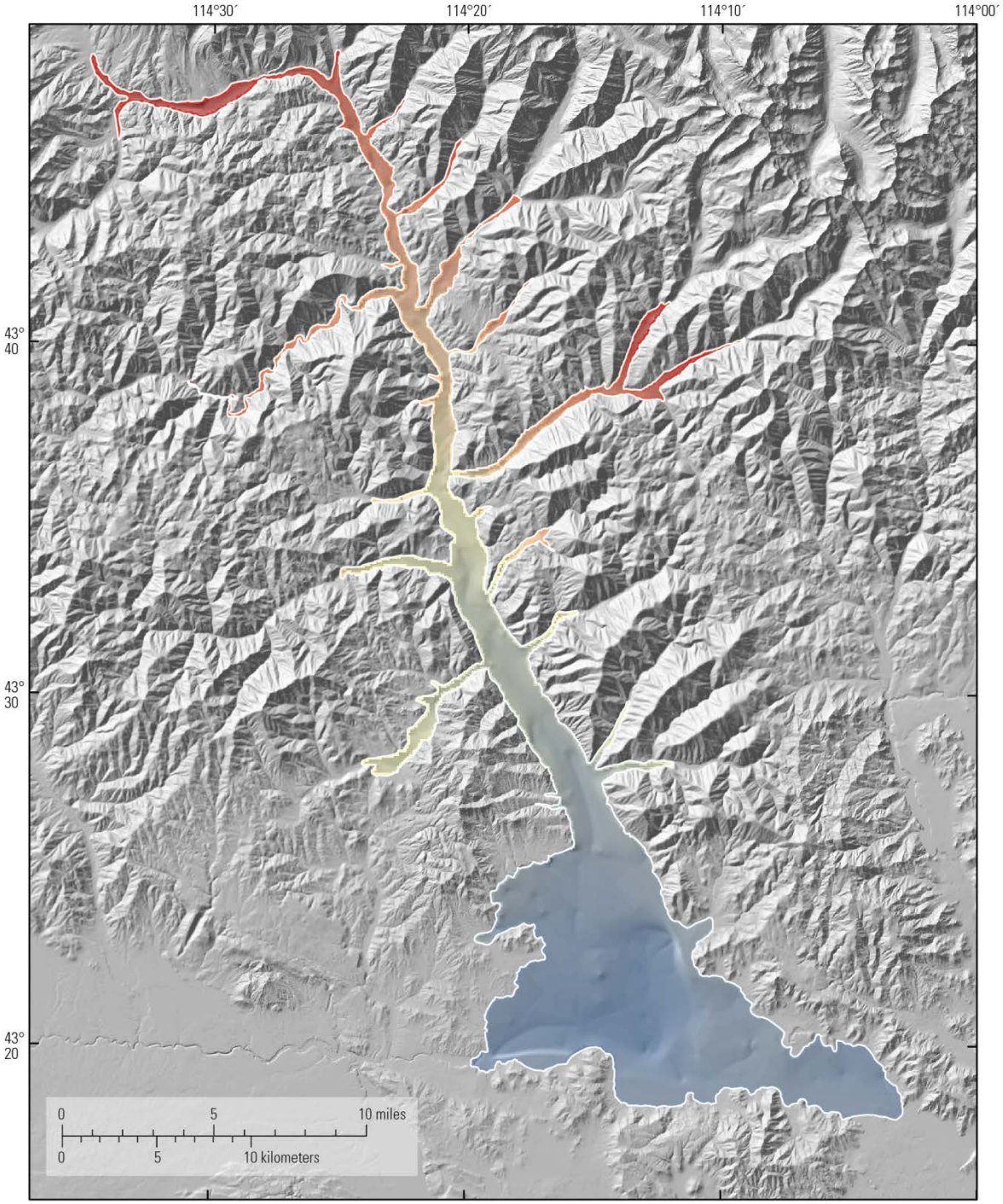
Wood River Valley
Modeling Technical Advisory Committee: Model Boundaries / MODFLOW-USG

Jason C. Fisher

U.S. Geological Survey
Idaho Department of Water Resources

PROVISIONAL: FOR INFORMATIONAL PURPOSES ONLY

These slides were presented at the Wood River Valley Modeling Technical Advisory Committee meeting Thursday, 01Aug2013, 10am-4pm at the Community Campus, Rm 200, in Hailey. Taken outside the context of the original presentation, these slides may not provide a complete or accurate representation of the speaker’s intent.



Coordinate system:

NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

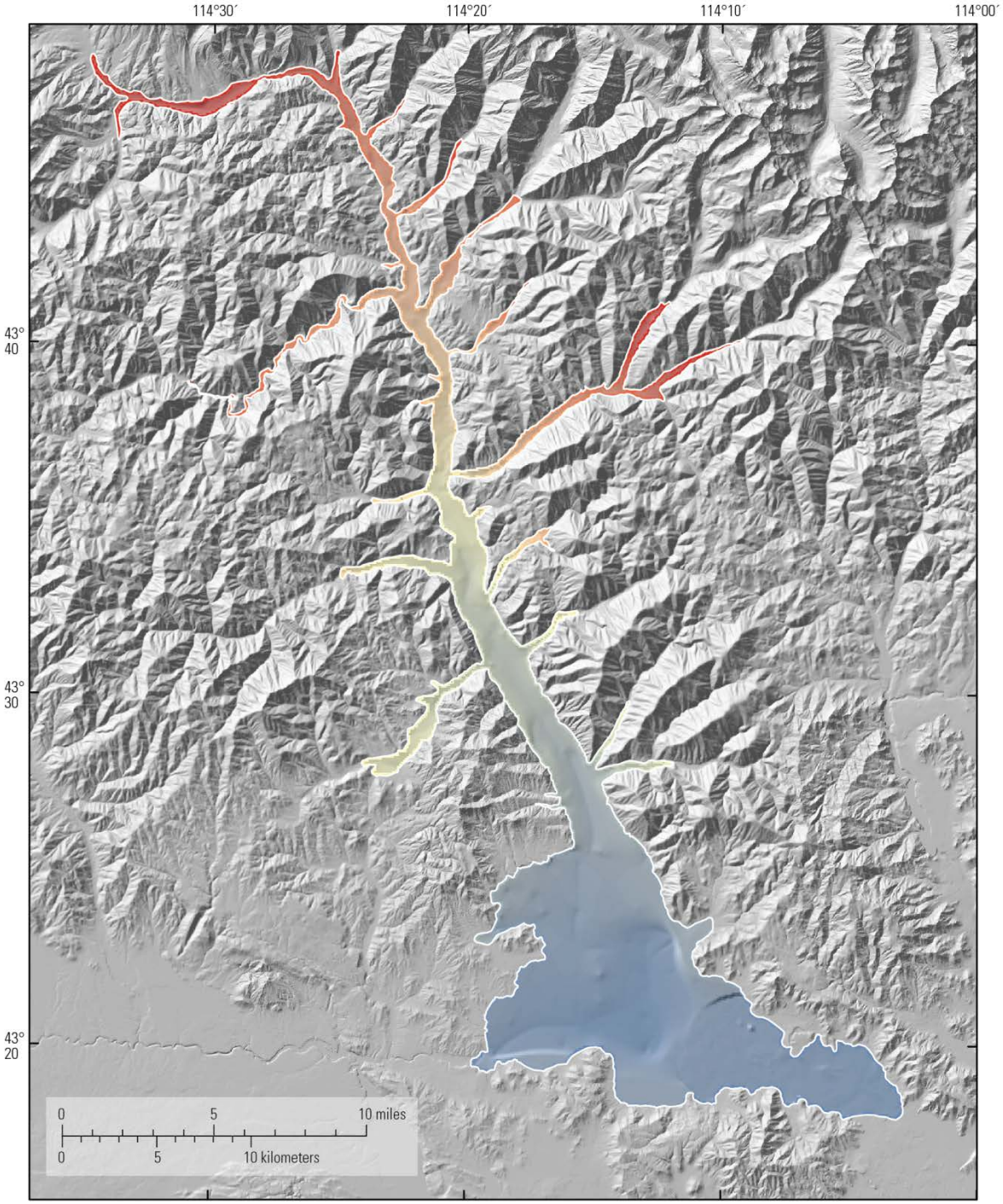
Aquifer extent (SIR 2012-5053)

Base of alluvium aquifer raster:

Resolution: about 26 meters
SIR 2012-5053 (modified)

2,068 meters

1,386 meters



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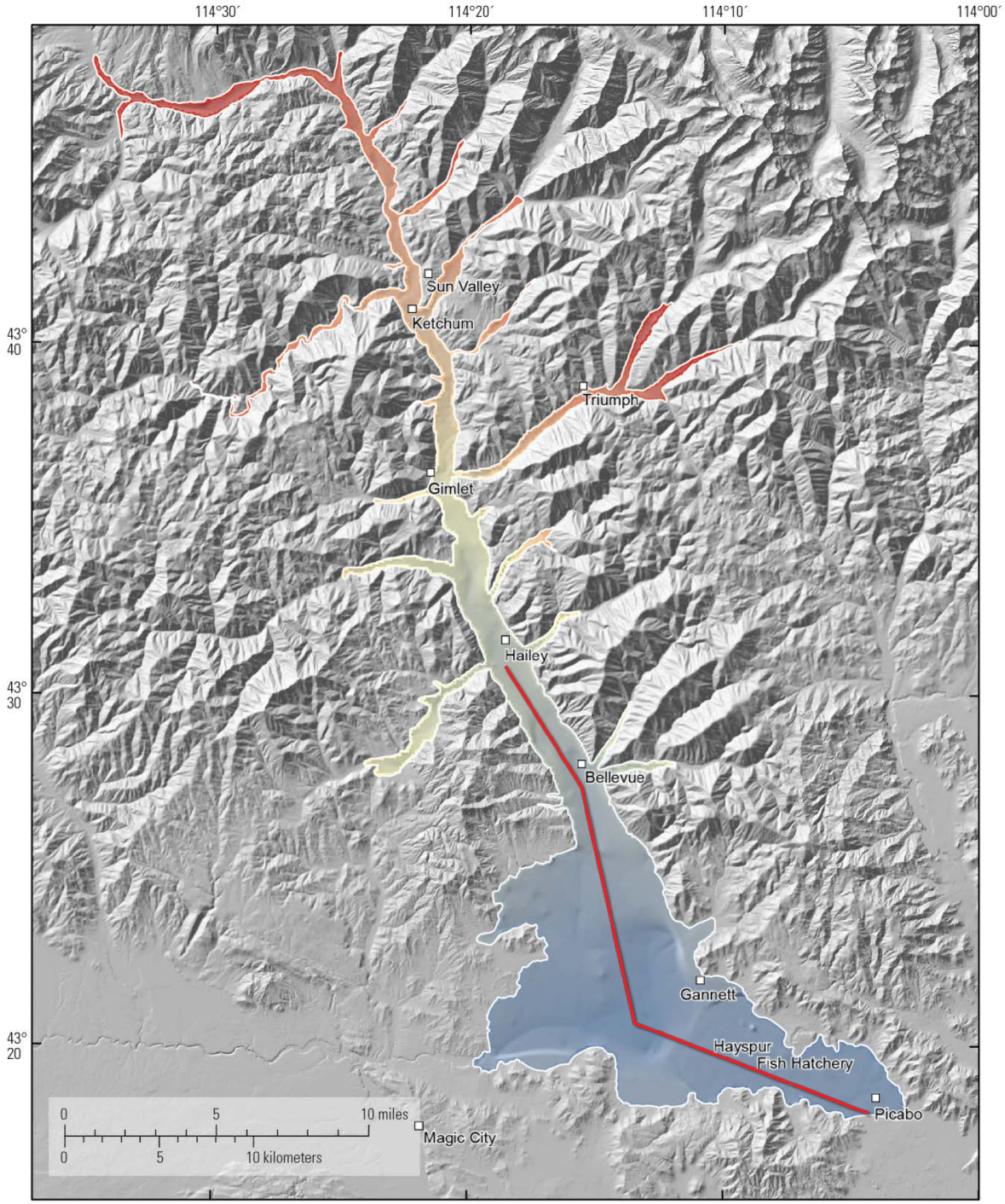
Aquifer extent (SIR 2012-5053)

Bedrock raster:

