Rebuttal Report to Jones and Mayo (2017)

PRESENTATION TO THE OFFICE OF THE NEVADA STATE ENGINEER

Prepared by

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Rebuttal Report to Jones and Mayo (2017)

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This rebuttal report was prepared in response to a report by Jones and Mayo (2017) entitled *Sustainability of the SNWA Pumping Project in Spring Valley, Nevada*, that was prepared on behalf of the Corporation of the Presiding Bishop of The Church of Jesus Christ of Latter-day Saints, a Utah corporation sole (CPB).This rebuttal report summarizes some of the major areas of Jones and Mayo's (2017) criticism, followed by specific issues and deficiencies, which are addressed in the order in which they occur in their report.

Major Areas of Criticism

The Jones and Mayo (2017) report was reviewed by SNWA to evaluate CPB's responses to four specific issues identified by Senior Judge Estes, of Seventh Judicial District Court of Nevada (the Court) (White Pine County and Consolidated Cases v. Jason King, 2013), which were remanded to the Nevada State Engineer (NSE) for resolution. These four issues are listed below, and are the sole subjects of the administrative hearing scheduled for September 25 through October 6, 2017 (NDWR, 2016a):

1. *The addition of Millard and Juab counties, Utah in the mitigation plan so far as water basins in Utah are affected by pumping of water from Spring Valley Basin, Nevada;*

2. *A recalculation of water available for appropriation from Spring Valley assuring that the basin will reach equilibrium between discharge and recharge in a reasonable time;*

3. *Define standards, thresholds or triggers so that mitigation of unreasonable effects from pumping of water are neither arbitrary nor capricious in Spring Valley, Cave Valley, Dry Lake Valley and Delamar Valley, and;*

4. *Recalculate the appropriations from Cave Valley, Dry Lake and Delamar Valley to avoid over appropriations or conflicts with down-gradient, existing water rights.*

Jones and Mayo (2017) only address two of the remand issues before the NSE (numbers 2 and 3), but, in doing so, rely on controversial opinions regarding the proper use of water budgets in water-resource management and an outdated previous version of the Central Carbonate-Rock Province (CCRP) model (Watrus and Drici, 2011). Some of the major flaws associated with their analysis are summarized below:

- Jones and Mayo (2017) seek to invalidate the long-established practice of the NSE with respect to using water budgets to establish perennial yield, a necessary first step in good water resource management.

- Jones and Mayo (2017) claim that the Spring Valley flow system does not reach equilibrium after 2000 years of pumping, by using an outdated version of the CCRP model and a SNWA production well configuration that is not designed for ET capture.

- Jones and Mayo (2017) claim that the only way the Spring Valley flow system could reach equilibrium is if the SNWA project was designed to capture evapotranspiration (ET) discharge. They further speculate that doing so, would affect the Ranch's water features, ignoring the complex three-dimensional hydrogeology of the area underlying the Ranch.

- Jones and Mayo (2017) falsely state that a 3M strategy would not adequately protect the Ranch's water rights, citing long recovery times and difficulty or even impossibility in differentiating pumping impacts from effects of natural phenomena.

Jones and Mayo (2017) Sustainability and Safe Yield (p. 9-17)

Jones and Mayo (2017) recite quotes from Lee (1915), Meinzer (1923), Theis (1935 and 1940) and others to present theoretical concepts of hydrology and aquifer mechanics that are widely accepted as fundamental principles, but are not the only consideration for calculation of perennial yield in Nevada. The authors cite definitions of perennial yield, safe yield, and sustainable yield, and discuss "The Water Budget Myth" of Bredehoeft et al. (1982). Based on these citations and Bredehoeft et al. (1982), the authors assert that the NSE's long-standing state-wide approach for assessing and quantifying water resources and awarding water rights is fundamentally flawed. In 2011, a rebuttal report was prepared (Prieur, 2011) and submitted as SNWA Exhibit 428, in response to Bredehoeft (2011), in which Bredehoeft espouses his Water Budget Myth report. The conclusions of Jones and Mayo (2017) are addressed as follows:

1. Jones and Mayo (2017) seek to invalidate the long-established practice of the NSE with respect to using water budgets to establish perennial yield and determine the groundwater available for appropriation. They recite quotes from recognized experts regarding non-controversial and fundamental principles of hydrology to bolster the overly-simplified and controversial hypothetical model of Bredehoeft et al. (1982), questioning the use of water-budget analyses to quantify perennial yield (p. 16).

Completing a "water budget analysis" or a water-resource assessment is, and has always been, a necessary first step for determining the quantity of groundwater available for appropriation in a particular basin. Between 1963 and 1975, the USGS performed water-budget analyses on 219 basins in Nevada. These analyses were documented in 60 Reconnaissance Series Reports that are on file with the NSE. Since their publication, these reports have been used as the starting point for decisions related to groundwater appropriations in Nevada. As more and better data have been collected in the basins, the initial USGS water budgets have been validated or revised. The USGS believes the development of water budgets are the foundation of water resource management (Healy et al., 2007).

In Nevada, approving a water rights application requires the NSE to perform a multi-step process, and the steps cannot be combined. Jones and Mayo (2017) essentially argue that the calculation of water available for appropriation should be collapsed with the conflicts and environmental soundness steps. In 2017, the traditional approach using water-budget analyses was reaffirmed by the Nevada Legislature in Section 1 of Senate Bill 47, which passed both houses of the legislature with overwhelming bipartisan support and signed into law by the Governor. This law requires the NSE to prepare a complete water budget for each basin located in the State that includes a calculated estimate of the groundwater available for appropriation.

The NSE appropriately used the most current and best-available estimate of groundwater ET, not estimates of recharge as alleged by Jones and Mayo (2017, p. 13), in order to calculate the perennial yield for Spring Valley. Existing committed rights in the basin were then subtracted from the perennial yield to quantify the amount of water that is available for appropriation. The NSE then used additional important factors to establish the duty associated with the SNWA permits. These factors include: (1) compliance with NRS 533.370, which mandates new appropriations do not conflict with existing rights, (2) that they be developed in an environmentally sound manner, and (3) that water is reserved in the basin for future development. For Spring Valley, the NSE did not blindly set the water available for SNWA equal to the perennial yield, he considered these other factors. The NSE denied four SNWA applications that he found might affect existing rights, mandated a staged-development approach and a comprehensive monitoring, management, and mitigation plan specifically designed to protect existing rights and environmental resources, and reserved 4,000 afy for future development in the basin (NDWR, 2012a).

Jones and Mayo (2017) mischaracterize the NSE's approach, inferring that the only factor the NSE considers in permitting applications is the perennial yield of the basin. In fact, the NSE completed a robust and comprehensive review of the best-available science, considered all of the factors he is required to, pursuant to NRS 533.370, and used sound judgment and expertise to conditionally permit some of the applications. These conditions will ensure that existing rights will be protected, and that the resource will be developed in an environmentally-sound manner.

2. Jones and Mayo (2017) provide references to others who believe groundwater models should be used to define safe yield (p. 14-15). SNWA would not disagree with this premise and believes that is precisely what the NSE has directed by requiring staged development in Spring Valley with continual monitoring and model updates.

Jones and Mayo (2017) incorrectly refer to SNWA being awarded 61,127 afa in Ruling 6164 and base all of their claims about the Water Budget Myth, time to equilibrium, groundwater mining, and impacts to water rights on this volume. The fact is, SNWA is only being allowed to pump up to 38,000 afa for a period of eight years, when the Groundwater Development Project (GDP) pumping begins. Data collected during this period will be provided to the NSE along with updated groundwater model results for the NSE to make the determination of whether or not SNWA may move on to Stage 2. During Stage 2, if approved by the NSE, SNWA would only be allowed to pump up to 50,000 afa for the next eight-year period. SNWA would, once again, submit all of the data collected along with the updated model results for the NSE's consideration of allowing Stage 3 development, or 61,127 afa.

The NSE's requirement of staged development along with data collection and model updates is exactly what Jones and Mayo (2017) are describing when they refer to safe and sustainable yield.

3. Jones and Mayo (2017) incorrectly attempt to link the time to equilibrium to groundwater mining (p. 16). Jones and Mayo (2017) offer this conjecture with apparent reference to Spring Valley, qualifying the uncertain nature of the process using the word "may". It is equally accurate to say that "it may take a reasonable period of time" and that "acceptable amounts of transitional storage will be captured in the process, without harm to existing water rights." While it may be true that in larger basins it may take longer for the system to reach a new

equilibrium in response to groundwater development, this does not, in and of itself, imply that groundwater mining is occurring. If that was the case, it would be next to impossible to ever develop groundwater resources in such basins.

