EXPERT REPORT: Case No. 18 WATER 14014

for

Daniel Clement, Burns & McDonnell

a) Consulted for: Equus Beds aquifer water usage and sustainable yield, recharge mechanisms and accounting, water resource conditions, and technical tools and models
b) The grounds for Daniel Clement's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Daniel Clement's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - 2.0 proposed ASR minimum index levels

          This part of the Proposal presents the tenets of the City's Drought Plan.

            - The Wichita City Council adopted the Drought Response Plan in 2013.
            - The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

        - Figure 12 - Historic Water Use in the ASR BSA

          This figure illustrates historic trends in water use in the Basin Storage Area.

            - The City total use of water for public supply has not demonstrated any increase since approximately 1992.
            - The City has demonstrated the ability to reduce its groundwater use of groundwater.
            - Groundwater use for irrigation in drought years of 2011 to 2013 were slightly higher than other historical peak use years.

        - Figure 13 - Historic Groundwater Level Changes in the ASR BSA

          This figure illustrates areas of aquifer level recovery since 1993.

            - The City's efforts to reduce its use of groundwater can result in aquifer recovery in areas depleted by pumping.

    ii. Expert opinions based on scientific analyses:

- 2.1 1% Drought Reconstruction - Palmer Drought Severity Index (PDSI)

  This portion of the Proposal introduces the PDSI and presents the 1930's drought as a 1% drought.

  - The PDSI is utilized by the National Oceanic and Atmospheric Administration (NOAA), the United States Department of Agriculture (USDA), the United States Drought Monitor (USDM), and other agencies to classify relative drought conditions.
  - HCH found that the PDSI chronology could be used to review historic droughts of record for their intensity and duration.
  - HCH calculated that a 1% drought can be approximated by the drought of 1933 through1940.

  Reference: Attachment B - Palmer Drought Severity Index, Research Paper No. 45

  Reference: Attachment C - HCH 1% Drought Reconstruction Technical Memorandum

- Table 2-2: 1% Drought Reconstruction from PDSI

  This table presents a variety of historical drought periods, their exceedance probability, and associated PDSI data.

  - PDSI data associated with the 1930's drought demonstrate conditions similar to reconstructed 1% droughts.

- 2.3 Integrated Water Resources Management During a 1% Drought Using MODSIM-DSS

  This part of the Proposal introduces MODSIM-DSS and conditions modeled during drought simulations.

  - MODSIM-DSS is a water resources management decision support system software that can simulate networked raw water resources such as reservoirs, streams, or aquifers.
  - The model was updated to reflect 1% drought conditions including hydrologic components, projected future demand, and water resources assumptions.
  - Water demand during modeled drought reflects reductions associated with the City's Drought Response Plan.

- Figure 1 - MODSIM DSS Network GUI

  This Figure presents reservoirs, streams, and aquifers represented by components of the MODSIM-DSS raw water resources model.

  - The model represents the resources as well as environmental effects.

- Table 2-3: MODSIM-DSS simulation results for the 1% drought utilizing projected 2060 demands

  This table presents the results of a 1% drought simulation.

  - Modeled demand for water during the drought is reduced by the Drought Response Plan.
  - Cheney Reservoir is used throughout the drought.
  - Use of groundwater is modulated based on the availability of surface water.
  - Use of ASR credits varies, and is limited to allowed withdrawal rates.

- Figure 2 - Simulated Conditions of 1% Drought Demand on Cheney Reservoir

  This figure presents the available storage in Cheney Reservoir, as well as the associated Drought Response Stage, during the modeled 1% drought.

  - Using both ASR credits and reductions of demand, Cheney Reservoir will not be depleted in the modeled 1% drought.

- 2.4 Groundwater Modeling Setup - 1% Drought Simulation

  This portion of the Proposal introduces the USGS Equus Beds Groundwater Flow Model (EBGWM).

  - EBGWM is a three-dimensional finite-difference groundwater-flow model based on MODFLOW-2000.
  - MODFLOW software is broadly recognized as the standard for simulation and prediction of groundwater conditions.
  - The model captures the areal extent of the City's ASR BSA, and is currently approved for use as the method for accounting and tracking of ASR credits.
  - The EBGWM provides a method to simulate the effects of a 1% drought on the aquifer water levels by the input of simulated drought variables including increased agricultural irrigation pumping, additional City pumping, reduced aquifer recharge, reduced streamflow, and increased evapotranspiration.
  - No changes were made to the original construction or hydrogeologic properties of the model.

  Reference: Attachment E - USGS SIR 2013-5042 Groundwater Model Report

- 2.4.1 Stress Period (SP) Development

The EBGWM utilizes data representing conditions at multiple stream gages and weather stations to create a simulation of drought conditions.

- The PDSI values from 1933 to 1940 were compared to more recent years to find and develop a complete hydrologic data set for simulating the duration and intensity of the 1% drought.
- Conditions exhibited in the years 2011 and 2012 were selected to repeat four times, for a total of eight years, to simulate a 1% drought.

Reference: Attachment F - Historic NOAA PDSI Values for SC Kansas

- Figure 3 - USGS Equus Beds Groundwater Flow Model Active Model Boundary

  This figure presents the areal extent of the modeled aquifer and associated streams.

  - Wichita's Central Wellfield lies in a well-known portion of the aquifer, away from the boundaries of the modeled aquifer.

- Table 2-4: PDSI values for South-Central Kansas

  This table presents annual and longer-term drought year PDSI data for South-Central Kansas.

  - The 12-month annual PDSI data shows the 2011-2012 drought to be less severe than the 1930's drought.
  - The 6-month seasonal PDSI data shows the 2011-2012 drought exhibited drier summer months than the 1930's drought.

- Table 2-5: Water Variables and Inputs to the EBGWM by Stress Period

  This table presents groundwater modeling inputs utilized for each stress period of the simulated 1% drought.

  - Using both ASR credits and reductions of demand, Cheney Reservoir will not be depleted in the modeled 1% drought.

- 2.4.2 Starting Groundwater Model Elevations

  This part of the Proposal discusses the basis for selecting the aquifer conditions assumed to be present at the start of the modeled drought.

  - Simulated groundwater levels representing the end of the 1998 period were selected as the best match for representing the groundwater levels required to maintain 30 MGD of physical ASR recharge capacity.

- The 1998 water levels represent an average of 91% full conditions across model cells inside the USGS Central Wellfield Study Area.
- These starting groundwater elevations represent the potential for reoccurrence of drought.

- 2.4.3 Groundwater Pumping - Agricultural Irrigation, Industrial Use, Other Municipal Users

  This part of the Proposal presents the means of representing groundwater pumped from the aquifer by other users in modeled drought.

  - For the drought and drought recovery simulation, the model utilizes the matching DWR reported pumping values from calendar years 2010, 2011, and 2012.
  - Some portion of agricultural irrigation the applied water returns to the aquifer as infiltration. The DWR reported quantity for model years of 2010, 2011, and 2012 were adjusted to account for this infiltration.

- Table 2-6: Net Irrigation Use in the 1% Drought Model

  This Table presents the annual groundwater pumping for irrigation in the modeled drought.

  - The net irrigation use modeled in the CWSA during the drought is less than authorized quantity.

- 2.4.4 Groundwater Pumping - City of Wichita

  This part of the Proposal presents the means of representing groundwater pumped from the aquifer by Wichita in modeled drought.

  - The total simulated City of Wichita groundwater pumping from the EBWF for drought years 1 through 8 is based on the MODSIM-DSS 1% drought modeling work completed by the City.
  - City well pumping was distributed based on the actual water rights allocation for each well as a percentage of total authorized EBWF water rights.