Resolution: about 26 meters

2,068 meters

1,386 meters



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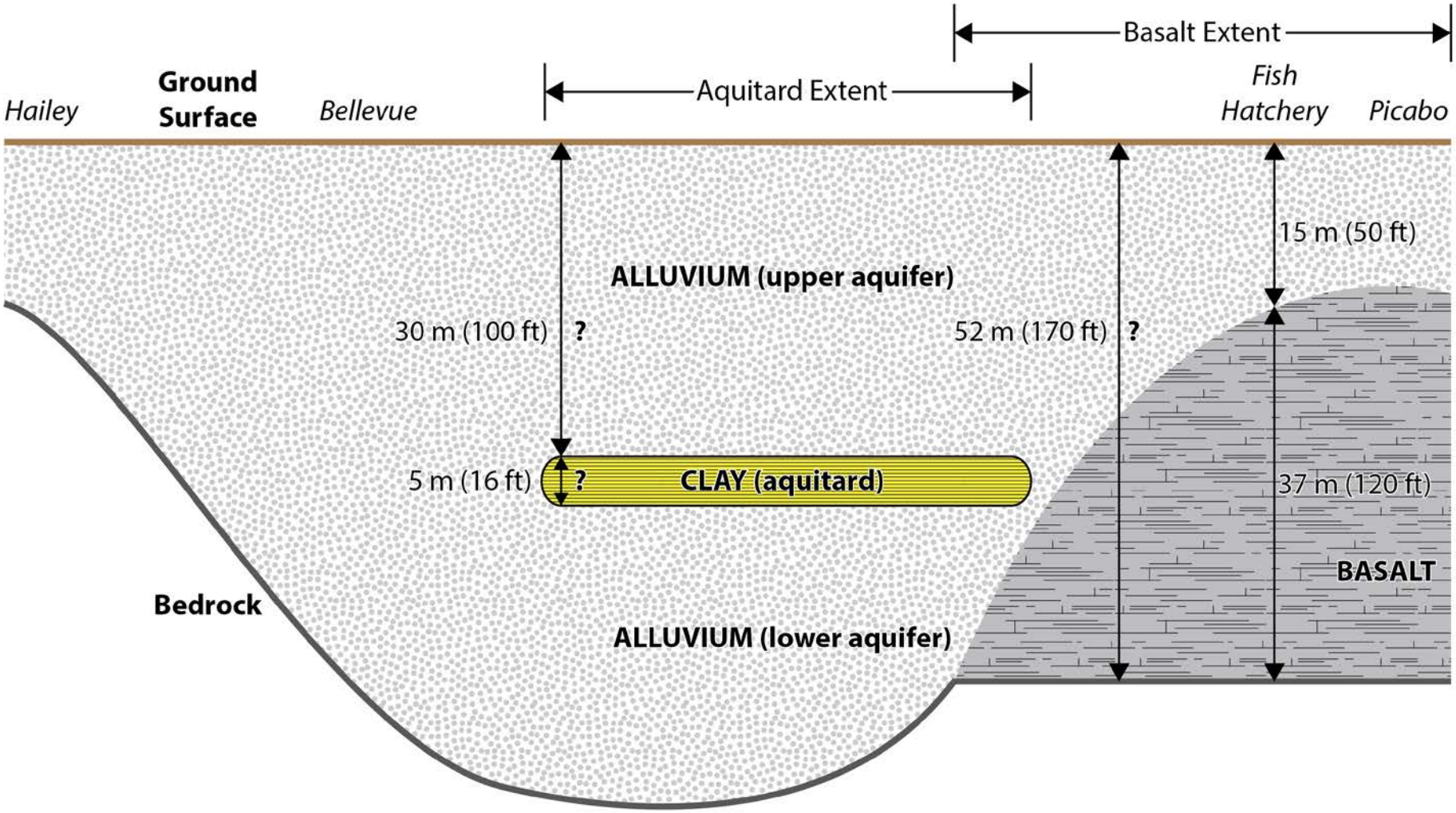
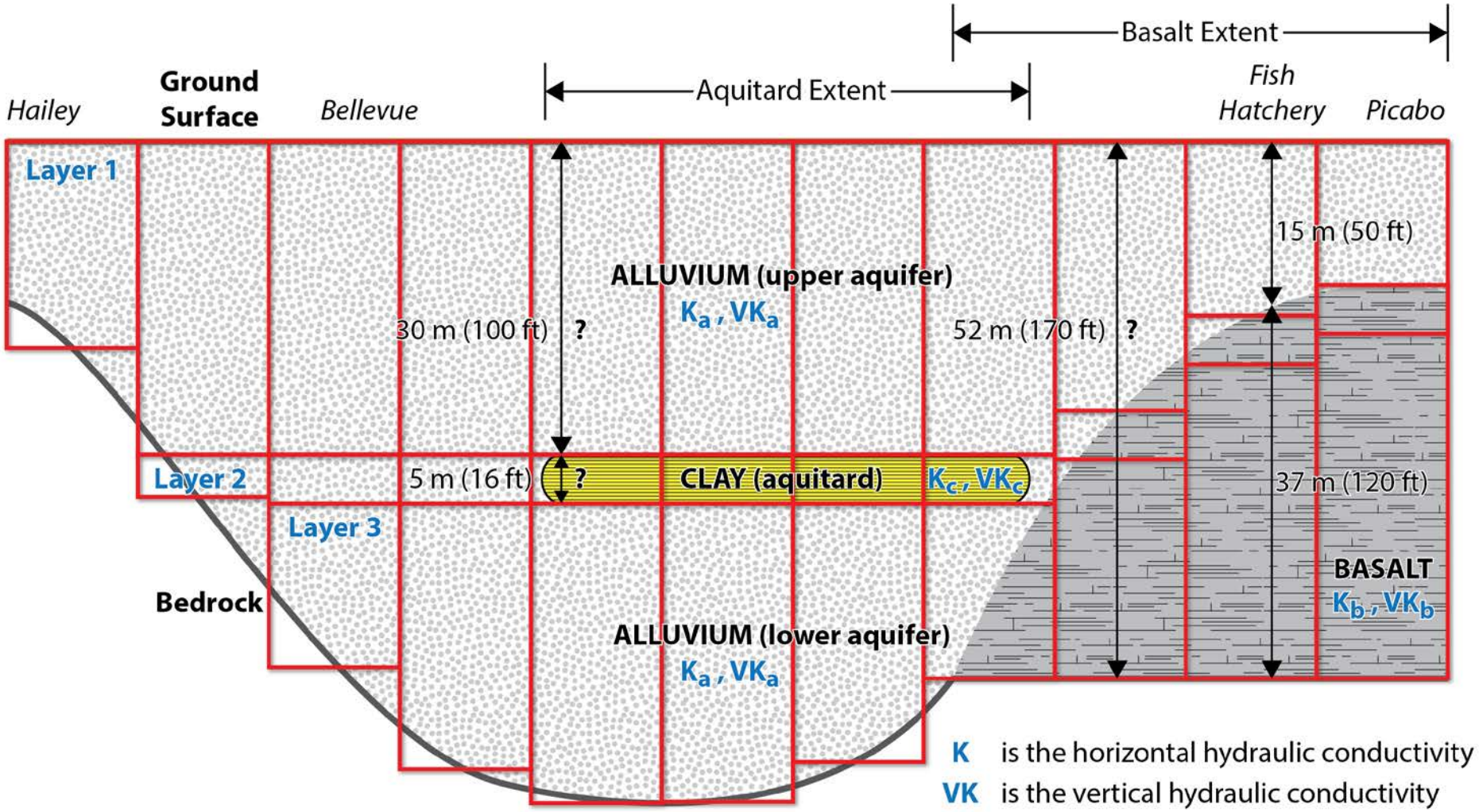
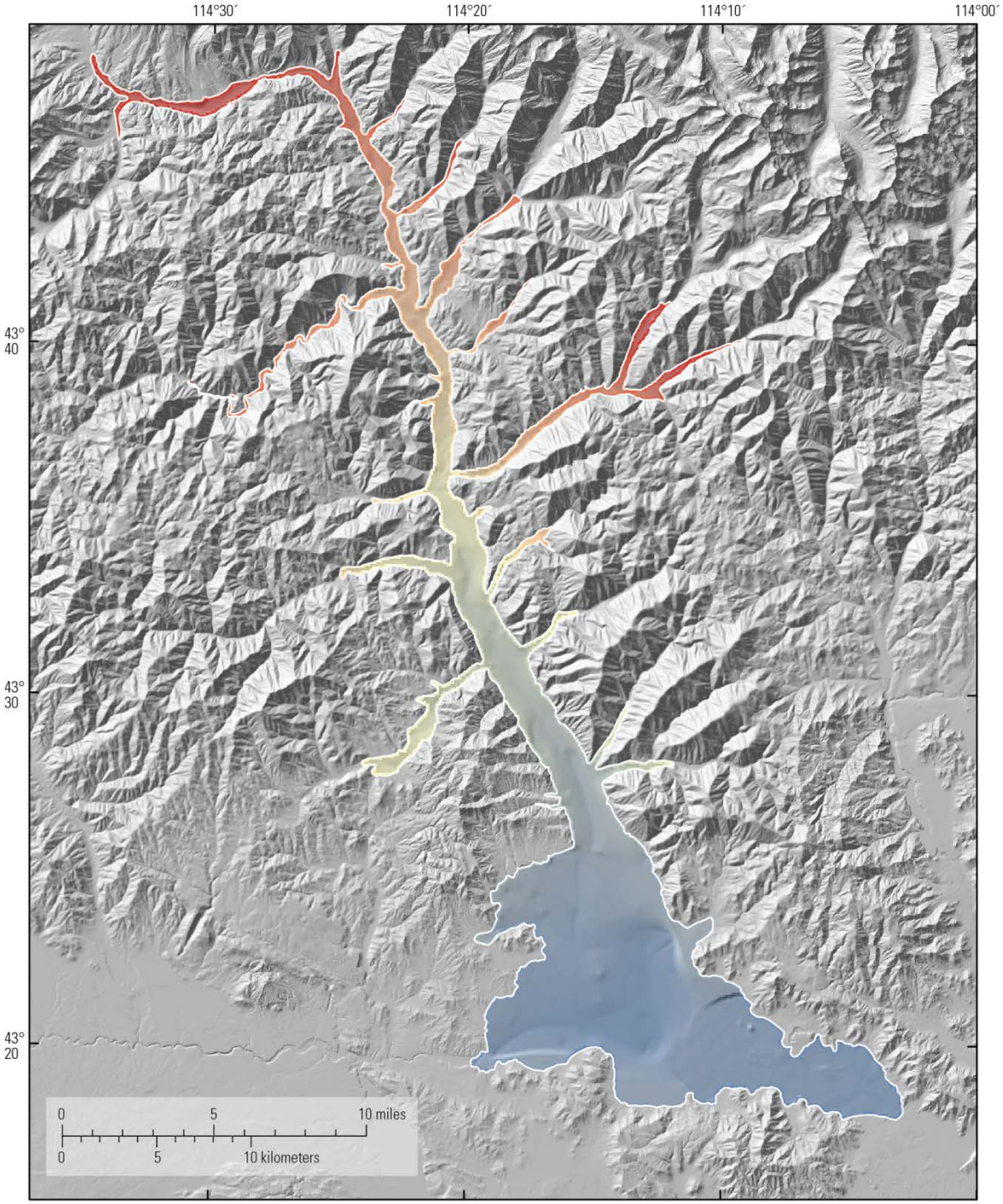
2,068 meters

1,386 meters


Basalt Extent
Aquitard Extent
Hailey
Ground Surface
Bellevue
Fish Hatchery
Picabo
15 m (50 ft)
ALLUVIUM (upper aquifer)
30 m (100 ft)
?
52 m (170 ft)
?
5 m (16 ft)
?
CLAY (aquitard)
37 m (120 ft)
BASALT
Bedrock
ALLUVIUM (lower aquifer)


Basalt Extent
Aquitard Extent
Hailey
Ground Surface
Bellevue
Fish Hatchery
Picabo
Layer 1
Layer 2
Layer 3
Bedrock
ALLUVIUM (upper aquifer)
K_a , VK_a
30 m (100 ft) ?
52 m (170 ft) ?
15 m (50 ft)
5 m (16 ft) ?
CLAY (aquitard)
K_c , VK_c
37 m (120 ft)
BASALT
K_b , VK_b
ALLUVIUM (lower aquifer)
K_a , VK_a
K is the horizontal hydraulic conductivity
VK is the vertical hydraulic conductivity



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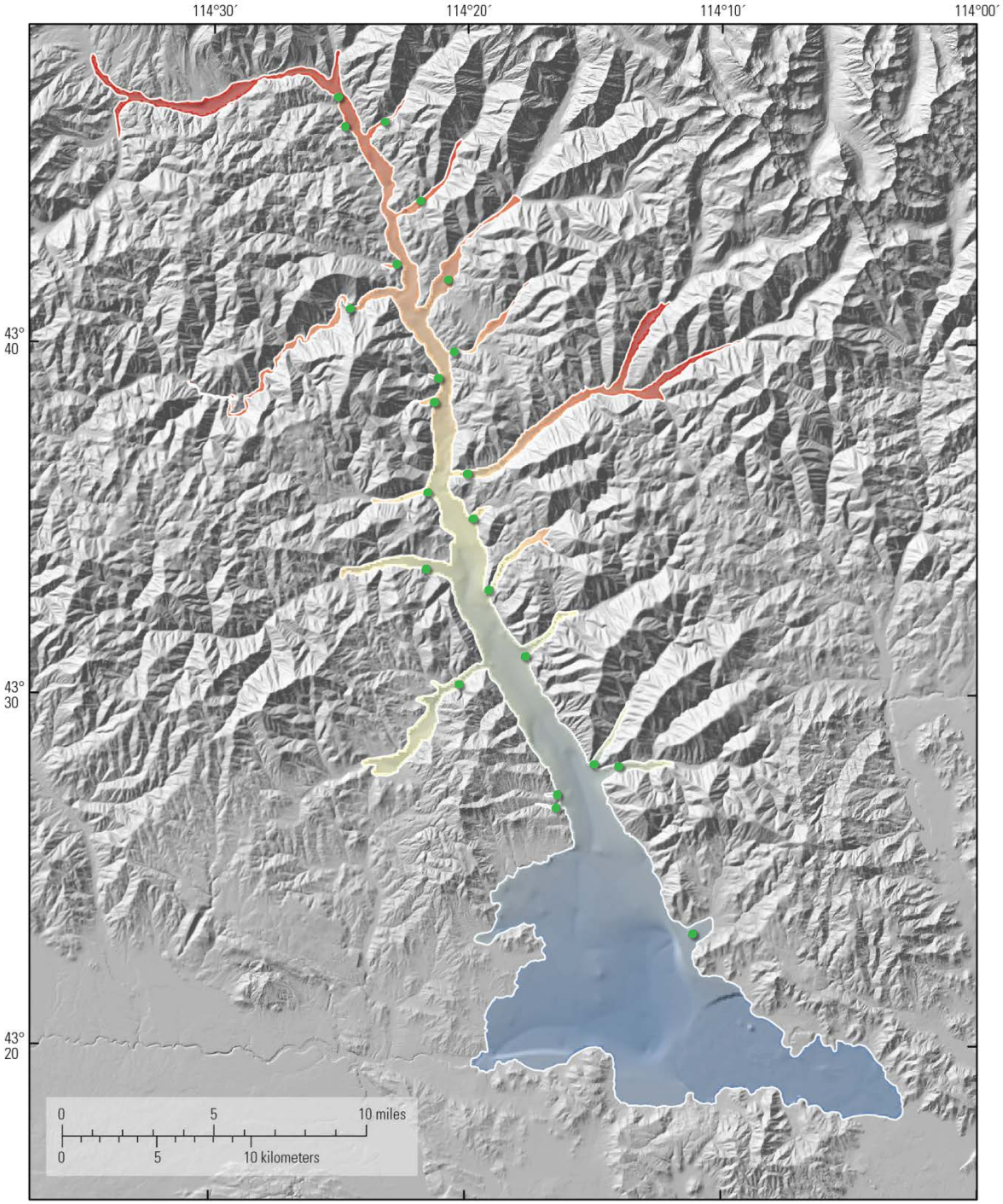
Aquifer extent (SIR 2012-5053)

Bedrock raster:

Resolution: about 26 meters

2,068 meters

1,386 meters



Coordinate system:

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Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

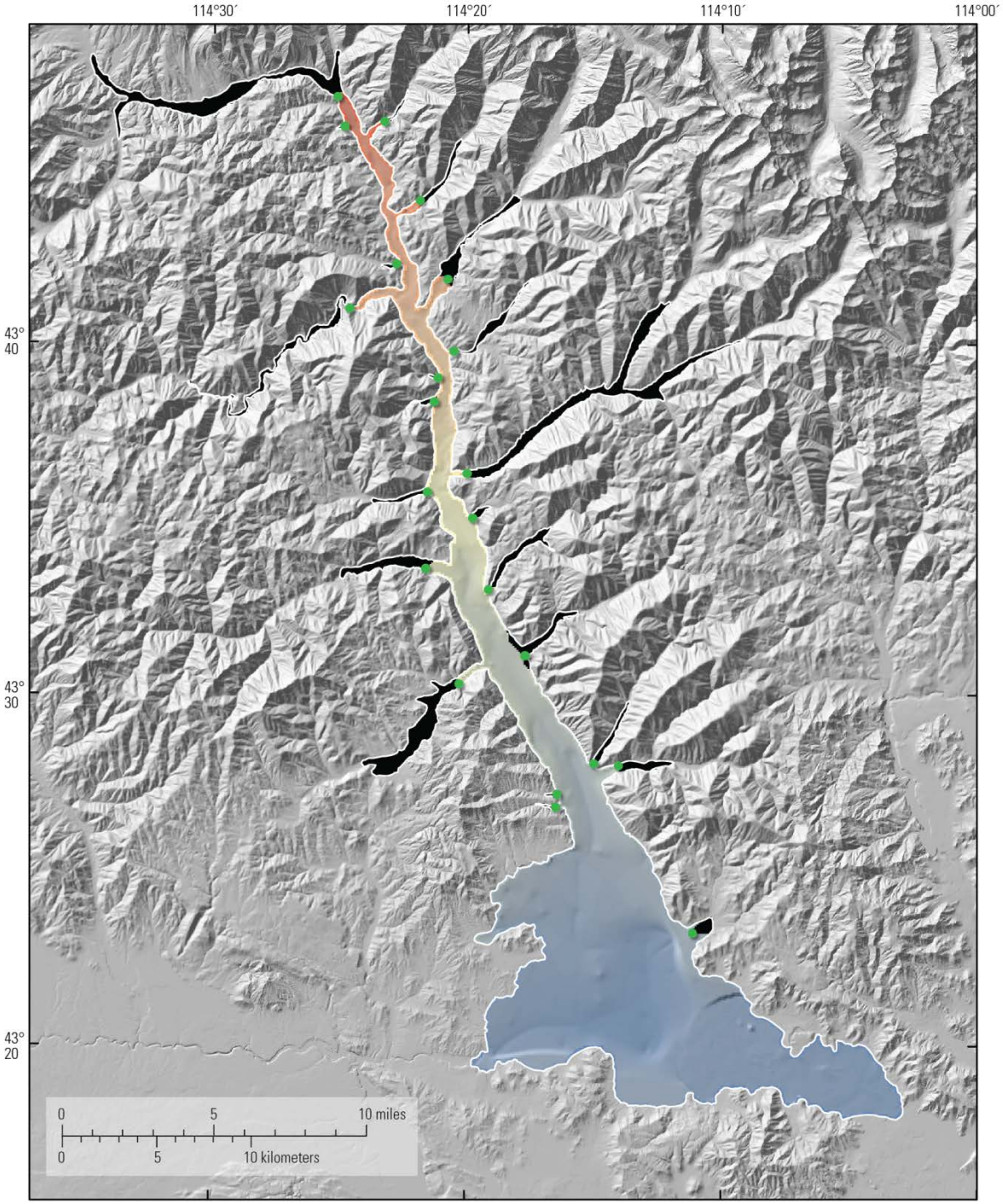
Source location

Bedrock raster:

Resolution: about 26 meters

2,068 meters

1,386 meters



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NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

Aquifer extent (SIR 2012-5053)