Jones and Mayo (2017) completely ignore the concept of transitional storage in reaching these conclusions. In Nevada, transitional storage is defined as the quantity of water in storage that is extracted during the transition between the natural equilibrium and a new equilibrium, or the amount of stored water, which is available for withdrawal by pumping during the period of non-equilibirum development (Scott et al., 1971). While Jones and Mayo assume the use of transitional storage is not permissible, the capture of transitional storage is both necessary and unavoidable; it serves as a “bridge” spanning the gap between the start of groundwater development and reaching a new equilibrium in the basin. All groundwater pumping, including SNWA's and CPB's, relies on capture of transitional storage. This does not mean that all groundwater pumping is groundwater mining.

The Drici et al. (2017) report is the most up-to-date modeling prepared for estimating the time to equilibrium in Spring Valley. The results of the simulation indicate that 98 percent of the captured water could come from ET salvage within as little as 75 to 200 years.

4. Jones and Mayo (2017) state that the location of the production wells relative to the location of the natural discharge area affects the time it takes a system to reach equilibrium; and that equilibrium may never be achieved if the production wells are not close enough to the natural discharge areas, resulting in groundwater mining. They further state that for pumping to result in equilibrium it must capture discharge, and that this interferes with discharge to springs and seeps (Jones and Mayo, 2017, p. 16).

These statements describe the obvious cause and effect relationship of well placement and capture of groundwater discharge and transitional storage. If project wells are placed closer to areas of groundwater discharge, the wells will capture that discharge sooner and use less transitional storage. Conversely, if project wells are placed farther from the areas of groundwater discharge, the wells will not capture the discharge as quickly and more transitional storage will be utilized. SNWA applications were not filed in 1989 with the intent of placing the wells in locations where they could quickly capture the groundwater discharge. Rather, for environmental and other reasons, the project wells were filed with the intent of placing wells in more transmissive alluvial-fan deposits away from existing water-right points of diversion (PODs) and significant environmental resources. While this means that it will take longer for the basin to reach a new equilibrium, the environmental benefits of this approach far outweigh the loss of additional transitional storage.

Up to this date, there is no provision in Nevada law requiring the wells be specifically located so as to capture groundwater discharge within a specified period of time. Such a requirement would imperil all existing groundwater rights in basins where there is no groundwater discharge. In basins where there is groundwater discharge, all existing groundwater rights would be imperiled if the owners of the existing rights have not demonstrated their pumping is fully capturing discharge in an amount equivalent to their permitted duty. The CPB’s requirement is problematic in states like Nevada, where the federal government owns the majority of land in and around groundwater discharge areas, making well siting difficult. Jones and Mayo are advocating for a rule that would put CPB's own existing groundwater rights at risk along with all other existing water rights owners in Spring Valley. Drici et al. (2017) shows that existing rights are currently capturing only about 60 percent of their production water from ET.

Requiring an applicant to capture ET within some arbitrary time frame will cause impacts between water users that could otherwise be avoided if the new wells are placed farther away from existing ones. Moreover, there is not necessarily a linear relationship or connection between the use of more transitional storage and impacts to water rights or the environment. The more time SNWA is allowed to capture ET, the more time there will be to monitor pumping responses and develop more accurate management tools to inform water managers, and guide resource development in a manner that protects existing rights and environmental resources, rather than focusing on an arbitrary time to capture ET.

5. As an initial matter, Jones and Mayo (2017) provide no evidence to support their contention that 5,848 acres of pasture land are watered by the springs in question. In addition, in Jones and Mayo (2011)**,** the authors presented data that indicate the water source of some of the springs is a combination of younger and older water (Jones and Mayo, 2011, p. 15). The source of the younger water is most likely Cleve Creek, and application of the water to irrigate CPB's pasture land also sustains, "an intertwined series of wetlands that have been proliferated and maintained as a result of the active irrigation manipulations conducted by the ranch" (Resources Concepts, 2011). The NSE afforded protection to CPB's rights by denying four SNWA applications closest to the Cleveland Ranch. The PODs associated with the approved SNWA permits are not located where they will intercept the source of these springs.

The springs CPB seeks to protect are an artifact of the active irrigation manipulations conducted by the ranch (Resource Concepts, 2011). CPB diverts Cleve Creek on the alluvial fan and routes it north to a pond from which water is conveyed to its pasture lands and pressurized irrigation systems. CPB also uses its winter ditch to convey Cleve Creek water to the southern portion of its Ranch. With the exception of the water used by the pressurized systems, the diverted water is used to flood irrigate pasture lands. This has resulted in elevated groundwater levels under the Ranch that also support pasture. This practice has created downgradient springs where the shallow groundwater table intersects the ground surface. CPB filed vested claims on these springs, in an apparent attempt to appropriate the same water twice.

Jones and Mayo (2017) Groundwater Model (p. 18-24)

In this section, Jones and Mayo (2017) briefly describe in general terms the CCRP model, and the scenario simulations performed by Watrus and Drici (2011) in support of the 2011 hearings. They then summarize their evaluation of the Watrus and Drici (2011) report and model files. Finally, they list the pumping scenarios they simulated in 2011 using the CCRP model (Jones and Mayo, 2011), and present a discussion of the simulated results mostly focused on the full pumping scenario, which includes all of the original SNWA applications. Specific issues are as follows:

1. Based on the full-scenario simulation results, Jones and Mayo (2017) claim that 200 years of SNWA project full production creates a large aggregate cone of depression that overlaps the CPB water rights locations in the valley floor. (p. 19)

Jones and Mayo (2017) misleadingly utilize the results of the full simulation, which includes all original SNWA application locations. The NSE already denied the four SNWA applications closest to Cleveland Ranch. Therefore, the effects of SNWA production from the permitted locations will not cause the drawdown described here by Jones and Mayo (2017). In any event, simulation drawdown due to SNWA GDP pumping is not one of the four remand issues.

2. Jones and Mayo (2017) use charts of simulated water table elevation versus time for each of CPB's water rights locations on the valley floor, to conclude that drawdowns caused by SNWA GDP pumping maintain a linear decline throughout the 200 years of full production. Their report shows a chart of simulated water levels versus time from the full scenario as an example, and concludes that the system does not reach equilibrium after a 200-year period (p. 19, Figure 4-1).

Figure 4-1 is misleading because it shows the results of a simulation that includes production wells that have not been permitted by the NSE (NDWR, 2012a-d). Furthermore, it is inappropriate to show the simulation results of a regional model for local features. The scenarios, cited by Jones and Mayo (2017) to conclude that the system does not reach equilibrium after 200 years of pumping, were not designed with system equilibrium as the objective.

3. Using the results of their predictive simulations, Jones and Mayo (2017) analyze the water budgets and conclude that the system does not reach equilibrium after the 200 years of full production (p. 19-20).

The flow system does not reach equilibrium after 200 years of pumping in the simulations Jones and Mayo (2017) reference, because the production well configuration was not designed to capture ET. Scenarios can be designed to capture ET within a reasonable time period of 75 to 200 years, as described in Drici et al. (2017).

4. In Section 4.2, *Updated Model Simulations*, Jones and Mayo (2017) describe a local model of Spring Valley they claim answers a series of questions, including how long it would take the flow system to reach a new equilibrium. They extracted this local model from the CCRP model and kept the model features and characteristics the same. They extracted boundary conditions from simulations of the CCRP model for the same simulation periods. Jones and Mayo (2017) split each cell of the CCRP model grid into 49 cells in the horizontal direction, and assigned model characteristic values by interpolation or assignment of the same values as in the CCRP model. They did not make changes to the model grid in the vertical direction. They then ran the local model for the same simulations presented in Watrus and Drici (2011), and verified that this local model yields essentially the same water budget as the CCRP model in Spring Valley. (p. 20-24)

The local model created by Jones and Mayo (2017) is not an improvement of the CCRP model as far as the accuracy of the simulated results. Their creation of a local finer-grid model from the CCRP model is the same as Myers telescoping the grid of the Regional Aquifer-System Analysis (RASA) model in the 2011 hearing. Myers (2011) had performed a similar refinement of the grid of the RASA model. In the Cave Valley Ruling number 6165, it is stated that:

> *Prudic, et al. note that the RASA model is only suitable to infer "broad concepts and large-scale features" due to its coarse resolution. The original authors used a target range of 250 feet to calibrate the model. Though Dr. Myers telescoped the model grid, he did this after the coarse model was calibrated to set model parameters. Dr. Myers did not update any of the model parameters. Dr. D' Agnese points out, and Dr. Myers agrees, that the telescoping of the model does little to improve the accuracy of its predictions, though it does result in a smoother representation of drawdown near the wells* (NDWR, 2012b).

