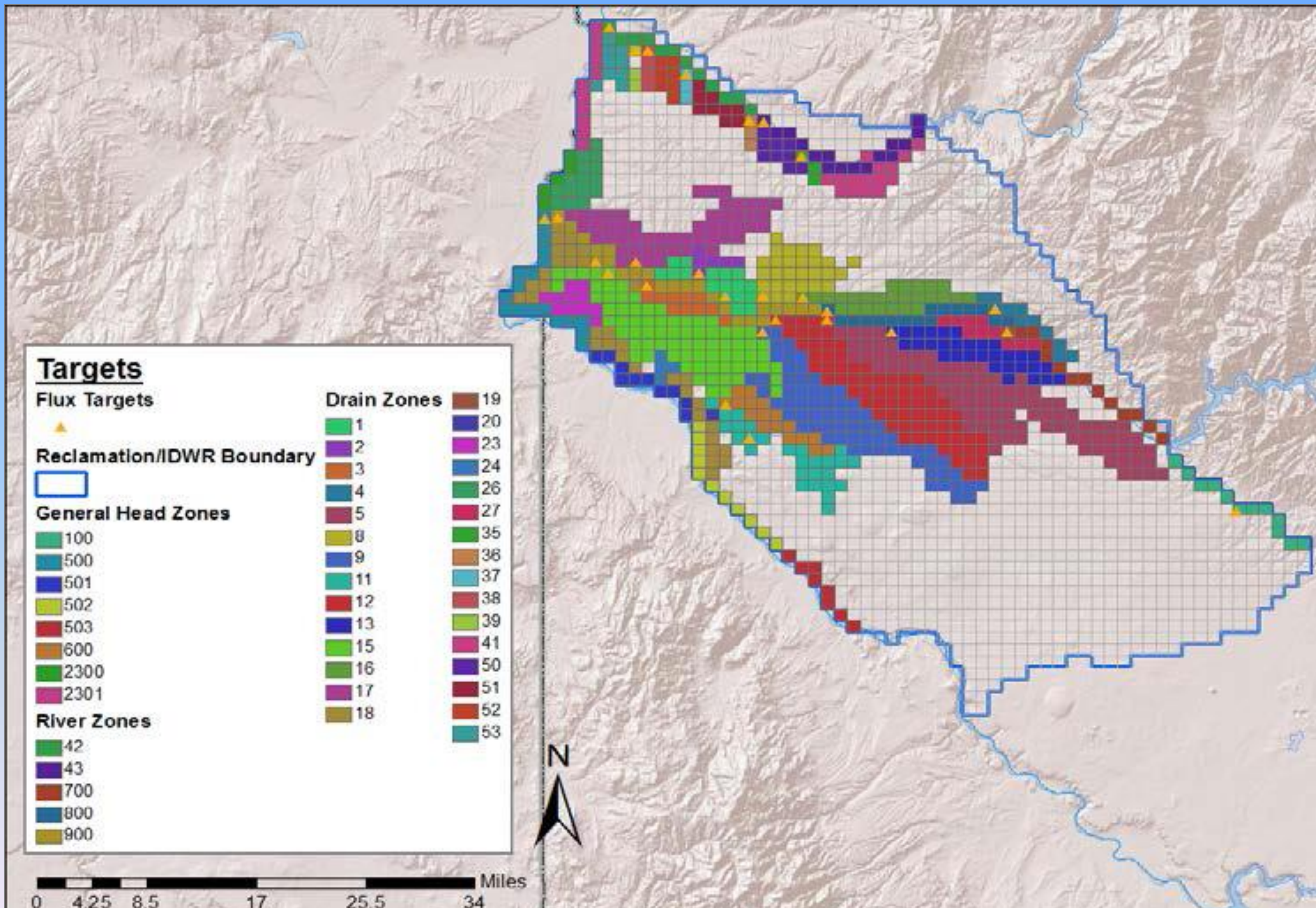
