IN THE OFFICE OF THE STATE ENGINEER
OF THE STATE OF NEVADA

IN THE MATTER OF APPLICATION 64692 FILED TO APPROPRIATE THE UNDERGROUND WATERS OF THE TULE DESERT HYDROGRAPHIC BASIN (221), LINCOLN COUNTY, NEVADA.

RULING
#5986

GENERAL

I.

Application 64692 was filed on December 11, 1998, by Lincoln County and Vidler Water Company Inc., later assigned to Lincoln County Water District and Vidler Water Company, Inc. (Vidler), to appropriate 10.0 cubic feet per second (cfs) of underground water in the Tule Desert Hydrographic Basin.[1] The water is to be used for municipal purposes within all of T.12S., R.71E., and Sections 1, 2, 11, 12, 13, 14, 23, 24, 25, 26, 35, and 36, T.12S., R.70E., M.D.B.&M. in the Virgin River Valley Hydrographic Basin. The proposed point of diversion is described as being located within the SE¼ SE¼ of Section 2, T.9S., R.69E., M.D.B.&M. Item 12 of the application provides that the use of water will be for future growth and development of the Mesquite area within Lincoln County, Nevada.

II.

Application 64692 was timely protested by the United States Department of the Interior, National Park Service (NPS);[2] however, the NPS withdrew its protests based on a Stipulation entered into with the applicants.[3] The Stipulation recites, among other things, that:

1. The application, together with application 64693, request a combined maximum duty of 14,500 acre-feet annually, and the Applicant initially intends to pump up to 7,240 acre-feet annually (afa) for a period of 42 years for the Toquop Energy Project, and thereafter for municipal and domestic uses in Lincoln County.
2. Lincoln County and Vidler propose to request the State Engineer hold in abeyance the remaining amount under the applications until a determination can

[1] Exhibit No. 2, public administrative hearing before the State Engineer, May 14-16, 2002, official records in the Office of the State Engineer. Hereinafter exhibits from this hearing will be referred to by their exhibit number and the transcript will be referred to by page number.
[2] Exhibit No. 5.
[3] Exhibit No. 8.

be made from the monitoring of the initial ground-water withdrawals that there are no unreasonable adverse impacts due to the initial ground-water pumping.

3. The parties to the Stipulation desire to implement a monitoring, management and mitigation program as set forth in Exhibit A to the Stipulation.

III.

Application 64692 was timely protested by the Virgin Valley Water District (VVWD) on the following grounds:[4]

1. The subject application was filed for purposes of speculation with no defined ultimate use or project and accordingly is not in the public interest.
2. The Applicant does not own or control the proposed place of use.
3. The granting of the subject application will adversely impact existing rights of the Protestant and could further adversely impact the potable water source for residents of the City of Mesquite, the Town of Bunkerville and others within the service area of the Protestant.
4. Upon information and belief, the granting of the subject applications, particularly when considered with other applications filed concurrently by the Applicants, will adversely impact the quality of water heretofore appropriated by the Protestant.
5. The granting of the subject application, particularly when considered with other applications filed concurrently by the Applicants, will adversely impact existing springs and seeps that provide a source of water for wildlife (including some species listed under the Endangered Species Act).
6. The source of resource the Applicants seek to appropriate is regional in character and the granting of the subject application, particularly when considered with other applications filed concurrently by the Applicant, will adversely impact existing rights, including but not limited to, those of the Protestant.
7. The Applicant, Vidler Water Company, Inc., is barred from appropriating public waters of this State due to deficiencies in its status with the Nevada Secretary of State.

Therefore, the Protestant requested the Applications be denied.

IV.

A public administrative hearing on Applications 64692 and 64693 was held on May 14-16, 2002, before the State Engineer at Carson City, Nevada.[5] State Engineer's Ruling No. 5181 was issued on November 26, 2002, wherein Application 64693 was granted in the amount of 2,100 afa and Application 64692 was held in abeyance while the Applicant pursued additional

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[4] Exhibit No. 6.

[5] Exhibit No. 1; Transcript, public administrative hearing before the State Engineer, May 14-16, 2002.

study, which was to include, among other things, the amount of ground water available from the Tule Desert Hydrographic Basin, recharge to the basin, and direction of ground-water flow. The additional study was to be peer reviewed and accepted by the United States Geological Survey (USGS) and the Nevada Department of Conservation and Natural Resources, Division of Water Resources.

V.

Following the issuance of Ruling No. 5181, Vidler completed a number of studies, both internally and with the assistance of consultants, to quantify the amount of ground water locally recharged on an annual basis within the basin, the direction of ground-water flow, and the potential effects of various pumping rates on ground-water aquifers in the Tule Desert and surrounding areas. A group of five technical reports were prepared and submitted to the Nevada State Engineer and the USGS. The USGS reviewed the reports at the request of the National Park Service and published USGS Open File Report 2008-1354 in late 2008 detailing the results of that review.[6]

FINDINGS OF FACT

I.

STATUTORY STANDARD TO GRANT

The State Engineer finds that NRS § 533.370(1) provides that the State Engineer shall approve an application submitted in the proper form, which contemplates the application of water to beneficial use if the applicant provides proof satisfactory of his intention in good faith to construct any work necessary to apply the water to the intended beneficial use with reasonable diligence, and his financial ability and reasonable expectation actually to construct the work and apply the water to the intended beneficial use with reasonable diligence.

