TECHNICAL REPORT
IN THE MATTER OF
DISTRIBUTION TO WATER RIGHTS
HELD BY RANGEN, INC.
Docket No. CM-DC-2014-004
(June 2014 Call for 1957-priority Right)

January, 2015
Upper Valley Pumpers
Bryce A. Contor

INTRODUCTION

This report provides technical information for a hearing scheduled for March 2015 (hereafter "Upcoming Hearing") in the matter of a delivery call for water serving the Rangen aquaculture facility from the Curren Tunnel, also known as the Martin-Curren Tunnel. It is prepared in context of an order by Idaho Department of Water Resources (IDWR) dated November 3, 2014 (Evidence Order)[1] regarding an earlier call for related water rights. The context also includes an IDWR order dated January 29, 2014 (Rangen 2014)[2], and a District Court opinion dated October 24, 2014 (Court 2014)[3].

TECHNICAL INFORMATION

Aquifer Models

Modelers tend to anthropomorphize the model, and a phrase often heard in the modeling committee is "Models do best what you teach them to do." "Teaching" the model to perform a particular task requires that a number of criteria be met simultaneously:

1. The conceptual model, model code, and configuration must be capable of performing the required calculations;

[1] Order Denying Motion for Summary Judgment; Order Regarding Presentation of Evidence
[2] Final Order Regarding Rangen, Inc.'s Petition for Delivery Call; Curtailing Ground Water Rights Junior to July 13, 1962
[3] Memorandum Decision and Order on Petitions for Judicial Review

2. The calibration data set, both the water budget and the target data, must contain reasonable representations of the phenomenon desired to be estimated;
3. The calibration process, including definition and weighting of targets and configuration of the objective function, as well as review of data and adjustments made in the calibration process, must carefully consider the model's performance with the question at hand.

Failure of any of these steps affects that particular use of the model. For instance, the ESPAM2.1 model is invalid for contaminant-transport analysis because the implementation of MODFLOW used for ESPAM2.1 did not include transport algorithms. This does not invalidate it for other purposes.

The effectiveness of a model for a given task can be assessed by comparing its results to empirical data, other models, analytical methods, and basic hydrologic reasoning.

<u>Determination of Hydrologic Effects</u>

The model cannot be used to determine which junior beneficial uses have a hydrologic effect upon Curren Tunnel discharges.

First, the model fails the criterion of being structurally able to perform such a determination. The ESPAM2.1 model and its predecessors were constructed in such a way that every cell within the model boundary must show a hydrologic effect to the model cell containing the tunnel, and conversely, that no location outside the model boundary can possibly show an effect to that cell. The model boundary was a decision made early on by modelers. The selection criteria never contemplated that the model was intended to include all cells, and only those cells, that would have an effect upon the Curren Tunnel. Second, there are few data that would constrain determinations of whether or not a distant well individually might affect Curren Tunnel. Third, using the model to determine which wells have effects was never considered in the calibration process. Finally, the model fails to honor basic hydrologic reasoning in the context of determining who has an effect upon the Curren Tunnel.

In the context of hydrologic reasoning of effects, Figure 1 (attached) illustrates four hypothetical points. Point A is along the canyon rim, near the Curren Tunnel. Point B is 53 miles to the northeast, outside the model domain, in the Wood River Valley tributary to the aquifer. Basic hydrologic reason suggests that curtailment of beneficial use at Point B would provide accrual at Point A by two mechanisms. Some secondary propagation may accrue entirely through the aquifer, via an increase in subsurface inflow from the Wood River Valley into the margins of the Eastern Snake Plain Aquifer, but the primary effect would be to increase net discharges of Silver Creek and the Big Wood River. Both streams traverse the aquifer and supply irrigation water to areas hydraulically connected to Point A. Increased supplies in Silver Creek and the Big

Wood River would increase bed loss from the two streams, increase incidental recharge from the canals and irrigated lands supplied by them, and/or reduce supplemental groundwater pumping on those lands. These effects would propagate through the aquifer and provide accrual to Curren Tunnel. Because of the rapid propagation of effects in surface-water systems, the effect of curtailment at Point B would provide accrual to Point A much more quickly than had the primary effect been transmitted entirely through the aquifer. Despite these hydrologic expectations, the model cannot, and does not, indicate that curtailment of beneficial use at Point B would provide relief to water rights at Point A.

Points C and D are located within the irrigated lands of the Upper Valley Pumpers, 177 and 161 miles from Point A, respectively. The hydrologic expectation is that the bulk of the effect of curtailment of beneficial use at these locations would accrue to the nearest hydraulically-connected river reaches, the Henrys Fork and the South Fork. A secondary expectation is that the residual effects would accrue to the large springs and river gains between Blackfoot and Minidoka. Third, the geologic features known as the Mud Lake Barrier and Great Rift lie between these points and Point A, and would be expected to impede propagation of effects. Finally, a large number of springs intervene spatially between Minidoka and Point A. These would be expected to intercept essentially all of any remaining accrual, leaving effectively nothing to accrue to Point A.

Both Point C and Point D are within the model boundary. Despite these hydrologic expectations, the model must, and does, indicate that curtailment at Points C and D would provide relief at Point A. Nevertheless, the indicated accrual to Curren Tunnel is very, very small; 0.02% of curtailed beneficial use at C and 0.06% at D, at infinite time. Another anthropomorphic phrase frequently repeated in the modeling committee is "The model is trying to tell us something." When the model is constrained to represent an effect from a particular location, and the calibration results in estimates of a very small effect, what the model is "trying to tell us" is that accrual, if any, is negligible.

Area of Common Supply

Figure 2 illustrates the location of Curren Tunnel, the IDWR Administrative Basins tributary to the plain, the model boundary, and the Great Rift. All the mapped tributary basins are tributary to the Snake River above King Hill. All have at least the potential to contribute to the aquifer, and in general all should be candidates for the Area of Common Supply. However, the current CMR 50 boundary excluded areas know at the time to have potential contribution; qualitatively, everything known today about groundwater contribution from tributary areas outside the CMR 50 boundary was explicitly represented in the USGS study from which that boundary was obtained. In fact, even the current ESPAM2.1 quantitative estimates of subsurface inflows are primarily derived from that study.

For the Rangen Call, the hydrologic discussion elsewhere in this report documents that there is no reasonable expectation of meaningful accrual from curtailment of beneficial use occurring east of the Great Rift, regardless of model constraints and indications. For the tributary basins west of the Great Rift, the following hydrologic expectations and proposed methodologies apply:

Basin 36. The small part of Administrative Basin 36 outside the model boundary on the west was excluded from the model based on understanding that pumping within the aquifer in Hagerman Valley is not likely to propagate to the Eastern Snake Plain Aquifer proper. Likewise, curtailment of wells in that area is unlikely to provide meaningful accrual to Curren Tunnel. Curtailment of beneficial use on the part of Basin 36 that is west of the Great Rift and above the canyon rim has the potential to provide accrual to Curren Tunnel. Its effects can be estimated with ESPAM2.1 and a 63% factor[4].

Basin 37. Curtailment of beneficial use in the part of Administrative Basin 37 overlying the aquifer provides accrual at the Curren Tunnel. This accrual can be quantified using ESPAM2.1 results for the Rangen Reach, with a 63% adjustment.

Outside the model boundary, the effect of curtailment will be equal to the quantity of reduction in beneficial consumptive use. For irrigation beneficial use, an estimate may be derived from METRIC[5] evapotranspiration estimates minus PRISM[6] precipitation estimates, and apportioned to the two boundaries. For other beneficial uses, applying the IDWR curtailment assumptions used for beneficial use within the model boundary will provide a consistent approximation. The propagation of relief from curtailment of beneficial use in the Wood River Valley portion of Basin 37 depends upon the aquifer layer tapped by the curtailed wells. A confining layer exists in the Bellevue Triangle, and wells may tap the aquifer beneath the confining layer, above it, or beyond its northern extent.

Curtailment of wells screened below the confining layer primarily affects the confined aquifer. Physically, the water-supply effects will propagate to the ESPAM2.1 tributary underflow boundary represented for Silver Creek, or to the ESPAM2.1 boundary represented by the underflow boundary for the Big Wood River. For purposes of assessing the effects of curtailment, the full quantity of effect may be apportioned between these two boundaries by inverse geographic distance. A modified

[4] Supreme Court 2011 p. 22.

[5] Mapping Evapotranspiration at High Resolution and Internalized Calibration. http://extension.uidaho.edu/kimberly/2014/06/metric-mapping-evapotranspiration-at-high-resolution-and-internalized-calibration/

[6] PRISM Climate Group, Oregon State University. http://www.prism.oregonstate.edu/

Glover/Balmer/Jenkins methodology[7] may be used to estimate the timing to the respective underflow boundaries. From the effects at ESPAM2.1 boundaries, ESPAM2.1 and the 63% factor can be used to estimate the relief accruing to Curren Tunnel.

