Summary Report:
Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

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Sponsors:

Bureau of Reclamation

Oklahoma Water Resources Board

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TABLE OF CONTENTS

APPENDICES

1.0 INTRODUCTION

This report provides an overview of the Bureau of Reclamation (Reclamation) and Oklahoma Water Resources Board (OWRB) sponsored Oklahoma Water Supply Reliability and Management Challenge (Drought Challenge). This challenge forum was held on September 17, 2014 as a precursor to the two-day Western Governors' Drought Forum at the National Weather Center in Norman, Oklahoma. Natural hazards such as earthquakes, hurricanes, flooding, wildfires and drought are a natural occurrence throughout the world and effective mitigation and response planning is necessary to minimize the negative impacts associated with these events. In addition to planning, exercises used to test established plans have proven to be an effective means to ensure preparedness. Such exercises may entail the simulation of a natural hazard, requiring participants to implement and test the plan. Droughts, due to their typically slow onset lasting months or years and multi-sector impacts, are challenging to address under the typical emergency exercise framework. The concept of a drought challenge forum was introduced as an alternate means of engaging preparedness for drought in Oklahoma. There are key differences between a challenge forum and an exercise. The challenge forum does not test an existing plan but requires participants to develop their response plans "on the fly" through a collaborative, team environment. The other key difference is that each team was judged and scored on the quality of their plans, thus fostering collaboration through spirited competition. This report summarizes the challenge background, design, development, and delivery. Feedback on the challenge is also provided in this report, specifically addressing strengths, areas for improvement and possible future applications.

2.0 OVERVIEW OF THE CHALLENGE

Challenge Background and Development

The concept of a drought challenge forum was introduced to AMEC at the National Integrated Drought Information System (NIDIS)-National Drought Mitigation Center (NDMC) Engaging Preparedness Communities Drought Conference in Chicago in June of 2011 through a presentation by the Science and Technology Branch, Agriculture and Agri-Food Canada. Agriculture and Agri-Food Canada had implemented two drought tournaments in February of 2011 and March of 2012. After this event, the Colorado Water Conservation Board (CWCB) and NIDIS jointly provided funding for AMEC to modify the general concept and components introduced in the Canadian challenge for the State of Colorado. This event was held on September 18, 2012 in Denver, Colorado. In attendance was a representative of the Oklahoma State Board of Agriculture, who then recommended the concept to OWRB. Reclamation, in partnership with OWRB, contracted with AMEC to perform a similar event in Oklahoma in September 2014. Specific objectives of the Drought Challenge included:

- Educate participants on the multidisciplinary and multi-sector implications of drought;
- Encourage collaboration among stakeholders with various backgrounds;
- Introduce the concept of the "challenge forum" as a tool to engage stakeholders and develop relationships;
- Provide a forum to develop contacts and information useful for future local, regional and statewide drought planning purposes; and

- Create an environment that was engaging, competitive, fun and worthwhile to attend from an educational and networking perspective.

The Drought Challenge design was led by AMEC spanning from the end of July to September 2014 under guidance of a "Design Team" that included the OWRB, Reclamation, NOAA-NIDIS, the National Drought Mitigation Center (NDMC), Army Corps of Engineers (COE), Oklahoma Climatological Survey (OCS), and Oklahoma Department of Environmental Quality (ODEQ). A series of design meetings and conference calls were held leading up to the challenge. An element of the design was a "simulation day" held on September 5th in Oklahoma City. This included exercising elements of the draft challenge with the Design Team and referees serving as the "players." The long-term planning round of the challenge was played using the pre-designed drought scenario. AMEC served as the challenge facilitator and referee role while OWRB, NIDIS, NDMC, COE, OCS, and ODEQ played the challenge utilizing two teams. One of the teams including Reclamation staff participated remotely via video-conference. While the remote play was challenging, all participants welcomed the opportunity to test the challenge. The simulation day also provided an opportunity to train those that would eventually be referees at the event. The simulation day provided valuable input into the challenge's refinement, including further definition of the referee and sponsor roles, round timing, and challenge day agenda development.

Challenge Day Overview

Over forty people were involved with the challenge either by directly playing the challenge or by facilitating, coordinating and developing the challenge (see Appendix A). The participants included:

- Five teams of five to six players - Each team consisted of players representing multiple sectors including agriculture public water supply, environmental, energy, industry, and tourism and recreation. These teams were charged with playing the challenge and providing feedback at the conclusion of the event.
- Seven referees – The referees consisted of drought and water resource experts from OWRB, NDMC, COE, OCS, ODEQ, and from AMEC. The referees helped to facilitate discussion among the teams, provide clarification and guidance when needed, and contributed to the challenge scoring.
- Fans – Members from Reclamation, OWRB, Oklahoma Department of Emergency Management, ODEQ and NIDIS observed the challenge and provided feedback. In addition, a "fan" from the Kansas Water Office was in attendance.
- Sponsors, facilitators and coordinators – This included staff from Reclamation, OWRB and AMEC.

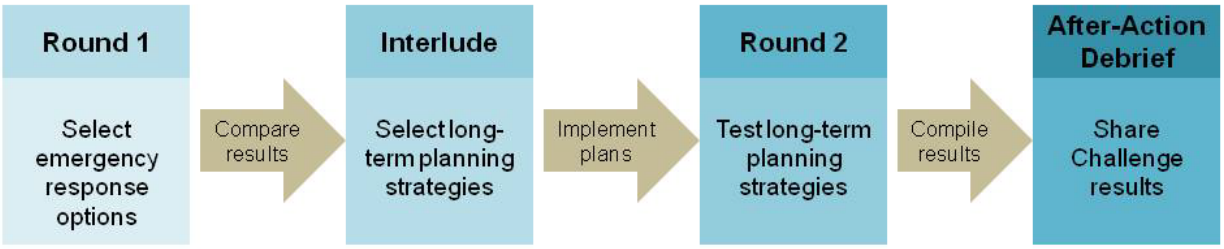
Each team represented a fictitious "Basin Drought Committee" and was charged with developing drought response plans for a fictitious watershed called Old Faithful Basin. Old Faithful Basin (Basin) was developed as a politically and geographically neutral basin in order to avoid common geographic and political water - related positions and to encourage an open, innovative discussion. Information on the Basin was provided by email to all participants in advance of the challenge in a fictitious basin report (Appendix B). An overview of the challenge was also sent prior (Appendix C). Key features of the Basin represented characteristics fairly typical of many

Oklahoma watersheds. These included two agricultural areas, two municipal areas, a small storage reservoir, a large storage reservoir, a power plant and a reach of river with prized fishing habitat. Appendix D presents the full agenda for the day.

Following an introduction to the challenge including challenge objectives and a Basin overview, team names were developed by each table as follows:

- Team A Drought Busters
- Team B Up the Creek
- Team C Aqua Thunder
- Team D Creative Water Solutions
- Team E Dusty Dynamos

The challenge play then commenced and included two "rounds" separated by an interlude to allow long-term planning strategies to be chosen. The first round consisted of an emergency drought response round depicting an intense, single-year drought followed by a long-term water planning round that was concluded with a round where emergency responses were ranked according to priority. The long-term planning round represented a multiple year period of average to wetter than average conditions and the final round included a drought similar to the first round. The difference between the first and final round drought conditions was that teams started "playing" in the middle of the drought in the first round without the benefit of long-term planning. In the final round, the teams could visualize results of their long-term planning strategies leading into the final round, which began at the onset of the drought. A spreadsheet model was developed so the teams could input their emergency response options and long-term planning strategies and visualize water supply and storage results real-time. The model was run after the first round and long-term planning round. After each model run, the teams were given print-outs regarding their reservoir storage contents based on the options and strategies chosen and the impending climatic conditions. This information allowed the teams to make appropriate decisions in later rounds, which was intended to mimic how things happen in reality.



During the first round, the challenge facilitators introduced the scenario and set the background for the Challenge. The hypothetical drought scenario applied to Old Faithful River Basin included realistic drought conditions in Oklahoma based on state historic hydrologic and climatic data. The players had a limited number of options to respond to the scenario, and each option had a cost. Each team was given $20,580 in Monopoly money to play with in round 1. Each team developed their emergency response plan and presented their ideas to the entire group. These

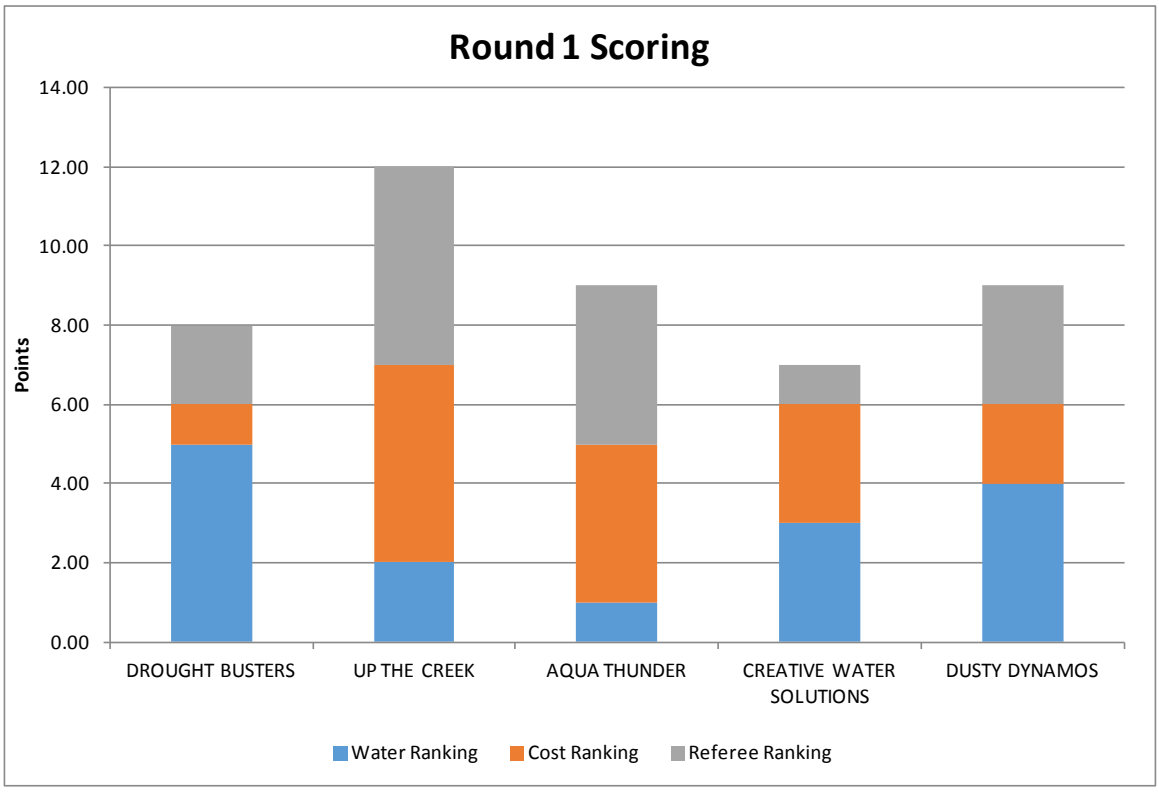
plans were evaluated for their effectiveness in reducing the impacts of the drought. See Appendix E for more detail on specific emergency response options available in round 1.

