Back to Table of Contents

Appendix H

Documentation of the Application of a Numerical Model to Simulate Ground Water Response to Pumping for the Proposed White Pine Energy Station in Steptoe Valley, Nevada

Documentation of the Application of a Numerical Model to Simulate Ground Water Response to Pumping for the Proposed White Pine Energy Station in Steptoe Valley, Nevada

PREPARED FOR: White Pine Energy Station EIS Project File

PREPARED BY: CH2M HILL

DATE: September 13, 2006

Introduction

Ground water from the basin-fill deposits in Steptoe Valley is proposed as the source of water for the White Pine Energy Station (WPES), a proposed up to 1,600-megawatt coal-fired electrical generating station to be located in Steptoe Valley, White Pine County, Nevada. The maximum annual water demand for the WPES is approximately 5,000 acre-feet (af). For the purpose of the analyses in this technical memorandum, the maximum project life with respect to this water demand is 40 years. This demand would be met through pumping from a wellfield composed of 8 wells, which are not yet constructed. The principal features of the proposed project, including the locations of each well in the wellfield, are shown in Figure 1 for the Proposed Action and in Figure 2 for Alternative 1.

The principal objective of this technical memorandum is to document the use of a numerical ground water flow model to simulate the response of the Steptoe Valley basin-fill aquifer system to ground water pumping required to meet the project demand for water, up to 5,000 acre-feet per year for 40 years. Although this demand for water would be the same for either the Proposed Action or Alternative 1, the demand would be met through the operation of two different wellfields, each consisting of eight water supply wells in a linear configuration on the valley floor roughly parallel to U.S. 93. Specifically, for the Proposed Action, the eight wells in the proposed wellfield would be located at intervals of between approximately 1 and 3 miles extending from the proposed energy station location northward for approximately 12 miles. The eight wells in the proposed wellfield for Alternative 1 would be located at intervals of between approximately 1 and 2.5 miles extending from the Alternative 1 energy station location south for approximately 5 miles.

This technical memorandum has been prepared to support the environmental documentation for the proposed WPES, which is being developed by White Pine Energy Associates, LLC, a wholly owned subsidiary of LS Power Development, LLC.

Ground Water Flow Model

Inasmuch as multiple wells would be required to meet the project water demand, a numerical ground water flow model was determined to be the most appropriate tool to determine a reasonable range of potential ground water level declines in the Steptoe Valley that could be anticipated to occur as a result of project specific ground water withdrawals in support of either the proposed action or the alterative energy station location.

In determining a reasonable range of anticipated decline in ground water levels, the principal objective is to gain an understanding the difference in ground water levels between non-project pumping and project pumping. A complete understanding of the current water levels is therefore not required; only the change in water level brought about by project pumping is important.

Accordingly, the simulation of potential project-induced ground water level decline was conducted using a revised version of a numerical model previously developed, in part, to examine the potential consequences of pumping from the same well locations as proposed for the WPES. Specifically, the model developed by Frick (1985) was re-created using grid dimensions and estimates for model input parameter values that matched as closely as possible the ones used previously by Frick. In addition, the model in Frick (1985) was revised to simulate transient conditions. The original model solved only for steady-state hydraulic heads.

Although the Frick model was calibrated to conditions in the mid-1980s, it was determined to be an appropriate tool to address the fundamental issue of potential project-induced ground water level declines (i.e., it sufficiently represents the ground water conditions in the basin-fill aquifer system in the Steptoe Valley to be able to provide reasonable approximations of the change in ground water levels that would occur as a result of project pumping). Frick (1985) acknowledges that although the model was considered calibrated, there were (and are in 2006) insufficient data to verify that the model can reproduce a historical hydrogeologic condition that is independent of or different from the conditions reproduced during calibration. Nevertheless, the calibrated model was still considered to be a valuable tool to test hypotheses about the basin-fill ground water system and its response to different stresses (Frick, 1985).The model developed by Frick (1985), and the one subsequently used for these analyses, is based on the three-dimensional finite difference ground water flow model commonly referred to as MODFLOW, which was first developed by McDonald and Harbaugh (1984) and subsequently formally documented in McDonald and Harbaugh (1988). Since initially published, MODFLOW has been updated to run on personal computers using Windows®-based platforms, and to simulate more complex ground water environments and boundary conditions with more efficient matrix solver routines. In re-creating Frick's model, the MODFLOW 96 version in Ground Water Vistas® 4.20 (GWV) was used. This version essentially uses the same basic computer code as originally published and, therefore, used in Frick (1985).

Principal Assumptions

The following assumptions provide important context for the model setup and subsequent simulation results:

- Fundamentally, the most important assumption is that the conceptual model of the Steptoe Valley basin-fill aquifer system developed by Frick (1985) is sufficiently accurate, and that the subsequent representation of the conceptual model by the MODFLOW-based model is also reasonable for the purpose of meeting the objectives of the simulations for the WPES environmental documentation. Accordingly, the lateral and vertical extent of the simulated problem domain, the finite-difference grid dimensions, the values for fundamental model input parameters, and the initial and boundary conditions for the re-created model are as close as possible to those employed by Frick (1985).
- Actual operating conditions for the project wellfield have not yet been determined. Therefore, each project well was pumped at the same rate (5,000 af/year ÷ 8 wells = 387 gallons per minute [gpm]) continuously for 40 years).
- In Frick (1985), background (non-project) ground water withdrawals were held constant at 20,289 af/year, and this rate was apportioned to different finite-difference cells based on known local pumping centers as of 1985. For the re-created model, background ground water pumping was held constant at the combined estimated rate as of 2000 (6,360 af/year), which is the last year for which published estimates of ground water withdrawals in Steptoe Valley are available (Lopes and Evetts, 2004). However, the current spatial distribution of pumping in Steptoe Valley is unknown; consequently, the same pumping areas identified in Frick (1985) were used in the re-created model, but with the pumping rate of 6,360 af/year evenly distributed across the same finite-difference cells identified as pumping cells in Frick (1985).
- The model developed by Frick (1985) only solved for steady-state hydraulic heads. Accordingly, storage properties of the aquifer system were neither quantified nor accounted for in the model input data in Frick (1985)[1]. However, to simulate ground water level declines after 40 years of project pumping, transient head solutions are required. Inasmuch as the solution to the partial differential equation for anisotropic time-dependent ground water flow requires that storage properties be known or assumed, appropriate values of both specific yield (Sy) and storage coefficient (S) are required for model layers representing unconfined and confined conditions, respectively. For the re-created model, it was assumed that the values of Sy and S would be constant in space. Specifically, the value of S applied to model Layers 2 and 3 representing confined conditions (see Model Setup section below) was 1×10^{-4} following sensitivity testing that revealed essentially no difference between results with $S = 10^{-3}$ and $S = 10^{-5}$. A value of $S = 10^{-4}$ is consistent with the results of aquifer testing in Steptoe Valley reported in Leeds, Hill, and Jewett (1983). However, simulation results were

[1] Under steady-state conditions, the right-hand side of the partial differential equation for ground water flow:

$$\frac{\partial}{\partial x}\left(K_x \frac{\partial h}{\partial x}\right) + \frac{\partial}{\partial y}\left(K_y \frac{\partial h}{\partial y}\right) + \frac{\partial}{\partial z}\left(K_z \frac{\partial h}{\partial z}\right) + W = S_s \frac{\partial h}{\partial t}$$

goes to zero because $\frac{\partial h}{\partial t} = 0$; therefore, under steady-state conditions, aquifer storage properties (specific storage [Ss]) are irrelevant. For the definitions of the other terms in this equation see, for example, Freeze and Cherry (1979).

sensitive to changes in the value of Sy assigned to Layer 1. For example, a value of Sy = 0.05 ultimately resulted in drawdowns in response to project pumping of between 1 and 10 feet higher than when Sy = 0.25. The greatest differences in drawdowns resulting from the different values of Sy were closest to the pumping centers while the smallest differences were at the margins of the cone of depression for the wellfield[2]. A value of Sy = 0.05 was used in the final simulations because it was the lowest reasonable value that was consistent with the documented near-surface lithology (see, for example, Clark and Riddell, 1920; Leeds, Hill, and Jewett, 1983). Selecting the lowest of the range of reasonable values of Sy maximizes the resulting simulated wellfield drawdowns in Layer 1.

Model Setup

Problem Domain and Model Grid

The simulated problem domain and the associated finite-difference grid are shown in Figure 3 relative to the location of the proposed wellfield under the Proposed Action, and in Figure 4 relative to the location of the proposed wellfield under Alternative 1. The problem domain and lateral (x-y) dimensions of the model grid are the same for both the Proposed Action and Alternative 1, and are the same as employed in Frick (1985) with the grid spacing of Δx = 5,280 feet (1 mile) and Δy = 10,560 feet (2 miles). The x-offset of the grid in GWV was 2215399.51, and the y-offset was 14118722.49 (NAD27, UTM 11N). These offsets placed the bottom left (southwest) corner of the finite difference grid as close to actual coordinates as possible.

In the vertical dimension, the problem domain was discretized into three layers following the approach in Frick (1985). The upper-most layer (Layer 1) represents the upper 100 feet of saturated thickness, and is assumed to be unconfined (LAYCON=1). Layer 2 represents the principal confined aquifer unit (LAYCON=0) and extends from the bottom of Layer 1 to approximately 1,000 feet below land surface at the lowest point along the east-west width of the valley. Layer 3, which is also confined, is below Layer 2 and represents deep ground water which, while not tapped directly by wells, influences the hydraulic response to pumping from Layer 2 (imposing a no-flow boundary at the base of Layer 2 would be inappropriate because it would limit the water available to deep wells).

The elevation and thickness (layer tops and bottoms) were created by approximating layer thickness directly from Figure 15a and 15b in Frick (1985). Specifically, the lowest point on Figure 15b was selected as the base elevation datum in the model (zero elevation). All other layer elevations in the model are a particular value above the datum based on the approximated thickness from Figure 15b in Frick (1985). While every effort was made to duplicate the layering discretization in the previous model, this portion of the model setup was not very well documented in Frick (1985). The resulting inherent differences in the vertical discretization between the two models ultimately led to the greatest differences in the solutions produced by the two models.

[2] Sensitivity testing indicated that at the margins of the cone of depression for the wellfield there was no significant difference in the results between Sy = 0.05 and Sy = 0.1.

Hydraulic connection between the layers is simulated through confining layers that are not specifically represented spatially by the model but are approximated through leakance parameters (these confining layers only transmit water in the vertical direction and are not capable of storing water).

Model Input Parameters

The values of the basic model input parameters (hydraulic conductivity, leakance, recharge, evapotranspiration) including grid specifics were taken from Frick (1985), and are presented spatially in Figure 5 through Figure 14.