Where wells draw from unconfined water-bearing zones vertically above or horizontally north of the confining layer, the effects of curtailment of beneficial use propagate primarily to the Big Wood River and/or Silver Creek, and then from the streams to the Eastern Snake Plain Aquifer as discussed below. For wells not tapping the confined aquifer, 100% of the net consumptive use volume can be assumed to affect the river and creek. Water-supply effects propagate in all directions (upgradient, downgradient and cross-gradient) and can be apportioned between Silver Creek and the Big Wood River by inverse geographic distance. The Glover/Balmer/Jenkins methodology with no-flow boundaries can be used to estimate the timing of propagation from wells to the streams.

For accruals to the streams, calculating relief to Curren Tunnel requires propagating the effects of curtailment from the streams into the aquifer. Water-budget analyses o the fate of surface water stored in Magic Reservoir, bed loss in the Big Wood River, Silver Creek and the Little Wood River, and irrigation from these streams, are beyond the scope of this report. However, data and standard methodologies are available to obtain a reasonable estimate of the increased net recharge/reduced supplemental pumping[8] that would result from a given increase of supply in the Big Wood River. IDWR hydrologists have strong credentials and capacity to perform these analyses.

From these water budget analyses, the effects of curtailment may be partitioned between the aquifer, canal users, and contributions to Snake River flow from the Big Wood and Little Wood Rivers via Malad Gorge. Water-budget analysis can indicate where and when the increases in bed loss and incidental recharge, and the reductions in supplemental pumping, would occur. These analyses can govern input to ESPAM2.1, which may be used with the 63% factor to estimate accrual to Curren Tunnel.

Most wells north of Bellevue will tap the unconfined aquifer and those south, the confined aquifer. Paradoxically, because effects propagate much more rapidly in a surface-water system than via the aquifer, curtailment of beneficial use north of Bellevue is likely to produce more immediate accrual to Curren Tunnel than is curtailment of beneficial use from the confined aquifer in the Bellevue Triangle.

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[7] Miller, C.D., D. Durnford, M.R. Halstead, J. Altenhofen and Val Flory. 2008. *Stream Depletion in Alluvial Valleys Using the SDF Semianalytical Model.* Ground Water 45, No. 4, 506-514

[8] From a water-supply standpoint, increasing recharge or reducing supplemental pumping are equally effective increases in supply.

Curtailment of beneficial use in the Camas Prairie portion of Basin 37 will essentially all be expressed as aquifer-flow increases at the ESPAM2.1 tributary inflow boundary. METRIC evapotranspiration estimates and PRISM precipitation estimates may be used to determine the effects of curtailment, with 100% of the quantity effect propagating to the tributary boundary. The timing of propagation to the ESPAM2.1 boundary may be estimated using the modified Glover/Balmer/Jenkins method, with a no-flow boundary representing the western extent of the Camas Prairie valley. From the model boundary, ESPAM2.1 and the 63% factor may be used to estimate accrual to Curren Tunnel.

Basin 43. As with the Camas Prairie, 100% of curtailed beneficial use in the Raft River basin will be expressed as increased flow to the aquifer at the tributary underflow boundary. These effects may be calculated and applied to the model in the same manner as described for the Camas Prairie.

Basin 45. Within the ESPAM2.1 boundary, the model and its data files may be used directly. Effects of curtailment of beneficial use outside the boundary may be calculated using METRIC evapotranspiration estimates and PRISM precipitation estimates. East and south of the ESPAM2.1 model boundary, these effects may be propagated to the boundary using the modified Glover/Balmer/Jenkins methodology. From the model boundary, accrual to Curren Tunnel may be estimated using ESPAM2.1 and the 63% factor.

Effects of curtailment of beneficial use within Basin 45, west of the model boundary and north of the mountains defining the western margin of Oakley Valley, should be partitioned between Rock Creek to the west, and the model boundary to the east, based on inverse geographic distance. Timing may be estimated using the University of Idaho adaptation of Balmer/Glover/Jenkins for a constant-head terminal boundary[9]. From the model boundary, effects may be propagated to accrual at Curren Tunnel using the methods described above.

Timing Criterion of Futility

Empirical Evidence of Timing. Fortunately, the historical record contains a very strong empirical observation of the response time of the springs. Figure 3[10] shows the familiar response at the springs to the large stimulus of incidental recharge from the development of surface-water irrigation. Spring discharges increased for a period of approximately 50 years following surface-water irrigation development in the latter part of the 19th century. Note that the plateau after 50 years corresponds to three significant water-budget changes: Development of groundwater irrigation; reduction

[9] Contor, B.A. 2011. Adaptation of the Glover/Balmer/Jenkins Analytical Stream-Depletion Methods for No-flow and Recharge Boundaries. Idaho Water Resources Research Institute Technical Completion Report 201101. University of Idaho.
[10] From the ESPAM2.1 Final Report

of incidental recharge from conversion of surface-water irrigation to sprinklers; and, loss of wintertime recharge due to the Palisades Winter Water Savings Agreement. Hence, though the empirical data indicate that the response time must have been at least 50 years, it actually may have been longer.

Figure 4 shows the surface-water irrigated lands on the plain as of 1980, divided into western and eastern blocks. The two blocks are separated by a block of non-irrigated lands stretching from west of the Aberdeen area in the south to Howe, Arco and the Craters of the Moon on the north. With simplistic assumptions of consumptive use, and an assumption that gross diversion volumes per acre in the east are three times those in the west, ESPAM2.1 steady-state response functions indicate that about 85% of the surface-water irrigation effects accruing downstream of Milner are attributed to irrigation in the west block. With assumptions of approximately equal diversion volumes per acre, more than 90% of spring accruals can be attributed to the west block. In either case, the data clearly indicate that the spatial distribution of the hydrologic signal for the 50 year response time is dominated by the western block of irrigation within an 80 or 90 mile radius of Curren Tunnel.

Aquifer Models and Timing. The case record shows that ESPAM2.1 tends to show more rapid propagation of effects than either of its numerical aquifer model predecessors, ESPAM1.1 or SRPAM[11]. As described below, it also shows more rapid propagation than do analytical methods. The other models and methods correspond more closely to the empirical record of timing than does ESPAM2.1. In large measure this is likely because the ESPAM2.1 model was not "taught" to make estimates of the long-range timing of effects from distant events such as curtailment. First, the calibration data set only included about 30 years of data, and these contained few distinct, distant signals to calibrate to. More importantly, the focus of calibration, weighting of targets, and specification of the objective function was on refining the model's ability to reproduce short-term seasonal variations in spring discharge. IDWR may choose to try to "teach" future versions of the model to estimate long-term responses to distant events. For now, ESPAM2.1, tailored to reproduce short-term phenomena, is the tool at hand.

Analytical Methods. Boggs et al[12] evaluated Eastern Snake Plain Aquifer response times using the arithmetic mean storage coefficient and geometric mean[13] transmissivity from ESPAM1.1. They stated: "In this aquifer, detectable annual and decadal cycles in discharge can result from recharge no further than 20 and 60 km

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[11] FMID technical report, October 2012

[12] Boggs, Kevin G.; Robert W. Van Kirk, Gary S. Johnson, Jerry P. Fairley, and P. Steve Porter, 2010. ***Analytical Solutions to the Linearized Bossinesq Equation for Assessing the Effects of Recharge on Aquifer Discharge***. Journal of the American Water Resources Association (JAWRA) 46(6):1116-1132. DOI: 101111/j.1752-1688/2010.00479.x

[13] Using a geometric mean is more appropriate than using an arithmetic mean given the process of groundwater flow. It produces an estimate of transmissivity greater than would the arithmetic mean. A larger transmissivity value produces more rapid estimates of response.

[approximately 12 and 36 miles] away from the discharge point, respectively. The effects of more distant, long-term recharge can be detected only after a time lag of several decades."

The Glover method (also known as Balmer or Jenkins) was developed explicitly to assess the timing of effects of pumping or recharge upon a hydraulically connected stream. The stream depletion factor or sdf is defined based upon distance from the reach of interest, aquifer storage coefficient and aquifer transmissivity. The units of the sdf are time units, and the time period of three times the sdf is the time required for approximately 50%[14] of pumped, recharged or curtailed volume to be expressed at the connected stream. Using a storage coefficient of 0.056 (the arithmetic mean of ESPAM2.1 model values) and a transmissivity of 398,133 ft2 per day (the geometric mean of ESPAM2.1 model values), the time to 50% at a distance of 50 miles from the Curren Tunnel is approximately 83 years, and the time to 50% at a distance of 100 miles is approximately 320 years.

