National Aeronautics and
Space Administration

**NASA
WESTERN WATER
APPLICATIONS
OFFICE**

Arkansas-White-Red River Basin Needs Assessment Report

Tools for managing a precious resource

December 2024

Executive Summary

From January 2023 to December 2024, HDR, Inc. (HDR) partnered with the National Aeronautics and Space Administration's (NASA) Western Water Applications Office (WWAO) to plan and conduct a workshop aimed at assessing water resource management needs in the Arkansas-White-Red (AWR) River Basin. The goal of the workshop was to identify current needs and gaps, with an emphasis on creating actionable use cases for potential future co-developed projects. Planning for this workshop drew on an internal basin characterization study completed by HDR and Aqua Strategies, Inc. (Aqua). The study summarized discussions with water resource users, managers, and other water-related practitioners and provided initial insights into their needs and challenges. The study also described potential areas for NASA collaboration and current utilization of remote sensing data in water-related decision-making processes.

This report provides a comprehensive overview of the physical and socioeconomic characteristics of the AWR River Basin. It outlines the objectives and methodology of the WWAO AWR Needs Assessment Workshop and introduces the practitioner participants and staff involved. The report highlights the primary water management needs identified by these practitioners and documents them through collaborative use cases developed with workshop staff. Its purpose is to underpin a future Request for Information (RFI) by WWAO, paving the way for potential project opportunities aimed at addressing these identified needs.

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List of Acronyms

ASCII	American Standard Code for Information Interchange
ARS	Agriculture Research Service

AWR	Arkansas-White-Red
DEM	Digital Elevation Model
DO	Dissolved Organics
EPA	Environmental Protection Agency
ET	Evapotranspiration
FEMA	Federal Emergency Management Agency
GPM	NASA's Global Precipitation Measurement Project
GRACE	Gravity Recovery and Climate Experiment
IMERG	Integrated Multi-Satellite Retrievals for GPM
LDAS	Land Data Assimilation System
LiDAR	Light Detection And Ranging
MODIS	Moderate Resolution Imaging Spectroradiometer
NASA	National Aeronautics and Space Administration
NGO	Non-governmental organization
NIDIS	National Integrated Drought Information System
NISAR	NASA-ISRO Synthetic Aperture Radar
NLCD	National Land Cover Database
NOAA	National Oceanic and Atmospheric Administration
NRCS	Natural Resources Conservation Service
NSIP	National Streamflow Information Program.
NWS	National Weather Service
ODEQ	Oklahoma Department of Environmental Quality
OSU	Oklahoma State University
OU	Oklahoma University
OWRB	Oklahoma Water Resources Board
PACE	Plankton, Aerosol, Cloud, ocean Ecosystem Mission
PRISM	Parameter-elevation Regressions on Independent Slopes Mode
RFI	Request for Information
SCCASC	South Central Climate Adaptation Science Center
SMAP	Soil Moisture Active Passive Mission
SRTM	Shuttle Radar Topography Mission
SWE	Snow Water Equivalent
SWOT	Surface Water and Ocean Topography Mission

TaDEM	TerraSAR-X add-on for Digital Elevation Measurements
USACE	United States Army Corps of Engineer
USAID	US Agency for International Development
USBR	United States Bureau of Reclamation
USDA	United States Department of Agriculture
USFS	United States Forest Service
USFWS	United States Fish and Wildlife Service
USGS	United States Geologic Survey
WLDAS	Western Land Data Assimilation System
WWAO	Western Water Applications Office

Introduction

The mission of the National Aeronautics and Space Administration's (NASA's) Western Water Applications Office (WWAO) is to improve how water is managed in the arid western United States by putting NASA data, technology, and tools into the hands of water managers and decision-makers. HDR, Inc. (HDR) and Aqua Strategies, Inc. (Aqua) were tasked with assisting WWAO in this endeavor by helping plan and conduct a needs assessment workshop and a companion pre-workshop webinar for the Arkansas-White-Red (AWR) River Basin. This report provides an overview of the AWR River Basin, a description of the pre-workshop efforts including a basin characterization study, and details of the needs assessment workshop including methods and participants. It also provides the use cases developed during the event.

Arkansas-White-Red River Basin

HDR and Aqua conducted a survey and characterization of the AWR River Basin for NASA WWAO in late 2023/early 2024. This characterization is included below.

The AWR River Basin, depicted in **Figure 1**, spans portions of eight states and approximately 247,000 square miles, reaching from the Rocky Mountains in Colorado in the west to the Mississippi River in the east. The basin comprises an entire Hydrologic Unit Code 2 (HUC2) and makes up approximately one-fifth of the Mississippi drainage area, draining approximately one-thirteenth of the land area of the continental United States. The AWR River Basin has diverse geography, climate, geology, and water resources. The basin is bounded by the high Southern Rocky Mountains in the west and the lower Ozark Plateau and Ouachita mountains in the east; between these two boundaries is a broad expanse of the Great Plains and a central Lowland, which both slope gradually from west to east.

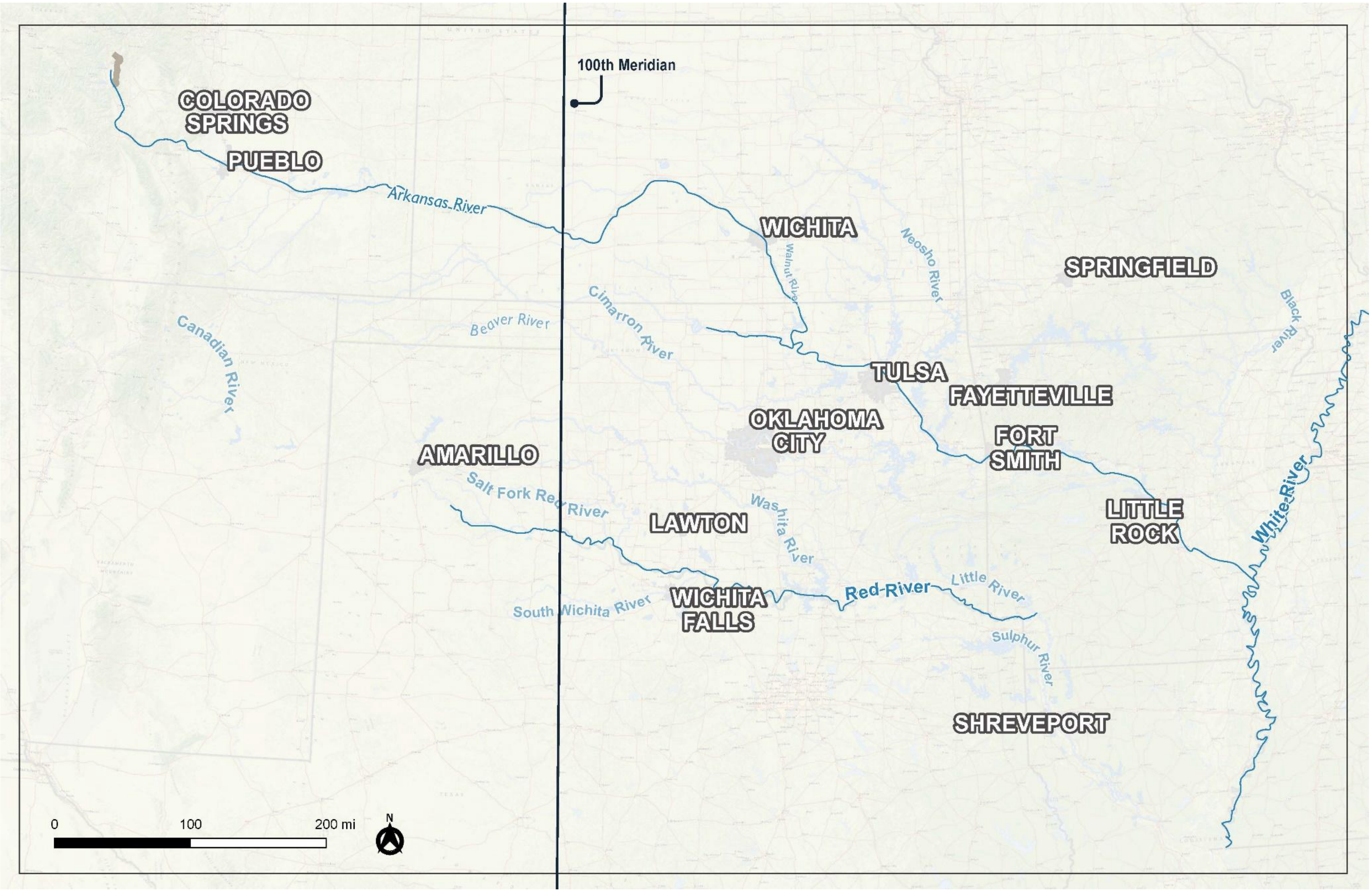
100th Meridian
COLORADO SPRINGS
PUEBLO
Arkansas River
WICHITA
Walnut River
Neosho River
SPRINGFIELD
Black River
Beaver River
Cimarron River
Canadian River
TULSA
FAYETTEVILLE
OKLAHOMA CITY
FORT SMITH
AMARILLO
Salt Fork Red River
Washita River
LAWTON
LITTLE ROCK
White River
WICHITA FALLS
South Wichita River
Red River
Little River
Sulphur River
SHREVEPORT
0
100
200 mi
N

Figure 1. Arkansas-White-Red River Basin

The longest river in the basin is the Arkansas River, the lower portion of which is navigable and controlled by a series of 18 locks and dams.[1] The White River begins in the Boston Mountains of Arkansas and flows north and then east to the Mississippi River. The Red River flows from eastern New Mexico southeast to the Mississippi River. The Arkansas River originates in central Colorado and flows through Kansas, Oklahoma and Arkansas before joining the Mississippi. The basin and its water resources provide significant economic, cultural, recreational, and transportation resources to the region and the six million people[2] within the basin. The largest population centers in the basin are Oklahoma City, Colorado Springs, Tulsa, and Wichita, in order of decreasing population.

The AWR River Basin supports a diverse range of habitats, including agricultural lands (pastures, range, and cropping), wetlands, forests, and open grasslands. These habitats in turn support a large range of species, including migratory birds, fish, and mammals. These water resources also attract a great number of tourists each year to take advantage of fishing, birding, boating, and other recreational activities.

The AWR River Basin's climate varies relatively uniformly from semiarid in the west to humid in the east. Precipitation follows this pattern, varying across the basin from west to east, from less than 16 inches per year to over 55 inches per year in parts of Louisiana and Arkansas.[3] A large portion of the watershed lies to the west of the 100th meridian, which delineates a general shift in precipitation from west (drier) to east (wetter).

Land Use

The AWR River Basin is a major agricultural area within the United States, producing cotton, soybeans, rice, and wheat. Irrigation supports agriculture in many parts of the region. Current land use within the basin demonstrates the shift from cultivated, irrigated crops and open grasslands in the central portion of the basin, and to the pasture and forest areas in the eastern portion of the basin.