During the interlude, which was a simulated drought-free period spanning several years, teams planned and adopted long-term planning strategies. Teams were limited to specific options provided in a matrix table (Appendix E), which had costs associated with them. The teams choose options within their budget, which was re-loaded to $20,580 at the beginning of the interlude. The strategies represented pro-active actions and planning steps taken to prepare for a drought before it actually occurs. These strategies enhanced the team's resources to address drought impacts and if played "right," gave teams an advantage in the Challenge. The teams filled out a specific plan with their long-term planning strategies that were used to reduce the consequences of the drought during response round 2. Teams again presented their long-term planning strategies to the entire group. Specific scoring did not take place during the interlude, although the effectiveness of their long-term strategies was taken into account during the scoring in round 2.

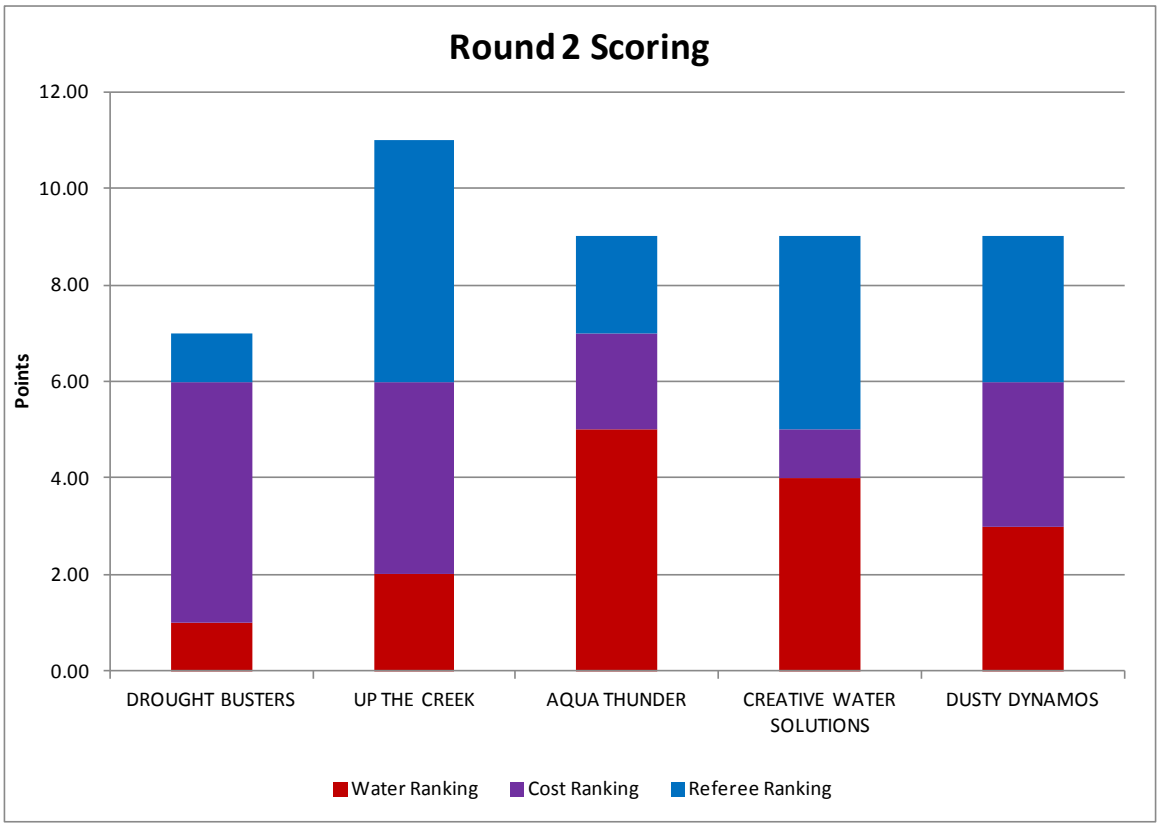
Round 2 was another drought that tested the effectiveness of the long-term strategy plans developed during the interlude. Each team was provided graphs of their reservoir contents based on how the long-term strategy plans impacted their water supply leading up to the second drought. Teams were then charged with ranking emergency responses for any remaining water shortages based on the same list of emergency response options from Round 1. The teams could only prioritize the emergency responses within their remaining budget, and some teams found that they had no money left to work with. An influx of federal and state drought disaster relief funds provided each team with an additional $10,000 of Monopoly money to use for emergency response. As with previous rounds, each team presented their plans at the conclusion of the round.

Scoring of each teams' drought response plans at the conclusion of round 1 and 2 was based on how well the team addressed drought vulnerability, identified potential drought impacts and on how effective their portfolio of emergency response options was in reducing impacts on a multi-sector level throughout the entire Basin. Response plans that addressed the social, environmental and economic aspects of drought on a multi-sector level received higher scores than plans that did not address the multi-dimensional aspect of drought. Scoring entailed a three-component system: a cost score (capital and unit costs expended for each option/strategy), a water score (minimum reservoir contents less any water shortages), and a subjective score by the referees. At the conclusion of the scoring, each of three scores were added together to determine a final team score for round 1 and round 2, as shown in the tables and figures below.

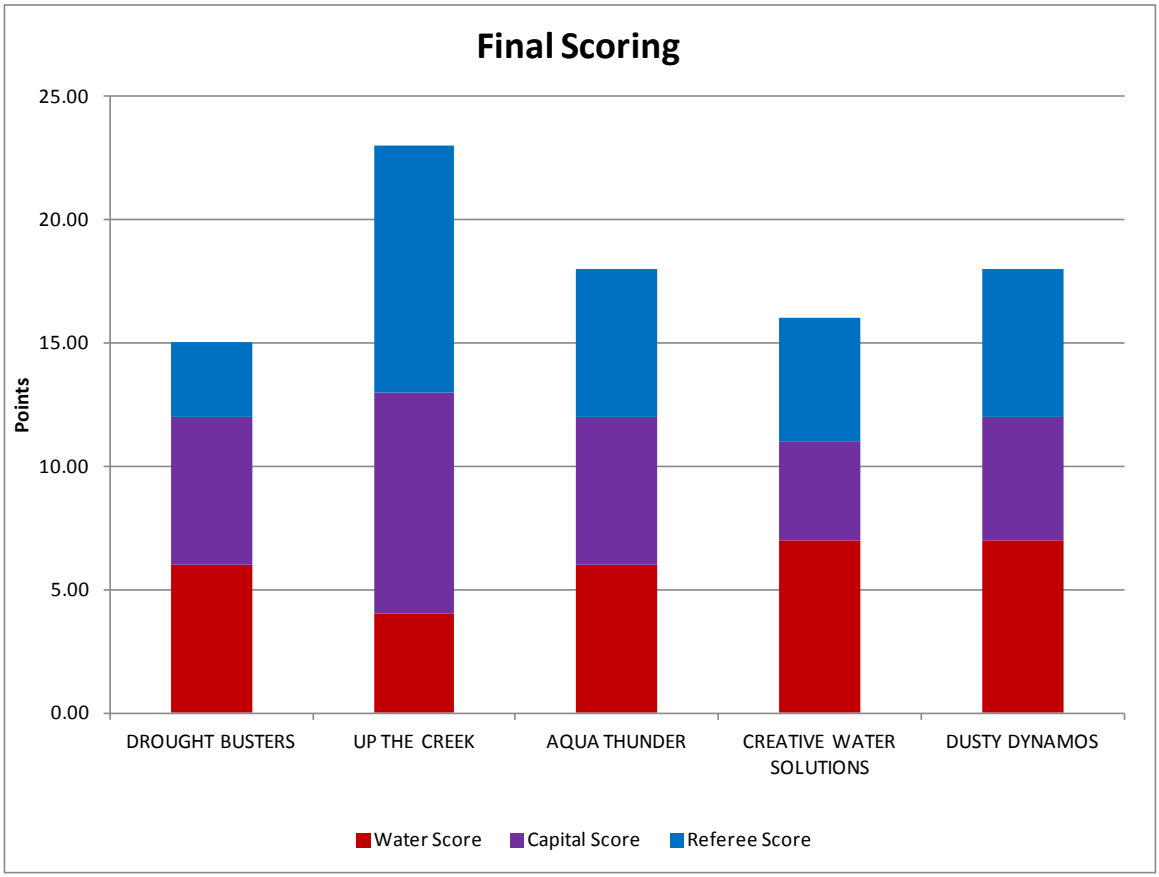
	DROUGHT BUSTERS	UP THE CREEK	AQUA THUNDER	CREATIVE WATER SOLUTION	DUSTY DYNAMOS
ROUND 1 SCORES					
ONE YEAR	Group A	Group B	Group C	Group D	Group E
Reservoir Contents					
Big Reservoir (min af)	1,303	231	-	811	1,009
Small Reservoir (min af)	50	50	-	-	-
Shortages (total af)	7,360	8,397	9,002	8,063	7,923
Water Result	-6007	-8116	-9002	-7252	-6914
Water Ranking	5.00	2.00	1.00	3.00	4.00
Capital & Unit Costs					
Capital Costs	$ 7,400	$ 3,500	$ 2,800	$ 5,800	$ 5,200
Unit Costs	$ -	$ -	$ 960	$ -	$ 990
Total Capital & Unit Costs	$ 7,400	$ 3,500	$ 3,760	$ 5,800	$ 6,190
Cost Ranking	1.00	5.00	4.00	3.00	2.00
Average Referee Score	5.90	7.70	7.60	5.70	7.30
Referee Ranking	2.00	5.00	4.00	1.00	3.00
TOTAL SCORE	**8.0**	**12.0**	**9.0**	**7.0**	**9.0**



	DROUGHT BUSTERS	UP THE CREEK	AQUA THUNDER	CREATIVE WATER SOLUTION	DUSTY DYNAMOS
LONG TERM PLANNING/ROUND 2					
TWO YEARS	Group A	Group B	Group C	Group D	Group E
Reservoir Contents					
Big Reservoir (min af)	4,947	3,828	13,517	19,031	5,716
Small Reservoir (min af)	31	-	59	-	70
Shortages (total af)	6,330	5,087	7,961	14,099	3,275
Water Result	-1352	-1259	5615	4932	2511
Water Ranking	1.00	2.00	5.00	4.00	3.00
Capital & Unit Costs					
Capital Costs	$ 15,800	$ 18,050	$ 20,200	$ 20,500	$ 19,300
Unit Costs	$ -	$ -	$ -	$ -	$ -
Total Capital & Unit Costs	$ 15,800	$ 18,050	$ 20,200	$ 20,500	$ 19,300
Cost Ranking	5.00	4.00	2.00	1.00	3.00
Average Referee Score	12.50	14.20	12.80	13.20	13.00
Referee Ranking	1.00	5.00	2.00	4.00	3.00
TOTAL SCORE	**7.0**	**11.0**	**9.0**	**9.0**	**9.0**



The final overall score for each team was determined by adding together the totals for round 1 and round 2. As shown below, Team "Up the Creek" won the challenge with an overall total score of 23. A tie for second place between Team "Aqua Thunder" and Team "Dusty Dynamos" required a tie-breaker. A bonus point was given to Team "Dusty Dynamos" to total 19 points (not shown in the figure below) for winning the dice roll tie-breaker. Third place was then given to Team "Aqua Thunder" for a total of 18 points.