II.

STATUTORY STANDARD TO DENY

The State Engineer finds that NRS § 533.370(5) provides that the State Engineer shall reject an application and refuse to issue the permit where there is no unappropriated water in the proposed source of supply, or where the proposed use conflicts with existing rights or with

[6] David L. Burger, et al., *Technical Review of Water – Resources Investigations of the Tule, Desert, Lincoln County, southern Nevada, Open-File Report 2008-1354,* (United States Geological Survey), 2008, (hereinafter USGS OFR 2000-1354).

protectable interests in existing domestic wells as set forth in NRS § 533.024, or where the proposed use threatens to prove detrimental to the public interest.

III.

STATUTORY STANDARD FOR INTERBASIN TRANSFERS

The State Engineer finds that NRS § 533.370(6) provides that in determining whether an application for an interbasin transfer of ground water must be rejected, the State Engineer shall consider: (a) whether the applicant has justified the need to import the water from another basin; (b) if the State Engineer determines a plan for conservation is advisable for the basin into which the water is imported, whether the applicant has demonstrated that such a plan has been adopted and is being effectively carried out; (c) whether the proposed action is environmentally sound as it relates to the basin from which the water is exported; (d) 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; and (e) any other factor the State Engineer determines to be relevant.

With the two exceptions of NRS § 533.370(5) relating to unappropriated water at the source of supply and conflicts with existing rights, the State Engineer finds the other provisions of NRS § 533.370(1), NRS § 533.370(5) and NRS § 533.370(6) were addressed and satisfied in Ruling No. 5181.

IV.

PERENNIAL YIELD

The perennial yield of a ground-water reservoir may be defined as the maximum amount of ground water that can be salvaged each year over the long term without depleting the ground-water reservoir. Perennial yield is ultimately limited to the maximum amount of natural discharge that can be salvaged for beneficial use. The perennial yield cannot be more than the natural recharge to a ground-water basin and in some cases is less. If the perennial yield is exceeded, ground-water levels will decline and steady-state conditions will not be achieved. Additionally, withdrawals of ground water in excess of the perennial yield may contribute to adverse conditions such as water quality degradation, storage depletion, diminishing yield of wells, increased economic pumping lifts, and land subsidence.

In many of Nevada's hydrographic basins, ground water is discharged primarily through evapotranspiration (ET). In those basins, the perennial yield is approximately equal to the estimated ground-water ET; the assumption being that water lost to natural ET can be captured by wells and placed to beneficial use. Many of the basins in the carbonate aquifer terrain discharge most of their ground water via subsurface flow to adjacent basins, that is, there is little or no ET. Accurate measurement of the subsurface outflow is exceedingly difficult, and in many cases may not be possible, and is therefore estimated as the total of local recharge and the subsurface inflow from adjacent basins. The amount of subsurface discharge that can be captured is highly variable and uncertain. Perennial yields for these basins have historically been set at one-half of the subsurface discharge. However, when conditions are such that there is subsurface flow through several basins, there is a potential for double accounting and over appropriating the resource if the perennial yield of each basin is equal to one half of the subsurface outflow, and basin subsurface inflows are not adjusted accordingly. Therefore, allowances and adjustments are required to the perennial yields of basins in these "flow systems" so that over appropriation does not occur.

A recent ruling by the State Engineer discussed in detail how perennial yield was determined in undeveloped basins that lacked in-basin ET and also had subsurface ground-water inflow and outflow.[7] In that ruling, for basins that discharged their ground water by subsurface outflow to an adjacent basin, there was a consideration for the proximity of the basin to other developed basins and as to whether the outflow from the basin was already allocated in the immediate downgradient basin. For the basins where the downgradient basin's ground water was fully appropriated or had regional springs that could be impacted by upgradient pumping, the perennial yield was set to be equal to one half of the in-basin recharge. Water entering the basin by subsurface inflow from an upgradient basin was not deemed to be a component of the perennial yield. For one basin that had an undetermined amount of subsurface inflow from an undeveloped basin, and subsurface outflow to an undeveloped basin, the perennial yield was determined to be all of the in-basin recharge. The State Engineer found in that ruling that subsurface ground-water inflow was not included in the basin's perennial yield, thereby addressing the issue of double counting the resource and regional over appropriation. Ruling No. 5875 also addressed the time frame for responsible decision making in regard to potential future

[7] State Engineer's Ruling No. 5875, dated July 9, 2008, official records in the Office of the State Engineer.

impacts, noting that impacts that may first occur several hundred years in the future were outside the limits of reasonable and responsible decision-making.[8]

Ground-water recharge in the Tule Desert was first estimated by Glancy and Van Denburgh in Water Resource - Reconnaissance Series Report 51.[9] They estimated 2,100 afa of ground-water recharge by using the standard Maxey-Eakin recharge coefficients with precipitation zones as described in Table 9.[10] In the first hearing on Applications 64692 and 64693, evidence was presented relating to higher estimates of recharge. This evidence was considered inconclusive, although it was recognized that there is a reasonable likelihood that recharge exceeds the reconnaissance estimate. Application 64693 was granted in the amount of 2,100 afa, but Application 64692 was held in abeyance until such time as the Applicant could demonstrate that recharge in the basin exceeded the reconnaissance report estimate.

