REBUTTAL REPORT: PART 1

REVIEW OF EVIDENCE REPORTS SUBMITTED BY SOUTHERN NEVADA WATER AUTHORITY IN SUPPORT OF WATER RIGHTS APPLICATIONS FOR SPRING, CAVE, DRY LAKE, AND DELAMER VALLEYS

Presented to the Office of the Nevada State Engineer

On behalf of Great Basin Water Network and the Confederated Tribes of the Goshute Reservation

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Date

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SUMMARY AND CONCLUSION

This rebuttal report is prepared on behalf of GBWN and the Confederated Tribes of the Goshute Indians. It is Part 1 of a three-part submission reviewing and rebutting SNWA's evidence. This part reviews SNWA's Conceptual Model (Burns and Drici, 2011), Geology report (Rowley et al, 2011), Isotope report (Thomas and Mihevc, 2011), effects analysis (Watrus and Drici, 2011), and various other supporting documents. Part 2 will be a detailed review of the SNWA numerical groundwater model and comparison with the Myers model (Myers, 2011c).

Just prior to the deadline for evidence reports, the Bureau of Land Management released the "Clark, Lincoln, and White Pine Counties Groundwater Development Project Draft Environmental Impact Statement" (DEIS), which analyzes the effects of SNWA pumping from five basins, the four being considered in this hearing and Snake Valley. The DEIS considers a distributed pumping option, which has SNWA pumping from about three times as many wells as the number reflected in SNWA's applications to even out the impacts over the valley. Part 3 of this rebuttal is a new simulation of hydrologic effects of SNWA's proposed project, based on the distributed pumping option as presented in BLM (2011) and another potentially more realistic option. SNWA presented hydrogeologic data in their evidence reports that differ substantially from that used in the DEIS; these differences are reviewed in this part.

SNWA supports their water rights applications with estimates of recharge for the various basins, including Spring and CDD valleys, presented in their conceptual model report. SNWA's current estimates differ from, and are mostly much more than, the estimates presented in the DEIS. This is especially true for Spring Valley, for which they now estimate more than 99,000 af/y of recharge, which could be compared to about 82,000 af/y estimated in the DEIS studies. The new estimate is too high.

Recharge estimates in both Dry Lake and Delamar Valleys also are too high. The estimates are too high due to various assumptions and methodologies used by SNWA in their water balance analysis of the White River Flow System (WRFS).

For the following reasons, SNWA's conceptual model is defective and its recharge estimates for Spring, Dry Lake, and Delamar Valleys are too high.

- SNWA assumes there is no interbasin flow from Steptoe Valley in any direction. This reduces the available water for satisfying discharge within the WRFS and Spring Valley.
- SNWA's method for determining recharge in the WRFS treats the entire system as one cell, essentially allowing recharge anywhere in the system to satisfy discharge anywhere else within the system.
- SNWA does not allow interbasin flow into Spring Valley from Steptoe or Lake Valley or from Spring to Snake Valley, except for a small amount through Hamlin Valley.
- The estimates for interbasin flow differ substantially from the estimates made using the groundwater model. SNWA's geology as presented for the hearing did not make it into the groundwater model.

- SNWA assumes there is flow to the Death Valley Flow System (DVFS) whereas research is inconclusive. They ignore recent DVFS research indicating there is flow from DVFS into the WRFS.
- SNWA grossly underestimates inflow from South Butte Valley to the WRFS.
- Comparison of interbasin flows calculated by SNWA for their conceptual model completed for the DEIS with those determined from their groundwater model show that many aspects of the new conceptual model were not included in the numerical groundwater model. Virtually all of the differences would lead to a larger estimate of recharge in the target basins.
- SNWA overestimates groundwater evapotranspiration (GWET) from Spring Valley by underestimating precipitation and assuming an average discharge that, in fact, is not representative of long-term averages.
- SNWA erroneously relies on faults as reasons that flow cannot occur across certain flow paths. However, in no instance do they present actual hydrology data to support their conclusions regarding faults.
- Errors in the precipitation distribution bias the results to inflate the estimated recharge in Dry Lake and Delamar Valleys.

SNWA presents an isotope analysis of the groundwater flowpaths in the WRFS and CDD area. The isotope report supports the arguments of this rebuttal report and of Myers (2011a) more than it supports SNWA's water rights applications. Specifically, this is because isotope data indicates that substantial groundwater flow enters the WRFS from the north, including Steptoe Valley, to discharge from the warm springs. Isotope data conclusively shows that groundwater flows from Cave Valley to springs in WRV and that groundwater takes less than 50 years to reach the springs. This supports the conclusion of Myers (2011a) and BLM (2011) that pumping in Cave Valley will significantly affect White River Valley (WRV) springs in less than 50 years.

SNWA also has completely downplayed their "Conflicts" analysis. They present just one pumping scenario, the original application amounts, even though it is clear from BLM (2011) that other alternatives are being considered. SNWA does not consider pumping less than the total application amount. Finally, despite the fact that the water rights SNWA seeks are permanent, they pump their model for only 75 years after build-out because they claim that is the life of the project and longer runs present more uncertain model results. So, they have not provided the Nevada State Engineer (NSE) with estimates of the time for pumping to reach equilibrium.

In summary, SNWA has estimated that far more water could be available than actually occurs in the targeted valleys. They present only a cursory analysis of the effects of pumping their proposal. SNWA has failed to make the case that any of their requested water rights could be granted without harming other water rights or protected values in the affected area.

Review of the Conceptual Model Report

Burns and Drici (2011) is SNWA's primary conceptual model and water balance report for the study area, and includes estimates of recharge, discharge, and interbasin flow.

Recharge

SNWA bases its argument for available water in the target basins on the recharge in those basins, and uses the measured/estimated discharges as a means of calculating the recharge. SNWA uses a Maxey-Eakin-like recharge calculation with new efficiencies based on groundwater balance calculations (Burns and Drici, 2011). They complete separate water balance calculations for Spring Valley and for the White River Flow System, of which the CDD valleys are a part.

Inflow to a basin, including recharge and interbasin inflow, must equal outflow from the basin including GWET and interbasin outflow. The analysis treats GWET and interbasin inflow/outflow as known values, having been estimated elsewhere in the report. Recharge can then be calculated from the water balance. For the WRFS, SNWA determines Maxey-Eakin-like recharge efficiencies for precipitation across the flow system so that total recharge equals the water-balance-determined value. They then determine recharge by basin using estimated precipitation and the flow-system-wide efficiencies.

The calculation calibrates a power function describing recharge efficiency as a function of precipitation rate; it differs from the traditional Maxey-Eakin methodology by being a continuous function rather than efficiencies set on precipitation intervals. This method differs from the previous groundwater balance completed by SNWA (for the earlier CDD hearing, SNWA, 2007) in that the earlier one established interbasin flows within the flow system as constraints. The calculation presented by SNWA this time treats the WRFS as one cell with interbasin flows (Table 1) and GWET and recharge determined over the entire system. This means their model allows recharge occurring anywhere in the WRFS to satisfy discharge occurring anywhere within the system. Their model simply requires that recharge within the WRFS must equal 148,400 af/y to satisfy GWET and interbasin outflow equaling 105,800 and 57,300 af/y, respectively with interbasin inflow of 14,700 af/y from Butte Valley South and Lower Meadow Valley Wash. The power function coefficients are set so that the efficiencies and PRISM precipitation estimates yield the **necessary recharge anywhere in the system without regard to the location of the discharge.**

Table 1: Interbasin flows to or from (inflow or outflow) to the White River Flow System as presented by SNWA in their Recharge Efficiency Water Balance calculation. Source: Burns and Drici (2011), Appendix G: Excel File SNWA-WRFS-Recharge Efficiencies.

Inflow	Butte V South to Jakes Valley	6700
Inflow	Lower Meadow Valley Wash to MRSA	8000
Outflow	Pahranagat Valley to Tikaboo Valley South (to the Death Valley Flow System)	5100
Outflow	Coyote Spring Valley to Hidden Valley	8600
Outflow	MRSA to California Wash	9900
Outflow	Muddy River Springs Discharge	33,700

Calculations for Spring Valley are simpler because SNWA treats Spring Valley as essentially a closed basin. For their estimated GWET of 94,800 and interbasin outflow (to Hamlin Valley) equaling just 4400, recharge must equal 99,200 af/y. They determine recharge efficiencies for this singular valley, but they are irrelevant because they are not ultimately used for anything (including as recharge distribution to the groundwater model). This is one of the highest estimates made for this valley, a point discussed below.

The remainder of this section reviews the components of the water balance calculation: GWET and interbasin flow. Because of the overlap, I consider the WRFS and Spring Valley jointly. The WRFS includes a north-south trend of basins commencing with Long and Steptoe Valleys in the north and culminating with Lower Moapa Valley and California Wash in the south. Figure 1 shows SNWA's perception of the WRFS, including the interbasin flow which will be considered below. Importantly, it does not include Steptoe Valley because they reject the concept of interbasin flow from that valley to the WRFS.

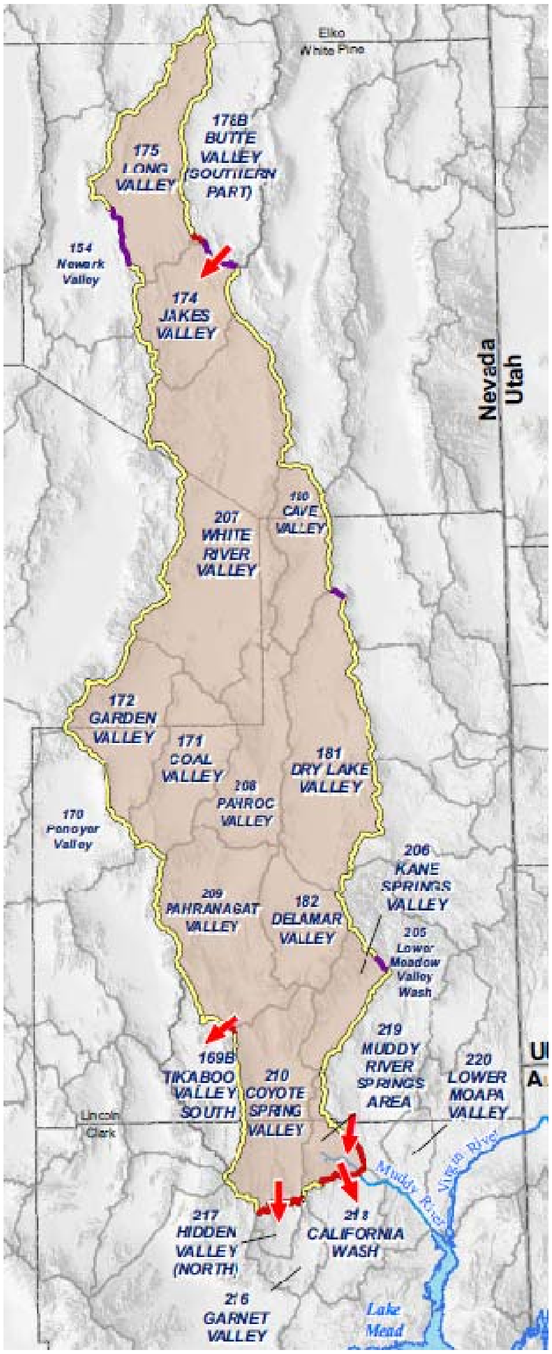
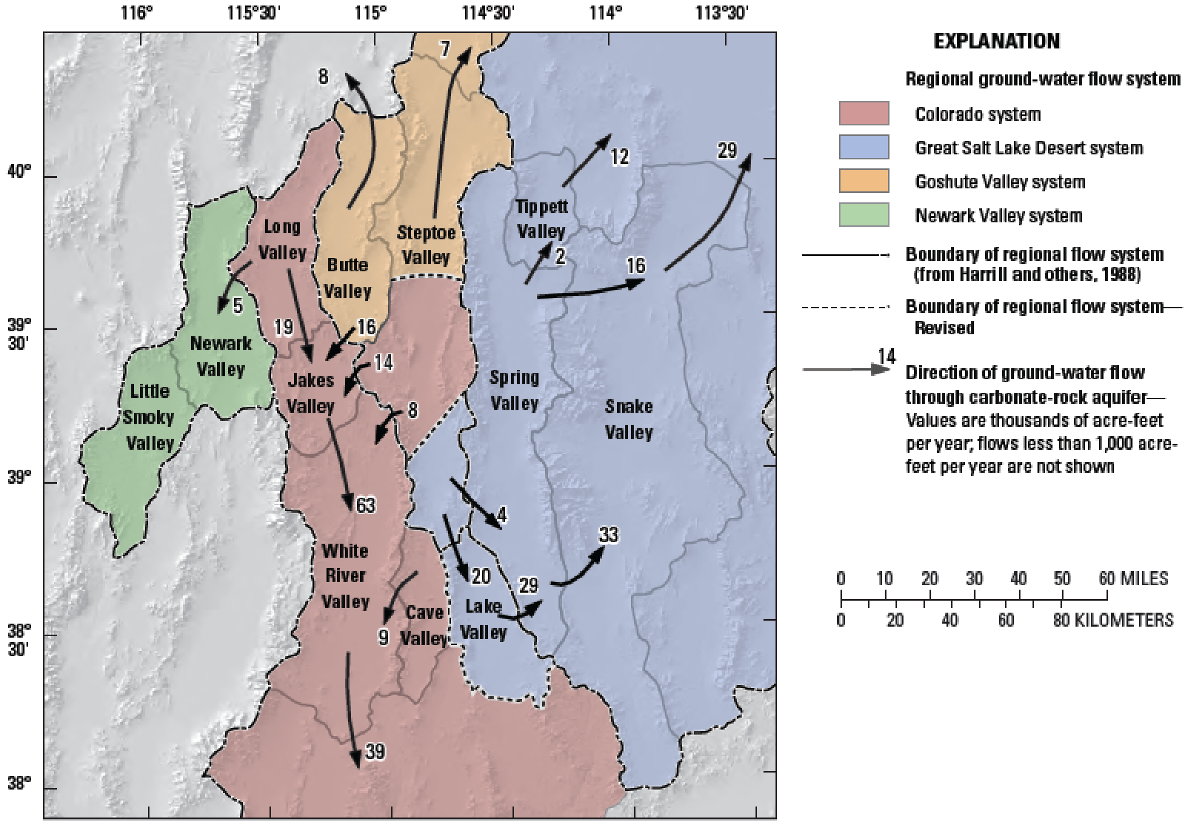


Figure 1: Snapshot of Figure E-1 (Burns and Drici, 2011) showing SNWA's perceived interbasin flow to or from the WRFS.

Interbasin Flow

SNWA considers interbasin flow to or from the flow system by considering first the geology (Rowley et al, 2011) and then by estimating the flow either on the basis of Darcy's law (Burns and Drici, 2011), if they can estimate transmissivity and flow gradient, or on the basis of previous studies. There are three sources of error in the Darcian flow estimates: (1) hydraulic gradient, (2) hydraulic conductivity, and (3) cross-sectional area including estimates of width or thickness. The estimated hydraulic properties are usually mean values for similar rock around the Great Basin rather than being obtained locally. SNWA uses straight lines between two wells to determine the gradient. An often-poor assumption occasionally made is that basin-fill well levels on two sides of a bedrock basin boundary represent the gradient through the bedrock, which is the media usually assumed to pass the flow. This methodology assumes a perfect hydraulic connection between aquifer types, which may not exist in reality. SNWA's cross-sectional area estimates are presented simply as assumptions often without justification.