Source location

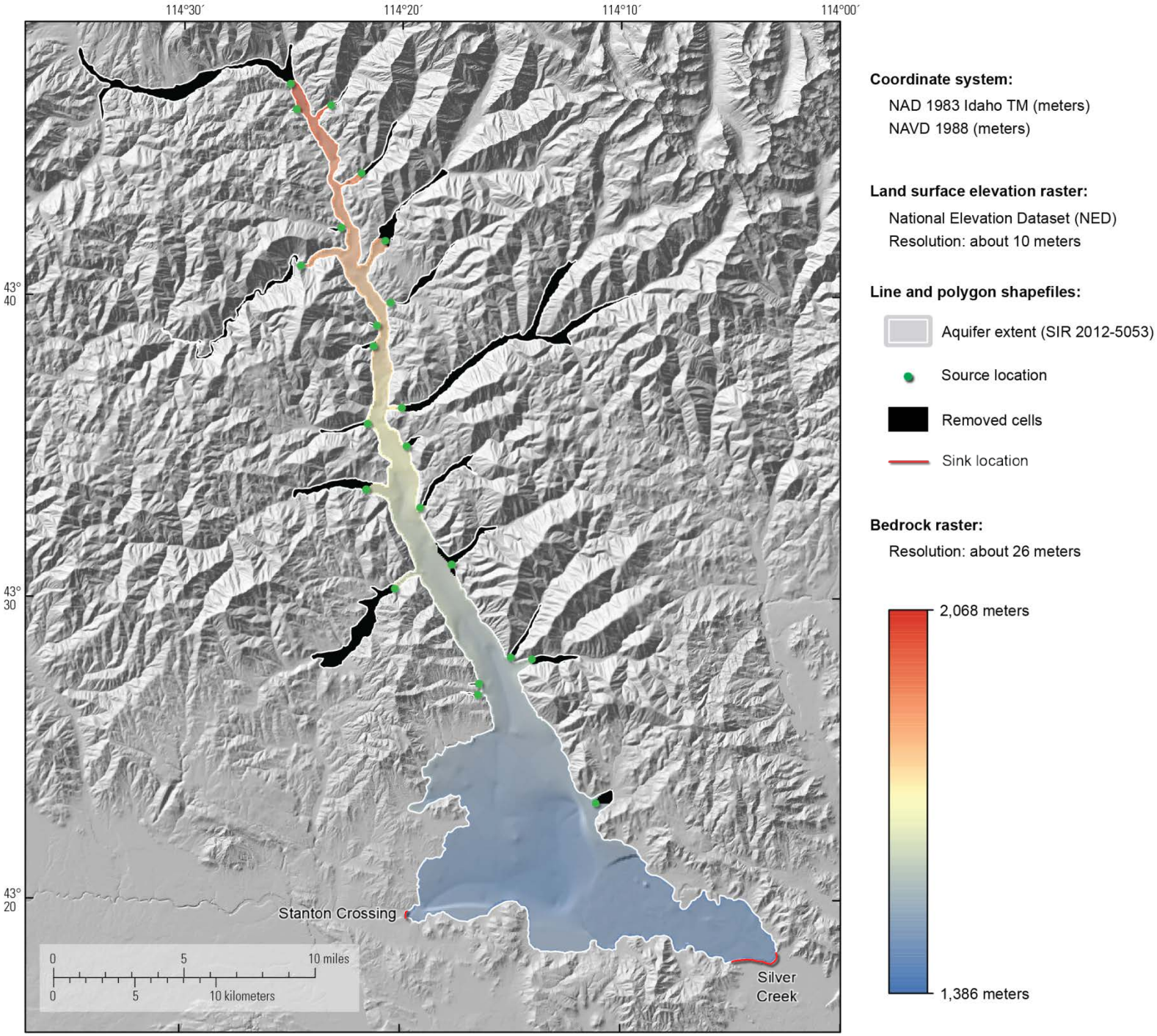
Removed cells

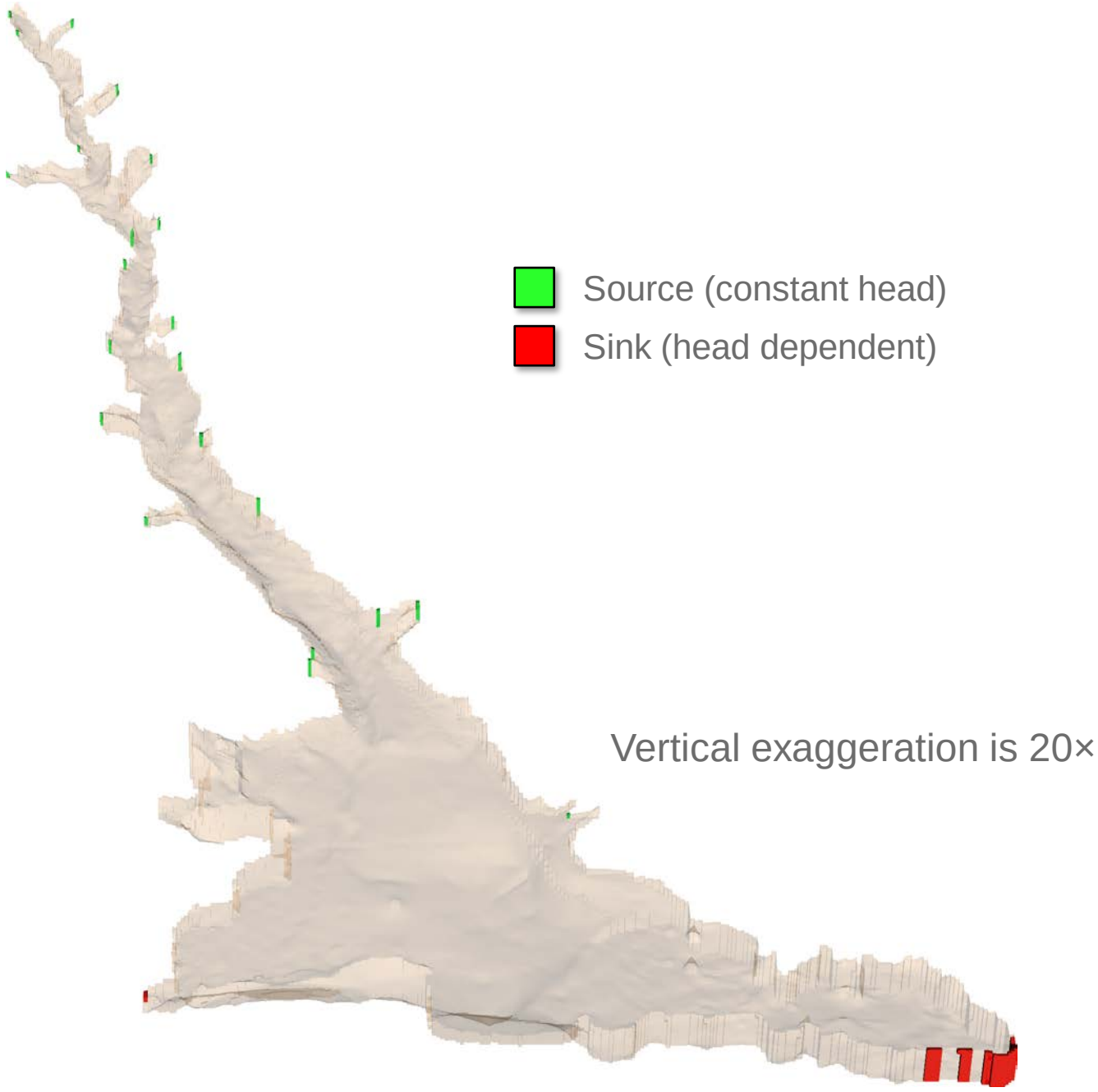
Bedrock raster:

Resolution: about 26 meters

2,068 meters

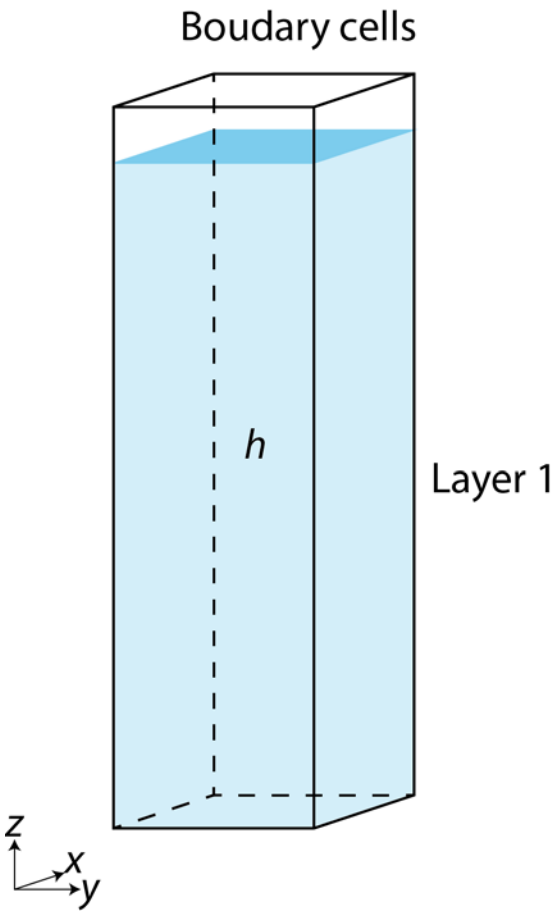
1,386 meters

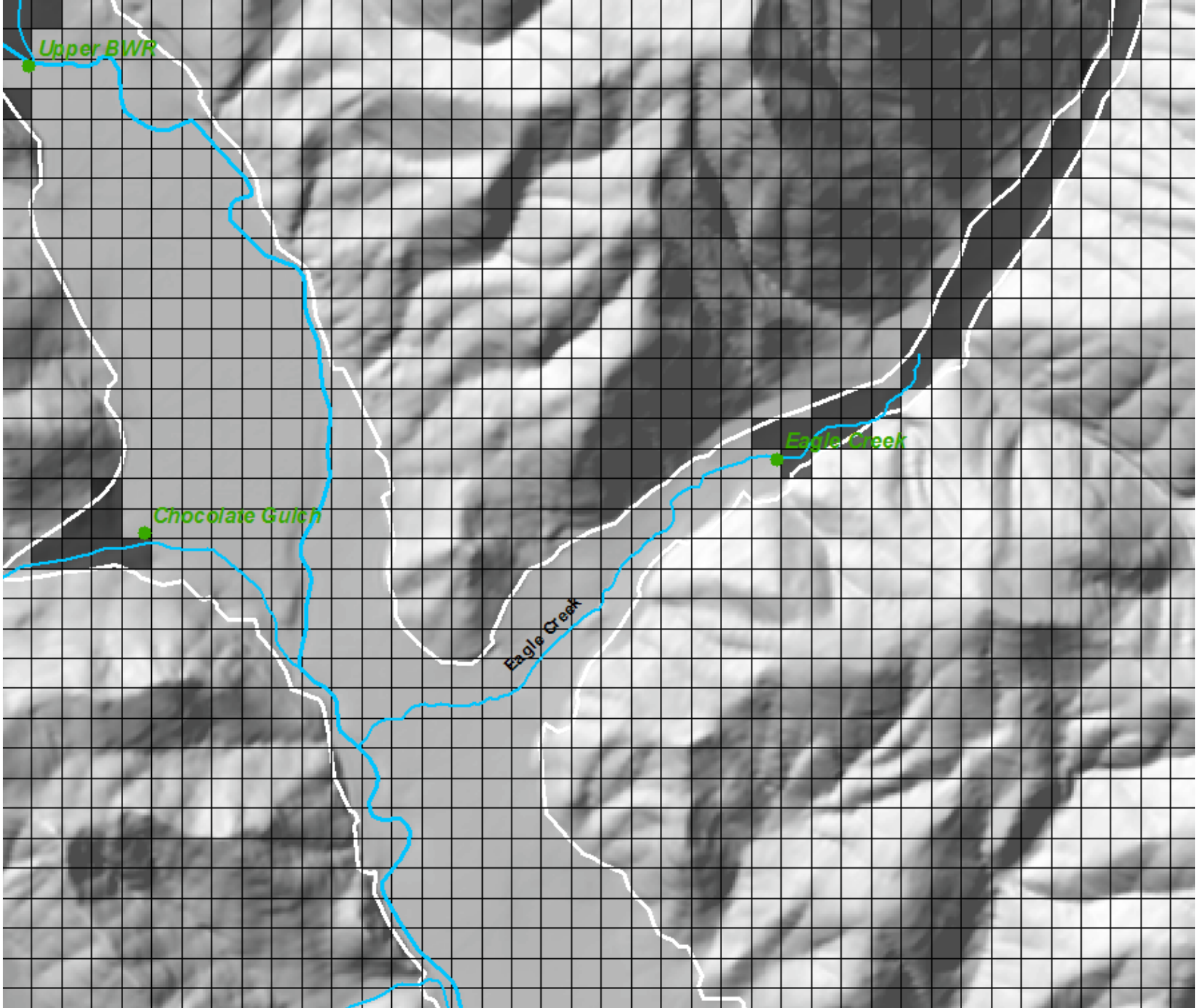

114°30′
114°20′
114°10′
114°00′
43° 40
43° 30
43° 20
Stanton Crossing
Silver Creek
0 5 10 miles
0 5 10 kilometers
Coordinate system:
NAD 1983 Idaho TM (meters)
NAVD 1988 (meters)
Land surface elevation raster:
National Elevation Dataset (NED)
Resolution: about 10 meters
Line and polygon shapefiles:
Aquifer extent (SIR 2012-5053)
Source location
Removed cells
Sink location
Bedrock raster:
Resolution: about 26 meters
2,068 meters
1,386 meters