- Table 2-7: Distributed City of Wichita Pumping by Stress Period

  This Table presents the annual groundwater pumping by Wichita in the modeled drought.

  - Modeled demand for water during the drought is reduced by the Drought Response Plan.

  - Use of groundwater is modulated based on the availability of surface water.
  - Use of ASR credits varies, and is limited to allowed withdrawal rates.

- 2.4.5 Streamflow - Arkansas River, Little Arkansas River, Cow Creek

  This part of the Proposal discusses how the model reflects that streams, creeks, and rivers can contribute to aquifer recharge or discharge.

  - Variations in river stage and flow are considered in the groundwater model using the MODFLOW-2000 stream package, and smaller streams and tributaries were simulated using the drain package.

  Reference: Attachment G - Streamflows for Arkansas, Little Arkansas River 2011-2012

- 2.4.6 Precipitation & Natural Aquifer Recharge

  This part of the Proposal presents that the EBGWM uses average precipitation and distributes the recharge across the modeled area.

  - The 1% drought model was constructed using precipitation and distributed natural recharge consistent with the original model documentation.

- Figure 4 - Locations of USGS Stream Gages Within and Near the ASR BSA

  This Figure illustrates the location of USGS stream gages throughout the active groundwater model.

  - Major sources of aquifer recharge adjacent to the BSA are represented in the model.

- Table 2-8: Simulated Natural Aquifer Recharge Inputs for EBGWM

  This table presents the average precipitation and the resultant recharge for each simulated model year.

  - Annual precipitation in modeled drought years is less than average.
  - Simulated recharge vary by location (recharge zones) in the model.

  What it says

- 2.4.7 Evaporation & Transpiration

  This portion of the Proposal explains how evapotranspiration in the model simulates the groundwater losses to evaporation and transpiration by plants.

- The rate of evapotranspiration was calculated using the process set up by the USGS during development of the EBGWM.

- 2.5 Groundwater Modeling Results - 1% Drought Simulation

  This portion of the Proposal discusses modeling results across the BSA and CWSA, including at Index Wells.

  - The average simulated water level change from initial model conditions to the end of the 8-year drought was -11.59 feet for model cells in the CWSA and -8.19 feet for model cells within the BSA.
  - Review of the constructed hydrographs at Index Wells indicates that groundwater levels within the EBWF are projected to fall below the current ASR minimum index levels during the simulated drought.
  - Interpolated shallow aquifer groundwater elevation surfaces for predevelopment and January 1993 shallow aquifer conditions were generated and assigned to model cells to facilitate relative comparison of total saturated aquifer thickness during simulated drought conditions.

  Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

  Reference: Figure 5 - Initial Groundwater Elevations at Beginning of Simulated Drought

  Reference: Figure 6 - Modeled Groundwater Elevations at the End of Simulated Drought (SP8)

  Reference: Figure 7 - Modeled Groundwater Elevations End of Simulated Recovery Year 1 (SP9)

  Reference: Figure 8 - Groundwater Elevations End of Simulated Recovery Year 2 (SP10)

  Reference: Figure 9 - 1993 Groundwater Levels as a Percentage of Predevelopment Saturated Aquifer Thickness

  Reference: Figure 10 - Modeled Aquifer Conditions by ASR Index Cell at the End of Simulated Drought (SP8)

  Reference: Attachment I - Drought Model Simulation Results & Hydrographs

- Table 2-9: Groundwater Modeling Results for 1% Drought Simulation

  This Table presents average modeled water level changes within the model at annual intervals.

- At the end of the 8-year simulated drought, the average remaining saturated thickness as a percentage of predevelopment saturated thickness was 86% for model cells in the CWSA.

- 2.6 Proposed Modifications to ASR Minimum Index Water Levels

  This part of the Proposal presents that the majority of the EBWF will drop below the currently permitted ASR minimum index level restrictions during drought; the City seeks reasonable alternative minimum index water levels to ensure recharge credits are available throughout periods of drought.

  - The results of the EBGWM 1% drought simulation were utilized to calculate the lowest groundwater elevation for each IW site throughout the eight-year simulated drought.
  - To account for variability in actual drought conditions, an additional contingency was subtracted from the calculated lowest groundwater elevations encountered during the groundwater modeling simulation for each IW site.
  - The City is requesting that the proposed minimum index levels be applied to all existing ASR Phase II infrastructure.
  - Modifications to the minimum index level on permits covering ASR Phase I infrastructure are not being requested at this time

  Reference: Figure 11 - Average Aquifer Conditions by Index Cell at Proposed Minimum Levels

- Table 2-10: Development of Proposed ASR Minimum Index Levels

  This Table demonstrates methods used to account for variability in actual drought conditions in arriving at proposed Index Well levels.

  - The lowest water level, modeled or exhibited in 1993, was used as a basis for the proposed level, which reflects a proposed contingency.

- Table 2-11: Proposed ASR Minimum Index Levels

  This Table presents a comparison of the proposed Index Well levels against the existing 1993 Levels, as well as the portion of predevelopment saturated thickness represented by the proposed Index Well levels.

  - Average remaining saturated thickness within CWSA Index Cells at Proposed levels exceeds 79% of predevelopment conditions.
  - Within the CWSA, the minimum remaining percentage of predevelopment conditions is 72%.

- 2.7 Summary

  This part of the Proposal reiterates that modeling indicates groundwater levels will drop below the currently permitted ASR minimum index water levels during a prolonged drought, preventing the withdrawal of ASR credits when they are needed most.

  - To address the concern of recharge credits becoming unavailable during drought the proposed ASR minimum index water level elevations illustrated in Table 2-11 have been submitted for consideration.

- 3.5 ASR Physical Recharge & ASR Operations Plan

  To illustrate the City's commitment to conducting physical recharge activities during periods when the aquifer permits physical recharge capacity, the City is proposing the use of an annual ASR Operations.

  - The operations plan will utilize groundwater level monitoring and the calculated recharge capacity of the ASR recharge well network to determine the quantity and eligibility to accumulate AMCs.
  - To determine the physical recharge capacity of the ASR recharge well network, the City proposing the implementation of an annual water level monitoring program in conjunction with a recharge capacity calculation table.

  Reference: Figure 14 - AMC Operations Table 2016 Example

- 4.0 Proposed ASR Accounting Methodology

  What it presents

  - ASR accounting is the process used to track the accumulation, migration, and recovery of recharge credits throughout the BSA.
  - The current physical recharge accounting system uses the EBGWM to track and model water physically injected to the aquifer.
  - The City is not proposing any modifications to the current physical recharge accounting process.

  Reference: Attachment J - ASR Accounting Simulations

  Reference: Table 4-1: Index Cell Infrastructure and Loss Percentage

  Reference: Figure 15 - ASR Accounting Loss Percentage Map

  Reference: Figure 16 - Current and Proposed Accounting Method Results Comparison

Reference: Table 4-2: Current and Proposed Accounting Method Results Comparison

Reference: Table 4-3: Theoretical Recharge Accounting Example for Index Cell 15

Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Daniel Clement are provided in the subdirectories Proposal, Proposal Communications, and Model.
   ii. Daniel Clement was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications and Reports.
   iii. Additional documents provided by Daniel Clement include correspondence found in the subdirectories Proposal Communication and Electronic Communications.
e) Daniel Clement is a Burns & McDonnell employee; the Contracts provided in the City's Production of Documents disclose a Fee Schedule for each class of employee.
f) Daniel Clement's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Daniel Clement's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Daniel Clement, Burns & McDonnell

EXPERT REPORT: Case No. 18 WATER 14014

for

Luca DeAngelis, Burns & McDonnell

a) Consulted for: historical and current aquifer conditions, such as chloride transport, and modeling simulation tools
b) The grounds for Luca DeAngelis' opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Luca DeAngelis' factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
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            – The Wichita City Council adopted the Drought Response Plan in 2013.

