In the Matter of Applications 53987, 53988,
53989, 53990, 53991 and 53992
filed to Appropriate Water in Cave Valley (Basin 180),
Dry Lake Valley (Basin 181), and Delamar Valley (Basin 182)
In White Pine and Lincoln Counties, Nevada

HYDROLOGIC REPORT

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INTRODUCTION

In 1989 the Las Vegas Valley Water District filed 146 Applications to appropriate water in Eastern Nevada. One of those applications was for surface water from the Virgin River and that application was acted upon in about 1992. Title to these applications was later assigned to the Southern Nevada Water Authority (SNWA). Approximately 21 applications were withdrawn. Nineteen applications were granted in 2007 for groundwater in Spring Valley in State Engineer Ruling No. 5726. Here, the State Engineer is being asked to hold an evidentiary hearing and take testimony on the granting of Applications 53987, 53988, 53989, 53990, 53991 and 53992 filed in Cave Valley (Basin 180), Dry Lake Valley (Basin 181), and Delamar Valley (Basin 182). This Special Hydrology Report is being submitted into evidence in support of those applications.

This report is based upon my 36 years as a hydrologist dealing with water rights, 24 of which have been in Nevada. Ten and one half of those years were spent as the Nevada State Engineer and four of those years were spent as Director of the Department of Conservation and Natural Resources. I submit this report as being an expert in Nevada Water Law and Nevada Hydrology.

This report analyzes the following issues:

1. The applicability of using the Theis equation to predict draw downs in a fractured flow system in carbonate rock.

2. Whether all or a portion of the recharge can be captured in one basin and whether any outflow from that basin can be captured in a down gradient basin. Whether all of the recharge in a particular basin can be captured rather than one half of the recharge.

3. The influence of the Pahranagant Shear Zone, not from a hydrogeology standpoint but rather from a conservation of mass standpoint.

4. Whether large scale agricultural applications, junior in priority, should be granted as part of the basin of origin protection provided for in NRS 533.370 (6)(d).

1.0 APPLICABILITY OF USING THE THEIS ANALISIS

Although the Theis equation has been used extensively in determining drawdown effects of pumping groundwater in Nevada, it is most applicable in alluvial aquifers and to analyze effects of a particular pumping well on another well within a fairly close proximity (e.g. one to two miles). Additionally, it has been used for fairly short duration pumping scenarios. The longer the pumping scenario, the more likely the aquifer will respond to boundary conditions, either a recharge boundary or a no-flow boundary.

Some of the assumptions made in using the Theis equation are:

The aquifer is infinite in aereal extent,

The aquifer is homogeneous, isotropic and of uniform thickness,

The pumping well fully penetrates the aquifer

There is no recharge.

Even though these conditions are rarely found in drilling a well in alluvial aquifers, the cone of depression is usually fairly uniform. Theis may slightly over estimate the effects on a neighboring well because there most likely is a recharge component. On the other hand, lateral porosity is sometimes an order of magnitude greater than vertical porosity resulting a slight under estimation of the effects on a nearby well. An additional complicating factor is whether there are confining layers. Theis will make slightly different predictions depending on whether the water bearing material is unconfined, slightly confined, or totally confined. Notwithstanding the limitations of using Theis, it is a good first step in determining effects of a pumping well on surrounding water resources.

The carbonate aquifer consists of fracture flow characteristics. Rarely are the Theis assumptions ever met when drilling into a fractured flow system. The aquifer is anything but homogeneous. The flow toward the well bore along the fractures can be orders of magnitude greater than the flow across the fractures. There are almost always boundary conditions. These can be simulated using an image well but it is not usually known if the boundary is a leaky boundary or a no-flow boundary. The drawdown cone will be elongated along the fracture or along a solution channel. Based on the characteristics of the carbonate system, in my opinion, the effects on other permitted groundwater rights in Cave Valley, Dry Lake Valley, and Delamar Valley by granting the subject carbonate applications is minimal if they exist at all. Water rights on springs are high on the mountain block and are perched by underlying bed rock; therefore, pumping groundwater on the valley floor could have no effect on these water rights.

