BEFORE THE OKLAHOMA WATER RESOURCES BOARD
STATE OF OKLAHOMA

IN THE MATTER of Determining the Maximum	)
Annual Yield for the Arbuckle-Simpson	)
Groundwater Basin underlying parts of Murray,	)
Pontotoc, Johnston, Garvin, Coal and Carter	)
Counties	)

MOTION TO ADMIT

Come now Protestants Arbuckle-Simpson Aquifer Protection Federation of Oklahoma, Inc., Charles Roos, Paul Warren, Bill Clark, John Sparks, and Floyd Bergen (Protestants) and move the Hearing Examiner to admit the attached report for Blaine T. Reely, PhD, P.E., and in support of such motion would state the following:

1) Due to the abbreviated time allowed for prehearing preparation, the written report was not available on the May 15, 2012 hearing date.

2) The report explains the basis and reasoning for Dr. Reely's oral testimony provided at the hearing on May 16, 2012.

Wherefore, Protestants Arbuckle-Simpson Aquifer Protection Federation of Oklahoma, Inc., Charles Roos, Paul Warren, Bill Clark, John Sparks, and Floyd Bergen move the Hearing Examiner to admit Dr. Reely's report.

Respectfully submitted,

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ATTORNEY FOR PROTESTANTS

In the Matter of

DETERMINING THE MAXIMUM ANNUAL YIELD FOR THE ARBUCKLE-SIMPSON GROUNDWATER BASIN

PUBLIC HEARING
SULPHUR, OKLAHOMA
May 15-16, 2012

Opinions of

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May 22, 2012

Prepared for

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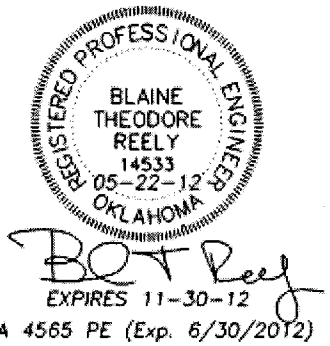

1. Overview

I have been retained on behalf of the Arbuckle-Simpson Aquifer Protection Federation of Oklahoma, Inc. to review the proposed Tentative Determination of Maximum Annual Yield (MAY) from the Arbuckle-Simpson Groundwater Basin, issued by the Oklahoma Water Resources Board (OWRB) dated March 13, 2012. In addition to the March 13, 2012 document, I also reviewed numerous supporting documents including scientific studies, reports, maps and related information which were developed in support of and /or related to the tentative MAY. Of primary focus in my review was the document prepared by the United States Geologic Survey (USGS), in cooperation with the OWRB, entitled "Hydrogeology and Simulation of Groundwater Flow in the Arbuckle-Simpson Aquifer, South-Central Oklahoma / USGS Scientific Investigations Report 2011–5029".

Based on my review of above referenced documents, I have developed opinions related to two (2) specific areas that I believe have pertinence to the proposed Tentative Determination of Maximum Annual Yield (MAY) from the Arbuckle-Simpson Groundwater Basin, issued by the OWRB dated March 13, 2012. My opinions regarding limited aspects of the proposed order are related to the following:

1. The rate of recharge to and total discharge from the basin which were utilized in determining the MAY;
2. The phased implementation of the MAY.

The scope of my investigation was limited to the areas discussed in the following paragraphs of this report due primarily to schedule and budget constraints. The following paragraphs summarize my investigation and opinions as they relate to the subject matter.

2. Scope of Investigation

Specifically my investigation focused on issues related to the methodology implemented by the USGS / OWRB scientists in attempting to quantify the aquifer rate of recharge which was utilized in the groundwater basin MAY study. Determining an accurate rate of recharge is critical to the determination of the MAY. This fact is acknowledged in Oklahoma law, which according to Section 1020.5 of Title 82 of the Oklahoma Statutes, after completing hydrologic surveys, the Board is to make a tentative determination of the maximum annual yield of groundwater to be produced from a basin or sub-basin based upon the following:

a. total land area overlying the basin or sub-basin;

b. amount of water in storage in the basin or sub-basin;

c. rate of recharge to and total discharge from the basin or sub-basin;

d. transmissibility of the basin or sub-basin; and

e. possibility of pollution of the basin or sub-basin from natural sources.

My analysis of the rate of recharge methodology involved developing an understanding of the data and techniques that were utilized by the USGS / OWRB scientists in estimating the recharge parameters and subsequently assessing how these parameters were incorporated into the MODFLOW groundwater model which was ultimately utilized to establish the recommended MAY to the OWRB. Consideration of the rate of recharge is crucial because the groundwater basin MODFLOW model was calibrated primarily through the use of the rate of recharge to gain acceptable simulations to historic stream flow data at two (2) locations. In short, the MAY for the Arbuckle-Simpson Groundwater Basin was estimated primarily to coincide with the estimated average annual rate of recharge. Any inaccuracies with the rate of recharge estimate will directly impact the MAY.