The method assumes a surface-water body (in this case, the series of springs at the west end of the aquifer) forming one boundary of a semi-infinite aquifer. The Eastern Snake River Plain aquifer is somewhat smaller than this; extending in the northeast direction from the reach containing Curren Tunnel it is approximately 200 miles long and 60 miles wide. University of Idaho[15] used image-well reasoning and numerical modeling to show that the method is fully applicable without adjustment to aquifers of less than infinite width. Miller et al[16] showed how image-well methodology can be used to represent a terminal no-flow boundary, when aquifers are less than infinitely long in the direction away from the surface-water body. Application of the Miller adaptation does not appreciably affect the 50-mile time to 50%. However, the 100-mile time to 50% is reduced to approximately 160 years by the eastern no-flow boundary's reflection of effects. Figure 5 shows the time to 50% at various distances from Curren Tunnel, using the Miller adaptation to represent the eastern boundary of the aquifer. At 12.5 miles (about the City of Gooding) the time to 50% is five years. At 18 miles (about the City of Jerome) the time to 50% is 10 years. The time to 50% at 28 miles (between Shoshone and Dietrich) is 25 years, at 39 miles (near Richfield) it is 50 years, and at 61 miles (near Burley) it is 100 years. Note that this is the number of years to 50% of the infinite-time relief, not the time to 50% of curtailed beneficial use.[17]

A final analytical approach is the Cooper-Jacob analysis. The Cooper-Jacob method allows calculation of an approximate distance to zero change in head (and hence zero accrual of relief) at a given time period. Figure 6 shows Cooper-Jacob lines of zero

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[14] More precisely 49.7%

[15] Idaho Water Resources Research Institute Technical Completion Report 201101, cited previously

[16] *Stream Depletion in Alluvial Valleys Using the SDF Semianalytical Model*, cited previously

[17] Even at infinite time, nowhere on the plain does the model indicate relief as much as 12% of curtailed beneficial use.

effect at various time periods. The five-year zero-effect line is at 33 miles (just east of Dietrich), the ten-year line is at 46 miles (between Eden and Paul), and the 25-year line is at 73 miles (east of Minidoka).

Summary of Timing Discussion. A clear empirical record establishes at least a 50-year response time of the springs to irrigation within 80 to 90 miles of Curren Tunnel. ESPAM2.1 tends to produce timing estimates roughly compatible, though more rapid than the empirical observation. The differences between the various numerical models and analytical methods show that there is uncertainty in the representation of timing. Because ESPAM2.1 produces more rapid estimates than the other methods, use of ESPAM2.1 to evaluate timing effects would allow uncertainty to cut in favor of the senior.

Waste of the Water Resource Criterion of Futility

ESPAM2.1 can be used to estimate the fraction of relief that will accrue to the Rangen Model Reach (the reach containing Curren Tunnel) at steady state. Multiplying the ESPAM2.1 steady-state response functions for the Rangen Reach by 63%, Figure 7 shows that at a distance of 15 miles, the model indicates the relief will begin to approach 1/20 of the foregone beneficial use. At model cells nearest Curren Tunnel, accrual to the tunnel will be approximately 1/10 of the volume of foregone beneficial use.

Combining Timing and Waste Criteria of Futility

Steady-state evaluation, such as that provided above, assumes that relief is allowed to accumulate until infinite time.

Timing and waste criteria of Futility may be combined in a specification that "A call is not futile which provides relief of X% or more of curtailed beneficial use, within a period of Y years." The ESPAM2.1 model operated in transient superposition mode, with responses at the Rangen Reach multiplied by 63%, can identify the Line of Futility corresponding to such a specification. Figures 8, 9 and 10 show cumulative relief percentages after various time periods. Relief is expressed as the ratio of (relief at Curren Tunnel) to (foregone beneficial use), calculated as a percentage.

Figure 8 shows relief after five years. The model cell containing Curren Tunnel shows over 10% relief. A band of 5% relief extends a few miles north and east, with the 1% band reaching about half way between Jerome and Burley.

The pattern of relief after 10 years is shown in Figure 9. The 10% relief band is unchanged, and the 5% band extends about a mile further than at 5 years. The 1% band reaches nearly to Burley.

Figure 10 illustrates the pattern of relief after 25 years. The 10% and 5% bands are unchanged from the 10-year locations, and the 1% band has extended to Rupert.

Absolute Quantity of Relief Criterion of Futility

To estimate the absolute quantity of relief that will accrue to Curren Tunnel from a given curtailment of beneficial use, the priority dates and consumptive beneficial use of candidate curtailed junior parcels must be considered. The IDWR "POD file" procedure is used with model input data to perform these calculations for administrative decisions. The effect of curtailment at each model cell is estimated based on a weighted priority factor for each cell, and IDWR uses special algorithms to extrapolate the priority factor to model cells containing groundwater irrigation but not water-right Points of Diversion (PODs).

For this report, an approximate routine was used to replicate the internal IDWR algorithms and process. The results will be similar but not exact, and should be considered an illustration only. The procedure employed was as follows:

1. For each model cell, the fraction of the cell junior to various priority dates was estimated from the POD File representation for that cell or extrapolated by searching for the nearest cell with a POD File representation[18];
2. For each model cell, the annual volume of consumptive beneficial use on groundwater irrigated lands was calculated from ESPAM2.1 model data;
3. For each model cell, the steady-state aquifer response function for the Rangen Reach (the model cell containing the Curren Tunnel) was obtained from ESPAM2.1 model results;
4. For each model cell, the steady-state acre foot volume of annual accrual of relief to Curren Tunnel from curtailment was calculated as the product of (Junior Fraction) x (Acre Feet Groundwater Consumptive Use) x (Steady-state Response Fraction) x (63%);
5. Acre feet of annual accrual were converted to annual average cfs;
6. A scale factor of 94% was applied to calibrate the results of a 1963 curtailment to match IDWR's results as presented in Rangen 2014 (10.6 cfs from curtailment within the CMR 50 Boundary), adjusting for differences introduced by approximating the IDWR methods[19];
7. Model cells were ranked from smallest to largest Steady-state Response Fraction, and within a given Steady-state Response Function, from furthest to nearest the Curren Tunnel;

[18] The extrapolation routine was to begin one row north and one column west of the cell in question, then interrogate three rows and three columns surrounding the model cell. The first identified cell with a POD representation was used as proxy. If none were identified, the search boundary was systematically increased until a cell with the necessary data was identified.

[19] In addition to the extrapolation algorithm, differences could arise from assumptions regarding evapotranspiration adjustment factors and the averaging period(s) for crop mix, evapotranspiration and precipitation.

8. In rank order, the cumulative cfs of relief to Curren Tunnel was summed.

Based on this procedure, Figure 11 shows the status of irrigated lands in model cells having at least some supply or water-rights from groundwater, color coded by the cumulative cfs of relief as described above for a July 1, 1957 priority curtailment. The irrigated lands whose cumulative relief is less than 0.64 cfs, those whose relief brings the sum to just less than 1.0 cfs, and those for whom the cumulative relief is greater than 1.0 cfs are identified separately. Cells whose cumulative relief is less than 0.64 include a handful of cells near large springs between Twin Falls and King Hill, two cells on the east of the Little Lost River Valley, areas to the east of the Little Lost, and cells northeast of Chubbuck and American Falls Reservoir. Cells that bring the cumulative relief to 1.0 cfs include the balance of the Little Lost River Valley model cells, and additional cells between Aberdeen and the 0.64 cfs line. The remainder of cells bring the cumulative sum of relief greater than 1.0 cfs. This analysis will approximate but not exactly reproduce the results that would be obtained using the IDWR assumptions and algorithms.

Uncertainty Trim Line

The case record shows clearly that ESPAM2.1, like ESPAM1.1, is subject to uncertainty from a variety of sources. On one hand, ESPAM2.1 is perhaps better calibrated than ESPAM1.1 and therefore might be considered to have less uncertainty. On the other hand, it is more complex, and therefore might be considered to have more uncertainty than ESPAM1.1.

Nevertheless, the models are more similar than they are different, in structure, data sources, and methodology. The primary drivers of uncertainty are the same in both cases. While it may be true that exact determination of uncertainty is impossible, it is true that an assignment of uncertainty can be made on a technical basis, for administrative purposes. ESPAM1.1 model uncertainty is "probably much higher than 10%[20]" and the case record shows that for some questions, ESPAM2.1 uncertainty is definitely much higher than 10%. Any imprecision in the understanding of uncertainty must cut in favor of the senior, yet it is inappropriate to apply the model without considering an assigned level of uncertainty. Therefore, the 10% assignment of uncertainty upheld for ESPAM1.1 is the technically best assignment to be applied to ESPAM2.1.

A large source of uncertainty for ESPAM2.1 is that some reaches are small relative to the spacing between Pilot Points, and therefore the model cannot represent the aquifer heterogeneity that strongly contributes to cell-to-cell differences in response. Secondarily, a practical effect of very small reaches is that whatever the assigned trim fraction, the enclosed area becomes small as the reaches become small. For both

[20] Supreme Court 2011 p. 33

these reasons, applying the 10% assignment to reaches similar in size to the ESPAM1.1 reaches is more technically suitable than applying it to the very small reaches of ESPAM2.1. A larger reach was constructed summing the ESPAM2.1 reaches comprising the ESPAM1.1 reach which contained Curren Tunnel, Thousand Springs to Malad. The reaches summed were:

1. Big Spring
2. Birch Spring
3. Drain D036014
4. Drain D037014
5. Drain D038014
6. Drain D040013
7. Drain D040014
8. Rangen Cell
9. The response for steady-state reach "GHB" (General Head Boundary) multiplied by 19%[21].

<u>Geologic Features</u>

Because the intent of a model is to represent the effect that geological features have upon the propagation of hydrologic effects, it is technically valid to augment model results with other knowledge of geologic features.

The Great Rift is a known geological feature. Its action as a hydrologic barrier is strongly reflected in the water-level input data to ESPAM2.1; it is clearly documented that the slope of the water table is much steeper across the Great Rift than it is east or west of the rift zone. This indicates that the geologic feature is a zone of low aquifer transmissivity, impeding flow and propagation of hydrologic signals.