The refinement of the grid after the model has been calibrated does nothing to improve the accuracy of any of the simulations performed using the CCRP model. Considering that the root mean square error (RMSE) of the hydraulic heads in the calibrated CCRP model is 91 ft (SNWA, 2009, Table 6-2, p. 6-9), using comparisons of hydraulic heads to land surface elevations at spring locations as described in a later section in the Jones and Mayo report is misleading. If the simulated hydraulic head at the spring location did not closely match the actual head in the CCRP model, refining the grid results in a similar value of hydraulic head at the same spring location. In other words, just refining the grid does not improve the accuracy of the CCRP model.

Jones and Mayo (2017) Simulation Results (p. 25-34)

This section only tangentially addresses one of the four remand issues for this hearing. That issue is "a recalculation of water available for appropriation from Spring Valley assuring that the basin will reach equilibrium between discharge and recharge in a reasonable time" (NDWR, 2016b). However, Jones and Mayo (2017) do not provide analysis or information to assist the NSE in calculating the quantity of water that is available for appropriation using equilibrium as a primary criteria. In fact, Jones and Mayo appear to concede that absolute equilibrium is not achievable, no matter the production volume or choice of well locations.

The simulation results section of Jones and Mayo (2017) presents a model simulation of SNWA's application PODs pumping at 61,000 afy for a period of 2,000 years with the stated purpose of determining when the system might reach equilibrium. The results are presented as a series of figures showing changes in ET, storage, and interbasin flows. The graphs indicate the most significant changes to these factors occur in the first 200 years, with the vast majority of the changes occurring within the first 500 years of production. The changes to the lines on the graphs slow down dramatically over the final 1,500 years of simulation.

Most importantly, Jones and Mayo (2017) do not perform any model simulations at lower levels of pumping to determine whether reducing the quantity of pumping, as suggested by the Court, will have the desired effect of shortening the period of time for the basin to reach a new equilibrium in response to SNWA's GDP pumping.

The results of the model simulations regarding time to equilibrium can change dramatically by simply altering the placement of wells in the simulation. Drici et al. (2017) demonstrated that by simply changing the well configuration, 98 percent of the approved project water can be produced from ET salvage within as little as 75 to 200 years (Figure 1). This further demonstrates that if ET capture is the primary goal of a water development project, well location, not quantity of pumping, is the key factor in achieving that goal.

Specific Comments:

1. When referring to their own model results, Jones and Mayo (2017) comment on how the results demonstrate that a new absolute equilibrium has not been achieved.

It is difficult to understand why Jones and Mayo (2017) argue for an absolute equilibrium when throughout their report they cite many hydrologists, such as Theis (1940), and Bredehoeft and Durbin (2009), as believing that absolute equilibrium is not possible. Accordingly, Jones and Mayo's proposed standard, that model results should eventually show zero capture from storage over time, is an impossible standard for any groundwater project to meet. A more realistic standard would be to determine at what level of change in storage must be achieved in order to render any associated changes in drawdown insignificant. Additionally, the results of the simulations depend on many factors such as locations of recharge and discharge, aquifer properties, vegetation dynamics, and the choice of groundwater production locations. Drici et al. (2017) demonstrated that by simply changing the well configuration, the model results demonstrate that 98 percent of the pumped water will come from ET salvage within as little as 75 to 200 years (Figure 1). Rather than admitting that the modeler's choice of well location has more impact on scenario equilibrium results, Jones and Mayo focus on a goal they are aware is a mathematical impossibility.

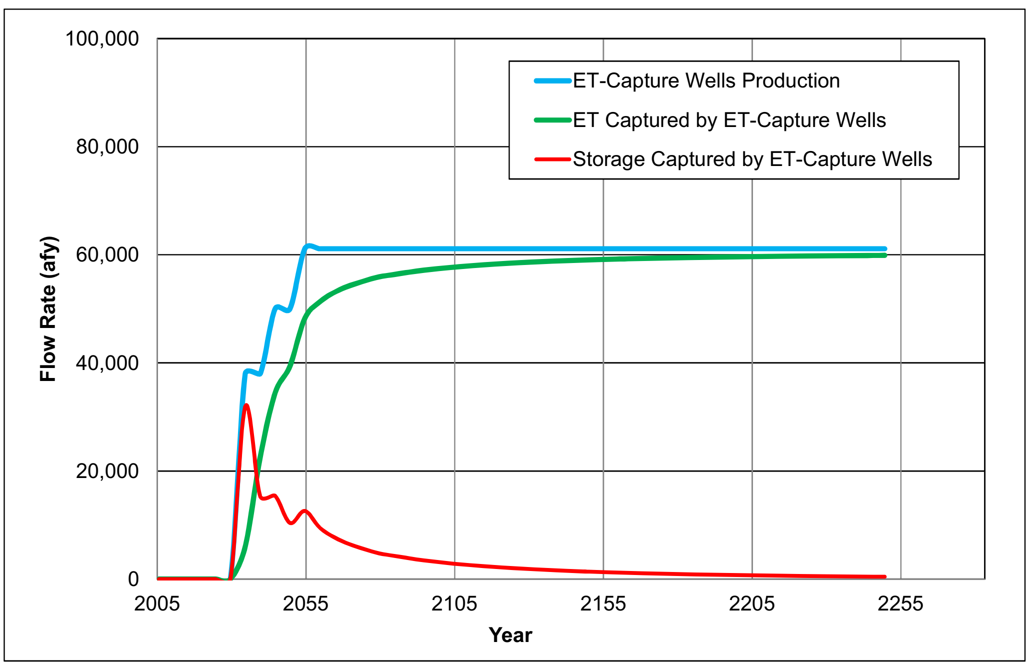


Figure 1
ET Discharge and Transitional Storage Captured by ET-Capture Wells as a Function of Time

2. Jones and Mayo (2017) also contains a rebound analysis, which they characterize as an analysis to see how Spring Valley aquifers would "rebound" (p. 36) after pumping stops. To perform this analysis Jones and Mayo (2017) simulated 300 years of groundwater production followed by 300 years of no pumping. In this simulation, ET and water levels returned to their pre-pumping levels prior the end of the simulation. Jones and Mayo interpret the results of their rebound analysis in a misleading manner.

The primary takeaway from this analysis, as shown on Figure 2, should have been that water-level recovery initially occurs rather quickly, but that full recovery may require the same amount of time as it takes for the drawdowns to initially occur. Rather than doing a 600-year simulation, Jones and Mayo could have just as easily demonstrated that, with a year of production related drawdowns, it would only take a year for full recovery. Jones and Mayo arbitrarily chose a 600 year simulation period with 300 years of pumping, thereby impacting the usefulness of their results.

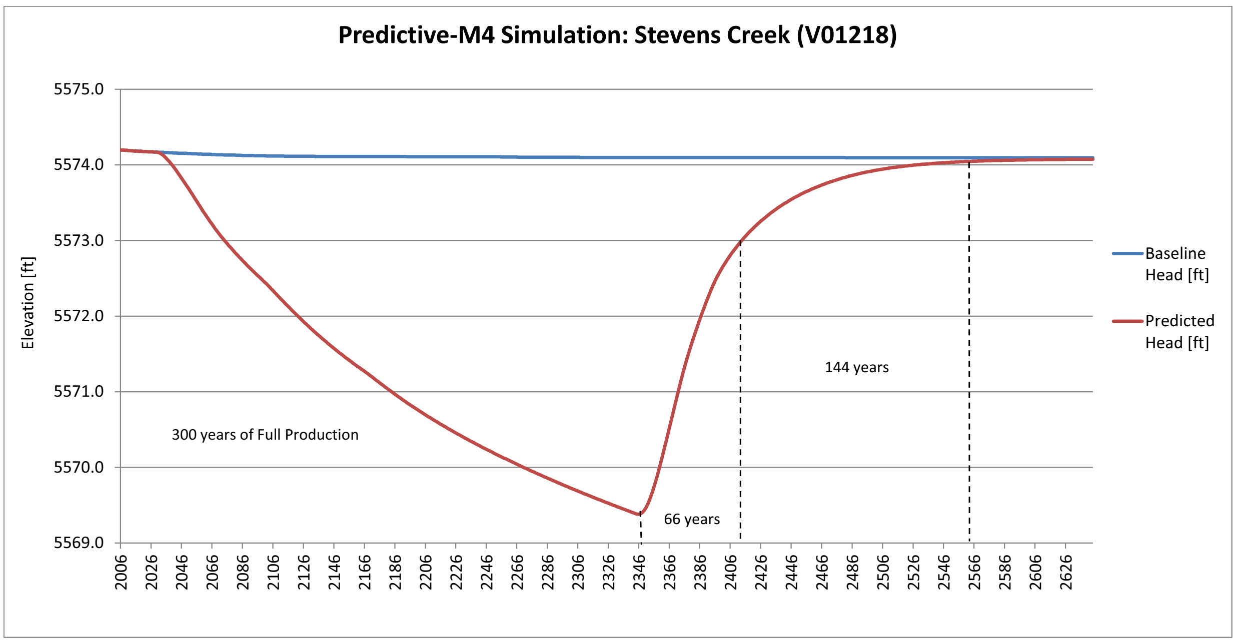


Figure 2
Figure 5-8 (Modified) from Jones and Mayo (2017)

A more detailed look at the data supporting the figure used in Jones and Mayo (2017) shows that after 300 years of groundwater production and drawdowns, all but the last foot of drawdown recovers within as little as 66 years of no pumping. It is the final foot of recovery that requires an additional 144 years to recover. Under this simulation, it only takes 210 years to fully recover from 300 years of full production (Figure 2).