3.0 FEEDBACK ON THE CHALLENGE

Following the last round, a post-challenge feedback session was facilitated to provide participants an opportunity to comment on their experience and provide input to the entire group. A survey asking the participants to assess and comment on the challenge was also distributed and collected at the end of the event. The fans attending the event were asked to complete a more comprehensive survey of their observations. Information from each of these mediums is summarized below.

3.1 Challenge Design and Effectiveness in Meeting Objectives

Using a rating scale of 1 to 5, the post-challenge survey asked each of the participants to rate the design and facilitation of the challenge, as well as to assess how well the challenge met objectives. The number 5 represented strong agreement with the statements provided in Tables 1 and 2 below and 1 indicated strong disagreement.

Table 1 shows that 96% of the surveyed participants were either in strong agreement (5 rating) or moderate agreement (4 rating) that the challenge was well /organized and appropriate for the level of each stakeholder. The majority of surveyed participants indicated strong or moderate agreement that the challenge was presented in a realistic fashion, that the materials were useful and appropriate, and that the selection of stakeholders was appropriate in terms of the mixture of disciplines. All of the participants indicated with strong or moderate agreement that they would encourage others in their agency/company to participant in another challenge exercise that would focus on obtaining other drought and water resources data.

Table 1 – Assessment of Challenge Design and Conduct

Assessment Factor	Percentage of Survey Responses				
	1- Strong disagreement	2	3	4	5 - Strong agreement
The Challenge was well structured and organized.	-	-	4%	70%	26%
The Challenge drought scenarios were plausible and realistic.	-	-	9%	57%	35%
The facilitators were knowledgeable about the material, kept the Challenge on target, and were sensitive to group dynamics.	-	-	-	52%	48%
Available tools and information materials were appropriate and helpful to my role.	-	4%	9%	52%	35%
Participation in the Challenge was appropriate for someone in my position.	-	-	4%	39%	57%
The participants included the right people in terms of level and mix of disciplines.	-	-	9%	34%	57%
I would encourage others in my agency/company to participate in another Challenge similar to this process that would focus on obtaining other drought and water resources data.	-	-	-	48%	52%

Table 2 shows that the majority of the participants were either in strong agreement (5 rating) or moderate agreement (4 rating) that the challenge was effective in educating participants on the multidisciplinary and multi-sector implications of drought, encouraged collaboration among participants of diverse backgrounds and was an effective tool for developing a competitive and fun environment to engage stakeholders and develop relationships. Seventy-eight percent of the surveyed participants agreed either strongly or moderately (ratings 4 or 5) that the challenge forum was an effective tool to collect information for planning purposes, while 22% were neutral. The neutral feeling may be attributed to the fact that the challenge was developed in a fictitious setting and that conducting the challenge under a real-life scenario for data collection purposes would require more time for critical thinking and effort in fostering a collaborative environment.

Table 2 – Effectiveness in Meeting Objectives

Assessment Factor	Percentage of Survey Responses				
	1- Strong disagreement	2	3	4	5 - Strong agreement
The Challenge effectively educated participants on the multidisciplinary and multi-sector implications of drought.	-	-	4%	61%	35%
The Challenge encouraged collaboration among those with diverse backgrounds.	-	-	-	35%	65%
This "challenge forum" is an effective tool to engage stakeholders and develop relationships.	-	-	17%	30%	53%
This challenge forum is an effective tool to collect information for future planning purposes.	-	-	22%	39%	39%
The Challenge created an environment that was engaging, competitive and fun.	-	-	4%	35%	61%

The fans were asked whether they saw a significant difference in group dynamic interaction between the rounds. One fan indicated that as can be expected, efficiency picked up as the day went on, most likely because of increasing familiarity with the facts and with each other. However, the fan thought interaction was pretty good even from the beginning. Another fan noted that participants seemed much more at ease and active in the later rounds as compared to the first round.

3.2 Strengths of the Challenge

The challenge effectively engaged participants in the challenge process. Participants generally described the experience as rewarding and worthwhile. The following discussion outlines the comments provided by participants during the post-challenge feedback session and on the survey regarding what they liked most about the challenge.

Concept of the Challenge
Several participants commented on the overall concept and format of the challenge, stating that it provided an excellent forum for discussion and critical thinking about drought.

- *Great format. Opened my eyes to other ideas, priorities and strategies. The 'challenge' format was good for open discussion without the need for absolute defense of territory.*
- *Excellent background information/graphics that set the stage for the challenge.*

Diversity of Stakeholders and Opportunity for Effective Collaboration
The participants enjoyed the opportunity to develop new relationships with people of different sectors with which they normally would not interact. They also enjoyed the multi-disciplinary nature of the challenge while working on a common goal in a fun environment. Participants found that they could effectively collaborate with representatives of other sectors to develop drought-related solutions in a relatively neutral political setting. The challenge effectively fostered a setting where participants were able to bring their experience "to the table" without needing to follow a specific agenda or special interest.

- *Puts you in a position probably different than you are normally in as far as making decisions.*
- *Great mix of people and backgrounds in the same team. Very worthwhile and enlightening experience.*
- *Working with the team was enjoyable and educational.*
- *Need to cooperate.*
- *Diverse representation in each group is essential.*
- *The knowledge sharing was great.*
- *Interaction with a diverse group of people.*
- *Got to understand and get a point of view from different stakeholders.*
- *Diversity among players; contacts made; the identification of various points of concern.*
- *The opportunity to dialogue with multi-sector users.*
- *Brought a variety of disciplines together to address the water issue.*
- *The mix of the teams working together.*

3.3 Suggestions for Improvement

Participants had the opportunity to provide suggestions on how the challenge could be improved during the post-challenge feedback session as well as on the written survey. The suggestions primarily focused on how the scoring process and materials could be improved and new additions that could strengthen the challenge.

Materials and Scoring Process
A couple participants indicated that additional material should be sent prior to playing the challenge and that further detail on the basin should be provided. Additionally, clarification on what the judges were looking for prior to starting the challenge would have been helpful. Specific comments include:

- *Possibly give the exercises to participants in advance to better prepare.*
- *More background information on basin flow.*
- *Would be helpful to know what exactly the judges were seeking? So we could improve. Seemed overly subjective.*

Suggestions on New Additions to the Challenge
Suggestions for new additions to the challenge included: expanding the breadth of activities in the basin and add more input from industry; include real world factors such as political issues; and mix things up by including curve-balls into the challenge that would force teams to adjust on the fly. Specific comments include:

- *More industry input, i.e., manufacturing, mining, etc.*
- *More recreation people in play.*
- *Add oil and gas activities.*
- *Include 'real world' factors such as politics, energy needs, environmental interest groups.*
- *Should have a team mix after lunch, one member or insert wild card endangered species or something.*
- *Toss in 'bombs' - something that would divert path taken – i.e., public outcry.*

Other Suggestions and Adjustments to Scenarios/Challenge Structure:
Additional suggestions for improvement include:

- *Keep refining the challenge so the questions are answered early on to keep things moving forward.*
- *Unless power plant is owned by municipality, public dollars aren't used to upgrade private business.*
- *Include other units and/or keep them consistent throughout, e.g. cfs vs. MGD, etc.*
- *Some issue with common 'language' ac-ft, cfs, no MGD, gpm – depends where you came from.*
- *We did not have much opportunity to share our ideas of what could work in the real world.*
- *Simplify the denominations of the 'fun' money – don't need small amount denominations.*
- *The third challenge was less coordinated and seemed a little less valuable to the experience.*
- *The final segment was somewhat confusing as to what to do.*
- *Public participation in the future.*
- *Indirect potable reuse would not require boil advisory if treated through water treatment plan.*
- *Desalination costs were probably shown to be more cost effective in short-term than reality dictates w/reject water disposal costs.*
- *Some of the options were ruled out on short-term exercise because they were considered long-term. This hurt some teams since they did not realize all options were considered short-term.*
- *Incentive. What's the prize? You might get the competitive personalities more engaged if they weren't already. One team in particular seemed to not interact much at all and that seemed reflected in their score. Intervene?*
- *Map was very useful. Perhaps make even more clear items such as diversion points, rates, etc.*
- *It appeared that where to start was a challenge. Should impacts be done 1st?*
- *Interruptions for clarifications disrupted train of thought and discussion. How can the focus be drought survival but saving water is not weighted in the score?*
- *Referees should have experience/practice "playing the game" in advance so some of the uncertainties encountered during the challenge could have been addressed.*
- *Should a goal be discussed?*
- *Is it possible to get more gender/ethnic diversity on the teams?*
- *Do members of general public need to be involved?*

3.4 Time Allotment

The survey also specifically asked participants about the amount of time allotted for each portion of the challenge and whether more or less time was needed. A large majority recommended that the time for round 1 be increased, and some also indicated the last round could be decreased, or even removed. Specific comments are as follows:

- *Maybe a little more time on the first round*
- *Groups were tired in the later afternoon.*
- *Allow more time in Round 1.*
- *Not 'enough time' on 1st round.*

- *Round 1 could have been a bit longer.*
- *More time for Round 1 to thoroughly understand all of the logistics, etc.*
- *More time for Round 1 instead of long range planning.*
- *1st session needs to be lengthened, shorten last session.*
- *The first challenge needed more time.*
- *More time with 1st round.*
- *More time needed initially in first rounds and reduce final round.*
- *Let groups get to know each other at beginning.*
- *90 minutes first round, 60 minutes second round (2).*
- *Part 1 was too short.*
- *Yes, we were given adequate time.*
- *Good. Eliminate 3rd challenge.*
- *Need more time for initial exercise.*
- *More time for early round, less time for later rounds.*
- *Yes. If I would have added any time it would have been in the first round.*
- *Observers should have copies of worksheets – it would be much easier to follow.*

3.5 Post Challenge After-Action Debrief

After the challenge was complete, participants were asked to provide general comments on the day and any areas of improvement. Feedback is presented below.

- *More time should be given for Round 1.*
- *The conservation context is important, e.g., implementing rate increases is not easy and public perception is an integral piece of this, work this concept into the challenge.*
- *Take advantage of existing resources versus curtailing junior appropriators.*
- *Need more about bass, flush out connection with water and recreational economy.*
- *Put political implications into game.*
- *Congrats to the teams!*
- *Get sectors together on topics - face to face makes a difference.*
- *Group dynamics were interesting and it was a good learning experience.*
- *There was a lot of talk at the tables.*
- *Materials were well done.*
- *It is easier to compromise with a made-up situation, could we integrate real-life interests?*
- *Could we breakout by sectors?*
- *A common water language would be helpful.*
- *Overlay map with acre-feet and cubic feet per second at each point.*
- *Add more public outcry, e.g., recreation impacts, social impacts, economic impacts – they all have ripple effects.*
- *While the transbasin option was expensive, why were none chosen? It could be that there was not enough information on the other side.*
- *Good innovative ideas. Some were thinking that those developed in the first round would be available in the second round.*

4.0 MEDIA COVERAGE OF THE CHALLENGE

Leading up to and following the Drought Challenge, there were numerous articles published summarizing the objectives, results and feedback of the challenge forum. These are summarized below. Various media representatives were on site during much of the Challenge and occasionally interviewed participants.