Dams and Reservoirs

Millions of people rely on the basin's water resources for water supply, as do many types of industry and hydropower generators. According to the National Inventory of Dams (NID), there are approximately 10,000 dams in the basin. These serve many purposes, including irrigation, flood control, and recreation. The U.S. Army Corps of Engineers (USACE) manages the largest

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[1] SECURE Water Act Section 9503(c) Report to Congress, Chapter 10: Other Western River Basins. US Department of the Interior, Bureau of Reclamation. March 2016. https://americaswatershed.org/reportcard/the-basins/arkansas-river-and-red-river/

[2] SECURE Water Act Section 9503(c) Report to Congress, Chapter 10: Other Western River Basins. US Department of the Interior, Bureau of Reclamation. March 2016. https://americaswatershed.org/reportcard/the-basins/arkansas-river-and-red-river/

[3] PRISM Climate Group, Oregon State U. (n.d.). Prism.oregonstate.edu. https://prism.oregonstate.edu/normals/

flood control reservoirs in the basin, including Lake Texoma, Greers Ferry Lake, Lake Eufaula, and Table Rock Lake.

Groundwater Resources and Aquifers

The AWR River Basin consists of six aquifer types: (1) stream-valley alluvium, (2) terrace alluvium, (3) alluvium of intermontane valleys and buried alluvial valleys, (4) carbonate and gypsum, (5) sand and sandstone, and (6) undifferentiated sandstone, carbonate rock, shale, and/or basalt. While over half of the AWR River Basin overlies rocks that produce very little groundwater, the two largest aquifers are the High Plains aquifer (53,000 square miles)—an unconsolidated sand and gravel aquifer, —and the Ozark Plateaus aquifer system (22,000 square miles)—a carbonate-rock aquifer.

Characterization Study

HDR and Aqua worked with WWAO to develop an initial characterization of water management priorities and challenges in the AWR river basin using publicly available information. This characterization study was supplemented with additional information gathered through an online survey and live discussions with end users and practitioners who have water management interests in the AWR river basin. A total of eighteen discussions were conducted to establish a deeper understanding of water resources responsibilities, needs, concerns, and challenges. In addition to the study, HDR, Aqua, and WWAO compiled a list of key water management end users and practitioners within the AWR river basin who could potentially benefit from NASA's remote-sensing research, tools, and data. The list included federal and state agencies, municipalities, tribal organizations, universities, multi-state coalitions, private companies, and drinking water providers or water districts. This list was used to identify practitioners willing to participate in live discussions and later when it came time to send out invitations for the workshop. The result of this effort was an internal Characterization Study report. The characterization report was used to lay the groundwork for a needs assessment workshop for the AWR River Basin which was held in June 2024.

Needs Assessment Workshop

Utilizing information gathered from the basin characterization study and water manager discussions, WWAO, HDR, and Aqua planned the AWR River Basin Needs Assessment Workshop. The goal of the workshop was to identify water management needs and document these needs as use cases. Each use case would describe a water challenge, the need or gap that must be met to address that challenge, and the desired result(s) if the need is met. The resulting use cases could then provide a basis for future water projects aimed at addressing key needs in the basin and may be referenced in a WWAO Request for Information (RFI), allowing partners and practitioners to propose solutions that utilize NASA data in addressing water-related challenges in the region.

Representatives of organizations that were identified and/or interviewed as part of the characterization study were invited to participate in the workshop. Invitations were also sent to approximately 100 additional water practitioners in the AWR Basin. A pre-workshop webinar with around 40 participants took place on Wednesday, April 10, 2024. The purpose of the webinar was to familiarize potential attendees with the NASA Earth Action Program and WWAO, explain the workshop format and approach, and introduce the concept of a "use case" along with the WWAO template for capturing use case details.

Workshop Format

The AWR River Basin needs assessment workshop was held June 11 through June 13, 2024, in Oklahoma City, Oklahoma at the Oklahoma City Convention Center. Attendees included 22 practitioner representatives, 9 NASA WWAO technical representatives, 3 HDR facilitators, and 6 Aqua workshop facilitators. **Table 1** lists the participants, and **Table 2** lists the workshop staff along with their affiliations and role during the workshop.

Table 1. Needs Assessment Workshop Participants

First Name	Last Name	Organization/Agency	Role/Title
Lauren	Hostert	Battelle/National Ecological Observatory Network	Field Science Manager
Jon	Dawson	120Water/Cherokee Nation	Director of Strategic Accounts – Tribal
Billy	Hix	Cherokee Nation	Sr. Director OEH&E
Mark	Micozzi	The Chickasaw Nation	Water Resources Planner
Jordyn	Thompson	The Chickasaw Nation	Administrative Compliance Analyst
Justin	Cortez	Choctaw Nation of Oklahoma	Water Quality Laboratory Manager
Ephraim	Kelley	Kiowa Tribe	Natural Resource Department Director
Terrance	Paukei	Kiowa Tribe	Natural Resources Specialist
Timothy	Rupert	LA Dept. of Environmental Quality	OEA/Assistant Secretary
Emily	Moyer	The Nature Conservancy	Resilient Waters Program Manager
Joel	Lisonbee	NOAA / NIDIS / CIRES	Drought Information Coordinator
Caleb	Biles	The Oka Institute at ECU	GIS Analyst
Duane	Smith	Oka Water Institute	Executive Director

First Name	Last Name	Organization/Agency	Role/Title
Gregory	Carr	Oklahoma Department of Environmental Quality	Water Quality Division Chief Engineer
Miko	Brandon	Oklahoma State University	Graduate Student
Julie	Chambers	Oklahoma Water Resource Board	Lake Monitoring Coordinator
James	Decker	Oklahoma Water Resource Board	Environmental Programs Manager
Eric	Fiorentino	Oklahoma Water Resources Board	Hydrogeologist
Jacqueline	Hicks	Oklahoma Water Resources Board	Water Rights Specialist
Lance	Phillips	Oklahoma Water Resources Board	Environmental Programs Manager
Nishan	Bhattarai	University of Oklahoma	Assistant Professor
Shana	Mashburn	U.S. Geological Survey	Hydrologic Studies Chief

Table 2. NASA, HDR and Aqua Workshop Staff

Organization	Name	Professional Titles
		NASA
WWAO / NASA JPL	Stephanie Granger	WWAO Program Manager; Workshop Presenter, Subject Matter Expert
WWAO / NASA JPL	Sharon Vasquez-Ray	WWAO Stakeholder Engagement Lead; Workshop Presenter, Floating Subject Matter Facilitator
WWAO / NASA ARC	Amber McCullum	WWAO Impact and Transition Lead; Workshop Subject Matter Expert
WWAO / NASA GSFC	Bailing Li	WWAO Science Team, Research Scientist; Workshop Subject Matter Expert
WWAO / NASA JPL	Renato Prata de Moraes Frasson	WWAO Science Team, Research Scientist; Workshop Subject Matter Expert
WWAO / NASA ARC	AJ Purdy	WWAO Science Team, Senior Research Scientist; Workshop Subject Matter Expert
WWAO / NASA GSFC	Amita Mehta	WWAO Science Team, Research Scientist; Workshop Subject Matter Expert
NASA JPL	Cathleen Jones	Senior Research Scientist; Workshop Subject Matter Expert
		HDR
HDR	Amanda Brandt	Communications Coordinator;

Organization	Name	Professional Titles
		Workshop Emcee and Presenter
HDR	Julie Molacek	Communications Coordinator; Workshop Logistics and Admin
HDR	Delani Watkins	Communications Coordinator; Workshop Logistics and Admin
Aqua Strategies		
Aqua Strategies	Barney Austin	CEO, Aqua Strategies; Workshop Subject Matter Facilitator
Aqua Strategies	Amy Hays	Trainer, For Science Sake; Workshop Subject Matter Facilitator
Aqua Strategies	Jonathan Ogren	Principal, Siglo Group; Workshop Subject Matter Facilitator
Aqua Strategies	Jeff Irvin	Principal Water Resources Engineer; Workshop Subject Matter Facilitator
Aqua Strategies	Peter Zamora	Hydrologist, Aqua Strategies; Workshop Subject Matter Facilitator
Aqua Strategies	Adrienne Wooten	Research Scientist, South Central Climate Adaptation Science Center; Workshop Subject Matter Facilitator
Metropolitan Group		
Metropolitan Group	Dante Francomano	Senior Director; Workshop Subject Matter Facilitator

The first day of the workshop included an overview of WWAO and relevant NASA capabilities, a description of the needs assessment process and use case methodology, and an overview of outcomes from the characterization study completed in the first half of 2024. Day 1 was also used to determine focus areas around which breakout groups would be organized on Day 2. Prior to the workshop, the WWAO team identified six tentative focus areas, drawing from the AWR River Basin characterization report and feedback gathered during the discussions and the pre-workshop webinar. Guided by WWAO, HDR, Aqua and additional staff coordinated by Aqua, participants were able to use these as a basis to determine a final set of focus areas that represented their areas of greatest interest and concern. Participants were then asked to rank their preferences for focus area participation.

It is worth noting that the original list of potential focus areas included "Watershed Health and Water Quality" and "Agriculture". However, at the end of Day 1, the majority of the group was interested in Watershed Health and Water Quality and very few were interested in Agriculture. Therefore, the NASA subject matter experts and facilitators felt it would be best to rearrange the group topics to allow for a more even distribution of participants in the breakout groups. The final focus areas were as follows:

- Watershed Health
- Groundwater
- Surface Water and Water Quality

- Agriculture and Land Use
- Water Infrastructure
- Hydroclimate Extremes

Participants were encouraged to consider climate change, energy, surface and groundwater interaction, social and behavioral requirements, and strategic messaging when developing their use cases on Day 2.

On Day 2 the participants were assigned to focus area breakout groups and use case development took place for most of the day. Brainstorming, identifying and prioritizing needs occurred first, with the remainder of the morning and most of the afternoon dedicated to converting the needs into use cases, starting with the highest priority needs first. The final hour of the day allowed participants to switch focus areas and join a different breakout group in order to provide input on other use cases.

Table 3 presents the template used in the development of the use cases. A primer version of the template included step-by-step instructions to help guide participants in capturing the use case in sufficient detail.

Table 4 presents the use cases developed within each focus area, ranked in priority order as determined by the end users in that specific area. Following Table 4, the use cases are described in detail.

Table 3. Use Case Template

Use Case Title		Descriptive Title Here (e.g. "Improved ET for Groundwater Management")
Must Haves	Current State or Water Management Challenge	Describe the decision(s), current process, and data/models used to support decision-making, or describe the water management challenge(s) where lack of information is inhibiting progress.
	Desired Result(s)	Describe desired improvements to the decision-making process or the water management challenge described above.
	Need/Gap	Describe the information needed to achieve the desired result (e.g., consumptive use, snow water equivalent, streamflow, vegetation health, forecast). Note: Needs should be agnostic to specific solutions.
	Information Requirements	To the extent possible, describe the required characteristics of the data needed to improve the decision (e.g., spatial resolution, temporal resolution, accuracy, latency, data formats). Include necessary modifications to existing models.
	Partner Potential	Identify the primary organization that would partner with WWAO to develop/implement a potential project to address the need (should it be selected). Provide name(s) and contact information.