Additionally, it is misleading to state that "turning off wells will not result in the restoration of the water rights" (Jones and Mayo, 2017). In the simulation, 300 years of full production of SNWA's water rights result in a mere 4.7 ft of drawdown at the location of the vested claim, or less than 0.2 inches of drawdown per year. Jones and Mayo's results suggest that even if water-level drawdowns impact the water rights in a 1:1 ratio, the water rights will be fully restored after a reasonable period of recovery.

It should be noted that, the vast majority of CPB's water rights are for surface water sources that may or may not be connected to the aquifers that will experience drawdowns. For example, there is no evidence that the POD for vested claim V01218, which is the subject of the figure used in Jones and Mayo (2017), is in connection with the water table. If there is no connection, then there will be no change in surface water flows resulting from a lowering of the water table beneath that POD. Even if a connection exists at this location, there are other contributing factors, such as channel morphology, and streambed conductance, that may prevent flux across the streambed. Currently, the site-specific data needed to accurately assess what the impacts to CPB's water rights will be, does not exist. It is also important to recognize that this regional model was not intended to be used for site-specific impact analysis, and thus, would also not be appropriate for looking at the recovery at site-specific locations.

The example chosen by Jones and Mayo (2017) provides a primer on why, at this time, the model should be used for general trends, and with caution, only as an aid in future analysis, as opposed to being used as the only tool to support decision making. While Jones and Mayo (2017) conclude, based solely on the model run, that the vested claim V01218 may be in jeopardy as a result of SNWA's GDP, the fact is, there is no chance of impact to this POD. As shown in the report prepared for CPB by Resource Concepts in 2011, Stephens Creek has been placed into a pipe approximately 3,600 ft upstream of this POD, thereby disconnecting the creek from the groundwater table (assuming the connection was even there in the first place). Since one factor that is required for groundwater drawdown to affect surface water is a saturated continuum or connection between the two sources, CPB's piping of the creek has insulated this water right from impacts. Therefore, drawdowns at the POD will have no impact on CPB's use of the water right (Figure 3), and modeling projections for this area are useless and irrelevant on this issue.

3. First, we would agree with Jones and Mayo (2017) that long-term model simulations are inappropriate for critiquing the hydrologic impacts at specific locations. However, Jones and Mayo go on to state and show several examples of how groundwater studies involving simulation periods of multiple centuries or millennia are common in the literature.

We would argue that these extremely long-term modeling simulations have little to no value in the real world. Jones and Mayo cite Thomas et al. (1989), Schaefer and Harrill (1995), Harrill and Prudic (1998), and Bredehoeft and Durbin (2009) as having performed such model simulations. These model simulations all have similar characteristics. The simulations were performed on large regional groundwater flow models without sufficient details regarding local geology, transmissivities, storage properties, and detailed locations of recharge and discharge. Additionally, all of the simulations included imaginary pumping locations and volumes. While all of these simulations tell a story of how the basins may respond to such pumping, not a single one of these models has been shown to be accurate based upon the actual properties and the pumping currently taking place in these valleys. Moreover, as Jones and Mayo admit, time to capture is dependent upon transmissivity of the aquifer.

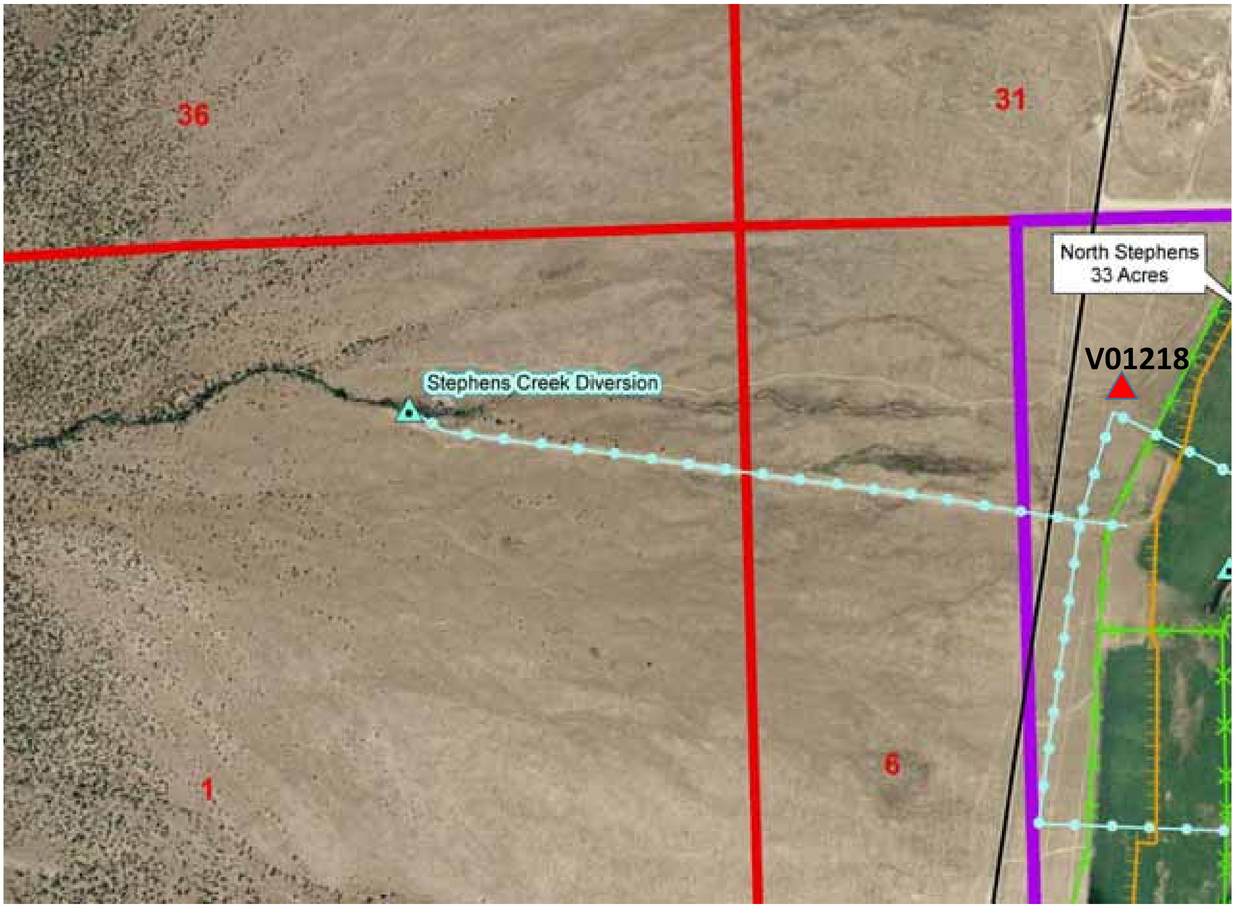


Figure 3
Red Triangle Denotes the Location of V01218 while light blue line shows where Stephens Creek has been placed in a pipe (modified from Resource Concepts, 2011)

The transmissivities in the model used by Jones and Mayo are estimates based upon regional geologic interpretations and do not account for the detailed non-uniformity of the aquifer.

Healy et al. (2007) describe a similar example where a model was constructed for an area of central Arizona and, despite the abundance of aquifer response data, the predictions of impacts from pumping did not match the actual field observations. Healy et al. (2007) based the discrepancy between predictions and observations on a lack of accurate locations for groundwater production, differences in the amount of water withdrawn, and changes in aquifer properties from the calibrated model. Based on this experience, Healy et al. (2007) believe that because groundwater budget models contain inherent uncertainties, they should be continually updated as development occurs.