- *Altus Times* – September 16, 2014. "OWRB and Bureau of Reclamation to host inaugural Oklahoma Drought Challenge"
- *USA Today* – September 17, 2014. The State by State section included a brief paragraph on the Challenge.
- *The Norman Transcript* – September 18, 2014. "Teamwork: Inaugural drought challenge promotes collaborative solutions"
- *The Oklahoman* – September 18, 2014. "Water users try their hands at drought mitigation during a simulation in Norman"

Additionally, other articles highlighting the Challenge are expected in the coming weeks, including:

- *NIDIS Newsletter*
- *The Oklahoma Water News*

5.0 CONCLUSIONS, RECOMMENDATIONS AND FUTURE APPLICATIONS

This challenge forum proved to be an effective means to engage and educate stakeholders on multi-sector impacts of drought, drought mitigation and response strategies, and the complexities of responding to a drought in simulated real-time. There is also value in the challenge forum as a tool to be applied in the future to collect critical information and data and develop strategic natural hazard mitigation and response plans. The following items provide recommendations on the development of future challenge exercises. This is followed by a discussion on future directions and potential applications of the challenge forum.

Challenge Enhancements

The 2014 event, similar to the initial application of the drought challenge concept in the United States, was designed to meet specific objectives with limited resources and time constraints. However, the Oklahoma Drought Challenge included an enhancement that was well received by the participants. This event included use of a spreadsheet model to show how the system performed in terms of water supply and storage. This allowed the participants to visualize and track their reservoir storage and water budgets in real-time, after each round finished and their response and/or long-term planning choices were input and their results printed out in hardcopy form as charts. The model addressed long-term planning periods and multi-year drought impacts by showing the implications that each team's choices, both as emergency responses and long-term planning strategies, had on their water supplies. This information was important as each team played subsequent rounds, taking into account the status of their water supply systems and

weighing how their choices would impact each sector in remaining rounds. The model also added a level of automation to the scoring process by tracking reservoir contents, water shortages, and unit costs for certain options and strategies.

A de-brief with the design team and sponsors was also held and identified the following areas of improvement for future challenges:

- Provide a checklist to the referees so they know what they should be engaging in throughout the day and the expectations for scoring.
- Incorporate measures to make the referees' scoring more transparent and less subjective
- Send the matrix tables of emergency response options and long-term planning strategies to the referees and the fans ahead of time.
- Provide a unit conversion cheat sheet and/or keep things in consistent units.
- Build in the cost of public perception and public awareness.
- Round 1 should be longer to allow more time for the players to get acquainted with one another, the challenge materials, and how to play.
- During the introductory session and facilitation of the rounds, the speaker should walk around the room to further engage the audience.
- Explain what is happening during the transitions between rounds so the players are well-informed, engaged, and know what to expect next, e.g., data is being input from each team into the model, the model will be run, and each team will be handed their results and charts; the referees are huddling now to discuss scoring and team evaluations, etc.
- During the presentation of scores and results, point out what each team did well. Even the losing teams should be acknowledged for their good ideas.
- It was suggested to provide the referees a gift for their time and effort spent on the challenge.

Future renditions of this activity could be enhanced even more if budget and time allows. There are many features that can be incorporated into a challenge exercise to both streamline the challenge process, and increase the complexity of the challenge scenario. Ideas proposed by the participants and the AMEC Team include:

- Developing and tracking specific trade-offs among selected strategies;
- Tracking economic and sector impacts (i.e. agricultural and environmental impacts);
- Model after a basin in Oklahoma and use real-world scenarios that include existing water permitting and physical availability; and
- A small focus group of participants / observers could fine tune the exercise process prior to challenge day.

Future Directions and Applications

Participants were surveyed at the conclusion of the challenge to determine whether they would like to see future drought exercises, and if so, how they would like to see them implemented. A majority of the responses indicated that the Drought Challenge would be a beneficial exercise to repeat and build upon. Surveyed participants also provided suggestions on how the challenge model could be implemented elsewhere, including developing challenges for specific entities in

the State or other states. Suggestions on potential future applications provided by the participants and the AMEC Team include the following:

- The challenge exercise could be scheduled in conjunction with the Governor's Water Conference or the AWWA annual state conference.
- Possible town hall challenge / forums in different quadrants of the state.
- This would be interesting exercise scaled to different age groups, as part of studying the water cycle in middle school for example, or as an exercise module in planning seminars in college.
- Army Corps of Engineers Districts could perform similar exercises with the States under the Planning Assistance to States Program.

In conclusion, the drought challenge forum encouraged collaborative decision-making and provided a forum for multi-sector discussion. Most participants agreed that it provided a fun, competitive environment to learn and think of new ideas about drought preparedness and to debate politically-sensitive adaptation options and foster innovation. Participants felt that it was time well spent and recognized the value of further applications of the forum in the future. Participants, challenge sponsors and designers noted that there is real value in expanding this type of event into other arenas in the future. Several refinements have been identified that could be used to enhance the challenge concept in future applications.

APPENDIX A

Roster of Participants

Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

ROSTER

Player	Affiliation	Contact
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U.S. DEPARTMENT OF THE INTERIOR BUREAU OF RECLAMATION

State of Oklahoma OWRB WATER RESOURCES BOARD the water agency

amec

Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

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Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

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Acronyms

BOR – Bureau of Reclamation
OWRB – Oklahoma Water Resources Board
NIDIS – National Integrated Drought Information System
NDMC – National Drought Mitigation Center
COE – Army Corps of Engineers
OCS – Oklahoma Climatological Survey
ODEQ – Oklahoma Department of Environmental Quality

APPENDIX B

Old Faithful Basin Report

OLD FAITHFUL RIVER BASIN REPORT

Introductory Materials

The Old Faithful River runs for a total of 79 miles from its headwaters to the Emerald River at the southern end of Chase County. The Clear Branch and the Salty Branch join to form the mainstem of the Old Faithful River 13 miles above its confluence with the Emerald River. The Old Faithful River system is an important economic and recreational resource for the State.

Setting, Climate and Economy

Originating in crystalline rock on the southern flank of the Humpy Hills, the Clear Branch of the Old Faithful River has the most reliable water supply and the best water quality in the basin. Two principal agricultural areas divert water from the Clear Branch--the Happy Cow Ranch and Green Valley Farms. Big Res impounds the Clear Branch and provides flood control, recreation and water supply benefits to the lower Old Faithful River and the Emerald River. Because of the region's favorable climate, relative proximity to urban areas and good lake fishing, Big Res is a popular destination for people within and outside the region that are seeking water-based recreation. A substantial part of the City of Wheatville's economy benefits from providing services and supplies to recreationists at Big Res. Below Big Res is a substantial population of the Logear Bass, prized by fisherpersons. Fierce fighters, Logear Bass occasionally jump when hooked. Some anglers prize its firm texture and good flavor. The Logear Bass is a hardy species, but recruitment is reduced when water temperatures are excessive, and adult fish are particularly sensitive to low oxygen levels. The Clear Branch below Big Res is impacted by wastewater effluent from Wheatville, but only during low flows is this impact significant.

The Salty Branch of the Old Faithful River originates in sedimentary rock in lowland areas on the western boundary of the basin and has much lower flows and high dissolved solids. The Salty Branch meets the Clear Branch about eight miles below Big Res and the two streams form the Old Faithful River.

The Old Faithful River flows largely through undeveloped rolling terrain. Because the river flows in a small canyon, agricultural development of water from the lower river has proven infeasible due to higher pumping costs and rolling terrain. A large diversion about four miles upstream of the confluence with the Emerald River supplies the West Ampere Power Plant, a coal-fired thermal power generating station that supplies electricity to the region and to the grid. In wetter conditions, flows and water quality in the Old Faithful River are dominated by the Clear Branch, while in drier conditions higher dissolved solids contributed by the Salty Branch and by return flows from Green Valley Farms can impact operations at the West Ampere Power Plant. The effluent discharges from Wheatville also affect oxygen levels in the Old Faithful River during low-flow periods.

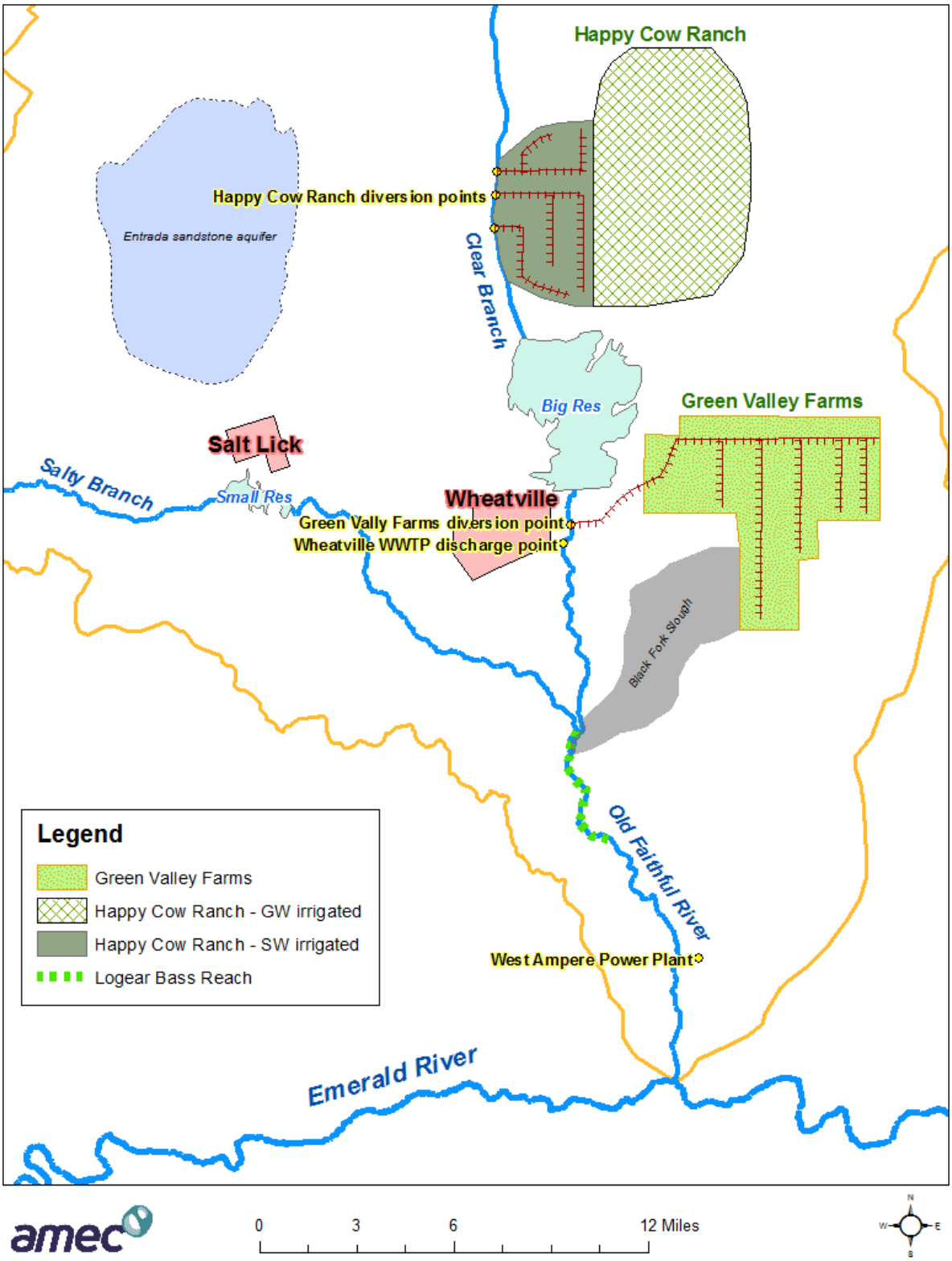


Figure 1. Old Faithful River Water Supply Systems.