APPLICATION TO UPPER VALLEY PUMPERS

By any of these technological analyses, the indication is that no meaningful quantity of relief will accrue to Curren Tunnel from curtailment of beneficial use in the areas irrigated by Upper Valley Pumpers. The only indication that any relief would accrue is from the numerical models, which were constrained by their very construction to show some quantity of relief.

[21] The 19% fraction for General Head Boundary response was obtained by comparing the sum of (cells x cell conductance) for the cells within the Thousand Springs to Malad reach, to the same sum for all General Head Boundary cells.

ATTACHMENTS

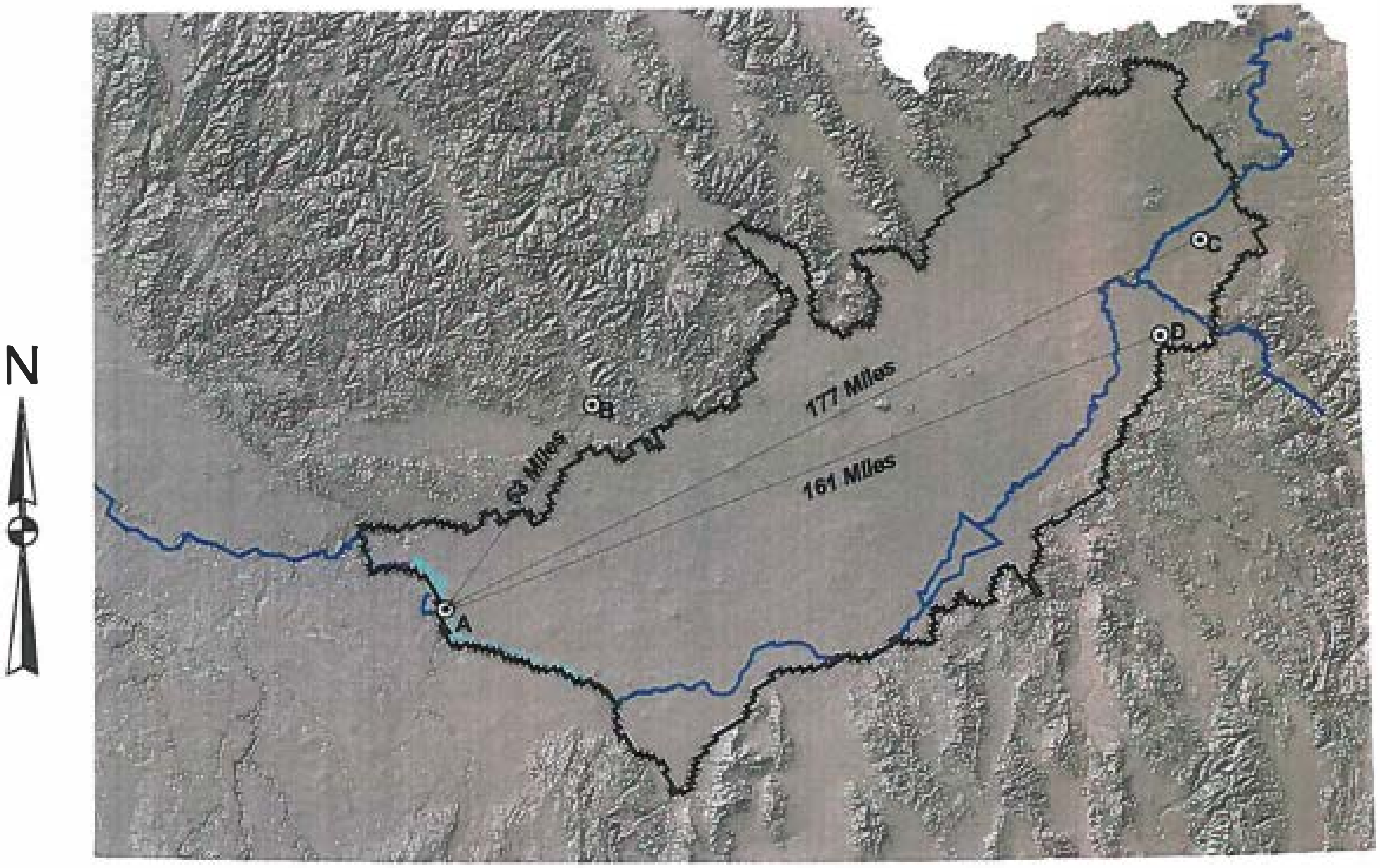

Figure 1: Hypothetical Points

Rocky Mountain ENVIRONMENTAL ASSOCIATES, INC.
482 Constitution Way, Idaho Falls ID 83402
208-524-2353

Hypothetical Points
Model Boundary
Modeled Springs
Snake River

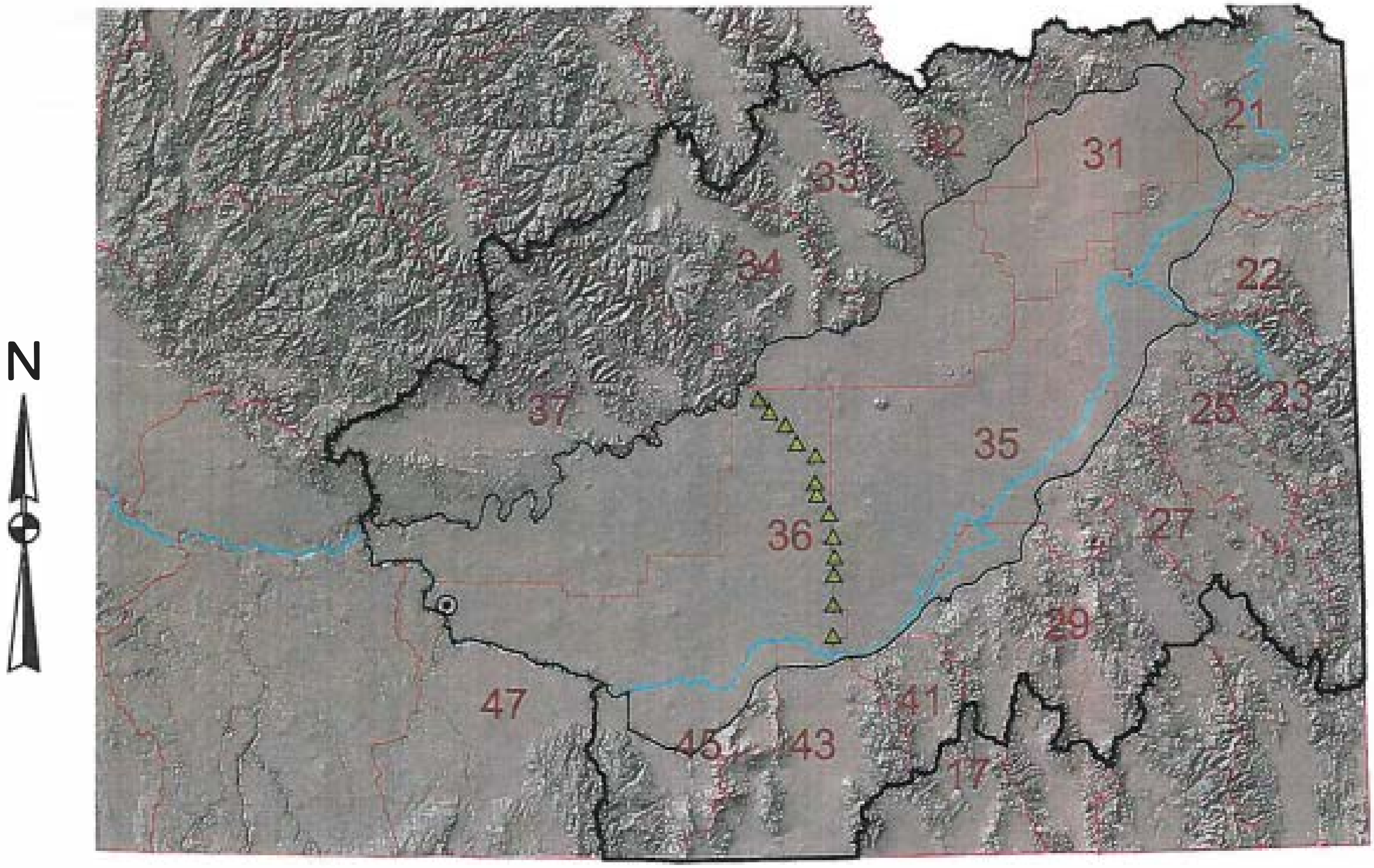

Figure 2: Relevant Features for Consideration of Area of Common Supply

Rocky Mountain ENVIRONMENTAL ASSOCIATES, INC.
482 Constitution Way, Idaho Falls ID 83402
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- ⊙ Curren Tunnel
- △ Great Rift (approx)
- Tributary Basins
- CMR 50 Boundary
- Snake River
- Administrative Basins