Alley et al. (1999) recognize the importance of groundwater models but highlight the uncertainties that result from sparsity of data, inaccurate data, poor definition of stresses, and errors of conceptualization. As such, Alley et al. (1999) conclude that model simulations are useful for decision making when they are periodically updated, as the actual groundwater system responds to the physical stresses being imposed by groundwater pumping.

These models, again, demonstrate that absolute equilibrium is likely an impossible standard to achieve. Jones and Mayo (2017) specifically point to Bredehoeft and Durbin (2009) as concluding that "equilibrium is not possible or meaningful in these cases" (Jones and Mayo, 2017, p. 33). This conclusion is particularly relevant to the granting of water rights. The changes in storage that occur over simulated millenia do not translate to the direct impacts to water-right owners or environmental resources. As such, the NSE's time should not be focused on equilibrium, but rather on the protection of water rights and environmental resources.

Jones and Mayo (2017) Monitor, Manage, Mitigate (p. 35-36)

1. Jones and Mayo (2017) state that, "developing a monitor, manage, and mitigate program for a basin the size of Spring Valley with the large distances and time scales involved that adequately protects existing water right holders is difficult, if not impossible" (p. 36).

The implementation of a 3M Plan in Spring Valley has certain difficulties, however, those difficulties can be overcome by using staged development and an approach as described in Section 3.0 in Marshall et al. (2017). The CBP senior water rights and environmental resources located on and in the vicinity of Cleveland Ranch will be protected by specific monitoring, management, and mitigation actions as described in the Spring Valley 3M Plan (SNWA, 2017). Hydrologic monitoring between SNWA GDP PODs and Cleveland Ranch will detect and measure propagation of drawdown. SNWA set specific quantitative investigation and mitigation triggers in the Spring Valley 3M Plan to implement management or mitigation actions to prevent or eliminate unreasonable effects. If an investigation trigger is activated, an investigation is performed to determine the cause, condition, and significance of the observed changes, and management actions may be taken (SNWA, 2017, Table 3-2 on p. 3-20, and Table 3-3 on p. 3-23).

The mitigation trigger is set in reference to the ability of the senior water right POD to produce the permitted diversion rate and/or annual duty, and is designed to protect the volume of water committed to beneficial use (Marshall et al., 2017, Sections 3.2 and 6.2; SNWA, 2017, Sections 3.2 and 3.3.1). Mitigation actions will be taken to avoid or eliminate a conflict with a senior water right. If a mitigation trigger is activated, at least one of the mitigation actions identified in the 3M Plan will be implemented within 30 days (SNWA, 2017, Tables 3-2 on p. 3-22 and Table 3-3 on p. 3-24). Mitigation actions may also be preemptively implemented to avoid activating the mitigation triggers. The 3M Plan provides a summary of this approach (SNWA, 2017, Section 3.3.1).

Numerical groundwater flow model drawdown projections in the vicinity of Cleveland Ranch are presented by Jones and Mayo (2017), but the projections do not accurately represent actual conditions that will occur in the future for a number of reasons, including that the projections are based on limited aquifer property and response data; do not take into account management actions or changes in production rate, duration, or distribution; and do not take into account wet year recharge events on the Cleve Creek alluvial fan. The model also does not consider groundwater-surface water interactions, nor does it reflect the effect of Cleveland Ranch irrigation practices on groundwater levels or spring discharge.

A detailed discussion of the mitigation actions, including discussion on efficacy and SNWA resources, is provided in the 3M Plan analysis report (Marshall et al., 2017, Section 6.2).

Management and mitigation actions will be effective, if they need to be applied on, or in the vicinity of Cleveland Ranch, because of the hydrogeologic conditions present at the sites and availability of replacement water. Details on monitoring frequency, investigation triggers, management actions, and mitigation actions to protect Cleveland Ranch water rights are presented in Marshall et al. (2017, Sections 6.2.2 and 6.2.3), and in the Spring Valley 3M Plan (SNWA, 2017, Section 3.0).

Figure 4 is a plan map showing monitoring locations in the vicinity of Cleveland Ranch. Figure 5 is a north-south cross-sectional profile A-A’ that illustrates the number, distance, and distribution of monitor wells along the alluvial fan between the SNWA GDP POD for permit number 54013 and Cleveland Ranch. Hydrologic monitoring is performed at three intermediate wells between SNWA GDP PODs and Cleveland Ranch along the alluvial fan to detect and measure groundwater drawdown propagation (391224114293601, Bastian South Well, and Bastian North Well). Five sentinel monitor wells are also located on, or near the south end of Cleveland Ranch (SPR7029M, SPR7029M2, SPR7030M, SPR7030M2, and SPR7044M [not shown on map]). Spring monitoring locations on Cleveland Ranch include South Spring (discharge measurements), North Spring (discharge measurements), and North Spring piezometer (SPR7031Z)(water-level measurements). Monitoring locations on Cleveland Ranch were selected in consensus with the NSE and CPB.

Additional 3M Plan monitoring includes continuous measurement of stream flow by USGS at the Cleve Creek gaging station as part of a SNWA-USGS joint funding agreement. Cleve Creek discharge is used as a reference site to compare hydrologic conditions (e.g., streamflow) to groundwater levels and spring discharge in Spring Valley. SNWA also proposes to install three additional stream gages associated with the Cleveland Ranch irrigation ditches, pending CPB permission: (1) upstream of the diversion splitter with the winter ditch, (2) downstream on the summer ditch, and (3) on the winter ditch at the Ranch. Regional baseline hydrologic data and aerial imagery on, and in the vicinity of the Ranch will be compared to irrigation diversions between the summer and winter ditches from Cleve Creek to establish influence of irrigation practices on spring discharge. The additional gaging stations will assist in evaluating the effect of volume and distribution of irrigation water including flood and sub-irrigation applications on the diffuse spring discharge.

2. Jones and Mayo (2017), in Section 6.2, question the ability to differentiate natural fluctuations in groundwater levels and drawdown from SNWA GDP pumping.

The 3M Plan hydrologic monitoring network will be able to differentiate significant drawdown caused by the GDP pumping from natural fluctuations. Groundwater levels will be measured at monitor wells at different distances from the SNWA GDP production wells. Baseline data has been collected at these monitor wells since 2006. The baseline record includes both wet and drought periods. The monitor well data will be compared to other reference wells outside the influence of SNWA pumping and to regional hydrologic data, such as precipitation and streamflow data, to observe if the wells are responding in a similar manner, or if there is a departure from expected behavior at the monitoring site. Analytical methods such as USGS Series SEE (Halford et al., 2012) will be used to determine if a water-level change at a monitor well is a natural fluctuation, which would also be seen in reference wells, or if there is a departure caused by another source, such as pumping. In addition, monitor wells closer to the production wells would exhibit more drawdown and could be used to project the amount of drawdown expected at the monitor well being analyzed.