The Applicant provided several analyses by Daniel B. Stevens and Associates, Inc. (DBS) to re-estimate ground-water recharge in Tule Desert. The analyses are contained in two reports and two supplemental memos: *Mean Annual Recharge for the Tule Desert Hydrographic Basin Lincoln County, Nevada*, January 8, 2008, *Addendum to Mean Annual Recharge for the Tule Desert Hydrographic Basin Lincoln County, Nevada*, April 14, 2008, a Technical Memo addressed to G. Bushner dated August 22, 2008, and a Technical Memo to G. Bushner dated October 15, 2008. A number of techniques and models were employed by DBS to estimate basin-wide recharge, including a physically based soil-water balance model, empirical models based on transfer equations such as the Maxey-Eakin method, the chloride mass balance (CMB) method, and using Darcy's law to estimate infiltration. The DBS-computed recharge estimates were initially provided in the January 8, 2008, report, but were revised in the Addendum report of April 14, 2008, and in both the August 22, 2008, and October 15, 2008, Technical Memos. The Tule Desert basin recharge was reported to range from a low of 2,600 afa using a version of the Maxey-Eakin method to a high of 10,500 using a transfer equation, with an average annual recharge of 6,100 acre-feet.[11]

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[8] *Ibid.*, p. 22.
[9] Patrick A. Glancy and A. S. Van Denburgh, *Water-Resources Appraisal of the Lower Virgin River Valley Area, Nevada, Arizona, and Utah*, Water Resources-Reconnaissance Series Report 51, (Department of Conservation and Natural Resources, Division of Water Resources and U.S. Department of Interior, Geological Survey), 1969.
[10] *Ibid.*, Table 9, p. 38.
[11] DBS, January 8, 2008, *Mean Annual Recharge for the Tule Desert Hydrographic Basin, Lincoln County, Nevada*, Table ES-1.

In the USGS review of the DBS technical reports, they recommended that only recharge estimates made using the water balance model, CMB, and composite analysis should be considered.[12] They also recommend that the DBS recharge estimates be adjusted downward because long-term precipitation rates were less than precipitation rates during the period of record of the precipitation models used by the Applicant. DBS' later Technical Memo[13] recalculated the water-balance estimates with precipitation adjusted to the 1937 to 2008 period as recommended in the USGS review,[14] and shows those results in Table 7 of the October 15, 2008 memo.[15] Neglecting the transfer equations, DBS' re-estimated recharge ranged from 3,900 to 8,000 afa, and averaged 5,400 afa.[16]

In determining the perennial yield of a hydrographic area, which in the case of Tule Desert will be based on average annual ground-water recharge from precipitation within the basin, the State Engineer desires to use the best available data. The Applicant provided many separate estimates of recharge, and stressed how well the estimates grouped around a central tendency of 6,000 afa.[17] The USGS OFR 2008-1354 discounted the estimates made with the use of transfer equations, and in a later document, the Applicant revised its average recharge to 5,400 afa. In past rulings, the State Engineer has found that the use of the Maxey-Eakin coefficients with any map other than the Hardman precipitation map is inappropriate and recharge estimated thereby would not be accepted.[18] Evidence presented in the Applicant's documents pointed out that there are two Hardman maps, a considerable difference exists between the two versions of the maps in the Tule Desert area, and recharge estimated with the maps also varied considerably. Furthermore, they point out that neither of the Hardman maps had actual data from the Tule Desert and precipitation estimates using either of the maps was inaccurate.[19] The Applicant went on to use a variety of other transfer functions to provide additional estimates of recharge.[20] State Engineer's Ruling No. 5181 required the Applicant conduct additional studies to support their

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[12] USGS OFR 2000-1354, p. 18.
[13] DBS Technical Memo, dated October 15, 2008.
[14] USGS OFR 2008-1354, p. 18.
[15] DBS Technical Memo, dated October 15, 2008, Table 7.
[16] *Ibid.*
[17] DBS Recharge Report, dated January 1, 2008, p. ES-1.
[18] State Engineer's Ruling Nos. 5712, p. 12, and 5782, p. 13, dated February 2, 2007, and September 17, 2007, official records in the Office of the State Engineer.
[19] DBS Recharge Report, January 1, 2008, pp. 2, 17 - 19.
[20] *Ibid.*, pp. 59 - 62.

contention that there was more than 2,100 afa of recharge in the basin. However, the use of more transfer functions as a means to refine the recharge does not provide the level of confidence the State Engineer is seeking, primarily because transfer functions are typically used for regional or reconnaissance-level investigations, provide a similar level of certainty as the original Maxey-Eakin methods reported in the reconnaissance reports, lack the technical merits sought by Ruling No. 5181, and are not an acceptable advancement in the confidence of the recharge estimates unless they are calibrated to the natural discharge of the basin or flow system. The State Engineer finds the Applicant's estimates of recharge using any of their transfer equations do not acceptably meet the requirements of Ruling No. 5181 and are hereby discounted.

Of the other methodologies used by the Applicant, they will be considered as acceptable methods to advance recharge estimates in the basin. However, the State Engineer must be cautious because the Applicant is requesting the full perennial yield of the basin, and wishes to export the water and use it for quasi-municipal purposes. The perennial yield must be based on recharge studies, which the State Engineer feels are less certain than estimates of ET discharge. Historically, the State Engineer has been conservative in his estimates of perennial yield so that the water resource is not over allocated. With each of the three main methods to estimate ground-water recharge used by the Applicant: the soil-water balance, chloride mass balance, and their composite analysis, there are inconsistencies and issues of concern that have a high level of uncertainty and could lead to an overestimation of the recharge.