Boundary Conditions

Boundary conditions for MODFLOW are: no-flow finite-difference cells (deactivated cells outside the model domain); ground water pumping cells (both non-project and project wells); stream cells representing Duck Creek and Steptoe Creek; and general head boundary (GHB) condition cells.

The GHB package in MODFLOW was used to represent ground water flow north from Steptoe Valley into Goshute Valley in the vicinity of Currie. The GHB cells are identified in Table 1.

TABLE 1
General Head Boundary Condition Location and Properties

Layer	Row	Column	Head Elevation (feet)	Width (feet)	Distance to GHB head (feet)	Hydraulic Conductivity (feet/day)	Saturated Thickness (feet)	Resulting Conductance ($feet^2$/day)
1	2	15	2,010	5,280	1,000	32.73	10	$1.72x10^3$
2	2	15	2,010	5,280	1,000	49.09	10	$2.59x10^3$
3	2	15	2,010	5,280	1,000	49.09	10	$2.59x10^3$

The stream package was applied to 61 cells in the model according to the routing detailed on Figure 22 in Frick (1985). The revised model employed the "compute stream stages" option available in GWV, based on the flux into the first stream segments (Row 42, Column 13, for Steptoe Creek and Row 31, Column 14, for Duck Creek) from Frick (1985).

Project Wellfield

The project wellfield consists of eight proposed wells at the locations (grid coordinates) listed in Table 2 (see also Figure 1).

TABLE 2
Location Coordinates of Project Wells

Well	Northing	Easting
Proposed Action		
Well 1	4401344.6525	689856.4924

TABLE 2
Location Coordinates of Project Wells

Well	Northing	Easting
Well 2	4399175.8120	689638.5035
Well 3	4413857.0747	692195.6371
Well 4	4416670.1487	692752.2903
Well 5	4419738.1191	693337.5647
Well 6	4410490.9652	691003.9852
Well 7	4407677.4845	690556.2981
Well 8	4405261.0926	690295.4449
Alternative 1		
Well 1	4372077.3005	687459.3944
Well 2	4374074.0148	686996.0219
Well 3	4376159.1912	687733.2054
Well 4	4377894.7320	688002.8040
Well 5	4378720.3776	687160.3085
Well 6	4380118.9202	687130.8211
Well 7	4381715.4492	687113.9712
Well 8	4382827.5433	688331.3772

For simulations involving the project wellfield, each well was assigned the pumping value of -74,589 cubic feet per day (387 gpm) for the entire period of simulated time. Note, the negative sign signals pumping to the model; a positive value would signal injection.

Time Steps

Transient simulations involved representing the 40-year period of simulated time through 40 stress periods of 365 days, with 100 time steps per stress period and a multiplier of 1.2 (the ratio of the length of each time step to that of the preceding time step).

Sensitivity Analysis

Extensive sensitivity testing of model input parameter values and analysis of the subsequent results were conducted and documented by Frick (1985). In addition, the effects of the results of the sensitivity analysis on the final calibration of the model were also documented by Frick (1985). Reasonable ranges of input values representing stream flow, aquifer transmissivity (including both aquifer thickness and hydraulic conductivity), evapotranspiration, recharge, and the northeast boundary condition (i.e., the GHB condition cells representing flow from Steptoe Valley to Goshute Valley). The results of the sensitivity testing at the time the original model was developed are summarized in Table 7 of Frick (1985).

In addition, as discussed above under Principal Assumptions, sensitivity Analysis was conducted on values of aquifer storage coefficient and specific yield.

Model Simulations

Steady-State Comparison with Frick (1985)

The first simulation by the re-created model was of the steady-state flow field with only non-project pumping. For this simulation, the background pumping was set in the re-created model to 20,300 af/year to be consistent with Frick (1985). The resulting water budget components are compared against those from Frick (1985) in Table 3.

TABLE 3
Simulated Water Budget Components: Steady-State Steptoe Valley Base Scenario (Background Pumping Only)

Water Budget Component	Frick (1985) Simulation Results (af/year)	Re-Created Model Simulation Results (af/year)
In		
Recharge	83,600	79,390
Stream Leakage	15,300	12,817
Total	**98,900**	**92,207**
Out		
Wells	20,300	20,300
Evapotranspiration	76,200	68,072
Stream Leakage	0	1,199
Head Dependent Boundary (Flow to Goshute Valley)	2,510	2,640
Total	**99,010**	**92,211**

The results indicate that the overall water budget is approximately 7 percent less in the results of the re-created model relative to the budget reported by Frick (1985), but that the budget balances well in both models. One notable point is that the re-created model required some reaches of either (or both) Duck Creek or Steptoe Creek to gain flow from ground water. This is inconsistent with conditions observed in the field and the results produced by Frick (1985). This error directly resulted in the difficulty to match the vertical discretization in the two models. However, the error is not considered significant with respect to the ability of the re-created model to represent reasonably the project wellfield and simulate time-dependent ground water level declines as a result of project pumping.

Transient Simulation Results

For the purpose of determining the magnitude of ground water level declines after 40 years of project pumping for the Proposed Action and Alternative 1, the re-created model was used to simulate three different future pumping scenarios. The first scenario involved the

simulation of the base case, which is ground water conditions 40 years into the future in the absence of ground water withdrawals for the proposed project (only non-project ground water pumping of 6,360 af/year was included in the simulation). The resulting ground water budget components from this simulation are summarized in Table 4.

TABLE 4
Simulated Water Budget Components – 40-Year Base Scenario (Background Pumping Only)

Water Budget Component	Re-Created Model Simulation Results (af/year)
In	
Storage	2,840
Recharge	79,390
Stream Leakage	9,923
Total	**92,153**
Out	
Storage	313
Wells	6,360
Evapotranspiration	82,474
Stream Leakage	340
Head dependent Boundary (Flow to Goshute Valley)	2,654
Total	**92,141**

The second scenario was the same as the first, but with the addition of project pumping using the Proposed Action wellfield configuration (40-year simulation of ground water conditions with both project [Proposed Action] and non-project [No Action Alternative] pumping). The resulting ground water budget components from this simulation are summarized in Table 5.

TABLE 5
Simulated Water Budget Components – 40-Year Combined Pumping Scenario (Background and Project Pumping) – Proposed Action Wellfield Configuration

Water Budget Component	Re-Created Model Simulation Results (af/year)
In	
Storage	3,572
Recharge	79,390
Stream Leakage	9,924
Total	**92,886**
Out	
Storage	338
Wells	11,360
Evapotranspiration	78,183
Stream Leakage	342
Head dependent Boundary (Flow to Goshute Valley)	2,654
Total	**92,877**

The last scenario was the same as the first, but with the addition of project pumping using the Alternative 1 wellfield configuration (40-year simulation of ground water conditions with both project [Alternative 1] and non-project [No Action Alternative] pumping). The resulting ground water budget components from this simulation are summarized in Table 6.

TABLE 6

Simulated Water Budget Components – 40-Year Combined Pumping Scenario (Background and Project Pumping) – Alternative 1 Wellfield Configuration

Water Budget Component	Re-Created Model Simulation Results (af/year)
In	
Storage	3,061
Recharge	79,390
Stream Leakage	9,865
Total	**92,316**
Out	
Storage	340
Wells	11,360

TABLE 6

Simulated Water Budget Components – 40-Year Combined Pumping Scenario (Background and Project Pumping) – Alternative 1 Wellfield Configuration

Water Budget Component	Re-Created Model Simulation Results (af/year)
Evapotranspiration	77,638
Stream Leakage	312
Head dependent Boundary (Flow to Goshute Valley)	2,654
Total	**92,303**

The difference in hydraulic head between the base case scenario and Proposed Action and Alternative 1 represents the change in ground water levels caused solely by project pumping (8 project wells pumping 625 gpm continuously for 40 years). The project-induced drawdown in Layer 1 (shallow unconfined aquifer) under the Proposed Action is presented in Figure 15, and the results for Layer 2 (deeper confined ground water) under the Proposed Action are presented in Figure 16. The project-induced drawdown in Layer 1 (shallow unconfined aquifer) under Alternative 1 is presented in Figure 17, and the results for Layer 2 (deeper confined ground water) under Alternative 1 are presented in Figure 18.

The results indicate a project-induced drawdown for the Proposed Action of up to 8 feet in Layer 1 and 8.5 feet in Layer 2. The results for Alternative 1 indicate a project-induced drawdown of up to 2.5 feet in Layer 1 and Layer 2. The significance of these drawdowns with respect to other water resources features (creeks, lakes, and springs) and other (non-project) points of ground water diversion is discussed in the WPES EIS.

References

Clark, W. O. and C.W. Riddell. 1920. *Exploratory Drilling for Water and Use of Ground Water for Irrigation in Steptoe Valley, Nevada*. U.S. Geological Survey Water Supply Paper 467.

Freeze, R. A., and J. A. Cherry. 1979. *Groundwater*. Prentice-Hall Inc. Englewood Cliffs, New Jersey.

Frick, E. A., 1985. "Quantitative Analysis of Groundwater Flow in Valley-Fill Deposits in Steptoe Valley, Nevada." Unpublished thesis for Master of Science in hydrology, University of Nevada, Reno.

Leeds, Hill and Jewett, Inc., 1983. *Groundwater Investigation, Phase III, Technical Report for the White Pine Power Project*. San Francisco.

Lopes, T.J., and D.M. Evetts, 2004. *Groundwater Pumpage and Artificial Recharge Estimates for Calendar Year 2000 and Average Annual Natural Recharge and Interbasin Flow by Hydrographic Area, Nevada*. U.S. Geological Survey Scientific Investigations Report 2004-5239.

McDonald, M. G. and A.W. Harbaugh, 1984. *A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model.* U.S. Geological Survey Open-File report 83-875. 528 p.

McDonald, M. G. and A.W. Harbaugh, 1988. "A Modular Three-Dimensional Finite-Difference Ground-Water Flow Model." *Techniques of Water-Resources Investigations of the United States Geological Survey*. Book 6, Chapter A1.