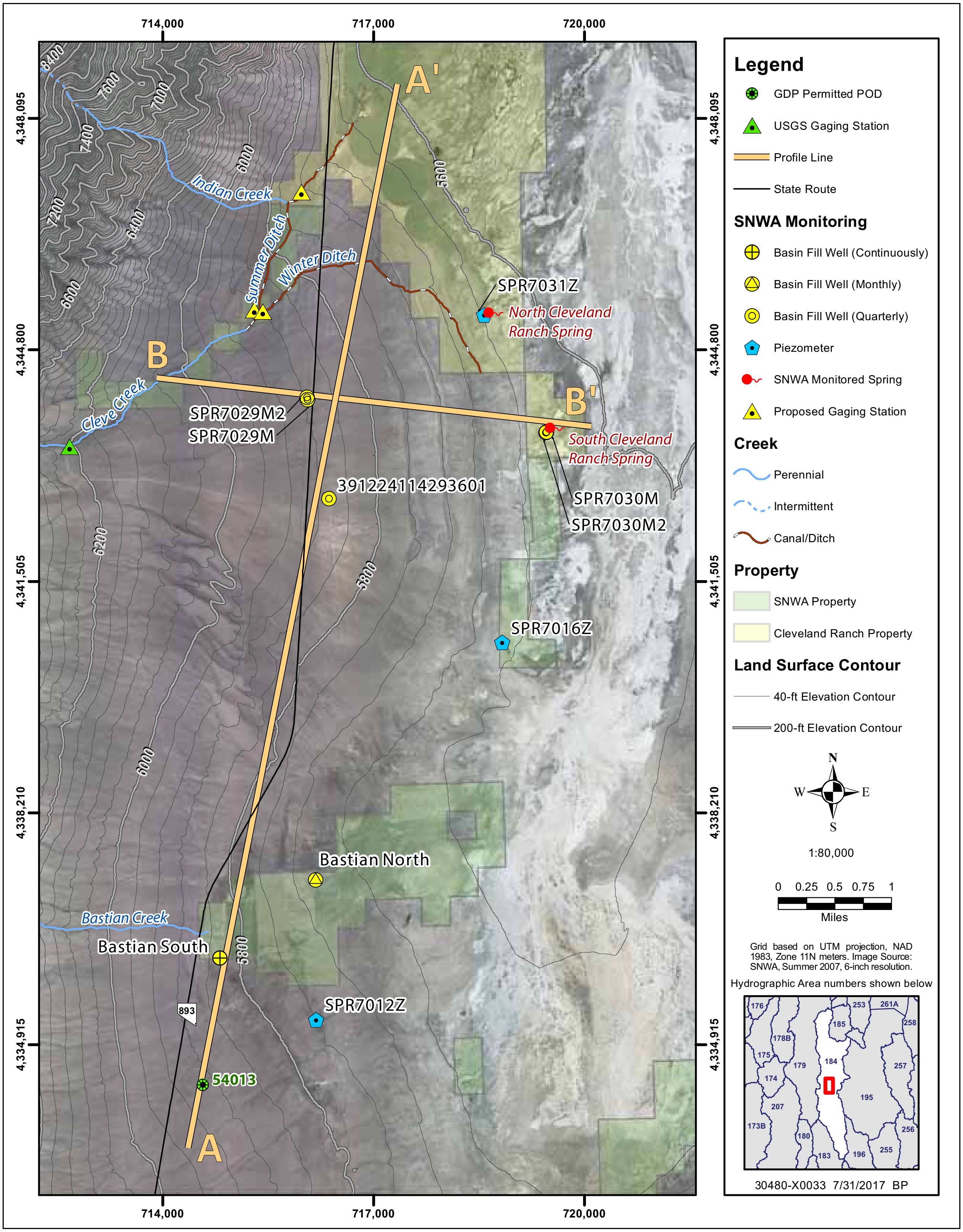


Figure 4
Hydrologic Monitoring and Profile Locations in the Vicinity of Cleveland Ranch

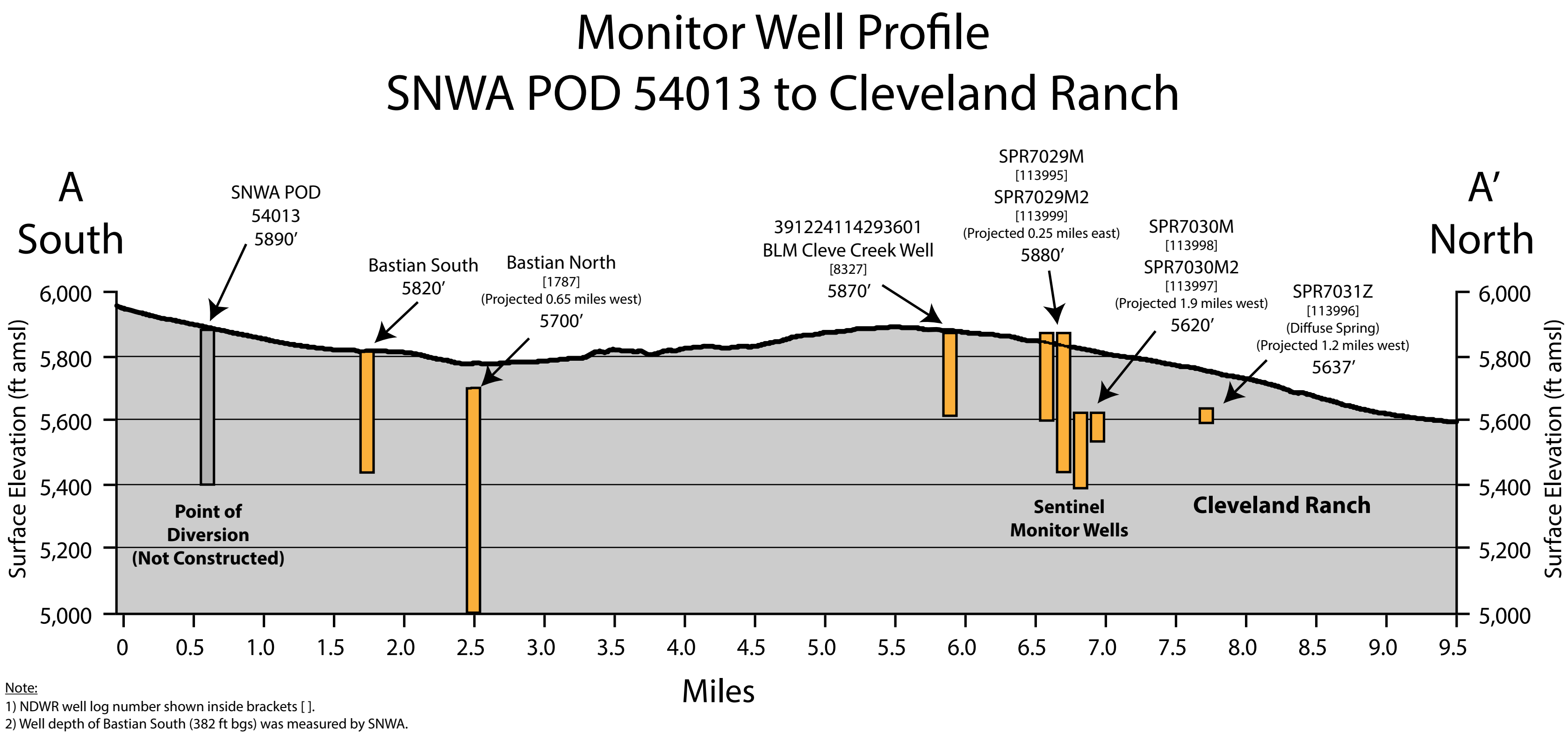


Figure 5
North - South Monitor Well Profile - SNWA POD 54013 to Cleveland Ranch

Contrary to Jones and Mayo's opinion, analysis methods are available to differentiate natural fluctuations from significant drawdown caused by SNWA GDP pumping.

3. Jones and Mayo (2017) reference the Bredehoeft (2011), and the Bredehoeft and Durbin (2009) time to full capture problem analysis (p. 36).

SNWA addressed Bredehoeft (2011), and Bredehoeft and Durbin (2009) in the rebuttal report submitted during the 2011 hearings (Prieur, 2011, Sections 2.0 and 3.0). The NSE addressed Bredehoeft's concerns in Ruling 6164, (NDWR, 2012a, p. 109-111) and stated that Bredehoeft highlights some difficulties in monitoring, but these difficulties can be overcome.

The statements and conclusions of Bredehoeft (2011) are oversimplified and do not reflect the local hydrogeologic conditions, basic principles of managing water production well fields, and state of the industry practice in regard to groundwater monitoring and adaptive management. Bredehoeft's articles dismiss understanding of the specific local hydrogeologic conditions to locate and operate individual wells in an optimal manner to minimize and manage impacts. Bredehoeft's articles also dismiss the state of the industry project monitoring and adaptive management practices which would be actively utilized by SNWA to refine predictive tools and system operation activities.

The degree of impacts presented by Bredehoeft are generalized and overexaggerated. Bredehoeft does not consider the degree of hydraulic connection between the specific pumping areas and areas of interest (streams, springs, wells, and phreatophytes). Bredehoeft's articles inadequately examine the site-specific conditions, and misapply generalized hypothetical examples to the project conditions and operations. Bredehoeft does not identify what constitutes significant harmful effects and discounts or dismisses the effectiveness of state of the industry management and mitigation measures without proper scientific consideration and examination. Therefore, it would be inappropriate for a decision maker to apply the results and conclusions of Bredehoeft's articles to SNWA's pumping in Spring Valley.

There are three additional key differences between the example in Bredehoeft (2011) and the Cleveland Ranch area. The first is the presence of a major recharge area, the Cleve Creek watershed, in the immediate vicinity of the Ranch. This is different than the example in the Bredehoeft article where the recharge area is located tens of miles across the valley from the hypothetical spring. The second is the number of wells located between the pumping site and the spring. In the Bredehoeft example the only monitor well was 48 miles downgradient of the pumping well, and only two miles from the spring. As discussed later in this report and in the Spring Valley 3M Plan (SNWA, 2017), in the real life situation there are multiple monitor wells between the GDP wells and Cleveland Ranch, which provide much earlier detection and measurement of any drawdown propagating toward the Ranch. The third is that the Bredehoeft example did not include specific investigation and mitigation triggers or management and mitigation actions that will be implemented by SNWA pursuant to the 3M Plan.