            – The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

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  - Simulated recharge vary by location (recharge zones) in the model.

  What it says

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  - The operations plan will utilize groundwater level monitoring and the calculated recharge capacity of the ASR recharge well network to determine the quantity and eligibility to accumulate AMCs.
  - To determine the physical recharge capacity of the ASR recharge well network, the City proposing the implementation of an annual water level monitoring program in conjunction with a recharge capacity calculation table.

  Reference: Figure 14 - AMC Operations Table 2016 Example

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Luca DeAngelis are provided in the subdirectory Proposal.
   ii. Luca DeAngelis was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications and Reports.
   iii. Additional documents provided by Luca DeAngelis include correspondence found in the subdirectory Electronic Communications.
e) Luca DeAngelis is a Burns & McDonnell employee; the Contracts provided in the City's Production of Documents disclose a Fee Schedule for each class of employee.
f) Luca DeAngelis' factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

EXPERT REPORT: Case No. 18 WATER 14014

for

Don Henry, Assistant Director, City of Wichita Public Works and Utilities

a) Consulted for: Municipal Water Utility Management and planning, including the history of the City's water resources, history and trends in the aquifer, 1993 water levels and the purposes of the changes contemplated by the City's current ASR proposal
b) The grounds for Don Henry's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Don Henry's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - Proposal Cover Letter
            - The Proposal Cover Letter presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - This Proposal Cover Letter further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.
        - 1.0 Introduction

            This part of the Proposal presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.

            - The Wichita City Council decided in April of 2014 to utilize a 1% exceedance probability drought for water resource planning for future water supplies.
            - The evaluation of current ASR permit conditions relative to drought has identified the 1993 levels as a limitation that will restrict the City's access to ASR recharge credits during prolonged drought.

            This part of the Proposal further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.

- The aquifer within the EBWF has recovered to nearly 100% full pre-development conditions, and higher groundwater levels limit the recharge capacity of the City's ASR program.
- The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 2.0 proposed ASR minimum index levels

  This part of the Proposal presents the tenets of the City's Drought Plan.

  - The Wichita City Council adopted the Drought Response Plan in 2013.
  - The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

- Table 2-1: City of Wichita Drought Response Plan (DRP) Stages

  This Table presents the Drought Response steps associated with the condition of Cheney Reservoir.

  - The planned reductions in water use increase as the 12-month average percentage of Conservation Pool decreases.

  Reference: Attachment A - City of Wichita Drought Response Plan

- 2.2 City of Wichita - Future Raw Water Demand Assessment

  This part of the Proposal presents the basis of future water demands incorporated into the City's planning efforts.

  - Projected future demands are based on a medium-growth forecasted population.
  - Future demands will be decreased by progressive water conservation efforts.

  Reference: Attachment D - City of Wichita Water Demand Assessment

- 3.0 Aquifer Maintenance Credits proposal

  This part of the Proposal presents an alternative recharge credit development strategy to address full aquifer conditions.

  - The ability to establish and recover ASR credits is a critical component of the City's plan to meet demand for raw water during an extended drought.

  - Current ASR permit condition allow lowering groundwater levels in the EBWF to create physical recharge capacity and storage for the ASR system.
  - The City proposes that the quantity of water diverted from the Little Arkansas River that cannot be physically recharged through the ASR system could be sent to the City's main water treatment plant to directly meet City water demands.
  - The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 3.1 Integrated Local Water Supply Plan (ILWSP)

  This part of the Proposal highlights the City's Plan, focused on strategic utilization of groundwater, surface water, and development of an Aquifer Storage and Recovery Program.

  - The implementation of the ILWSP has resulted in a substantial increase in the percentage of surface water used by the City to meet demands.
  - The groundwater level recoveries within the EBWF area are a direct result of the implementation of the ILWSP and the City's ASR program.

- 3.2 City of Wichita ASR Program Development

  This part of the Proposal discusses the goals and methods of the ASR program.

  - The reductions in water demand have shifted the need for ASR recharge credits from a normal daily source of supply to a long-term resource only required during extended drought.
  - The focus of the ASR program on drought mitigation allows for the same water quantity and water quality benefits as originally envisioned and results in utilization of ASR recharge credits less frequently.

- 3.3 Benefits of ASR Aquifer Maintenance Credits (AMCs)

  This part of the Proposal presents additional discussion of the parameters of the AMC Proposal.

  - The availability of water in the Little Ark River for diversion would remain identical to the base flow and seasonal limits developed as part of the ASR Phase 1 and Phase 2 permitting process.

- Use of this water directly replaces diversions that would otherwise be required from the EBWF resulting in an equal amount of groundwater effectively left in storage to the benefit of all aquifer users.

- 3.4 Proposed AMC Permit Conditions

  This part of the Proposal presents key components and generally anticipated permit conditions that would guide the operations and accounting of AMCs.

  - The proposed Permit Conditions present that the City is willing to adhere to project parameters that are in the public interest.

- 3.6 Outcome Based Management of Water Resources

  This part of the Proposal reinforces the City's commitment to outcome-based management of water resources.

  - The City of Wichita remains committed to optimizing the use of all available water supply resources both in times of abundance and times of drought.
  - The City remains committed to making water resource management practices that are governed by outcome based results focused on the long-term sustainability of all available water supplies.
  - The City will continue to maintain an ASR operational priority focused on generation of physical recharge credits where and when possible.
  - The ability to develop and recover AMCs results in an aquifer management strategy focused on maintaining the maximum quantity of water possible in aquifer storage within the EBWF.

- Table 3-1: Benefits to Multiple Aquifer Users and Water Resources from AMCs

  This table presents outcomes for several water resources with and without AMCs.

  - The AMC proposal will result in benefits to each water resource.

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Don Henry are provided in the subdirectories Proposal and Proposal Communications.
   ii. Don Henry was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications and Reports.
   iii. Additional documents provided by Don Henry include correspondence found in the subdirectory Electronic Communications.
e) Don Henry is a City of Wichita employee; his compensation is publicly available.

f) Don Henry's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Don Henry's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Don Henry, Assistant Director, City of Wichita Public Works and Utilities

EXPERT REPORT: Case No. 18 WATER 14014

for

Alan King; Director, City of Wichita Public Works & Utilities

a) Consulted for: Municipal Utility Management, and also City Council directions and policy development with regard to water utility infrastructure, water conservation, and drought response
b) The grounds for Alan King's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Alan King's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
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            - The Proposal Cover Letter presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - This Proposal Cover Letter further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.
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          This part of the Proposal presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - The Wichita City Council decided in April of 2014 to utilize a 1% exceedance probability drought for water resource planning for future water supplies.
            - The evaluation of current ASR permit conditions relative to drought has identified the 1993 levels as a limitation that will restrict the City's access to ASR recharge credits during prolonged drought.

          This part of the Proposal further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.

- The aquifer within the EBWF has recovered to nearly 100% full pre-development conditions, and higher groundwater levels limit the recharge capacity of the City's ASR program.
- The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 2.0 proposed ASR minimum index levels

  This part of the Proposal presents the tenets of the City's Drought Plan.

  - The Wichita City Council adopted the Drought Response Plan in 2013.
  - The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

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  This Table presents the Drought Response steps associated with the condition of Cheney Reservoir.

  - The planned reductions in water use increase as the 12-month average percentage of Conservation Pool decreases.