The soil-water balance model is the most technical of the methods employed. The method uses daily time steps with estimated values of precipitation, bare soil evaporation, transpiration, runoff, runon, snow accumulation, snowmelt, snow sublimation, soil-water storage, soil and bedrock hydraulic properties, and net infiltration. Infiltration past the root zone is the net infiltration and is considered ground-water recharge. A variety of precipitation estimates were considered and net infiltration for each was computed and reported in the DBS documents.[21,22] DAYMET 1981-2003[23] precipitation estimates were used as the primary temporal data source for the model. The temporal distribution of precipitation was simulated by providing DAYMET daily precipitation for the pixel coincident with the Garden Springs RAWS

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[21] DBS Recharge Report January 8, 2008, Table 8-1.
[22] DBS Memo, October 15, 2008,Table 7.
[23] DAYMET, 2007, DATMET U.S. Data Center, Available at <http:/www.daymet.org>.

(Remote Automated Weather Station), and the spatial distribution of daily precipitation was simulated by using a regional precipitation altitude relationship derived from surrounding National Climate Data Center (NCDC) 1971-2000 precipitation estimates. Prior to spatially distributing the precipitation with the regionally derived precipitation altitude relationship, the DAYMET precipitation record was adjusted downward by 20% to match the regional NCDC stations. The DAYMET precipitation record was also adjusted downward by 29% to match the estimated mean from the 2007 water-year study period. The unadjusted DAYMET data was also used in a simulation. Resulting recharge from the water-balance modeling using various precipitation distributions vary significantly. Simulations using the raw DAYMET (DAYMET*1.0) resulted in recharge of 10,500 afa, the NCDC adjusted (DAYMET*0.8) resulted in recharge of 5,300 afa, and the 2007 water year adjusted (DAYMET * 0.71) resulted in recharge of 3,500 afa.[24] In other words, a 20% decrease in precipitation resulted in a 50% decrease in recharge, and a 29% decrease in precipitation resulted in a 66% decrease in recharge.

DBS conducted an extensive uncertainty analysis of water-balance model predictions by analyzing the uncertainty in the model input parameters using a Monte Carlo type, Latin Hyper Cube sampling technique. Sensitivities of the parameters and their influence on net infiltration were then analyzed using stepwise regression. Results of the sensitivity analysis (ensemble 2) indicated that the precipitation adjustment factor used to adjust DAYMET daily precipitation explained 35% of the variation in net infiltration. When combined with the second most sensitive parameter, soil depth overlying carbonate and sedimentary rocks in the southern portion of the basin (soil group 1), those parameters were found to explain 47% of the variation in the net infiltration.[25] These results highlight the extreme uncertainty in the water-balance predictions due to uncertainty in precipitation and other factors, and warrants the State Engineer to be extremely cautious when dealing with water-balance model predictions of recharge that are not calibrated to discharge.

In the USGS review of the DBS technical reports, the USGS recommended that the precipitation distribution for Tule Desert be decreased to be more representative of the long-term average, rather than the 1971-2000 time period. DBS addressed this issue and reduced their

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[24] DBS Recharge Report January 8, 2008, Table 8-1.
[25] DBS *Addendum to Mean Annual Recharge for the Tule Desert Hydrographic Basin Lincoln County, Nevada*, April 14, 2008, p. 71, Table 16.

estimated mean area weighted precipitation for Tule Desert from 10.6 inches to 9.9 inches, representative of the 1931-2008 time period. Recharge for the Tule Desert Hydrographic Basin using the revised precipitation estimate was then computed by applying a power function between precipitation and simulated recharge from the previous model runs, as recommended by the USGS, which resulted in a calculated recharge estimate of 4,400 afa.[26]

DBS presented results of the uncertainty analysis by describing the expected values and probability distributions of recharge. For the field capacity model (ensemble 2), the likely range of recharge was stated to be between 3,700 to 8,600 afa, with an expected mean of 5,600 afa. The cumulative distribution function for ensemble 2 illustrated that there is a 70% to 95% probability that the mean annual recharge is greater than 4,000 afa.[27] Casting recharge estimates in terms of exceedance probabilities is very useful for the decision-making process; however, the results of the uncertainty analysis are entirely dependent on the ranges of the parameter values used in the uncertainty analysis; therefore, input parameter ranges must be accurate and defensible. As discussed earlier, the precipitation adjustment factor was found to be the most sensitive parameter. The Applicant estimated that 80% of the 1981-2003 DAYMET average precipitation was approximately equal to regional NCDC 1971-2000 normals. The USGS report states that the long-term precipitation may be 11% less than the 1971-2000 period;[28] therefore, the long-term average precipitation could be approximately 70% of 1981-2003 DAYMET. The Applicant used a range of 70% to 100% of 1981-2003 DAYMET in their uncertainty analyses to represent a reasonable range of precipitation. If the actual long-term average precipitation is only about 70% of 1981-2003 DAYMET, as suggested by the USGS, then a lower range of precipitation relative to 1981-2003 DAYMET would be appropriate to use in the uncertainty analyses. If a lower precipitation range were used in the analyses, the resulting recharge estimates and cited exceedance probabilities would be significantly lower.