Hydrogeologic setting and the influence of irrigation practice on the 3M Plan at Cleveland Ranch

The hydrogeologic setting in the vicinity of the Cleveland Ranch is summarized to provide the context for the effectiveness of the monitoring network and mitigation actions. The hydrogeologic setting in the vicinity of Cleveland Ranch is summarized in Marshall et al. (2017, Section 6.2.3), and in Jones and Mayo (2011). The area east of the Schell Creek Range mountain block in the vicinity of Cleveland Ranch consists of upper alluvial fan sediments generally composed of coarse sands and gravel as shown in lithologic logs from SPR7029M, SPR7029M2, and the Old Cleve Well (391224114293601). The coarse alluvial fan sediments transition to finer grain sediments to the east, with distance, then encounter clay lacustrine (lake) deposits. Most of the diffuse springs are located at the toe of the alluvial fans or near the alluvial fan-lake bed interface.

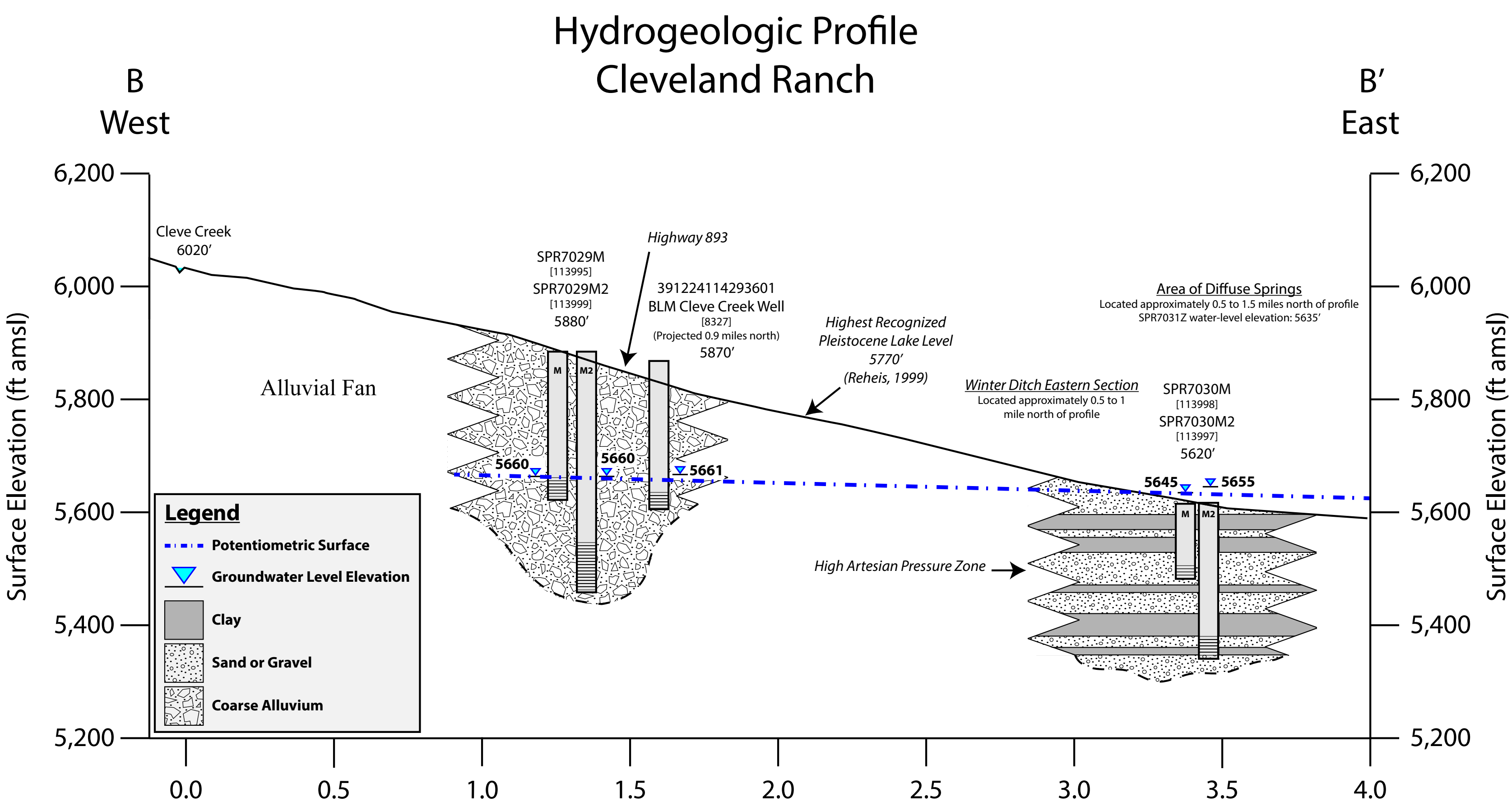
An east-west cross-sectional profile B-B' from Cleve Creek to Cleveland Ranch across the southern portion of the Ranch, presented in Figure 6, illustrates the local hydrogeologic conditions, lithology, monitor-well construction, and groundwater head levels. The cross section illustrates the transition of the unconfined conditions and coarse sediments associated with the alluvial-fan sediments and the interfingered low hydraulic conductivity clays and locally confined conditions, which underlay most of the eastern and southern portions of the Ranch, as observed in the lithologic logs from SPR7030M2 and SPR7030M2.

Groundwater in the vicinity of Cleveland Ranch is sourced from infiltration water from losing Cleve Creek and other creeks, along with other mountain block runoff infiltrating into the alluvial fan. The groundwater encounters finer sediments to the east that are interfingered with coarser materials on the valley floor, resulting in local confined conditions. The groundwater flowing though the shallower coarser grained sediments encounters the clay interface on the valley floor and causes shallow groundwater occurring above the clay to discharge through a series of diffuse springs orientated in a north-south direction. Hydraulic head measured in SPR7030M and SPR7030M2 are under artesian pressure, with the head levels of 28 and 38 ft above ground surface, respectively. The artesian pressure is indicative that the clay layers present underlaying the Cleveland Ranch have low vertical hydraulic conductivity and low leakage.

It follows that, if water is supplied to the ground surface underlain by these confining units, there would be limited downward leakage. Thus, continued application of water as part of regular CPB irrigation practices or replacement water, if needed as a mitigation measure under the 3M Plan, will maintain diffuse springs and associated mesic habitat. The clay layers are expected to be laterally continuous where the lake sediments existed. Because of the low vertical hydraulic conductivity and low leakage, the clay would buffer or minimize the impacts on the overlying shallow groundwater that may be caused from drawdown, should it occur in sediments below the clays.

The primary source of water for the Ranch is derived from:

- Surface water directly applied from Cleve, Indian, Freehill, and Stephens Creeks.
- Infiltration losses from the creeks and irrigation ditches on the alluvial fans west of Cleveland Ranch, which recharge groundwater and then discharge at the springs on Cleveland Ranch.



Notes:
1) SPR7030M and SPR7030M2 are under artesian pressure.
2) NDWR well log number shown inside brackets [ ].

Figure 6
Cross Sectional Profile Cleve Creek to Cleveland Ranch

- Groundwater derived from mountain-block runoff and infiltration, which discharges at the springs at Cleveland Ranch.

- Some amount of water discharging from the diffuse springs are expected to contain commingled irrigation return flows, tail water, and rejected recharge. Due to the presence of the low hydraulic conductivity clay underlying the Ranch, this water would tend to resurface, or is shallow sub-irrigation instead of recharging the deeper groundwater system, or be captured by deeper groundwater extraction.

Surface water in the creeks that does not infiltrate through stream losses will not be impacted by SNWA GDP pumping because the streambeds are located above the water table, as shown by comparing streambed elevation to groundwater levels (over 200 ft) at SPR7029M, SPR7029M2, and the Old Cleve Well (391224114293601). Therefore, the POD for senior certificated water right 2852, and vested claims V00790 and V01217 on Cleve Creek, and water in the streambed from Indian and Freehill creeks, as well as Stephens Creek vested claim V01218, would not be affected by SNWA GDP pumping. Groundwater recharge derived from infiltration of stream losses from Cleve Creek, Indian Creek, and Stephens Creek, and additional infiltration from summer ditch and winter ditch streambed are substantial. Jones and Mayo (2011 p. 11-12), present results of gain-loss stream segment measurements and analysis of infiltration. The gain-loss measurements were performed to help document the relationship between surface water infiltration and the groundwater recharge sources of the springs.