Use Case Title		Descriptive Title Here (e.g. "Improved ET for Groundwater Management")
		Primary partner: <Contact Info/Phone number here> Other interested parties: <Contact info and phone numbers>
	Affected area or community	Indicate if the need or challenge described above varies in significance across different communities or regions (e.g., urban, rural, communities). Further explanation may be provided if necessary.
Supports WWAO Needs Prioritization	Description/Decision Context	Describe the decision to be made, how the decision is made, and who makes the decision with as much detail as possible, including information about what data are used to inform the decision-making process and who is currently responsible for producing and/or interpreting the data.
	Obstacles to Addressing the Need	Describe obstacles (e.g., technical, institutional, cultural, financial, etc.) to addressing the need
Supports WWAO Project Development and Partnering	Current Workflow	Describe the flow of information from a set of inputs to models (as appropriate) to outputs (e.g., monthly reports, graphs) that are used to make the decision.
	Potential Data Sources	Identify potential information sources that could aid in addressing the decisions or challenges described above. These sources may include but are not limited to NASA data.
	Participants	Describe the primary participants who are impacted by this need.

Table 4. Use Cases by Category with Ranking

Use Case Topic	Use Case Ranking (1 = most important)
Focus Area A: Watershed Health	
Use Case A-1: Water Availability	1
Use Case A-2 (Combined with B-3): Aquifer Recharge/ Improving Natural Groundwater Recharge Estimates	2
Use Case A-3: Water Supply Systems	3
Use Case A-4: Watershed Health 2.0	4
Focus Area B: Groundwater	
Use Case B-1: Improving Groundwater Withdrawal Estimates	1
Use Case B-2: Monitoring Groundwater Levels	2
Use Case B-3: Improving Natural Groundwater Recharge Estimates	3

Use Case Topic	Use Case Ranking (1 = most important)
Use Case B-4: Improving Density and Coverage of Surface Water Elevation and Discharge Measurements to Enhance Groundwater-Surface Water Exchange Estimates	4
Use Case B-5: Enhanced Groundwater Sustainability in the Southern High Plains: Addressing Agricultural Demands and Recharge Challenges	-
Focus Area C: Surface Water and Water Quality	
Use Case C-1: Refine Water Balance in Surface Water Basins	1
Use Case C-2: Early Detection and Warning System for Harmful Algal Blooms (HABs)	2
Use Case C-3: Water Quality Measurements	3
Use Case C-4: Identify Land and/or Water Contamination in Early Stages (Rural)	4
Focus Area D: Agriculture and Land Use	
Use Case D-1: Water Use Efficiency	1
Use Case D-2: Quantify Irrigation Water Use	2
Use Case D-3: Evaluate Land Management Practices	3
Use Case D-4: Riparian Zone Mapping	4
Use Case D-5: Invasive Species Mapping	5
Focus Area E: Water Infrastructure	
Use Case E-1: Impact of Subsidence on Infrastructure on Tribal and Rural Lands	1
Use Case E-2: Failures of Wastewater Infrastructure Leading to Unpermitted Discharges into Streams	2
Use Case E-3: Watershed Hydrology Information for Infrastructure Needs Assessment	3
Use Case E-4: Information Needs for Dam Risk Assessment, Flood Emergency Planning, and Flood Response	4
Use Case E-5: Stream-related Risks to Infrastructure	5
Focus Area F: Hydroclimate Extremes	
Use Case F-1: Identification of Available Water Supply Under all Climatic Conditions (including hydrologic extremes)	1
Use Case F-2: Rapid Detection of Drought and Drought Impacts	2
Use Case F-3: Drought-Flood Whiplash Likelihood and Area Identification	3
Topics Not Covered, but Should be Considered	
Snow and Snowmelt	
Energy	
Climate Change	
Social Change / Behavioral Modification	
Overlapping Topics Between Focus Groups	
Water Supply and Availability	
Resilience	

Use Case Topic	Use Case Ranking (1 = most important)
Water Quality	
Water Recharge	
Timing	

The final set of 26 use cases are described in the following sections and include the completed templates for each use case.

Use Cases

Focus Area A: Watershed Health

Facilitator: Amy Hays
SME: Amita Mehta

Participants:

Participant Name	Organization
Lauren Hostert	Battelle/National Ecological Observatory Network
Jaqueline Hicks	Oklahoma Water Resources Board
Emily Moyer	The Nature Conservancy
Jordyn Thompson	The Chickasaw Nation

Use Case A-1: Water Availability

Accurate real-time water availability assessments are needed, including seasonal distribution, quality, and usability. Groundwater data is limited, and streams lack sufficient data, requiring innovative measurement methods.

Use Case Element	Description
Current State or Water Management Challenge	Spatial and temporal distribution of water is tied distinctly to watershed health. There is no actual estimate of the water availability because there is incomplete information on the true water availability (precipitation, evapotranspiration, surface water availability, soil moisture, run-off, ground water: aquifer specific). Current allocation is based on requested use, permits, historical information—not necessarily data—on what is “available” and it is disconnected from water quality (how much is consumable/usable). Current information is based on point measurements (rainfall measurements) but not connected or related to the resource water is drawn from. Current state: Watershed health is based on inaccurate water use information rather than water availability.
Desired Result(s)	1. More accurate assessment of water availability in real-time, including: 1.1. Special distribution: Seasonally appropriate to growing and dormant seasons 1.2. Annual allocation: Both holistic and continuous 2. Better indication of water quality of the available water. Also determine: 2.1. Is it usable, and for whom (animal, human, energy, recreation)? 3. Is there a baseline? If yes, what are the sources, or do the sources need to be established?

Use Case Element	Description
Need/Gap	● Watershed-wide, spatial distribution of water, and when is it available? ● How much water is permitted/allocated (correctly or incorrectly)? ● How far off from baseline in a given year or timeframe? ● What is the quality of the water? Groundwater has more data available for allocation decisions, although it is limited by well depth and measurement capabilities. In contrast, streams and surface water are much more variable, with insufficient data to capture seasonal fluctuations accurately. Innovation is needed to develop methods for measuring what is currently difficult or time-consuming to assess with traditional approaches.
Information requirements	Needed information includes: ● Baseline water availability ● Evapotranspiration ● Precipitation ● Surface water availability ● Soil moisture ● Run-off ● Ground water: Aquifer ● Management boundaries ● Growing/non-growing regions influenced by vegetation zones, precipitation zones
Partner Potential	Potential partnerships include: ● USACE ● Aquifer authorities ● Groundwater management association ● Water Resource Boards (permitting) ● USGS ● ARS/USDA ● Universities ● NASA ● NOAA
Affected area or community	Natural: Could be delineated by extents that have a shared water resource (aquifer or large lake: Texoma, basin). Human/Political/Social: Could be delineated by shared boundaries where allocation rules/process/policies drive the potential for over-allocation.
Description/Decision Context	How will decisions be made: Possibly regionalize by supply rather than “false boundaries,” (because water doesn’t abide by political

Use Case Element	Description
	boundaries). Water planning could be conducted by hydrologic units, rather than counties, states, etc. Balance the supply, demand and reserve, earmarking water supplies to meet future needs. Example: For the AWR river basin, identify availability and demand locations and develop strategies not limited by county or municipality boundaries (as location of availability often does not match where the demands are). Develop a regionally rational calculator. Who will make decisions: States, nations, municipalities, water managers, industry, energy, and agricultural users would be involved in decision-making. ● Allocation for use ● Distribution for transfer ● How to keep it sustainable, secure, and reliable ● Create projection scenarios
Obstacles to addressing the need	Obstacles to addressing needs include: ● Funding ● Social, political, economic – current structure is based on state-based management ● How should the information be distributed? ● Need to get buy-in and data trust (validity of data) ● Long-term projects, need to establish where to start ● Reservoir/dam mentality
Current Workflow	Several organizations are interested in this, each with different interests. States are interested in real-time water availability assessments for water rights administration and to maximize beneficial use of limited water supplies. Environmental organizations want to know how much water is in the environment and how much is available. Water use is usually self-reported after the fact, so the only information available in real time is measured streamflow. The various components of a basin water accounting model are not usually available in real time and are compiled months or years later.
Potential Data Sources	NASA satellite data could be useful here, such as Landsat or SWOT. Also SMAP/Sentinel-1 for soil moisture, OpenET, LDAS data to monitor water availability, Landsat/Sentinel-2 to monitor water quality, and NEX GDDP data for climate projections.
Participants	No participants have been identified yet.

Use Case A-2 (combined with B-3): Aquifer Recharge / Improving Natural Groundwater Recharge Estimates

Improved groundwater management needs better data on recharge rates and zones to support informed allocation and sustainable planning. The Arbuckle-Simpson Aquifer is also mentioned in this use case.

Use Case Element	Description
Current State or Water Management Challenge	Groundwater withdrawal permit decisions are based on studies and models that simulate groundwater flows along with other considerations as determined by the OWRB; recharge is a large component of the groundwater budget and recharge to aquifers is difficult to estimate. Very little information is known about critical water recharge zones where recharge rates are potentially larger. Additionally, recharge cannot currently be measured directly. All current models rely on 1 km Daymet precipitation data (based on weather station interpolation) as an input. Soil type, landcover, and evapotranspiration data are also used as inputs. The evapotranspiration data are not great, they are currently based on interpolation and more detail is needed. Soil type data are coarse, and assumptions about the relationships between soil type and hydrologic conductivity could be improved. Soil moisture is considered as well, but not as a direct input (either from in situ or Earth observation data). The precipitation data might be missing local-scale precipitation events. In Oklahoma specifically, the U.S. Environmental Protection Agency has designated the Arbuckle-Simpson (ASA) aquifer's eastern portion as a Sole Source Aquifer, a mechanism to protect drinking water supplies in areas with limited water supply alternatives. The ASA is also part of both the Chickasaw and Choctaw Nation treaty area.
Desired Result(s)	1. Groundwater management improvement that provides users with more information related to groundwater recharge zones and rates. 2. Ability to track groundwater recharge and receive more accurate reporting on the water budget. 3. Better informed allocation/permitting based on analysis of the availability of groundwater, the recharge rate, and the recharge zones. What portion of water becomes recharged, what becomes surface water, etc. 4. Better planning with respect to land development, industrial development, tribal water sovereignty, sustainability, cultural and ecological conservation.