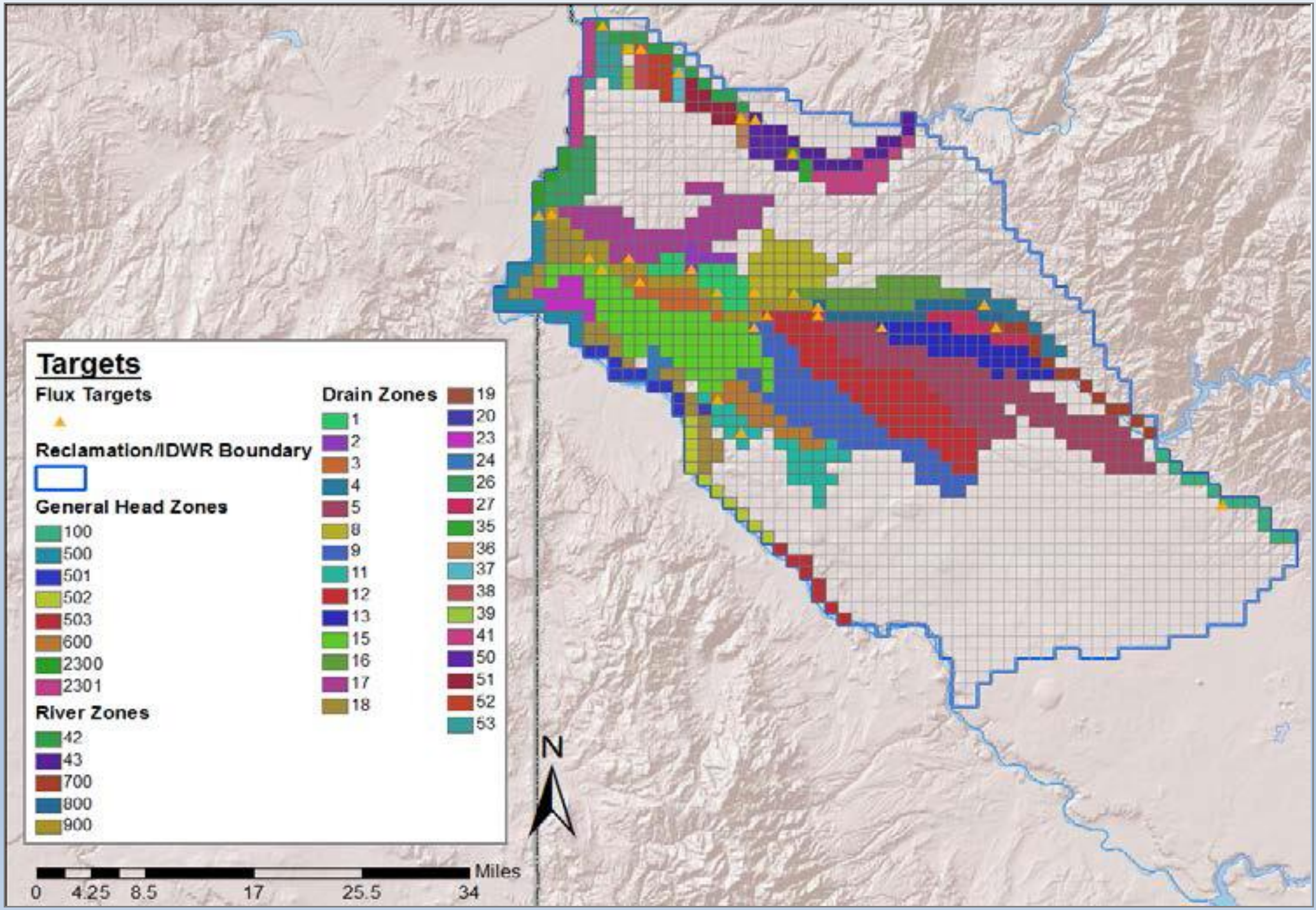