The infiltration rates of total streamflow reported by Jones and Mayo (2011) ranged from 31 to 93 percent of the total perennial stream flow. The groundwater recharge rate into the west side alluvial fans was about 40 percent of the total stream flow during August, 2010. Under natural conditions the net infiltration rate would be greater than measured because the measured rates only include the stream reaches upgradient of Cleveland Ranch PODs. The amount of stream-loss by infiltration through the streambed and recharge groundwater, measured in 2010 and shown in Jones and Mayo (2011, p. 14), was over 1.5 cfs per mile along Cleve Creek in the alluvial fan.

SNWA has ownership of the land on which Cleve Creek flows across a portion of the alluvial fan, between the mountain block and Cleveland Ranch Reservoir. There is concern the SNWA GDP pumping would capture groundwater flow to Cleveland Ranch, including water that is lost through infiltration through the streambed. A mitigation measure that would address this concern would be the treatment or lining of the streambed, or the construction of an aqueduct to reduce infiltration and allow direct conveyance of stream water to Cleveland Ranch that would have otherwise infiltrated through the streambed and moved to Cleveland Ranch through the subsurface. The conveyed stream water could supplement springflow by being applied in areas that are underlain by the clay lake deposits and would not, therefore, be effected by deeper groundwater levels underlying the area.

The source water and irrigation practices associated with Cleveland Ranch are discussed in detail by Resource Concepts (2011, p. 9-11). Water from the streams is used to irrigate the western portion of Cleveland Ranch, and tail water from the upper pastures is collected and commingled to flood or subirrigate the eastern portion of the Ranch. The report states:

> *Infiltration of water from Cleve Creek that occurs across the three miles of alluvial fan between the USGS Gaging Station and the Reservoir is believed to recharge many of the springs in the southern portion of the Cleveland Ranch, as they are directly down-gradient from this section of the creek* (Resource Concepts, 2011, p.11).

The report also states that the southern portion of Cleveland Ranch is almost exclusively watered by, or sub-irrigated by spring water. Some of the springs in the southern portion of the Cleveland Ranch are influenced and recharged as a result of winter flood irrigation from Cleveland Creek. The report further states that the wetlands on the east side of Cleveland Ranch have proliferated and are maintained as a result of active irrigation manipulations performed by the Ranch.

The reduction of infiltration from Cleve Creek, especially over the area of land owned by SNWA, and direct conveyance of this water to the Cleveland Ranch is a viable mitigation alternative to supplement the Ranch springs if needed. The source water for the diffuse springs would be similar with a more efficient conveyance method. This action can be further supplemented by diversion of other SNWA permitted surface water, or use of irrigation wells to supplement Cleveland Ranch water, if needed.

These, and other effective mitigation actions are identified in the 3M Plan. At least one of the mitigation action would be implemented if a mitigation trigger is activated at the Cleveland Ranch spring water right to avoid or eliminate any conflict with a senior water right. Management and preemptive mitigation actions may be taken earlier to avoid activating a mitigation trigger.

SNWA GDP pumping will not affect Cleve, Indian, Freehill, and Stephens creeks, or the winter and summer ditches, because of the depth to groundwater underlying the creeks. The creeks are losing streams, which result in substantial infiltration, which provide additional groundwater, which is conveyed through the subsurface above the lake sediment clays to the diffuse springs. The diffuse springs located on the Ranch are underlain by low vertical hydraulic conductivity clays, with low vertical leakage. Should significant drawdown occur below the Ranch and clays, which change the strong upward vertical gradient, the clays will buffer or minimize downward leakage. Lining of the streambed, especially on SNWA-owned property, to more effectively convey water that would have infiltrated and flowed as groundwater to the Ranch, is a viable mitigation action. This can be supplemented by other SNWA water rights to be diverted to the Ranch.

Jones and Mayo (2017) Conclusions (p. 37)

Jones and Mayo (2017) offer the following conclusions:

1. Jones and Mayo (2017) seek to invalidate the approach used by the NSE, questioning the use of water-resource assessments to quantify perennial yield. Preparing a water budget analysis, or a water-resource assessment, is a necessary first step for determining the water available for appropriation in a given basin. The USGS performed this first step for 219 basins in Nevada and reported the results in 60 Reconnaissance Series Reports. As more data were acquired through the decades, some of the assessments were revised and new perennial yield values adopted.

It is overly simplistic to suggest that sustainability is only related to well-field design, and that it can be assessed through long-term computer simulations. The modeling performed by Jones and Mayo (2017) using outdated simulations, demonstrated that Spring Valley did not reach absolute equilibrium within the 2,000-year period.

Jones and Mayo (2017) failed to highlight that the largest changes occurred in the first 200 years of simulation, and by 500 years of simulation, the changes had slowed down dramatically. Drici et al. (2017) demonstrated that with a model updated for ET recharge, the new total permitted rights, and a different pumping configuration, the model reaches equilibrium much sooner. The models used in these runs, as well as the others described within the Jones and Mayo report, are all regional-scale models without the necessary details regarding geology, aquifer properties, and ET dynamics to make accurate predictions.

2. Jones and Mayo (2017) claim that the only way the Spring Valley flow system could possibly reach equilibrium is by lowering the groundwater table to capture the well production from ET discharge. They then speculate that this cannot be accomplished without lowering the water table below the Ranch and affecting the Ranch's seeps, springs, and wells.

We agree that the Spring Valley flow system could reach equilibrium faster if the production wells configuration were designed to capture ET discharge, as Jones and Mayo (2017) claim (Drici et al., 2017). However, the potential effects on the Ranch are pure speculation at this time as the complex three-dimensional hydrogelogy underlying the Ranch is not known at this time. Such complexities are not currently included in the CCRP model. Therefore, simulation results indicating a drawdown under the Ranch do not necessarily indicate effects on the Ranch's water features. Besides, the CPB's sole water right is on Cleve Creek, which will not be affected by SNWA pumping. The natural water features, including the vested springs are an artifact of CPB's conveyance method of their water right on Cleve Creek and an apparent attempt to claim the same water twice.

3. Jones and Mayo (2017) claim that a monitor, manage, and mitigate strategy would not adequately protect the Cleveland Ranch' water rights. They also claim that by the time the effects of pumping are detected at the location of their water rights, the flow system would take centuries to recover if pumping is stopped. They further claim that it would be difficult or impossible to differentiate the effects of pumping from the effects of changes in natural stresses.

The CPB's senior water rights and environmental resources located on and in the vicinity of Cleveland Ranch will be protected by monitoring, management, and mitigation actions as described in the Spring Valley 3M Plan (SNWA, 2017). Hydrologic monitoring performed between SNWA GDP PODs and Cleveland Ranch will detect and measure propagation of drawdown. SNWA has set specific quantitative investigation and mitigation triggers in the Spring Valley 3M Plan to implement management or mitigation actions to prevent or eliminate unreasonable effects. Mitigation actions, if needed, will be effective based upon the hydrgeologic setting and availability of replacement water.

Jones and Mayo (2017) make inaccurate conclusions based upon their model simulations. They base this specific conclusion on the fact that the drawdown, at a vested claim on a former segment of Stevens Creek, is a mere 4.7 ft after 300 years of simulated groundwater development. Because Jones and Mayo (2017) allowed their model simulation to have 300 years of continuous pumping, it required 210 years for full recovery. Had they stopped the model after a single year, the recovery would have taken place the following year. While the 4.7 ft of drawdown over 300 years amounts to less than 0.2 inches per year, this consistent drawdown would be apparent in data collected and/or future model predictions, prior to the 300-year time frame. As such, management actions could be taken much sooner than the 300-year time frame chosen by Jones and Mayo (2017).

In addition, the numerical groundwater flow model drawdown projection in the vicinity of Cleveland Ranch presented by Jones and Mayo (2017), do not accurately represent actual conditions that will occur in the future for a number of reasons. These include that the projections (1) are based on limited aquifer property and response data; (2) do not take into account management actions or changes in production rate, duration, or distribution; and (3) do not take into account wet year recharge events on the Cleve Creek alluvial fan. The average monthly flow of Cleve creek between 1960 and 2010 ranged from 6.5 to 23 cfs, and the average annual flow ranged from 5.6 to 22.2 cfs. The model also does not consider groundwater-surface water interactions, nor does it reflect the effect of Cleveland Ranch irrigation practices on groundwater levels or spring discharge.

We agree that it may be difficult to separate the effects of pumping from those of changes in natural stresses, but we strongly disagree that it is impossible. With adequate records of (1) SNWA production and monitoring data, (2) natural stresses such as climate variables, (3) anthropogenic stresses caused by other users such as CPB, (4) updated and more reliable groundwater flow models, and (5) careful data analyses, using numerical modeling and other techniques; the effects of SNWA pumping can be segregated from the effects caused by other stresses on the flow system.

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