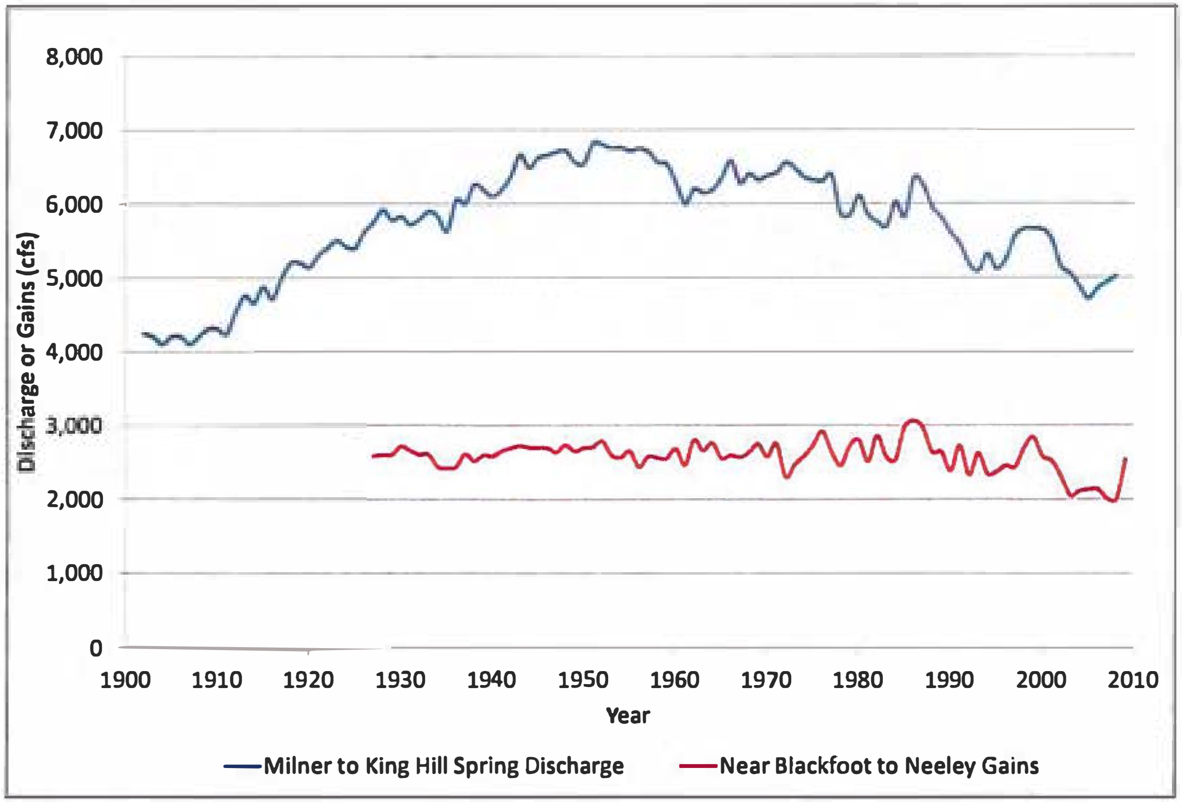

Figure 9. Average annual spring discharge for Milner-to-King Hill and near Blackfoot-to-Neeley river gains (from IDWR data).

Rocky Mountain ENVIRONMENTAL ASSOCIATES, INC.

Figure 3: Empirical Response Time to Irrigation Recharge

From ESPAM 2.1 Final Report (Figure 9)