2.0 CAPTURE OF ALL THE RECHARGE

Recharge from precipitation occurs over a very large area. A lot of the groundwater basins in Nevada are completely surrounded by mountains. This is the case for Cave Valley, Dry Lake Valley, and Delamar Valley. It is on these mountain blocks where the greatest amount of precipitation occurs and therefore the greatest amount of recharge occurs. It had always been assumed, based on limited private landownership, that no single appropriator, at any single point of diversion or on any single farm unit could possibly capture all the recharge. Therefore the State Engineer, in the past, determined that the perennial yield is one-half of the basin recharge and that was all that he would allow to be appropriated.

The SNWA is not bound by land ownership. Most or all of the wells sought in Cave Valley, Dry Lake Valley, and Delamar Valley are on public land. By following the statutory change application process, the SNWA could drill multiple wells over a very large area and presumably capture all or nearly all of the recharge. Of course, the State Engineer has to evaluate injury to other water rights both in the original appropriation and any subsequent change application to change points of diversion. There are so few water rights in these valleys that if interference were to occur it could surely be mitigated easily. Through proper study and monitoring, wells could be strategically located to minimize impacts and at the same time maximizing the capture of the basin recharge.

The recharge/discharge relationship in Dry Lake Valley and Delamar Valley has been studied by Eakin and others but those studies were done in the 1960's. Precipitation data was scarce in the 1960's. Recharge coefficients were calculated by balancing the precipitation from the Hardman Map and discharge by phreatophytes in basins that were closed with no outflow. Discharge processes were even less understood. The Las Vegas Valley Water District (LVVWD) updated those studies in 2001 using the PRISM method for precipitation estimates as well as many more high mountain precipitation gages.

There is no discharge by phreatophytes in either Dry Lake Valley or Delamar Valley. Based on data provided in SNWA's 2007 report, SNWA now estimates that recharge in Dry Lake Valley as approximately 15,700 AF, which is in the range of precipitation and recharge values in these basins that were estimates by LVVWD in 2001 and the Reconnaissance values. Add to that 2000 AF of inflow from northern Pahroc Valley and the total available water is approximately 17,700 AF. With no ET from phreatophytes it is assumed that all of this water is represented by inflow to Delamar Valley. SNWA has applied for permits to appropriate 11,584 AF in Dry Lake Valley. Even if the State Engineer were to grant the permits in total, there would still be more than 6000 AF flowing into Delamar Valley. Add to that approximately 6400 AF of recharge in Delamar Valley, and over 12,000 AF is available for capture in Delamar Valley. Inter-basin flow has been appropriated in many down-gradient basins in Nevada. SNWA has suggested that Dry Lake Valley and Delamar Valley be managed as one basin since there appears to be no hydrologic or geologic divide. The State Engineer need not have to manage the basins as one. The State Engineer should approve the appropriate amount of water from Dry Lake Valley allowing substantial amounts of water to continue to out flow to Delamar Valley and allow the appropriation of the recharge plus inflow in Delamar Valley.

Therefore, substantial amounts of water can be permitted in both valleys while at the same time, addressing the basin of origin considerations pursuant to NRS 533.370.

3.0 INFLUENCE OF THE PAHRANAGAT SHEAR ZONE

The Southern Nevada Water Authority (SNWA) studied and recalibrated the recharge/discharge relationship for the entire White River flow system. Using the PRISM map and recent updated precipitation gages, a much more accurate estimate of total precipitation was derived. The largest component of discharge in the White River

Flow System is groundwater evapotranspiration (ET). Areas of groundwater ET were mapped and the latest technology for estimating potential ET were used to calculate discharge in the system. Using computer technology, estimates of recharge coefficients were determined for different precipitation bands. Although the recharge coefficients are higher that those used by Maxey and Eakin in the 1960's they are lower than those used by the Las Vegas Valley Water District (LVVWD) in their studies in 2001. By using the mid-range values for recharge and discharge, a mid-range value was calculated for the entire system yield of the entire White River Flow System. The entire flow system is in balance.

Using these same values on a more microscopic scale, the recharge/discharge relationship was calculated for Cave Valley, Dry Lake Valley and Delamar Valley. It was found that much more water exits Delamar Valley to Coyote Spring Valley than previously recognized in the original studies by the USGS. Water cannot exit Delamar Valley directly west into Pahranagat Valley or to the east to Kane Springs Valley because of geologic features, therefore it must exit to the southwest to Coyote Spring Valley. SNWA 2007. It is a simple matter of conservation of mass. One can speculate as to why the USGS studies resulted in such a low number but they had to have at least 35,000 AF flowing into Coyote Springs Valley because that plus the recharge in Coyote Springs Valley has to match the discharge at Muddy River Springs.