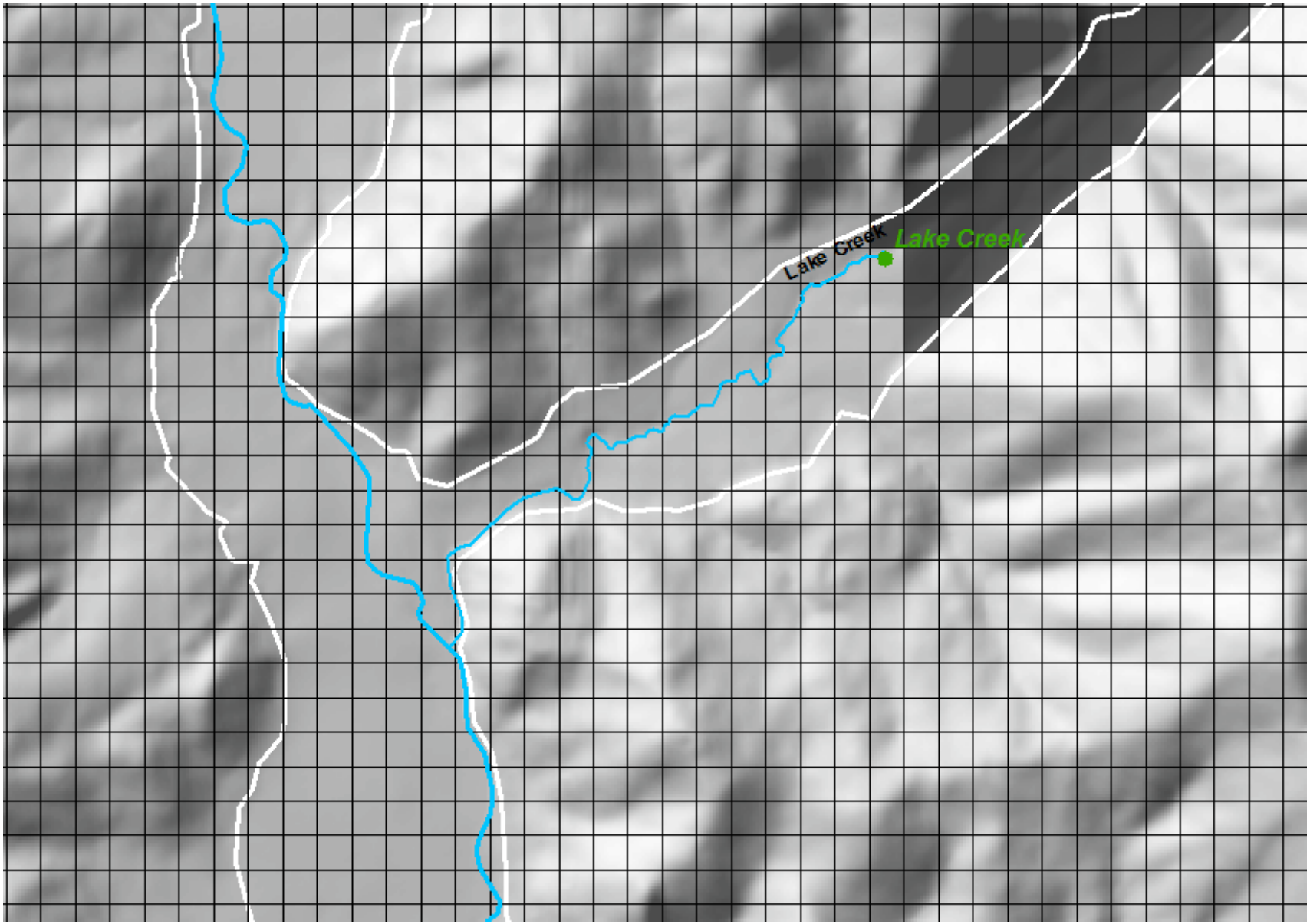

Source (constant head)
Sink (head dependent)
Vertical exaggeration is 20×

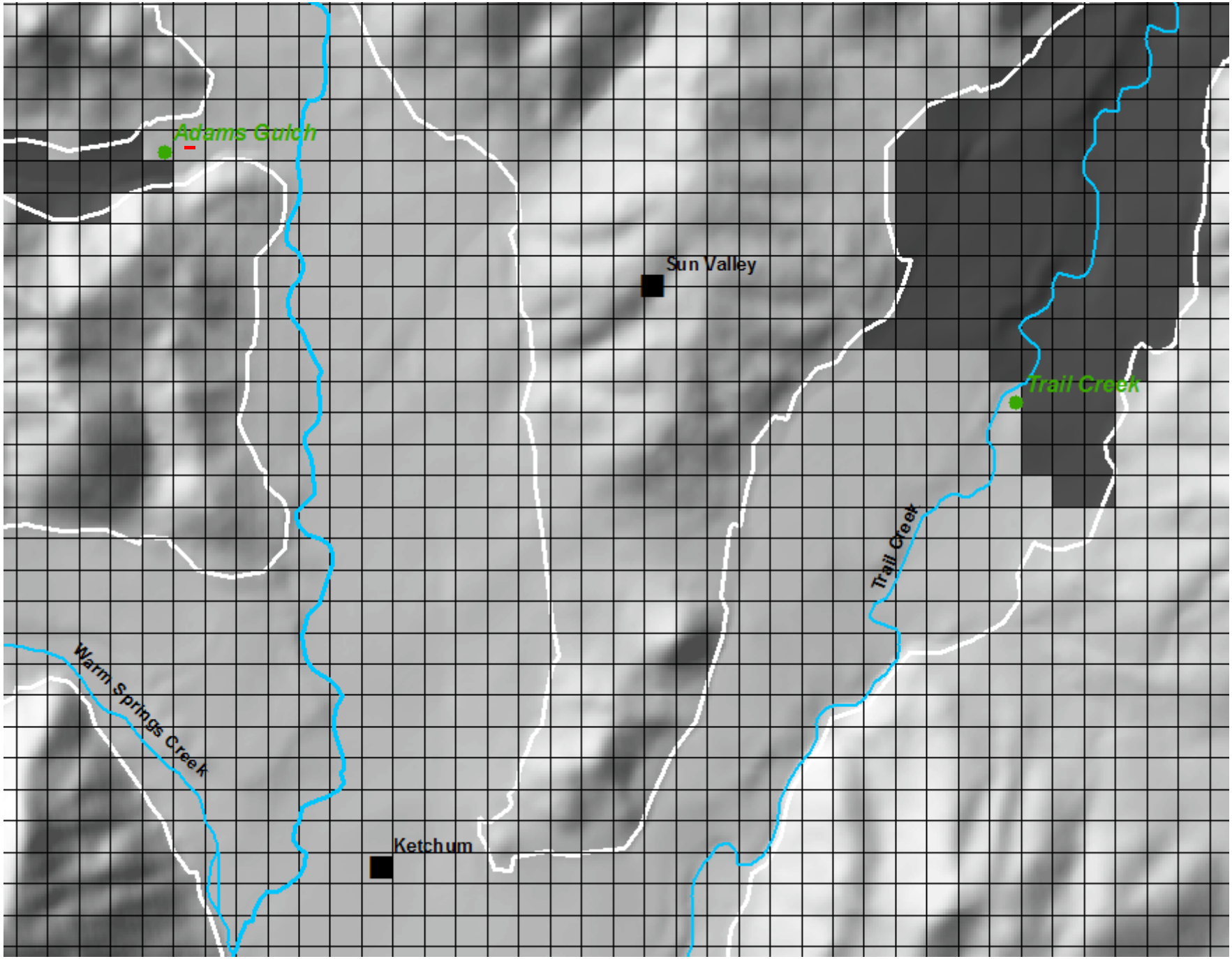
Tributary Underflow

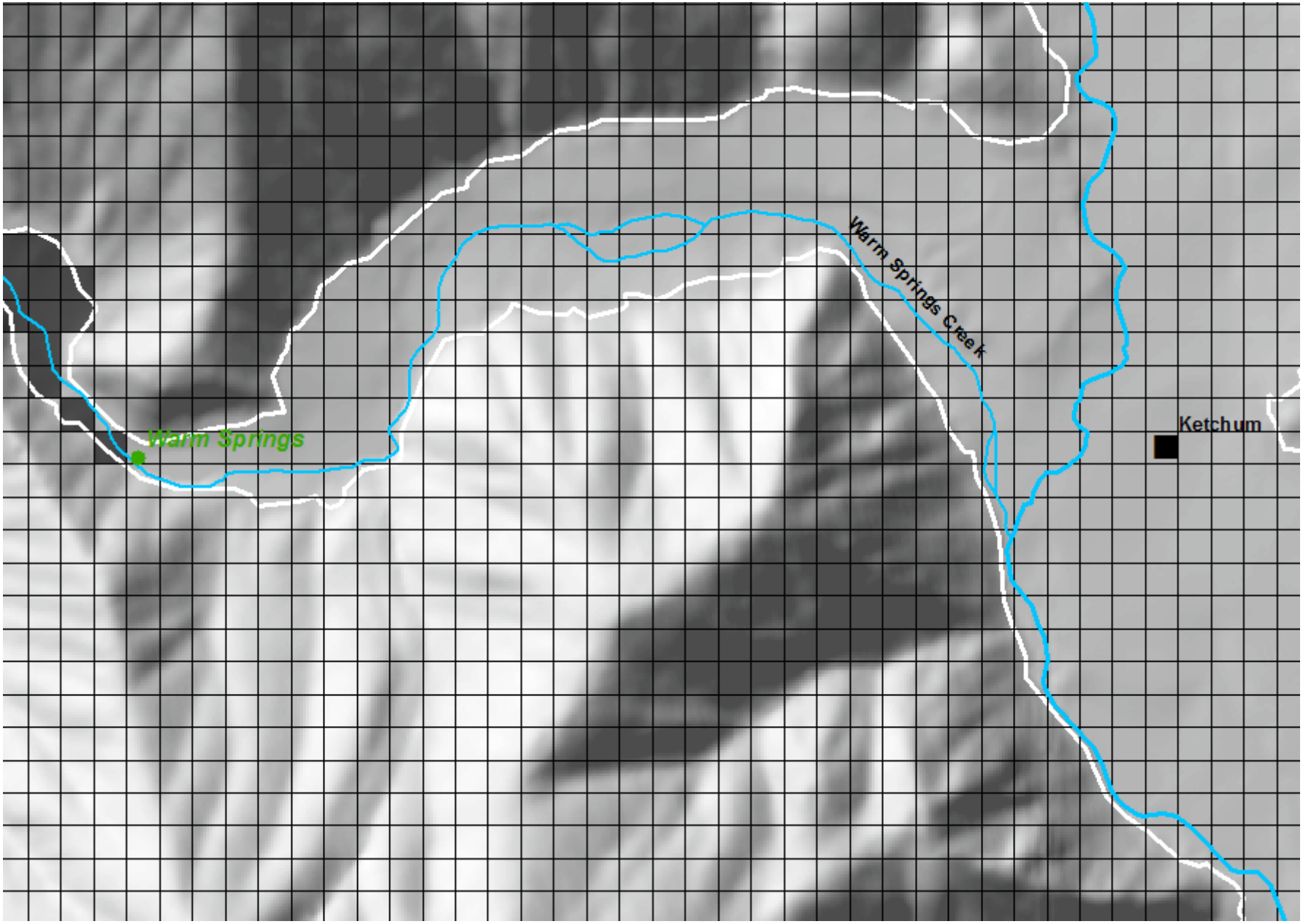
Modeled as constant head boundaries

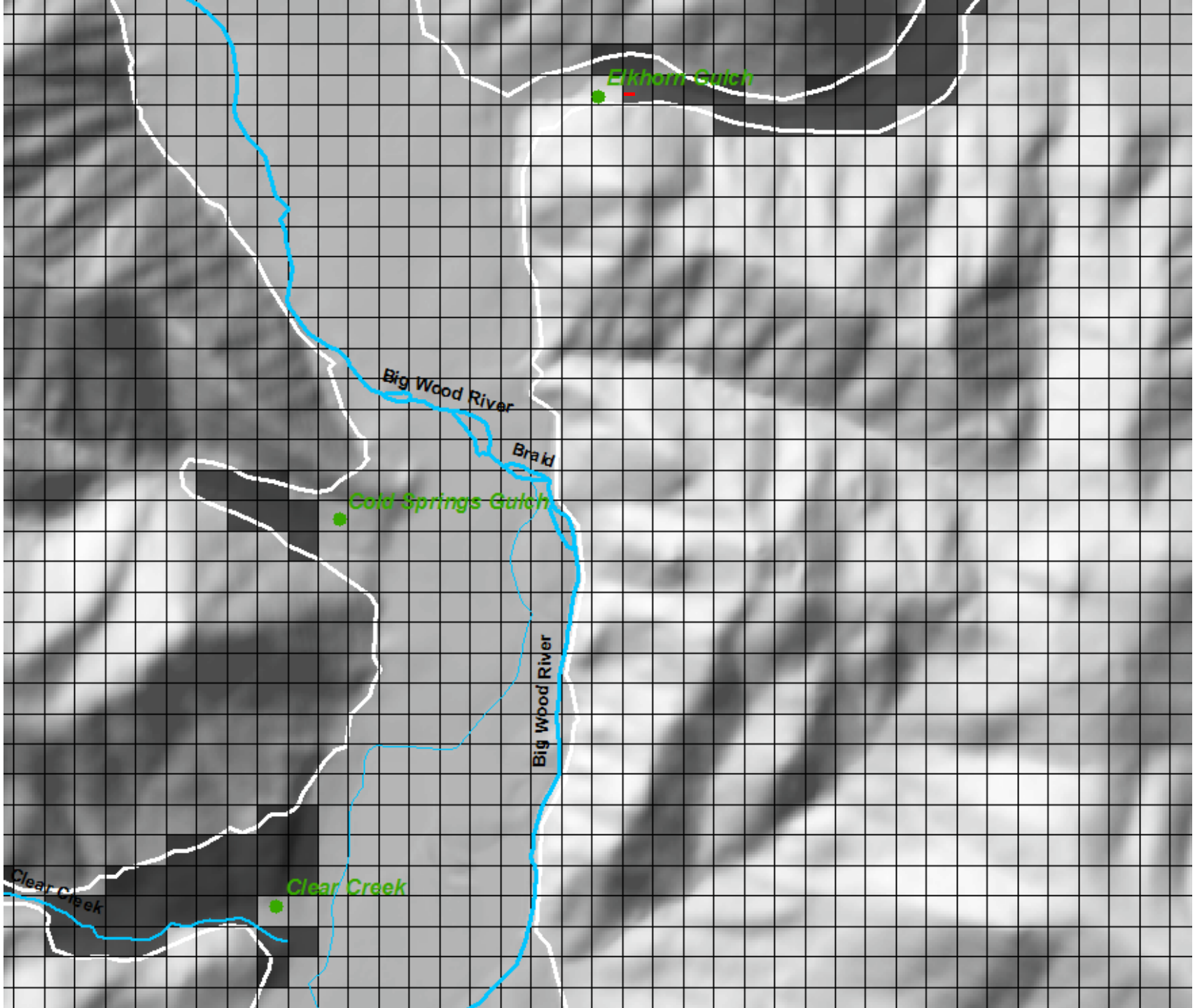


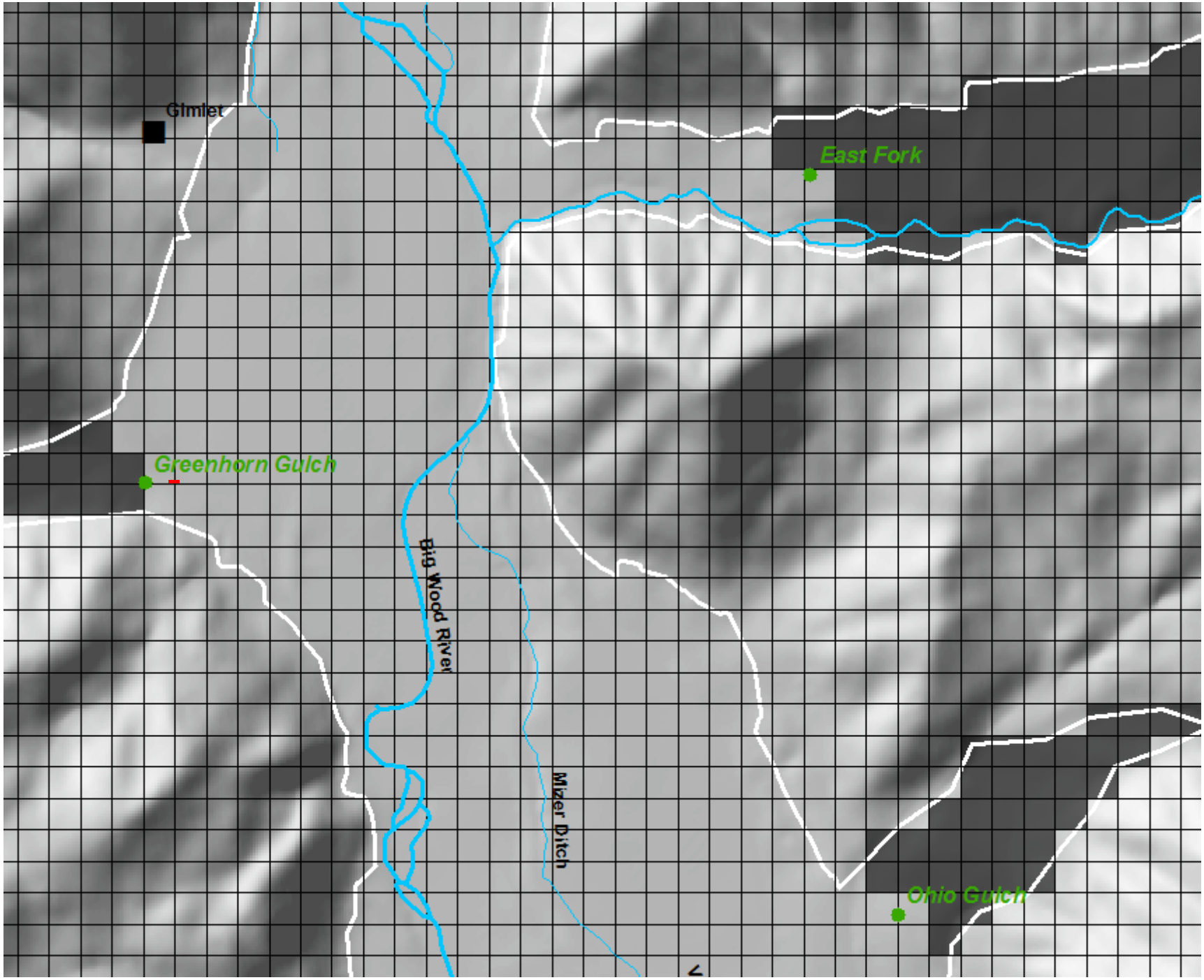

Upper BWR
Eagle Creek
Chocolate Gulch
Eagle Creek

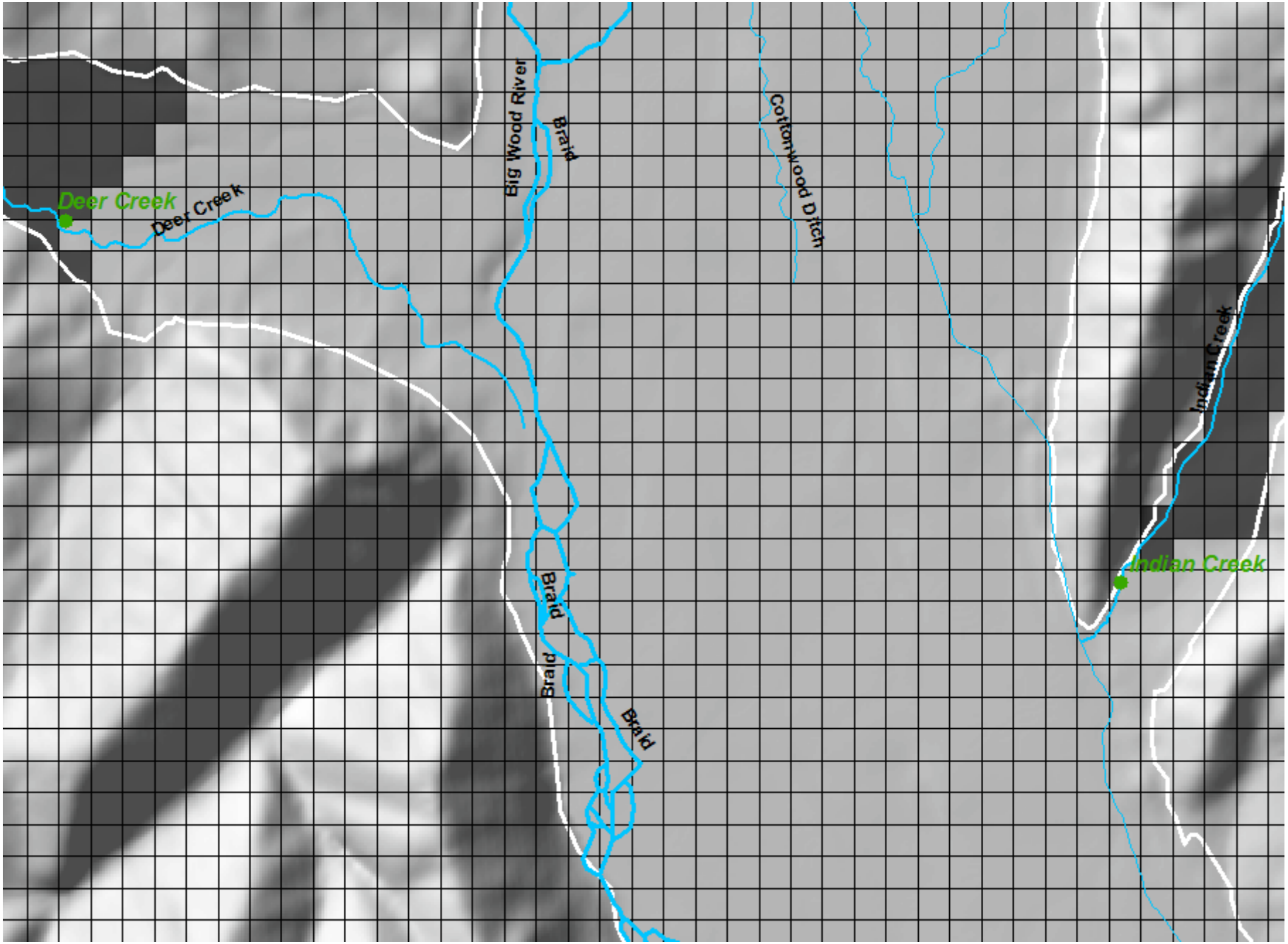

Lake Creek
Lake Creek

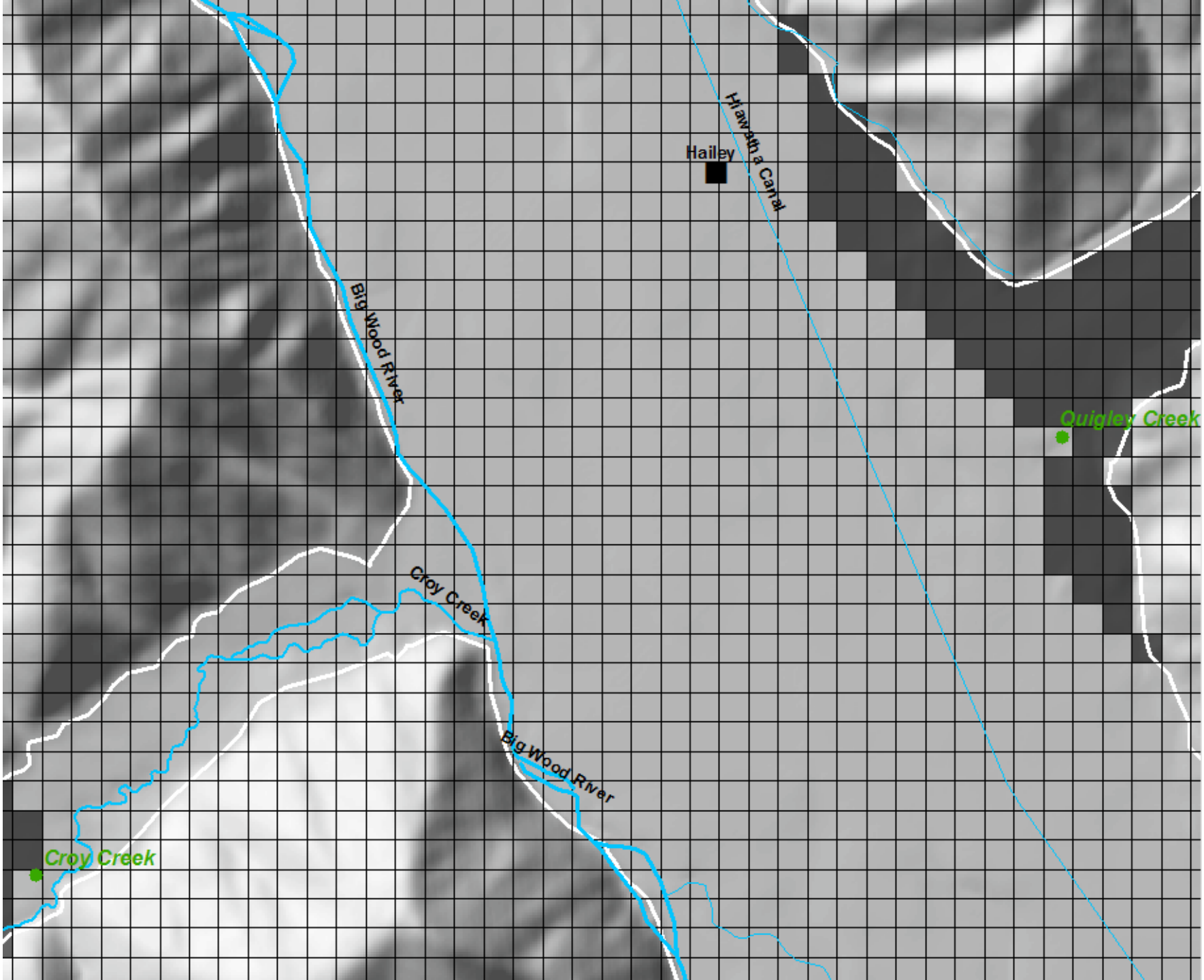

Adams Gulch
Sun Valley
Trail Creek
Trail Creek