<table>
<tr><th>Use Case Element</th><th>Description</th></tr>
<tr><td>Need/Gap</td><td>Know where the recharge rate is high (soil condition, karst features, percolation, rainfall distribution, and geomorphology) as well as more accurate estimates of natural groundwater recharge.</td></tr>
<tr><td>Information requirements</td><td>Needed information includes:
Rainfall, terrain
Surface hydrology, topography and geology
Soil condition (soil moisture, infiltration capacity)
Land management
Industry development
Evapotranspiration
Temporal extent: 30 years to present
Temporal resolution: Annual at a minimum; monthly would be great
Spatial extent: Regional based on the extent of the large relevant unconfined aquifers
Spatial resolution: 1 km
Accuracy: Aquifer-dependent, likely on the order of feet (vertical)
Latency: <1 year
Data formats: NetCDF, ASCII</td></tr>
<tr><td>Partner Potential</td><td>Potential partners include:
USGS
EPA
OSU
OU
OWRB
Texas Water Development Board
U.S. Bureau of Reclamation
USACE
Oka Institute
Chickasaw Nation
Choctaw Nation of Oklahoma
NASA
USDA
Energy
Environmental NGO
Non-profits (e.g. NEON)
Municipalities</td></tr>
<tr><td>Affected area or community</td><td>The target area is south central Oklahoma, specifically the Arbuckle-Simpson aquifer which underlies more than 500 square miles in Chickasaw territory. This aquifer serves as the main water source for around 39,000 people in Ada, Sulphur, and surrounding areas. It also supplies several key springs in the region, including Byrds Mill Spring, and the springs in the Chickasaw National Recreation Area, which</td></tr>
</table>

Use Case Element	Description
	attracts about 3.4 million visitors annually. The aquifer is Ada's primary drinking water source,
Description/Decision Context	Groundwater recharge is notoriously difficult to estimate but is critically important to the water balance, which in turn governs spring flow and regulations related to use. A better understanding of recharge rates would help water managers make more informed decisions and regulations related to management of the aquifer, including how the Oklahoma Water Resources Board issues permits for landowner groundwater withdrawals.
Obstacles to addressing the need	It is currently impossible to directly measure recharge, and estimating runoff is difficult. Identifying sensitive areas for recharge might create tension around land ownership and management. The GRACE product has a very coarse scale, and it may not be suitable for a complex aquifer like the ASA. However, downscaling techniques are promising. Other measurements such as soil moisture and precipitation are directly related to recharge and may work as a surrogate. There would be a lot of enthusiasm (and partners) for this project!
Current Workflow	The aquifer recharge rate is typically back calculated from known or estimated water use and spring flow data. However, these estimates are poor. The current ASA groundwater model is about to be refined and any more information on recharge rates would be very valuable.
Potential Data Sources	• GPM-IMERG • WLDAS • DEM (SRTM, TanDEM) • Land Cover and Land Use data (Landsat, MODIS) • Soil Condition: Texture, composition • Evapotranspiration products (OpenET may be useful) • SMAP • NISAR • Landcover and vegetation types
Participants	Chickasaw Nation (and other tribal nations), USGS, OWRB, TWRB, mining companies (possibly), Oka Institute, EPA Kerr Lab, OSU, Irrigation districts, agricultural communities, groundwater conservation districts and others.

Use Case A-3: Water Supply Systems

Timely and continuous monitoring of lakes and their watersheds is needed to ensure accurate water quality readings. Lake Texoma is mentioned in this use case.

Use Case Element	Description
Current State or Water Management Challenge	Drinking water supply systems are highly impacted by natural and human disturbances.

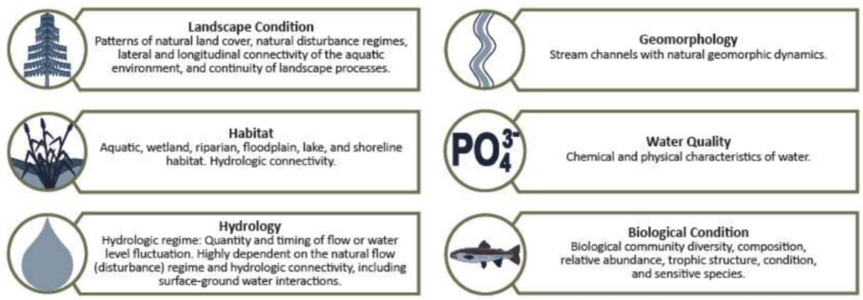
Use Case Element	Description
	In-situ measurements are infrequent and sporadic regarding water supply and their source watersheds. Timing of in-situ measurements are independent of watershed conditions.
Desired Result(s)	1. Access to more timely and pertinent readings of lakes and the lake watersheds. 2. Continuous monitoring of water quality in lakes.
Need/Gap	Need a way to measure conductivity remotely, particularly for surface water. Conductivity is a good indicator of water quality. Need a correlated measurement that could indicate a breakdown in conductivity. Conductivity and dissolved oxygen decreases are important indicators of decreases in water quality
Information requirements	Needed information includes: • Algal bloom (harmful species) • Nutrification • Temperature • Turbidity • Salinity • Temperature
Partner Potential	Potential partners include: • USACE • USGS • EPA • OSU • OU • OWRB • Oka Institute • Chickasaw Nation • Choctaw Nation of Oklahoma • NASA • USDA • Energy • Environmental NGOs • Non-profits • Municipalities
Affected area or community	Lake Texoma provides drinking water for many communities in north Texas and southern Oklahoma.
Description/Decision Context	Changes in measurements that look like an anomaly can trigger a site visit or inquiry, saving time.
Obstacles to addressing the need	The lake spans the state border, with Texas using its full water allocation while Oklahoma uses none. Texas is seeking access to some of Oklahoma's water, making any study potentially controversial;

Use Case Element	Description
	however, collaboration between the two states is essential. A nonprofit, bi-state organization is already in place and could bring together the necessary partners to manage the process.
Current Workflow	Many folks are involved in monitoring water quality in the watershed, but not many are involved in developing and implementing remediation practices. This would be an interesting project to coordinate, and could lead to a large, beneficial effort.
Potential Data Sources	Landsat, Centinet2, Sentinel-3, PACE (Algal bloom, water surface temperature, turbidity, CDOM) Watershed model (such as SWAT): weather data from GPM, MERRA-2; vegetation/crop information from Landsat /Sentinel-2-MSI; terrain data from SRTM/ASTER.
Participants	EPA, the north Texas water providers, Choctaw and Chickasaw Nations, USACE, and potentially many others.

Use Case A-4: Watershed Health 2.0

There is currently no reliable index or integrated data to regularly assess watershed health. Monitoring watersheds during recovery is needed to better understand their resilience.

Use Case Element	Description
Current State or Water Management Challenge	Categorize resilience of the watershed at a state in time to identify: 1. Changes that might be prone to magnifying impacts 2. Ability to predict the ability of a watershed to withstand climate fluctuations (drought, flood)
Desired Result(s)	1. Ranking/rating or qualitative index of health that is based on temporally and spatially relevant information. 2. Identify broken systems across water, energy, nutrients, and biodiversity. 3. A WWAO–Watershed Health Index monitoring portal.
Need/Gap	Not much is known about watersheds until they are in crisis. Science has already shown that healthy watersheds are more resilient to change and recover faster from crises. However, there isn't an index with reliable data to assess watershed health regularly. Integrated watershed health assessment information is not available. There is a need to capture data or information as systems go through recovery. The ability to monitor a watershed system as it goes through recovery would help to determine the resilience of watersheds.
Information requirements	Needed information includes:

Use Case Element	Description
	Indicators of Watershed Health:  Six types of subindices that combine to make up the watershed health index
Partner Potential	Potential partners include: • FEMA • NOAA • NRCS • EPA • Nature Conservancy • USAID • Water suppliers (river authorities, cities, private water sellers, etc.) • Clean Lakes and Waters • NGOs • Land Trusts • Commodity organizations (food, fiber) • Insurance organizations
Affected area or community	Can focus on any or all watersheds in AWR River Basin. Regionalizing would be beneficial for taking action.
Description/Decision Context	Watershed health assessments could serve as an early warning system so that decision-makers can put programs into action. Watershed health assessments could focus on pre/post stress cycles (extended drought, flood, fire) and suggest a restoration path to take. These could also forecast what systems (water, food and fiber, other resources) would be impacted. Example questions that could be answered: • Determine if less food/fiber production should be expected after extended drought. • Determine unusual flooding (longer extent), excessive nutrient loading into waterways, degraded riparian areas. A pre- and post-disaster (fires, floods, droughts) Watershed Health Index (or Indices) would help develop mitigation/adaptation/restoration strategies to make a watershed more resilient.

Use Case Element	Description
Obstacles to addressing the need	This is very complex, and scale is important.
Current Workflow	There isn't an organization leading the charge on this. It's complex, but there are many new remote sensing data products that could be brought to the table which can help prioritize the use of limited resources to make a positive impact on the ecosystem and our communities.
Potential Data Sources	Fires (FIRMS, MODIS & VIIRS, Landsat/Sentinel-2 and GOES), surface inundation (Sentinel-1, NISAR), land surface temperatures (Landsat 8-9, Next Generation), hydrology components (GPM, LDAS with a routing model?), SWOT, SMAP, GRACE-FO), water quality, land cover, habitat and biological conditions – (LST), vegetation, in-water – water temperature and trophic state (Landsat, Sentinel-2, PACE).
Participants	See organizations listed in "Partner Potential." Universities would want to lead the charge on this.

Focus Area B: Groundwater

Facilitator: Dante Francomano/Peter Zamora
SME: Bailing Li

Participants:

Participant Name	Role/Organization
Eric Fiorentino	Oklahoma Water Resources Board
Shana Mashburn	U.S. Geological Survey

Use Case B-1: Improving Groundwater Withdrawal Estimates

Improved reporting on the groundwater budget is needed, this will also provide for more informed groundwater withdrawal permitting.

Use Case Element	Description
Current State or Water Management Challenge	USGS conducts modeling and provides outputs to the Oklahoma Water Resources Board, which also conducts soil water balance modeling and issues withdrawal permits (after an internal review and board approval process that can take years). Details by use sector: • Municipal—relies on monthly metered data from municipalities • Agriculture—self-reported annually based on acres irrigated and number of irrigations (likely biased by fear of losing allocations) • Industry—self-reported annually • Private domestic—no reporting, allowed 5 acre-feet per year per household (small relative to other sectors) • Surface mining— self-reported quarterly and annual reports of water volumes
Desired Result(s)	1. More accurate reporting on the groundwater budget

Use Case Element	Description
	2. Better informed groundwater withdrawal quantity permitting
Need/Gap	Groundwater withdrawal estimates
Information requirements	Needed information includes: • Temporal extent: Prior 30 years to present • Temporal resolution: Daily average • Spatial extent: Regional based on the extent of the large relevant aquifers • Spatial resolution: 200 m to 2 km (depending on the area of interest) • Accuracy: Discussed, but needs more background research • Latency: <1 year • Data formats: NetCDF, ASCII
Partner Potential	Potential partners include: • USGS • OWRB • Texas Water Development Board • Groundwater conservation districts • US Bureau of Reclamation • USACE • Kansas Geological Survey (sustainable withdrawal)
Affected area or community	The affected area includes Oklahoma and Texas.
Description/Decision Context	OWRB issues permits for landowner groundwater withdrawals.
Obstacles to addressing the need	For sectors other than agriculture, evapotranspiration estimates will not provide much relevant information. Lack of access to private metered data is a challenge. Domestic use is not metered or reported. There is cultural resistance to monitoring—it is seen as a threat to resource access.
Current Workflow	Data are self-reported and assembled a long time after data collection.
Potential Data Sources	OpenET
Participants	• Tribes, interested parties, agricultural communities

Use Case B-2: Monitoring Groundwater Levels

Improved groundwater budget reporting and withdrawal permitting are needed, along with publicly available data for those interested in or concerned about well levels.

Use Case Element	Description
Current State or Water Management Challenge	Aquifer water levels influence permitting for groundwater withdrawals. Monitoring is currently based entirely on wells. The number of wells is insufficient and is currently limited to inactive wells with good aquifer connectivity that are known to be within a single basin and have access granted by a landowner.