  Reference: Attachment A - City of Wichita Drought Response Plan

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Alan King are provided in the subdirectories Proposal and Proposal Communications.
   ii. Alan King was provided, relied upon, or reviewed documents included in the subdirectories Proposal, Proposal Communications and Reports.
   iii. Additional documents provided by Alan King include correspondence found in the subdirectory Electronic Communications.
e) Alan King is a City of Wichita employee; his compensation is publicly available.
f) Alan King's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Alan King's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Alan King; Director, City of Wichita Public Works & Utilities

EXPERT REPORT: Case No. 18 WATER 14014

for

Don Koci, Burns & McDonnell

a) Consulted for: Wichita's ASR project history, goals and mission, in addition to water rights and regulatory structures
b) The grounds for Don Koci's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Don Koci's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - 3.0 Aquifer Maintenance Credits proposal

          This part of the Proposal presents an alternative recharge credit development strategy to address full aquifer conditions.

            - The ability to establish and recover ASR credits is a critical component of the City's plan to meet demand for raw water during an extended drought.
            - Current ASR permit condition allow lowering groundwater levels in the EBWF to create physical recharge capacity and storage for the ASR system.
            - The City proposes that the quantity of water diverted from the Little Arkansas River that cannot be physically recharged through the ASR system could be sent to the City's main water treatment plant to directly meet City water demands.
            - The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

        - 3.1 Integrated Local Water Supply Plan (ILWSP)

          This part of the Proposal highlights the City's Plan, focused on strategic utilization of groundwater, surface water, and development of an Aquifer Storage and Recovery Program.

            - The implementation of the ILWSP has resulted in a substantial increase in the percentage of surface water used by the City to meet demands.

- The groundwater level recoveries within the EBWF area are a direct result of the implementation of the ILWSP and the City's ASR program.

- 3.2 City of Wichita ASR Program Development

  This part of the Proposal discusses the goals and methods of the ASR program.

  - The reductions in water demand have shifted the need for ASR recharge credits from a normal daily source of supply to a long-term resource only required during extended drought.
  - The focus of the ASR program on drought mitigation allows for the same water quantity and water quality benefits as originally envisioned and results in utilization of ASR recharge credits less frequently.

- 3.3 Benefits of ASR Aquifer Maintenance Credits (AMCs)

  This part of the Proposal presents additional discussion of the parameters of the AMC Proposal.

  - The availability of water in the Little Ark River for diversion would remain identical to the base flow and seasonal limits developed as part of the ASR Phase 1 and Phase 2 permitting process.
  - Use of this water directly replaces diversions that would otherwise be required from the EBWF resulting in an equal amount of groundwater effectively left in storage to the benefit of all aquifer users.

- 3.4 Proposed AMC Permit Conditions

  This part of the Proposal presents key components and generally anticipated permit conditions that would guide the operations and accounting of AMCs.

  - The proposed Permit Conditions present that the City is willing to adhere to project parameters that are in the public interest.

- 3.6 Outcome Based Management of Water Resources

  This part of the Proposal reinforces the City's commitment to outcome-based management of water resources.

  - The City of Wichita remains committed to optimizing the use of all available water supply resources both in times of abundance and times of drought.

- The City remains committed to making water resource management practices that are governed by outcome based results focused on the long-term sustainability of all available water supplies.
- The City will continue to maintain an ASR operational priority focused on generation of physical recharge credits where and when possible.
- The ability to develop and recover AMCs results in an aquifer management strategy focused on maintaining the maximum quantity of water possible in aquifer storage within the EBWF.

- Table 3-1: Benefits to Multiple Aquifer Users and Water Resources from AMCs

  This table presents outcomes for several water resources with and without AMCs.

  - The AMC proposal will result in benefits to each water resource.

ii. Expert opinions based on scientific analyses:

- 4.0 Proposed ASR Accounting Methodology

  What it presents

  - ASR accounting is the process used to track the accumulation, migration, and recovery of recharge credits throughout the BSA.
  - The current physical recharge accounting system uses the EBGWM to track and model water physically injected to the aquifer.
  - The City is not proposing any modifications to the current physical recharge accounting process.

  Reference: Attachment J - ASR Accounting Simulations

  Reference: Table 4-1: Index Cell Infrastructure and Loss Percentage

  Reference: Figure 15 - ASR Accounting Loss Percentage Map

  Reference: Figure 16 - Current and Proposed Accounting Method Results Comparison

  Reference: Table 4-2: Current and Proposed Accounting Method Results Comparison

  Reference: Table 4-3: Theoretical Recharge Accounting Example for Index Cell 15

  Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

d) Documents presented in Wichita's Responses to Production Requests

i. Documents prepared by or under the supervision of Don Koci are provided in the subdirectories Proposal and Proposal Communications.

ii. Don Koci was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications, Reports, and Model.

iii. Additional documents provided by Don Koci include correspondence found in the subdirectory Electronic Communications.

e) Don Koci is a Burns & McDonnell employee; the Contracts provided in the City's Production of Documents disclose a Fee Schedule for each class of employee.

f) Don Koci's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.

g) Don Koci's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Don Koci, Burns & McDonnell

EXPERT REPORT: Case No. 18 WATER 14014

for

Scott Macey, Water Resources Engineer, City of Wichita Public Works & Utilities

a) Consulted for: current and historical water use trends, current City treatment processes and infrastructure planning, and technical tools and models used for water resource decision making
b) The grounds for Scott Macey's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Scott Macey's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - 2.0 proposed ASR minimum index levels

          This part of the Proposal presents the tenets of the City's Drought Plan.

          – The Wichita City Council adopted the Drought Response Plan in 2013.

          – The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

        - Table 2-1: City of Wichita Drought Response Plan (DRP) Stages

          This Table presents the Drought Response steps associated with the condition of Cheney Reservoir.

          – The planned reductions in water use increase as the 12-month average percentage of Conservation Pool decreases.

          Reference: Attachment A - City of Wichita Drought Response Plan

        - 2.2 City of Wichita - Future Raw Water Demand Assessment

          This part of the Proposal presents the basis of future water demands incorporated into the City's planning efforts.

          – Projected future demands are based on a medium-growth forecasted population.

          – Future demands will be decreased by progressive water conservation efforts.

          Reference: Attachment D - City of Wichita Water Demand Assessment

ii. Expert opinions based on scientific analyses:

- 2.1 1% Drought Reconstruction - Palmer Drought Severity Index (PDSI)

  This portion of the Proposal introduces the PDSI and presents the 1930's drought as a 1% drought.

  - The PDSI is utilized by the National Oceanic and Atmospheric Administration (NOAA), the United States Department of Agriculture (USDA), the United States Drought Monitor (USDM), and other agencies to classify relative drought conditions.
  - HCH found that the PDSI chronology could be used to review historic droughts of record for their intensity and duration.
  - HCH calculated that a 1% drought can be approximated by the drought of 1933 through1940.

  Reference: Attachment B - Palmer Drought Severity Index, Research Paper No. 45

  Reference: Attachment C - HCH 1% Drought Reconstruction Technical Memorandum

- Table 2-2: 1% Drought Reconstruction from PDSI

  This table presents a variety of historical drought periods, their exceedance probability, and associated PDSI data.

  - PDSI data associated with the 1930's drought demonstrate conditions similar to reconstructed 1% droughts.

- 2.3 Integrated Water Resources Management During a 1% Drought Using MODSIM-DSS

  This part of the Proposal introduces MODSIM-DSS and conditions modeled during drought simulations.