Warm Springs Creek
Ketchum

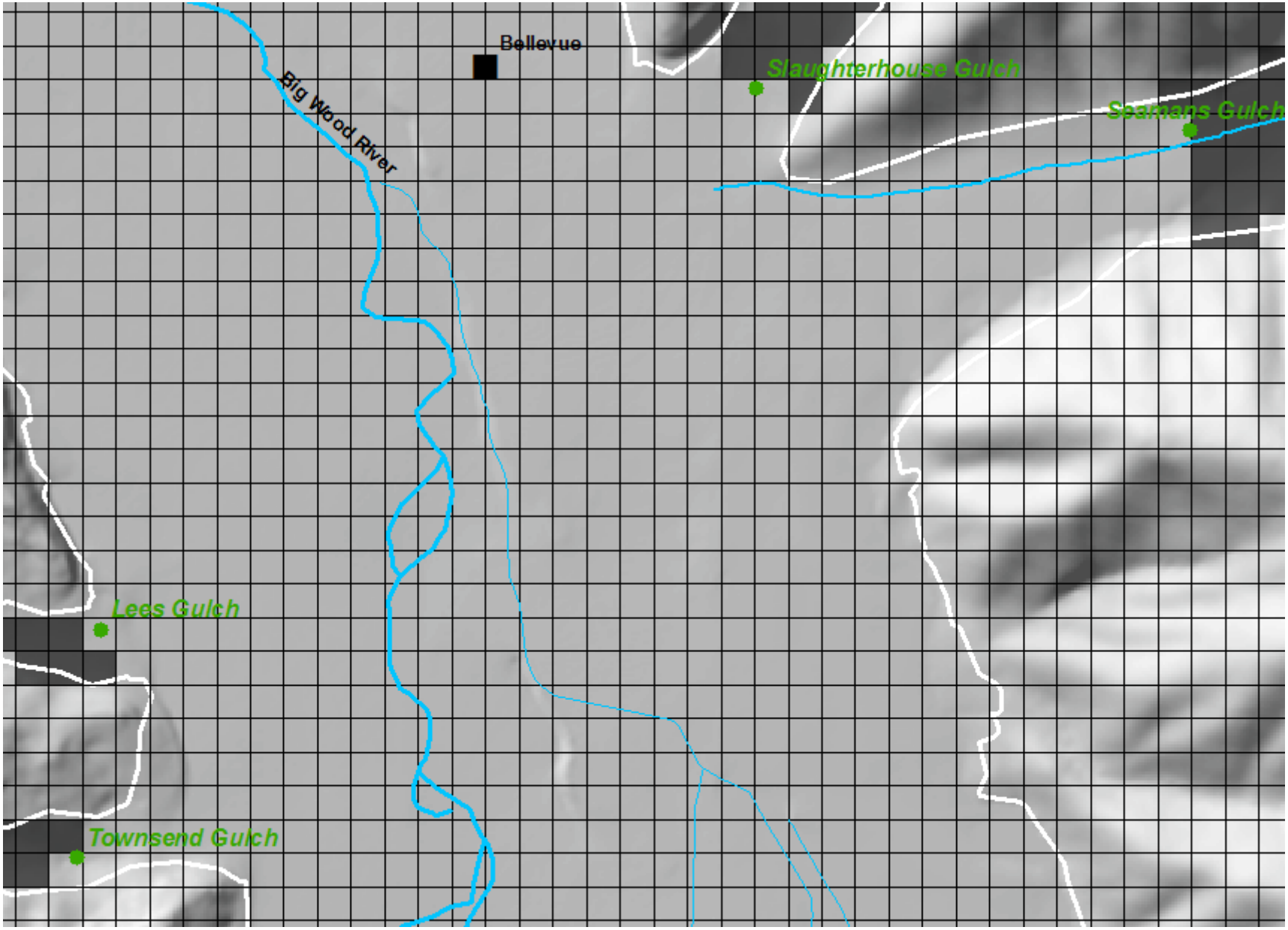

Warm Springs Creek
Warm Springs
Ketchum

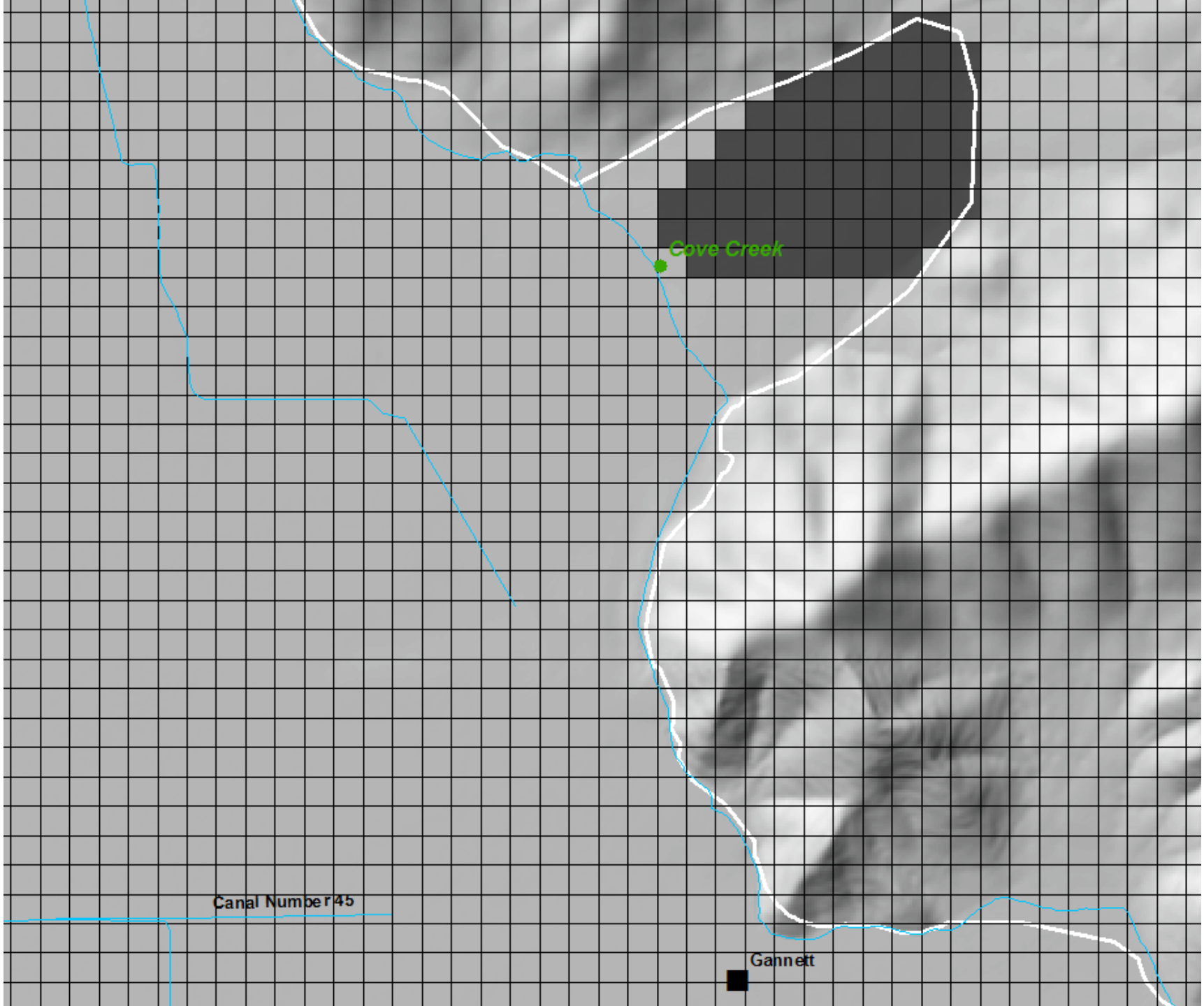

Elkhorn Gulch
Big Wood River
Braid
Cold Springs Gulch
Big Wood River
Clear Creek
Clear Creek


Gimlet
East Fork
Greenhorn Gulch
Big Wood River
Mizer Ditch
Ohio Gulch

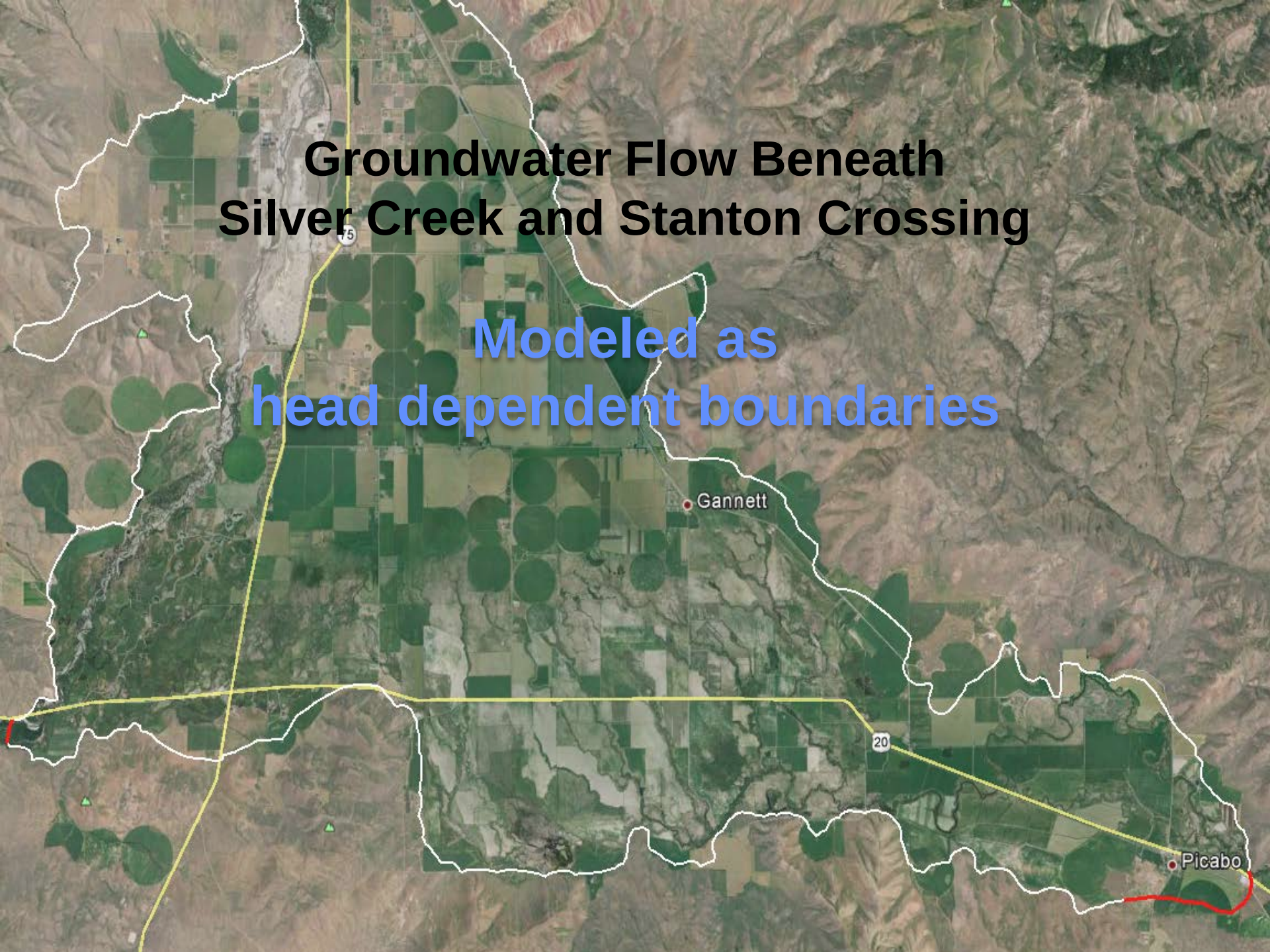

Deer Creek
Deer Creek
Big Wood River
Braid
Braid
Braid
Braid
Cottonwood Ditch
Indian Creek
Indian Creek


Hailey
Hiawatha Canal
Big Wood River
Croy Creek
Big Wood River
Quigley Creek
Croy Creek