Use Case Element	Description
	Most monitored wells are not equipped with data loggers and are only checked once or twice a year. Data records are too short for 20-year modeling.
Desired Result(s)	1. More accurate reporting on the groundwater budget. 2. Better informed groundwater withdrawal quantity permitting. 3. Publicly available data for anyone interested in drilling a well or concerned about their well level.
Need/Gap	Groundwater levels
Information requirements	Needed information includes: • Temporal extent: Prior 30 years to present • Temporal resolution: Monthly at a minimum; daily would be preferable • Spatial extent: Regional based on the extent of the large relevant unconfined aquifers • Spatial resolution: 1 km • Accuracy: Aquifer-dependent, likely on the order of feet (vertical) • Latency: <1 year • Data formats: NetCDF, ASCII
Partner Potential	Potential Partners include: • USGS • OWRB • Texas Water Development Board • Groundwater conservation districts • US Bureau of Reclamation • USACE
Affected area or community	The affected area includes Oklahoma and Texas.
Description/Decision Context	OWRB issues permits for landowner groundwater withdrawals.
Obstacles to addressing the need	There is cultural resistance to monitoring—it is seen as a threat to resource access. NASA does not currently measure groundwater levels. There is limited knowledge of hydrogeological characteristics; karst aquifers in particular would be a challenge (see additional undeveloped use case).
Current Workflow	All states have a network of monitoring wells from which data are collected and compiled periodically; however, the temporal and spatial resolution need to be improved to better manage the resource.
Potential Data Sources	• Existing well level measurements (by tape measure and data loggers) • Well drillers' reports • Geophysical logs (private companies have most logs; USGS has some logs)
Participants	Tribes, interested parties, agricultural communities, irrigation districts.

Use Case B-3: Improving Natural Groundwater Recharge Estimates

*Because Use Case B-3 was so similar to Use Case A-2, they were combined into the use case labeled A-2 in the preceding section.

Use Case B-4: Improving Density and Coverage of Surface Water Elevation and Discharge Measurements to Enhance Groundwater-Surface Water Exchange Estimates

More accurate groundwater budget reporting and improved spatial resolution of surface water elevation and discharge from surface water estimates are needed to enhance groundwater withdrawal permitting and surface water management.

Use Case Element	Description
Current State or Water Management Challenge	Groundwater-surface water exchange is considered in USGS groundwater modeling. Current methods include hydrograph separation, differential gauging or seepage runs, and DEM-based elevation assumptions. Reservoirs are addressed through an empirical head-dependent relationship and some gauges to monitor outflow. Current estimates of exchange are spatially coarse or absent for a given body or reach of water (e.g., playas for the Ogallala).
Desired Result(s)	1. More accurate groundwater budget reporting. 2. Better informed groundwater withdrawal quantity permitting 3. Better informed surface water management
Need/Gap	Improving spatial resolution surface water elevation and discharge from surface water estimates
Information requirements	Needed information includes: ● Temporal extent: As far back as possible ● Temporal resolution: Daily ● Spatial extent: All bodies of surface water ● Spatial resolution: 1 km ● Accuracy: Unknown ● Latency: <1 year ● Data formats: ASCII
Partner Potential	Potential partners include: ● USGS ● OWRB ● Texas Water Development Board ● US Bureau of Reclamation ● USACE ● The National Water Model can be used to identify occurrence and location of low flows.
Affected area or community	The affected area includes Oklahoma and Texas.
Description/Decision Context	OWRB issues permits for landowner groundwater withdrawals.
Obstacles to addressing the need	Current SWOT data will require validation.

Use Case Element	Description
Current Workflow	This work is done only sporadically across the nation, mostly through individual studies. One is currently taking place on the Brazos River in Texas, while another is about to begin on the Rio Grande in New Mexico.
Potential Data Sources	● SWOT ● Drone-based elevation data
Participants	Primary interest will be from the state agencies who handle water permitting.

Use Case B-5: Enhanced Groundwater Sustainability in the Southern High Plains: Addressing Agricultural Demands and Recharge Challenges

The following use case was not developed during the AWR Needs Assessment workshop, but was provided through collaboration with the NASA ACRES initiative. NASA ACRES leverages NASA capabilities to support U.S. agriculture, and this particular agricultural use case was included due to its relevance to water needs that align with NASA WWAO's water resource management focus. The affected region, located near the Arkansas-White-Red River Basin, falls outside the scope of areas WWAO will address in future needs assessments, making it a valuable addition to this report.

Use Case Element	Description
Current State or Water Management Challenge	In the U.S. southern high plains, over 90% of groundwater in the region is used for agriculture, where the land is mostly privately owned and therefore difficult to access. The region, which is a key provider of beef and cotton, faces significant groundwater challenges including: ● Inconsistent withdrawal reporting ● Insufficient in-situ well data for accurate model calibration, though localized data may exist ● Difficulty in determining recharge rates; withdrawals exceed recharge in many areas ● Challenges in identifying high-recharge "payoff" zones in large watersheds ● Reliance on old engineering standards and conservative assumptions, such as considering recharge rates as zero ● Use of outdated engineering standards hampers accurate assessments Groundwater conservation districts, composed of irrigating farmers, provide information about the state of the water table. They can track storage changes and subsequently utilize a tax abatement. They also aim to achieve long-term sustainability and work toward desired future conditions 50 years ahead, though issues such as limited in-situ well data and slow adoption of improved farming practices hinder progress. In an effort supported by the Texas Water Development Board, modelers try to determine the available groundwater to be used in the planning process for future scenarios. Climate change may pose additional risks to irrigated and rain-fed lands, while cities increasingly seek new well locations. Playa lakes are potential recharge zones, but their contributions remain poorly

Use Case Element	Description
	understood, and caprock water flow and produced water usage present potential opportunities but require further exploration. Opportunities exist to enhance water resource management, such as better modeling of recharge in key areas like playa lakes, expanded use of innovative water sources like produced water, and adoption of sustainable agricultural practices. Addressing these challenges requires improved data, updated practices, and stronger planning tools.
Desired Result(s)	Provide sufficiently accurate information to reliably estimate groundwater levels and groundwater recharge rates and demonstrate their value to landowners in managing their acreage effectively.
Need/Gap	Monitoring of cover crops. Determine: ● Crop type ● Field planted or not planted Groundwater ● Recharge rates ● How much groundwater recharge is from surface water ● How groundwater levels are changing with groundwater withdrawals High-resolution monitoring of land use/land cover changes and regenerated ecosystems Accurate, accessible data on consumptive water use from irrigation (Note: OpenET can provide 30 m resolution)

Information requirements	Cover Crop Monitoring
	● Crop type; Field planted or not planted. Both require:
	    ○ <= .5 m (pivot circles can contain different crops, and parts of it can be irrigated. Can also plant in concentric circles)
	    ○ Daily (to observe growth rates over time)
	
	Groundwater Recharge
	● Determine recharge rate
	● Determine how much groundwater recharge comes from surface water:
	    ○ Unit = inches per year (The current boilerplate groundwater assumption is ½” recharge/year from surface water; recharge source is large episodic rainfall events)
	● How groundwater levels change with irrigation:
	    ○ 1 mile x 1 mile (or ½ mile by ½ mile depending on the model; Many growers use more than one well for a pivot, you can’t tell which pivot they are tied to)
	    ○ Daily
	
	Consumptive Water Use from Irrigation

Use Case Element	Description

	• Fields:
	  ○ 30 m would be good
	  ○ Daily or weekly for most larger scale models
	• Playas:
	  ○ 1 m is needed for topographic information
	  ○ Daily or weekly for most larger scale models
	
	High-resolution monitoring of land use/land cover changes, including ecosystem regeneration
	• Resolution TBD

Partner Potential	• Texas Water Development Board
Affected area or community	This use case was developed for the U.S. Southern High Plains, focusing on the Llano Estacado region, which encompasses the Texas Panhandle and extends into eastern New Mexico, reaching as far as the Pecos River.
Description/Decision Context	-
Obstacles to addressing the need	-
Current Workflow	-
Potential Data Sources	-
Participants	-

Additional Groundwater Use Case Ideas

The Groundwater Focus Area Group came up with other potential ideas for future use cases that they were unable to develop during the workshop. These ideas included:

- Mapping karst recharge zones
- More consistent integration of robust climate projections in groundwater recharge and level monitoring
- Identifying locations for aquifer storage and recovery; determining how it will impact geochemistry
- Aquifer-aquifer interactions
- Identifying locations of salty aquifers—vertically and gridded

Focus Area C: Surface Water and Water Quality

Facilitator: Barney Austin/Sharon Ray
SME: Renato Frasson

Participants:

Participant Name	Role/Organization
Gregory Carr	Oklahoma Department of Environmental Quality
Tim Rupert	Louisiana Department of Environmental Quality

Use Case C-1: Refine Water Balance in Surface Water Basins

Better quantification of water use, availability, and basin water budgets—supplemented by flow meters and lake level monitoring—supports more accurate water trading and management, especially during droughts.

Use Case Element	Description
Current State or Water Management Challenge	Water rights are based on a first come, first served basis in the western states–they are not based on need. Shortages occur that could potentially be addressed through market mechanisms. This has a better chance of success than a regulatory approach.
Desired Result(s)	Better quantification of water use, demand, inefficiencies or water losses, and availability, both historically and in real time, such that buying and selling water can happen as droughts develop.
Need/Gap	Better quantification of water uses, availability, and basin water budget. Need to supplement data being collected on the ground through flow meters and lake level monitoring.
Information requirements	Needed information includes: • Evapotranspiration, surface water flows and recharge, diversions rates and usage (both groundwater and surface water), wastewater return flows, environmental flows/needs • Can work with what's available • Latency: Less important
Partner Potential	Potential partnerships include: • OWRB • State agencies that manage water planning processes • Water users
Affected area or community	All water users in the watershed are affected. Particular beneficiaries are junior water right holders with important water needs (e.g. small municipalities).
Description/Decision Context	Although difficult to implement, this would be a tremendous tool in over-allocated basins (such as the Brazos in Texas).
Obstacles to addressing the need	Implementation will require a combination of different data sets from different sources and a decision-support tool that water managers can use to make recommendations and/or facilitate water transfers. This would pair well with a USBR-type Drought Contingency Plan.
Current Workflow	While a Water Bank and a Water Trust exist in Texas, the other states in the AWR River Basin do not have a system for buying and selling water (or leasing water rights) during drought conditions. Providing real-time information on the quantities of water available would facilitate this process, which would primarily involve agricultural users selling water (or rights) to municipalities with more junior rights.
Potential Data Sources	• Water rights from state agencies

Use Case Element	Description
	• Water uses from state agencies (need better than annual reporting) • Evapotranspiration data from OpenET • Flow information and groundwater levels from USGS and state agencies • Data from irrigation districts
Participants	USGS; USBR, USACE, State agencies; municipal, industrial, and agricultural water users; other potential partners could be identified

Use Case C-2: Early Detection and Warning System for Harmful Algal Blooms

Early detection and tracking of harmful algal blooms (HABs) and related water quality issues are needed for timely reporting and management.