  - MODSIM-DSS is a water resources management decision support system software that can simulate networked raw water resources such as reservoirs, streams, or aquifers.
  - The model was updated to reflect 1% drought conditions including hydrologic components, projected future demand, and water resources assumptions.
  - Water demand during modeled drought reflects reductions associated with the City's Drought Response Plan.

- Figure 1 - MODSIM DSS Network GUI

  This Figure presents reservoirs, streams, and aquifers represented by components of the MODSIM-DSS raw water resources model.

- The model represents the resources as well as environmental effects.

- Table 2-3: MODSIM-DSS simulation results for the 1% drought utilizing projected 2060 demands

  This table presents the results of a 1% drought simulation.

  - Modeled demand for water during the drought is reduced by the Drought Response Plan.
  - Cheney Reservoir is used throughout the drought.
  - Use of groundwater is modulated based on the availability of surface water.
  - Use of ASR credits varies, and is limited to allowed withdrawal rates.

- Figure 2 - Simulated Conditions of 1% Drought Demand on Cheney Reservoir

  This figure presents the available storage in Cheney Reservoir, as well as the associated Drought Response Stage, during the modeled 1% drought.

  - Using both ASR credits and reductions of demand, Cheney Reservoir will not be depleted in the modeled 1% drought.

- 2.4.2 Starting Groundwater Model Elevations

  This part of the Proposal discusses the basis for selecting the aquifer conditions assumed to be present at the start of the modeled drought.

  - Simulated groundwater levels representing the end of the 1998 period were selected as the best match for representing the groundwater levels required to maintain 30 MGD of physical ASR recharge capacity.
  - The 1998 water levels represent an average of 91% full conditions across model cells inside the USGS Central Wellfield Study Area.
  - These starting groundwater elevations represent the potential for reoccurrence of drought.

- 2.4.4 Groundwater Pumping - City of Wichita

  This part of the Proposal presents the means of representing groundwater pumped from the aquifer by Wichita in modeled drought.

- The total simulated City of Wichita groundwater pumping from the EBWF for drought years 1 through 8 is based on the MODSIM-DSS 1% drought modeling work completed by the City.
- City well pumping was distributed based on the actual water rights allocation for each well as a percentage of total authorized EBWF water rights.

- 3.5 ASR Physical Recharge & ASR Operations Plan

  To illustrate the City's commitment to conducting physical recharge activities during periods when the aquifer permits physical recharge capacity, the City is proposing the use of an annual ASR Operations.

  - The operations plan will utilize groundwater level monitoring and the calculated recharge capacity of the ASR recharge well network to determine the quantity and eligibility to accumulate AMCs.
  - To determine the physical recharge capacity of the ASR recharge well network, the City proposing the implementation of an annual water level monitoring program in conjunction with a recharge capacity calculation table.

  Reference: Figure 14 - AMC Operations Table 2016 Example

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Scott Macey are provided in the subdirectories Proposal and Proposal Communications.
   ii. Scott Macey was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications, Reports, and Model.
   iii. Additional documents provided by Scott Macey include correspondence found in the subdirectory Electronic Communications.
e) Scott Macey is a City of Wichita employee; his compensation is publicly available.
f) Scott Macey's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Scott Macey's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

EXPERT REPORT: Case No. 18 WATER 14014

for

Paul McCormick, Burns & McDonnell

a) Consulted for: aquifer water usage and sustainable yield, recharge mechanisms and accounting, water resource conditions, and technical tools and models
b) The grounds for Paul McCormick's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Paul McCormick's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - 2.0 proposed ASR minimum index levels

          This part of the Proposal presents the tenets of the City's Drought Plan.

            – The Wichita City Council adopted the Drought Response Plan in 2013.
            – The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

    ii. Expert opinions based on scientific analyses:
        - 2.4 Groundwater Modeling Setup - 1% Drought Simulation

          This portion of the Proposal introduces the USGS Equus Beds Groundwater Flow Model (EBGWM).

            – EBGWM is a three-dimensional finite-difference groundwater-flow model based on MODFLOW-2000.
            – MODFLOW software is broadly recognized as the standard for simulation and prediction of groundwater conditions.
            – The model captures the areal extent of the City's ASR BSA, and is currently approved for use as the method for accounting and tracking of ASR credits.
            – The EBGWM provides a method to simulate the effects of a 1% drought on the aquifer water levels by the input of simulated drought variables including increased agricultural irrigation pumping, additional City pumping, reduced aquifer recharge, reduced streamflow, and increased evapotranspiration.

- No changes were made to the original construction or hydrogeologic properties of the model.

Reference: Attachment E - USGS SIR 2013-5042 Groundwater Model Report

- 2.4.1 Stress Period (SP) Development

  The EBGWM utilizes data representing conditions at multiple stream gages and weather stations to create a simulation of drought conditions.

  - The PDSI values from 1933 to 1940 were compared to more recent years to find and develop a complete hydrologic data set for simulating the duration and intensity of the 1% drought.
  - Conditions exhibited in the years 2011 and 2012 were selected to repeat four times, for a total of eight years, to simulate a 1% drought.

  Reference: Attachment F - Historic NOAA PDSI Values for SC Kansas

- Figure 3 - USGS Equus Beds Groundwater Flow Model Active Model Boundary

  This figure presents the areal extent of the modeled aquifer and associated streams.

  - Wichita's Central Wellfield lies in a well-known portion of the aquifer, away from the boundaries of the modeled aquifer.

- Table 2-4: PDSI values for South-Central Kansas

  This table presents annual and longer-term drought year PDSI data for South-Central Kansas.

  - The 12-month annual PDSI data shows the 2011-2012 drought to be less severe than the 1930's drought.
  - The 6-month seasonal PDSI data shows the 2011-2012 drought exhibited drier summer months than the 1930's drought.

- Table 2-5: Water Variables and Inputs to the EBGWM by Stress Period

  This table presents groundwater modeling inputs utilized for each stress period of the simulated 1% drought.

  - Using both ASR credits and reductions of demand, Cheney Reservoir will not be depleted in the modeled 1% drought.

- 2.4.2 Starting Groundwater Model Elevations

  This part of the Proposal discusses the basis for selecting the aquifer conditions assumed to be present at the start of the modeled drought.

  - Simulated groundwater levels representing the end of the 1998 period were selected as the best match for representing the groundwater levels required to maintain 30 MGD of physical ASR recharge capacity.
  - The 1998 water levels represent an average of 91% full conditions across model cells inside the USGS Central Wellfield Study Area.
  - These starting groundwater elevations represent the potential for reoccurrence of drought.

- 2.4.3 Groundwater Pumping - Agricultural Irrigation, Industrial Use, Other Municipal Users

  This part of the Proposal presents the means of representing groundwater pumped from the aquifer by other users in modeled drought.

  - For the drought and drought recovery simulation, the model utilizes the matching DWR reported pumping values from calendar years 2010, 2011, and 2012.
  - Some portion of agricultural irrigation the applied water returns to the aquifer as infiltration. The DWR reported quantity for model years of 2010, 2011, and 2012 were adjusted to account for this infiltration.

- Table 2-6: Net Irrigation Use in the 1% Drought Model

  This Table presents the annual groundwater pumping for irrigation in the modeled drought.

  - The net irrigation use modeled in the CWSA during the drought is less than authorized quantity.

- 2.4.4 Groundwater Pumping - City of Wichita

  This part of the Proposal presents the means of representing groundwater pumped from the aquifer by Wichita in modeled drought.

  - The total simulated City of Wichita groundwater pumping from the EBWF for drought years 1 through 8 is based on the MODSIM-DSS 1% drought modeling work completed by the City.
  - City well pumping was distributed based on the actual water rights allocation for each well as a percentage of total authorized EBWF water rights.