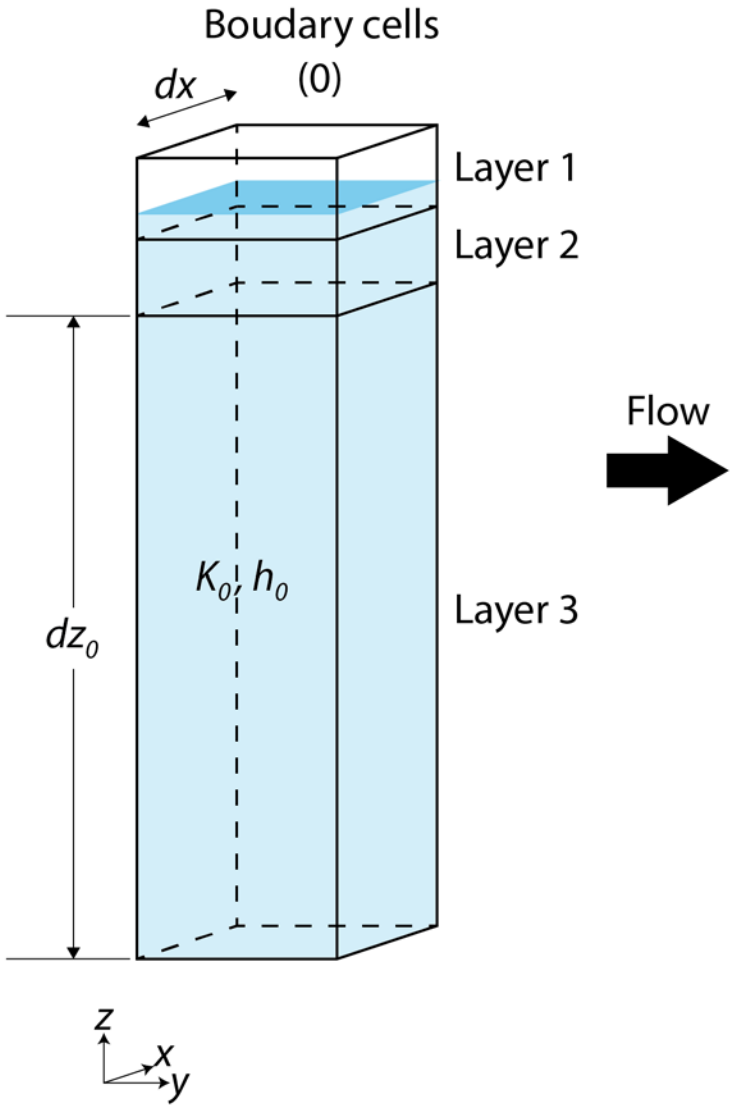

Bellevue
Big Wood River
Slaughterhouse Gulch
Seamans Gulch
Lees Gulch
Townsend Gulch


Cove Creek
Canal Number 45
Gannett

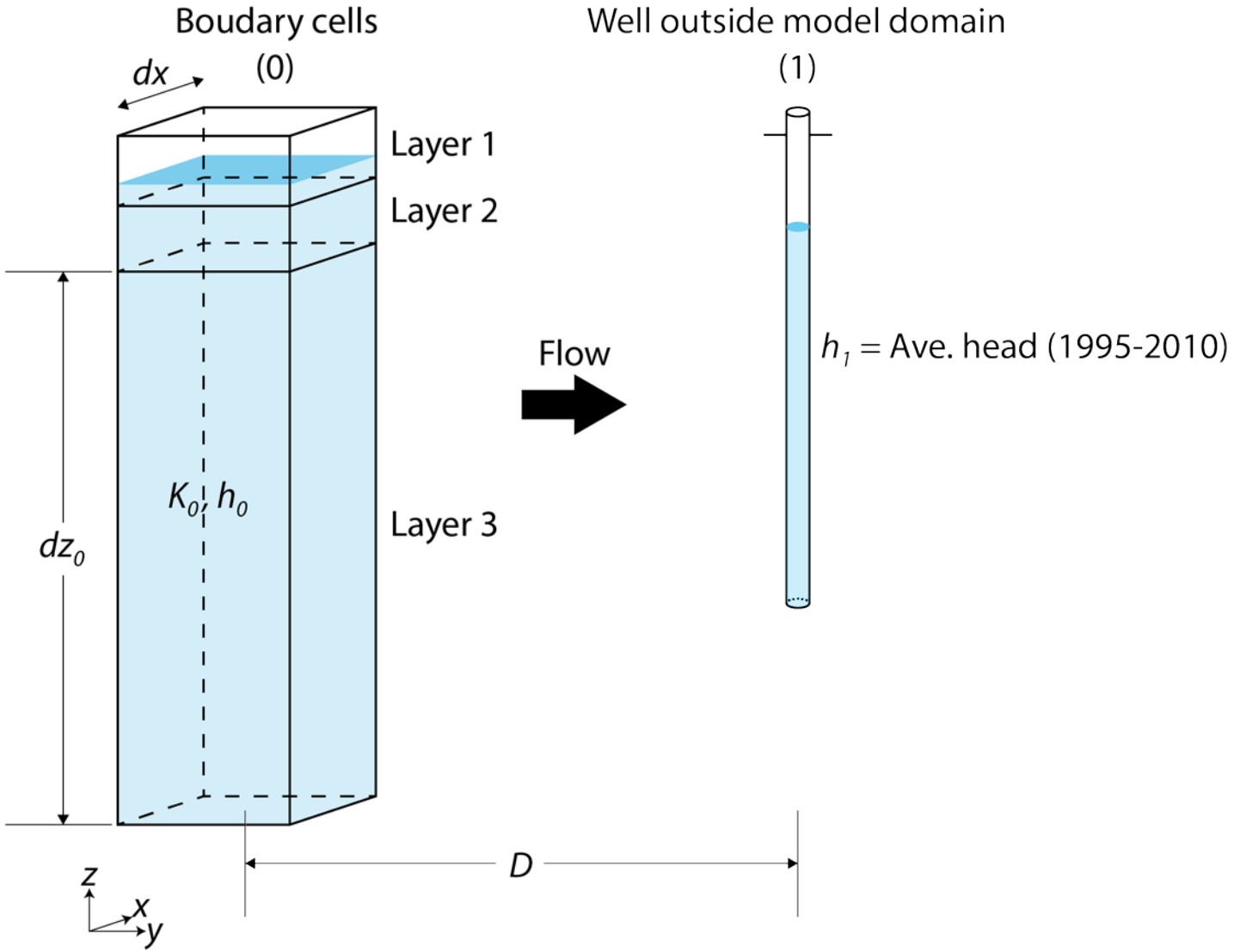
Groundwater Flow Beneath Silver Creek and Stanton Crossing



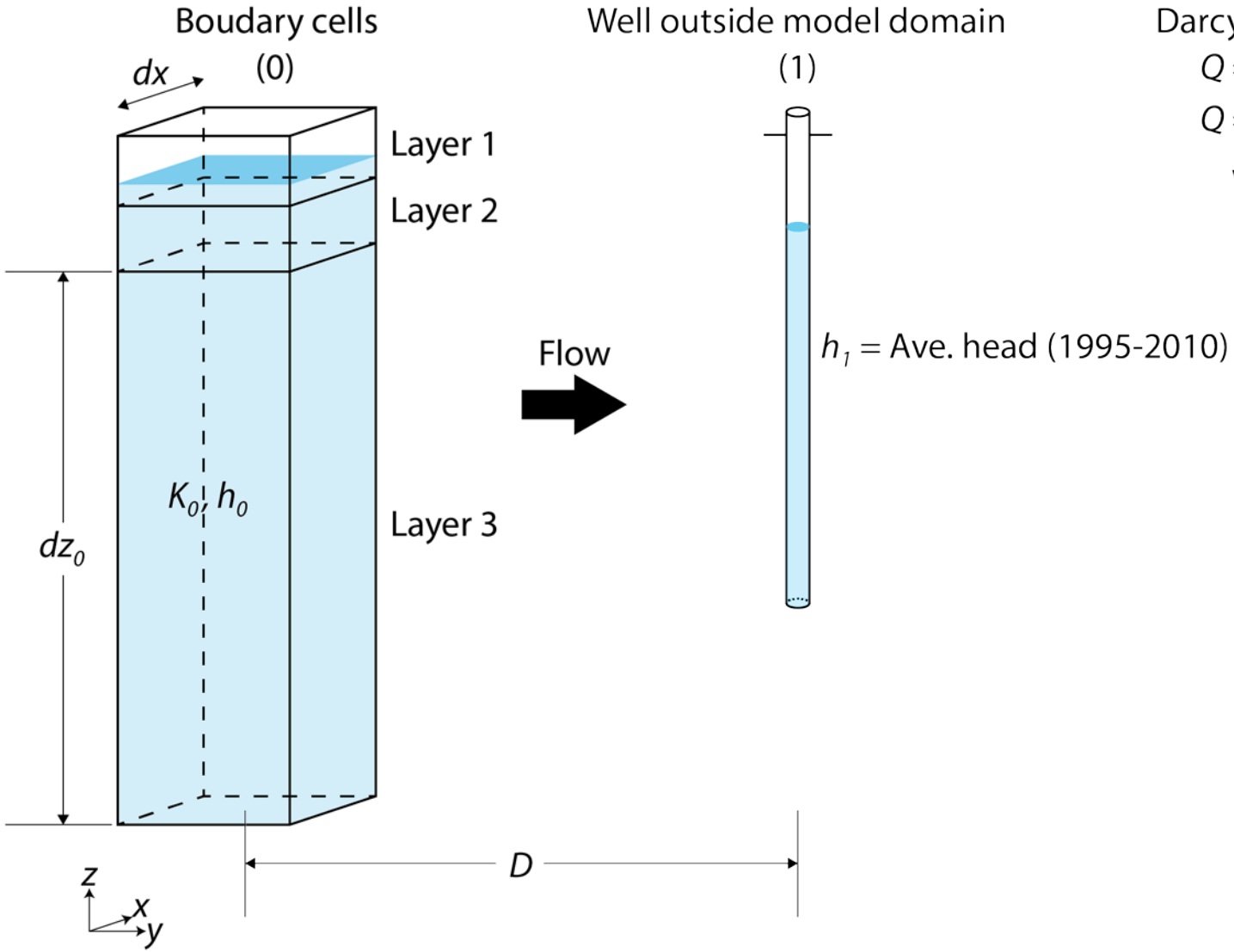
Head Dependent Boundary Cell



Head Dependent Boundary Cell



Head Dependent Boundary Cell



Darcy's Law:

$$Q = - K A [(h_1 - h_0) / D]$$

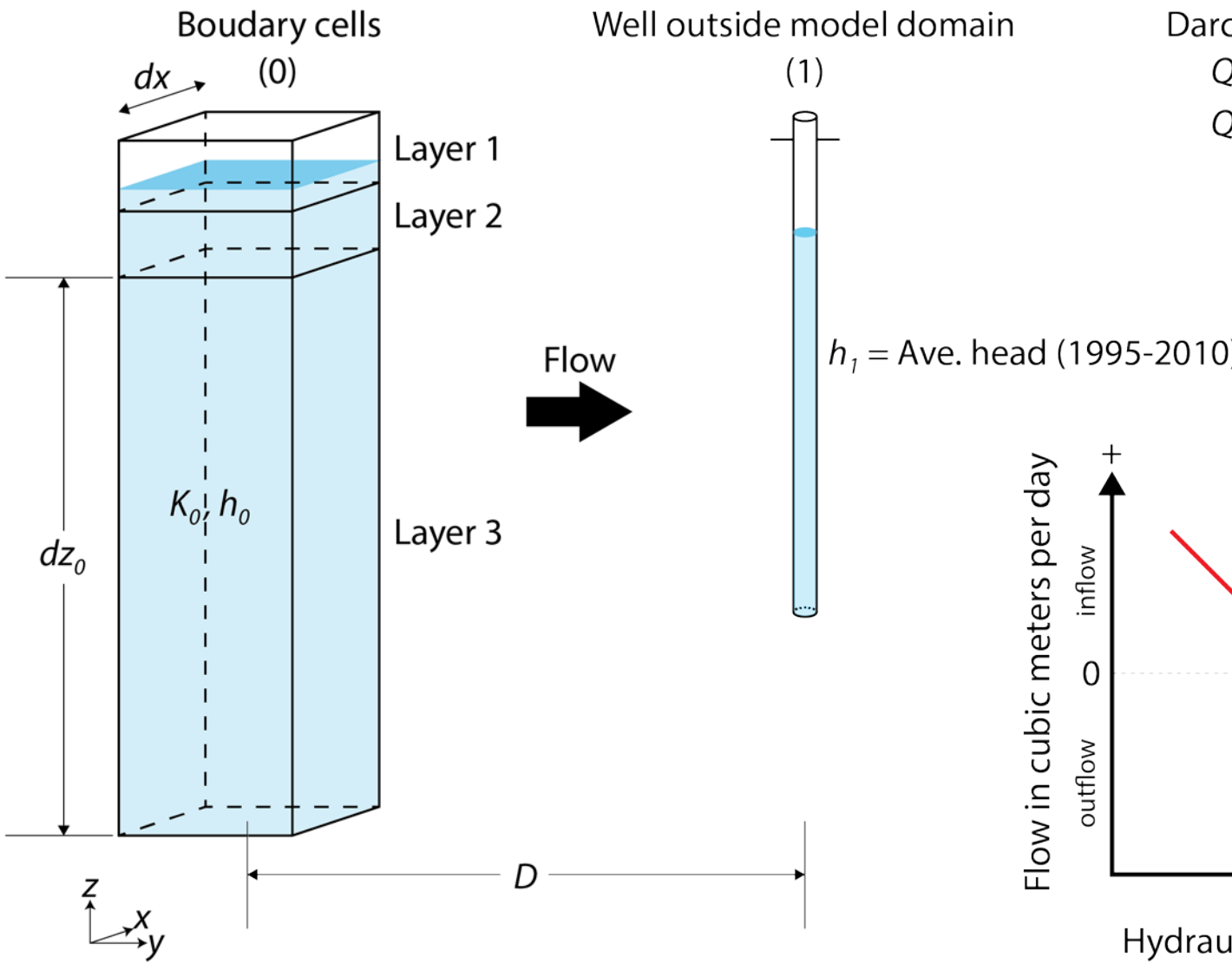
$$Q = - C (h_1 - h_0)$$

where

$$C = K A / D$$

$$C = [K_0 (dx\, dz_0)] / D$$

Head Dependent Boundary Cell



Darcy's Law:

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$$Q = - C (h_1 - h_0)$$

where

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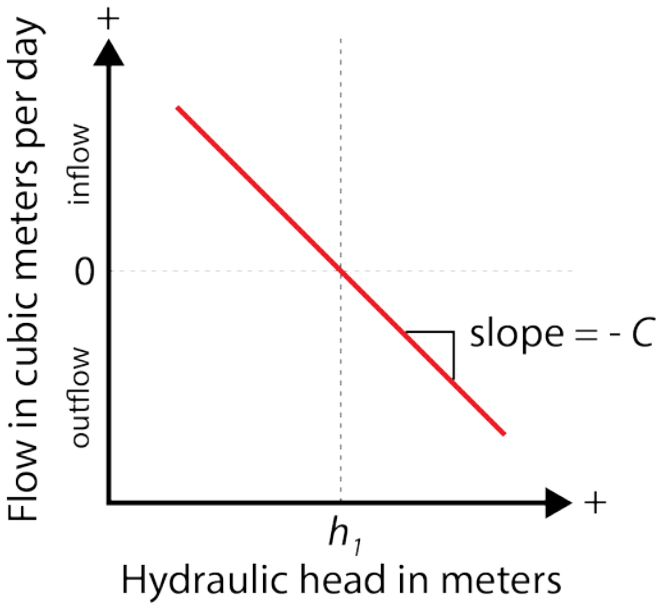
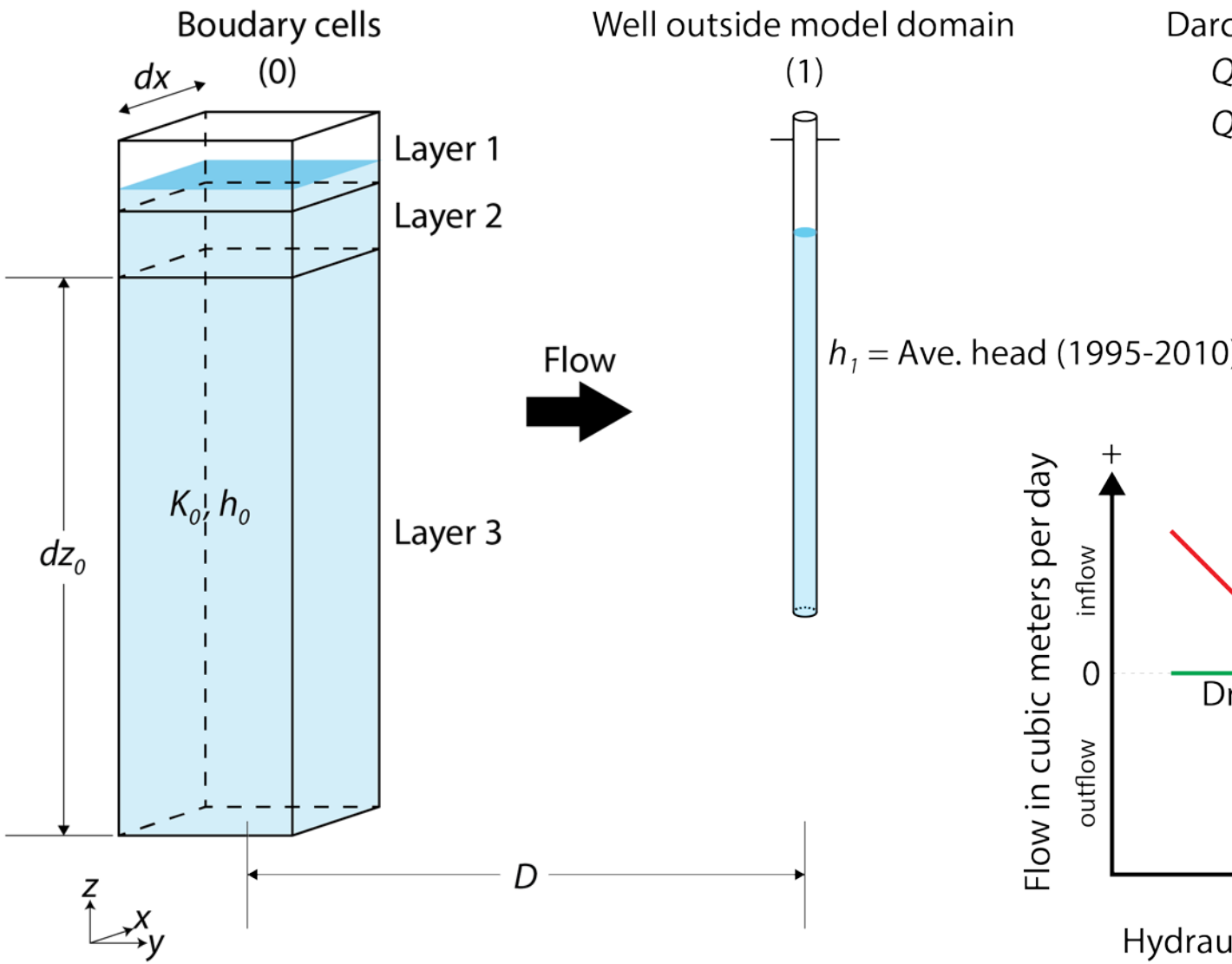