Figure 3-11: Observed and calculated water levels at target locations shown in Figure 3-10 in which the seasonal timing is not matched.

BOR (2013) flux calibration targets



BOR (2013) flux calibration targets



BOR (2013) flux calibration targets

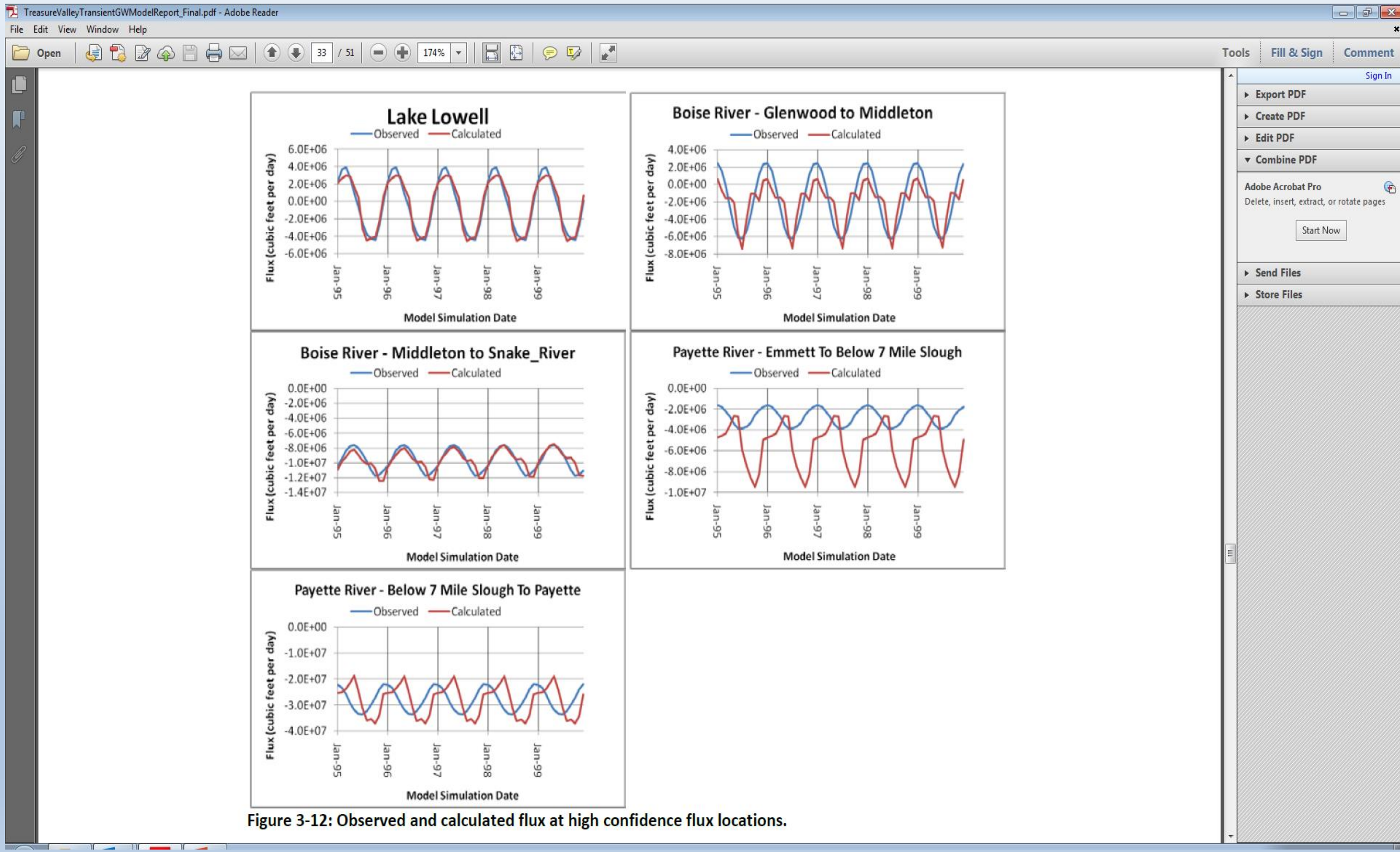
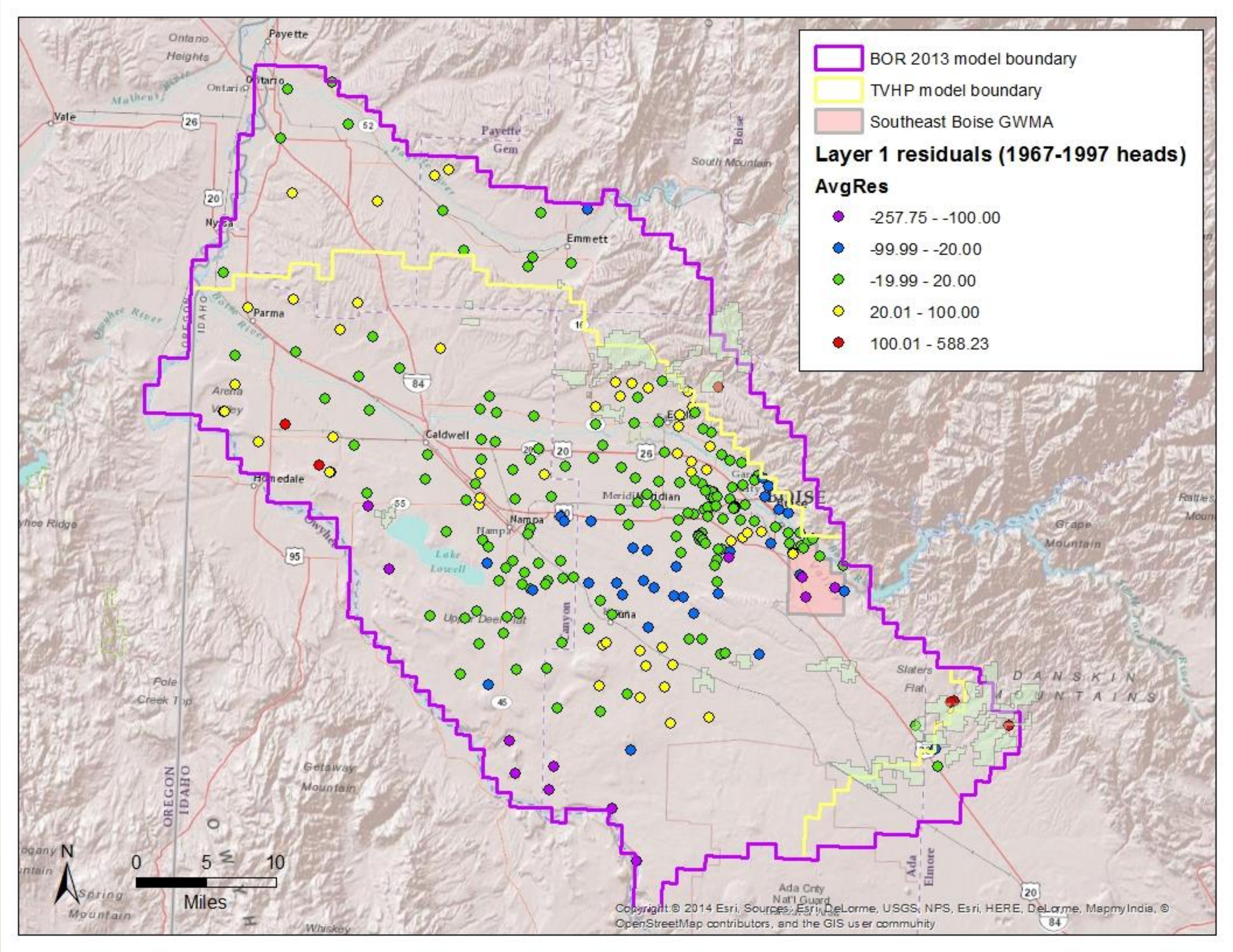