- Table 2-7: Distributed City of Wichita Pumping by Stress Period

This Table presents the annual groundwater pumping by Wichita in the modeled drought.

  - Modeled demand for water during the drought is reduced by the Drought Response Plan.
  - Use of groundwater is modulated based on the availability of surface water.
  - Use of ASR credits varies, and is limited to allowed withdrawal rates.

- 2.4.5 Streamflow - Arkansas River, Little Arkansas River, Cow Creek

  This part of the Proposal discusses how the model reflects that streams, creeks, and rivers can contribute to aquifer recharge or discharge.

  - Variations in river stage and flow are considered in the groundwater model using the MODFLOW-2000 stream package, and smaller streams and tributaries were simulated using the drain package.

  Reference: Attachment G - Streamflows for Arkansas, Little Arkansas River 2011-2012

- 2.4.6 Precipitation & Natural Aquifer Recharge

  This part of the Proposal presents that the EBGWM uses average precipitation and distributes the recharge across the modeled area.

  - The 1% drought model was constructed using precipitation and distributed natural recharge consistent with the original model documentation.

- Figure 4 - Locations of USGS Stream Gages Within and Near the ASR BSA

  This Figure illustrates the location of USGS stream gages throughout the active groundwater model.

  - Major sources of aquifer recharge adjacent to the BSA are represented in the model.

- Table 2-8: Simulated Natural Aquifer Recharge Inputs for EBGWM

  This table presents the average precipitation and the resultant recharge for each simulated model year.

  - Annual precipitation in modeled drought years is less than average.
  - Simulated recharge vary by location (recharge zones) in the model.

  What it says

- 2.4.7 Evaporation & Transpiration

  This portion of the Proposal explains how evapotranspiration in the model simulates the groundwater losses to evaporation and transpiration by plants.

  - The rate of evapotranspiration was calculated using the process set up by the USGS during development of the EBGWM.

- 2.5 Groundwater Modeling Results - 1% Drought Simulation

  This portion of the Proposal discusses modeling results across the BSA and CWSA, including at Index Wells.

  - The average simulated water level change from initial model conditions to the end of the 8-year drought was -11.59 feet for model cells in the CWSA and -8.19 feet for model cells within the BSA.
  - Review of the constructed hydrographs at Index Wells indicates that groundwater levels within the EBWF are projected to fall below the current ASR minimum index levels during the simulated drought.
  - Interpolated shallow aquifer groundwater elevation surfaces for predevelopment and January 1993 shallow aquifer conditions were generated and assigned to model cells to facilitate relative comparison of total saturated aquifer thickness during simulated drought conditions.

  Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

  Reference: Figure 5 - Initial Groundwater Elevations at Beginning of Simulated Drought

  Reference: Figure 6 - Modeled Groundwater Elevations at the End of Simulated Drought (SP8)

  Reference: Figure 7 - Modeled Groundwater Elevations End of Simulated Recovery Year 1 (SP9)

  Reference: Figure 8 - Groundwater Elevations End of Simulated Recovery Year 2 (SP10)

  Reference: Figure 9 - 1993 Groundwater Levels as a Percentage of Predevelopment Saturated Aquifer Thickness

  Reference: Figure 10 - Modeled Aquifer Conditions by ASR Index Cell at the End of Simulated Drought (SP8)

  Reference: Attachment I - Drought Model Simulation Results & Hydrographs

- Table 2-9: Groundwater Modeling Results for 1% Drought Simulation

This Table presents average modeled water level changes within the model at annual intervals.

  - At the end of the 8-year simulated drought, the average remaining saturated thickness as a percentage of predevelopment saturated thickness was 86% for model cells in the CWSA.

- 2.6 Proposed Modifications to ASR Minimum Index Water Levels

  This part of the Proposal presents that the majority of the EBWF will drop below the currently permitted ASR minimum index level restrictions during drought; the City seeks reasonable alternative minimum index water levels to ensure recharge credits are available throughout periods of drought.

  - The results of the EBGWM 1% drought simulation were utilized to calculate the lowest groundwater elevation for each IW site throughout the eight-year simulated drought.
  - To account for variability in actual drought conditions, an additional contingency was subtracted from the calculated lowest groundwater elevations encountered during the groundwater modeling simulation for each IW site.
  - The City is requesting that the proposed minimum index levels be applied to all existing ASR Phase II infrastructure.
  - Modifications to the minimum index level on permits covering ASR Phase I infrastructure are not being requested at this time

  Reference: Figure 11 - Average Aquifer Conditions by Index Cell at Proposed Minimum Levels

- Table 2-10: Development of Proposed ASR Minimum Index Levels

  This Table demonstrates methods used to account for variability in actual drought conditions in arriving at proposed Index Well levels.

  - The lowest water level, modeled or exhibited in 1993, was used as a basis for the proposed level, which reflects a proposed contingency.

- Table 2-11: Proposed ASR Minimum Index Levels

  This Table presents a comparison of the proposed Index Well levels against the existing 1993 Levels, as well as the portion of predevelopment saturated thickness represented by the proposed Index Well levels.

  - Average remaining saturated thickness within CWSA Index Cells at Proposed levels exceeds 79% of predevelopment conditions.

- Within the CWSA, the minimum remaining percentage of predevelopment conditions is 72%.

- 2.7 Summary

  This part of the Proposal reiterates that modeling indicates groundwater levels will drop below the currently permitted ASR minimum index water levels during a prolonged drought, preventing the withdrawal of ASR credits when they are needed most.

  - To address the concern of recharge credits becoming unavailable during drought the proposed ASR minimum index water level elevations illustrated in Table 2-11 have been submitted for consideration.

- 3.5 ASR Physical Recharge & ASR Operations Plan

  To illustrate the City's commitment to conducting physical recharge activities during periods when the aquifer permits physical recharge capacity, the City is proposing the use of an annual ASR Operations.

  - The operations plan will utilize groundwater level monitoring and the calculated recharge capacity of the ASR recharge well network to determine the quantity and eligibility to accumulate AMCs.
  - To determine the physical recharge capacity of the ASR recharge well network, the City proposing the implementation of an annual water level monitoring program in conjunction with a recharge capacity calculation table.

  Reference: Figure 14 - AMC Operations Table 2016 Example

- 4.0 Proposed ASR Accounting Methodology

  What it presents

  - ASR accounting is the process used to track the accumulation, migration, and recovery of recharge credits throughout the BSA.
  - The current physical recharge accounting system uses the EBGWM to track and model water physically injected to the aquifer.
  - The City is not proposing any modifications to the current physical recharge accounting process.

  Reference: Attachment J - ASR Accounting Simulations

  Reference: Table 4-1: Index Cell Infrastructure and Loss Percentage

  Reference: Figure 15 - ASR Accounting Loss Percentage Map

Reference: Figure 16 - Current and Proposed Accounting Method Results Comparison

Reference: Table 4-2: Current and Proposed Accounting Method Results Comparison

Reference: Table 4-3: Theoretical Recharge Accounting Example for Index Cell 15

Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

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   i. Documents prepared by or under the supervision of Paul McCormick are provided in the subdirectories Proposal, Proposal Communications, and Model.
   ii. Paul McCormick was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications and Reports.
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e) Paul McCormick is a Burns & McDonnell employee; the Contracts provided in the City's Production of Documents disclose a Fee Schedule for each class of employee.
f) Paul McCormick's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Paul McCormick's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Paul McCormick, Burns & McDonnell

EXPERT REPORT: Case No. 18 WATER 14014

for

Brian Meier, Burns & McDonnell

a) Consulted for: Wichita's ASR project history, including its missions, goals, and methods, and the interagency coordination as the City's water utility employed a dynamic plan for its water resources
b) The grounds for Brian Meier's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Brian Meier's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - Proposal Cover Letter
            - The Proposal Cover Letter presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - This Proposal Cover Letter further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.
        - 1.0 Introduction

          This part of the Proposal presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - The Wichita City Council decided in April of 2014 to utilize a 1% exceedance probability drought for water resource planning for future water supplies.
            - The evaluation of current ASR permit conditions relative to drought has identified the 1993 levels as a limitation that will restrict the City's access to ASR recharge credits during prolonged drought.