Recharge estimated using the soil water-balance method with the various adjusted precipitation maps and time frames are not compared to any estimates of discharge in the Tule Desert or elsewhere; thus, there is no way to know if those recharge estimates are reasonable.

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[26] DBS Memo dated October 15, 2008, p. 5.
[27] DBS *Addendum to Mean Annual Recharge for the Tule Desert Hydrographic Basin Lincoln County, Nevada*, April 14, 2008, pp. 68-69.
[28] USGS OFR 2008-1354, p. 5.

Similar soil-water balance methods were applied by Hevesi[29] in the Death Valley Region and by Flint, et al.[30] in the Great Basin. In both of those cases, the authors considerably revised their original estimates of recharge in later publications after natural discharge was considered.[31,32] In the case of Hevesi's investigations, the net infiltration (recharge) was considerably less in the later models than the original model. The State Engineer finds the DBS soil-water balance model provides state of the art techniques for estimating recharge, and that estimates of ground-water recharge made with the technique are within the range of recharge using other techniques. The State Engineer also finds that recharge estimates lower than those reported by the Applicant are possible, are also within the range of recharge using other techniques, would be supported by the technique if long-term precipitation is less than used by the Applicant in the model, and there remains a high level of uncertainty due to the lack of basin-wide and regional comparison to natural ground-water discharge.

In the chloride mass balance analysis, the concentration of chloride in ground water is compared to the chloride concentration of precipitation to calculate the percent of precipitation that becomes recharge. For accurate results, one must know the average chloride content of precipitation across the study area and the average chloride content of the ground water that was derived from that precipitation. Other sources of chloride or ground water contribute to analytical error. The Applicant's CMB estimate is of concern because of inconsistencies in data interpretation. The chloride concentration of bulk precipitation used in the analysis included precipitation at the lower elevations in the valley, which contained the highest concentration of chloride,[33] even though precipitation at low elevation contributes insignificantly to recharge.[34] If the precipitation at low elevation does not contribute to ground-water recharge, then that precipitation and the chloride contained therein should not be considered when computing the basin's recharge. By doing so, the Applicant has possibly overestimated recharge.

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[29] J. A. Hevesi, et al., *Preliminary Estimates of Spatially Distributed Net Infiltration and Recharge for the Death Valley Region, Nevada-California*, USGS Water Resources Investigation Report 02-4010, 2002.
[30] A.L. Flint, et al., *Fundamental Concepts of Recharge in the Desert Southwest: A Regional Modeling Perspective, in Groundwater Recharge in a Desert Environment, The Southwest United States*, Hogan J.F., et al., eds. 2004.
[31] J. A. Hevesi, et al., *Potential Recharge Using a Distributed-Parameter Watershed Model of the Death Valley Region, Nevada and California*, USGS Water Resources Investigation Report 03-4090, 2003.
[32] A.L. Flint and L.E. Flint, *Application of the Basin Characterization Model to Estimate In-Place Recharge and Runoff Potential in the Basin and Range Carbonate-Rock Aquifer System, White Pine County, Nevada and Adjacent Areas in Nevada and Utah*, USGS Scientific Investigation Report 2007-5099, 2007.
[33] DBS Recharge Report, January 8, 2008, Table 5-2a.
[34] *Ibid.*, pp. 35 and 62, Figure 5-27.

The chloride concentration of locally-recharged ground water is highly uncertain,[35] and wells recognized as having primarily local recharge such as PW-2, FF-1, and FF-2b[36] were not used in the analysis while water thought to be derived from the regional carbonate aquifer such as well MW-5 was included.[37,38] Ground water identified in the Glanzman Geochemistry report as being primarily of local origin[39] has a narrow range of chloride concentration ranging from 12 to 20 mg/l and averaging about 16 mg/l.[40] If only the middle-and upper-elevation precipitation collection sites are used to determine the chloride concentration of precipitation, then the average would be approximately 0.5 mg/l. Therefore, the chloride data suggests that about 3.1% of precipitation (0.5/16 = 0.031) that falls on the alluvial fans and mountain blocks becomes ground-water recharge, and precipitation that falls on the valley floor will not appreciably recharge ground water.[41] It is not known precisely on which areas of the valley floor direct recharge from precipitation occurs, and which areas do not receive recharge as evidenced by the chloride soil profiles, but at the lower end it would be 3.1% of the mountain block precipitation of 52,000 afa, up to perhaps 3.1% of the precipitation that falls on both mountain block and alluvial fan, which is probably not more than 75,000 afa. Therefore, a reasonable alternative estimate of recharge using the Applicant's chloride data and estimated precipitation would be 1,600 to 2,300 afa, that is, 3.1% of 52,000 to 75,000 afa of precipitation. In addition, the Applicant used its averaged precipitation of 11.3 inches per year, which the USGS reported might be biased high.[42] If actual long-term precipitation is less than estimated, then the recharge results of the CMB method would be proportionately lower. The State Engineer finds the Applicant's CMB analyses and estimates of recharge are only partially accepted, and that the data indicate recharge could range from 1,600 to 5,400 afa.