Back to Table of Contents

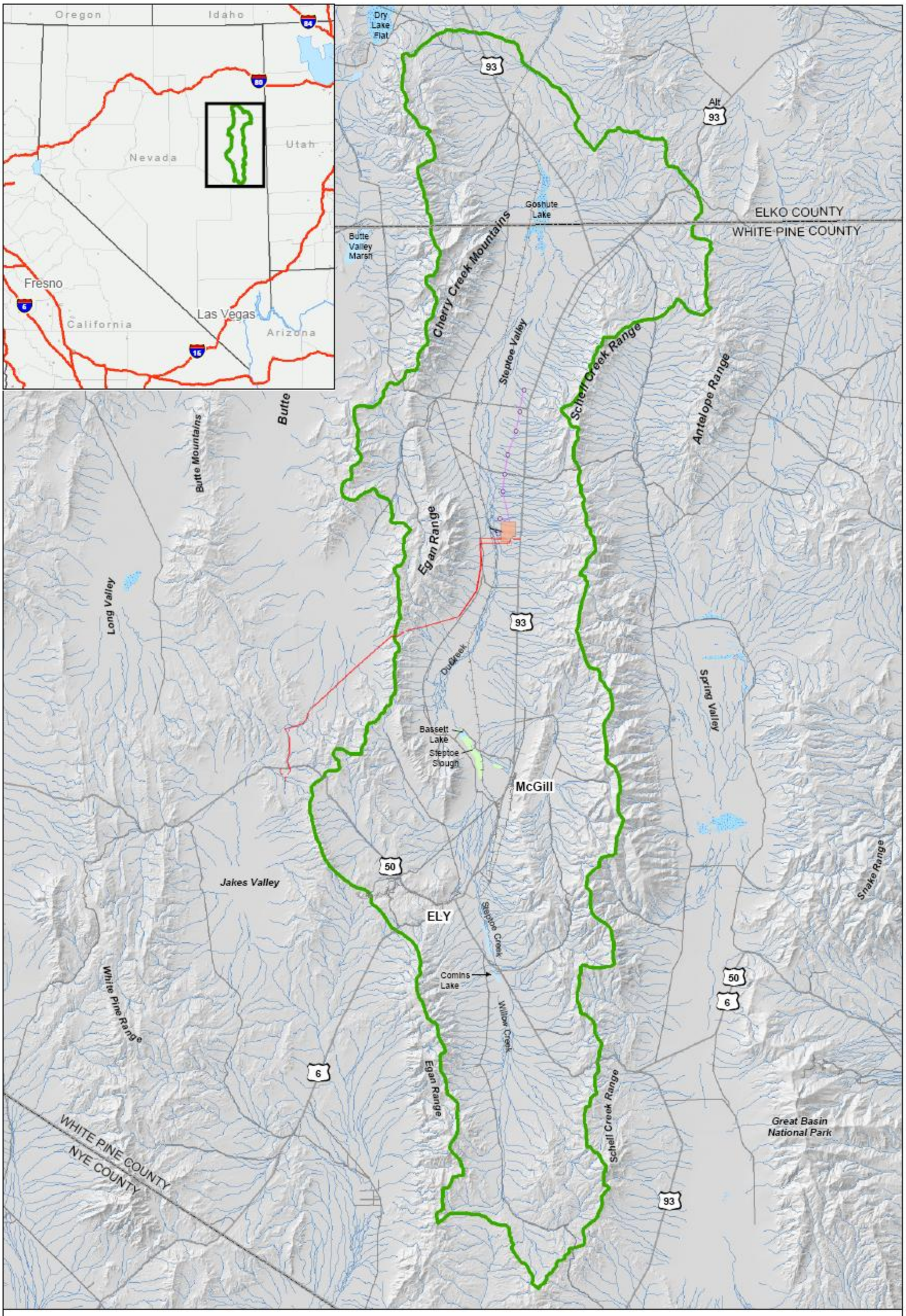

Figure 1
WPES Proposed Action Project Location

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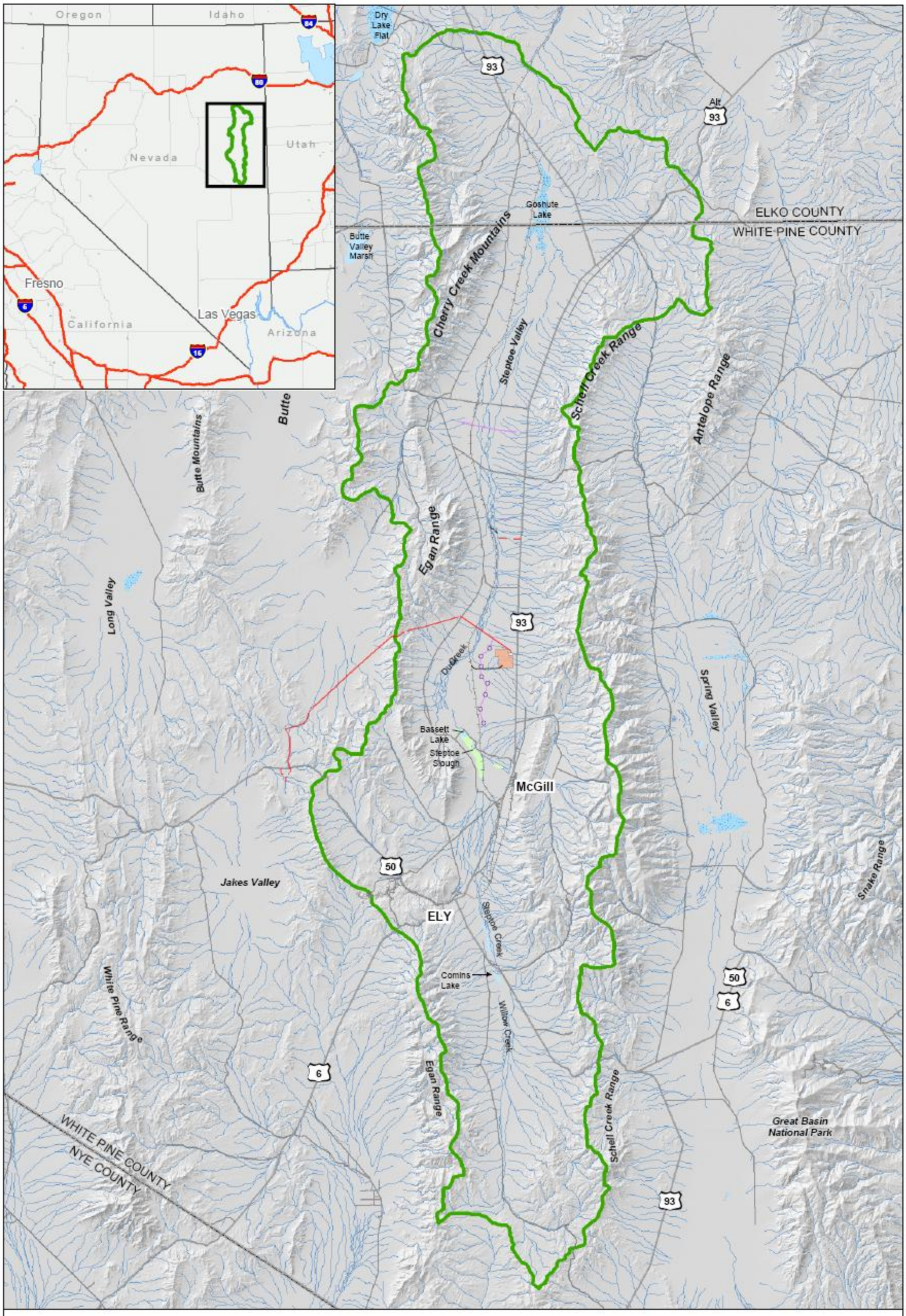

Legend

- Power Plant Well
- Water Line
- Transmission Line
- Railspur
- Road
- Railroad
- Stream or Ephemeral Drainage
- Power Plant Site
- Substation
- Hydrographic Boundary
- Lake
- Wetland (from Nevada Natural Heritage Program)
- Intermittent Water

0 2 4 8 Miles

N

Figure 2
WPES Alternative 1
Project Location

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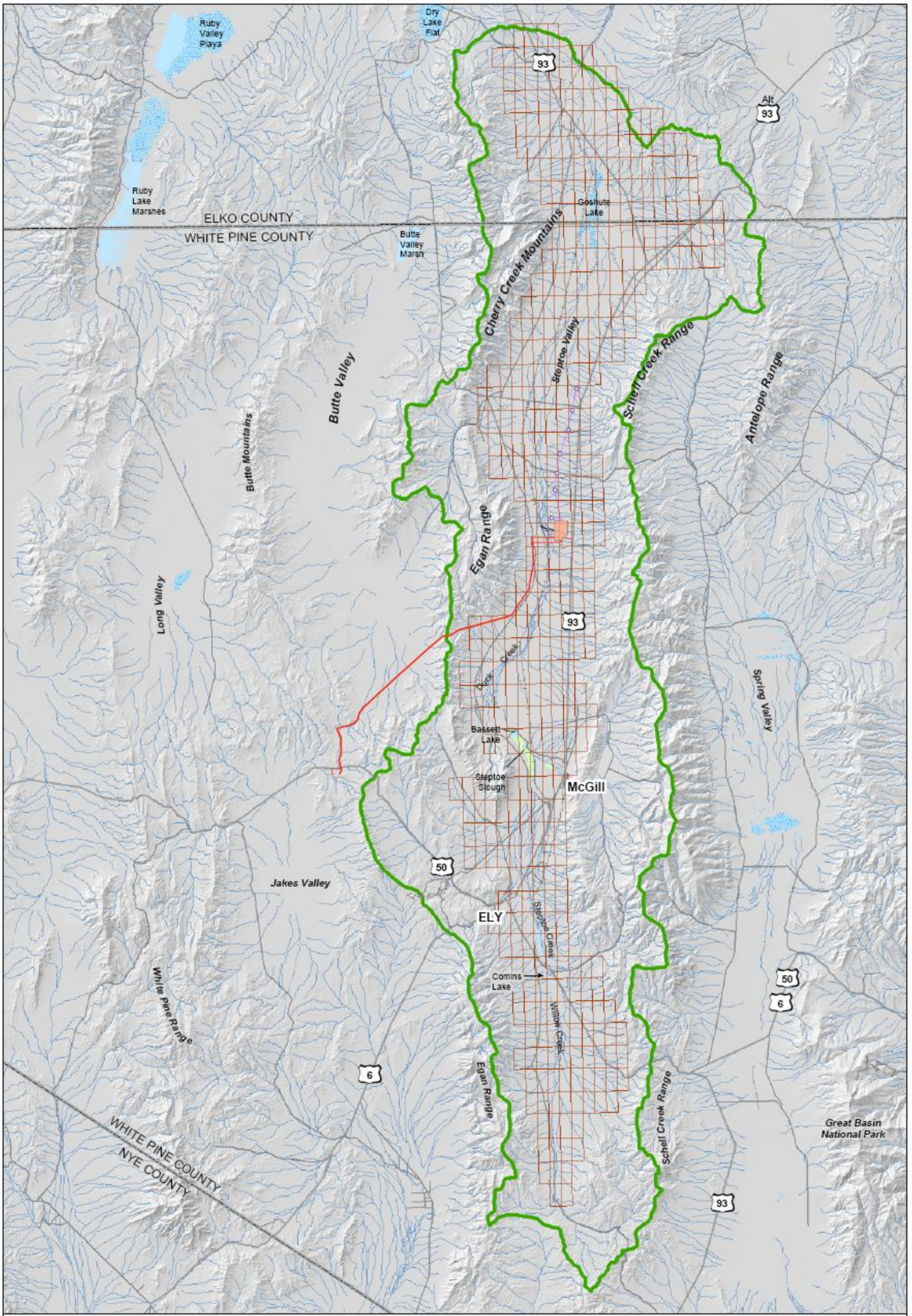