OLD FAITHFUL RIVER BASIN REPORT

Introductory Materials

The climate in the Old Faithful River Basin is typified by a short cold winter, mild spring and fall, and hot summers. Average temperature is 62 °F. Precipitation totals about 31 inches per year, on average, but ranges from 11 inches to 51 inches. In an average year about one third of precipitation comes in May and June. Summer days are clear and dry, suitable for harvest and recreation, but providing insufficient precipitation to support crops to harvest. As a result, crops and forage in the basin usually require irrigation from July until harvest.

Wheatville, located about six miles above the confluence of the Clear Branch and the Salty Branch, came into existence with the advent of farming at Green Valley Farms and grew as farming there became more successful. Today the small city has about 15,000 residents. Its economy is supported primarily by farming, but recreation is also a significant element.

The small ranching town of Salt Lick, located about 13 miles up the Salty Branch, was established around the turn of the last century by dry-land farmers and ranchers. It has a population of 1,200.

Hydrology

The Clear Branch of the Old Faithful River has a good flow of water during the late winter, spring and early summer, but very low flows in mid- to late summer, fall and early winter. Water in the Clear Branch is good quality. Average annual flow of the Clear Branch near Wheatville is about 55,000 acre-feet. Diversions and storage at Big Res entirely deplete the flow of the Clear Branch during summer and fall. In its lower reaches, the Clear Branch is a gaining stream, as is the Old Faithful River. Gains, and return flows from Green Valley Farms, accrue to the river below the dam and help maintain summertime flows for the Logear Bass and the West Ampere power plant. The average monthly hydrograph of the Clear Branch above Big Res is shown in Figure 2.

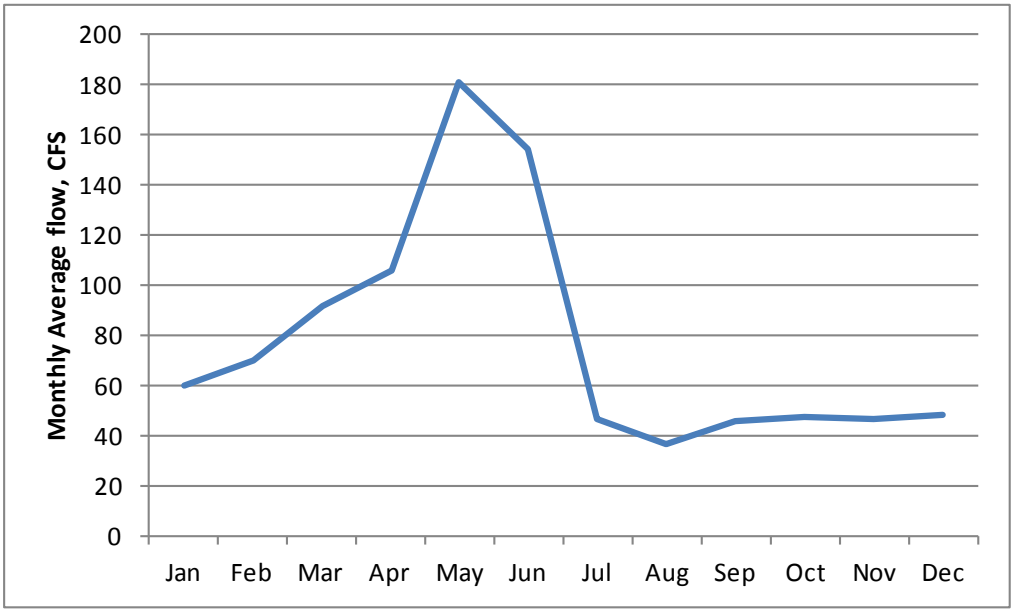


Figure 2. Monthly hydrograph, Clear Branch above Big Res

The upper Salty Branch is a very small stream. Storage at Small Res completely depletes the Salty Branch below the dam during summer and fall. Resurging groundwater begins to accrue to the stream midway between Salt Lick and the Clear Branch and give the Salty Branch a year-round flow at its mouth. Average annual flow of the Salty Branch at Salt Lick is about 5,000 acre-feet. The average monthly hydrograph of the stream is shown in Figure 3.

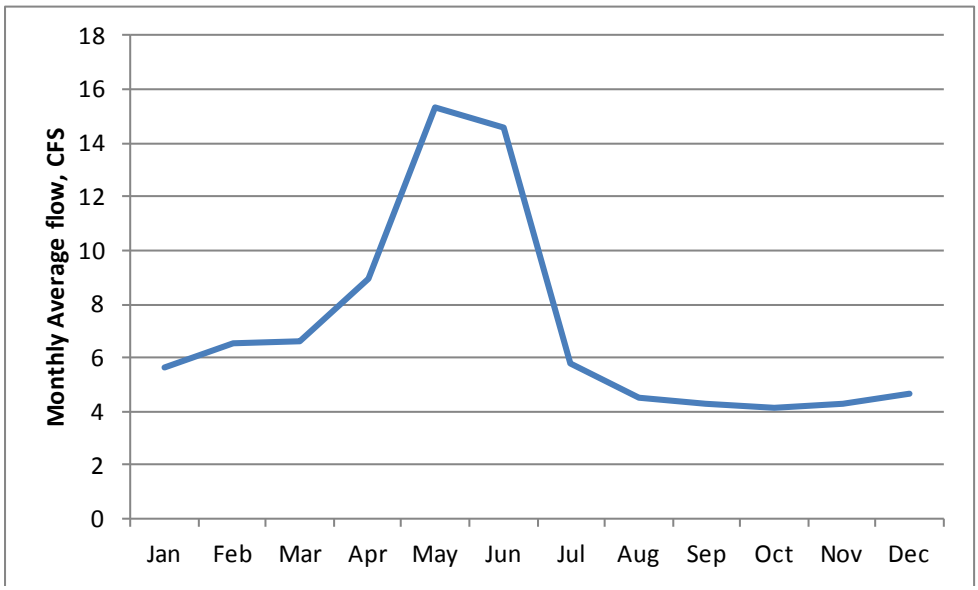


Figure 3. Monthly hydrograph, Salty Branch at Salt Lick

Below the two dams, low-season flows in the tributaries and the main stem of the Old Faithful River are entirely the result of gains. Many of these base flows are from groundwater, so low-season flows in the lower Old Faithful River are somewhat more reliable than are the low-season flows in the upper reaches of the tributaries. Average annual flow of the Old Faithful River at West Ampere is about 70,000 acre-feet. The average monthly hydrograph of the stream is shown in Figure 4.

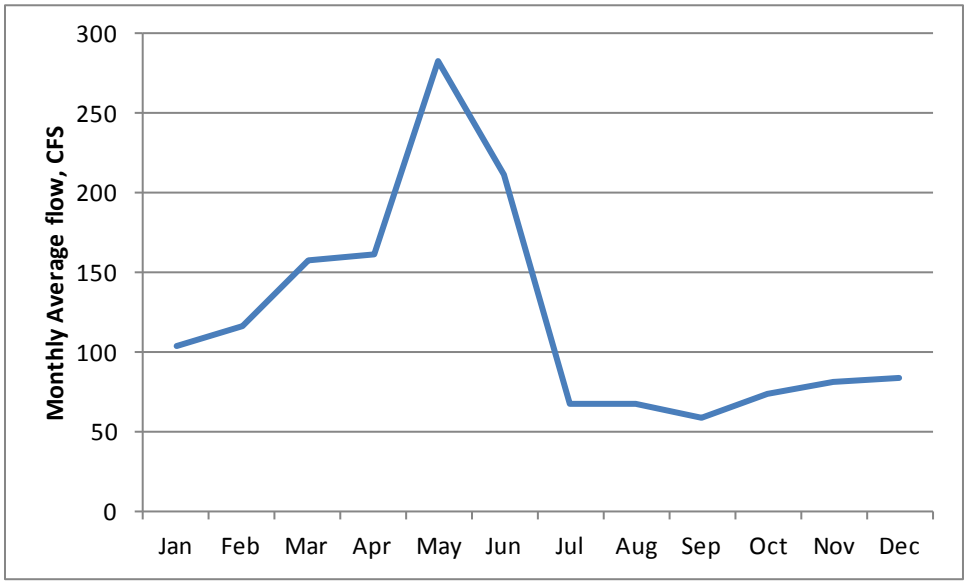


Figure 4. Monthly hydrograph, Old Faithful River at West Ampere

Base flows in Clear Branch and Old Faithful River have been slowly declining for the past three decades, partly due to drier climate but also due to increased alluvial groundwater development in the upper reaches of the Clear Branch and along the Old Faithful River below the confluence of the Clear Branch and the Salty Branch.

Groundwater levels in the basin have typically been declining for the last thirty years, probably due to generally drier conditions and the widespread installation of alluvial wells. A bedrock aquifer lies under rolling hills about ten miles north of Salt Lick. Because of its depth and relatively remote location, it has not yet been evaluated to estimate potential yields from production wells.

History of Water Development

The first farmers arrived in the Chase County region in the last decades of the 19th century. They depended only on the rains to water crops of grains and cotton. Sporadic droughts limited their success at best and, at worst, led to bankruptcy. The waters of the Clear Branch were sufficient to irrigate many acres of land, but the river's location in a low canyon demanded too much investment to bring water to the farms. Two decades into the 20th century, farmers finally received Federal assistance in the form of low-interest loans with which to construct a 12-mile canal from the Clear Branch to their farms. The farmers formed Green Valley Farms to own and operate the canal and delivery system and funded loan repayment and operations with land assessments and water delivery fees. The canal, completed in 1938, has a capacity of 50 cubic feet per second (CFS). Permits were not filed for the withdrawal until 1949. In the best years no irrigation at all was necessary—the rains came with sufficient regularity. In drier years, the canal could make up what rainfall didn't provide from late June through mid-October. Water supply is sufficient even in below-average years, but in driest years, the combination of low precipitation and low river flows has required deficit irrigation. Still, this was far superior to the frequent poor or failed crops before irrigation. In the last four decades, farmers have shifted out of cotton so that feed corn now dominates the irrigated lands. The loan to build the canal was paid off in 1988, and since that time the farmers of Green Valley Farms have enjoyed relative stability and even prosperity.