The composite analysis presented in the DBS Recharge report is obtained by summing three distinct recharge locations using a methodology applicable to those locations. The composite analysis includes separate calculations of recharge in the mountain block, below

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[35] *Ibid.*, p. 57.
[36] Glanzman Geochemistry Report, December 27, 2007.
[37] *Ibid.*
[38] DBS Recharge Report, January 8, 2008, Table 5-9.
[39] Glanzman Geochemistry Report, December 27, 2007, p. 8.
[40] *Ibid.*, Table 1.
[41] DBS Recharge Report, January 8, 2008, pp. 35 and 62, Figure 5-27.
[42] USGS OFR 2008-1354, pp. 5 - 6.

ephemeral streams, and diffuse recharge on the valley floor. In the mountain block recharge calculation, DBS used the CMB method. By using basin-average chloride concentration, rather than only chloride concentrations from precipitation that falls on the mountain block, their computed recharge is proportionately higher. Similarly, by using a chloride concentration of 14 mg/l to represent the average chloride content of recharge in the mountain block, they may also have overestimated the recharge. The 14 mg/l sample is the lowest measured chloride content of any of the 16 reported samples from the mountain block, and it is unclear why they did not select a representative set of samples to average, as they have done with other analyses.[43] The analysis could more accurately have shown results similar to the CMB estimate described in the above paragraph of 1,600 afa rather than their own estimate of mountain block recharge of 2,681 to 3,240 afa.[44] An additional 991 afa of recharge was estimated from infiltration of runoff and diffuse recharge.[45] The State Engineer finds that the Applicant's composite estimate of recharge could reasonably range from 2,600 to 4,200 afa.

In their last correspondence, the Applicant provided a comparison of the INFILv3[46] recharge rate estimates from the Death Valley Regional Flow System (DVRFS) applied to the Tule Desert.[47] Because the INFILv3 technique was later applied to a calibrated Death Valley Flow System ground-water flow model,[48] albeit subsequently adjusted during calibration, recharge estimated as a function of percent of precipitation could be applied to the Tule Desert area as a general comparison to their estimates. They concluded that INFILv3 would have estimated approximately 4,900 afa of recharge in Tule Desert, which is in the same approximate range as their other estimates.[49] However, the Applicant did not consider zero net infiltration values in developing their empirical relationship between PRISM precipitation and INFILv3 Model 1 net infiltration, making their analysis biased toward more recharge. By taking the Applicant's power function ($NI(mm) = 1.74E\text{-}5 * PPT(mm)^{1.9369}$)[50] and applying it to the PRISM

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[43] DBS Recharge Report January 8, 2008, p. 58, Table 5-8.
[44] *Ibid.*, pp. 65 - 66.
[45] *Ibid.*, p. 65.
[46] J. A. Hevesi, et al., *Potential Recharge Using a Distributed-Parameter Watershed Model of the Death Valley Region, Nevada and California*, USGS Water Resources Investigation Report 03-4090, 2003.
[47] DBS October 15, 2008, memo.
[48] W. R. Belcher, ed., *Death Valley Regional Ground-Water Flow System, Nevada and California--Hydrogeologic Framework and Transient Ground-Water Flow Model*, USGS Scientific Investigation Report 2004-5205, 2004.
[49] *Ibid.*, pp. 6 - 7.
[50] *Ibid.*, p.7.

precipitation map, the computed recharge for the DVRFS was more than twice the amount used in the calibrated DVRFS model. Therefore, the recharge computed by this technique for the Tule Desert could also be overestimated by a factor of two. State Engineer staff constructed a similar empirical relationship by regressing 1971-2000 PRISM 800m precipitation with the mean INFILv3 Model 1 net infiltration per PRISM pixels for the entire DVRFS, while including all zero net infiltration values in the averaging. When the power function of $NI(mm)=9.33E\text{-}7*PPT(mm)^{2.745}$ is applied to the PRISM 800m precipitation map for the Tule Desert Hydrographic Basin, the net infiltration (recharge) equals approximately 2,800 afa. Another estimate could be made by simple comparison of the percent of precipitation that becomes recharge for the Death Valley area basins using INFILv3 Model 1 to the Applicant's estimate for the Tule Desert. Recharge efficiencies for the basins in the Death Valley region were determined to be between 1 and 3 percent and averaged 1.5%.[51] Applied to Tule Desert where precipitation is between 105,000 and 125,000 afa, recharge would be 1,050 to 3,750 afa. The State Engineer finds the Applicant's use of the power function applied to INFILv3 and PRISM does not fully support their recharge estimates, but indicates that recharge estimates of less than 3,000 afa should also be considered as within the reasonable range.

The State Engineer finds the recharge reports prepared by DBS are rigorous investigations into the mechanisms involved in ground-water recharge, and represent a significant advancement in the understanding of precipitation and recharge in the Tule Desert. Their work and discussions utilizing transfer equations are of a regional nature and do not adequately meet the goal of State Engineer's Ruling No. 5181 to provide additional studies to demonstrate additional recharge in the Tule Desert. The soil-water balance model is a valid technique currently applied by other hydrologists, but results of the methodology are not adequately compared to ground-water discharge, and there is a high degree of uncertainty in the model results. The CMB analysis is an accepted technique, but the State Engineer finds that other reasonable interpretations and applications of the method would result in a wider range of estimates of recharge. The composite analysis incorporated a CMB component, which for the reasons mentioned above, may have also neglected the lower possible recharge estimates. Estimates of Tule Basin ground-water recharge as shown in the Applicant's final correspondence

[51] J. A. Hevesi, et al., *Potential Recharge Using a Distributed-Parameter Watershed Model of the Death Valley Region, Nevada and California*, USGS Water Resources Investigation Report 03-4090, Table 21, 2003.

and the analyses completed by the State Engineer are shown in Table 1. The State Engineer finds the Applicant's reported recharge estimates of 3,900 to 8,000 afa, with an average of 5,400 afa are higher than the provided data supports. The State Engineer further finds that ground-water recharge in the Tule Desert Hydrographic Basin, as supported by the available data, is likely in the range of 2,500 to 5,000 afa.

