No. 126, Original

IN THE
SUPREME COURT OF THE UNITED STATES

STATE OF KANSAS,

Plaintiff,

v.

STATE OF NEBRASKA

and

STATE OF COLORADO,

Defendants.

Before Jeffrey C. Fereday
Arbitrator

PRE-FILED TESTIMONY OF KANSAS EXPERT STEVEN P. LARSON

February 24, 2014

<u>Section 1 – Qualifications</u>

Q: Please state your name and business address for the record.

A: My name is Steven P. Larson. My business address is 7944 Wisconsin Avenue, Bethesda, Maryland.

Q: Please describe your educational background.

A: I hold a bachelors degree in civil engineering from the University of Minnesota that I received in 1969 and I also hold a masters degree in civil engineering from the University of Minnesota that I received in 1971.

Q: Please describe your employment history after you received those degrees.

A: After obtaining my masters degree in 1971, I was hired by the Water Resources Division of the United States Geological Survey as a hydrologist. My first assignment with the United States Geological Survey, or USGS as it is often referred to, was to attend a 6-month training program in Denver, Colorado to learn about the various activities, projects and work products of the Water Resources Division. Following that training I was assigned to the district office of the Water Resources Division in St. Paul, Minnesota. From 1971 to 1975 I conducted various water resource related projects within the State of Minnesota including several projects that involved the development, calibration and application of groundwater models. In 1975, I was transferred to the National Headquarters of the USGS in Reston, Virginia to work in a research capacity within the Northeast Region of the Water Resources Division. My duties in that position were basically threefold. One was to conduct research into the development and use of computer models for simulating various groundwater flow processes. Second, I conducted training courses for other hydrologists within and outside the USGS in the use and application of various groundwater flow models. Third, I provided consulting support to hydrologists in other offices of the Water Resources Division to assist them in using and applying groundwater flow models.

In 1980, I left the USGS and joined S. S. Papadopulos and Associates, Inc. At S. S. Papadopulos and Associates, Inc. we provide consulting services regarding environmental and water resource problems. I have been with S. S. Papadopulos and Associates, Inc. for more than 30 years. During that time, I have worked on a variety of water resource and environmental problems for clients in both the public and private sector. As part of my work, I have also provided expert testimony in a number of forums ranging from administrative hearings to original actions before the U. S. Supreme Court.

Q: Please give us some examples of projects that you have worked on that would be relevant to your work in this matter.

A: I worked for the State of Kansas in the case of Kansas versus Colorado dealing with the Arkansas River Compact. My role in that case was to evaluate impacts to stream flows associated with groundwater use and other water projects that occurred historically along the river. I served as an expert in the areas of hydrology, water rights engineering and modeling analysis and provided expert testimony before the special master in the case. I have worked for the State of Nebraska in the case of Nebraska versus Wyoming regarding development and water use along the Platte River. My role in that case was to review groundwater and surface water models of the river system and nearby areas and to evaluate stream flow data and changes in stream flow that occurred over time. I prepared an expert report in the case describing my evaluations and conclusions but the case was settled before going to trial. I have worked for the State of South Carolina in the case of South Carolina versus North Carolina regarding development and water use along the Catawba River. My role in that case was to review and evaluate stream flow data and a reservoir operations model called CHEOPS that was developed to simulate river flows and power production from several hydroelectric plants located along the river system. I have also worked for the State of New Mexico regarding groundwater development along the Pecos River and efforts by New Mexico to maintain compliance with the Pecos River Compact. My role in that case has been to update and recalibrate the Roswell Artesian Basin Groundwater Model and to evaluate impacts from new well fields designed to provide augmentation water for purposes of compact compliance. I am currently working for the State of Montana in the case of Montana versus Wyoming. My role in that case is to provide expert analysis and testimony regarding groundwater related issues.

Perhaps most relevant is my prior work in this case. I have worked for the State of Kansas in the case of Kansas versus Nebraska since its inception. I have served as Kansas' principal modeling expert in the development of the RRCA Groundwater Model as part of the Final Settlement Stipulation. I was a member of the Modeling Committee on behalf of Kansas and actively participated in the development and calibration of the RRCA Groundwater Model. As a result of this work, I am intimately familiar with the structure and application of the RRCA Groundwater Model for purposes of quantifying impacts to stream flows along the Republican River stream system.

Q: We had marked as Exhibit WSY/RC K1, a copy of your curriculum vitae. Is Exhibit WSY/RC K1 a copy of your curriculum vitae?

A: Yes it is.

To the arbitrator: The State of Kansas offers Mr. Larson as an expert in the areas of hydrology and hydrologic modeling analysis

<u>Section 2 – Expert Report and Exhibits</u>

Q: Have you prepared any expert reports in this matter?