          This part of the Proposal further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.

- The aquifer within the EBWF has recovered to nearly 100% full pre-development conditions, and higher groundwater levels limit the recharge capacity of the City's ASR program.
- The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 3.0 Aquifer Maintenance Credits proposal

  This part of the Proposal presents an alternative recharge credit development strategy to address full aquifer conditions.

  - The ability to establish and recover ASR credits is a critical component of the City's plan to meet demand for raw water during an extended drought.
  - Current ASR permit condition allow lowering groundwater levels in the EBWF to create physical recharge capacity and storage for the ASR system.
  - The City proposes that the quantity of water diverted from the Little Arkansas River that cannot be physically recharged through the ASR system could be sent to the City's main water treatment plant to directly meet City water demands.
  - The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 3.1 Integrated Local Water Supply Plan (ILWSP)

  This part of the Proposal highlights the City's Plan, focused on strategic utilization of groundwater, surface water, and development of an Aquifer Storage and Recovery Program.

  - The implementation of the ILWSP has resulted in a substantial increase in the percentage of surface water used by the City to meet demands.
  - The groundwater level recoveries within the EBWF area are a direct result of the implementation of the ILWSP and the City's ASR program.

- 3.2 City of Wichita ASR Program Development

  This part of the Proposal discusses the goals and methods of the ASR program.

  - The reductions in water demand have shifted the need for ASR recharge credits from a normal daily source of supply to a long-term resource only required during extended drought.

  - The focus of the ASR program on drought mitigation allows for the same water quantity and water quality benefits as originally envisioned and results in utilization of ASR recharge credits less frequently.

- 3.3 Benefits of ASR Aquifer Maintenance Credits (AMCs)

  This part of the Proposal presents additional discussion of the parameters of the AMC Proposal.

  - The availability of water in the Little Ark River for diversion would remain identical to the base flow and seasonal limits developed as part of the ASR Phase 1 and Phase 2 permitting process.
  - Use of this water directly replaces diversions that would otherwise be required from the EBWF resulting in an equal amount of groundwater effectively left in storage to the benefit of all aquifer users.

- 3.4 Proposed AMC Permit Conditions

  This part of the Proposal presents key components and generally anticipated permit conditions that would guide the operations and accounting of AMCs.

  - The proposed Permit Conditions present that the City is willing to adhere to project parameters that are in the public interest.

- 3.6 Outcome Based Management of Water Resources

  This part of the Proposal reinforces the City's commitment to outcome-based management of water resources.

  - The City of Wichita remains committed to optimizing the use of all available water supply resources both in times of abundance and times of drought.
  - The City remains committed to making water resource management practices that are governed by outcome based results focused on the long-term sustainability of all available water supplies.
  - The City will continue to maintain an ASR operational priority focused on generation of physical recharge credits where and when possible.
  - The ability to develop and recover AMCs results in an aquifer management strategy focused on maintaining the maximum quantity of water possible in aquifer storage within the EBWF.

- Table 3-1: Benefits to Multiple Aquifer Users and Water Resources from AMCs

This table presents outcomes for several water resources with and without AMCs.

- The AMC proposal will result in benefits to each water resource.

ii. Expert opinions based on scientific analyses:

- 4.0 Proposed ASR Accounting Methodology

  What it presents

  - ASR accounting is the process used to track the accumulation, migration, and recovery of recharge credits throughout the BSA.
  - The current physical recharge accounting system uses the EBGWM to track and model water physically injected to the aquifer.
  - The City is not proposing any modifications to the current physical recharge accounting process.

  Reference: Attachment J - ASR Accounting Simulations

  Reference: Table 4-1: Index Cell Infrastructure and Loss Percentage

  Reference: Figure 15 - ASR Accounting Loss Percentage Map

  Reference: Figure 16 - Current and Proposed Accounting Method Results Comparison

  Reference: Table 4-2: Current and Proposed Accounting Method Results Comparison

  Reference: Table 4-3: Theoretical Recharge Accounting Example for Index Cell 15

  Reference: Attachment H - USGS SIR 2013-5170, Revised 1993 Groundwater Levels

d) Documents presented in Wichita's Responses to Production Requests
   i. Documents prepared by or under the supervision of Brian Meier are provided in the subdirectories Proposal and Proposal Communications.
   ii. Brian Meier was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications, Reports, and Model.
   iii. Additional documents provided by Brian Meier include correspondence found in the subdirectory Electronic Communications.
e) Brian Meier is a Burns & McDonnell employee; the Contracts provided in the City's Production of Documents disclose a Fee Schedule for each class of employee.
f) Brian Meier's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.

g) Brian Meier's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Brian Meier, Burns & McDonnell

EXPERT REPORT: Case No. 18 WATER 14014

for

Joseph T. Pajor, Deputy Director, City of Wichita Public Works and Utilities

a) Consulted for: Wichita's historical interactions with Groundwater Management District No. 2, the history of the City's water resources and the purposes of the changes contemplated by the City's current ASR proposal
b) The grounds for Joseph T. Pajor's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) Joseph T. Pajor's factual observations and opinions, as presented in the Proposal documents, include:
    i. Expert opinions based on factual observations:
        - Proposal Cover Letter
            - The Proposal Cover Letter presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.
            - This Proposal Cover Letter further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.
        - 1.0 Introduction

            This part of the Proposal presents a summary of the City's reasons to seek revised minimum index level for the existing ASR project so that recharge credits are available throughout periods of long-term drought.

            - The Wichita City Council decided in April of 2014 to utilize a 1% exceedance probability drought for water resource planning for future water supplies.
            - The evaluation of current ASR permit conditions relative to drought has identified the 1993 levels as a limitation that will restrict the City's access to ASR recharge credits during prolonged drought.

            This part of the Proposal further presents a summary of the City's reasons to seek an alternative recharge credit development strategy during full aquifer conditions.

  - The aquifer within the EBWF has recovered to nearly 100% full pre-development conditions, and higher groundwater levels limit the recharge capacity of the City's ASR program.
  - The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 2.0 proposed ASR minimum index levels

  This part of the Proposal presents the tenets of the City's Drought Plan.

  - The Wichita City Council adopted the Drought Response Plan in 2013.
  - The Drought Response plan will reduce demand at the customer level and has the effect of extending the viability of both Cheney Reservoir and the EBWF during prolonged drought.

- Table 2-1: City of Wichita Drought Response Plan (DRP) Stages

  This Table presents the Drought Response steps associated with the condition of Cheney Reservoir.

  - The planned reductions in water use increase as the 12-month average percentage of Conservation Pool decreases.

  Reference: Attachment A - City of Wichita Drought Response Plan

- 2.2 City of Wichita - Future Raw Water Demand Assessment

  This part of the Proposal presents the basis of future water demands incorporated into the City's planning efforts.

  - Projected future demands are based on a medium-growth forecasted population.
  - Future demands will be decreased by progressive water conservation efforts.

  Reference: Attachment D - City of Wichita Water Demand Assessment

- 3.0 Aquifer Maintenance Credits proposal

  This part of the Proposal presents an alternative recharge credit development strategy to address full aquifer conditions.