SNWA does not constrain the flow estimate based on the water budget of either basin, the source or receiving basin, as was done in Basin And Range Carbonate Aquifer System Study (BARCAS) (Welch et al, 2008; Lundmark et al, 2007). BARCAS' approach was to estimate interbasin flow based on the difference in recharge and GWET and to distribute this to downgradient basins, if interbasin flow between the basins was probable or permissible, based on their discharge (Lundmark et al, 2007). In other words, BARCAS set the interbasin flow based on pre-calculated recharge and discharge (Figure 2). BARCAS used Darcy's Law calculations to determine whether the necessary transmissivity at each of the interbasin flow reaches is within a reasonable range (Figure 42 in Welch et al, 2008).



Shaded relief base from 1:250,000-scale National Elevation Data; sun illumination from northwest at 30 degrees above horizon.
1:1,000,000 scale watershed boundaries from USGS digital data.
Universal Transverse Mercator Projection, Zone 11, NAD83

Figure 2: Figure 41 from BARCAS (Welch et al, 2008) showing the calculated interbasin flow rates (kaf/y).

Of interest for this report, BARCAS had found that recharge far exceeded discharge in Steptoe Valley and that discharge from Snake Valley required interbasin flow, in addition to the in-basin recharge, to satisfy it. The excess recharge in Steptoe Valley provided interbasin flow to both the WRFS and Spring Valley, which in turn passed interbasin flow to Snake Valley, where it helps to satisfy some of the discharge. Because SNWA does not consider this interbasin flow, its method requires much more recharge to be generated with their water balance model to just meet the specified discharge within and from the study areas, including the targeted basins.

Many of SNWA's arguments for and against interbasin flow depend on an assessment of the geology of these boundaries, mostly based on geologic arguments made by Rowley et al (2011). A major problem with their analysis is that **they make hydrologic conclusions regarding faults without any hydrologic data**. They conclude based on their interpretation of the geology, with a heavy emphasis on faulting, whether flow is likely, permissible, or impossible.

Rowley et al (2011) rely heavily on the paper "Fault zone architecture and permeability structure" by Caine et al (1996). That paper is an excellent discussion of the conceptual flow model for flow through or along a fault. It relates the fraction of the fault which is core to the likely permeability through the fault, but the authors acknowledge there is a lack of data to assess fault permeability. Rowley et al (2011) omit perhaps the most important paragraph in Caine et al:

> In spite of the dearth of laboratory-determined grain-scale permeability values from samples of damage zone materials, our field observations suggest that damage zone permeability is fracture dominated. The juxtaposition of highly fractured damage zone materials with undeformed protolith and generally unfractured fault core materials forms major permeability contrasts within a fault zone. Preliminary estimates of damage zone fracture permeability, using the fracture-permeability estimation methods …, in both the Dixie Valley fault zone and fault 6, are two to three orders of magnitude greater than the permeability of fractured protolith and four to six orders of magnitude greater than the fault core grain-scale permeabilities. The **magnitude and spatial variability of this permeability** contrast may be the primary control on fault zone barrier-conduit systematics. (Caine et al, 1996, p. 1028, references omitted, emphasis added)

This quotation notes that a fault with a significant core could have low permeability zones, but that the contrasts, or heterogeneity, would be the rule. Groundwater flow takes the path of least resistance. Any estimates of the fault conductance based on cores of the fault core would likely be gross underestimates due to scaling; considered as a hydrogeologic feature, a fault is likely to have fractures rather than be a continuous sheet of low-permeability gouge. The conductivity of the overall fault zone would be much higher due to scaling effects (Schulz-Makuch et al, 1999).

SNWA also discusses how north-south normal fault zones may be very conductive and pass a lot of water between basins or north-south within basins. This ignores the fact that a fault zone is finite and that recharge to it would be through bulk media on either side. The description of conductive faults, as a damage zone surrounded by low-conductivity protolith, suggests that the fault zone will eventually drain; a well could initially be highly productive only to become drained since faults are of a limited extent.

Rowley et al (2011) utilize three criteria for judging whether a basin boundary would transmit flow: (1) whether it is topographically high or low, (2) whether the material is an aquifer or otherwise is highly fractured, and (3) whether the orientation of structures would permit the flow. If the material is otherwise transmissive, the height of the boundary should not matter or is of lesser importance. Deeper formations may have lower conductivity due to compaction, but it is unlikely that this would make an otherwise conductive formation impermeable. Topographically high divides could have higher recharge which could form a groundwater mound which could prevent flow (Welch et al, 2008), but Rowley et al (2011) do not make this argument; such a boundary could be altered due to pumping stresses. Structure could certainly affect the flow, but as discussed in detail above, the heterogeneities in faults would prevent them from preventing flow over large areas; a fault should not be used to argue that no flow occurs unless there is clear hydrologic proof, as argued by Welch et al (2008, p. 33).

Flow from Steptoe Valley

SNWA argues there is no flow from Steptoe Valley to any adjacent valley, based on strident geologic arguments (Rowley et al, 2011, ps. 6-6, 6-7, 6-11, and 6-12). The arguments are based mostly on the presence of faults or high elevations over the pass, and simply do not have any hydrologic data to support them. For example, Figure 3 shows significant Riepe Spring and Ely Limestone in the Egan Range south of Ely and significant faults, but they present no hydrologic evidence that no flow occurs.

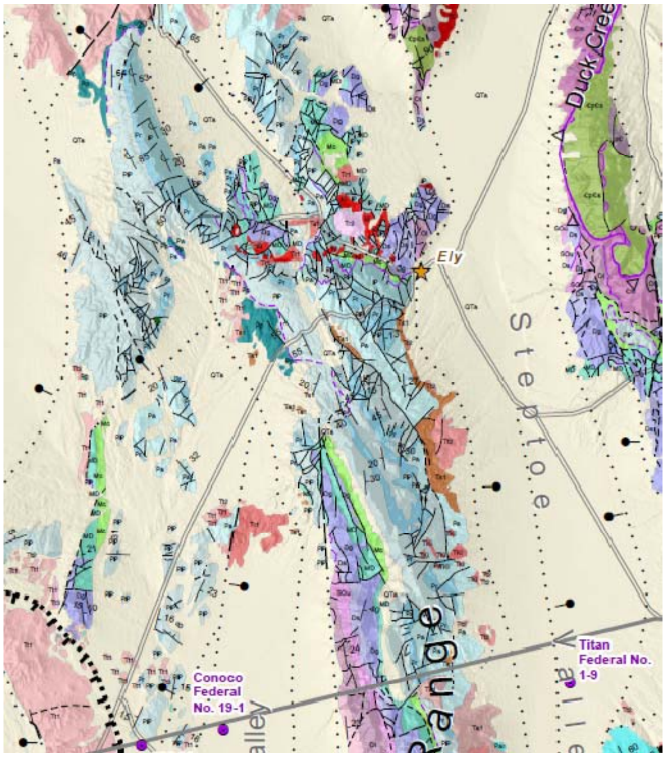


Figure 3: Snapshot from Rowley et al (2011), Plate 1, showing their geology in the Egan Range and other areas near Ely.

SNWA argues that there is no inflow to Spring Valley from Steptoe Valley (Burns and Drici, 2011) in their estimate of recharge in Spring Valley; they address flow from Steptoe Valley only by dismissing the inflow estimate from Steptoe Valley as an "imbalance required that excess recharge be shunted to adjacent basins" (Burns and Drici, 2011, p. 7-8) without actually refuting the water balance analysis for Steptoe Valley in BARCAS. BARCAS predicted that 154,100 af/y recharged and 101,500 discharged through GWET from Steptoe Valley, leaving 52,600 af/y to discharge from the valley as interbasin flow (Laczniak et al, 2008); SNWA dismisses these numbers by not considering them which effectively means that SNWA has not explained where the excess recharge goes.

There is significant hydrologic evidence for flow into the WRFS from Steptoe Valley. The first considers the location of recharge in the Egan Range portion of Steptoe Valley. As shown by Laczniak et al (2008), much of the recharge in Steptoe Valley, including all along the Egan Range south of Ely, is mountain block. In order for this recharge to actually reach the points of GWET discharge, the flow would have to pass through the normal faults bounding the mountains; the evidence supporting this is the lack of large springs which discharge onto the basin fill to provide secondary recharge (Murry Springs is an exception but the flow is a small proportion of the total water balance flux in the basin.)

A second piece of evidence is from the Robinson Mine itself, which has required significant dewatering over the years. One old report (Leggette, Brashears and Graham, 1959) details how the water levels in an early shaft would fill as the shaft encountered highly fractured rock zones. This directly counters the opinion by Rowley et al that "buried plutons and metamorphosed and mineralized rocks" are "likely confining zones" and prevent flow to WRV or Jakes Valley from Steptoe Valley (Rowley et al, 2011, p. 6-12).

The BARCAS estimate for flow from Steptoe in to WRFS is 8000 af/y (Figure 2).

SNWA also discounts flow from southern Steptoe to northern Lake Valley, through carbonate rock, by invoking the fault argument and also by claiming the 300 ft relief would cause sufficient "lithostatic pressure from the weight of rocks" to "close prospective flow paths" (Rowley et al, 2011, p. 6-6). They provide no reference or other proof that 300 feet is sufficient, and I am aware of no such study (deeper formations do compress and cause permeability to be decreased. BARCAS indicates that flow is permissible if "permeable rocks are likely to exist at depth such that ground-water flow likely is permitted by subsurface geology" (Welch et al, 2008, p. 33). Much of the interbasin flow would emanate from recharge that occurs in the Schell Creek Range along Conner Pass into the faulted carbonates; it is reasonable for this flow to be south towards Cave Valley.

Finally, SNWA's groundwater model as used in BLM (2011) demonstrates that flow can occur between Steptoe and Spring Valley. Figure 3.2-5 (BLM, 2011) shows that up to 50 feet of drawdown occur in the north end of Lake and the southeast portion of Steptoe Valley (Figure 4). This can only occur if and only if the geology coded into the model allows this flow. The baseline data reports for the DEIS model (BLM, 2011) were SNWA (2008 a and b). SNWA (2008b) does not specifically address this interbasin flow. The conceptual model report (SNWA, 2009a) includes the flow only as part of an uncertainty analysis in their flow system water balance model. It seems that SNWA's reports reject the potential for flow between Steptoe and surrounding valleys, but the model authors found it difficult to code the faults as substantial enough barriers to truly prevent the flow. BARCAS estimated that 20,000 af/y flows to Lake and 4000 af/y to Spring Valley from Steptoe Valley (Figure 2).

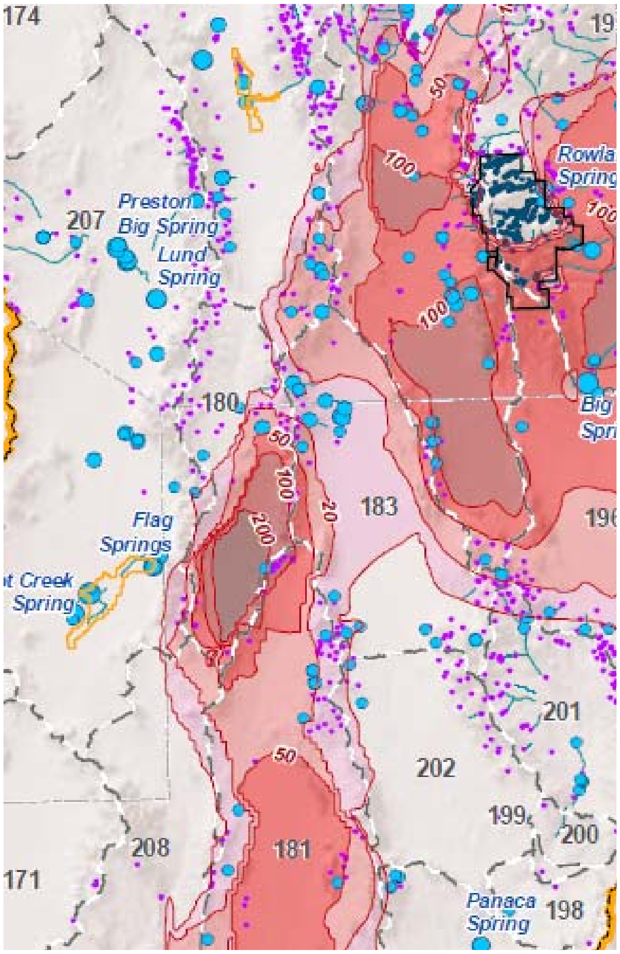


Figure 4: Snapshot from DEIS Figure 3.2-5 (BLM, 2011) showing drawdown in Spring, Lake, Steptoe, and Cave Valleys.

SNWA rejects flow into Spring Valley from Lake Valley by invoking the geology argument, even though the rock is mostly carbonate. With range front faults on both sides of the Schell Creek Range in this area, but no springs along the fault, it is necessary for the groundwater to flow into the adjoining valleys. The BARCAS estimate for flow from Lake into Spring Valleys is 29,000 af/y, which includes Steptoe Valley inflow and local Lake Valley recharge. A simple water balance argument indicates that flow must occur to the south and east from Steptoe Valley. There is little in-basin discharge (GWET) in southern Steptoe Valley, but significant recharge Figure 5). Although nothing may prevent northward flow from this area, most of the recharge is in the far south end, so the pathway for some of the recharge would be southward into Lake Valley. The argument for the flow going from Lake into Spring Valleys relies in part on the presence of discharge downgradient in Spring Valley (27,000 af/y in nearby Spring v 6000 af/y in Lake Valley). In the absence of any countervailing evidence, SNWA's rejection of any interbasin flow from Lake Valley to Spring Valley seems arbitrary and unsound.

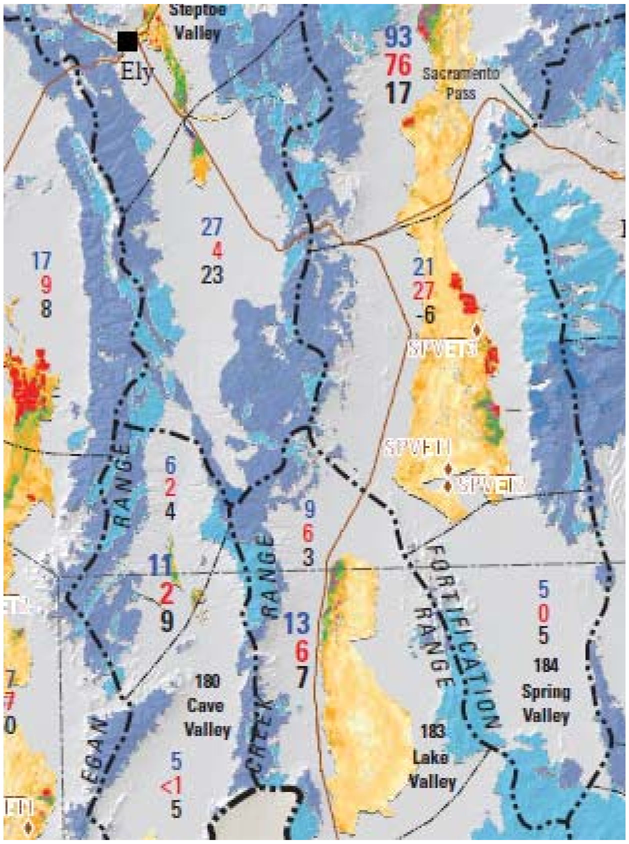


Figure 5: Snapshot from Lazcniak et al (2008) showing the recharge, discharge, and interbasin flow from southern Steptoe Valley, and surrounding valleys.