In addition to considering the rate of recharge utilized in the MAY determination, I also performed an analysis of the impacts to the aquifer that would result from the recommended phased implementation of the MAY. For the purposes of this part of my analysis, I performed a comparison of the existing and pending water rights for the groundwater basin. In addition, I performed a comparison between previously studied groundwater basins where the OWRB had performed a MAY determination and how implementation of the MAY was approached. A summary of the impacts to the City of Enid is provided for comparison purposes.

My opinions are based on the information set forth in the following paragraphs of this report; the documents I reviewed; my exposure to the testimony of witnesses at the May 15-16 public hearing in Sulphur, Oklahoma; my education and training; and my professional experience.

I have worked professionally as a civil engineer and hydrologist for more than 25 years, with specific experience on a multitude of project types including water resource engineering, site characterization and numerical modeling of groundwater & surface water systems. My experience with these project categories includes design and engineering / hydrologic analysis related to projects similar to that which is the subject of the referenced matter.

I have earned a BSc. in geological engineering and a MSc. in Civil Engineering from the University of Arizona in Tucson, Arizona. In addition, I have earned a PhD in civil engineering from Oklahoma State

University in Stillwater, Oklahoma. I am a registered professional civil engineer in numerous states. Over the course of my career I have worked on the engineering and scientific aspects of numerous litigation and regulatory matters. Many of these matters required that I provide depositions and testimony as an expert witness.

2. Opinions

My analysis of available literature, my education, training, and professional work experience have led me to the following opinions:

Opinion 1

The USGS / OWRB scientists established in the early stages of the groundwater basin investigation that the primary goal was to determine the volume of water that could be withdrawn from the Arbuckle-Simpson Groundwater Basin for beneficial uses while protecting springs and streams. This primary goal resulted from an interpretation by the OWRB of the requirements of SENATE BILL 288. In 2003, the Oklahoma Legislature enacted Senate Bill 288, which amended the Oklahoma Groundwater Law. One of the provisions of Senate Bill 288 imposed a moratorium on the use of groundwater outside the boundaries of a sensitive sole source groundwater basin or sub-basin until the OWRB approves a maximum annual yield for such a basin that will ensure that any permit for the removal of water from such basin *will not reduce the natural flow* of basin area springs or streams.

The concept of *natural flow* was established by the OWRB to be essentially a volumetric flow rate within the local streams that represents no more than a 25% reduction in historical base flow. This threshold volumetric flow rate was based on qualitative estimates of fish habitat protection requirements. Subsequently, base flow, the flow in a stream channel that represents groundwater discharge and not runoff from storms, was computed for Blue River near Connerville (07332390) and Pennington Creek near Reagan (07331300). Due in large part to this interpretation of *natural flow* by the USGS / OWRB scientists, a direct correlation was made between stream base flow and recharge.

The dominant recharge process for the Arbuckle-Simpson Groundwater Basin is infiltration of precipitation through the soil zone. The primary method used to determine recharge for this study was a recession curve-displacement technique. This method is based on the measurement of the change in the total groundwater discharge (base flow) as estimated at a critical time after the peak by extrapolation from the pre-peak and the post-peak recession periods. Recharge from each precipitation event was assumed to be the difference between the groundwater discharge and the groundwater discharge that would have happened at the same time in the absence of the recharge event, based on extrapolation of the stream flow

hydrograph prior to the recharge event. Recharge commonly is divided by the area of the drainage basin and expressed as a rate, for example, inches of recharge per year.

Recharge from infiltration of precipitation is difficult to quantify because the recharge rate can vary greatly over short spatial and temporal scales, and is difficult to measure directly. Previous investigators estimated an average recharge rate for the Arbuckle-Simpson Groundwater Basin of about 4.7 inches per year. Based on data presented in the "Hydrogeology and Simulation of Groundwater Flow in the Arbuckle-Simpson Aquifer, South-Central Oklahoma / USGS Scientific Investigations Report 2011–5029", the USGS / OWRB scientists computed recharge, based on the stream flow data and previously described methodology, to average between 8.40 and 11.21 inches per year.

The MODFLOW groundwater simulation model, that was subsequently used to determine the MAY, was manipulated by varying the recharge parameters to achieve a correlation between the measured stream flows at the following two (2) stream gage locations: Blue River near Connerville (07332390) and Pennington Creek near Reagan (07331300). Initial attempts to get the model to simulate pre-designated stream gage calibration data were unsuccessful and the USGS / OWRB scientists concluded that the only source of water to the Arbuckle-Simpson aquifer is recharge; therefore, errors in the simulated stream flow were because of errors in the designated recharge rate. Ultimately, the recharge parameters within the MODFLOW model were manipulated, both quantitatively and spatially, until the modelers achieved an extremely good correlation between simulated stream flows and historic stream flow gage data for the record period between 2004 – 2008, at the two (2) stream gage locations: Blue River near Connerville (07332390) and Pennington Creek near Reagan (07331300). The area-weighted recharge values for these five (5) years ranged from 2.57 – 11.61 inches per year, with the five year average = 5.58 inches per year.