Shortly after WWII, Wheatville, which had developed based on shallow alluvial wells, began experiencing water shortages and deteriorating water quality. Wheatville and Chase County, coupled with the support of flood-prone agricultural and residential interests in the basin, successfully convinced the Federal Government to authorize and fund development of Big Res for multiple beneficial uses: municipal water supply, flood control and recreation. Big Res, located about three miles above Wheatville, was completed by The Federal Agency in 1958 with 150,000 acre-feet of flood control storage, 20,000 acre-feet of conservation storage, and 1,000 acre-feet of dead storage. Green Valley Farms declined to participate in the development of the reservoir due to costly repayment obligation relative to the returns available to agriculture. Wheatville obtained a water permit from the state and a storage contract for present use from The Federal Agency, but soon found that it had greatly over-estimated the town's water supply demands and lost a portion of their water right due to non-use.

In 1969 the Megawatt Corporation, which had plans to build a regional power plant in the basin and needed storage to supply cooling water during the low-flow months, applied for a stream water permit in the amount of 50,000 acre-feet per year with water to be diverted from Old Faithful River and supplemented with storage releases from Big Reservoir. At that time, Wheatville transferred most of its unused storage allocation to Megawatt, which also contracted for the remaining unallocated storage in the reservoir. Currently, Wheatville has a contract for 2,000 acre-feet of storage (estimated yield of 7,000 acre-feet/year), and Megawatt has a contract for 18,000 acre-feet of storage (estimated yield of 50,000 acre-feet per year).

In 1972 Megawatt built the 200 MW West Ampere power plant to take advantage of plentiful coal reserves and access to regional power markets. The plant is cooled by once-through cooling with water withdrawn from the Old Faithful River. As noted above, Megawatt had obtained a permit from the state for 50,000 acre-feet of water per year at the time the plant was planned. Supplies on the Lower Old Faithful River have generally been of suitable quality and quantity, so that the power plant needed modest amounts of storage to smooth out the dramatic seasonal fluctuation in flow.

Ranching began on the upland grasslands along the upper Clear Branch in the 19th century, but the carrying capacity of the land was limited by dry summer conditions. Beginning with the advent of rural electrification in the area in the 1980's, a few cow-calf operators began irrigating pasture and forage crops using surface and groundwater. Those operators with property along river pumped surface water for irrigation, while ranchers without access to the river developed shallow wells. This has allowed operators to expand to stocker production and thereby increase their profits. The success of these pioneers did not go unnoticed, and in the late 1980's the availability of less-expensive power and more efficient pumps led to the widespread adoption of late-season irrigation using groundwater in the Happy Cow Ranch area. Recent gradual declines in groundwater levels have dulled the favorable economics due to the cost of drilling deeper wells and increased costs for pumping, but profits have only been reduced marginally to date.

Salt Lick obtained its water from individual domestic wells, which do not require a permit under state law, but by 1989 groundwater levels and groundwater quality in the area had declined to the point where the town looked for alternatives. With a low-interest loan from the Rural Development Agency, Salt Lick built Small Res on the Salty Branch, with an active storage capacity of 100 acre-feet and dead storage of five acre-feet. During the spring rains, relatively copious amounts of good quality runoff flows in the upper reaches of the Salty Branch; in the summer, the flow in the stream drops to virtually nothing. Since its construction, Small Res has been able to supply the requirements of Salt Lick.

Current Water Use

The table below shows the historical water use for major water users in the basin.

User	Amount (Acre-feet per year)
Green Valley Farms	10,000
Wheatville	5,600
Salt Lick	400
West Ampere Power Plant	43,000 (approx. 2,400 consumed)
Happy Cow Ranch	3,900

Water Rights Permitting

The following table shows the priority and permitted amount for the stream water permits under which water is withdrawn and stored in the Old Faithful River system.

Owner	Priority	Amount (acre-feet)	Type of use
Green Valley Farms	1949	15,000	Irrigation
Wheatville	1958	7,000	Municipal & Industrial
Megawatt Co.	1969	50,000	Industrial
Various owners (Happy Cow Ranch Area)	1982	3,892	Irrigation
Salt Lick	1989	500	Municipal & Industrial

Megawatt and Wheatville support their permits with contracts for 18,000 acre-feet and 2,000 acre-feet, respectively, of storage space in Big Res. Salt Lick supports its permit with 100 acre-feet of active storage at Small Res.

Groundwater use at Happy Cow Ranch amounts to an average of 6,000 acre-feet/year, but this use is under well permits and has no associated priority.

Fisheries

The Logear Bass is found in the Clear Branch below Big Res and in the Old Faithful River below the confluence with the Salty Branch. It is a sport fish much prized for its fighting and eating qualities. The Logear Bass is not as tolerant of high water temperature and low dissolved oxygen as are other warm-water fish.

Since its construction, Big Res has stored all flows in the Clear Branch during the drier months of all but the wettest years. In good years the Clear Branch fishery is one of the best in the State, but in the very driest years the Logear Bass has survived in the relatively reliable gains that accrue to the lower Clear Branch, supplemented by water released from Big Res for the West Ampere Power Plant. When water is released to the Power Plant, the habitat for the Logear Bass extends all the way to the Dam, but because the West Ampere Power Plant only calls for flows during the driest times, there are months in some

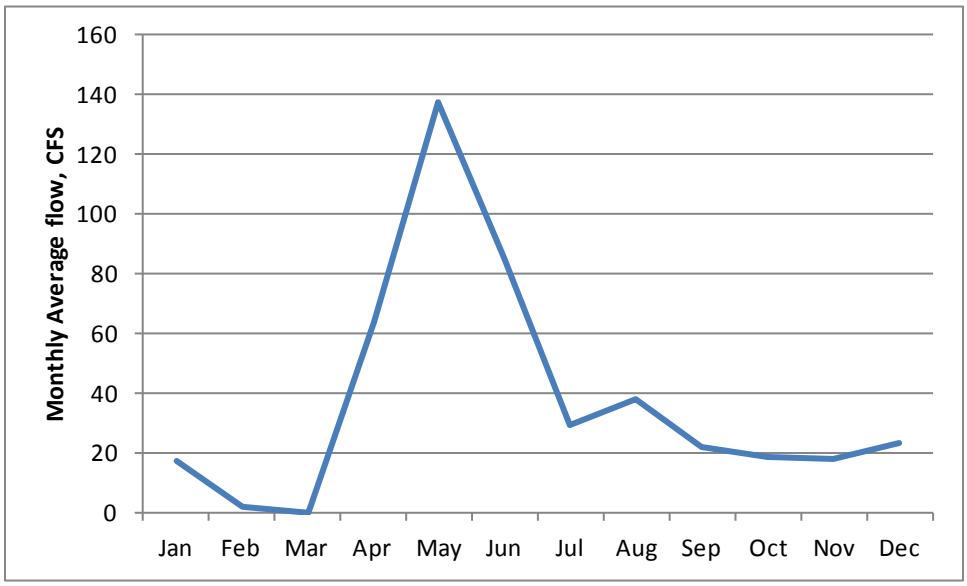


Figure 5. Monthly hydrograph, Clear Branch below Big Res

years when there is no flow below Big Res. In that situation the Logear Bass is limited to reaches of the Old Faithful River where sufficient gains have accrued. Figure 5 shows the hydrograph for flows below Big Res during a typical year. There is no flow in March and very low flows in February. As shown in Figure 4, flows above the West Ampere Power Plant, where adequate gains have accrued, provide ample habitat for the Logear Bass in typical years.

Big Res also supports a productive sport fishery, but that fishery is impacted by low reservoir levels during dry years.

Recreation

Fishing and boating are popular pastimes on Big Res, and these activities comprise about 15% of the economy of Wheatville. Low water levels on Big Res impact boating access on the reservoir, and can reduce the habitat available for recruitment and survival of fish.

APPENDIX C

Overview and Introductory Materials

Overview and Introductory Materials

The first annual Oklahoma Water Supply Reliability and Management Challenge (Drought Challenge) is being held on September 17th at the National Weather Center in Norman. The Drought Challenge is an exciting new approach to further drought mitigation, preparedness and response in Oklahoma by educating participants on the multidisciplinary and multi-sector implications of drought through an engaging competition. In short, the Drought Challenge aims to encourage collaboration among water users and enthusiasts of various backgrounds as participants navigate fictitious, yet challenging, water shortage scenarios. Not only will the Drought Challenge serve as a platform to engage stakeholders, but it will also help develop relationships and collect information for future drought planning purposes.

Key features of the Drought Challenge include the following:

- Five teams will compete against each other during the Challenge. The teams will consist of five to six players with a mix of representation from diverse sectors including agriculture, tourism and recreation, public water supply, energy, environment, and industry.
- A fictitious watershed (the Old Faithful River Basin) will be subjected to a series of hypothetical droughts. The watershed will be politically and geographically neutral in order to avoid real-world emotional attachment, thus encouraging an open, innovative discussion. The drought scenarios will be representative of realistic drought conditions in Oklahoma based on state historic data.
- Prior to each round, teams will be presented with a list of emergency response options and/or long-term planning strategies. The team members will collaborate on how to mitigate and respond to impacts associated with each drought scenario. Following each round, the teams will present their long-term planning strategies and emergency response options to Drought Challenge referees.
- The referees will score each team, based on a scoring system developed in advance of the event, and present the results leading into the next round. Scoring will be based on how well each team has sufficiently addressed the drought impacts from an economic, environmental, water supply, and social perspective.
- Prizes will be made available for the winning team.

Who else is going to be involved with the challenge?

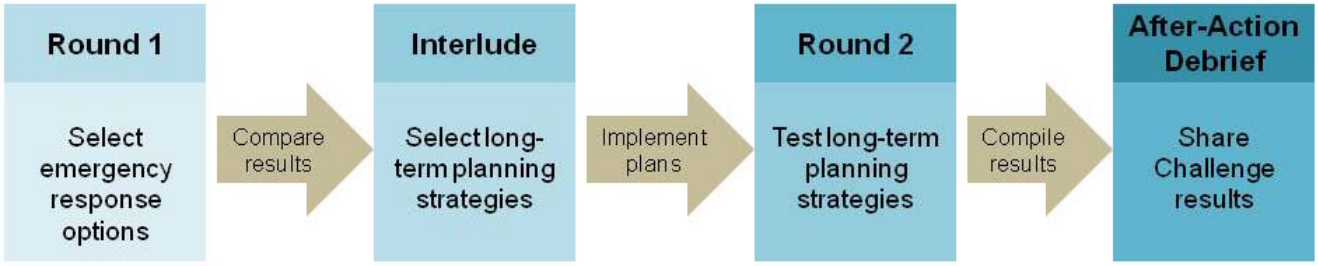
- Six referees – The referees will regulate discussion among the teams, provide clarification and guidance where needed, and contribute to the challenge scoring.
- Fans and sponsors – The Oklahoma Water Resources Board (OWRB) and Bureau of Reclamation (Reclamation) are sponsoring the event. Members from these entities in addition to several 'fans' will be observing the challenge and providing feedback.
- Facilitators and support staff – AMEC Environment & Infrastructure, Inc has developed the Challenge and will facilitate the event.

How will teams participate?