Use Case Element	Description
Current State or Water Management Challenge	Need to track conditions conducive to water quality issues that impact recreation, ecosystem services and/or public water supply. Also need early detection of HABs.
Desired Result(s)	1. Early warnings or identification of pre-existing conditions leading to HABs 2. Subsequent tracking of the extent and evolution of the algal blooms themselves
Need/Gap	Timely reporting of related water quality conditions and algal blooms.
Information requirements	Near real-time information on water quality constituents that lead to blooms and early detection of the blooms themselves. • Summer/hot conditions – drought or flood. • Daily time step (or better) would be ideal • Start with water supply lakes (1000-acres+)
Partner Potential	Potential partners include: • ODEQ • OWRB • Department of Tourism • Department of Health • Oklahoma Corporation Commission • Louisiana Department of Environmental Quality • Louisiana Department of Energy and Natural Resources • Municipalities • Recreation/environmental groups • Anyone considering indirect reuse and wastewater discharge
Affected area or community	The effect of this is basin-wide, particularly reservoirs/lakes that have had HABs before.
Description/Decision Context	Action typically only takes place when someone calls in an issue. A more predictive method would allow action to be taken as early as possible. It could also enhance the ability to take preventative action, which would be ideal.

Use Case Element	Description
Obstacles to addressing the need	Lack of resources for widespread and timely in situ monitoring of HABS.
Current Workflow	Water quality measurements/samples are taken but could potentially be ramped up to help identify relationships between remote sensing measurements with in situ measurements.
Potential Data Sources	State and local measurements.
Participants	City managers, utility director, marina managers, lake managers

Use Case C-3: Water Quality Measurements

More frequent and widespread water quality measurements are needed, as current spot data is limited. Remote sensing should be used to enhance coverage beyond in situ measurements.

Use Case Element	Description
Current State or Water Management Challenge	There is a need for more water quality measurements. Currently, we only have spot measurements available that are too far apart both spatially and temporally.
Desired Result(s)	To be able to use remote sensing measurements of key water quality parameters, instead of relying on in situ measurements.
Need/Gap	More coverage of water quality measurements.
Information requirements	Needed information includes: • Spatial resolution: Whatever is available (approximately 30 m) • Temporal resolution: Daily, preferably • Latency: Less important • Parameters: Turbidity, Total Suspended Solids, Dissolved Oxygen, pH, Nitrogen, Phosphorus, conductivity, temperature, total carbon
Partner Potential	Potential partners include: • State agencies and Tribes who take water quality measurements • Community science organizations • Larger cities
Affected area or community	Regions with aquatic environments are the most likely to be affected.
Description/Decision Context	This information would help with: • Implementation of water quality standards • Primary body contact (recreation safety) • Prioritizing Best Management Practices • Regulatory activities
Obstacles to addressing the need	It is important that any remote sensing data that is collected and used must be reasonably accurate because it will be used (or will want to be used) for regulatory purposes. Uncertainty/accuracy standards are important and will need to be described in Quality Assurance Project Plans. If the data cannot be used for regulatory purposes, it might help direct where samples should be taken in situ.

Use Case Element	Description
Current Workflow	In situ measurements are taken to support decision making, but are costly, therefore, their frequency and the sample locations are not ideal.
Potential Data Sources	Landsat, Sentinel 2 and 3, EMIT, SBG, PACE. To be validated with water quality measurements taken by the above agencies/organizations.
Participants	Water agencies

Use Case C-4: Identify Land and/or Water Contamination in Early Stages (Rural)

Early detection of contamination from disused mines, oil and gas wells, and landfills is essential for effective containment and remediation. Users require maps and information on contamination sources and their extent.

Use Case Element	Description
Current State or Water Management Challenge	Contamination from disused mines, oil and gas wells and landfill sites can occur without being detected. Users need to be able to detect these “spills” in the very early stages in order to be able to contain and address the problem.
Desired Result(s)	1. Maps and locations of contamination sources and the extent of the contamination.
Need/Gap	Issues are often reported or go undetected until they escalate into significant problems, complicating the cleanup process.
Information requirements	Needed information includes: • Contamination information: Dead vegetation, bright colors from heavy metals, etc. Multispectral imagery should be able to detect these things early and effectively.
Partner Potential	Potential partners include: • Office of Mines • EPA • ODEQ and State water quality agencies • County officials Tribes
Affected area or community	This can affect all areas, particularly those with heavy oil and gas and known past and present mining activities.
Description/Decision Context	Remote sensing is the only way these sources of contamination can be identified on private land before they become a problem to public water supplies.
Obstacles to addressing the need	The Office of Mines would be a good partner, but they were not able to make it to the workshop in Oklahoma City.
Current Workflow	Presently, land or water contamination is reported by the public and only when it is noticed. In some instances, nothing is done for a long time which results in more extensive remediation. Early detection of contamination is an effort that could be spearheaded by a number of organizations (see list of participants and partners).

Use Case Element	Description
	The appeal of this type of project is that it would seem fairly easy to conduct a proof of concept and subsequently get it implemented, which would benefit many people and ecosystems.
Potential Data Sources	Multi-spectral imagery. Needs to be corroborated with on-the-ground field surveys. Office of Mines staff do these surveys.
Participants	Office of mines, EPA, ODEQ and State water quality agencies, county officials, Tribes, etc.

Focus Area D: Agriculture and Land Use

Facilitator: Jonathan Ogren
SME: AJ Purdy, Amber McCullum

Participants:

Participant Name	Role/Organization
Nishan Bhattarai	University of Oklahoma
Mark Micozzi	The Chickasaw Nation
Justin Cortez	Choctaw Nation of Oklahoma

Use Case D-1: Water Use Efficiency

Inefficient water use in agriculture stems from poor irrigation systems, land management, and field topography. Strategies are needed to optimize water use, maximize crop yield, and improve efficiency.

Use Case Element	Description
Current State or Water Management Challenge	Inefficient water use exists due to inefficient irrigation systems and management, improper land management, and low-lying spots in fields.
Desired Result(s)	1. Maximize the amount of applied water used by the crop, thus minimizing the amount of water needed. 2. Decision support on where within a field to apply water 3. Yield maximization 4. Optimize water use management in croplands 5. Identify optimal strategies to improve efficiency (e.g. till vs no till fields)
Need/Gap	Early detection of where irrigation is needed. Currently unknown where more irrigation is needed in agricultural fields. Crop consumptive use information is absent. Currently, it is unknown how much water is used for transpiration and evaporation. Crop water use efficiency (yield / applied water) is absent. Quantifying potential tradeoffs of water use vs yield vs sustainability.
Information requirements	Needed information includes: • Regional assessment tool that resource managers can use to understand the entire system and support individual landowners

Use Case Element	Description
	● Spatial resolution: 30m is workable; <30m would be better ● Temporal resolution: Daily to weekly ● Latency: Forecast data available real-time, real-time data available for OpenET. ● Format: Accurate crop water needs in .jpeg format, or some kind of easily accessed and interpreted imagery. ● Accuracy: TBD
Partner Potential	Potential partners include: ● Chickasaw Nation ● Choctaw Nation ● Oka Institute ● University of Oklahoma ● Oklahoma State University ● USDA- NRCS ● Oklahoma Conservation Commission ● Lake of the Arbuckles Watershed Association ● Lake Texoma Watershed Association ● Soil Conservation Districts ● Water Resource Department.
Affected area or community	Affected areas include any irrigated croplands.
Description/Decision Context	Most farmers do not significantly adjust their irrigation schedule based on soil moisture, rainfall, temperature, evapotranspiration rates, etc. A remote sensing data product that is focused on estimating the exact amount of water needed to maximize crop yield, while not wasting water, is desired by the farming community.
Obstacles to addressing the need	The results need to be tied to the irrigation controller. Most of the irrigation scheduling is automated, but not adjusted based on these factors. Proof of concept is needed to convince the farmer to adopt this kind of technology.
Current Workflow	Irrigation schedule is set by the farmer based on the crop planted, typical seasonal pattern of growth, and daily temperatures. Usually, the irrigation is adjusted if there is significant rainfall, but otherwise it remains the same.
Potential Data Sources	Lots of remote sensing products could and should be brought to bear here, including the OpenET product, soil moisture, precipitation estimates, and perhaps multi-spectral analysis to determine crop condition.
Participants	This seems like something USDA would be interested in, or an irrigation district. In the initial phase, perhaps a university could be involved. Texas Tech, Texas A&M, and OSU have active programs with farmers that could be built on.

Use Case D-2: Quantify Irrigation Water Use

Actual irrigation water use is often unknown due to reliance on estimates and potentially inaccurate reporting by farmers. Improved data is needed, especially in areas with declining aquifer levels and reduced streamflow.

Use Case Element	Description
Current State or Water Management Challenge	The actual amount of water used for irrigation is unknown, only the estimates of the actual water used are available.
Desired Result(s)	1. Better understanding of actual water use in irrigation. Farmers are often not required to report water use, and if they are it is often mis-reported due to erroneous units or lack interest and/or the will to report accurately. It is desired to estimate use of water resources more accurately, especially in areas with declining aquifer levels and/or reduced streamflow.
Need/Gap	Water availability cannot be predicted if an accurate idea of current water use is not available. Assuming current self-reporting is not as accurate as needed. It is likely hard to get meters on wells.
Information requirements	Needed information includes: ● Using groundwater level and GRACE to determine.
Partner Potential	Potential partners include: ● USGS ● Kiowa Nation ● Other Tribal Nations ● OWRB
Affected area or community	Areas more dependent on groundwater would be affected.
Description/Decision Context	Resource managers charged with modeling groundwater and surface water resources are hampered by the fact they do not have accurate water use figures in agricultural areas.
Obstacles to addressing the need	None, except perhaps some political pushback from the irrigation industry who are notoriously secretive about their water use. This is particularly true in parts of Texas where there is no groundwater district. Suggest focusing on a part of the basin where there is a strong desire for this data and broad support from the irrigators.
Current Workflow	Groundwater and surface water availability models require knowledge of water use in the basin or aquifer. When this information is not available, estimates must be made, which are often gross approximations based on harvest.
Potential Data Sources	OpenET, GRACE, and other remote sensing products.
Participants	Participants have not yet been identified.

Use Case D-3: Evaluate Land Management Practices

Adopting climate-smart practices requires robust data on their impacts and improved water quality and quantity metrics. Tracking agricultural practices will help understand impacts to soil health and land productivity.