A: Yes, I have prepared one expert report.

Q: We have marked as Exhibit NCORPE K-102, a copy of your report. Is this a copy of the expert report that you prepared in this matter?

A: Yes, Exhibit NCORPE K-102 is a copy of my expert report.

Q: Please describe generally what is contained in the expert report that you prepared, which has been marked as Exhibit NCORPE K-102.

A: The report deals with two general areas, 1) hydrologic concepts associated with stream augmentation, specifically, hydrologic concepts associated with transit losses associated with stream augmentation , and 2) quantitative evaluations of transit losses using the RRCA Groundwater Model to illustrate the nature and magnitude of transit losses that might occur associated with Nebraska's N-CORPE augmentation proposal. Specifically, we provided a quantitative illustration of the hydrologic consequences of stream augmentation and transit losses in the Medicine Creek Sub Basin from the discharge location to Harry Strunk Lake.

Q: Are the two areas you listed described in your expert report?

A: Yes. My report describes both the hydrologic consequences associated with transit losses of augmentation water and quantitative evaluations we conducted using the RRCA Groundwater Model to illustrate these hydrologic consequences as they apply to the Medicine Creek Sub Basin where Nebraska's N-CORPE augmentation has been proposed.

Q: With respect to the first general area that you addressed in your report, would you summarize why you conducted this evaluation?

A: Yes. In the previous arbitration proceeding regarding Nebraska's Rock Creek Augmentation Project, Nebraska contended that transit losses associated with augmentation water were likely to be small and should not be considered regardless of their magnitude. The arbitrator also concluded that transit losses should not be considered in determining an augmentation credit. However, the notion that transit losses associated with augmentation water can be ignored fails to account for the hydrologic consequences of transit losses in terms of both determining an appropriate augmentation credit and in determining the impact of augmentation flow on stream gage measurements that are used for computing the virgin water supply and allocation of that supply under the FSS and the Compact. This latter consideration is especially important since it can directly affect Kansas allocations under the FSS and the Compact. Furthermore, transit losses are potentially much more significant in the Medicine Creek Sub Basin given the more than 70 miles of stream between the location of the proposed discharge point and the nearest accounting point under the FSS accounting procedures.

Q: Can you describe the hydrologic consequences associated with transit losses from augmentation water that you mentioned in your answer?

A: Yes. Conceptually, when transit losses from augmentation water occur, the lost water will initially return to the groundwater system beneath the area where the losses occur. The lost water will cause groundwater levels to increase above levels that would have occurred absent the addition of augmentation water to the stream system. The increased groundwater levels constitute an increase in groundwater storage. Depending upon a number of factors such as the amount of the loss and the location and depth to groundwater, this may be the ultimate disposition of the losses. In this circumstance, the losses merely represent groundwater storage that has been moved from one location, the location where the augmentation water was pumped, to another location, the location beneath and surrounding the location where the losses occur. Conceivably, these locations, that is, the location of pumping and the location of the losses, could be relatively close to one another.

Q: Does moving groundwater storage from one location to another location mean that the water is permanently lost?

A: Not necessarily. The increases in groundwater storage are a direct result of an increase in groundwater levels. If these increases in groundwater level propagate into an area of the model domain where evapotranspiration is occurring, the result could be an increase in the computed rate of evapotranspiration from groundwater. In that case, the amount of increased evapotranspiration would represent a permanent loss of water. If increased evapotranspiration from groundwater does not occur, the water would continue to exist in groundwater storage. If the increased groundwater levels were large enough and widespread enough, they could produce stream flow accretions in portions of the stream system.

Q: With respect to the second general area addressed by your report, would you summarize what you did?

A: The second general area that we addressed was to provide some general levels of quantification of losses using the RRCA Groundwater Model. The purpose of these quantifications is to demonstrate the nature and extent of impacts as support for and illustration of the concepts described in the first section of our report. What we did was to use the RRCA Groundwater Model to calculate what would happen to the groundwater system and associated stream flows when augmentation water is discharged into the Medicine Creek stream network under the Nebraska augmentation plan. We used the same future scenario used by Nebraska in their analyses of stream depletions to construct a series of future scenarios corresponding to different amounts of augmentation water being discharged into Medicine Creek. The RRCA Groundwater Model output for each scenario was then compiled to illustrate changes to various hydrologic components of the groundwater system caused by the addition of the augmentation water to the stream system.

Q: Did you prepare graphics to illustrate the changes to the hydrologic components that were compiled from the model runs?

A: Yes, my expert report at Figure 2 contains a series of graphs that illustrate those results. And my expert report also provides a description of what is shown by the graphs.

Q: Could you give us a summary of what the graphs show?