Each team will be representing a fictitious "Basin Drought Committee" and will be developing drought response plans for Old Faithful River Basin. Scoring of each team's drought response plans will be based on how well each team has addressed drought vulnerability and identified potential drought impacts, as well as on how effectively their portfolio of emergency response options reduces impacts on a multi-sector level throughout the entire Basin. Response plans that address the social, environmental and economic aspects of drought on a multi-sector level will receive higher scores than plans that do not address this multi-dimensional aspect of drought. The team with the highest score at the conclusion of the rounds will be the winner. There is a prize! Besides bragging rights, each player from the winning team will receive a mystery prize!

What are the challenge rounds?

The Oklahoma Drought Challenge will proceed in two rounds, separated by an interlude to allow planning of long-term planning strategies, and followed by an After-Action debrief. Refer to the *Old Faithful River Basin Report* for a description of the Basin and entities.



Emergency Response Round 1

The game managers will introduce the scenario and set the background for the Challenge. The hypothetical drought scenario applied to Old Faithful River Basin will include realistic drought conditions in Oklahoma based on state historic hydrologic and climatic data. The players have a limited number of options to respond to the scenario (see table below), and each option will have a cost. Each team will develop their response plan, which will be evaluated for its effectiveness in reducing the impacts of the drought. Cost and water shortages will be used to evaluate effectiveness. In addition to subjective evaluation by Challenge Referees, the evaluation will include a simple model of the system showing how the system performed in terms of water supply and storage.

Round 1 Emergency Response Options	
Emergency Response Option	**Description**
Use temporary auxiliary equipment to access alternate/supplemental water supplies	E.g., use temporary intakes, pumps, lines, etc. to access dead storage. Assume water quality is acceptable for potable use.
Emergency indirect potable reuse	Discharge wastewater effluent into a water supply reservoir. This water is non-potable and can serve to maintain pressure in the system. Boil orders and bottled water will be required.
Re-install and re-start pumps	Being pumping again from low quality wells. This water is non-potable and can serve to maintain pressure in the system. Boil orders and bottled water will be required.
Purchase bottled water	Provide emergency supply of water for indoor use by buying bottled water.
Bring in potable water using trucks	Emergency supply of water for indoor use by trucking in potable water and serving it from portable household cisterns.
Use portable treatment facilities to treat impaired water.	Use of temporary treatment equipment to treat saline groundwater to usable quality.
Ban outdoor watering	Ban all outdoor watering.

Round 1 Emergency Response Options	
Emergency Response Option	**Description**
M&I voluntary water restrictions	Municipalities start a conservation campaign that includes voluntary water restrictions for all customers. Cost is minimal since there is no enforcement.
M&I mandatory water restrictions	Mandatory water restrictions are placed on all customers requiring expense for enforcement.
Adjust water rates	If a municipality has water meters, adjust rates to complement water restrictions.
Leasing in-basin supplies	Leasing of in-basin water. (Note that Salt Lick does not have access to any water that can be leased in this round.)
Curtail or reduce water to junior users	Call the OWRB if necessary.

Interlude: Long-Term Planning Strategies

During the Interlude, teams will plan and adopt long-term planning strategies. Teams will be limited to options in the table below, which will have a cost (and benefit) associated with them. The teams must choose options within their remaining budget. The interlude is a simulated drought-free period spanning several years. The strategies represent pro-active actions and planning steps taken to prepare entities for a drought before it actually occurs. Teams may use their selected long-term planning strategies as a "wildcard" during the subsequent response round to alleviate drought-related impacts. These strategies enhance a team's resources to address drought impacts and if played "right," can give teams an advantage in the Challenge. The teams will fill out a specific plan with their long-term planning strategies that will be used to reduce the consequences of the drought during Round 2.

Long-Term Planning Strategies	
Long-Term Planning Strategy	**Description**
Marginal Quality Water / Reuse	
Install infrastructure for non-potable reuse for irrigation/industry	Upgrade water distribution infrastructure.
Indirect potable reuse	WWTP discharge point moves upstream. Increased monitoring and reporting will be required. Public education and acceptance will be a challenge.
Upgrade water treatment plant to have direct potable reuse capability.	Retrofit WWTP to treat wastewater to government drinking standards. Public education and acceptance will be a challenge.
Build a desalination/RO plant to make Marginal Quality Water available for M&I use.	Design, permit, and construct a water treatment plant capable of treating MQW to drinking water quality standards.
Water Conservation	
Implement M&I metering program	Install meters for municipalities without them.

Long-Term Planning Strategies	
Long-Term Planning Strategy	**Description**
M&I water efficiency program	Lower annual use by implementing leak detection programs.
	Adopt and enact conservation/increasing block water rate structure
	Implement high-efficiency indoor water use ordinances to lower annual demands
Xeriscaping program	Provide incentives to reduce the area of outdoor landscaping.
Increase agricultural efficiency	Smart irrigation scheduling to more precisely meet crop water needs
	Increase field application efficiency, e.g., shift to sprinkler systems, implementation of LEPA nozzles, shift to micro-irrigation
Develop Drought Response Plans	Identify specific triggers for demand management, contracts, other actions, etc.
Regionalization	
Build interconnections/redundancy between municipalities and nearby supplies	This opportunity exists between two municipalities.
New / Expanded Water Supply	
Drill new bedrock wells	Moderately expensive and uncertain results.
Construct a pipeline to import water from a distant basin	Substantial political opposition, uncertain permitting, high and uncertain costs. Pumping costs will be substantial.
New reservoir upstream on Clear Branch	Possible political opposition, uncertain permitting, high and uncertain costs.
Small Res expansion	Possible political opposition, uncertain permitting, high and uncertain costs.
Convert power plant to re-circulating cooling	A power plant in the basin uses once-through cooling. By building a cooling pond, the withdrawal requirement for the plant can be greatly reduced.
Water Leasing / Water Rights Administration	
Pre-drought water leasing arrangements, water banks	A systematic approach to leasing supplies is developed in advance of the drought. This improves efficiency and reduces the administrative costs necessary for leasing. An option payment is paid every year whether water is used or not, and an exercise payment when water is used.
Funding / Programs / Improvements	
Restoration and protection of habitat	A program to better support fish at low flows and high temperatures, e.g., re-configure channel, plant shade trees along river, restrict grazing right up against river bank.

Long-Term Planning Strategies	
Long-Term Planning Strategy	**Description**
Collaboration / Education	
Public Education/Outreach	Educate public on the importance of water conservation. This increases the effectiveness of demand management action.
Fish flow regimes	Establish agreed-upon flow regimes for aquatic species to meet minimum flow requirements.
Innovative Long-Term Planning Strategy	
Teams can develop and implement their own innovative long-term planning strategy pending referee approval.	Referees will determine costs and benefits on a case by case basis.

Emergency Response Round 2: Testing Preparedness

Round 2 will be a second drought that will test the effectiveness of the long-term strategy plans developed during the Interlude. Teams will be able to invoke responses from the same list of emergency response options from Round 1, but also incorporate strategies from their long-term strategy plans. As with Round 1 each team will present their plans at the conclusion of the round.

After-Action Debrief

Following Round 2, there will be a facilitated debrief on the Challenge. Score results for all teams will be compiled and shared with the entire group. Comments and suggestions from all participants will be solicited. The referees will select a winning team and announce the selection.

How will the scoring be conducted?

The teams' response plans will be scored at the end of Rounds 1 and 2 using a weighted three-component scoring system that will include referee judgment, left-over budget, and water availability. At the conclusion of the scoring, the three weighted scores will be added together to determine a final team score. The team with the best cumulative score at the end of Round 2 wins the game.

Do the teams have to play within a certain monetary budget?

Yes, as with the "real world," money is a factor. The teams will be assigned an initial budget consisting of Monopoly money to help keep track of their funds. Costs will be assigned to a pre-determined list of long-term planning strategies and emergency response options. Teams will also have an opportunity to develop innovative long-term planning strategies and options. Referees will need to be consulted to assign costs to these innovative strategies.

What is the most important thing to remember?

Review the basin report in advance of Challenge Day, have fun and interact with your fellow teammates and competitors!

APPENDIX D

Challenge Agenda

Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

AGENDA

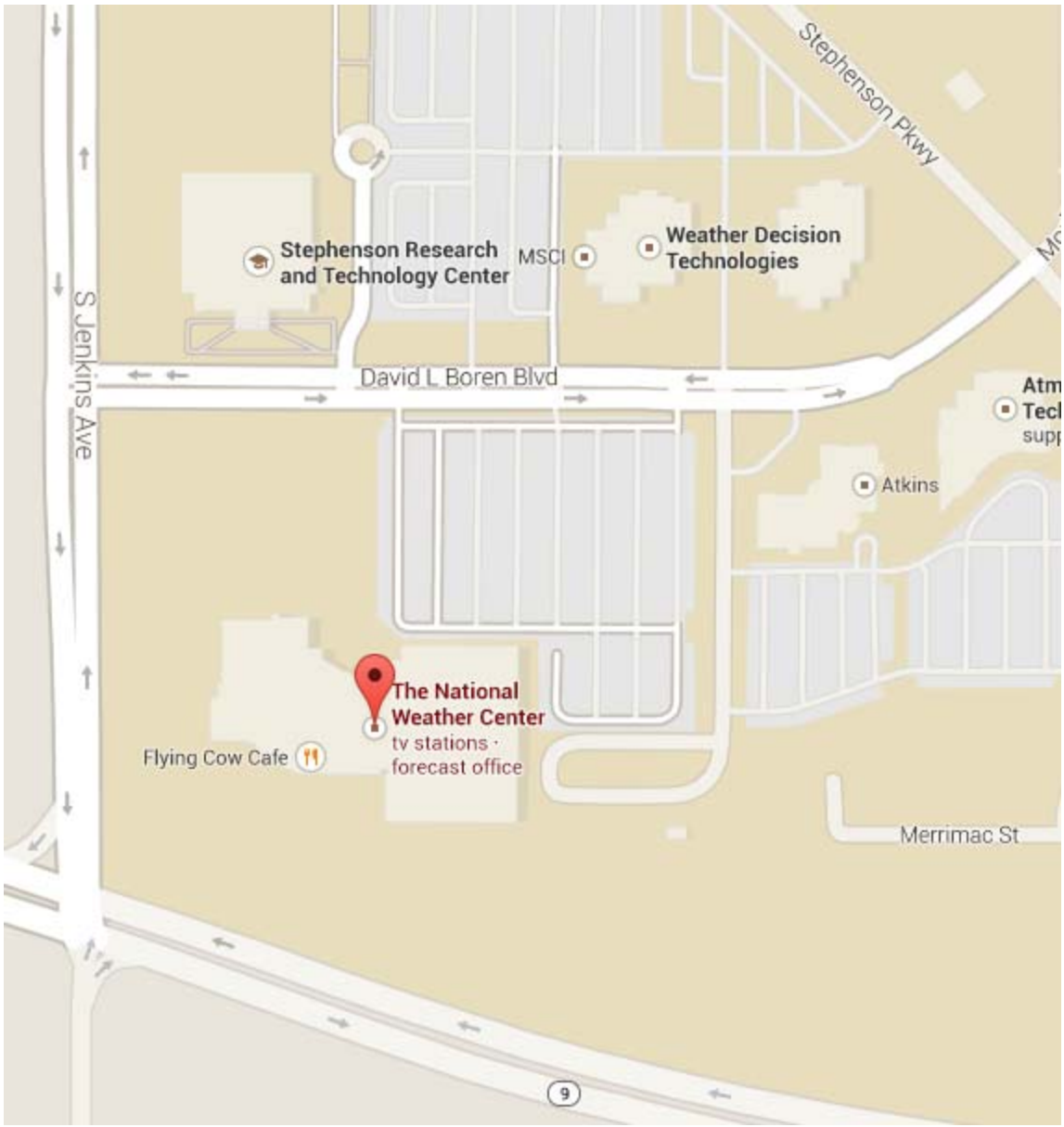
Registration and Continental Breakfast	**8:30 - 9:00**
Introductions, Background and Objectives	**9:00 – 9:15**
How to Play	**9:15 – 9:30**
Basin Overview	**9:30– 9:45**
Emergency Response Round 1	**9:45 – 11:30**
❖ Scenario presentation ❖ Team naming ❖ Teams select response options ❖ Teams provide options to referees ❖ Team presentations	
Emergency Response Round 1 Scoring Results/ Working Lunch	**11:30 – 12:00**
Long Term Planning Round ❖ Post drought conditions and round overview ❖ Team work session	**12:00 – 1:30**
Emergency Response Round 2 ❖ Scenario presentation ❖ Team select response options and implement long term planning	**1:30 – 2:45**
– 15 Minute Break –	**2:45 – 3:00**
❖ Team emergency response plan presentations	**3:00 – 3:30**
Post- Challenge After Action Debrief	**3:30 - 4:15**
Final scoring results	**4:15 – 4:30**
Award Ceremony	**4:30 – 4:45**
Concluding Remarks	**4:45 – 5:00**