Use Case Element	Description
Current State or Water Management Challenge	Support for broader adoption of climate smart practices requires good data on the impacts of using those practices — paddocks, no-till drill,

Use Case Element	Description
	cross fencing, protecting riparian areas, native plant seeding vs Bermuda, fire, etc. Better water quality and quantity data are needed (total nitrogen, phosphorus, ammonia, nitrate, nitrite in the soil).
Desired Result(s)	1. Track agricultural practices and the impacts they have on soil health and land productivity. 2. Improve water quality, water quantity, and soil moisture. 2. Prioritize areas for Climate Smart Practices. 3. Quantify the water-related benefits or trade-offs of climate smart practices over time.
Need/Gap	Consistent monitoring at management scales is resource intensive.
Information requirements	Needed information includes: ● ET and consumptive use before and after project implementation. Soil moisture before and after project implementation to quantify the benefit of soil water carry over from one season to the next. Land cover mapping. ● Spatial resolution: 10 m workable, ideally 1 m ● Temporal frequency: Seasonal (2 to 4 times per year) ● Latency: Within the next year. GeoTIFFs ● Accuracy: (TBD?)
Partner Potential	Potential partners include: ● Chickasaw Nation ● Choctaw Nation ● Oka Institute ● OU ● OSU ● USDA-NRCS ● Oklahoma Conservation Commission ● Lake of the Arbuckles Watershed Association ● Lake Texoma Watershed Association
Affected area or community	Affected areas include agricultural areas and ranchland.
Description/Decision Context	This project would be for research purposes initially, but ultimately it will help farmers and land managers be better stewards of the land they manage.
Obstacles to addressing the need	It will be important to properly define the goals at the outset, and solutions need to work in several different types of environments – perhaps comparing and contrasting a concentrated animal feeding operation to a ranch.
Current Workflow	It is unknown what type of models already exist for this work. Many groups are currently using GIS tools and techniques to manage data and model results from lots of different sources, but it is unclear what/where all the data are located, and the quality of that data.

Use Case Element	Description
Potential Data Sources	A broad range of remote-sensing data could/should be used and validated with on-the-ground measurements.
Participants	Research organization paired with a farmer's group.

Use Case D-4: Riparian Zone Mapping

Landowners cropping and grazing near waterways are causing erosion and habitat degradation. Assessing riparian areas and monitoring land management impacts are essential for improvement.

Use Case Element	Description
Current State or Water Management Challenge	Many landowners are cropping or grazing up to the edge of waterways. Bank erosion and habitat degradation is occurring due to a lack of riparian areas. Livestock are getting into water in riparian areas.
Desired Result(s)	1. Determine size/width of riparian area 2. Determine change over time 3. Determine species composition of riparian areas 4. Determine areas to invest in riparian improvement 5. Measure the impacts of land management practices
Need/Gap	Currently, there is no data associated with riparian zone limits. It would be suggested to have data at a 50-foot buffer of riparian zones. NLCD has this information; however, it is not resolved enough to determine riparian areas.
Information requirements	Needed information includes: ● Regional: 10 m; 1 m would be ideal ● 2 to 3 maps per year up to seasonal ● Latency: Within month ● Accuracy: 80% accurate
Partner Potential	Potential partners include: ● Chickasaw Nation ● Choctaw Nation ● Oka Institute ● OU ● OSU ● USDA- NRCS, Oklahoma Conservation Commission ● Lake of the Arbuckles Watershed Association ● Lake Texoma Watershed Association ● Soil Conservation Districts ● Water Resource Department
Affected area or community	Affected areas include the Chickasaw Nation and the Choctaw Nation.
Description/Decision Context	While there are no rules or regulations requiring ranchers to keep their cattle out of the rivers, this activity has a highly detrimental impact on the health of surface water bodies. Some farmers and ranchers have fenced off the rivers – typically for safety purposes – however, most do not. Knowing where these properties are is the first step to mitigating the impacts.

Use Case Element	Description
Obstacles to addressing the need	There would need to be some ground-truthing to validate the remote sensing data. This issue is not insurmountable, but the farmers would know that the researcher is targeting this issue.
Current Workflow	Water resource managers have to manage the impact of encroachment of animals in the riparian zone, but typically do not know where it is occurring, or how extensive it is. Impacts to water quality include elevated organics and fecal coliforms, erosion and turbidity, and reduced aquatic and terrestrial habitat, in areas that would typically support a very rich diversity of species.
Potential Data Sources	Primarily visual imagery, but potentially supplemented with multi-spectral data for identification of individual plant/tree species.
Participants	There will be very active interest in this from the Choctaw and Chickasaw Nations, as well as other organizations in the basin with land management responsibilities, and/or who have an active interest in the water bodies downstream.

Use Case D-5: Invasive Species Mapping

The extent of invasive species in the basin is unclear, but they impact water availability for crops and native species. Actions needed include mapping invasives, reducing their water use, and restoring biodiversity.

Use Case Element	Description
Current State or Water Management Challenge	While there are substantial economic and ecological costs to the dominance of invasive species across the basin, their extent is not fully known. Their water use impacts the water available for crops and native species.
Desired Result(s)	1. Define where specific invasive species occur including old world bluestem, salt cedar, Bermuda grass, Sericea lespedeza, Chinese privet, trifoliate orange, Bradford pear, Russian olive, Johnson grass, mimosa, eastern red cedar 2. Reduction in consumptive use by invasives 3. Increase in biodiversity/habitat restoration 4. Increase forage—economic value 5. How have invasive species spread over time? 6. Greater water infiltration
Need/Gap	Need a detailed vegetation map at the species level that can identify stands of invasive species.
Information requirements	Needed information includes: ● 1 m or better ● 2 weeks ● Hyperspectral to identify species ● Potential LIDAR ● Accuracy: 90% ● GeoTIFF
Partner Potential	Potential partners include: ● Chickasaw Nation

Use Case Element	Description
	• Choctaw Nation • Oka Institute • OU • OSU • USDA- NRCS • Oklahoma Conservation Commission • Lake of the Arbuckles Watershed Association • Lake Texoma Watershed Association • Soil Conservation Districts • Water Resource Department
Affected area or community	Affected areas include the Chickasaw Nation and the Choctaw Nation.
Description/Decision Context	The Chickasaw Nation is actively involved in identifying Eastern red cedar and supporting an eradication program, with controlled burns. This program/process may have other applications elsewhere – for example, Ashe Juniper and Mesquite in the upper parts of the basin.
Obstacles to addressing the need	Need to work with many landowners for ground-truthing.
Current Workflow	The process of prioritizing land for controlled burns is very difficult without remote sensing, because it is hard to get a sense of the density of invasive plant species on land, from the land. Remote sensing tools help understand the size, age, and density of plants to help determine the suitability of the land for controlled burns and to prioritize land parcels based on that suitability and other factors.
Potential Data Sources	Landsat and similar products (i.e. hyperspectral sensors), with ground-truthing.
Participants	See "Partner Potential" section. USDA, NRCS, and state agencies should be willing participants. NRCS is sponsoring the Eastern red cedar project that the Chickasaw Nation is conducting.

Use Case D-6: Impervious Cover

Impervious cover affects water quality and is poorly mapped in smaller municipalities and rural areas. Key actions include identifying impervious areas, monitoring changes, and examining their relationship with water quality.

Use Case Element	Description
Current State or Water Management Challenge	Impervious cover has a substantial impact on water quality and is not well mapped in smaller municipalities and rural areas.
Desired Result(s)	1. Determine areas of impervious cover in particular components of the basin. 2. Determine change over time. 3. Look at relationships to water quality variables. 4. Can look at a broader landscape with the same lens as a water infiltration issue.

Use Case Element	Description
Need/Gap	Need a detailed map of areas with impervious vs pervious surfaces that define where water infiltration can occur.
Information requirements	Needed information includes: • Regional: 1 m or less • Once per year • Latency: Within month • Accuracy: 90% accurate
Partner Potential	Potential partners include: • Chickasaw Nation • Choctaw Nation • Oka Institute • OU • OSU • USDA- NRCS • Oklahoma Conservation Commission • Lake of the Arbuckles Watershed Association • Lake Texoma Watershed Association • Soil Conservation Districts • Water Resource Department • Municipalities • Counties
Affected area or community	The largest effect would be in more developed areas.
Description/Decision Context	A true and accurate assessment of impervious cover would be useful for land and water resources managers. Impervious cover affects aquifer recharge rates, soil moisture, timing and magnitude of rainfall-runoff, and has water quality impacts. Being able to automate this from satellite imagery would be useful if that process does not exist already.
Obstacles to addressing the need	Very few obstacles or challenges have been identified, although areas where the degree of "imperviousness" is ambiguous (such as gravel roads). May require certain assumptions to be made.
Current Workflow	Land cover and land use maps are currently made available by the USGS but they lack detail and spatial resolution.
Potential Data Sources	Satellite sensors that provide multi-spectral imagery.
Participants	See list of potential partners.

Use Case D-7: Fuel Loads and Burn Mapping

Woody encroachment in the basin likely harms water quality but using fire to reduce it can improve water infiltration. Improved mapping of fuel loads and burn areas is needed to optimize land management and assess fire impacts on water resources.

Use Case Element	Description
Current State or Water Management Challenge	Traditional management techniques have resulted in woody encroachment throughout much of the basin that is believed to have impacts on water quality. Fire is seen as a tool to reduce overall woody material and promote savannas and grasslands throughout the area that increase water infiltration and overall water availability. While fire is becoming a more regularly used tool for land management, the mapping of fuel loads and burns is sporadic. Having a good understanding of where and when burns have occurred as well as fuel loads could better direct land management resources and better quantify the effects of fire on water resources.
Desired Result(s)	1. Determine fuel loads throughout the basin and areas where fire is a greater risk. 2. Track burn areas over time. 3. Look at burn patterns as they relate to water availability, evapotranspiration, and water quality variables to better understand the efficacy of burning as a land management tool in the basins. 4. Prioritize areas for future burning.
Need/Gap	Need a good data source regarding burning and fuel loads within the basin.
Information requirements	Needed information includes: ● Regional: 10 m; 1 m ideal ● 2 to 3 maps per year up to seasonal ● Latency: Within month ● Accuracy: 80% accurate
Partner Potential	Potential partners include ● Chickasaw Nation ● Choctaw Nation ● Oka Institute ● OU ● OSU ● USDA- NRCS ● Oklahoma Conservation Commission ● Lake of the Arbuckles Watershed Association ● Lake Texoma Watershed Association ● Soil Conservation Districts ● Water Resource Department.
Affected area or community	Areas affected by this include the Chickasaw Nation and Choctaw Nation.
Description/Decision Context	Land managers want to know where the fuel load is for fire risk and for land management opportunities. High risk or high opportunity areas could be identified and prioritized through this process.

Use Case Element	Description
Obstacles to addressing the need	Most of the land in the basin is privately owned so there would be a need to coordinate with landowners, both for ground-truthing and for any of the proposed burn activities to take place.
Current Workflow	Currently, most controlled burns are conducted based on landowner requests, but these areas do not always correspond to where the need is.
Potential Data Sources	Landsat and other multi-spectral remote sensing products need to be paired with land parcel and ownership information.
Participants	Farmers and land managers.

Additional Use Case Ideas for Agriculture and Land Use Focus Area

The Agriculture and Land Use Focus Area Group determined other potential ideas for future use cases, but didn't have the time to fully develop them during the workshop. These ideas included:

1. Carbon and Biodiversity Market Quantification
2. Nutrient Loading
3. Mining Discharge
4. Sediment Loading
5. Metals in Water
6. Stocking Rates (Cattle)

Focus Area E: Water Infrastructure

Facilitator: Jeff Irvin
SME: Cathleen Jones

Participants:

Participant Name	Role/Organization
Terrance Paukei	Kiowa Tribe
James Decker	Oklahoma Water Resources Board
Billy Hix	Cherokee Nation
Jon Dawson	120Water/Cherokee Nation

Use Case E-1: Impact of Subsidence on Infrastructure on Tribal and Rural Lands

Unknown areas of land subsidence may contribute to localized flooding and infrastructure damage. A plan for short- and long-term actions is needed to mitigate future impacts.