SNWA estimates that 6700 af/y flows from southern Butte to Jakes Valley (Figure 6), whereas BARCAS estimated 16,000 af/y. Interestingly, their map (Burns and Drici, 2011, Figure E-2) shows flow through this section only as “permissible” and also shows several normal faults that are perpendicular to the proposed flow path; they do not explain why these faults do not prevent the flow when in some many other points throughout the study domain normal faults do prevent flow. However, they may have underestimated the interbasin flow in the WRFS by setting the thickness too low. They used a mean K of 6.16 ft/d and two cross-sections, 30,000 by 500 feet and 15,000 by 1500 feet; the thicker section is on the right (Figure 6). Burns and Drici (2011) do not justify their assumed thickness. Their figure shows thickness of up to 4500 feet, which could be thicker yet if the carbonate rock continues lower than the chosen section. Even if their chosen conductivity is too high (a mean K may not apply to bulk carbonate rock), the additional thickness applied to the section suggests the cross-sectional flow could be much higher - much closer to the BARCAS value. This is another example of how SNWA’s Darcian flow estimate’s failure to account for surrounding basin water budgets leads it to significantly underestimate inflow to the WRFS.

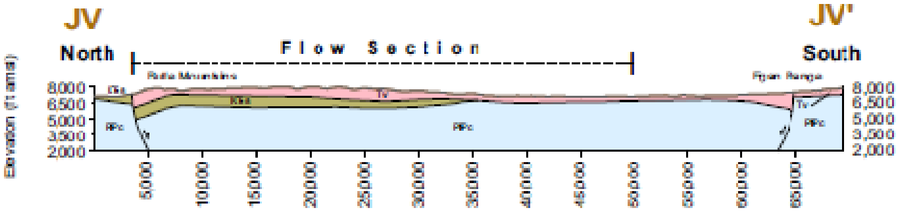


Figure 6: Snapshot from Figure E-2 of SNWA cross-section for flow from southern Butte to Jakes Valley. The section ranges from northwest to southeast from left to right. The light blue section is Permian-Pennsylvanian carbonate rocks, which underlay Cretaceous-Triassic clastic rocks and Tertiary volcanic rocks.

Interbasin outflow estimates from the WRFS are just as fraught with uncertainty. For this analysis, SNWA cut off the south end of the WRFS at the discharge from the Muddy River Springs Area to California Wash and from Coyote Spring Valley to Hidden Valley. The MRSA discharge consists of discharge from the springs, which SNWA estimates to be 33,700 af/y, and groundwater flow to California Wash estimated to be 9900 af/y. The problem with the groundwater flow estimate is that there would be no available flow from the area of the springs because the springs are controlled by faulting (Rowley et al, 2011) (Figure 7) which would cause most to discharge.

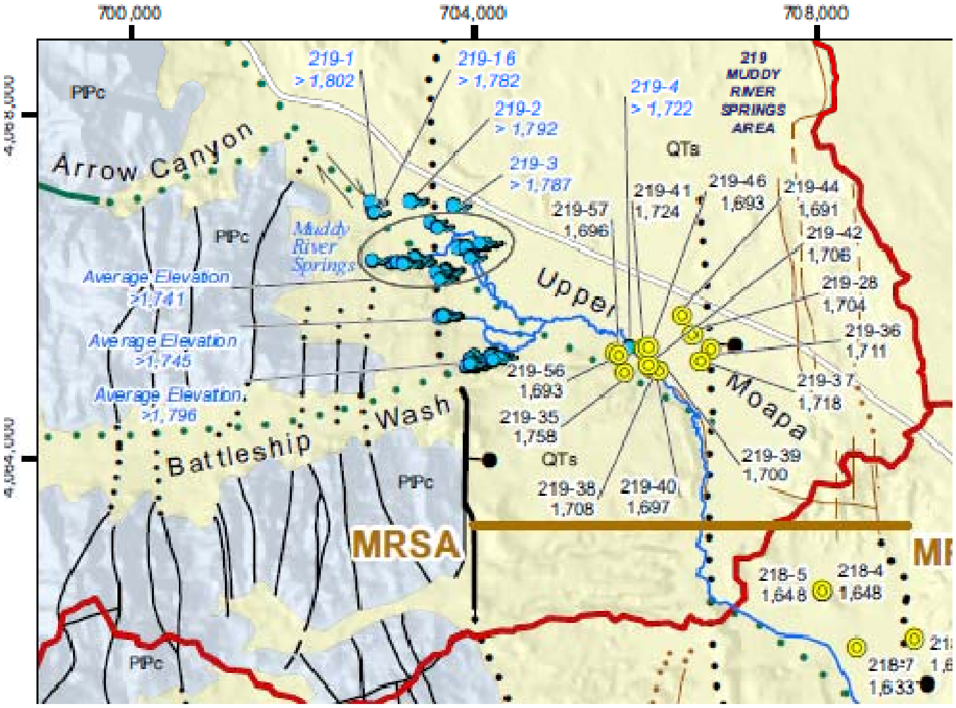


Figure 7: Snapshot from Figure E-4 (Burns and Drici, 2011) showing Muddy River springs and the fault that controls the springs. The map also shows the cross-section used by SNWA for estimating flow from MRSA to California Wash.

SNWA estimates flow across the cross-section in Figure 7 to be 9900 af/y, but as noted based on the faults controlling the springs, there is likely little flow from upstream in the WRFS to this section. SNWA estimates that 8000 af/y enters the MRSA from the Lower Meadow Valley Wash; they base their estimate on other studies. Based on the location to the east side of the MRSA and the faults, it is not likely that much of this water discharges from the springs either. For the purpose of the WRFS, it would be appropriate to assume that discharge to California Wash from the MRSA equals the flow from the Lower Meadow Valley Wash, and not include it in further water balance calculations.

SNWA also estimated that groundwater flows from the Pahranagat Shear Zone into the Death Valley Flow System, specifically into Tikaboo Valley South. They estimated a flow equal to 5100 af/y, or an average of estimates from three studies. They chose not to make an original estimate due to a "lack of hydraulic head data" (Burns and Drici, 2011, p. #-9). They did not consider the Death Valley Flow System conceptual model which estimated that 9.5 mil m^3/y flows into the WRFS from the DVFS and 1.5 mil m^3/y leaves the WRFS (San Juan et al, 2004, Figure C-8), or 7700 af/y entering and 1200 af/y leaving. The net would be 6500 af/y entering the WRFS from the DVFS. The DVFS estimate is based on Darcy's Law calculations. SNWA also has ignored their previous analysis for the CDD valleys in which they did not consider flow to or from the DVFS (SNWA, 2007).

The gradient from Coyote Springs to Hidden Valley is essentially flat), with a six foot drop from well 210-32 to 217-1, over about eight miles (Figure 8). SNWA estimated flow between these valleys using Darcy's law with a geometric mean transmissivity of approximately 213,000 ft^2/d and a 30,000-foot width and a gradient determined between wells CSVM-2 (210-32) and GV-1 (216-18)(Figure 8). The extremely low gradient and high transmissivity are both potential errors in this calculation. Over this long distance, it is a large assumption that the flow paths are connected so that the gradient accurately depicts the real situation. Intermediate water levels could be significantly higher so that a smaller gradient or even a divide is reality; a few feet could make the difference. SNWA uses an average transmissivity from the tabulated pump tests (Table E-1, Burns and Drici, 2011). SNWA claims these are representative because they only used long-term tests. Several of the wells on that table are known high producers. SNWA likely represents wells in significant fracture zones which would have a high conductivity. It should be noted that the section (Figure 8) spans a carbonate outcrop several miles into Coyote Spring Valley, again near the high producing wells. There is no evidence this section is representative for flow between the valleys.

Although it is impossible to rule out any flow, based on the extremely low gradient and fracture-based transmissivity of fracture systems, the flow would be much closer to zero. The deuterium measurements provided do not indicate a flow but merely indicate the groundwater in the carbonate rock in Coyote Spring and Garnet Valley could have a similar source.

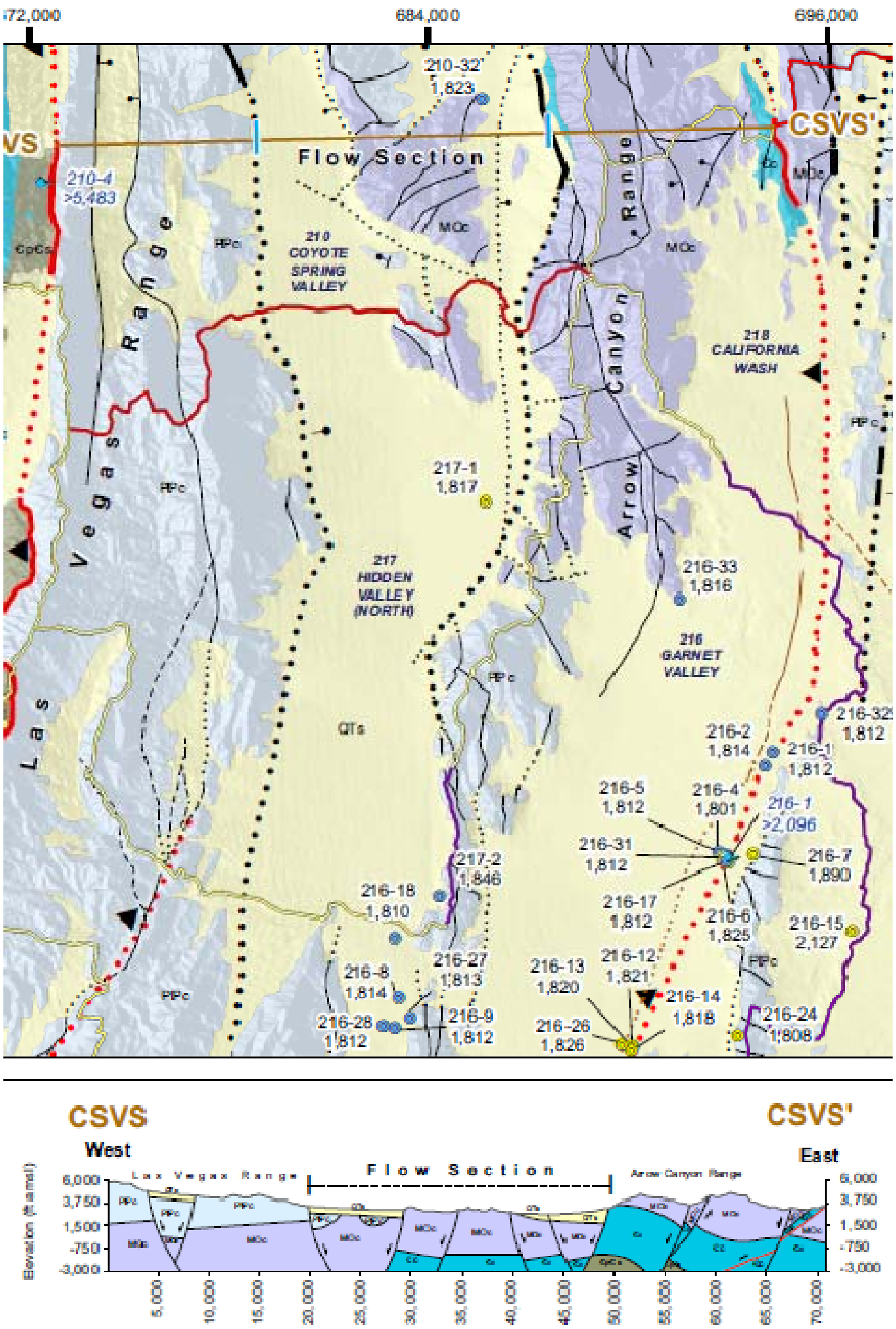


Figure 8: Snapshot from Figure E-3 (Burns and Drici, 2011) showing the perceived flow path from Coyote Spring to Hidden Valley.

In sum, SNWA's estimates for interbasin flow are fraught with error. The most significant error could be that they ignore inflow from Steptoe Valley to both WRFS and Spring Valley (mostly by way of Lake Valley). Additionally, SNWA inappropriately uses an assigned discharge from Coyote Spring to Hidden and Pahranagat Valley to the DVFS. These errors lead to increased simulated recharge within both

WRFS and Spring Valley, and an increased estimate of water available to SNWA. All are wrong. The actual effects will be considered below.

Precipitation

SNWA uses PRISM 1970-2000 version 3 annual precipitation data for the target valleys and surrounding flow systems. For the purpose of target basin water balance and groundwater availability, PRISM precipitation is used to distribute flow system recharge among the flow system basins. This is relevant only for the WRFS because SNWA treated Spring Valley as close, with no inflow, so that all discharge must equal recharge within Spring Valley.

The distribution of annual precipitation determined with PRISM and the precipitation stations used by SNWA to compare with PRISM estimates is shown on Figure 9. The major problem with this distribution is the band of high precipitation that is evident, mostly in lower elevations, from southern Cave Valley through Lake and Patterson Valley to southern Hamlin Valley. This band of higher precipitation in the valleys ranges from 12 to 15 in/y. Southern Cave Valley is in this band even though it is 1000 feet or more lower than the valley in the northern part. The low divide between Patterson and Lake Valley is less than 6000 feet, but precipitation is in the 12 to 15 in/y range (Figure 9). PRISM has a broad extent of Spring Valley, near or slightly lower than 6000 feet, with precipitation ranging from 8 to 10 in/y.

Halford and Plume (2011) found and adjusted the precipitation from PRISM in southern Hamlin Valley. SNWA (2008), in their conceptual model for the DEIS (BLM, 2011), assigned Maxey-Eakin recharge efficiencies from the Meadow Valley Wash system to southern Hamlin Valley. Myers (2011b and c), when developing his groundwater model for Spring Valley, had the same problem.

Even SNWA found that PRISM substantially overestimated precipitation for several years at rain gages they were using at their GWET measuring sites (Burns and Drici, 2011, p. 5-6, 7). For the GWET calculation, they adjusted PRISM grids by adding the average difference. This however verifies the concerns expressed above about PRISM overestimating precipitation in eastern Great Basin valleys, including at low elevations. An error of half an inch at low elevations also has a huge effect on the precipitation estimate, by basin, because of the large areas of the valley which are at low elevations and in low precipitation zones.

There are few, if any stations within Cave, Dry Lake or Delamar Valleys, and just a few around the rim of Spring Valley (Figure 9).