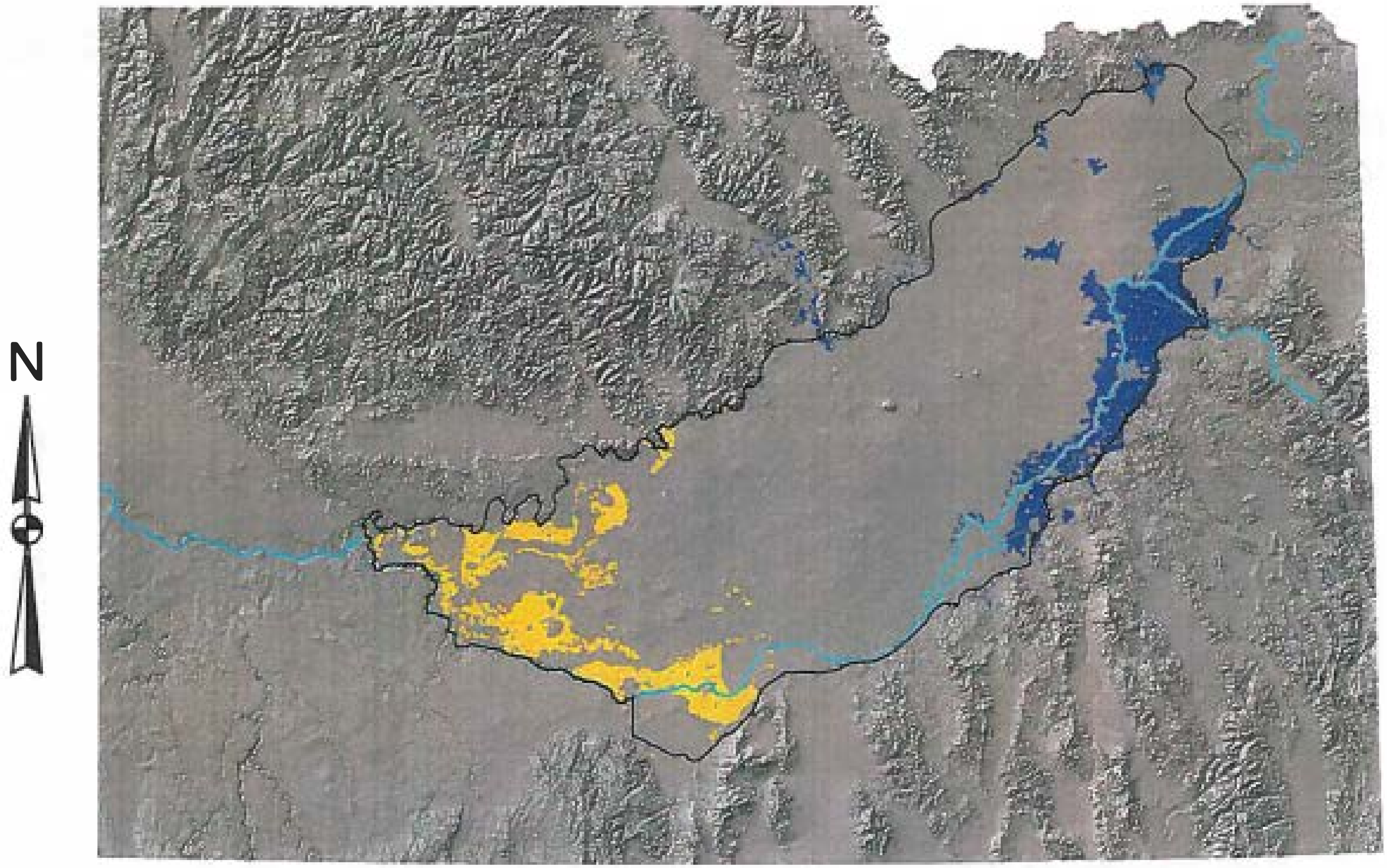

Figure 4: East and West Surface Irrigation, 1980, ESPAM2.1 Data

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CMR 50 Boundary
Snake River

ESPAM2.1 Surface-water Irrigated Lands
East
West

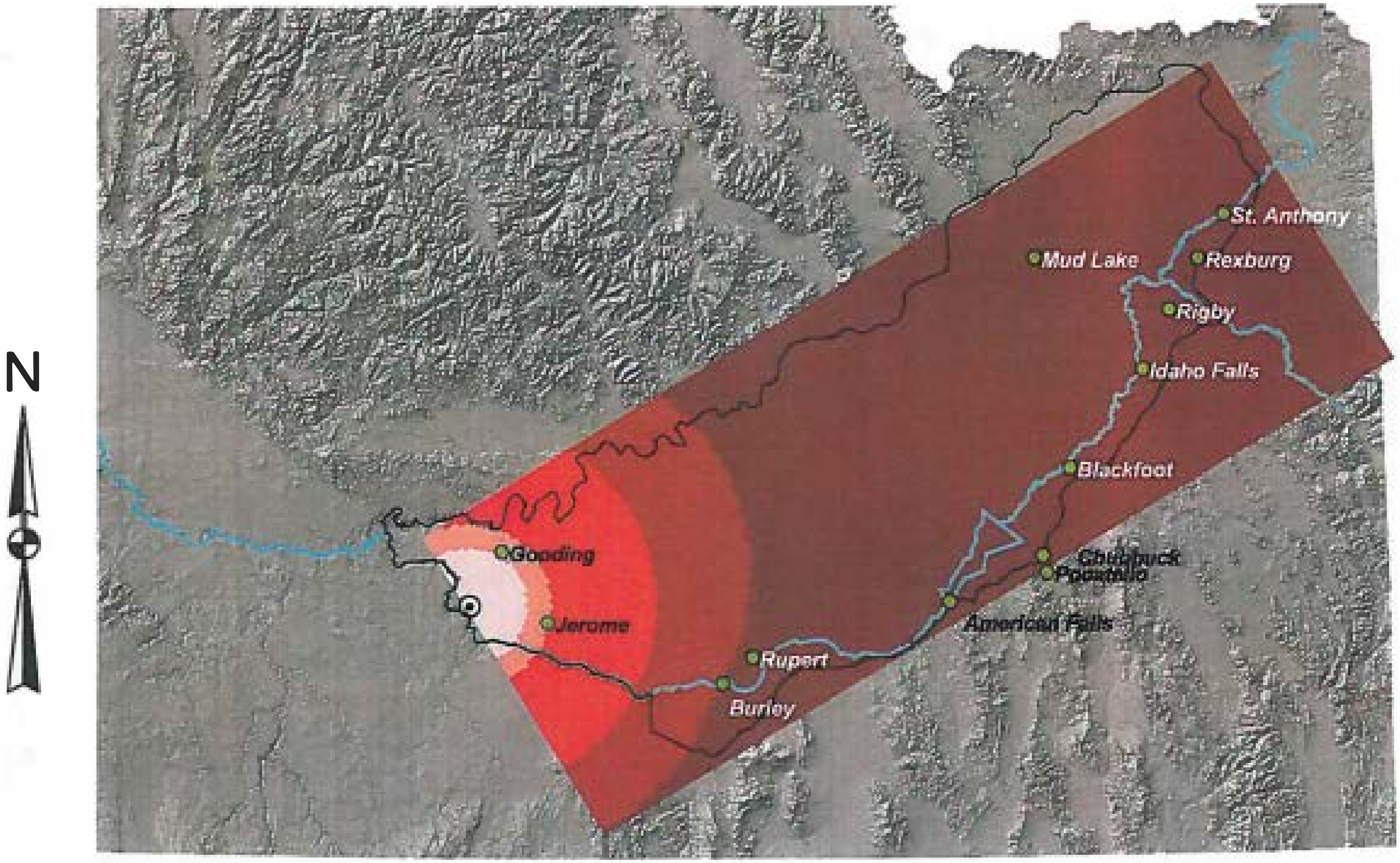

Figure 5: Glover/Balmer/Jenkins Time to 50% Using Miller No-Flow Boundary Adaptation

Rocky Mountain Environmental Associates Inc.
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208-524-2353

- Cities
- Curren Tunnel
- CMR 50 Boundary
- Snake River

Years to 50% of Full Relief

- 0 - 5
- 5 - 10
- 10 - 25
- 25 - 50
- 50 - 100
- >100

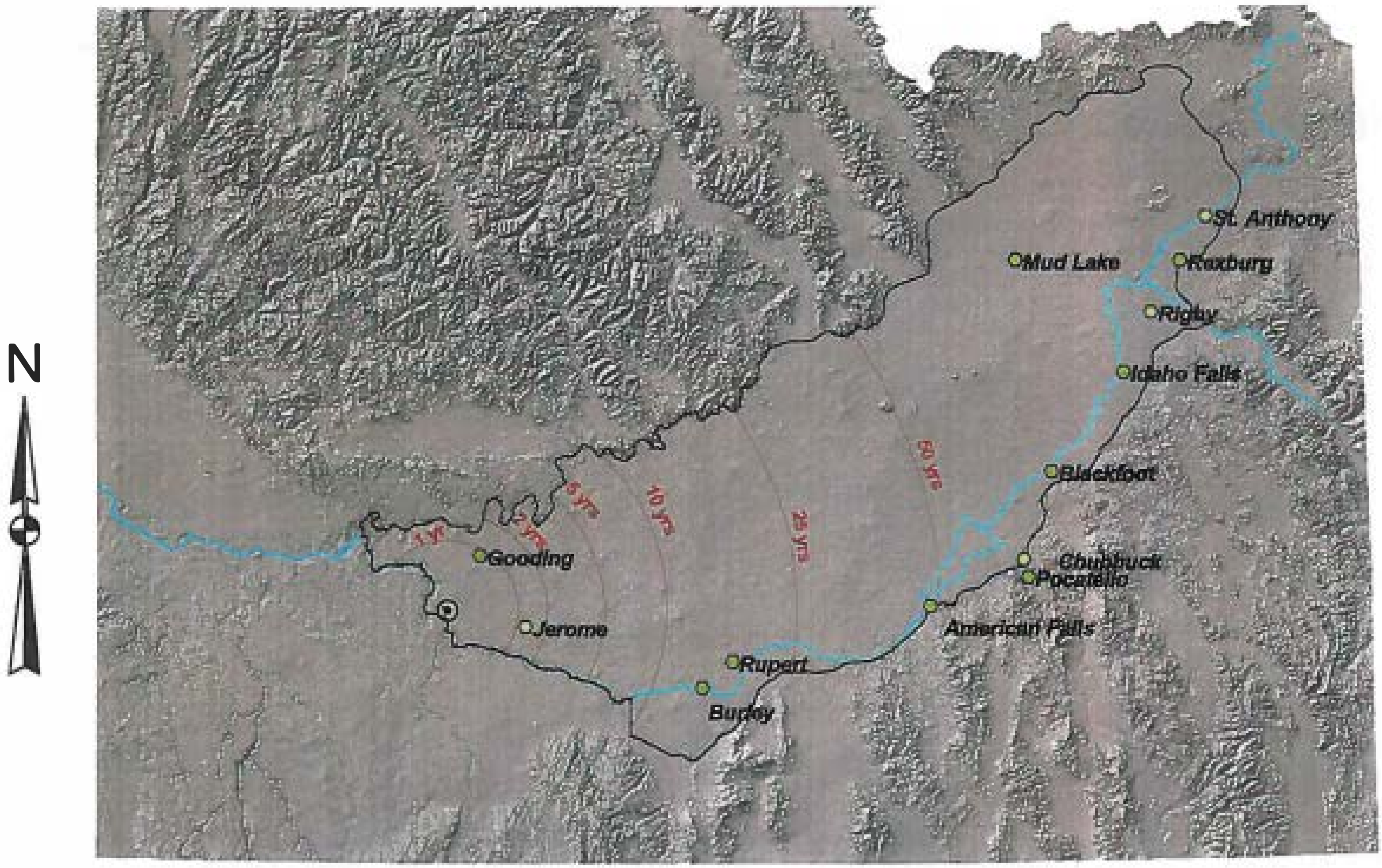

Figure 6: Cooper-Jacob Lines of Zero Effect

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Cities
Curren Tunnel
CMR 50 Boundary
Snake River
Cooper-Jacob Lines of Zero Effect

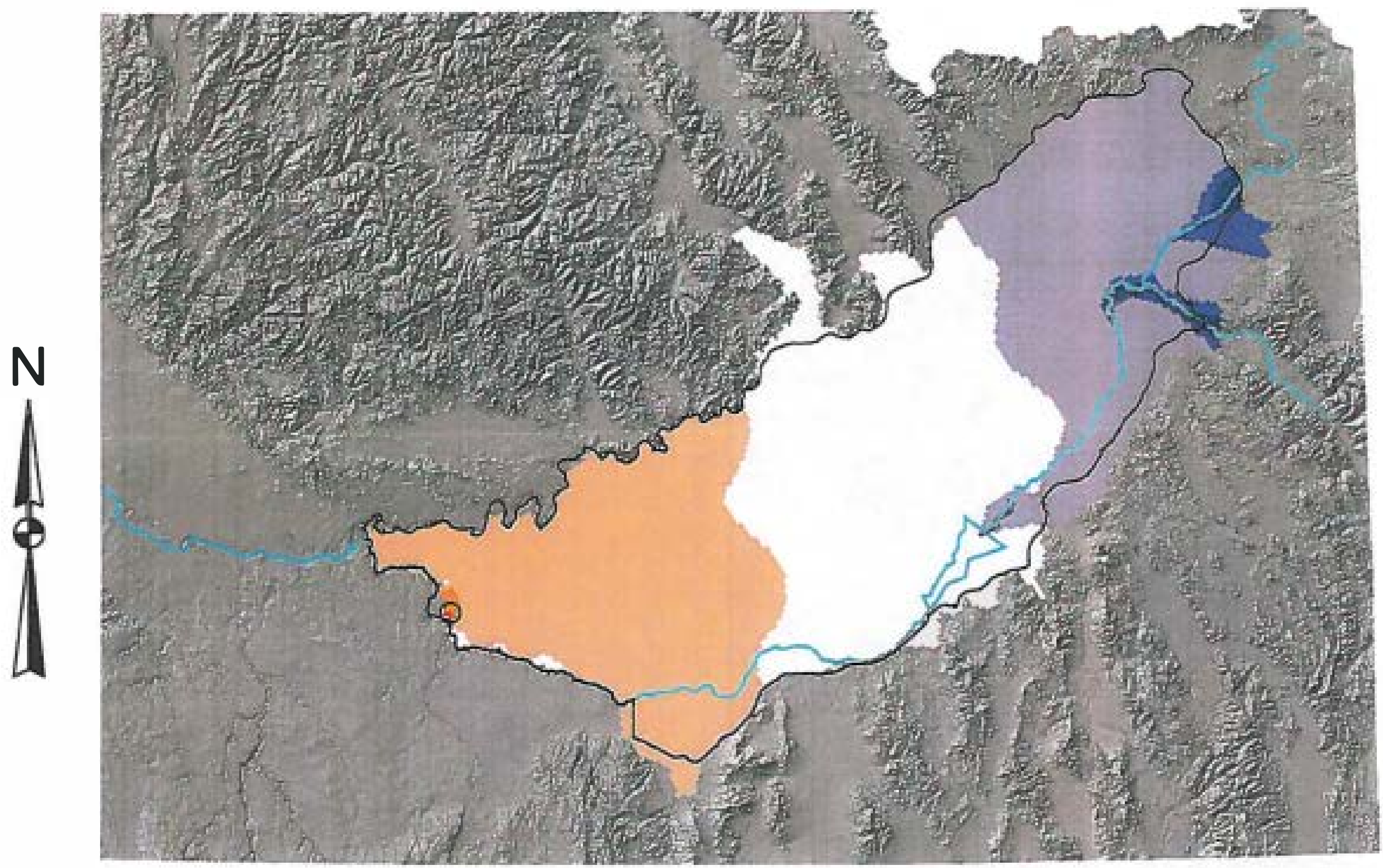

Figure 7: Ratio of (Relief at Curren Tunnel) to (Foregone Beneficial Use) at Steady State (infinite time)

Rocky Mountain ENVIRONMENTAL ASSOCIATES INC.