Table 1. Recharge Summary for Tule Desert.

Model/estimation method	Specifics	DBS Recharge Range	DBS Average	State Engineer Range	State Engineer Average
Water Balance Models	Field Capacity	3,500 - 10,500	5,900	4,400 - 5,300[1]	5,660
	Van Gnuchten-Mualem	6,100	6,100		
	Field capacity stochastic	5,500	5,500		
	VGM stochastic	8,000	8,000		
	Est. based on DVRFS recharge	4,900	4,900	2,800 - 4,900[2]	
Chloride Mass Balance	Entire basin	5,400	5,400	1,600 - 5,400[3]	3,500
Composite	CMB in mtn. block, infiltration of runoff, diffuse infiltration on valley floor	3,600 - 4,200	3,900	2,600 - 4,200[4]	3,400
Transfer Equations	M-E coeff - revised Hardman	5400	5,400		NA
	M-E coeff - PRISM 1971-2000	6200	6,200		NA
	Nichols (2000)	9600	9,600		NA
	Budyko	7800	7,800		NA
Water balance	Flint BCM Model 2004	4500	4,500	1,500 - 4,500[5]	3,000
Modified transfer	Walker (2000)	7,300 - 8,100	7,700		NA
Modified Maxey Eakin	Glancy & Van Denburgh, Recon Report 51	2,100	2,100		NA
Basin Average Recharge			5,929		3,890

1. Soil water balance estimates using DAYMET 1981-2003 and 2007 precipitation data discounted by State Engineer.
2. Lower value as computed by NDWR using DBS method.
3. Lower value as computed by NDWR using using recharge zone chloride in precipitation and ground-water sites specified in Glanzman Geochemistry report..
4. Lower value as computed by NDWR using Mtn. block chloride in precipitation and ground water.
5. Both estimates from Flint, A.L., et al., 2004, Fundamental Concepts of Recharge in the Desert Southwest: A Regional Modeling Perspective, in Groundwater Recharge in a Desert Environment, The Southwest United States, Hogan J.F., et al., eds.

An analysis of impacts to local and regional ground-water levels as a result of proposed pumping in the Tule Desert was provided as stipulated in Ruling No. 5181.[52] The Applicant provided a modeling report (Mock report) and simulations for pumping at various rates in the basin.[53] The MODFLOW model simulations include pumping at annual rates of 6,000 to 9,340 acre-feet for a period of 100 years followed by 100 years of simulation without pumping. The purpose of the model simulations was to provide a more realistic prediction of future drawdown

[52] State Engineer's Ruling No. 5181, p. 9, 25.
[53] Peter Mock, *Projection of Groundwater Impacts in Response to Proposed Pumping from Beneath the Tule Desert in Southeastern Nevada Using MODFLOW-2000*, 2008.

due to pumping than prior Theis analytical solutions. The model was not calibrated due to a lack of data.[54] The USGS in their review of the model cite the lack of calibration as their major criticism.[55] Model results indicate drawdown due to pumping in the central portion of Tule Desert at rates up to 9,340 afa would result in a lowering of the potentiometric surface by less than 30 feet in the Virgin River Valley Hydrographic Area after 100 years of pumping. Such a drawdown is not considered unreasonable. The effects of ground-water pumping on discharge to the Beaver Dam Wash, the Virgin River, and Lake Mead cannot be estimated with the model, but based on projected water-level changes estimated by the model, significant effects are not anticipated. The State Engineer finds the Applicant's ground-water flow model provides a reasonable, first order estimate of drawdown due to pumping in Tule Desert. The State Engineer further finds that by limiting pumping to the perennial yield, there will not be unreasonable impacts to existing water rights in adjacent basins, including the Virgin River Valley.

In conformance with recent rulings of the State Engineer, the perennial yield of the Tule Desert will be equal to one half of the locally-derived subsurface discharge, which in this basin is also equal to one half of the in-basin ground-water recharge. In consideration of the remoteness of the region and the predicted reasonable amount of drawdown due to proposed pumping, the recharge used for this perennial yield estimate will be at the upper end of the reasonable range of 2,500 to 5,000 afa. The State Engineer finds the perennial yield of the Tule Desert Hydrographic Basin is 2,500 acre-feet, which is equal to one-half of the upper range of the basin recharge of 5,000 afa.

V.

UNAPPROPRIATED WATER

Existing ground-water rights in the basin total 2,103.62 acre-feet. Of that amount, 2,100 acre-feet are owned by the Applicant and 3.62 acre-feet are other private stock water rights. The perennial yield in the basin is 2,500 acre-feet. The State Engineer finds that there is 396 acre-feet of unappropriated water in the Tule Desert Hydrographic Basin.

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[54] *Ibid.*, p. 20.
[55] USGS OFR 2008-1354, p. 18.