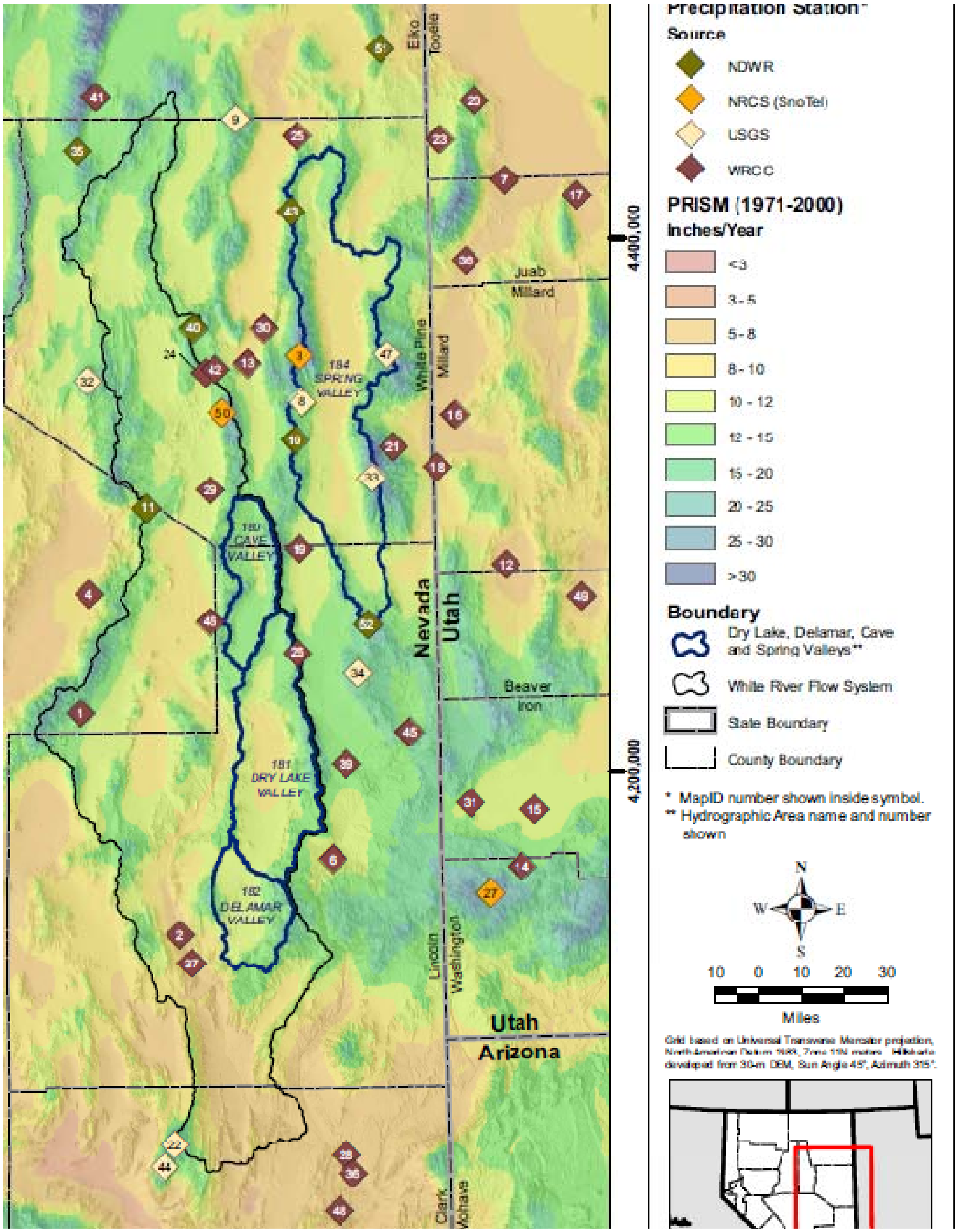


Figure 9: Snapshot of portion of Burns and Drici (2011) Figure B-2, Locations and Data Sources for Precipitation Stations Located in Area of Interest.

The apparent overestimation of precipitation using PRISM is verified by considering the figures SNWA uses to claim excellent agreement (Burns and Drici, 2011, Figure B-5). This figure shows that overwhelmingly, the PRISM estimates are higher than station means. At greater than about 18 in/y, PRISM estimates for four stations plot above the 1:1 line, just one station plots below the line, and two stations plot near to the line. Eyeballing all of Figure B-5 indicates that PRISM overestimates mean precipitation by at least one in/y over the entire range of precipitation.

Other comparisons made by SNWA are relatively meaningless. First, the long-term comparison of annual average precipitation by zone (Burns and Drici, 2011, Figures B-8 and B-9) apparently shows a difference less than 10%. Considering the averaging that occurred over all of the 800 m PRISM cells within each climate zone, if the PRISM estimates were accurate they should have converged to much closer than a 10% error, due to the Central Limit Theorem in statistics, rather than replicating the error shown in Figure B-5.

Second, the stations used for SNWA's evaluations are all at high elevation. (Burns and Drici, 2011, Figures B-6 and B-7). Even if these are very accurate (they are not), the comparison is biased to high precipitation estimates. Further, in the Cave, Dry Lake, and Delamar Valleys, SNWA's comparison is with other stations within the WRFS because there are none in the target basins, which further undermines the reliability of SNWA's estimates.

Distributing the precipitation among basins incorrectly results in estimating that more recharge is occurring in the basins with overestimated precipitation. Because the high precipitation occurs all along the east side of Dry Lake and Delamar, and across much of southern Cave Valley, the distribution biases the analysis to predict more recharge in these valleys – the valleys targeted by SNWA for development.

Groundwater Evapotranspiration

GWET is a primary groundwater discharge mechanism from Nevada groundwater basins. In this analysis, the estimates drive the ultimate determination of recharge. It is also the only flux in a basin water balance calculation that can ostensibly be measured. Many studies attempt to measure ET either through lysimeters or with energy flux calculations. GWET is the amount of ET not satisfied by precipitation. GWET over a basin depends on the extent of phreatophytes or areas of wet soil/playa evaporation connected to groundwater. These areas may fluctuate due to wet or dry conditions in the basin. The amount of ET satisfied by groundwater may also fluctuate due to changes in precipitation. Therefore, the "measurement" of GWET from a basin depends on accurate estimates of the following:

- ET for each phreatophyte type (including wet soil)
- Areal extent of each phreatophyte type
- Precipitation distribution over the GWET zones
- Runoff reaching the GWET zones
- Spring flow

These estimates vary for various reasons. ET varies with climate, so less occurs during a cooler summer season than a warm season, all else being equal. Phreatophyte areas evolve both in areal extent and plant density. Precipitation may be more variable during certain years. More runoff occurs during wet periods so that less ET actually depends on groundwater.

GWET estimates may vary for all of the reasons just described. The problem is that a recharge estimate for a steady state water balance analysis is an annual average but most studies completed to determine ET rates or GWET are for a given year – wet or dry and warm or cool.

SNWA found that PRISM substantially overestimated for rain gages at their GWET zones (Burns and Drici, 2011, p. 5-6, 7). For the calculation, they adjusted PRISM grids by adding the average difference, which effectively decreases precipitation in the GWET estimate (and increases the proportion of ET assigned to groundwater).

ET for Spring Valley varied significantly, from 153,500 to 186,600 af/y, over the five year period, for a range that equaled 19% of the mean 174,500 af/y (Burns and Drici, 2011, Table 5-2). This significant variation is due either to the normalized difference vegetation index (Burns and Drici, 2011) or climate. If the former, it represents how the phreatophyte zones may change with time, so that an average is elusive. If the differing ET is due to differing temperatures and wind, the table also shows a high variation. Either way, the range is too high to consider any year representative.

SNWA then determined GWET for five years by subtracting the yearly PRISM precipitation estimates for the basin (those that had been adjusted because they were too high). Of the five years, GWET averaged 91,500 af/y but four of the five years had higher values and the estimate for 2010 was much lower which lowered the estimate (Burns and Drici, 2011, Table 5-3). 2010 was a wet year which caused the lower GWET estimate (the ET estimate for 2010 was just a little higher than average). SNWA argues the 2010 estimate is "anomalously low" because of the assumption that 100 percent of the precipitation is effective for satisfying ET. They state, without reference, that the assumption is likely invalid and that during wet years effective precipitation is likely less than 100% (Burns and Drici, 2011, p. 5-9). They claim the excess precipitation is either stored in the ground or seeps past the root zone to the water table (*Id.*). Water stored in the ground would simply be used the following year which suggests that their method of estimating GWET would overestimate GWET the year following a wet period because the method would ignore holdover soil moisture. Water that seeps past the root zone could reach the water table, but it could also be drawn back into the root zone due to changing moisture above in the root zone, in a process known as exfiltration.

Finally, SNWA misses the most important loss of precipitation during a wet year – runoff. Their whole analysis ignores runoff which likely causes the method to overestimate GWET during most years. Due to the heterogeneity of the soil surface, runoff (during any year) would find portions of the soil more receptive to seepage and become effective. In areas that receive runoff, the "effective" precipitation could actually exceed 100 percent.

SNWA's discussion of GWET from Spring Valley does not include springs. Ostensibly, spring discharge supports wetlands and riparian areas whose discharge was estimated as part of the analysis. However, Spring Valley has many springs which support wetlands on the valley bottom and support the wet playas and open water surfaces. Because springs discharge from a point or a line (at the base of a fan, for example), the water supports wetlands as runon to the wetland. Therefore, the water balance method used by SNWA (equation 5-1 in Burns and Drici (2011)) could be completely wrong for parts of Spring Valley. Considering just the springs with discharge rates listed in the Springs appendix to Burns and Drici (2011), the average and maximum spring flow is 6.2 and 12.0 cfs, or 4490 to 8680 af/y.

SNWA's Cave Valley GWET estimate is reasonable, but it should be noted that much of the 1290 af/y could be supplied by Cave Springs, which has high and low flow periods (Myers, 2011a). During high flow periods, secondary recharge could replenish a significant amount of the groundwater that supports the small amount of GWET. It is also noted that all of the Cave Valley discharge occurs in the northern portion of Cave Valley (Burns and Drici, 2011, p. 5-14).

Intrabasin Flow in Cave Valley

SNWA makes a significant argument around groundwater flow from north to south in Cave Valley and downplays the amount that flows into White River Valley through Shingle Pass. Although SNWA's geology report declares that flow through the pass is "permissible", they estimate just 3800 af/y passes that way and that most recharge in northern Cave Valley flows south to southern Cave Valley (Burns and Drici, 2011). There is a block of carbonate rock that extends northeastward from just south of Shingle Pass, and Myers (2007 and 2011a) argued that it could block and divert most flow toward the pass. BARCAS estimated up to 9000 af/y flowed through the west boundary of Cave Valley to the WRFS (Welch et al, 2008). SNWA argues that a flow path along the west side of the Schell Creek Range passes most of the groundwater to the southern portion of the valley (Burns and Drici, 2011, p. 8-6; Rowley et al, 2011, p. 6-7 – 6-9).

The geology as presented by Rowley et al (2011) does not support the argument and even provides substantive evidence opposing SNWA's view. Figure 10 shows Rowley et al's hydrogeology map for Cave Valley; the carbonate block extending northeast across the valley from the Egan Range is obvious on the map. Cross-section R-R' (Figure 11) shows a section which would support flow along the east side of Cave Valley, but unless the carbonate block is fractured, it would not. Section U-U' (Figure 12) shows a thin fill section underlain by volcanic, carbonate, and clastic rocks. A section through the tip of the carbonate block showing their perception of the section between the block and the Schell Creek Range would have been useful.

The carbonate block extends about two-thirds of the distance across Cave Valley, so groundwater generated on the western two-thirds or that flows from the Schell Creek Range into the western two-thirds would be blocked by the carbonate block and diverted toward Shingle Pass. The block itself contains Mississippian chainman shale (SNWA, 2008b), generally a very impervious layer separating carbonate aquifers. SNWA (2008b) generally describes the block as separating the valley into two subbasins – hardly a description they would make if most of the water in northern Cave Valley would flow south.

Even groundwater from the Schell Creek Range apparently crosses the perceived groundwater flow path to the south, as exemplified by Cave Springs. This spring discharges from carbonate rock about three miles north of the carbonate block (Myers, 2011a, Figure 9). This suggests the carbonate outcrops shown on Figure 10 and on Myers (2011a) Figure 2 allow groundwater to cross Rowley et al.'s fracture zone flowpath and be diverted southwest toward Shingle Pass (Myers, 2011a; Welch et al, 2008).

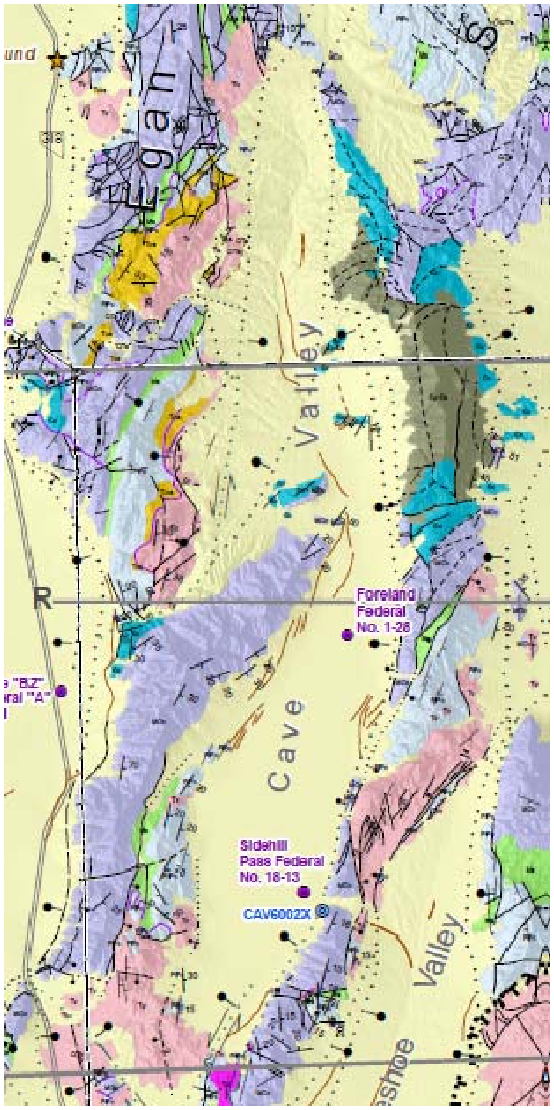


Figure 10: Snapshot of the Cave Valley portion of Plate 6, Rowley et al (2011). Section R-R' crosses the middle of Cave Valley and the section above it, with labels outside of the snapshot, is U-U'

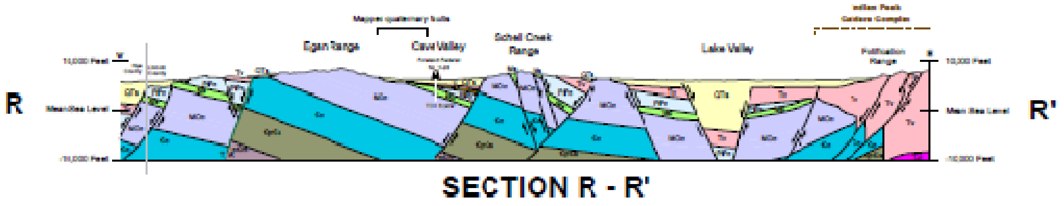


Figure 11: Snapshot of section R-R' from Plate 8, Rowley et al (2011).

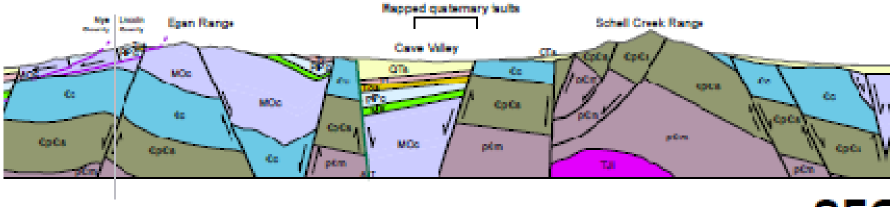


Figure 12: Snapshot of portion of section U-U' from Plate 8, Rowley et al (2011).

White River Flow System Internal Flows

SNWA include in their analysis the entire WRFS, including Long and Jakes Valley (Figure 1). This means that the same precipitation/recharge relationship that applies as far south as the Muddy River Springs Area also applies at the far north end. Average precipitation in those northern valleys appears similar to that in Spring Valley and Steptoe, but significantly less on average than that in Cave Valley (Figure 9). This is particularly true in the White Pine Range, which bounds the west side of Jakes Valley and northwest portion of WRV. BARCAS calculated that 63,000 af/y entered the WRV from Jakes Valley; the flow from Jakes Valley included inflow from Long, Steptoe, and Butte Valley (Figure 2). The interbasin flow was so high because there was little GWET in either Long or Jakes Valley (Lazcniak et al, 2008); most recharge in those valleys was excess and has to go somewhere as interbasin flow.