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Curren Tunnel
CMR 50 Boundary
Snake River

Curren Tunnel Relief Ratio

- Up to 1/10,000
- 1/10,000 - 1/5,000
- 1/5,000 - 1/1,000
- 1/1,000 - 1/100
- 1/100 - 1/20
- 1/20 - 1/10
- 1/10 - 1/8

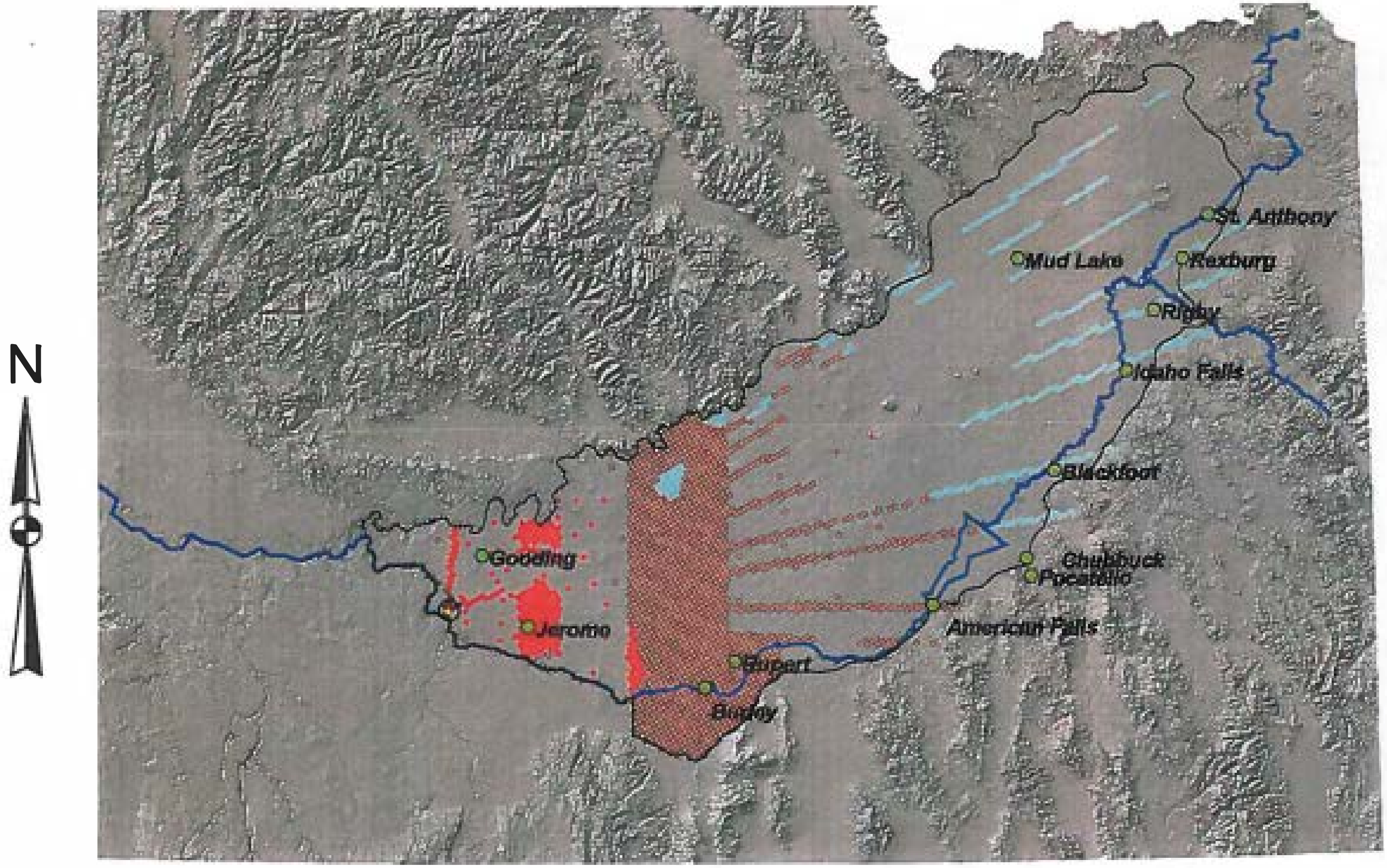

Figure 8: Cumulative Relief Percentage after Five Years (Relief as % of Curtailed Benefical Use)

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Cities
Curren Tunnel
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Snake River

Curren Relief Percentage - 5 yrs

0-0.1%
0.1% - 1%
1% - 5%
5% - 10%
10% - 12%

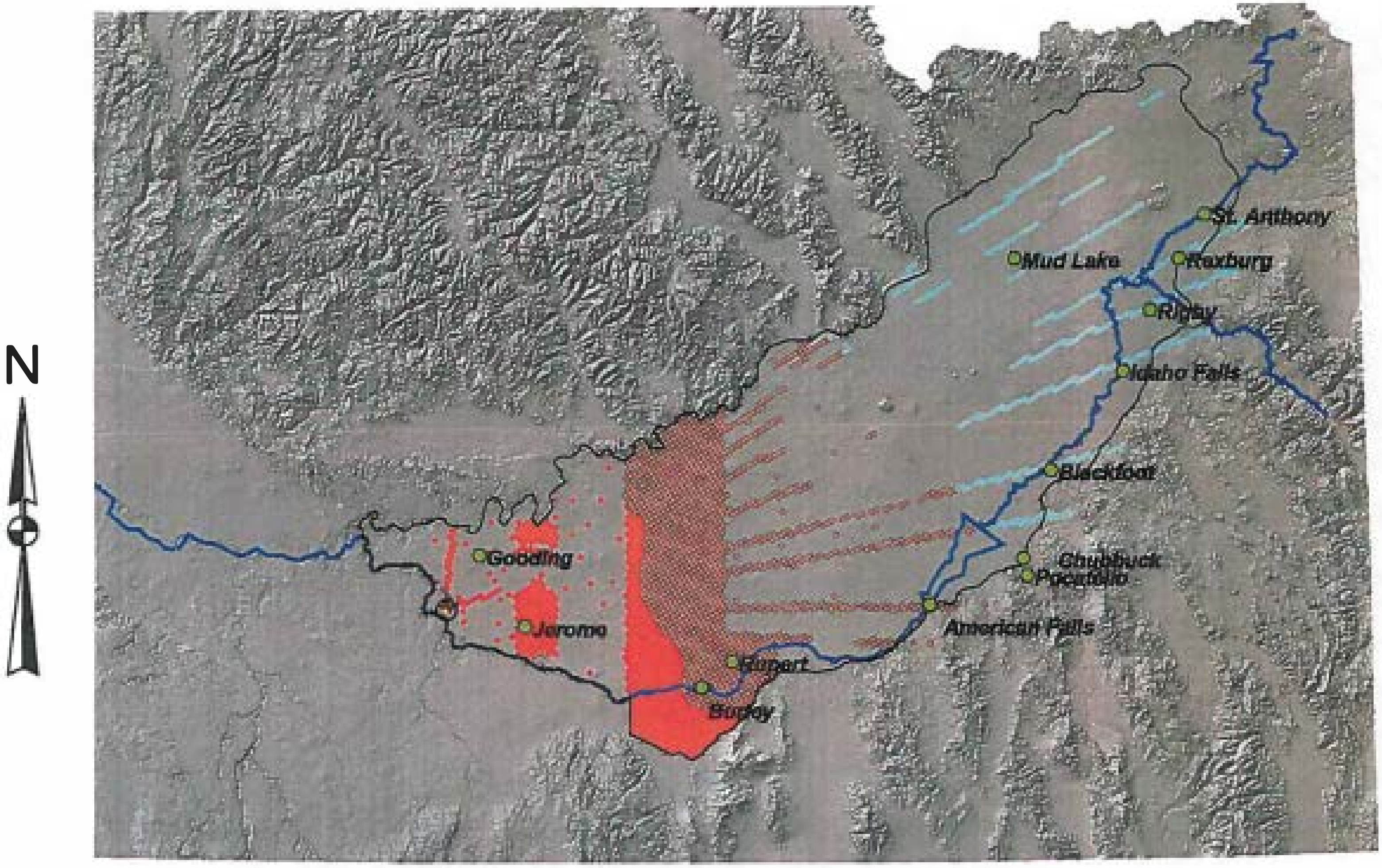

Figure 9: Cumulative Relief Percentage after 10 years (Relief as % of Curtailed Beneficial Use)