Legend

- Power Plant Well
- Water Line
- Transmission Line
- Railspur
- Road
- Railroad
- Stream or Ephemeral Drainage
- Power Plant Site
- Substation
- Hydrographic Boundary
- Lake
- Wetland (from Nevada Natural Heritage Program)
- Intermittent Water

0 3 6 12 Miles

N

Figure 3
Proposed Action
Finite - Difference Grid

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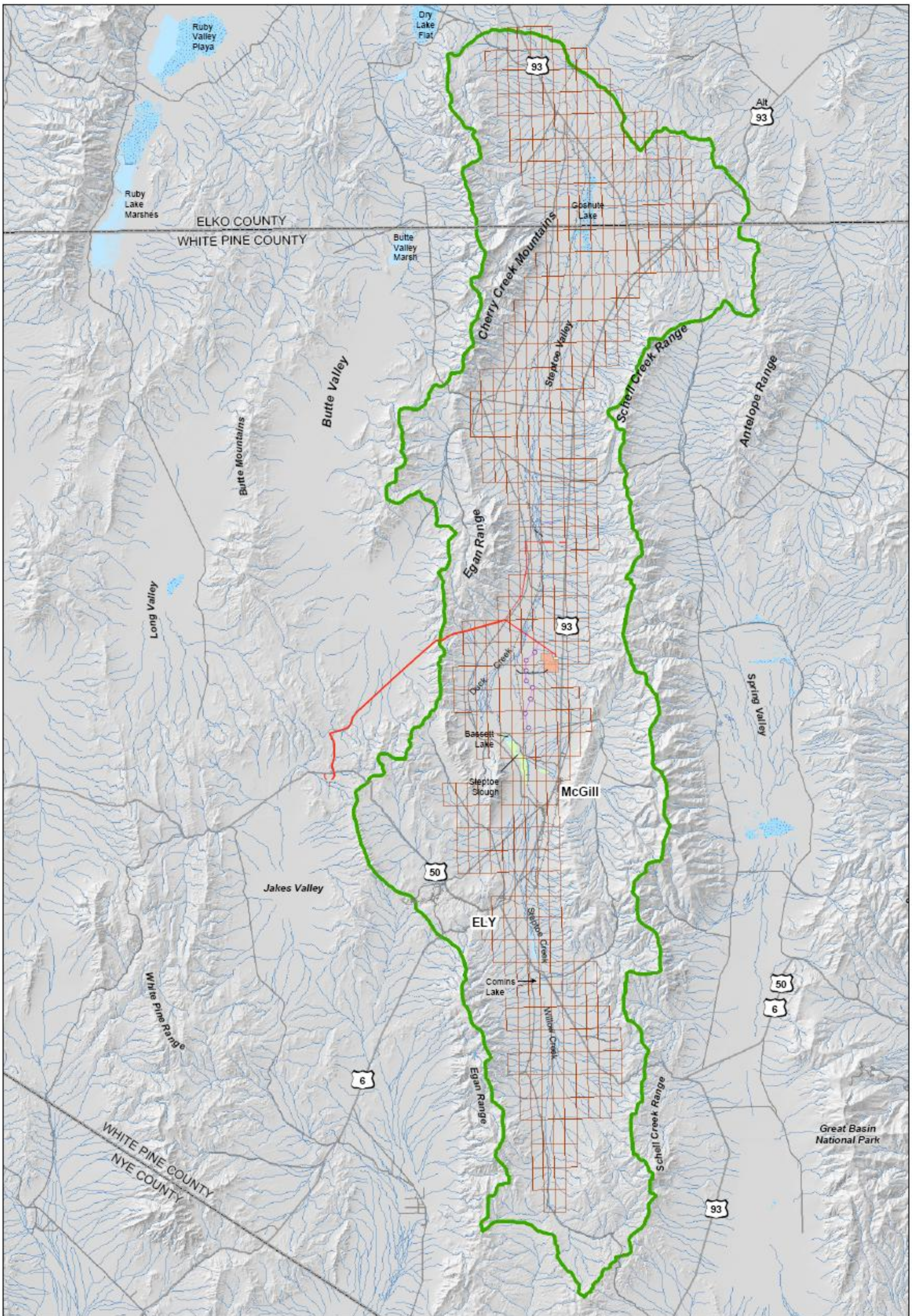

Legend

- Power Plant Well
- Water Line
- Transmission Line
- Railspur
- Road
- Railroad
- Stream or Ephemeral Drainage
- Power Plant Site
- Substation
- Hydrographic Boundary
- Lake
- Wetland (from Nevada Natural Heritage Program)
- Intermittent Water

0 3 6 12 Miles

N

Figure 4
Alternative 1
Finite - Difference Grid

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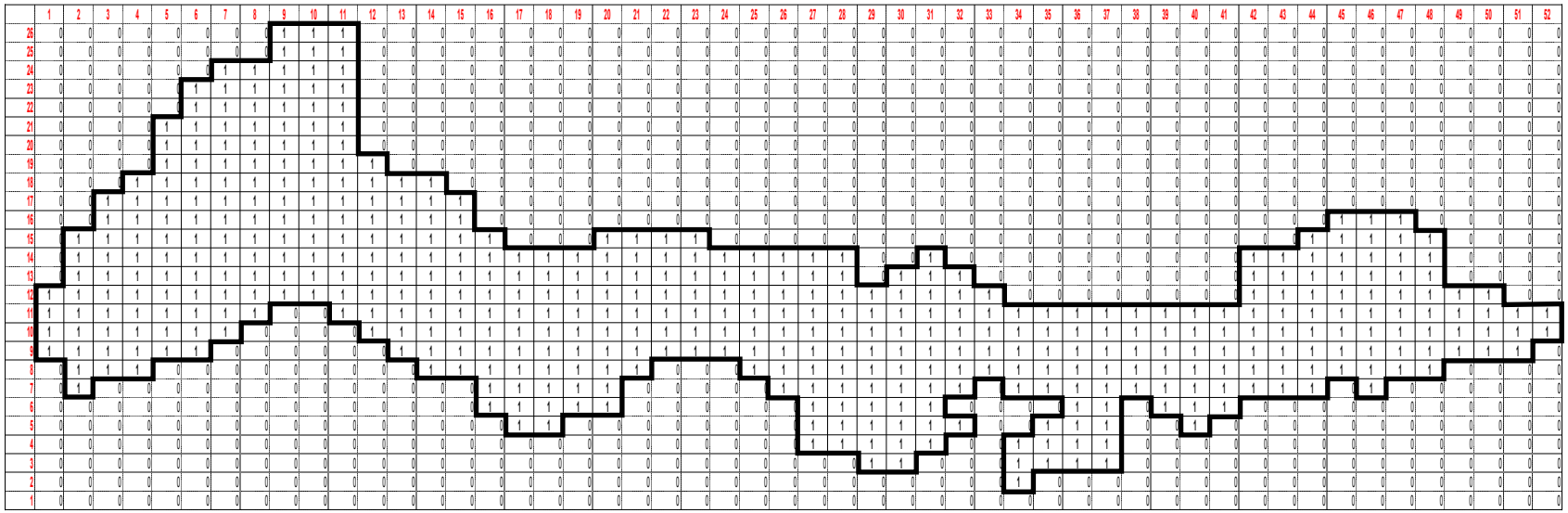
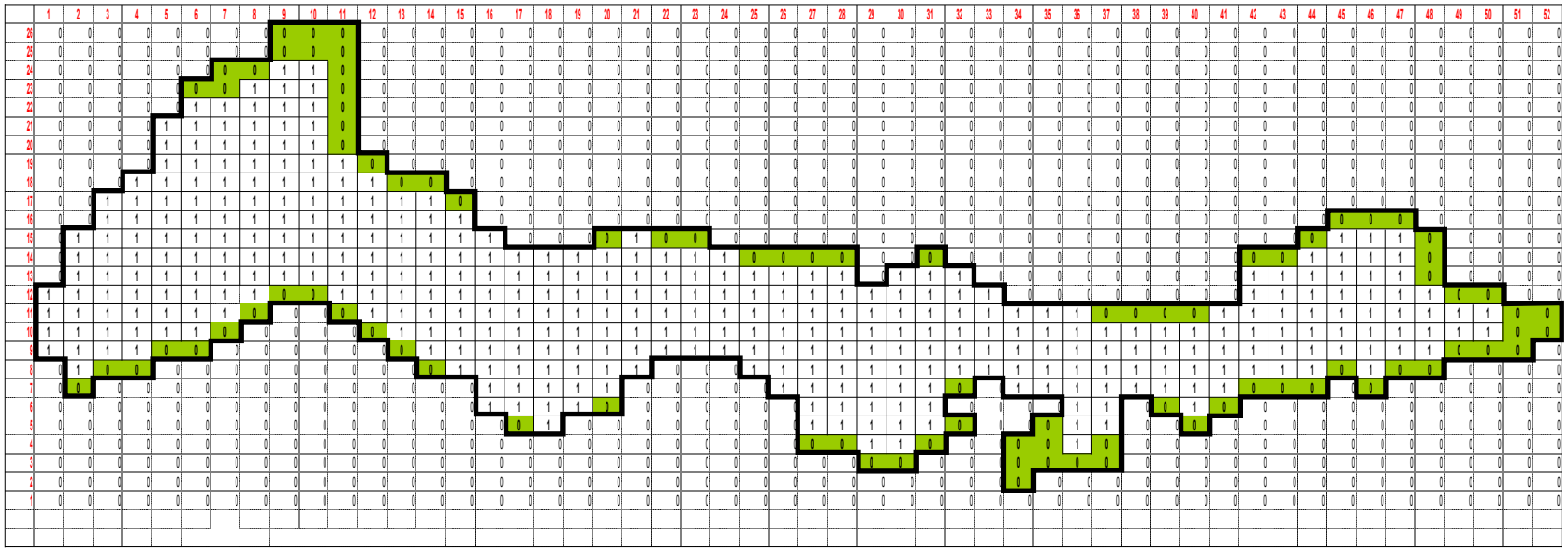


Figure 5
Finite-difference grid (layers 1 & 2)



Cell in Layer 1 and 2 that is eliminated in Layer 3

Figure 6
Finite-difference grid (layer 3)