SNWA did not account for flow from this area adequately because they grouped all of the WRFS basins into one cells, as described elsewhere.

Isotope Analysis

SNWA uses isotopes to argue for various flowpaths in support of their arguments that flow from some spring areas does or does not emanate from specific recharge zone. Their primary report is Thomas and Mihevc (2011). It must be noted that SNWA does not use this report or isotope analysis in general to support their water balance analysis.

Isotope values from WRV warm springs are light, more negative, compared to many other springs and wells in the area (Thomas and Mihevc, 2011). Specifically, the δD mean and median values for Preston Big, NWRV, Hot Creek, and SWVR springs are -122.0 and -121.8, -123.1 and -123.6, -119.1 and -119.1, and -119.2 and -119.4 permil, respectively (Figure 13). These values do not reflect the local recharge in WRV or Cave Valley, as the values on the surrounding mountains, the Egan and Grant Range, demonstrate (Figure 13). Rather, they reflect the recharge isotopic values in Steptoe, Long, or Butte Valley (Figure 14) and support the concept of substantial interbasin flow from those valleys into the WRV, contrary to the water budget (Burns and Drici, 2011) and geology arguments (Rowley et al, 2011) made by SNWA.

Additionally, the isotope data demonstrates that flow from Cave Valley is an important source of flow in WRV. The isotopic values of the cold springs in White River Valley reflect local recharge in the Egan Range, all along the west boundary of Cave Valley and the southwest boundary of Steptoe Valley (Figure 13). This supports the concept of interbasin flow from Cave Valley and southern Steptoe Valley to WRV, as stated by Thomas and Mihevc (2011). "These values (isotope values in springs in southeastern WRV) are similar to the average isotopic composition of recharge to the southern Egan Range in southern White River Valley and western Cave Valley" (Thomas and Mihevc, 2011, p. 24).

> Thus, the southern Egan Range is the most likely source of water supplying these springs… This includes recharge from the Egan Range to northwestern Cave Valley which could flow into southeastern White River Valley along the Shingle Pass fault system. Thus, outflow from northwestern Cave Valley could supply some of the flow observed at Emigrant, Butterfield and Flag # 3 springs in southeastern White River Valley. (Thomas and Mihevc, 2011, p. 24, emphasis added)

Additionally, they note that "[g]roundwater flow from northwestern Cave Valley to southeastern White River Valley is discharged by cool springs along the range-bounding fault of the Egan Range and is lost by evapotranspiration in the valley…" (Thomas and Mihevc, 2011, p. 25). This statement acknowledges that GWET estimated for WRV is partly satisfied by spring discharge.

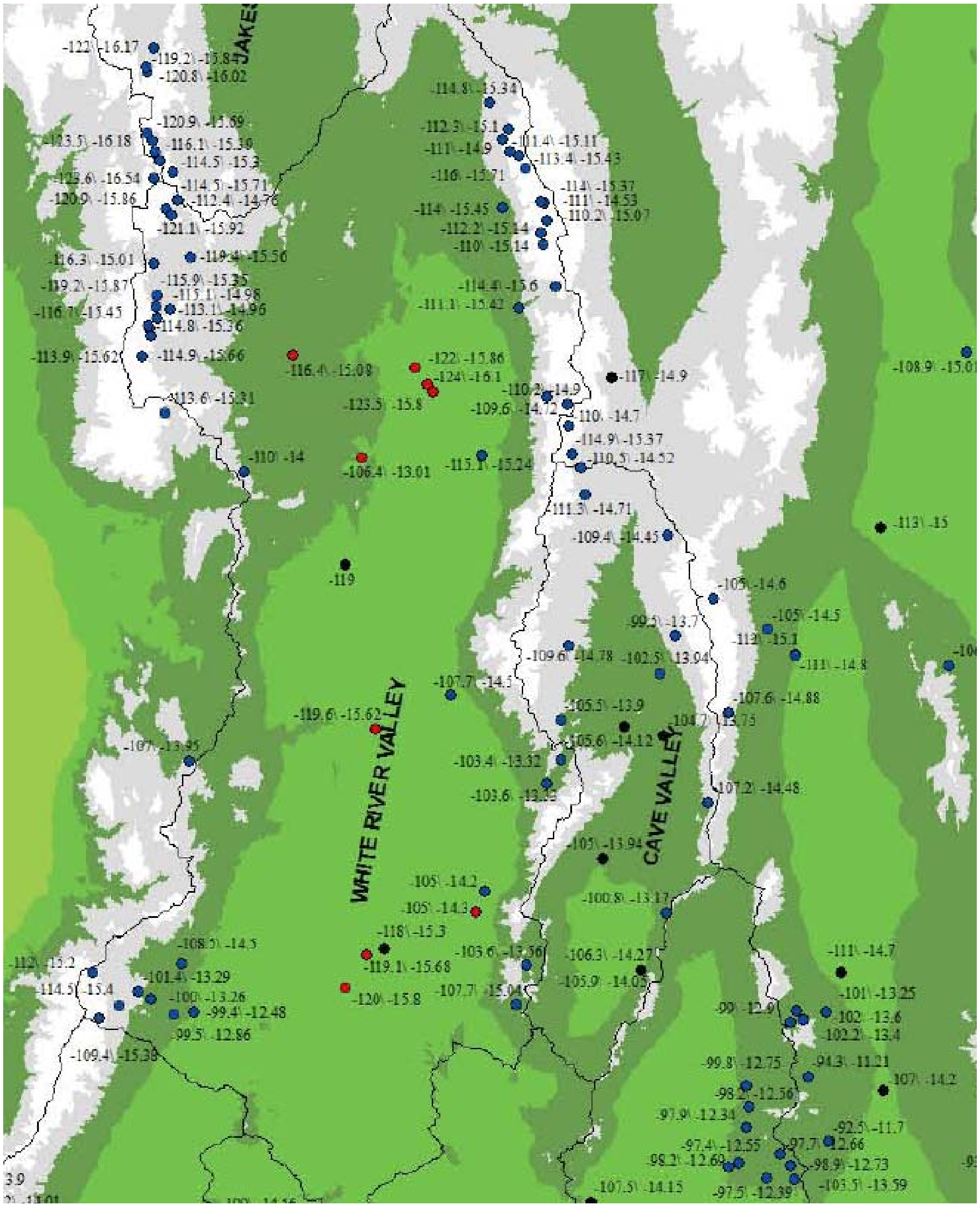


Figure 13: Snapshot of White River and Cave Valley and surrounding area isotope values from Thomas and Mihevc (2011), Plate 2. Blue, red, and black circles are cold and warm springs, and representative wells, respectively.

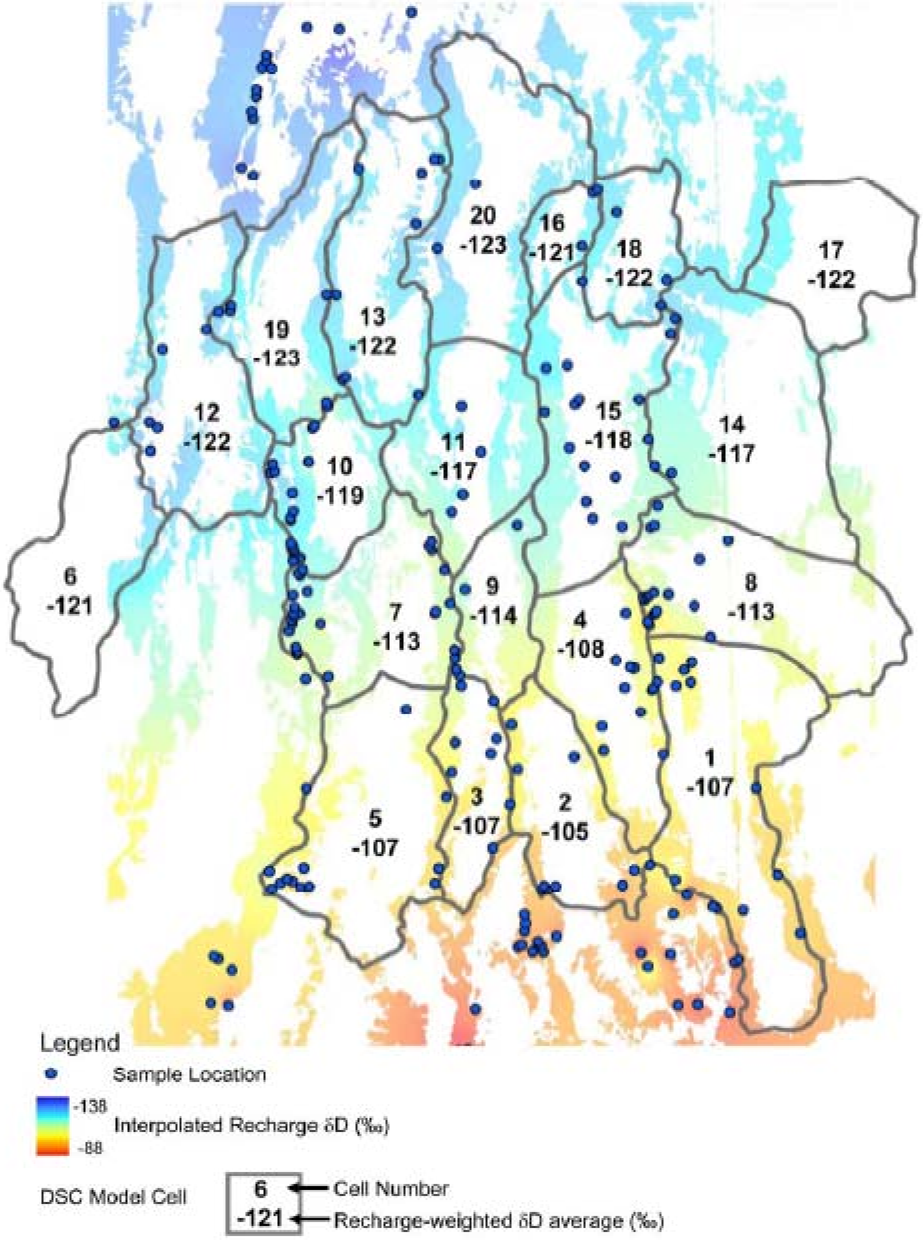


Figure 14: Snapshot of map in Figure 4 of Lundmark et al (2007) showing the variation of δD over the study area. The basins are broken in to subbasins as described in Welch et al (2008). The southernmost are the south portion of White River, Cave, and Lake Valleys.

The isotope data in Dry Lake Valley (Figure 15) support the idea that the valley actually has very little recharge. The authors suggest that the well in the northwest portion of the valley with δD equal to -107.5 permil has water from Pahroc or Cave Valley to the west (Thomas and Mihevc, 2011, p. 22). This could be correct, and if so, it suggests there is little mixing of this interbasin flow with local recharge; all springs representing local recharge have δD greater than -100 permil. The authors acknowledge that the two wells in the central portion of the valley having δD equal to -104.9 and -101 permil do not reflect local recharge (*Id.*). Of the two wells in the far south of the valley, only the one with δD equal to -

95 permil could reflect local recharge, although its value is actually less negative than most of the recharge observations. The only springs with less negative values are in the far south of the valley which suggests the water in that well reflects recharge in that portion of the valley.

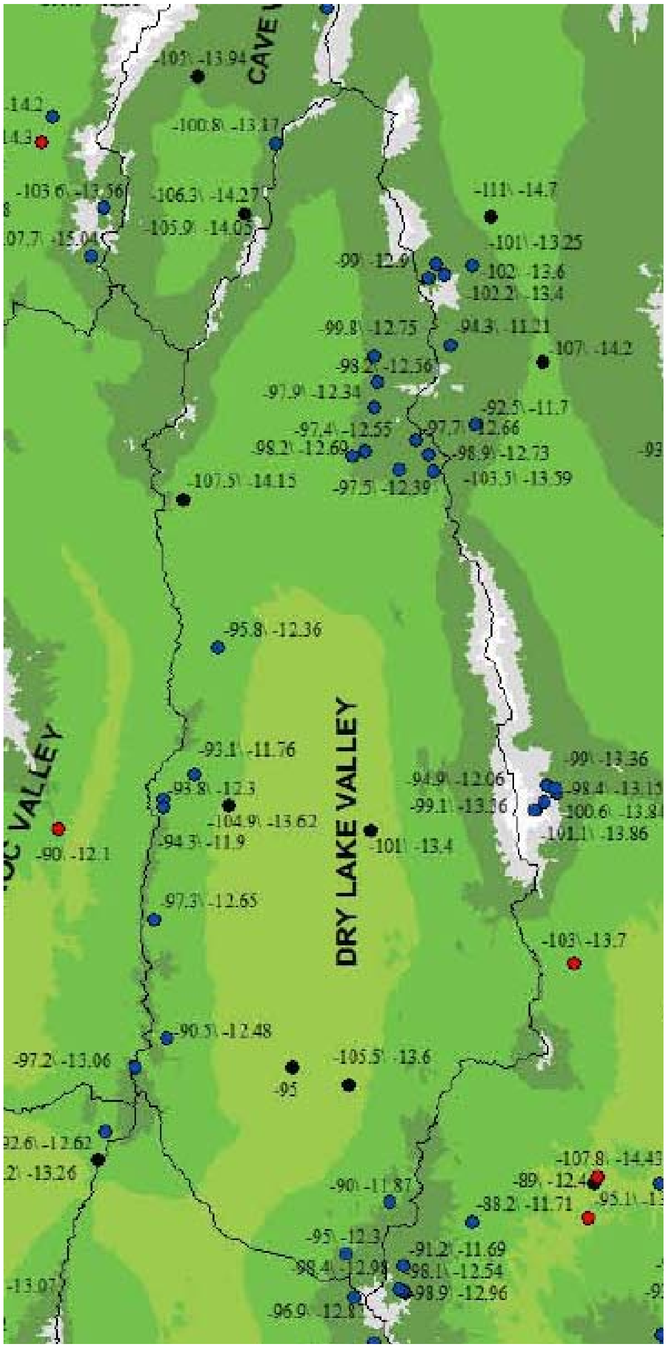


Figure 15: Snapshot of Dry Lake Valley and surrounding area isotope values from Thomas and Mihevc (2011), Plate 2. Blue, red, and black circles are cold and warm springs, and representative wells, respectively.

Five of the six wells that represent native groundwater in Dry Lake Valley apparently reflect groundwater from further up the flow system – interbasin flow. Little of the groundwater in Dry Lake Valley actually results from recharge within the valley. This supports the rebuttal arguments elsewhere and the direct evidence in Myers (2011a) suggesting that recharge in Dry Lake Valley is much less than determined by Burns and Drici (2011). If the groundwater within the Valley does not reflect recharge within the valley, the only conclusion is that the groundwater is from interbasin flow.

The data for Delamar Valley reflects the more negative deuterium values rather than any mixture of interbasin flow with recharge. SNWA acknowledges that the mixture reflects more interbasin flow than local recharge, which again indicates the recharge estimate for Delamar Valley may be significantly too high (Thomas and Mihevc, 2011, p. 23). Claiming their data is wrong because the development water has not been completely removed from the aquifer is just an excuse for the fact that the data does not support their recharge arguments. Or, it demonstrates sloppiness on behalf of SNWA and their well drillers.