The Pahranagat Shear Zone is a large complex of northeast/southwest trending faults. The hydraulic head potential between the south end of Pahranagat Valley and the north end of Coyote Springs Valley is approximately 1400 feet. I have known for a long time of this head difference. When the monitoring plan was being developed for pumping in Coyote Springs Valley, the then owner of the Buckhorn Ranch wanted a monitoring well near the south end of Pahranagat Valley. I thought at the time that would be senseless since no amount of pumping in Coyote Springs Valley could "jump" a 1,400 foot water fall. Given the volume of water and the head differential SNWA has calculated, the transmissivity of the shear zone is 5500 feet squared per day. This number is certainly plausible and could even be low.

If the State Engineer can accept the conservative values of precipitation, evapotranspiration, and recharge then he has to accept that the system is in balance and that a lot more water passes the Pahranagat shear zone than was estimated in the 1960's. It is a simple matter of conservation of mass. All of this water has to be going somewhere and all indications are that it passes the shear zone. This water can be permitted north of the shear zone with little or no impact to the water rights down gradient. If for example, permitting additional water rights in Cave Valley, Dry Lake Valley and Delamar Valley were to lower the water table north of the shear zone by five feet, that would reduce the head differential by 3 tenths of one percent. Given the uncertainties in the precipitation estimates, recharge coefficients, and the ET, this hypothetical decrease is insignificant.

One can speculate on whether the granting of the applications that are the subject of the upcoming hearings will impact down gradient water rights. If the pumping of water in

Cave Valley, Dry Lake Valley, and Delamar Valley is later determined to have a potential impact on the flow at Muddy River Springs, certainly mitigation to protect senior water right holders would have to occur. On the other hand, if much more water passes the Pahranagat shear zone into Coyote Spring Valley and is taken up by ET then no injury occurs. If impacts of pumping affects senior water right holders in Coyote Spring Valley, the impacts can be mitigated since SNWA holds the majority of the senior water rights in Coyote Spring Valley.

4.0 RESERVING WATER FOR THE BASIN OF ORIGIN

Nevada Revised Statutes (NRS) Chapter 533.025 states that all the water in this state, whether above or below the surface of the ground belongs to the public. This statute was one of the original statutes passed by the 1913 session of the legislature. After the Las Vegas Valley Water District (LVVWD) filed applications in 1989 to import water from Nye, Lincoln, and White Pine Counties, the legislature passed NRS 533.438 in 1991 which allowed counties of origin the ability to tax water that leaves their county. This was the first time in the history of the state that counties had some say in managing the water within their boundaries. Then in 1995, the legislature, after an interim study committee, amended NRS 533.370 to allow some protection for the "basin" of origin. The State Engineer must now, in considering whether to approve or reject an application, determine "whether the proposed action is an appropriate long-term use which will not unduly limit the future growth and development in the basin from which the water is exported." NRS 533.370 (6)(d).

Nevada Revised Statutes 534.030 allows the State Engineer to designate a groundwater basin in need of additional administration and to designate preferred uses. When a basin is determined to be fully appropriated or nearly fully appropriated, he will designate that basin and in many of these basins state that irrigation is NOT a preferred use of water. This designation stems from the fact that irrigation has the least amount of economic return per acre foot of developed water.

Should the State Engineer consider applications for irrigation filed later in time than those filed for municipal use as falling within the "future growth and development" of the basin of origin? My opinion is that he should not. In the past 150 years, there has been no groundwater developed for irrigation purposes in Cave Valley, Dry Lake Valley, or Delamar Valley. I believe it was the intent of the legislature to have the State Engineer look at the potential economic growth in the Basin of Origin in terms of municipal and industrial growth. It was also the intent of the legislature not to reserve water in the Basin of Origin for speculative purposes but to consider the future growth potential from an economically viable standpoint. Further, the "future growth and development" requirement is not intended to benefit any one individual or project, or to undermine the prior appropriation doctrine. If there is little or no municipal or industrial growth planned in the Basin of Origin then the State Engineer has fulfilled that obligation and he may grant the entire amount of unappropriated water in a basin provided the provision of NRS 533.370 are met.

If the State Engineer were to grant the applications filed by SNWA, he should designate Cave Valley, Dry Lake Valley, and Delamar Valley as basins in need of additional administration, and irrigation would not be a preferred use.