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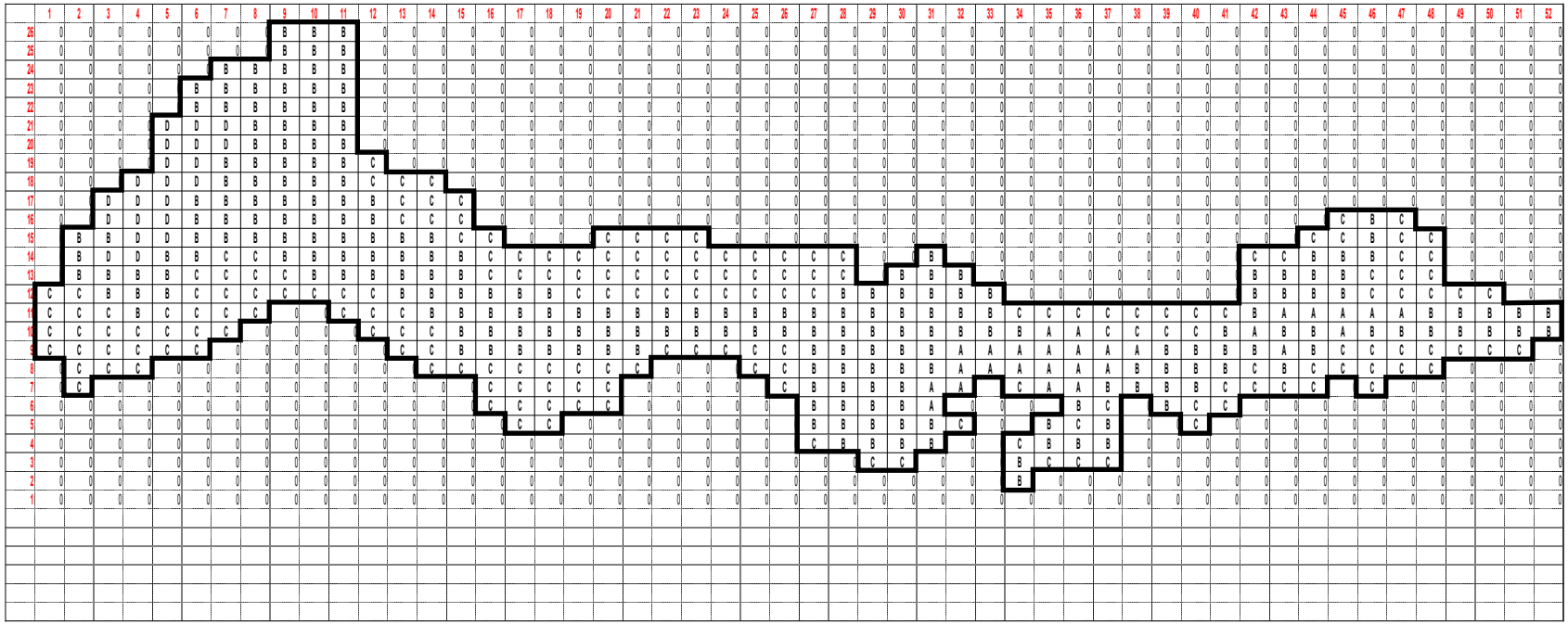
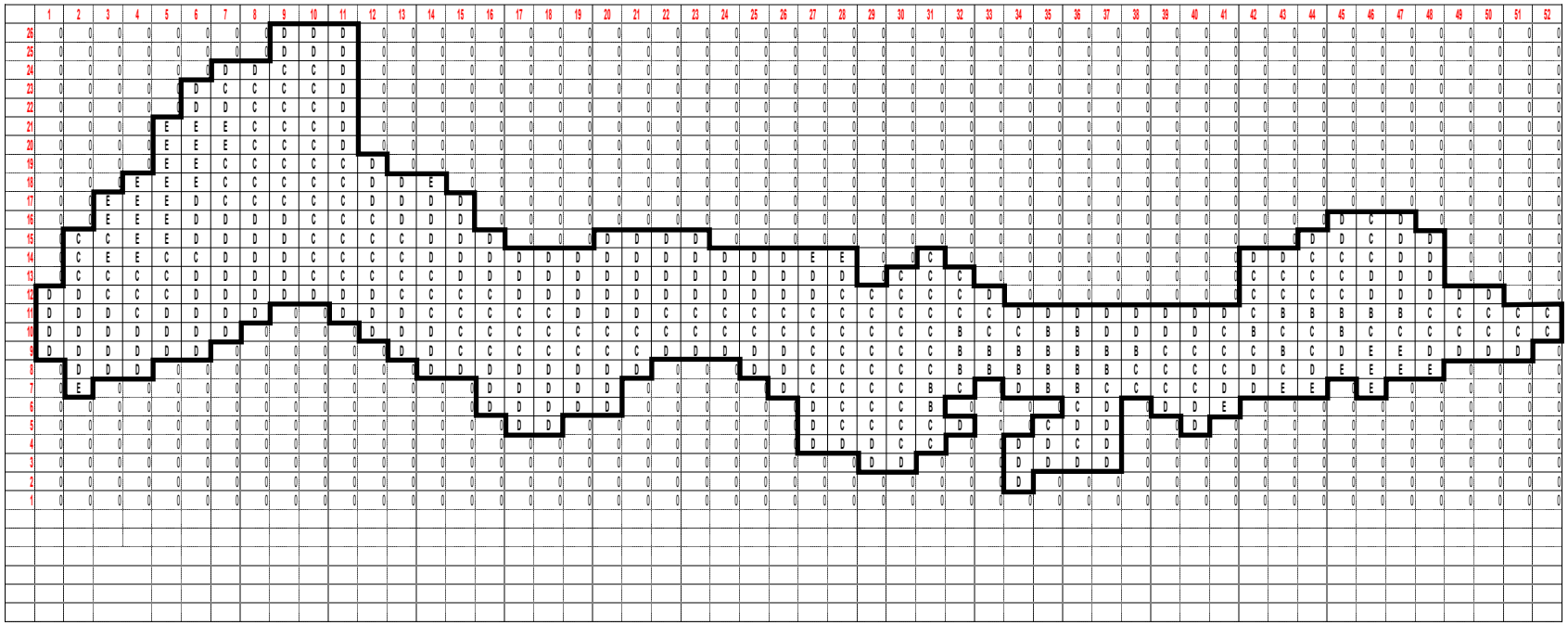


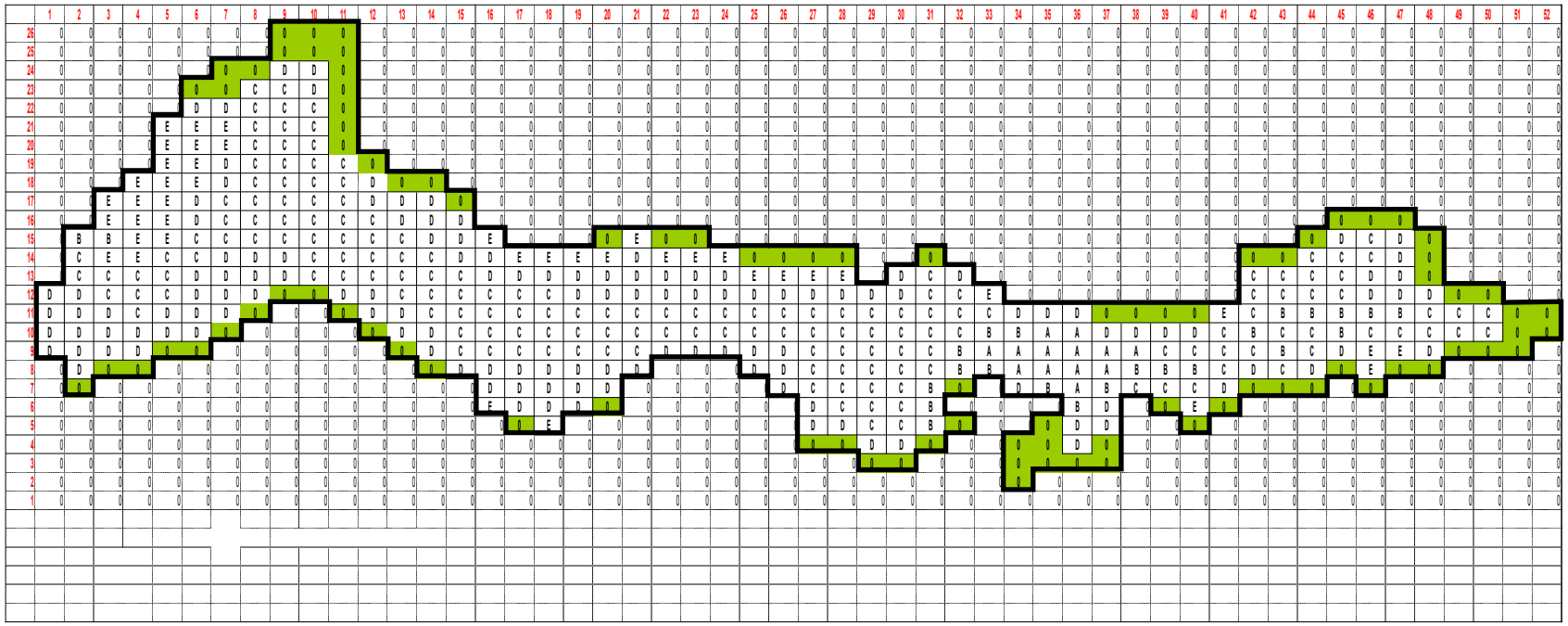
A = 1 to 5E-3 ft/sec
B = 1 to 9E-4 ft/sec
C = 1 to 9E-5 ft/sec
D = 1 to 9E-6 ft/sec

Figure 7
Hydraulic conductivity(K) distribution (layer 1)



A = 0.1-0.155 ft2/sec
B = 0.05-0.099 ft2/sec
C = 0.01-0.049 ft/sec
D = 0.001-0.0099 ft2/sec
E = 0.0001-0.0009 ft2/sec