SNWA's suggestion that inaccurate data is the result of failure to remove well-development water, if supportable, is additional evidence that there is very little water available in the aquifers in Dry Lake and Delamar Valleys, at least where SNWA drilled these wells. At least in three places regarding Dry Lake and Delamar Valleys, the authors argue that water from the wells may not reflect the native water because of all the water brought in from elsewhere to develop the wells (Thomas and Mihevc, 2011, ps. 22 and 23). If sampling the well involved purging up to three well volumes from the well and only the most recent sample was reported, and still SNWA cannot get a representative sample from these wells, the wells must have been constructed in a poor aquifer with a low groundwater flux, implying little recharge or interbasin inflow.

Further south in the WRFS, the isotope report notes that Cave Valley water supports springs in Pahranagat Valley and even further south. "Thus, the isotopic data indicate that some of the groundwater flowing out of southwestern Cave Valley likely contributes to Pahranagat Valley warm spring discharge. Some groundwater originating in Cave Valley likely flows south past the Pahranagat Valley warms springs as part of the mixture of regional groundwater flow in the WRFS" (Thomas and Mihevc, 2011, p. 25).

It should be noted that nothing on Plate 2 (Thomas and Mihevc, 2011) precludes interbasin flow from Steptoe or Lake Valley to Spring Valley. The plate shows a few data – certainly it was not intended to present all of the data in those valleys – that demonstrate that groundwater in Lake and Spring have very similar δD values and that they closely resemble the recharge within the basin (and on the south Schell Creek and Egan Range).

The groundwater discharging from the warm springs in the WRFS reflects current climatic conditions because the isotopic values reflect current isotope readings in upgradient basins (Thomas and Mihevc, 2011, p. 26 and discussions above in this rebuttal regarding isotopes). "This is supported by the fact that if warm springs in the WRFS were discharging a significant amount of groundwater recharged under a cooler and wetter climate than the current climate, the isotopic values of the regional spring discharge would be significantly more negative than is currently measured" (*Id.*).

Tritium data presented by SNWA supports the idea that cold WRFS springs are discharging water that recharged less than 60 years ago while the warm springs are discharging water that recharged prior to that time (Thomas and Mihevc, 2011, ps. 26 and 27). Springs receiving local recharge would have young water. The fact that the springs near Shingle Pass in WRV are cool with young recharge supports Myers (2011a) estimation that pumping in Cave Valley could affect these springs within a couple of decades.

Comparison of Interbasin Flow from the Evidence Report Conceptual Model and the Groundwater Model

Myers (2011e) reviews the SNWA groundwater model. This rebuttal report considers only the brief results presented by SNWA as evidence (Watrus and Drici, 2011). Table 2 presents the interbasin flows for the SNWA model, as determined from files created for the DEIS model runs. This table shows that SNWA's groundwater model simulates flows through basin boundaries that Burns and Drici (2011) and Rowley et al (2011) argued were impervious. The interbasin flow that occurs in the SNWA numerical model (SNWA, 2009b) demonstrates that the numerical model does not implement the conceptual model presented by Burns and Drici (2011).

The first obvious difference is that, in the numerical model, Steptoe Valley is the source of significant interbasin flow to at least six valleys, with at least 28,700 af/y discharging to Lake, Spring or White River Valley. Second, Spring Valley discharges 7600 af/y to Hamlin Valley and 11,800 af/y to Snake Valley; this second value is to northern Snake Valley through a pathway Rowley et al (2011) and Burns and Drici (2011) claimed would not pass flow. Delamar Valley discharges primarily to Pahranagat Valley, contrary to the conceptual model. Pahranagat Valley does not discharge to the DVFS because the model is not coded to allow this flow. Coyote Spring Valley discharges 2400 af/y to Hidden Valley, a value less than one third of that used in the conceptual model; apparently the model coding used a much smaller transmissivity than the conceptual model. These results all demonstrate that SNWA changed their conceptual model for the water rights hearings in ways that would cause much more recharge in the targeted basins.

Table 2: Interbasin flow for the steady state groundwater model as calibrated for the DEIS (BLM, 2011). Model files IBF?UCTH814_1944SS.PC 2009 ED. Basins are highlighted to draw attention.

Basin #	Sourc Basin	Flow	Basin #	Basin	Flow System Source Basin
178	Butte V	3300	174	Jakes	Goshute
		5600	175	Long	
		12800	179	Steptoe	
179	Steptoe	500	185	Tippett	
		2600	180	Cave	
		3600	174	Jakes	
		4400	183	Lake	
		8800	184	Spring	

		15500	207	White River	
212	Las Vegas	700	210	Coyote Spring	Las Vegas
		1000	216	Garnet	
204	Clover	2000	203	Panaca	Meadow Valley Wash
		5400	205	Lower Meadow Valley Wash	
198	Dry Valley	1900	203	Panaca	
200	Eagle V	0	198	Dry V	
		4600	199	Rose	
183	Lake	1900	180	Cave	
		3000	181	Dry Lake	
		3700	184	Spring V	
		4500	202	Patterson	
205	Lower Meadow Valley Wash	13600	220	Lower Moapa	
203	Panaca	800	205	Lower Meadow Valley Wash	
202	Patterson	200	200	Eagle	
		800	198	Dry	
		1600	181	Dry Lake	
		9500	203	Panaca	
199	Rose	4300	198	Dry	
201	Spring V	700	202	Patterson	
		800	183	Lake	
		1500	196	Hamlin	
		3700	200	Eagle	
258	Fish Springs Flat	2300	195	Snake	Great Salt Lake
196	Hamlin	0	198	Dry	
		100	200	Eagle	
		29400	195	Snake	
184	Spring V	7600	196	Hamlin	
		11800	195	Snake	
185	Tippett	0	194	Pleasant	
		2000	184	Spring V	
218	California Wash	700	215	Black Mountains Area	White River
		1600	205	Lower Meadow Valley Wash	
		4100	220	Lower Moapa	
180	Cave V	1300	181	Dry Lake	
		1600	208	Pahroc	
		17100	207	White River	
171	Coal	10800	208	Pahroc	
		29200	209	Pahranagat	
210	Coyote Spring	2400	217	Hidden V North	
		49,200	219	Muddy River Spgs Area	
182	Delamar	0	205	Lower Meadow Valley Wash	

		27300	209	Pahranagat	
181	Dry Lake	100	203	Panaca	
		300	205	Lower Meadow Valley Wash	
		900	208	Pahroc	
		21800	182	Delamar	
172	Garden	25,300	171	Coal	
216	Garnet	3400	218	California Wash	
217	Hidden V North	3000	216	Garnet	
174	Jakes	19600	207	White River	
206	Kane Springs	200	182	Delamar	
		1800	210	Coyote Spring	
		2000	205	Lower Meadow Valley Wash	
175	Long	2000	174	Jakes	
220	Lower Moapa V	9300	215	Black Mountains Area	
219	Muddy River Spgs Area	2500	205	Lower Meadow Valley Wash	
		8600	218	California Wash	
209	Pahranagat	41700	210	Coyote Spring	
208	Pahroc	25700	209	Pahranagat	
207	White River Valley	3200	172	Garden	
		7300	208	Pahroc	
		9800	171	Coal	

Comparison between SNWA's Water Rights Proposal and the DEIS

Just before the evidence reports for this water rights hearing were due, the Bureau of Land Management released the draft environmental impact statement (DEIS) for SNWA's pipeline through Lincoln, White Pine, and Clark Counties (BLM, 2011). There are many differences between the DEIS and the evidence provided by SNWA in this hearing before the Nevada State Engineer in support of their water rights applications.

For example, with the exception of the groundwater model reports, SNWA has updated both their conceptual model report (Burns and Drici, 2011) and geology report (Rowley et al, 2011). Table 3 shows the hydrogeology references from the DEIS.

Table 3: SNWA references used in the Water Resources Chapter of the DEIS (BLM, 2011).

Southern Nevada Water Authority (SNWA). 2010a. Addendum to the Groundwater Flow Model for the Central Carbonate-Rock Province: Clark, Lincoln, and White Pine Counties Groundwater Development Project, Draft, August 2010. 48 pp.
_____. 2010b. Simulation of Groundwater Development Scenarios Using the Transient Numerical Model of Groundwater Flow for the Central Carbonate-Rock Province–Clark, Lincoln, and White Pine Counties Groundwater Development Project. Prepared in Cooperation with the Bureau of Land Management: Southern Nevada Water Authority, Las Vegas, Nevada, Draft, September 2010. 82 pp.
_____. 2009a. Conceptual Model of Groundwater Flow for the Central Carbonate-Rock Province–Clark, Lincoln, and White Pine Counties Groundwater Development Project. Southern Nevada Water Authority, Las Vegas, Nevada, 416 pp.
_____. 2009b. Transient Numerical Model of Groundwater Flow for the Central Carbonate-Rock Province–Clark, Lincoln, and White Pine Counties Groundwater Development Project: Prepared in Cooperation with the Bureau of Land Management. Southern Nevada Water Authority, Las Vegas, Nevada. 394 pp.
_____. 2009c. Spring Valley Hydrologic Monitoring and Mitigation Plan (Hydrographic Area 184).
_____. 2009d. Hydrologic Monitoring and Mitigation Plan for Delamar, Dry Lake and Cave Valleys December 2009.
_____. 2008. Baseline Characterization Report for Clark, Lincoln, and White Pine Counties Groundwater Development Project. January 2008.
_____. 2007. Water Resources Assessment and Hydrogeologic Report for Cave, Dry Lake, and Delamar Valleys, November 2007. Presentation to the Office of the State Engineer.
_____. 2006. Water Resources Assessment for Spring Valley, June 2006. Presentation to the Office of the State Engineer.

One of the biggest differences between the evidence reports and DEIS reports is in recharge. SNWA now estimates more recharge, especially in Spring Valley. Burns and Drici (2011) claim 99,000 af/y recharge in Spring Valley, while in the DEIS they estimated 82, 300 af/y (SNWA, 2009a).

The biggest difference of course is that the proposed action for the DEIS is for distributed pumping (Figure 16). The proposed action assumes that SNWA will apply for and the NSE will grant change applications for the water rights being considered in this hearing. It basically acknowledges that the effects estimated for the water rights hearing do not resemble what will eventually occur in the valley. Distributed pumping as proposed in the DEIS (BLM, 2011) would have substantially different impacts on the water resources in Spring Valley than would pumping from the original application locations (alternative B in the DEIS).

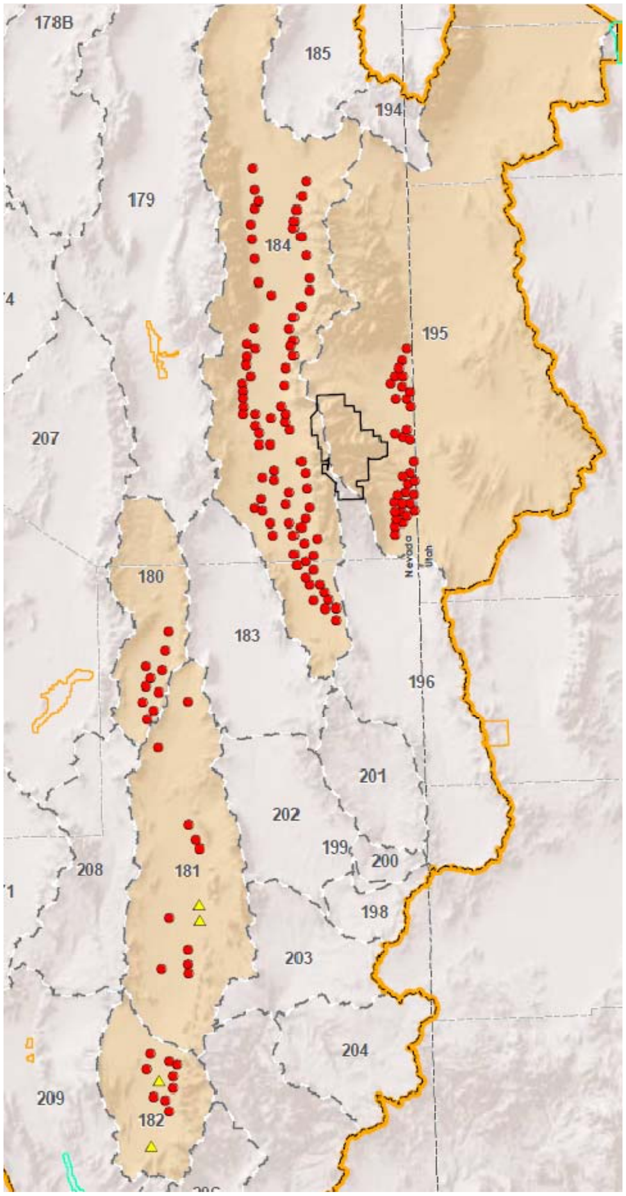


Figure 16: Snapshot from DEIS Figure 3.3.2-2 (BLM, 2011) showing the well locations for the proposed action.

BLM (2011) is not clear on how SNWA selected the locations or the amount for distributed pumping. The locations would be selected to "help minimize the pumping effects" (BLM, 2011, p. 2-33) based on "geology, hydrology, well interference studies, environmental issues, existing senior water rights, and proximity to main and lateral pipelines" (BLM, 2011, p. 2-35). Pumping rates would range from 800 to 1000 gpm at a 1000 to 2000 ft depth (BLM, 2011, p. 2-36). It seems clear that the actual water rights being applied for represent a moving target as far as concerns the four target valleys.

Another big difference is the model results provided for the DEIS. The BLM ran the model for 200 years after full build-out, but SNWA stopped at 75 years for the water rights applications (Watrus and Drici, 2011), arguing that the facilities would only last that long. Also, the DEIS (BLM, 2011) pumps from the distributed wells and other alternatives at lesser amounts. Three scenarios are relevant to this hearing.

- Proposed action: The proposed action is pumping from wells distributed around the target basins, as described above and shown on Figure 16.
- Alternative B: This alternative pumps the full amount from the original application locations, and is the same as the collection of water rights being considered in this hearing except that the DEIS also includes Snake Valley.
- Alternative E: This involves pumping a reduced amount of water from the distributed well locations for just Spring, Cave, Dry Lake, and Delamar Valleys. The reduced amount equals the amount granted during previous water rights hearings.

While the proposed action and alternative B in the DEIS include pumping from Snake Valley, pumping from Snake Valley does not draw significantly from Spring Valley because there is sufficient local recharge and some impedance on the flows, at least for stresses imposed for just 75 years. The numbers and figures presented herein are merely for comparison.

It has already been shown that the proposed action will cause drawdown from pumping Cave and Spring Valleys to overlap and affect Steptoe Valley (Figure 4). Similar drawdown and overlap into Steptoe Valley will occur for pumping the original application locations (Figure 17). In fact, pumping from the original applications causes the 100 foot drawdown to extend into Steptoe and Lake Valleys (Figure 17). This is due to the original applications removing much more water from the southern portion of Spring Valley, near the location of potential interbasin flow from Steptoe and Lake Valleys. The DEIS (BLM, 2011) proposed action has many wells north of the applications so drawdown from that scenario extend much further north into Tippet Valley and northern Spring Valley (Figure 4). This will be considered in much more detail using the Myers Spring/Snake Valley model to pump two different distributed pumping regimes in part 3 of this rebuttal.

Alternative E represents pumping only the basins targeted by SNWA in this hearing at a reduced rate (c. 79,000 af/y). Figure 18 shows that even this alternative will result in drawdown in Steptoe Valley. In fact, the results show that the area affected by drawdown is very similar to that predicted for the DEIS (BLM, 2011) proposed action, except that Snake Valley has little drawdown (compare Figure 4 with Figure 18).