Although the USGS / OWRB scientists did achieve groundwater model simulation results that closely simulated the flow in the Blue River and Pennington Creek, upon closer examination of the MODFLOW simulation results, the MODLOW model did not achieve very good simulation results of the aquifer potentiometric surface within the majority of the groundwater basin. The investigators report that this should not raise concern because the "study objectives emphasize modeling stream flow, not heads, so that the differences between observed and simulated water levels were considered to be acceptable".

The purpose of the MAY determination is to establish the maximum annual volume of water that can be extracted from the Arbuckle-Simpson Groundwater Basin from groundwater wells for beneficial use, subject to applicable laws. For the purposes of this study, the MAY determination was strongly biased to replicate limited stream flow data, while simultaneously ignoring poor predictive behavior of the remainder of the hydrologic conditions within the groundwater basin. It is my opinion that the current MODFLOW model should be modified to achieve a numerical simulation of the groundwater basin under

transient behavior, which is calibrated to accurately simulate the behavior of the aquifer in it's entirety. The results from this modified groundwater basin model will likely result in a different MAY recommendation.

Opinion 2

Under the terms of the tentative determination of the maximum annual yield of the Arbuckle-Simpson Groundwater Basin, there is 78,404 acre-feet of groundwater available for withdrawal on an annual basis. The equal proportionate part of the yield to be allocated to each acre of land overlying the basin, based on the maximum annual yield and total overlying land area, is tentatively determined to be 0.20 acre-foot per acre per year (equivalent to two and four tenths inches (2.4") per acre per year).

Based on a review of the tentative determination of the maximum annual yield of the Arbuckle-Simpson Groundwater Basin, the OWRB has recommended that before regular permits for the equal proportionate part of the maximum annual yield are issued to replace existing valid temporary permits to withdraw groundwater from the Arbuckle-Simpson Groundwater Basin, such temporary permits shall remain in effect (subject to revalidation) for a period of five (5) years from the effective date of a final order determining the maximum annual yield, unless an extension of time is granted for good cause shown.

A review of the existing and pending water rights for the Arbuckle-Simpson Groundwater Basin indicates that the if the prior rights and all existing temporary permits remain in place, then the permitted right to withdraw groundwater within the basin will be over-allocated by approximately 1,816 acre-feet. Not only would this proposed transitional period preclude any further allocation to the applicants with pending water rights applications, it would also preclude the consideration of any new applications for groundwater. A summary of the existing and pending water rights permits / applications is presented below:

- **PRIOR RIGHTS**
  - **11 Permits**
  - **5696 Ac-Ft**
- **TEMPORARY PERMITS**
  - **48 Permits**
  - **74,524 Ac-Ft**
  - **45,419.9 Ac**
- **PENDING PERMITS**
  - **13 Permits**
  - **109,901.6 Ac-Ft**
  - **57,128.4 AC**

Given that the proposed transitional implementation of the MAY would result in an immediate over-allocation of the water designated for permitted withdrawal from the Arbuckle-Simpson Groundwater Basin, based on the tentative findings of the OWRB, it is prudent to avoid any transitional period and immediately convert all existing temporary groundwater permits (subject to validation) to regular permits with an allocation based on the equal proportionate share defined by the OWRB in it's final order in this matter. Subsequently, the OWRB should consider the existing pending permit applications and issue regular permits to those applicants. Under this scenario, all parties would have access to their equal proportionate share, and there would be sufficient additional groundwater that could be allocated to either existing permit holders that require additional supplies and / or new applicants.

- If all existing temporary permits are immediately converted to 0.2 Ac-Ft / Acre then (45,419.9 Ac X 0.2) = 9083.98 Ac-Ft
    - Available Additional Allocation = 63,624.02 Ac-Ft
- If all existing pending permit applications are awarded at 0.2 Ac-Ft / Acre then (57128.4 X 0.2) = 11,425.68 Ac- Ft
    - Available Additional Allocation = 52,198.34 Ac-Ft

I am unaware that the OWRB has previously ordered a phased implementation of the MAY for a groundwater basin where the final MAY determination has been made. I have personal knowledge and experience as the former Public Works Director for the City of Enid. In the early 1980's the City of Enid relied heavily on groundwater wells which derived their supplies from the Enid isolated Terrace Aquifer. Based on the results of a hydrologic study of the groundwater basin by Kent, Beausoleil & Witz, the OWRB made the determination that the MAY for the groundwater basin is 0.5 acre-feet per acre. There was no transitional phase in period. Permitted users of groundwater within the basin were either required to acquire additional surface acres to permit withdrawal of water volumes to meet their previous allocations which were granted under temporary permits and/or reduce their annual withdrawlas to comply with the MAY / equal proportionate share determination. As a result this MAY determination, the City of Enid elected to acquire extensive new water rights in the Cimarron River Terrace & Alluvial Groundwater Basin and subsequently invested approximately $60 million to develop water production capabilities in the basin. In my opinion, allowing a transitional implementation of the MAY would not be justified, prudent or equitable on the part of the OWRB in this matter.