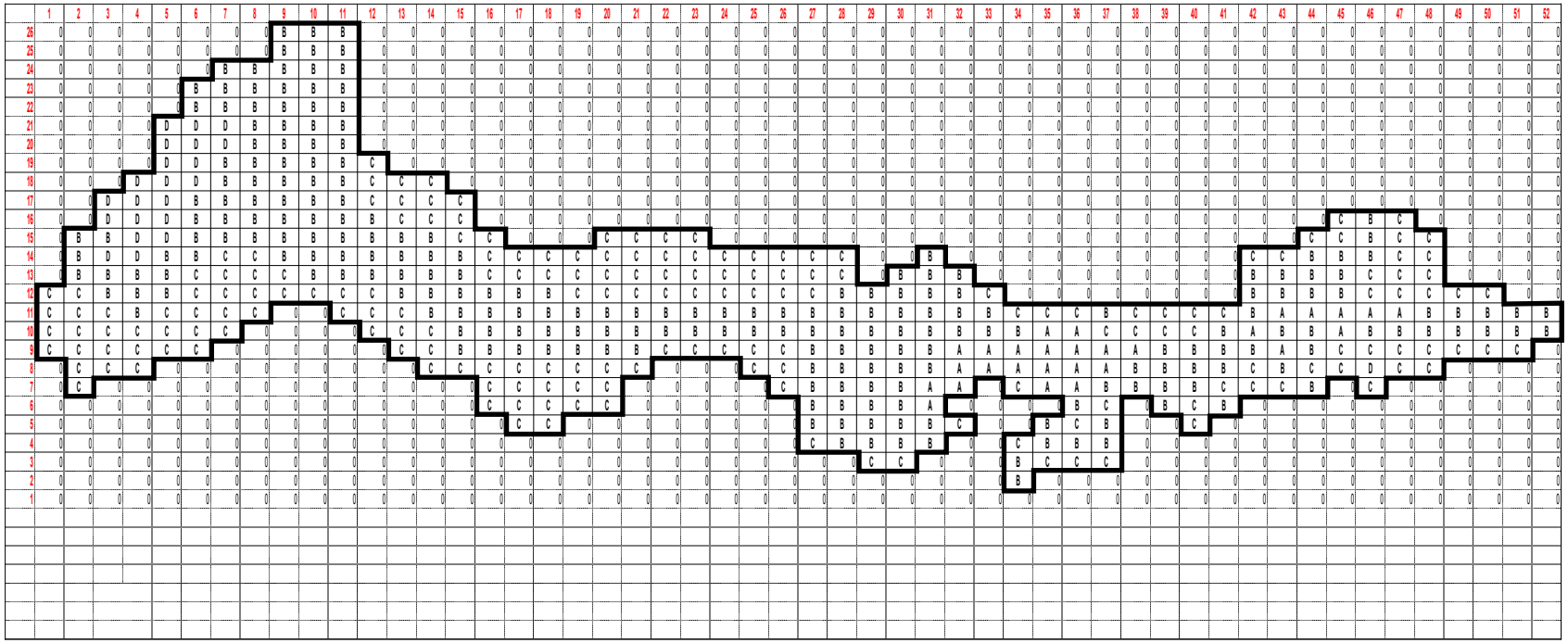
Figure 8
Transmissivity (T) distribution (layer 2)



A = 0.1-0.155 ft2/sec
B = 0.05-0.099 ft/sec
C = 0.01-0.049 ft/sec
D = 0.001-0.0099 ft/sec
E = 0.001-0.009 ft/sec

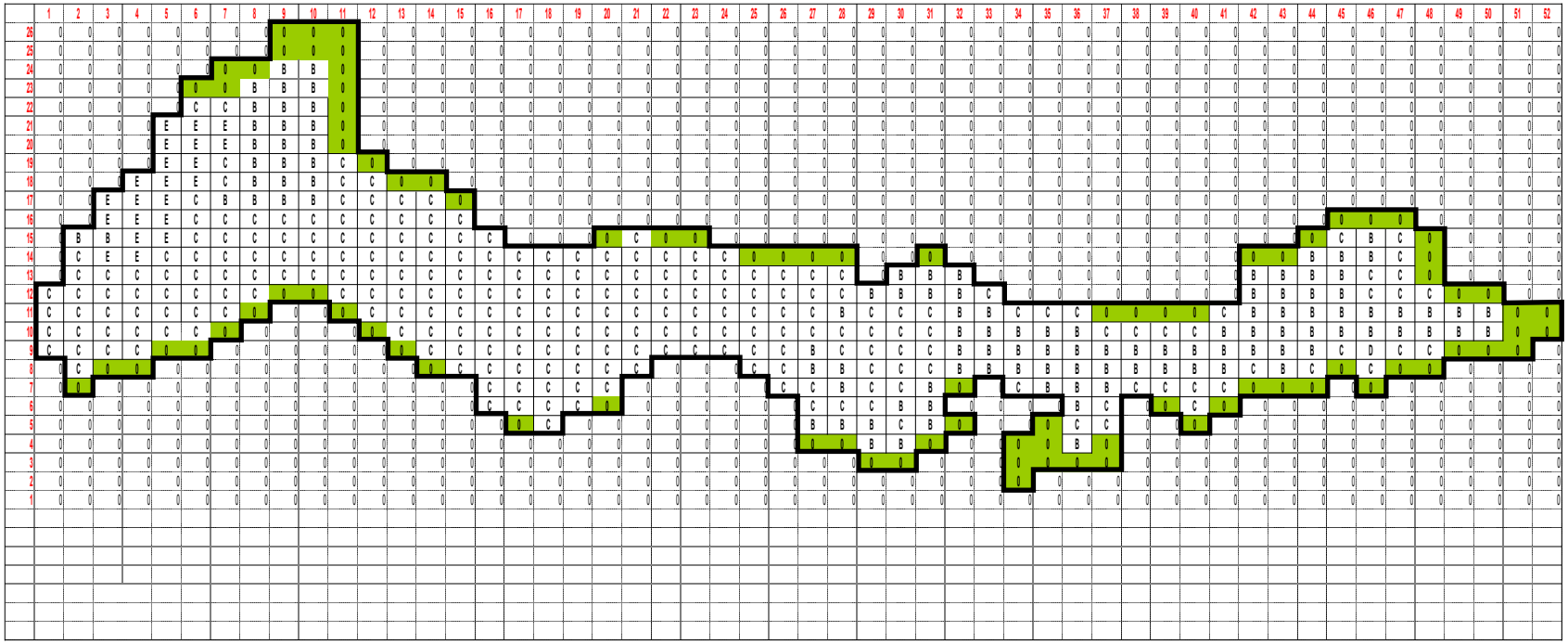
= Cell in Layer 1 and 2 that is eliminated in Layer 3

Figure 9
Transmissivity (T) distribution (layer 3)



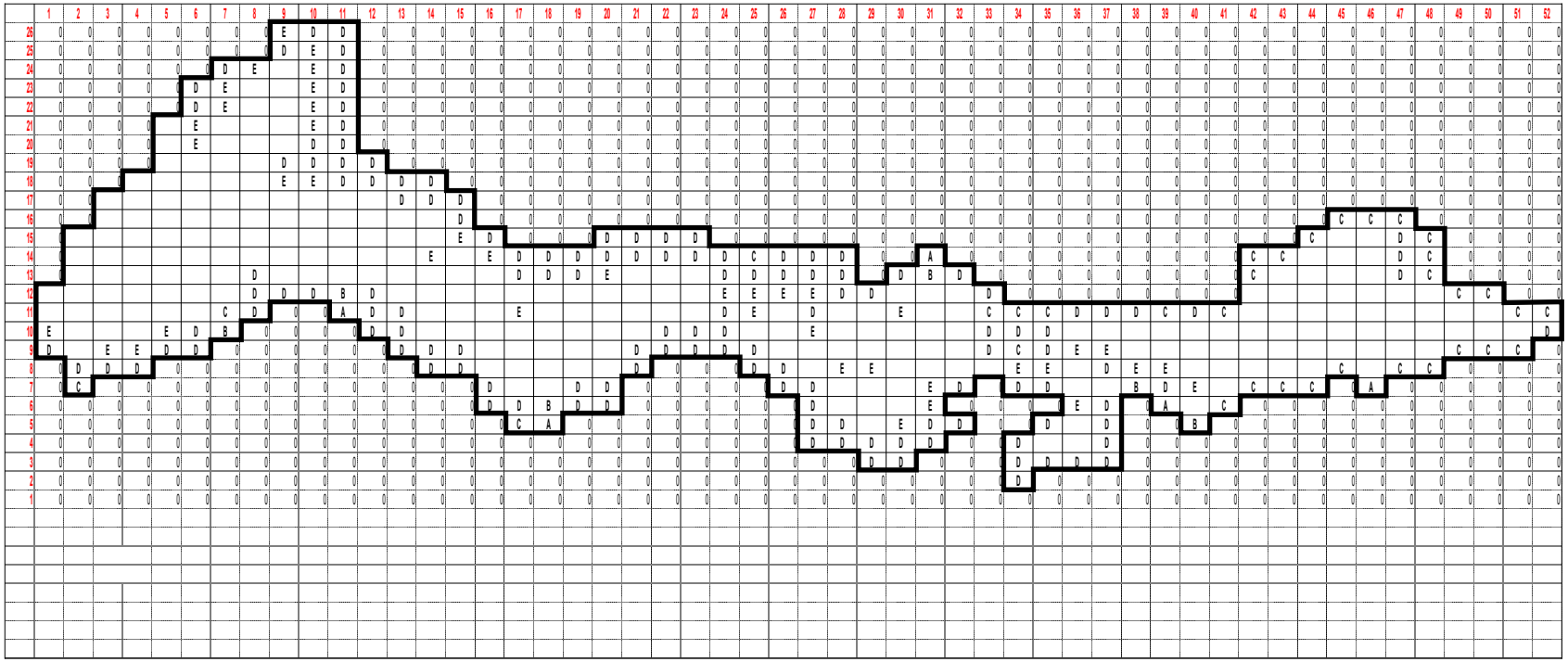
A = 1 to 99E-8 1/sec
B = 1 to 99E-9 1/sec
C = 1 to 99E-10 1/sec
D = 1 to 99E-11 1/sec
E = 1 to 99E-12 1/sec

Figure 10
Leakance distribution between layers 1 & 2



A = 1 to 99E-8 1/sec
B = 1 to 99E-9 1/sec
C = 1 to 99E-10 1/sec
D = 1 to 99E-11 1/sec
E = 1 to 99E-12 1/sec

Figure 11
Leakance distribution between layers 2 & 3



A = 2000-3000 AF/yr
B = 1000-1999 AF/yr
C = 500-999 AF/yr
D = 100-499 AF/yr
E = 100 AF/yr
Blank = 0