Figure 3-12: Observed and calculated flux at high confidence flux locations.

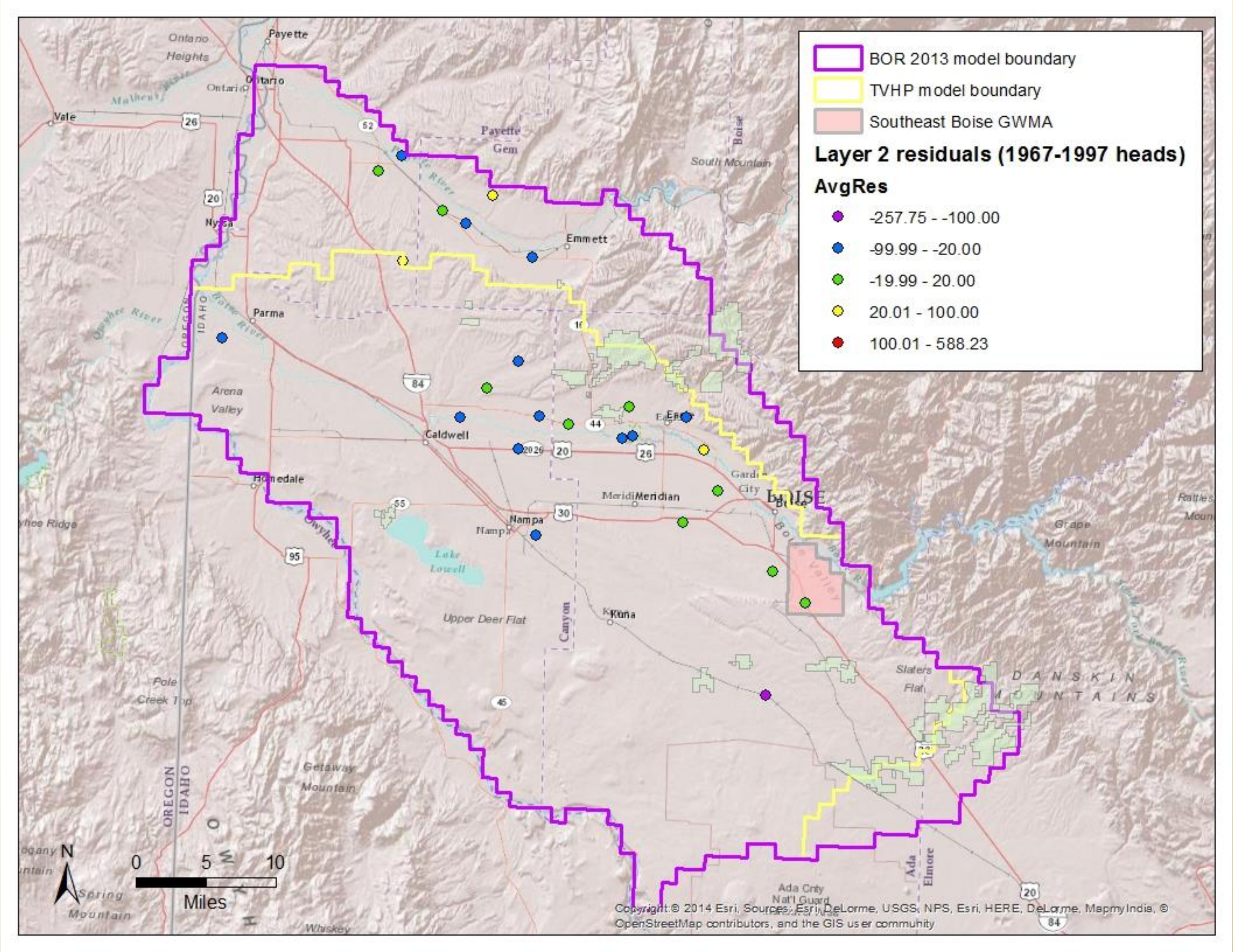
IDWR review of BOR (2013) model

- BOR (2013) model was calibrated to support a research project and is not adequately calibrated to be useful for the State of Idaho as a tool for water supply planning or water management
- Average monthly water budget for 1967-1997 assumes aquifer system is in equilibrium on an annual basis
- Few head targets used for calibration
- Flux targets for groundwater discharge to drains estimated based on little or no measured data, given little weight during calibration