Head Dependent Boundary Cell



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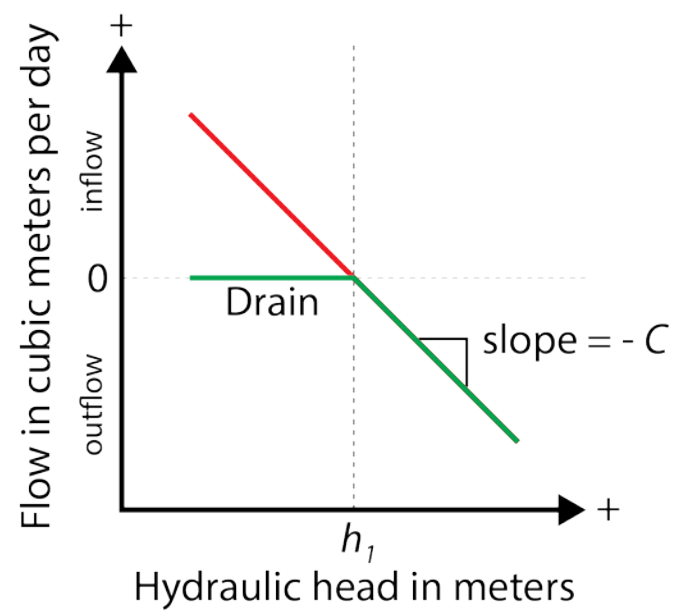
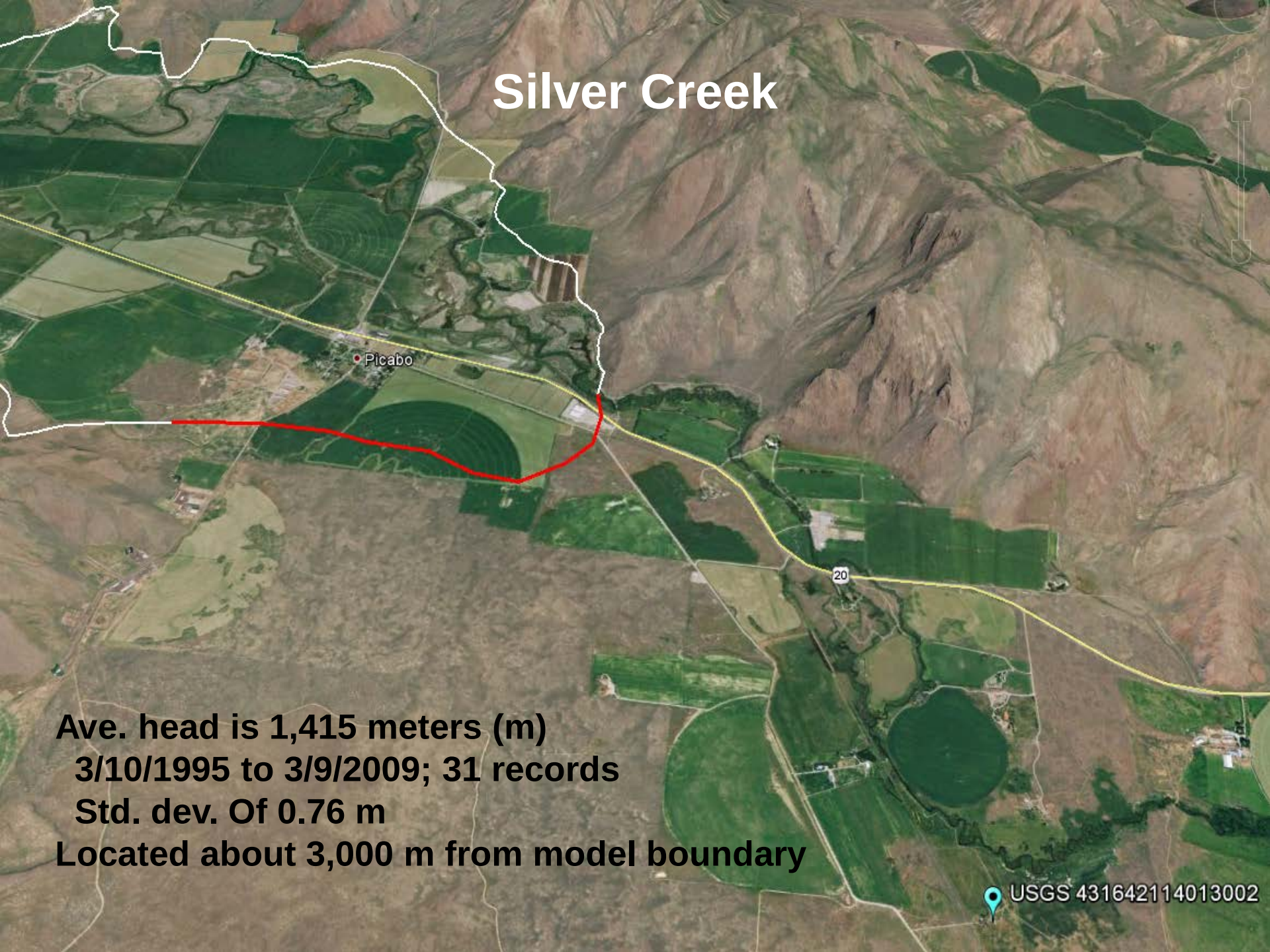
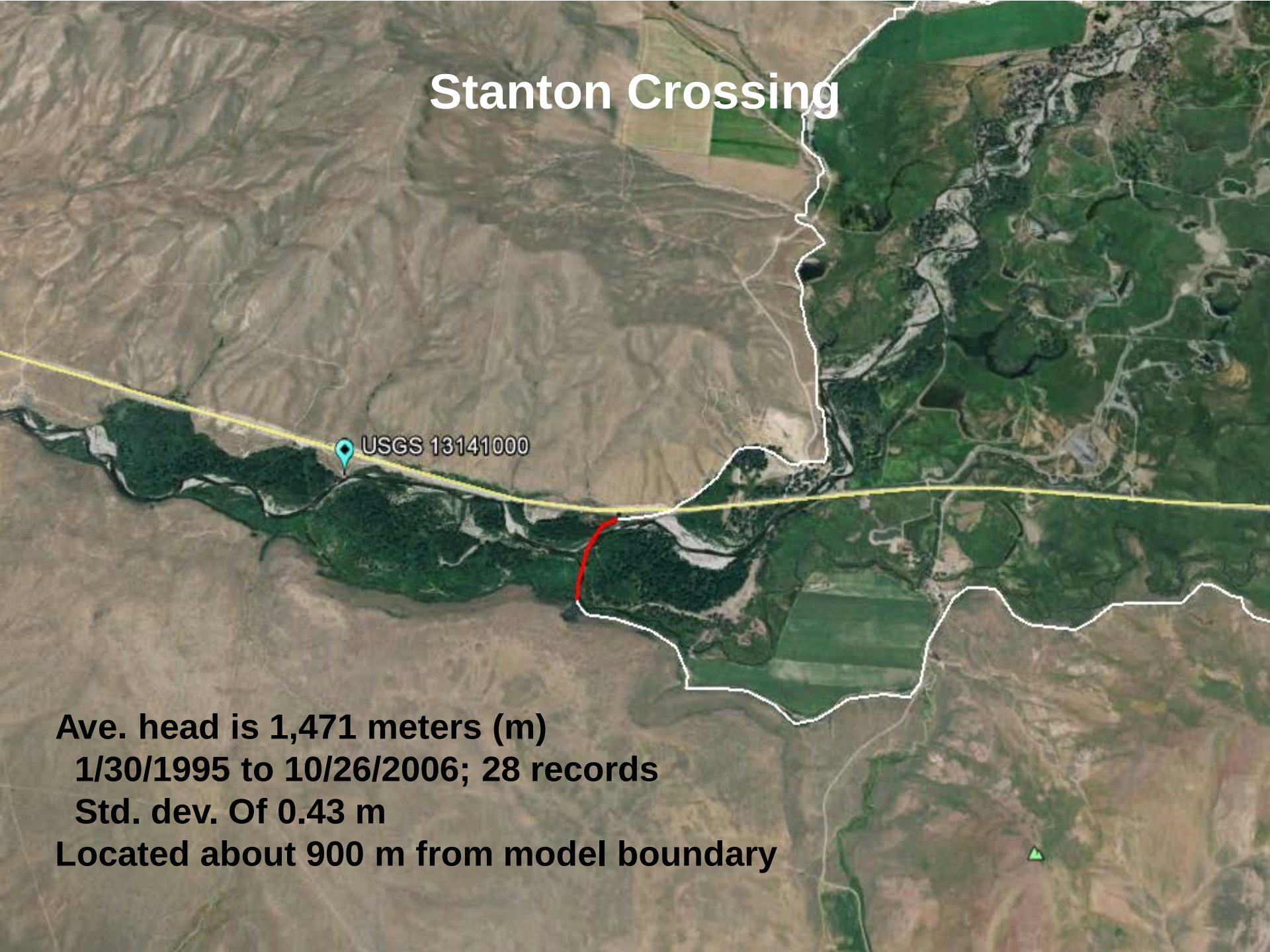


Silver Creek



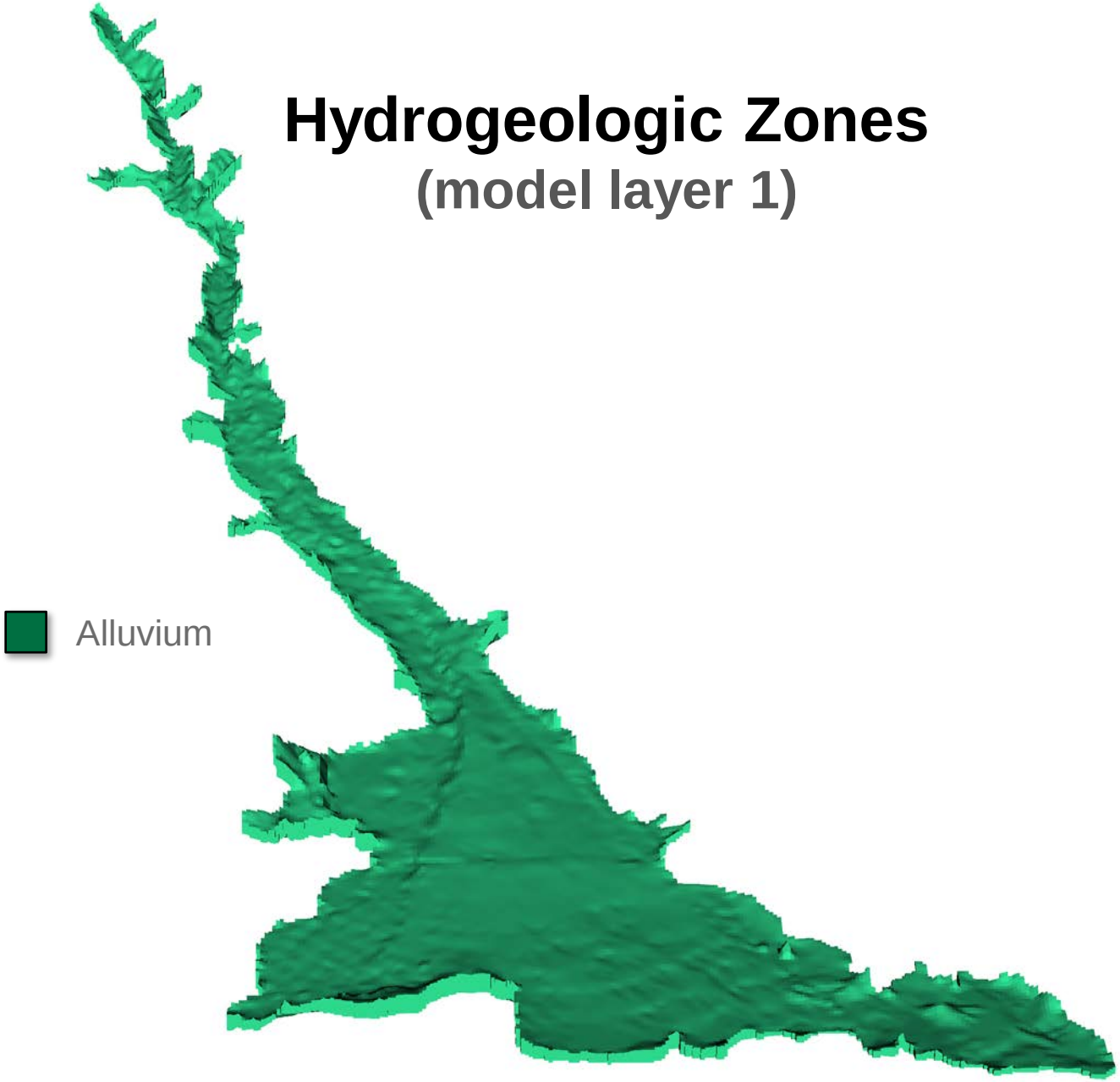
Ave. head is 1,415 meters (m)
3/10/1995 to 3/9/2009; 31 records
Std. dev. Of 0.76 m
Located about 3,000 m from model boundary