Figure 12
Recharge distribution layer 1

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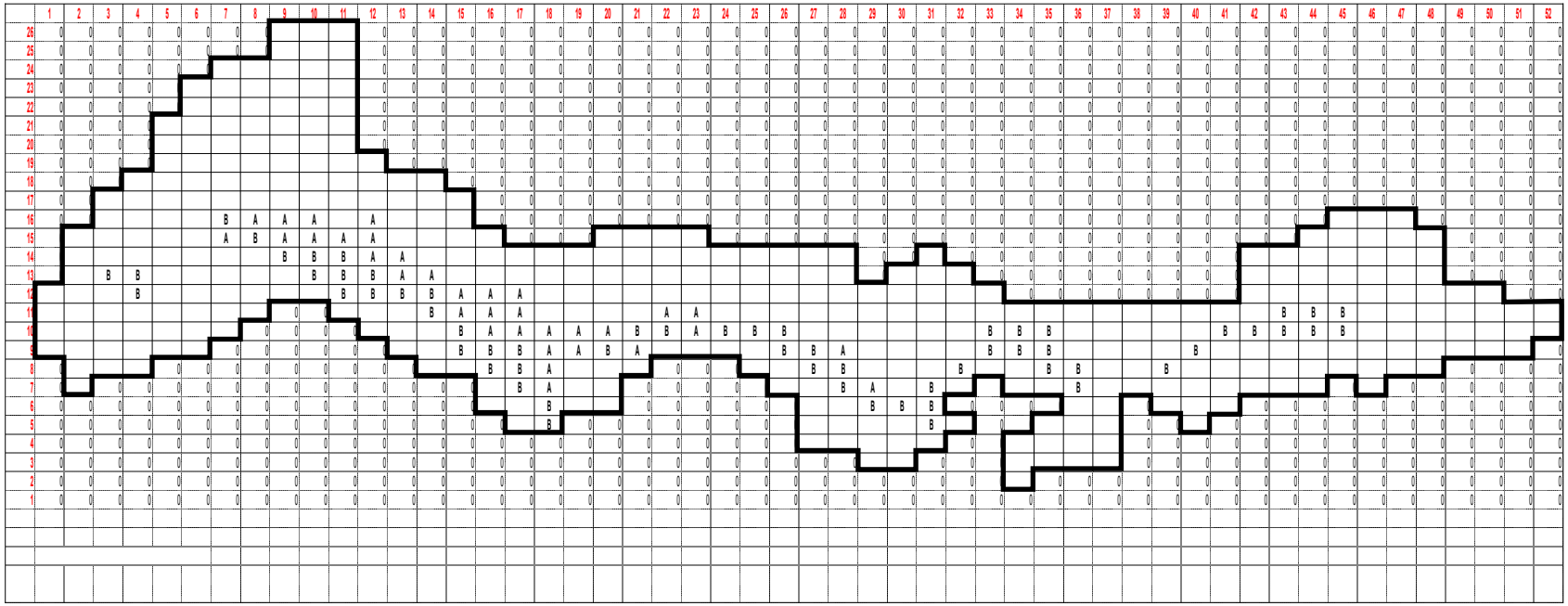

Distribution of evaporation (no values reported)
Blank = 0
A = Steady-state simulation
B = Project pumping simulation

Figure 13
Evapotranspiration cells layer 1

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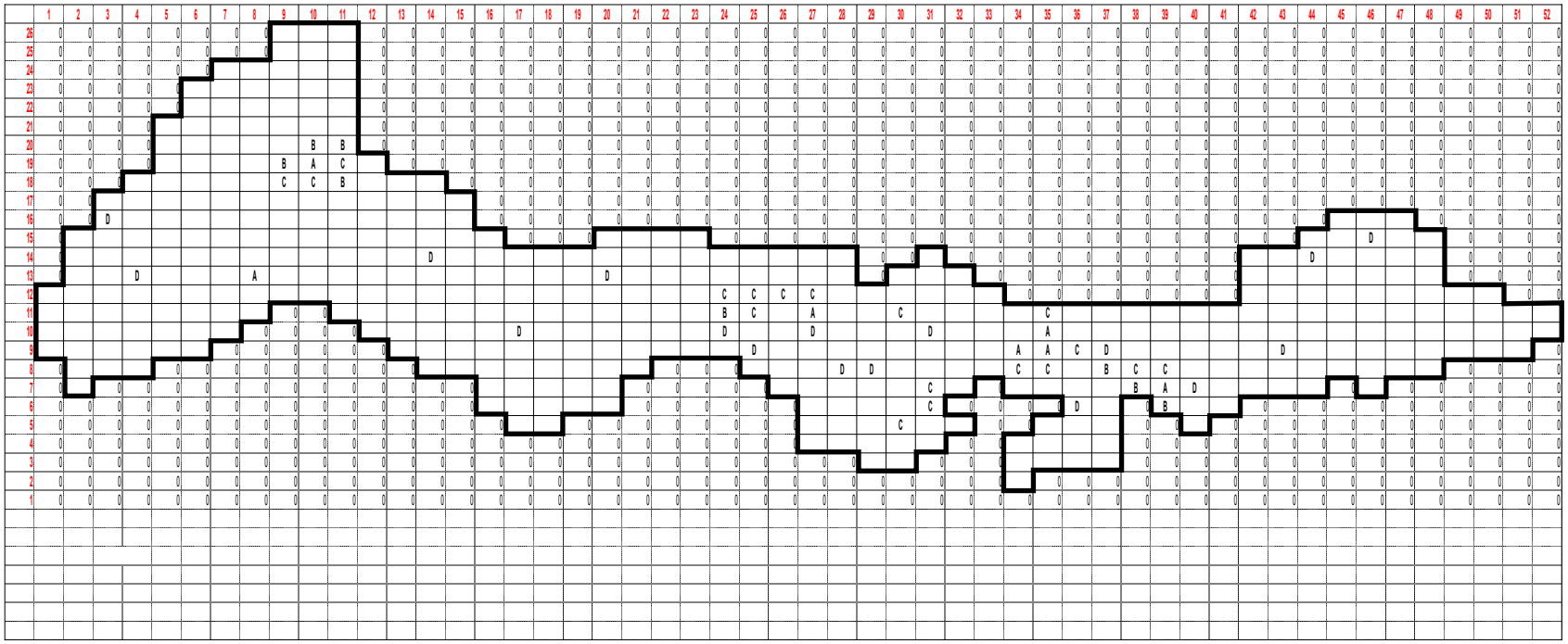

A = 1000-1900 AF/yr
B = 500-999 AF/yr
C = 100-499 AF/yr
D = 100 AF/yr
Blank = 0

Figure 14
Background pumping distribution

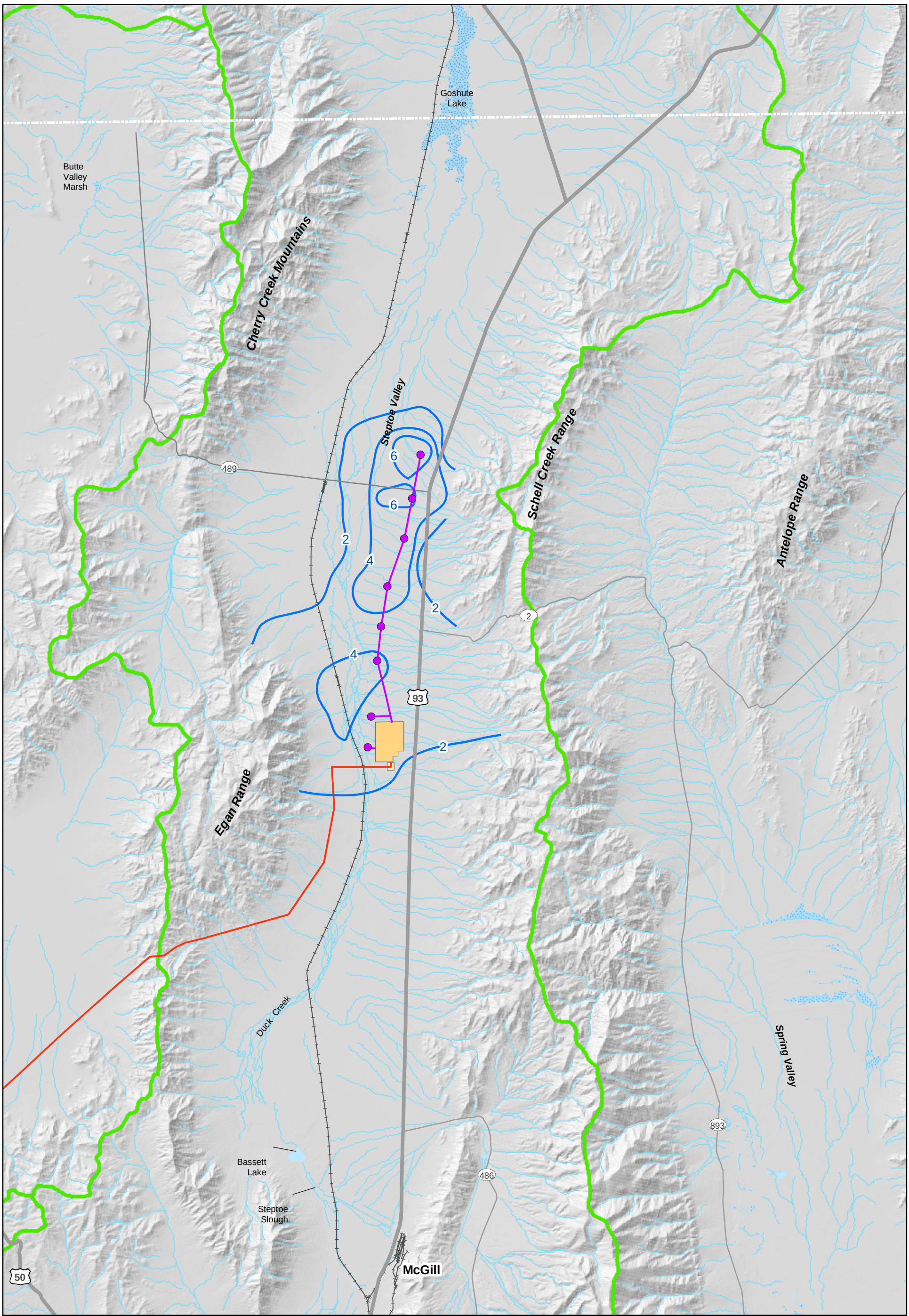

Figure 15
White Pine Energy Station
Proposed Action
Potential Project Induced
Ground Water Level Declines
Model Layer 1