VI.
INTERBASIN TRANSFER STATUTE

Nevada Revised Statute § 533.370(6) provides that in determining whether an application for an interbasin transfer of ground water must be rejected, the State Engineer shall consider: (a) whether the applicant has justified the need to import the water from another basin; (b) if the State Engineer determines a plan for conservation is advisable for the basin into which the water is imported, whether the applicant has demonstrated that such a plan has been adopted and is being effectively carried out; (c) whether the proposed action is environmentally sound as it relates to the basin from which the water is exported; (d) 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; and (e) any other factor the State Engineer determines to be relevant.

The Applicant satisfied subsection (a) in a document and attached exhibits dated January 16, 2008, addressed to the State Engineer.[56] The Applicant satisfied subsection (b) with three documents submitted in January 2009. These documents include Toquop Township Planned Unit Development Ordinance, Title 14 of Lincoln County Code; Standard Development Agreement between Lincoln County, Nevada and BLT Lincoln County Land, LLC.; and Lincoln Highlands Corporation Development Agreement between the County of Lincoln and Lincoln Highlands Development Corporation. Together, these documents satisfactorily address water conservation, reuse, and water use alternatives for the planned developments at the proposed places of use. Because of the lack of valley floor springs and wetlands in Tule Desert that could be affected by the development, the State Engineer finds the proposed action is environmentally sound as it relates to the basin of origin, and subsection (c) is satisfied.

Whether the proposed action is an appropriate long-term use that will not unduly limit the future growth and development in Tule Desert is in large part determined by the extent of private land holdings in the basin. A lands map published by the BLM shows that 100% of the land in the basin is owned by the U.S. government and managed by the BLM. Because of the basin's remote nature, the State Engineer finds that no additional ground water need be reserved for potential future growth and development in the basin. Therefore, subsection (d) is satisfied.

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[56] Letter dated January 16, 2008, from Vidler and Lincoln County, official records in the Office of the State Engineer.

The State Engineer finds that the provisions of NRS § 533.370(6) have been adequately addressed and do not constitute reason to deny the application.

VII.

PROTESTS BY THE VIRGIN VALLEY WATER DISTRICT

Of the Virgin Valley Water District's (VVWD) seven protest issues, protest issue numbers 3, 4, and 6 relate to impacts to existing rights. The Applicant's supplied information addresses these issues as discussed below. Protest items 1, 2, 5, and 7 were overruled in Ruling No. 5181 and are again overruled for the same reasons here.

The Protestant VVWD alleged that the granting of the subject applications will adversely impact existing rights of the Protestant and could further adversely impact the potable water source for residents of the City of Mesquite, the Town of Bunkerville and others within the service area of the Protestant. The State Engineer finds, after consideration of the perennial yield of the basin and the Applicant's model analyses, the Applicant has adequately demonstrated that there will not be unreasonable adverse impacts to the Protestant's or other water rights in the Virgin River Valley Hydrographic Area, and protest issues 3 and 6 are hereby overruled.

The Protestant VVWD alleged that the granting of the subject applications would adversely impact the quality of water heretofore appropriated by the Protestant. The State Engineer finds that no evidence was presented to support this claim, nor is there any supportive evidence in the records of the Office of the State Engineer, and the protest issue 4 is overruled.

CONCLUSIONS OF LAW

I.

The State Engineer has jurisdiction over the parties and the subject matter of this action and determination.[57]

II.

The State Engineer is prohibited by law from granting a permit under an application to appropriate the public waters where:[58]

A. there is no unappropriated water at the proposed source;
B. the proposed use or change conflicts with existing rights;

[57] NRS chapters 533 and 534.
[58] NRS § 533.370(5).

C. the proposed use or change conflicts with protectible interests in existing domestic wells as set forth in NRS § 533.024; or
D. the proposed use or change threatens to prove detrimental to the public interest.

III.

The State Engineer concludes there is unappropriated water in the Tule Desert Hydrographic Basin at the quantity granted, there is no substantial evidence the proposed use will conflict with existing rights, there is no substantial evidence that the proposed use will conflict with protectible interests in existing domestic wells, or the use will threaten to prove detrimental to the public interest

IV.

The State Engineer concludes that the Applicant provided proof satisfactory of its intention in good faith to construct any work necessary to apply the water to the intended beneficial use with reasonable diligence, and its financial ability and reasonable expectation actually to construct the work and apply the water to the intended beneficial use with reasonable diligence.

V.

The State Engineer concludes that based on the findings that the Applicant has justified the need to import the water from Tule Desert, that a plan for conservation has been adopted, that the use of the water is environmentally sound as it relates to the basin of origin, and that the export of the water will not unduly limit the future growth and development of the basins of origin.

VI.

The State Engineer concludes the amount granted should protect existing ground-water rights of the Protestant VVWD.

VII.

The State Engineer concludes it does not threaten to prove detrimental to the public interest to allow an additional allocation of the underground waters of the Tule Desert Hydrographic Basin coupled with monitoring and additional study.

RULING

The protests to Application 64692 are hereby overruled. The perennial yield of the Tule Desert Hydrographic Basin is 2,500 acre-feet. Current appropriations in the basin total 2,104 afa. Application 64692 is hereby granted in the amount of 396 acre-feet annually, subject to:

1. Existing rights;
2. Payment of the statutory permit fees;
3. A monitoring and management plan approved by the State Engineer.

Respectfully submitted,

Jason K. P.E.
for TRACY TAYLOR, P.E.
State Engineer

TT/RAF/jm

Dated this 29th day of

April, 2009.