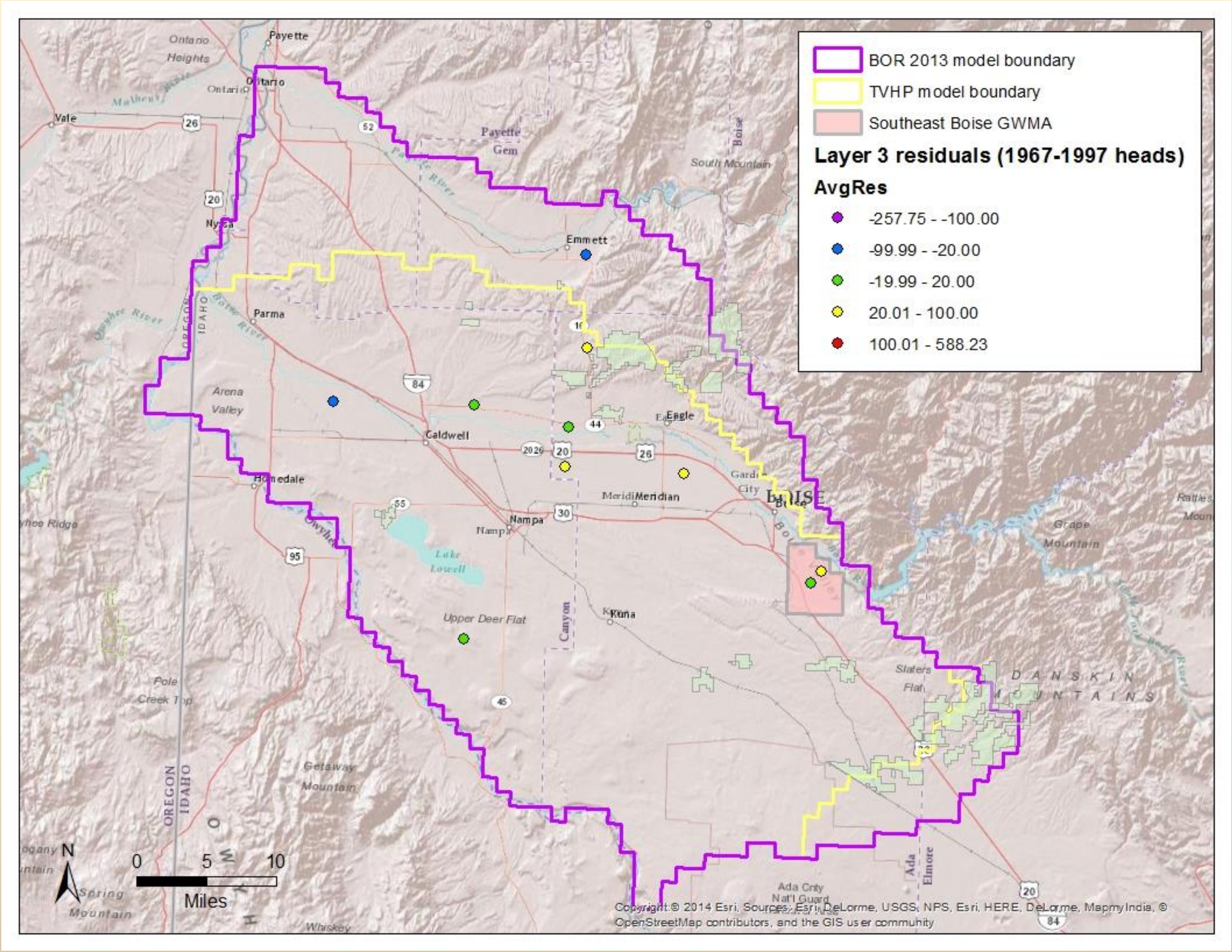
IDWR review of BOR (2013) model



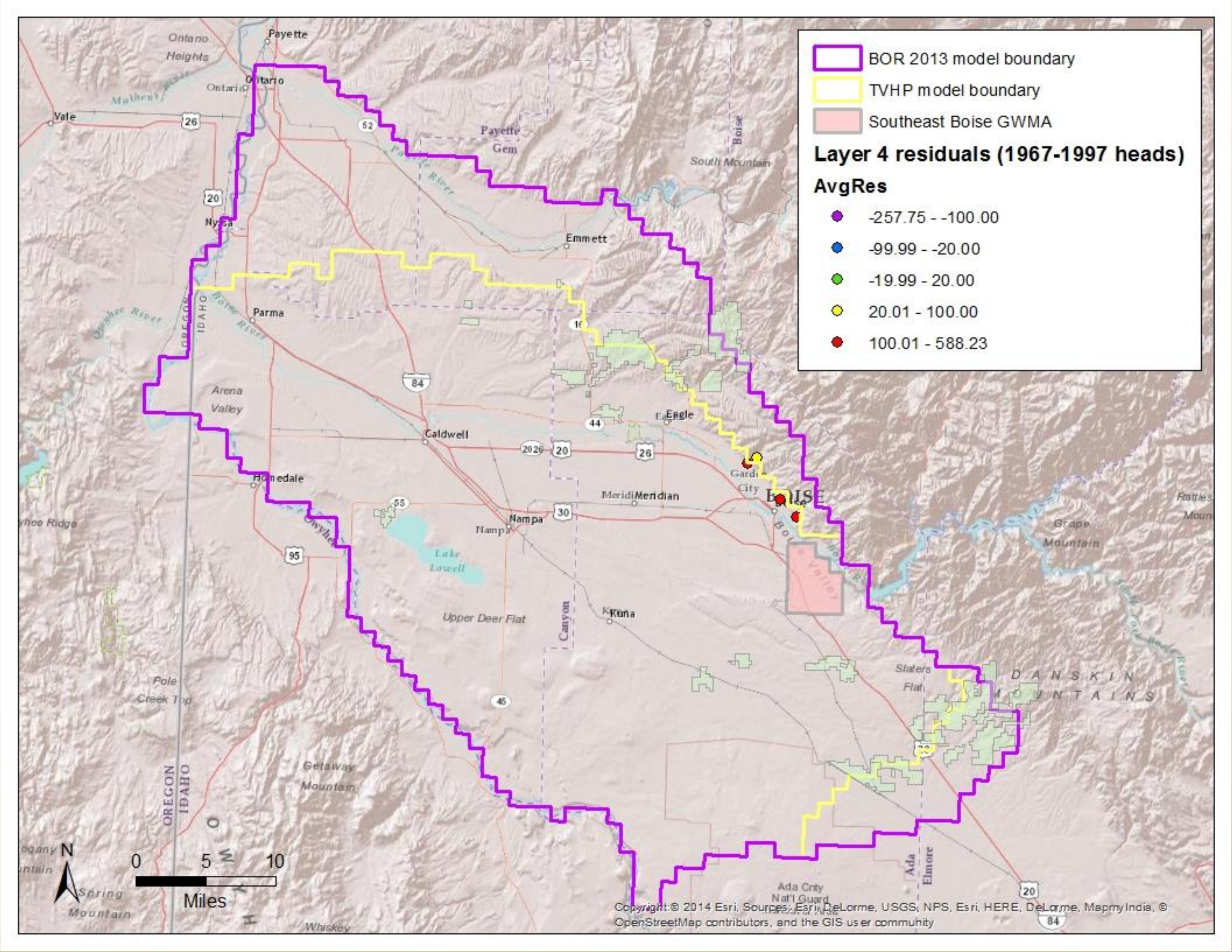
IDWR review of BOR (2013) model



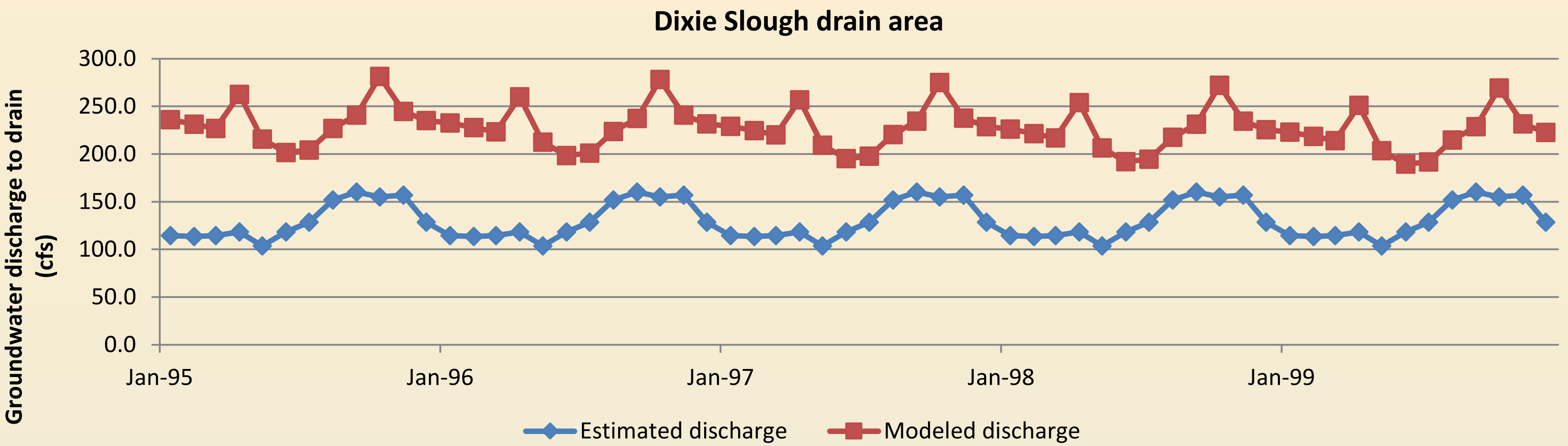
IDWR review of BOR (2013) model

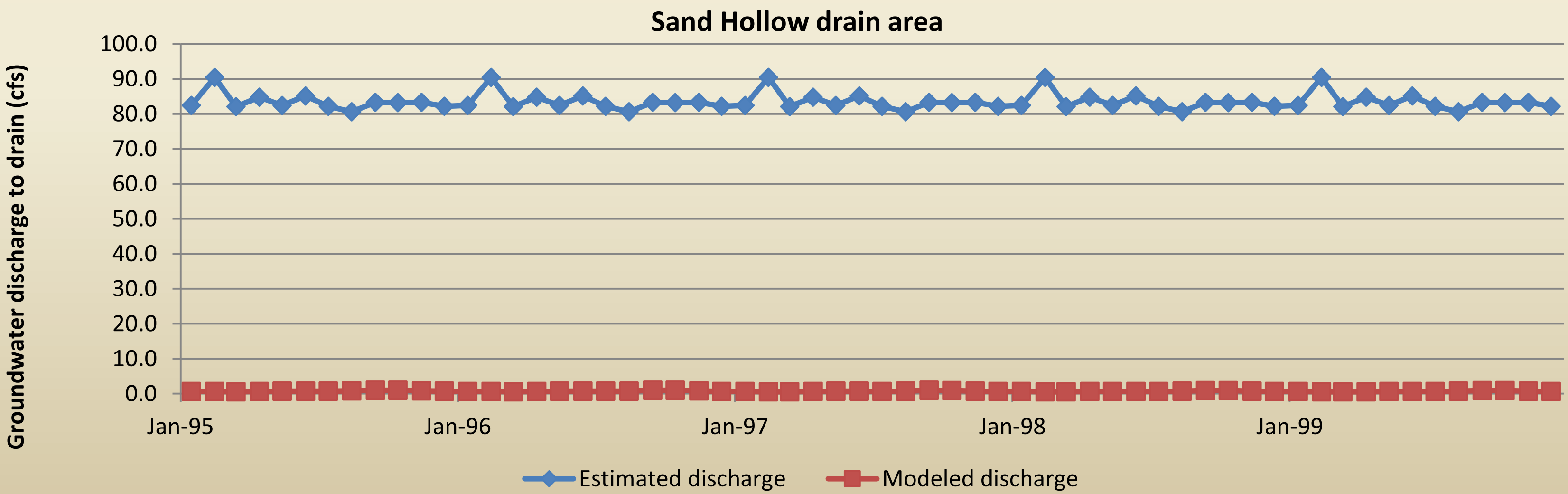


IDWR review of BOR (2013) model



IDWR review of BOR (2013) model





IDWR recommendations for future work (2016)

- Develop monthly water budget for 30 years (1986-2015) to capture variety of climatic conditions, population growth, and land use changes, and to take advantage of additional water level data and vertical gradient data

- Establish continuous recording gage stations at twelve sites to quantify groundwater discharge to drains (USGS/IPCO)

- Correlate drain baseflow with measured water levels to develop flux targets during model calibration period

- Improve ET estimates by developing METRIC ET data and irrigation land use data sets for eight years and interpolating between METRIC years using climate and land use data (UI)

IDWR recommendations for future work (2016)

- Re-evaluate model layer extents and elevations based on currently available geologic and water level data
- Re-evaluate drain boundary conditions BOR added to model cells within TVHP boundary
- Request cooperation of municipal and industrial water systems in providing additional water level measurements representative of deeper aquifer layers
- Compile head change targets in addition to absolute head targets
- Convert the model to MODFLOW-USG or newer version of MODFLOW to allow use of the SMS solver