A: The graphs illustrate the difference in various flows associated with the addition of augmentation water to the Medicine Creek stream network. Specifically, the graphs illustrate the change in flow into or out of groundwater storage, the change in groundwater evapotranspiration and the change in groundwater discharge (or recharge) from the stream network. The latter change is referred to as stream leakage on the graphs and groundwater evapotranspiration is referred to as ET. In general, the graphs show that the amount of stream leakage (transit loss) increases as the amount of augmentation water added increases, although not proportionately. They also show that most of the stream leakage (or transit losses) go into groundwater storage, at least initially. The amount of change in groundwater evapotranspiration also increases with increasing amounts of stream leakage. This is to be expected as the greater amounts of stream leakage will cause larger increases in groundwater levels which, in turn, increase the amount of groundwater evapotranspiration. The graphs also show that in the intervening years between periods of augmentation, some of the increase in groundwater storage is returned to the stream in the form of stream flow accretion. This is shown on the graphs by the groundwater storage line going from positive values (increasing storage) during the periods of stream flow augmentation to negative values (decreasing storage) during the intervening years when no augmentation water is assumed to be added. However, the positive flows (increasing groundwater storage) are relatively much higher than the negative flows so the net effect over an augmentation cycle is an increase in groundwater storage.

Q: Where does the net increase in groundwater storage occur?

A: It will occur over an area that is centered on the location where the stream leakage or transit losses occur. The area will increase with time as stream leakage continues and the effect of the continuing leakage spreads outward through the groundwater system from the location of the leakage.

Q: Did you prepare a graphic in your expert report to illustrate location of groundwater storage changes caused by the addition of augmentation water?

A: Yes, Figure 4 in my expert report shows the changes in groundwater levels after the first cycle of augmentation for the scenario assuming 10,000 acre feet per year of augmentation discharge.

Q: The figure shows a sort of radial pattern around the upper portions of the Medicine Creek stream system. Is that the spreading that you referred to earlier?

A: Yes, the stream leakage is greatest in the upper portion of the stream network where the stream flow is not perennial. Once the augmentation water reaches the location of perennial stream flow, stream leakage or transit losses are much smaller. This is very consistent with what one would expect from a hydrologic perspective

Q: And what is the origin of the water that increases the groundwater storage?

A: The water is derived from the stream leakage or transit loss that occurs as a result of adding the augmentation water to the stream system. So in effect, it is groundwater storage that was pumped from the augmentation well field and moved to groundwater storage in this area just south of the well field area.

Q: And how far was this groundwater storage moved?

A: About six to ten miles to the south.

Q: What conclusions do you draw from your evaluation of the fate of the augmentation water after it is added to the Medicine Creek stream system?

A: There are two principal conclusions. One is that transit losses that will occur as the augmentation water flows from the discharge location to Harry Strunk Lake, some 60 miles downstream, will largely return to groundwater storage. Second, these losses will have an impact of stream flows and will affect the amount of flow registered at stream gages along Medicine Creek.

Q: How will these losses impact Kansas?

A: If the losses are not accounted for in evaluating the sources of water that comprise the gaged stream flows, Kansas allocation of the computed water supply that is derived from those gaged flows will be reduced.

Q: Does the Nebraska proposal account for these losses?

A: No, as shown by the example calculation in the Nebraska proposal, the proposal assumes that all of the augmentation water will reach the gages. As a result, any loss that occurs would reduce the amount of the computed water supply that is allocated between Kansas and Nebraska.

Q: Does the Nebraska proposal include any provisions for estimating the losses or confirming their assumption that no loss will occur?

A: No, the proposal does not acknowledge or attempt in any way to estimate the amount of losses that might occur. Furthermore, the proposal does not include any description or evaluation of what data or analysis would be used to adjust the stream flow gage records to account for losses, apart from assuming that no losses will occur.

Q: Do you believe that Nebraska's assumption that no losses will occur is realistic?

A: No. Given the considerable distance between the discharge location and the stream flow gages on the stream system and the hydrologic realities of the Medicine Creek stream network, it is unrealistic to assume that there will be no losses. The uppermost portion of the Medicine Creek stream network just below the proposed discharge location is not perennial and some losses to augmentation water in this area are inevitable. Furthermore, the amount of perennial stream flow in Medicine Creek can vary considerably seasonally and this variation could create losing stream reaches even though the overall condition of the stream flow is perennial. In other words, having perennial stream flow in Medicine Creek is no guarantee that losses to augmentation water will not occur, especially given the distance that augmentation water must travel before reaching stream gages that are used to determine the computed water supply and the allocation of water of the water supply between the States.

Pursuant to 28 U.S.C. §1746, I declare under penalty of perjury that the foregoing is true and correct.

Executed on February 24, 2014.