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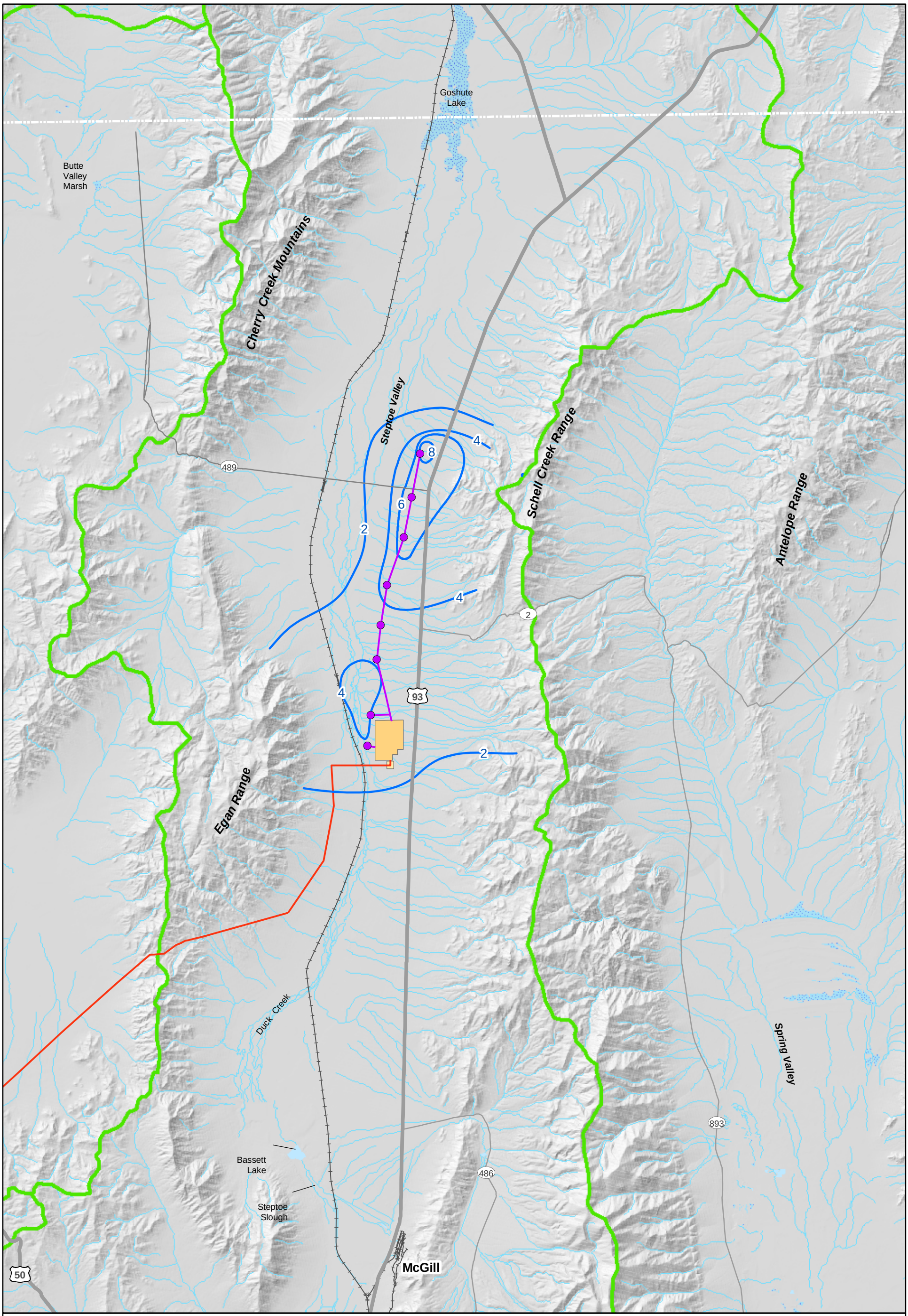

Figure 16
White Pine Energy Station
Proposed Action
Potential Project Induced
Ground Water Level Declines
Model Layer 2

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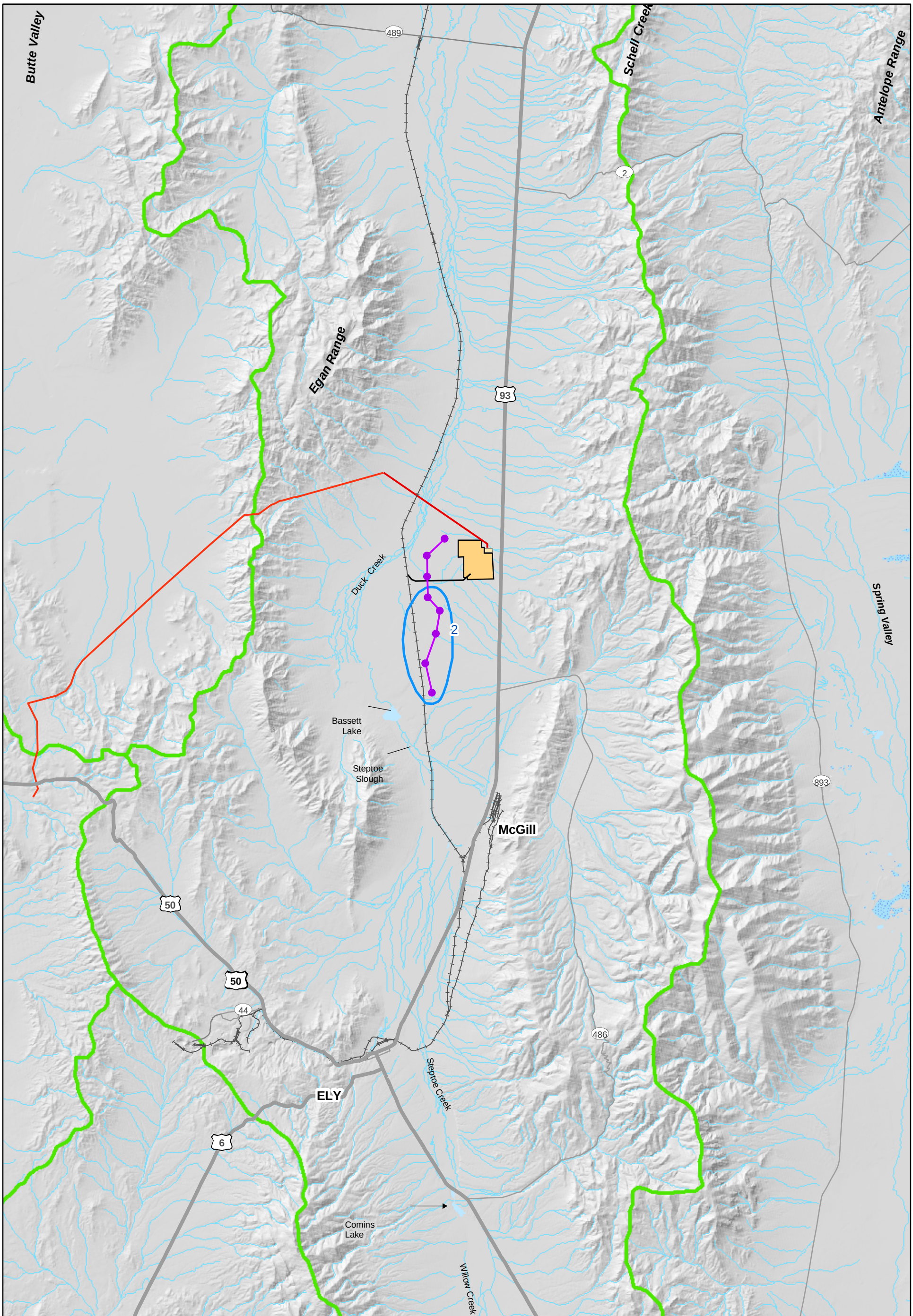

Legend

- Groundwater Drawdown Contours
- Southern Wells
- Alternate Site
- Alternate Substation
- Transmission Line
- Alternate Rail Spur
- Water Line
- Hydrographic Boundary
- Lake
- Intermittent Water
- Railroad

0 1 2 4 Miles

N

Figure 17
White Pine Energy Station
Alternative 1
Potential Project Induced
Ground Water Level Declines
Model Layer 1

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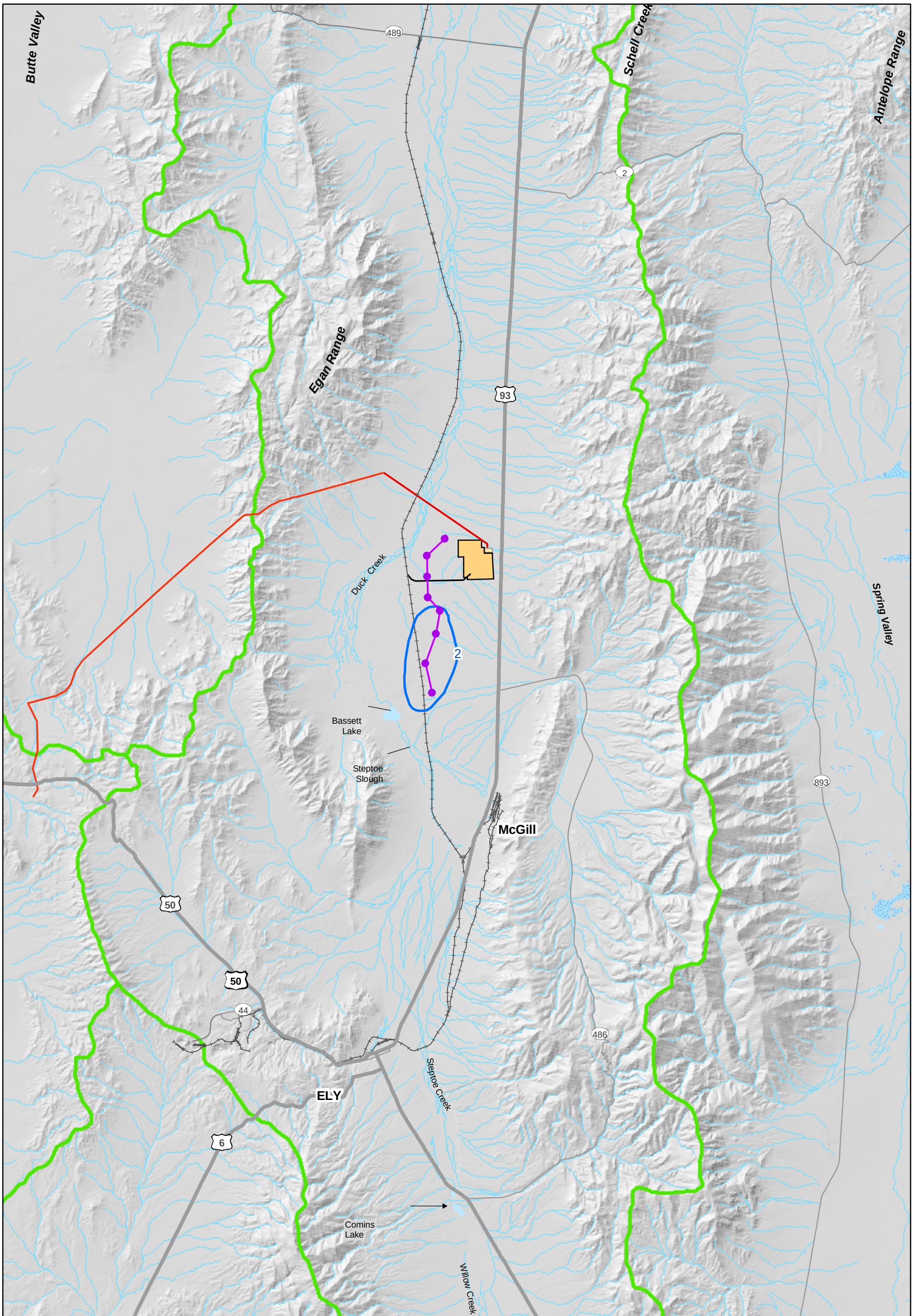

Legend

- Groundwater Drawdown Contours
- Southern Wells
- Alternate Site
- Alternate Substation
- Transmission Line
- Alternate Rail Spur
- Water Line
- Hydrographic Boundary
- Lake
- Intermittent Water
- Railroad

0 1 2 4 Miles

N

Figure 18
White Pine Energy Station
Alternative 1
Potential Project Induced
Ground Water Level Declines
Model Layer 2

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