Rocky Mountain
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208-524-2353

- Cities
- Curren Tunnel
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- Snake River

Curren Relief Percentage - 10 yrs

0-0.1%	1% - 5%
0.1% - 1%	5% - 10%
	10% - 12%

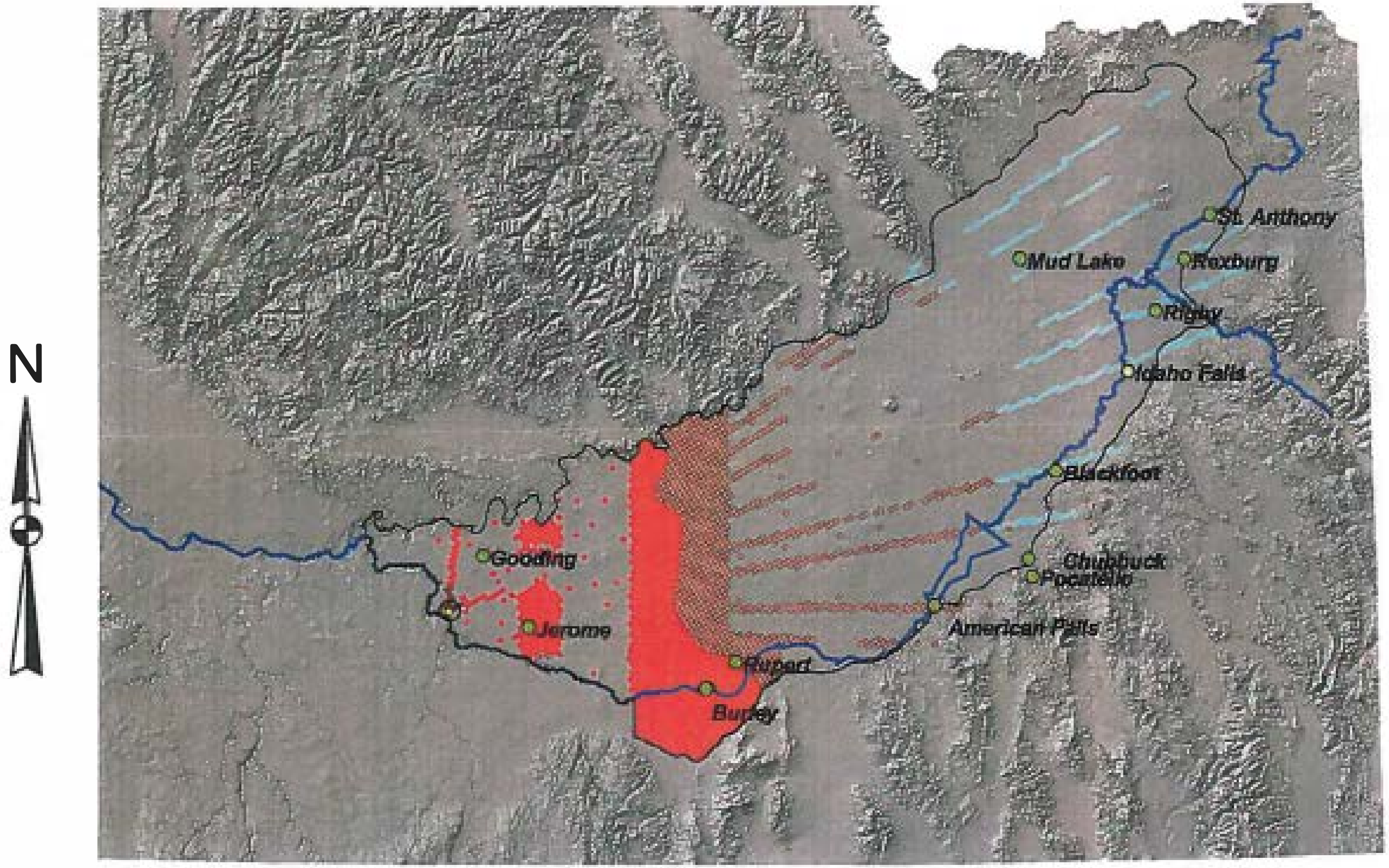

Figure 10: Cumulative Relief Percentage after 25 years (Relief as % of Curtailed Beneficial Use)

Rocky Mountain Environmental Associates, Inc.
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Cities
Curren Tunnel
CMR 50 Boundary
Snake River

Curren Relief Percentage - 25 yrs
0-0.1%
0.1% - 1%
1% - 5%
5% - 10%
10% - 12%

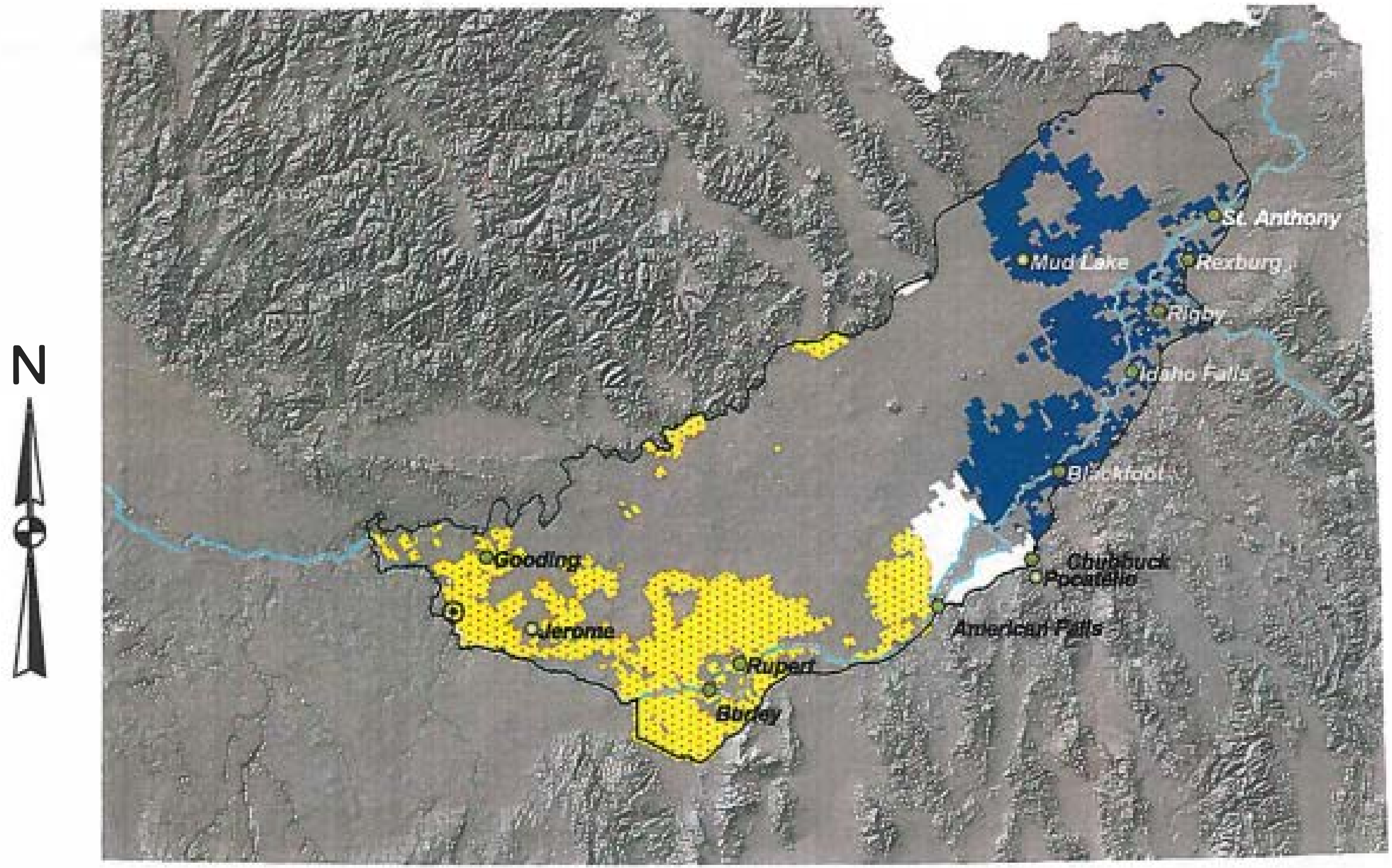

Figure 11: Cumulative CFS of Relief for July 1, 1957 Priority Curtailment.

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- Cities
- Curren Tunnel
- CMR 50 Boundary
- Snake River

Cumulative CFS - 1957 Curtailment

- < 0.64 cfs
- 0.64 - 1.00 cfs
- > 1.00 cfs