  - The ability to establish and recover ASR credits is a critical component of the City's plan to meet demand for raw water during an extended drought.

- Current ASR permit condition allow lowering groundwater levels in the EBWF to create physical recharge capacity and storage for the ASR system.
- The City proposes that the quantity of water diverted from the Little Arkansas River that cannot be physically recharged through the ASR system could be sent to the City's main water treatment plant to directly meet City water demands.
- The water left in the aquifer as a result of utilizing Little Arkansas River flows would be considered as an ASR Aquifer Maintenance Credit (AMC) with similar characteristics to the current ASR recharge credits.

- 3.1 Integrated Local Water Supply Plan (ILWSP)

  This part of the Proposal highlights the City's Plan, focused on strategic utilization of groundwater, surface water, and development of an Aquifer Storage and Recovery Program.

  - The implementation of the ILWSP has resulted in a substantial increase in the percentage of surface water used by the City to meet demands.
  - The groundwater level recoveries within the EBWF area are a direct result of the implementation of the ILWSP and the City's ASR program.

- 3.2 City of Wichita ASR Program Development

  This part of the Proposal discusses the goals and methods of the ASR program.

  - The reductions in water demand have shifted the need for ASR recharge credits from a normal daily source of supply to a long-term resource only required during extended drought.
  - The focus of the ASR program on drought mitigation allows for the same water quantity and water quality benefits as originally envisioned and results in utilization of ASR recharge credits less frequently.

- 3.3 Benefits of ASR Aquifer Maintenance Credits (AMCs)

  This part of the Proposal presents additional discussion of the parameters of the AMC Proposal.

  - The availability of water in the Little Ark River for diversion would remain identical to the base flow and seasonal limits developed as part of the ASR Phase 1 and Phase 2 permitting process.

- Use of this water directly replaces diversions that would otherwise be required from the EBWF resulting in an equal amount of groundwater effectively left in storage to the benefit of all aquifer users.

- 3.4 Proposed AMC Permit Conditions

  This part of the Proposal presents key components and generally anticipated permit conditions that would guide the operations and accounting of AMCs.

  - The proposed Permit Conditions present that the City is willing to adhere to project parameters that are in the public interest.

- 3.6 Outcome Based Management of Water Resources

  This part of the Proposal reinforces the City's commitment to outcome-based management of water resources.

  - The City of Wichita remains committed to optimizing the use of all available water supply resources both in times of abundance and times of drought.
  - The City remains committed to making water resource management practices that are governed by outcome based results focused on the long-term sustainability of all available water supplies.
  - The City will continue to maintain an ASR operational priority focused on generation of physical recharge credits where and when possible.
  - The ability to develop and recover AMCs results in an aquifer management strategy focused on maintaining the maximum quantity of water possible in aquifer storage within the EBWF.

- Table 3-1: Benefits to Multiple Aquifer Users and Water Resources from AMCs

  This table presents outcomes for several water resources with and without AMCs.

  - The AMC proposal will result in benefits to each water resource.

d) Documents presented in Wichita's Responses to Production Requests

   i. Documents prepared by or under the supervision of Joseph T. Pajor are provided in the subdirectories Proposal and Proposal Communications.

   ii. Joseph T. Pajor was provided, relied upon, or reviewed documents included in the subdirectories Proposal Communications and Reports.

   iii. Additional documents provided by Joseph T. Pajor include correspondence found in the subdirectory Electronic Communications.

e) Joseph T. Pajor is a City of Wichita employee; his compensation is publicly available.
f) Joseph T. Pajor's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.
g) Joseph T. Pajor's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

Joseph T. Pajor, Deputy Director, City of Wichita Public Works and Utilities

EXPERT REPORT: Case No. 18 WATER 14014

for

John Winchester, High Country Hydrology

a) Consulted for: municipal water resources planning, hydrological analyses, drought simulation, use of the 1% drought in the planning process, and technical tools and models
b) The grounds for John Winchester's opinions are knowledge of pertinent information presented in City of Wichita's Response to Production Request of Equus Beds Groundwater Management District No.2 and City of Wichita's Responses to Intervener's Production Requests.
c) John Winchester's factual observations and opinions, as presented in the Proposal documents, include:
   iv. Expert opinions based on scientific analyses:
      - 2.1 1% Drought Reconstruction - Palmer Drought Severity Index (PDSI)

        This portion of the Proposal introduces the PDSI and presents the 1930's drought as a 1% drought.

        – The PDSI is utilized by the National Oceanic and Atmospheric Administration (NOAA), the United States Department of Agriculture (USDA), the United States Drought Monitor (USDM), and other agencies to classify relative drought conditions.

        – HCH found that the PDSI chronology could be used to review historic droughts of record for their intensity and duration.

        – HCH calculated that a 1% drought can be approximated by the drought of 1933 through1940.

        Reference: Attachment B - Palmer Drought Severity Index, Research Paper No. 45

        Reference: Attachment C - HCH 1% Drought Reconstruction Technical Memorandum

      - Table 2-2: 1% Drought Reconstruction from PDSI

        This table presents a variety of historical drought periods, their exceedance probability, and associated PDSI data.

        – PDSI data associated with the 1930's drought demonstrate conditions similar to reconstructed 1% droughts.

      - 2.3 Integrated Water Resources Management During a 1% Drought Using MODSIM-DSS

        This part of the Proposal introduces MODSIM-DSS and conditions modeled during drought simulations.

- MODSIM-DSS is a water resources management decision support system software that can simulate networked raw water resources such as reservoirs, streams, or aquifers.
- The model was updated to reflect 1% drought conditions including hydrologic components, projected future demand, and water resources assumptions.
- Water demand during modeled drought reflects reductions associated with the City's Drought Response Plan.

- Figure 1 - MODSIM DSS Network GUI

  This Figure presents reservoirs, streams, and aquifers represented by components of the MODSIM-DSS raw water resources model.

  - The model represents the resources as well as environmental effects.

- Table 2-3: MODSIM-DSS simulation results for the 1% drought utilizing projected 2060 demands

  This table presents the results of a 1% drought simulation.

  - Modeled demand for water during the drought is reduced by the Drought Response Plan.
  - Cheney Reservoir is used throughout the drought.
  - Use of groundwater is modulated based on the availability of surface water.
  - Use of ASR credits varies, and is limited to allowed withdrawal rates.

- Table 2-4: PDSI values for South-Central Kansas

  This table presents annual and longer-term drought year PDSI data for South-Central Kansas.

  - The 12-month annual PDSI data shows the 2011-2012 drought to be less severe than the 1930's drought.
  - The 6-month seasonal PDSI data shows the 2011-2012 drought exhibited drier summer months than the 1930's drought.

d) Documents presented in Wichita's Responses to Production Requests

i. Documents prepared by or under the supervision of John Winchester are provided in the subdirectory HCH.

ii. John Winchester was provided, relied upon, or reviewed documents included in the subdirectory HCH.

iii. Additional documents provided by John Winchester include correspondence found in the subdirectory Electronic Communications.

e) John Winchester is a High Country Hydrology employee; the subdirectory Contracts provided in the City's Production of Documents discloses contractual agreements with R.W. Beck, Inc., and SAIC Energy, Environment & Infrastructure, LLC. Each company was directly engaged by the City of Wichita; these Contracts are also provided.

f) John Winchester's qualifications are as presented in the City of Wichita's Preliminary Expert Disclosure.

g) John Winchester's factual observations and opinions are as presented above in this Expert Report, ASR Permit Modification Proposal, cover letter, and supporting appendices.

John Winchester, High Country Hydrology