Stanton Crossing

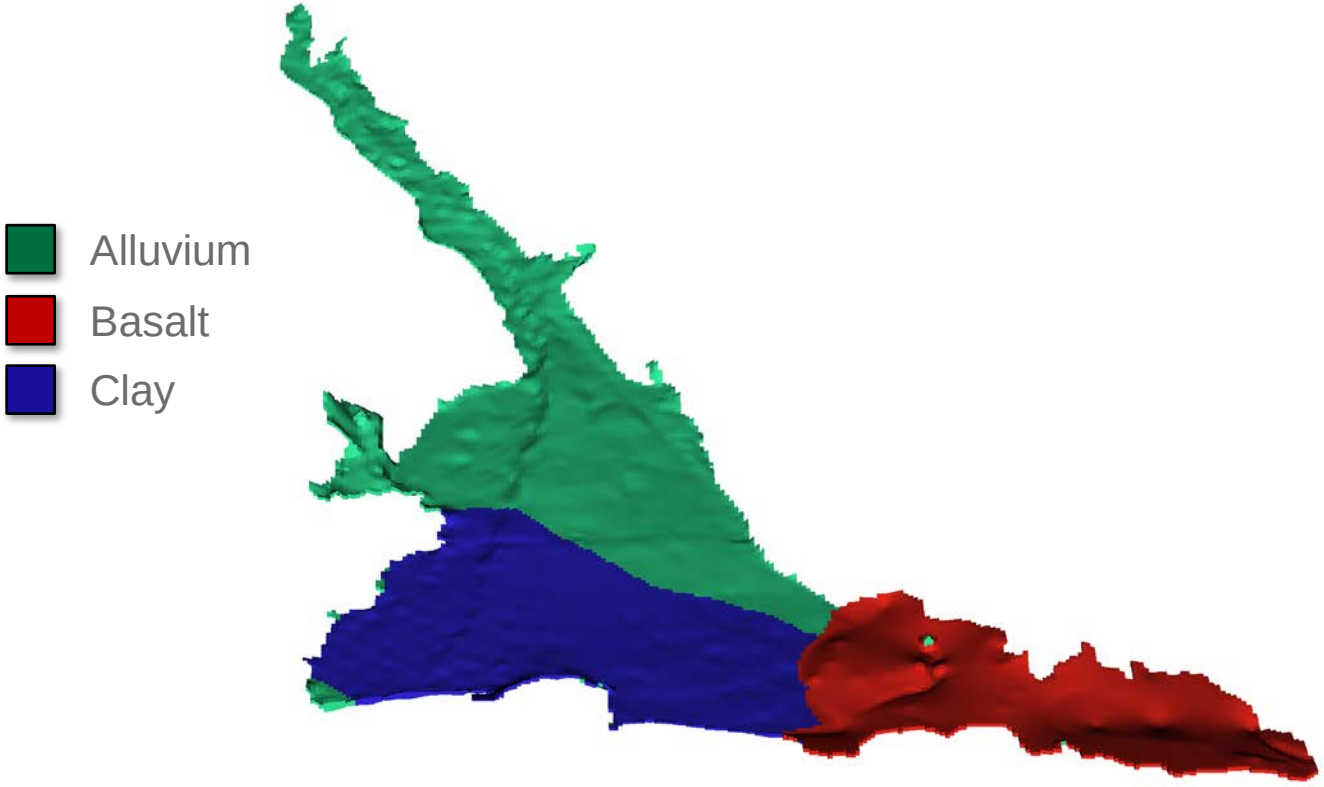


Ave. head is 1,471 meters (m)
1/30/1995 to 10/26/2006; 28 records
Std. dev. Of 0.43 m
Located about 900 m from model boundary

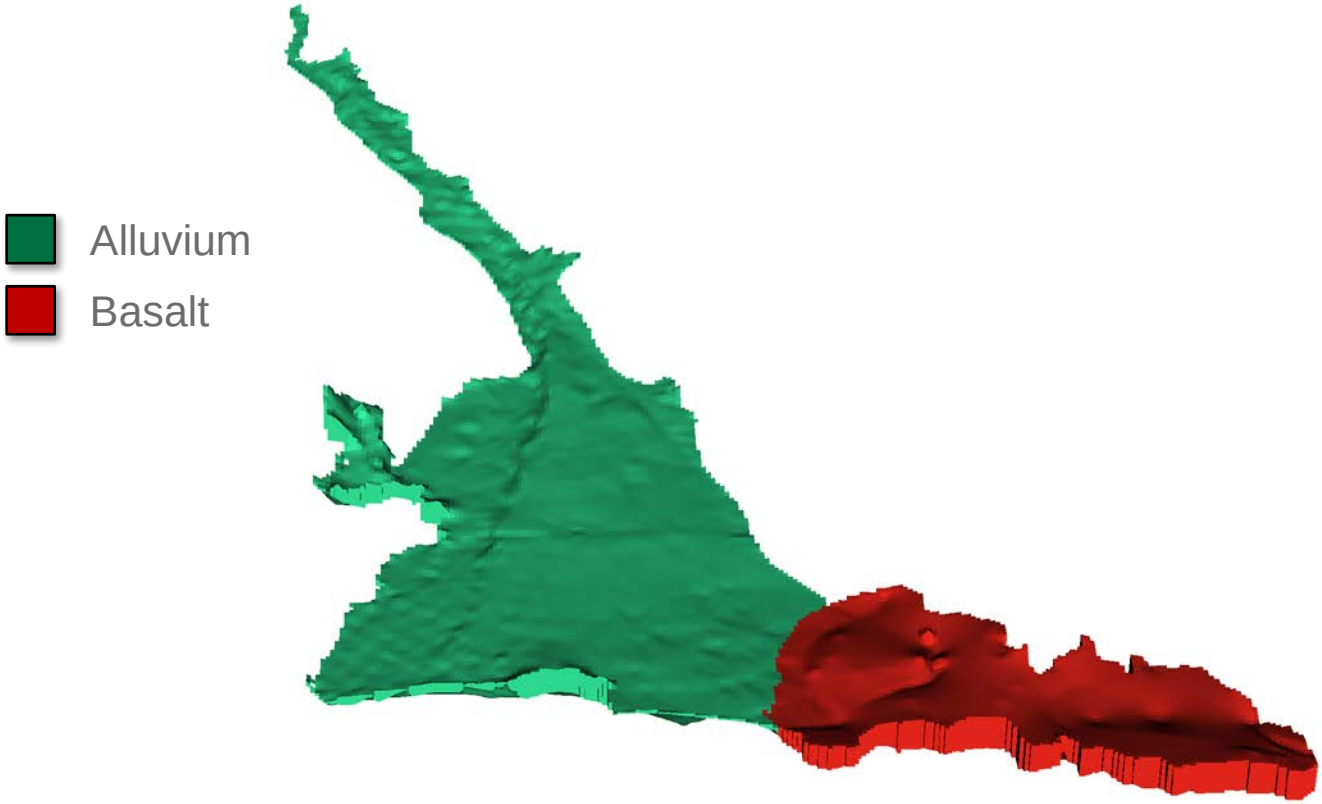
Hydrogeologic Zones
(model layer 1)



Hydrogeologic Zones
(model layer 2)



Hydrogeologic Zones
(model layer 3)



USGS
science for a changing world

Groundwater Resources Program

Prepared in collaboration with AMEC

MODFLOW–USG Version 1: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using a Control Volume Finite-Difference Formulation

Chapter 45 of
Section A, Groundwater
Book 6, Modeling Techniques

USGS
science for a changing world

Groundwater Resources Program

Prepared in collaboration with AMEC

Structured

MODFLOW–USG Version 1: An Unstructured Grid Version of MODFLOW for Simulating Groundwater Flow and Tightly Coupled Processes Using a Control Volume Finite-Difference Formulation

Chapter 45 of
Section A, Groundwater
Book 6, Modeling Techniques

MODFLOW-USG Packages

Groundwater flow process:

Basic

Discretization

Zone

MODFLOW-USG Packages

Groundwater flow process:

- **Basic**
- **Discretization**
- **Zone**

Groundwater flow:

- **Layer-Property Flow**

Boundary conditions:

General-Head Boundary

Boundary conditions:

General-Head Boundary

Drain

Time-Variant Head

Streamflow-Routing

Evapotranspiration

Well

Boundary conditions:

General-Head Boundary

Drain

Time-Variant Head

Streamflow-Routing

Evapotranspiration

Well

Solver:

Sparse Matrix Solver

Nonlinear solution method that uses a Newton-Raphson iteration scheme with under-relaxation

Boundary conditions:

General-Head Boundary

Drain

Time-Variant Head

Streamflow-Routing

Evapotranspiration

Well

Solver:

Sparse Matrix Solver

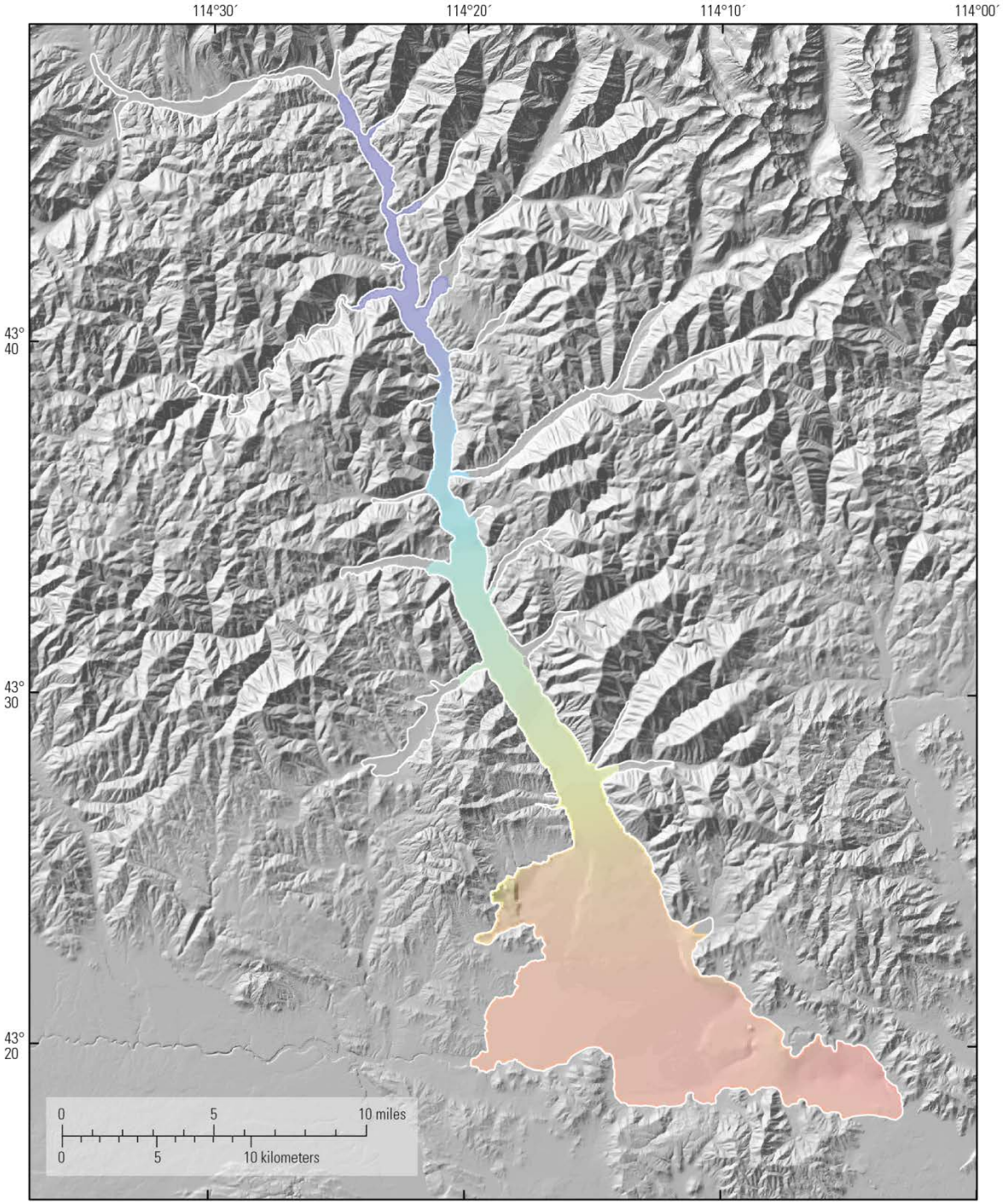
Nonlinear solution method that uses a Newton-Raphson iteration scheme with under-relaxation

Output control:

Output Control Option

MODFLOW-USG Run

- Steady-state simulation
- Model layer 1 is convertible, layers 2 and 3 are confined
- Initial heads at 90% saturation in model layer 1
- Horizontal conductivity (*provisional values*):
  - $K_{alluvium}$ = 30.48 m/d
  - K_{basalt} = 86.40 m/d
  - $K_{clay} = 8.64 \times 10^{-7}$ m/d
- Vertical conductivity: VK = K / 1000



Coordinate system:

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NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

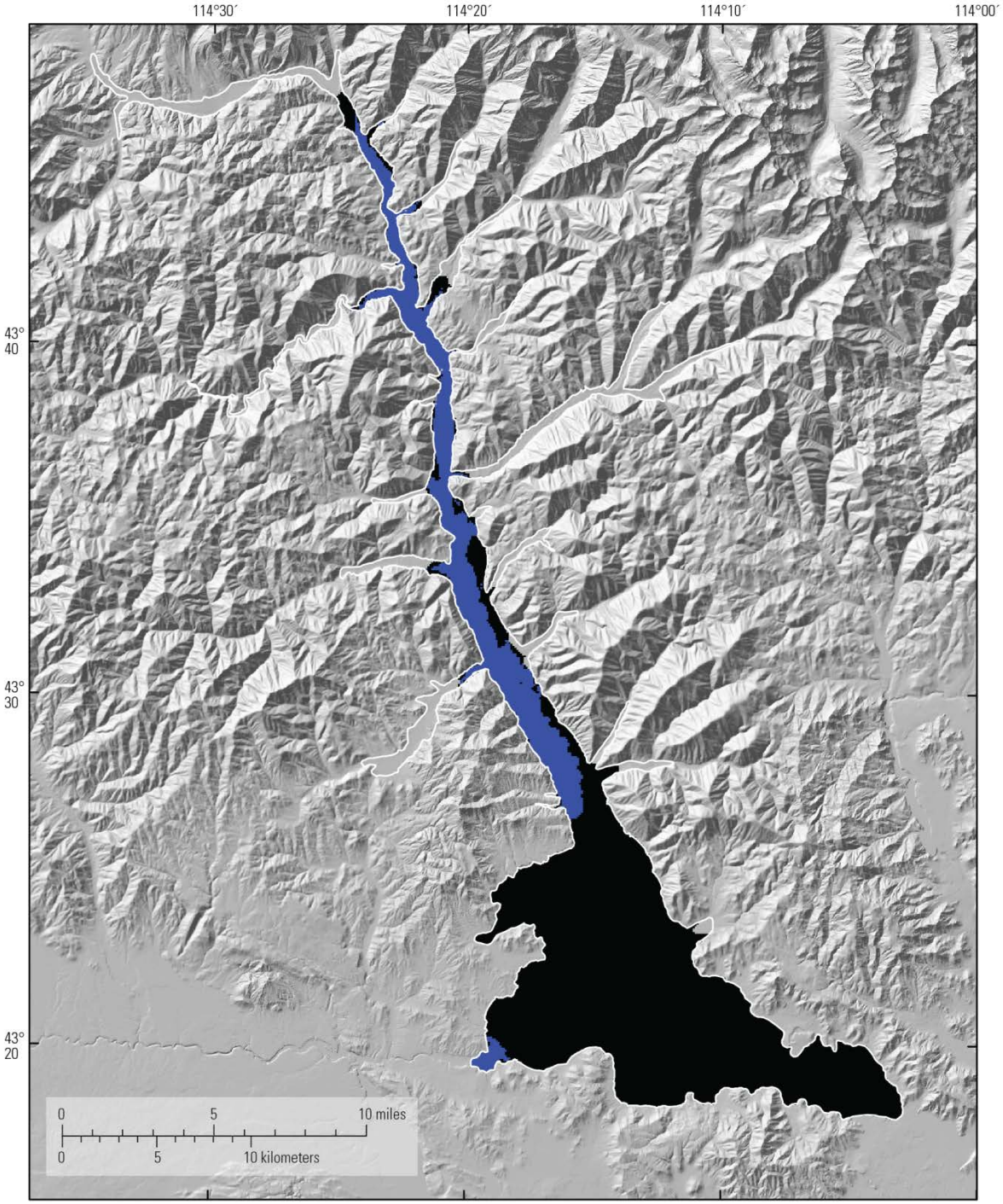
Aquifer extent (SIR 2012-5053)

Heads of model layer 1 raster:

Model resolution: 100 meters

1,907 meters

1,444 meters



Coordinate system:

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NAVD 1988 (meters)

Land surface elevation raster:

National Elevation Dataset (NED)
Resolution: about 10 meters

Line and polygon shapefiles:

- Aquifer extent (SIR 2012-5053)
- Partially-saturated cell
- Saturated cell (Model layer 1)
- Dry cell (Model layer 1)

```
****FAILED TO CONVERGE****

VOLUMETRIC BUDGET FOR ENTIRE MODEL AT END OF TIME STEP      1 IN STRESS PERIOD      1

--------------------------------------------------------------------------------------

   CUMULATIVE VOLUMES      m**3       RATES FOR THIS TIME STEP      m**3/d

   ------------------                 ------------------------

         IN:                                  IN:

         ---                                  ---

           STORAGE =          0.0000            STORAGE =          0.0000

     CONSTANT HEAD =   193647602.2800      CONSTANT HEAD =      35343.6033 (10,465 acre-ft/yr)

   HEAD DEP BOUNDS =          0.0000    HEAD DEP BOUNDS =          0.0000

          TOTAL IN =   193647602.2800           TOTAL IN =      35343.6033

        OUT:                                 OUT:

        ----                                 ----

           STORAGE =          0.0000            STORAGE =          0.0000

     CONSTANT HEAD =    19142483.5663      CONSTANT HEAD =       3493.7915 ( 1,035 acre-ft/yr)

   HEAD DEP BOUNDS =   217937690.7461    HEAD DEP BOUNDS =      39776.9102 (11,778 acre-ft/yr)

         TOTAL OUT =   237080174.3124          TOTAL OUT =      43270.7016


          IN - OUT =   -43432572.0000           IN - OUT =      -7927.0981

PERCENT DISCREPANCY =        -20.17   PERCENT DISCREPANCY =        -20.17
```

Where to go next…

- Surface water boundary conditions
- Model convergence

Questions

USGS