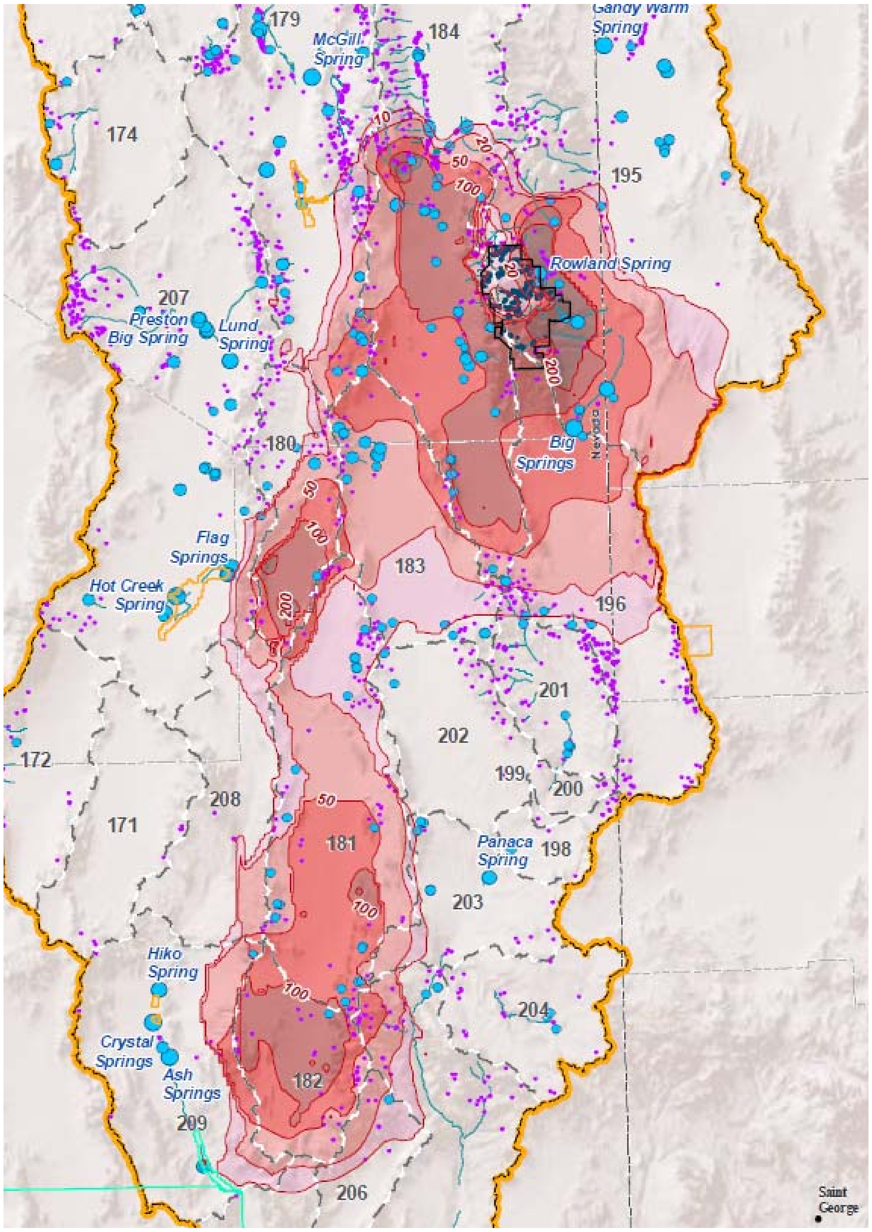


Figure 17: Snapshot from DEIS (BLM, 2011) Figure 3.3.2-18 showing drawdown for Alt B, the original applications, after 200 years.

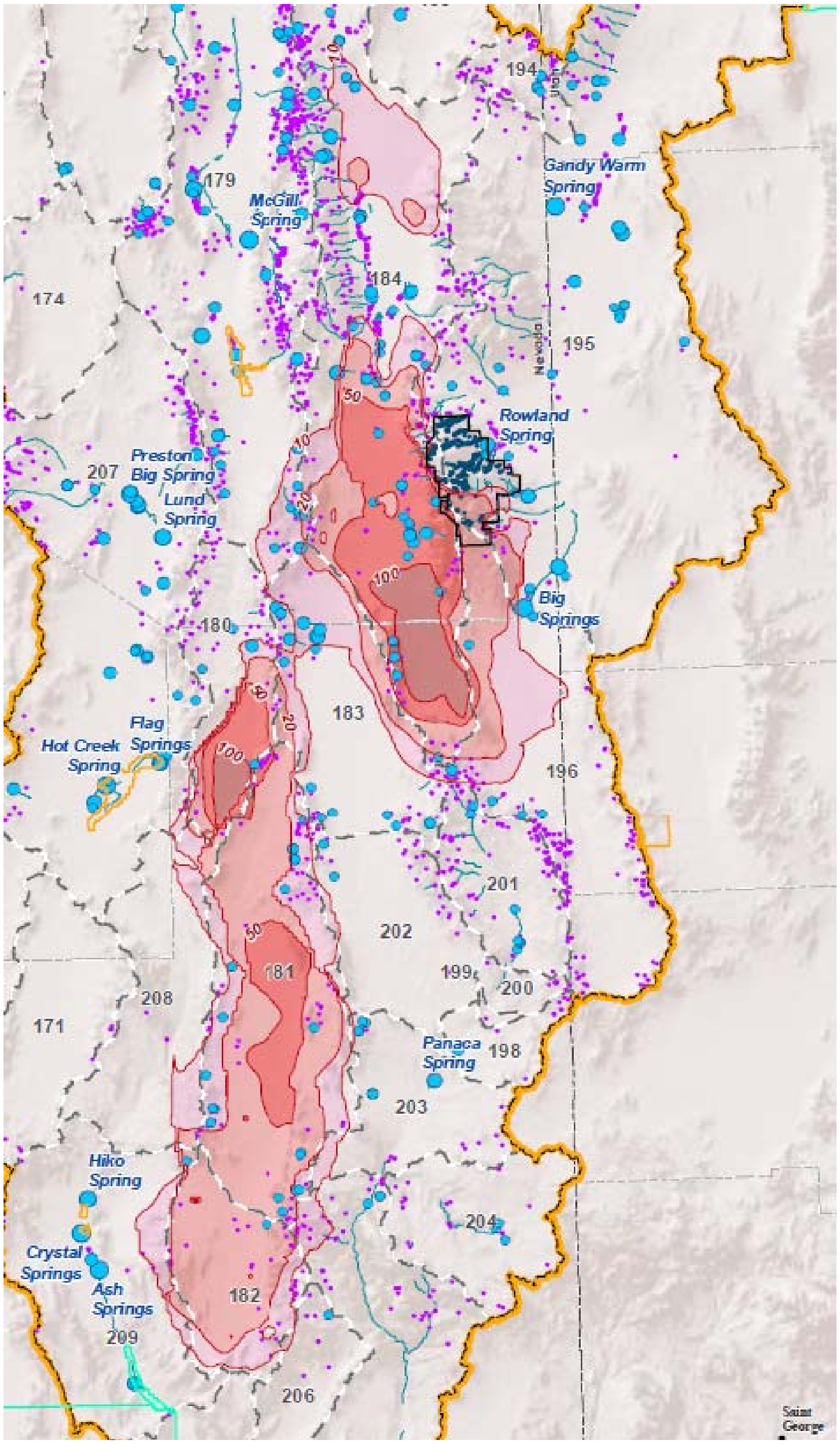


Figure 18: Snapshot from DEIS (BLM, 2011) Figure 3.3.2-29 showing drawdown for Alt E after 200 years.

The three alternatives considered here substantially affect spring flow, as analyzed in the DEIS (BLM, 2011) using the SNWA model (Table 4). The DEIS analysis indicates that pumping the original applications would reduce flow in Butterfield and Flag Springs #3 by 45 and 37 percent, respectively, 200 years after full build-out. Both of the Millick Springs in Spring Valley would be substantially affected, with South Millick essentially going dry. Distributed pumping affects Keegan Springs much more because it moves the wells further north near that spring.

Table 4: Spring flows as determined with the SNWA groundwater model in the DEIS (BLM, 2011) for three alternatives. Assimilated from tables in DEIS Chapter 3.3.

				Model Simulated Reduction (%) 200 Years After Full Build-out		
Flow System	Basin	Spring	Measured Flow (gpm)	Prop Action	Alt B - Orig Apps	Alt E
White River	White River	Amoldson	1608	1	2	0
		Butterfield	1225	18	45	8
		Cold	582	1	2	1
		Flag Spgs 3	969	17	37	8
		Hardy	200	1	4	1
		Hot Creek	5032	3	7	2
		Lund	3594	1	2	1
		Moon River	1707	1	2	1
		Moorman	405	3	6	1
		Nicolas	1185	1	1	0
		Preston Big	3572	1	2	1
	Pahranagat V	Ash	6909	2	2	1
		Brownie	224	0	0	0
		Crystal	4235	1	1	1
		Hiko	2735	2	2	1
Great Salt Lake	Spring	Keegan	234	100	5	36
		N Millick	284	75	42	11
		S Millick	506	99	99	24
	Snake	Big	4289	100	100	78

Review of SNWA Effects Analysis (Conflicts Analysis Related to Southern Nevada Water Authority Groundwater Applications in Spring, Cave, Dry Lake, and Delamar Valleys, Nevada and Vicinity)

This section reviews the Watrus and Drici (2011) predictions and how they are presented. This effects analysis used the “original” version of the Central Carbonate Rock Province (CCRP) model, rather than the final version used in the DEIS (p. 2-1). The difference between the two versions has to do with the way the models handle a fault near Big Springs (p. 2-3). Unless noted, in this and subsequent sections, the review of the model is of the original version. This rebuttal report does not review the details of the groundwater model used by SNWA to make these predictions; Myers (2011e) reviews the model and contrasts it with the Myers (2011c) model.

The authors of this report attempt to downplay effects by emphasizing the uncertainty in just about everything that goes into the model. While it is true that the model includes many uncertainties and simplifications, SNWA presents it as the best decision-making tool available. This section considers statements and discussion in the referenced report in some detail. Page numbers refer to page numbers in that document.

The effects analysis report considers only the drawdown or reductions in flow at various points. The report does not provide a drawdown map, although these are available as shape files on the SNWA-provided model DVD.

SNWA considered only one potential pumping scenario, as shown in Figure 19. The details of this are that starting in 2019 and 2028, the simulation pumps 14,077 and 34,751 af/y from the Cave, Dry Lake and Delamar Valleys; and in 2028, 2038, and 2042, the simulation pumps 35,000, 64,544, and 91,222 af/y, respectively, from Spring Valley (Table 4-1). Presumably the amount by valley is distributed proportionally among the wells (the report does not state as much). SNWA has not provided the NSE with a full-range of pumping rates or schedules for comparison, as does Myers (2011d).

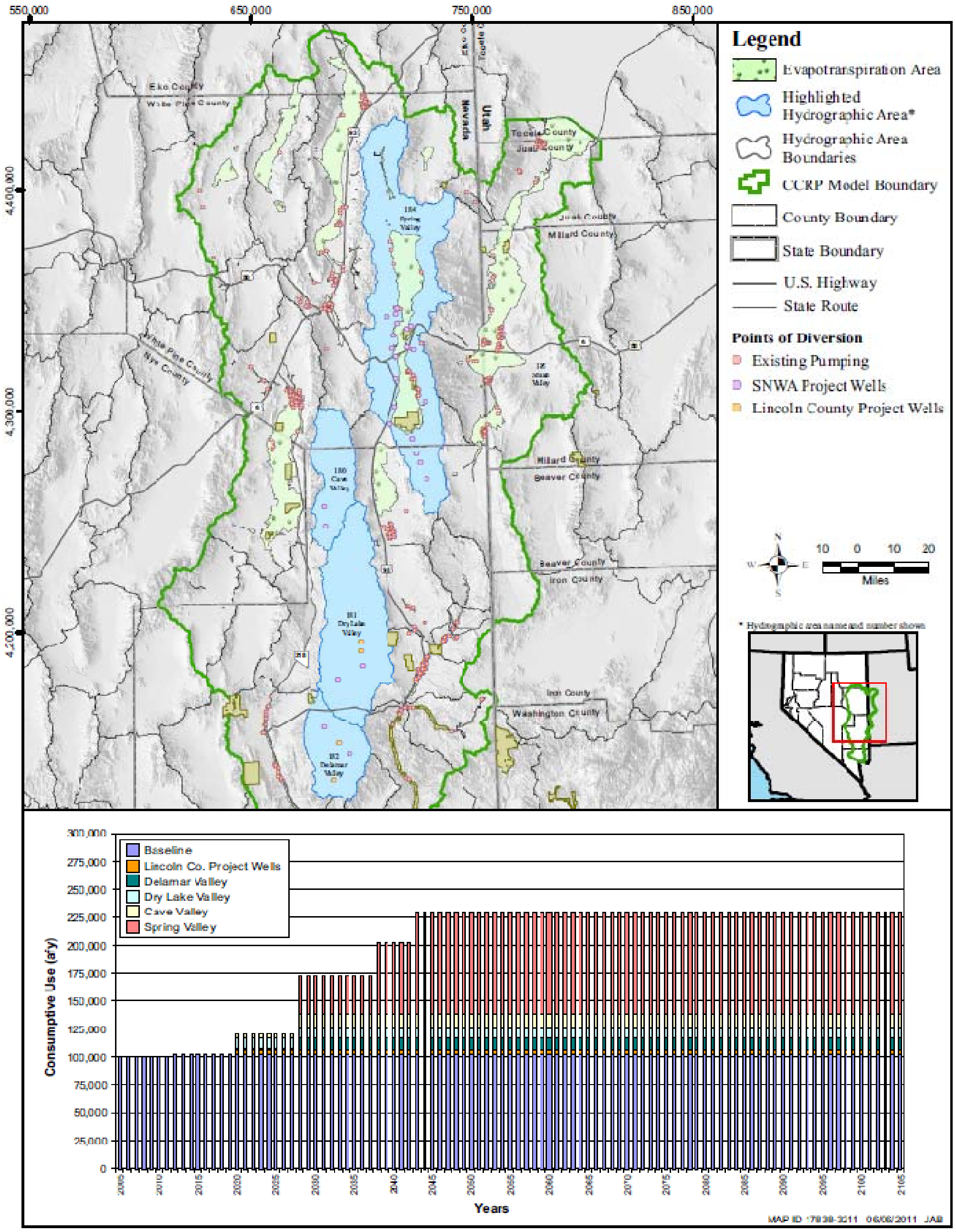


Figure 4-1
Pumping Distribution and Schedule for SNWA Pumping Simulation

Figure 19: Snapshot of Figure 4-1 from the SNWA Effects report.

The report describes the simulation as unrealistic and conservative (p. 4-3). It is anything but – SNWA may pump the full amount from the day the NSE grants the water rights and SNWA constructs the facilities. The ramping schedule analyzed (Figure 19) is not described or justified in the Effects report. There is no justification for considering anything less than pumping the full granted amount from the beginning.