Oklahoma Water Supply Reliability and Management Challenge

September 17, 2014

LOCATION AND PARKING INSTRUCTIONS

The National Weather Center is located at 120 David L. Boren Blvd., Norman, OK 73072. Challenge participants can park in the first two rows of the National Weather Center parking lot and enter through the first floor main entrance of the National Weather Center. The registration table will be just beyond the security desk.



APPENDIX E

Matrix Tables: Short-Term Emergency Response Options and Long-Term Planning Strategies

Oklahoma Water Supply Reliability and Management Challenge
September 17, 2014

Starting Budget: $20,580

Emergency Response Round 1: Response Options Matrix

Option No.	Emergency Response Option	Description	Cost Information	Increase in Supply or Decrease in Demand	Place a check mark to indicate which entity the option is being applied to, and an amount where one is called for: Wheatville	Salt Lick	West Ampere Power Plant	Total Costs to Implement Option
R1.1	Use temporary auxiliary equipment to access alternate/supplemental water supplies	Use of intakes, pumps, lines, etc. to access dead storage. Assume water quality is acceptable for potable use.	Capital cost - fixed; Salt Lick: $300 Wheatville: $1,500	Increase in supply: Salt Lick: 5 AF total Wheatville: 1,000 AF total				
R1.2	Emergency indirect potable reuse	Discharge wastewater effluent into a water supply reservoir.	Capital cost - fixed; $700	90% decrease in indoor demand				
R1.3	Use portable treatment facilities to treat impaired water (portable RO)	Use of temporary treatment equipment to treat saline groundwater to usable quality.	Capital cost - fixed; $1,200 O&M/Unit cost - $60/AF	Note desired increase in supply: Salt Lick: Max 46 AF/mo				
R1.4	M&I voluntary water restrictions	Municipalities start a conservation campaign that includes voluntary water restrictions for all customers. Cost is minimal since there is no enforcement.	Capital cost - fixed; Wheatville: $600 Salt Lick: $200	-10% decrease in indoor demand -15% decrease in outdoor demand				
R1.5	M&I mandatory water restrictions	Mandatory water restrictions are placed on all customers requiring expense for enforcement.	Capital cost - fixed; Wheatville: $5,000 Salt Lick: $1,000	-10% decrease in indoor demand -60% decrease in outdoor demand				
R1.6	Emergency M&I water rate increases	If a municipality has water meters, adjust rates to complement water restrictions.	No cost	10% decrease in demand				
R1.7	Leasing in-basin supplies	Leasing of in-basin water. Note that Salt Lick does not have any leasing options in this round.	O&M/Unit cost - $15/AF of maximum monthly use.	Identify limit on how many AF/mo to lease from Green Valley Farms as an increase in supply. Max 500 AF/mo; April through September				(Estimate)
R1.8	Curtail or reduce water to junior users	Call the OWRB if necessary.	No cost	Some supplies increase, but some decrease.				

Total Capital Costs of Emergency Response Round 1 Options: $

Remaining Budget: $

Oklahoma Water Supply Reliability and Management Challenge
September 17, 2014

Starting Budget: $20,580

Long-Term Water Planning Round: Long-Term Water Planning Matrix

					Place a check mark to indicate which entity the option is being applied to, and an amount where one is called for							
Strategy No.	**Long-term Water Planning Strategy**	**Description**	**Cost Information**	**Increase in Supply or Decrease in Demand**	**Wheatville**	**Salt Lick**	**West Ampere Power Plant**	**Happy Cow Ranch**	**Green Valley Farms**	**Logear Bass Habitat**	**Total Costs to Implement Option**	**Notes**
Marginal Quality Water / Reuse												
P.1	Install infrastructure for non-potable reuse for irrigation/industry	Upgrade water distribution infrastructure	Capital cost $4,000	90% decrease in indoor demand:								
P.2	Indirect potable reuse	WWTP discharge point moves upstream.	Capital cost $4,000	90% decrease in indoor demand:								
P.3	Upgrade water treatment plant to have direct potable reuse capability.	Retrofit WWTP to treat wastewater to government drinking standards	Feasibility study $1,000 Capital cost $6,000	90% decrease in indoor demand:								If you are contemplating this option, flag a referee
P.4	Build a desalination/RO plant to make Marginal Quality Water available for M&I use.	Design, permit, and construct a water treatment plant capable of treating MQW to drinking water quality standards	Capital cost $6,000 Uniit cost $40/AF	Supplies all requirements								
Water Conservation												
P.5	Implement M&I metering program	Install meters for municipalities without them.	Capital cost: Wheatvile $1,500 Salt Lick $500	1/3 reduction in demand								
P.6a	M&I water efficiency program	Lower annual use by implementing leak detection programs	Capital cost: Wheatvile $1,000 Salt Lick $300	7% decrease in demand								
P.6b		Adopt and enact conservation/increasing block water rate structure	Capital cost: Wheatvile $200 Salt Lick $100	10% decrease in demand								
P.6c		Implement high-efficiency indoor water use ordinance to lower annual demands	Capital cost: Wheatvile $200 Salt Lick $100	10% of indoor use								
P.6d		Xeriscape program - Provide incentives to reduce the area of outdoor landscaping.	Capital cost : Wheatvile $1,500 Salt Lick $300	60% of outdoor use								
P.7a	Increase agricultural efficiency	Increase delivery efficiency, e.g., smart irrigation scheduling to more precisely meet crop water needs, lining ditches	Capital cost $2,000	15% reduction in withdrawal								
P.7b		Increase field application efficiency, e.g., shift to sprinkler systems, implementation of LEPA nozzles, shift to micro-irrigation	Capital cost $2,000	20% reduction in withdrawal								
P.8	Develop Drought Response Plans	Identify specific triggers for demand management, contracts, other actions, etc.	Capital cost $200	5% decrease in demand								
Regionalization												
P.9	Build interconnections/redundancy between municipalities and nearby supplies	This opportunity exists between two municipalities.	Capital cost $2,000	Max 46 AF/mo								
New / Expanded Water Supply												
P.10	Drill new bedrock wells	Drill wells into the Entrada Sandstone Aquifer, north of Salt Lick. The yield is uncertain and requires a yield study. The accuracy of the yield study is uncertain.	Yield study cost $500 Capital cost $3,000	Max 46 AF/mo								If you are contemplating this option, flag a referee
P.11	Construct a pipeline to import water from a distant basin	Build a long pipeline from a basin to the east. The success, schedule and cost of this project are uncertain due to political, engineering and permitting factors.	Capital cost $14,000	300 af/month								

Oklahoma Water Supply Reliability and Management Challenge
September 17, 2014

Starting Budget: $20,580

Long-Term Water Planning Round: Long-Term Water Planning Matrix

					Place a check mark to indicate which entity the option is being applied to, and an amount where one is called for							
Strategy No.	**Long-term Water Planning Strategy**	**Description**	**Cost Information**	**Increase in Supply or Decrease in Demand**	**Wheatville**	**Salt Lick**	**West Ampere Power Plant**	**Happy Cow Ranch**	**Green Valley Farms**	**Logear Bass Habitat**	**Total Costs to Implement Option**	**Notes**
P.12	New reservoir upstream on Clear Branch	Build a new reservoir on the Clear Branch above Big Res. The yield is uncertain and requires a yield study. The accuracy of the yield study is uncertain.	Yield study cost $1,000 Capital cost $12,000	Maximum yield of 3,600 AF								If you are contemplating this option, flag a referee
P.13	Small Res expansion	Expand Small Res on the Salty Branch. The yield is uncertain and requires a yield study. The accuracy of the yield study is uncertain.	Yield study cost $500 Capital cost $3,000	Maximum expansion of 406 AF								If you are contemplating this option, flag a referee
P.14	Convert power plant to re-circulating cooling	A power plant in the basin uses once-through cooling. By building a cooling pond, the withdrawal requirement for the plant can be greatly reduced.	Capital cost $10,000	Reduces West Ampere water requirement by 90%								
Water Leasing / Water Rights Administration												
P.15	Pre-drought water leasing arrangements, water banks	A systematic approach to leasing supplies is developed in advance of the drought. This improves efficiency and reduces the administrative costs necessary for leasing.	Capital cost $1,800 Uniit cost $10/AF	Variable								
P.16	Curtail or reduce water to junior users	Call the OWRB if necessary.	None	Some entities have increased supply while some have reduced supply.								
Funding / Programs / Improvements												
P.17	Restoration and protection of habitat	A program to better support fish at lows flows and high temperatures, e.g., re-configure channel, plant shade trees along river, restrict grazing right up against river bank,	Capital cost $1,000	Reduces required fish flows by 1/3 from 15 cfs to 10 cfs								
Joint Action / Agreements / Education												
P.18	Public Education/Outreach	Educate public on the importance of water conservation. This complements water conservation programs.	Capital cost $200	2% additional decrease in demand								
P.19	Fish flow regimes	Establish agreed-upon flow regimes for aquatic species to meet minimum flow requirements.	Capital cost $100	None, but this action provides a framework for obtaining water supplies to support the fish flows.								
P.20	Reallocation of saved water	Negotiate and implement transfers and sharing of water stored in Big Res, some of which will be the saved water.	Capital cost $100	None, but this action provides a framework for regional, cross-sector solutions to water shortages..								

Total Capital Costs of Long-Term Planning Strategies: $

Remaining Budget: $