By the same token, unless the permitted water rights are limited in duration to 75 years from full buildout, there is no justification for simulating pumping for just 75 years from full buildout (p. 4-4). The authors' excuse for doing so is that 75 years is the expected life of the facilities. The second argument is that the model predictions become more uncertain after 75 years. While certainly correct, not simulating beyond 75 years leaves the NSE with no guidance as to what environmental resources and water rights will be affected in the future. In part 3 of the rebuttal, I present results from the predictive model (Myers, 2011d) for the same points considered in Watrus and Drici (2011). Additionally, part 3 of the rebuttal considers the effects of pumping from the distributed pumping option as analyzed in BLM (2011) as well as a more likely distributed pumping option.

SNWA only considers drawdown to be an "effect" if the drawdown exceeds 50 feet, and only considers a spring/stream flow reduction to be an "effect" if the simulated flow reduction is 15% (p. 6-1). The 50 feet applies to both water rights, regardless of source, and environmental sites (springs, the Cedars). They justify the drawdown on "increased confidence of the model's predictions" and the "unavoidable generalization of geologic features with a regional model" (p. 6-1, emphasis added). There was no consideration as to the effect that 50 feet has on pumping from a well or on the flow from a spring. Regarding a well, SNWA throughout the Effects report has emphasized how the model does not adequately consider stratification as a reason to suggest the model may overpredict drawdown. Both upper and lower valley fill units can be highly stratified, which indicates that even a well screened over a thick aquifer section could produce the majority of its water from a thin lithologic layer. If that layer is shallow, near the top of the well screen, a small drawdown could effectively ruin the well yield.

At a spring, any drawdown can significantly affect the flow rate. If the spring is phreatic, a drawdown as little as one foot could change a low flowing seep into a mud hole. Larger springs can be affected without any drawdown; all that is necessary is for the gradient controlling flow from the spring to be reduced (Mayer and Congdon, 2007). SNWA predicts that three Spring Valley springs of environmental interest will be affected by drawdown (Table 6-4). This means drawdown will exceed 50 feet at the Unnamed 5 spring and Four Wheel Drive Spring and that flow from South Millick Spring will be decreased by fifteen percent. They note that S Millick spring is a site with less than 50 feet of drawdown that will have a significant flow reduction, but they attempt to diminish the importance of this finding by stating that it had not been used for calibration (p. 6-12). The DEIS-predicted effect on the springs was discussed above.

SNWA also notes that the DEIS uses a ten-foot threshold and five percent flow reduction for consideration of impacts (p. 6-2). SNWA indicates the BLM uses these criteria "as a frame of reference … to help make a reasoned choice among alternatives" (p. 6-2). There is no more important decision than the one to be made by the NSE regarding the amount of water to be granted.

I emphasized "regional" model above because the Myers Spring/Snake Valley model is more local with more finely discretized model cells, allowing for more detailed simulations of drawdown within Spring Valley.

The Effects report, while considering impacts to water rights in the targeted valleys, fails to consider water rights in downgradient valleys. The model predicts that flow rates in two springs in White River Valley will be affected by 2042 (Table 6-4). Their simulation is that flow from Flag and Butterfield Springs will be reduced by at least 15% within 23 years of commencing pumping upstream in Cave Valley. These springs have spring water rights that SNWA has not considered in their effects analysis. The duty to protect water rights does not end at the basin boundary.

SNWA's Effects report considered pumping just the applications, with no alternatives. The BLM (2011) considered at least three different well distributions with two different pumping rates, which clearly are being contemplated by SNWA. The proposed action in the DEIS is for pumping from about three times as many points of diversion as SNWA has water rights applications considered herein.

Conclusions Regarding SNWA's Effects Report

SNWA does not consider an adequate range of pumping rates or schedules.

SNWA has set its potential significant effects much too high. The reality is that any drawdown can affect a spring seriously and just a few feet can affect a well. A fifteen percent flow reduction in a fully appropriated spring causes water rights holders to lose their rights.

SNWA's report does not provide drawdown maps so the reader cannot assess drawdown at points of interest.

SNWA fails to even consider impacts to water rights in downsteam basins, such as White River Valley or Pahranagat Valley.

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APPENDIX A: Model Simulated Flow Changes from the DEIS Appendix F 3.3.6 for Select Alternatives

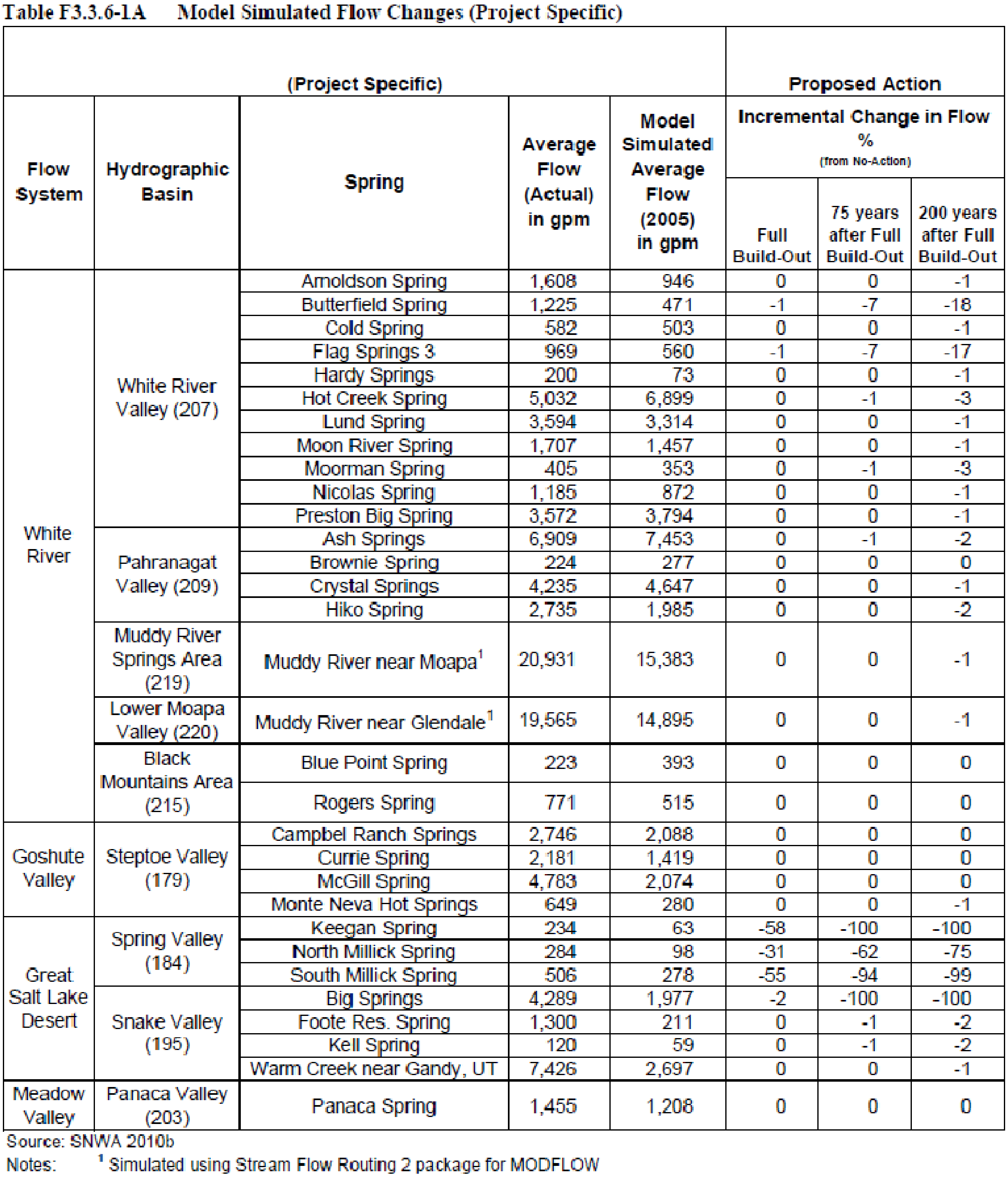

Table F3.3.6-1A Model Simulated Flow Changes (Project Specific)

(Project Specific)					Proposed Action		
Flow System	**Hydrographic Basin**	**Spring**	**Average Flow (Actual) in gpm**	**Model Simulated Average Flow (2005) in gpm**	**Incremental Change in Flow %** (from No-Action)		
					Full Build-Out	75 years after Full Build-Out	200 years after Full Build-Out
White River	White River Valley (207)	Arnoldson Spring	1,608	946	0	0	-1
		Butterfield Spring	1,225	471	-1	-7	-18
		Cold Spring	582	503	0	0	-1
		Flag Springs 3	969	560	-1	-7	-17
		Hardy Springs	200	73	0	0	-1
		Hot Creek Spring	5,032	6,899	0	-1	-3
		Lund Spring	3,594	3,314	0	0	-1
		Moon River Spring	1,707	1,457	0	0	-1
		Moorman Spring	405	353	0	-1	-3
		Nicolas Spring	1,185	872	0	0	-1
		Preston Big Spring	3,572	3,794	0	0	-1
	Pahranagat Valley (209)	Ash Springs	6,909	7,453	0	-1	-2
		Brownie Spring	224	277	0	0	0
		Crystal Springs	4,235	4,647	0	0	-1
		Hiko Spring	2,735	1,985	0	0	-2
	Muddy River Springs Area (219)	Muddy River near Moapa[1]	20,931	15,383	0	0	-1
	Lower Moapa Valley (220)	Muddy River near Glendale[1]	19,565	14,895	0	0	-1
	Black Mountains Area (215)	Blue Point Spring	223	393	0	0	0
		Rogers Spring	771	515	0	0	0
Goshute Valley	Steptoe Valley (179)	Campbel Ranch Springs	2,746	2,088	0	0	0
		Currie Spring	2,181	1,419	0	0	0
		McGill Spring	4,783	2,074	0	0	0
		Monte Neva Hot Springs	649	280	0	0	-1
Great Salt Lake Desert	Spring Valley (184)	Keegan Spring	234	63	-58	-100	-100
		North Millick Spring	284	98	-31	-62	-75
		South Millick Spring	506	278	-55	-94	-99
	Snake Valley (195)	Big Springs	4,289	1,977	-2	-100	-100
		Foote Res. Spring	1,300	211	0	-1	-2
		Kell Spring	120	59	0	-1	-2
		Warm Creek near Gandy, UT	7,426	2,697	0	0	-1
Meadow Valley	Panaca Valley (203)	Panaca Spring	1,455	1,208	0	0	0

Source: SNWA 2010b

Notes: [1] Simulated using Stream Flow Routing 2 package for MODFLOW

Table F3.3.6-3A Model Simulated Flow Changes (Project Specific)

(Project Specific)					Alternative B (Points of Diversion)		
Flow System	Hydrographic Basin	Spring	Average Flow (Actual) in gpm	Model Simulated Average Flow (2005) in gpm	Incremental Change in Flow % (from No-Action)		
					Full Build-Out	75 years after Full Build-Out	200 years after Full Build-Out
White River	White River Valley (207)	Arnoldson Spring	1,608	946	0	-1	-2
		Butterfield Spring	1,225	471	-20	-34	-45
		Cold Spring	582	503	0	-1	-2
		Flag Springs 3	969	560	-19	-29	-37
		Hardy Springs	200	73	-1	-2	-4
		Hot Creek Spring	5,032	6,899	-3	-5	-7
		Lund Spring	3,594	3,314	0	-1	-2
		Moon River Spring	1,707	1,457	-1	-2	-2
		Moorman Spring	405	353	-2	-4	-6
		Nicolas Spring	1,185	872	0	-1	-1
		Preston Big Spring	3,572	3,794	0	-1	-2
	Pahranagat Valley (209)	Ash Springs	6,909	7,453	0	-1	-2
		Brownie Spring	224	277	0	0	0
		Crystal Springs	4,235	4,647	0	0	-1
		Hiko Spring	2,735	1,985	0	-1	-2
	Muddy River Springs Area (219)	Muddy River near Moapa[1]	20,931	15,383	0	0	-1
	Lower Moapa Valley (220)	Muddy River near Glendale[1]	19,565	14,895	0	0	-1
	Black Mountains Area (215)	Blue Point Spring	223	393	0	0	0
		Rogers Spring	771	515	0	0	0
Goshute Valley	Steptoe Valley (179)	Campbel Ranch Springs	2,746	2,088	0	0	0
		Currie Spring	2,181	1,419	0	0	0
		McGill Spring	4,783	2,074	0	0	0
		Monte Neva Hot Springs	649	280	0	0	0
Great Salt Lake Desert	Spring Valley (184)	Keegan Spring	234	63	0	-3	-5
		North Millick Spring	284	98	-2	-18	-42
		South Millick Spring	506	278	-8	-47	-99
	Snake Valley (195)	Big Springs	4,289	1,977	-7	-100	-100
		Foote Res. Spring	1,300	211	0	0	-1
		Kell Spring	120	59	0	0	-1
		Warm Creek near Gandy, UT	7,426	2,697	0	0	0
Meadow Valley	Panaca Valley (203)	Panaca Spring	1,455	1,208	0	0	0

Source: SNWA 2010b

Notes: [1] Simulated using Stream Flow Routing 2 package for MODFLOW

Table F3.3.6-6A Model Simulated Flow Changes (Project Specific)

(Project Specific)					Alternative E (Spring, Cave, Dry Lake, Delamar Only)		
Flow System	**Hydrographic Basin**	**Spring**	**Average Flow (Actual) in gpm**	**Model Simulated Average Flow (2005) in gpm**	**Incremental Change in Flow % (from No-Action)**		
					Full Build-Out	**75 years after Full Build-Out**	**200 years after Full Build-Out**
White River	White River Valley (207)	Arnoldson Spring	1,608	946	0	0	0
		Butterfield Spring	1,225	471	0	-3	-8
		Cold Spring	582	503	0	0	-1
		Flag Springs 3	969	560	-1	-3	-8
		Hardy Springs	200	73	0	0	-1
		Hot Creek Spring	5,032	6,899	0	-1	-2
		Lund Spring	3,594	3,314	0	0	-1
		Moon River Spring	1,707	1,457	0	0	-1
		Moorman Spring	405	353	0	0	-1
		Nicolas Spring	1,185	872	0	0	0
		Preston Big Spring	3,572	3,794	0	0	-1
	Pahranagat Valley (209)	Ash Springs	6,909	7,453	0	0	-1
		Brownie Spring	224	277	0	0	0
		Crystal Springs	4,235	4,647	0	0	-1
		Hiko Spring	2,735	1,985	0	0	-1
	Muddy River Springs Area (219)	Muddy River near Moapa[1]	20,931	15,383	0	0	0
	Lower Moapa Valley (220)	Muddy River near Glendale[1]	19,565	14,895	0	0	0
	Black Mountains Area (215)	Blue Point Spring	223	393	0	0	0
		Rogers Spring	771	515	0	0	0
Goshute Valley	Steptoe Valley (179)	Campbel Ranch Springs	2,746	2,088	0	0	0
		Currie Spring	2,181	1,419	0	0	0
		McGill Spring	4,783	2,074	0	0	0
		Monte Neva Hot Springs	649	280	0	0	0
Great Salt Lake Desert	Spring Valley (184)	Keegan Spring	234	63	-12	-28	-36
		North Millick Spring	284	98	-4	-9	-11
		South Millick Spring	506	278	-10	-21	-24
	Snake Valley (195)	Big Springs	4,289	1,977	-2	-26	-78
		Foote Res. Spring	1,300	211	0	0	0
		Kell Spring	120	59	0	0	0
		Warm Creek near Gandy, UT	7,426	2,697	0	0	0
Meadow Valley	Panaca Valley (203)	Panaca Spring	1,455	1,208	0	0	0

Source: SNWA 2010b

Notes: [1] Simulated using Stream Flow Routing 2 package for MODFLOW