Use Case Element	Description
Current State or Water Management Challenge	Areas of localized flooding, pipeline leakage, and road degradation are potentially traceable to land subsidence. The areas experiencing land subsidence are unknown. This prevents development of remediation measures to address the damage, including planning to address further subsidence and measures to reduce future subsidence.
Desired Result(s)	1. Develop a plan for short- and long-term actions to reduce future infrastructure damages from subsidence.

Use Case Element	Description
Need/Gap	Historical, present, and estimated future land elevation changes are unknown. Structures potentially impacted by land elevation change are not identified.
Information requirements	● Historical, current, and future land elevation and land elevation change, at a spatial scale from 40-160 acres ● Data at least seasonally, with monthly or less desired
Partner Potential	Potential Partners include: ● OK DEQ ● Indian Health Services ● Bureau of Indian Affairs ● Tribal agencies to include those responsible for public works, water, environment, and health ● Bureau of Land Management ● USGS
Affected area or community	Tribal and rural lands
Description/Decision Context	Tribal and rural governments need to determine actions to take to address ongoing infrastructure damage and community impact from subsidence and flooding associated with subsidence. Better information and insights can support requests for funding from responsible parties.
Obstacles to addressing the need	Lack of expertise to access and use remote sensing data; lack of funds to plan for the usage of the data and development of short- and long-term remedial actions to reduce damages.
Current Workflow	The issue of subsidence is not currently being addressed.
Potential Data Sources	Synthetic Aperture Data: Historical SAR from open sources, particularly Sentinel-1. Current & future data from Sentinel-1 and NISAR.
Participants	Tribal nations and local impacted communities.

Use Case E-2: Failures of Wastewater Infrastructure Leading to Unpermitted Discharges into Streams

Wastewater infrastructure failures in tribal communities have caused unpermitted discharges into local water bodies, with no system for local health authorities to assess these issues, hindering early detection and remediation.

Use Case Element	Description
Current State or Water Management Challenge	Selected tribal communities have experienced failure of wastewater infrastructure in local water treatment plants leading to unpermitted discharge into local streams, lakes, and drainage conveyance. There is no current system for the local health authority to characterize such failures.
Desired Result(s)	1. Failures are identified earlier, and remediation can be implemented thoroughly.

Use Case Element	Description
Need/Gap	The duration, location, severity, and impact area of releases into streams are currently unknown.
Information requirements	Needed information includes: • Quantify initial release time, duration, and quantity of the releases into water bodies and the extent of the impact (space and time). • Event specific; request information from community. • Spatial requirements = as high as possible, image streams. Could use types of vegetation or soil moisture. • GIS compatible format and user-specified content/visualization. Input into ESRI which will make use within GIS toolkits much easier to use. • Classification based on user-input calibration and validation data.
Partner Potential	Potential partners include: • Tribal Nations • EPA • OK DEQ • Indian Health Services • County public works and health agencies
Affected area or community	Areas affected include communities along streams, lakes, riparian corridors.
Description/Decision Context	Issue health and safety notifications, determine areas to sample water and soils, provide information to enforcement agencies for remediation/fines.
Obstacles to addressing the need	• Funding for upkeep of aging infrastructure • Design and construction of new facilities
Current Workflow	Word of mouth, citizen complaints, very rarely from reports from operators. Notify the state agency to launch an investigation. Same actions as noted under Decisions but not as targeted.
Potential Data Sources	Hyperspectral Sentinel-2 for water color and vegetation type. Maybe SAR for soil moisture and detection of leakage/seepage.
Participants	Cities, state agencies with water quality responsibilities, EPA, etc.

Use Case E-3: Watershed Hydrology Information for Infrastructure Needs Assessment

Future water infrastructure planning is needed for addressing climate change impacts, but information is often lacking for tribal and rural areas, leaving existing system capacities unclear. Assessing current water supply sustainability is essential for forecasting future needs.

Use Case Element	Description
Current State or Water Management Challenge	Prioritizing future water infrastructure planning is essential, particularly regarding storage and water availability in the context of climate change. However, information is often lacking for tribal and rural areas, and the capacity of existing systems remains unclear.

Use Case Element	Description
Desired Result(s)	1. Identify sustainability of current water supplies and extrapolation to meet future needs
Need/Gap	Planning is hampered by the lack of historical data on lake levels and streamflow, and in many instances major data gaps in less populated parts of the basin. Temporal and spatial resolution of data is lacking for rigorous statistical analysis of both trends and extremes.
Information requirements	Needed information includes: ● Soil moisture for modeling at (Cherokee) 20-100 acres, (Kiowa) 40-160 acres ● Lake water surface elevation from water extent plus existing DEM (10 cm accuracy) from the state ● Lake surface elevation (e.g., SWOT) with 10-25 cm uncertainty is usable ● Water extent on the lakes/reservoirs to 1 m is needed for dam/reservoirs, upper limit of usable resolution is a topic of study (would do cross calibration with water gauges in the lakes)
Partner Potential	Potential partners include: ● OWRB ● USACE ● USBR ● USDA-NRCS ● Tribal water agencies
Affected area or community	This can affect areas across the entire AWR River Basin.
Description/Decision Context	Water availability information is needed for community planners, drainage designers, water supply managers, water users, etc.
Obstacles to addressing the need	Obstacles to addressing the needs include funding and gauging.
Current Workflow	Assessments of water availability are sometimes based on models that are in turn built on a paucity of data. Remote sensing data products could be used to improve assessments of water availability in real time, but also to monitor trends and help determine the impacts of development and climate change.
Potential Data Sources	SWOT and similar data products.
Participants	See list of potential partners above.

Use Case E-4: Information Needs for Dam Risk Assessment, Flood Emergency Planning, and Flood Response

Risk assessments for small and medium-sized dams are limited by insufficient data, hindering storm preparedness and post-flood assessments. Improved data collection is essential for better risk assessment and maintenance planning.

Use Case Element	Description
Current State or Water Management Challenge	Current dam and dam infrastructure (spillways) risk assessment for selected small/medium sized dams (typically less than 40 feet hydraulic height) is impaired by lack of current structure, watershed, and hydrologic information. Planning for potential infrastructure damage due to storms is potentially inhibited by a lack of information and training. Post-flood damage assessments are similarly not efficiently performed due to lack of information and training. In some instances, due to development, low hazard dams should be reclassified as high hazard dams and require regular inspections.
Desired Result(s)	1. Improved small/medium dam risk assessments from expanded dam-specific datasets 2. Improved planning for dam inspections/condition assessments 3. Improved planning for impending storms and improved post-flood response to address damages/heightened flood risk 4. Determine long term maintenance needs
Need/Gap	Selected small/medium dams lack elevation-storage-discharge information and structure stability assessments. Available impending storm data for small/medium dams is not considered in dam owner planning for pre-storm and post-storm response. Information on subsidence, seepage, and vegetation in the vicinity of structures is also needed.
Information requirements	Information needed for a large number of small/medium dams includes: ● Current elevation-storage-discharge information ● Pre-storm reservoir elevation ● Pre-storm watershed antecedent runoff condition, and post storm watershed reservoir elevation ● Vegetation cover ● Subsidence/movement ● Evidence of seepage
Partner Potential	Potential partners include: ● NRCS ● USGS ● Local water purveyors ● USACE ● USBR ● Tribes ● County emergency managers ● State office of dam safety (OWRB)
Affected area or community	Affected areas include dams and reservoirs in rural areas.
Description/Decision Context	Many small and medium size dams across the U.S. have questionable flood retention capability, and their ability to retain floodwater is not known or is questionable. State agencies, who have dam safety programs, have limited resources for inspecting all these dams. Remote sensing would help identify where some of the problems exist.

Use Case Element	Description
Obstacles to addressing the need	Many of these structures are on private land where landowner approval would be required to access the site, after identifying a problem from remote sensing data.
Current Workflow	The state agencies have dam safety programs, but these programs are poorly funded and rely on third parties for inspections of high hazard dams. Post-event inspections rarely take place unless there was a failure of the structure and/or significant flood damage occurred.
Potential Data Sources	Each state has a dam safety program with a database of small and medium-sized dams. Satellite visual imagery and multi-spectral imagery could be used to identify some of the issues described above. Additional datasets include as-built drawings, rating curves, LiDAR, etc.
Participants	This should be conducted in coordination with state dam safety programs and/or flood control districts.

Use Case E-5: Stream-Related Risks to Infrastructure

Water lines and bridges have become increasingly washed-out during floods over the past decade, necessitating improved monitoring and risk evaluation of critical infrastructure.

Use Case Element	Description
Current State or Water Management Challenge	In recent years, water lines with pipe diameters of 6", 12", and 24" have been washed out more frequently during floods. Similarly, bridges have also been more prone to washouts during flooding events, with both occurrences becoming increasingly common over the past decade. The challenge is to identify and monitor critical water supply pipelines and transportation infrastructure post-flood and to evaluate the risk pre-flood.
Desired Result(s)	1. Replace at-risk waterlines as needed and better plan for their maintenance. 2. Systemic and synoptic monitoring of infrastructure along streams.
Need/Gap	Need/gaps include: ● Identify significant public water systems' utility stream crossings and bridges and assess their vulnerability to wash out during floods. ● Assess the stability of areas around the junctions, particularly the stream banks. ● Identify significant movement of channels.
Information requirements	Information requirements include: ● Image stream banks at1 m spatial resolution, both post flood and monthly for planning purposes ● Use lower resolution for movement of channels, including historical trends

Use Case Element	Description
	• Determine ground stability around significant pipeline (sole source water for a community) and critical routes (bridge locations)
Partner Potential	Potential partners include: • OWRB • TWDB • Water providers • County road departments • FEMA • County emergency response organizations • Local water districts • Public water systems
Affected area or community	Affected areas include tribal and rural lands.
Description/Decision Context	Need to prioritize locations where the water and wastewater lines that cross streams are in danger of washing out. No coordinated process or program for doing this exists.
Obstacles to addressing the need	The availability of good GIS data on pipelines, including depth, may be limited. Some of these pipelines are 50 years old.
Current Workflow	Presently, problems are addressed when they occur, and often not proactively. When a water line is washed out, emergency crews respond to make repairs, but the process takes time and cannot be completed overnight. During this period, the community must rely on alternative water sources, if available. This issue is more common with smaller, older water lines, while larger lines tend to be newer and buried deeper, making them less vulnerable.
Potential Data Sources	Water and wastewater service providers will have most of the pipeline data. Remote sensing data should be used to look at the historical migration of rivers and to forecast where problems will likely occur in the future.
Participants	Cities, emergency managers, water providers, river authorities, etc.

Additional Water Infrastructure Use Case Ideas

The Water Infrastructure Focus Area Group determined other potential ideas for future use cases, but there was not time to develop these use cases during the workshop. These ideas included:

1. Cyanobacterial blooms
2. Water usage and contamination of groundwater from oil/gas production
3. Pipeline leak detection
4. Pipeline mapping
5. Well water supply and rehabilitation

Focus Area F: Hydroclimate Extremes

Facilitator: Adrienne Wooten|
SME: Stephanie Granger

Participants:

Participant Name	Role/Organization
Ephraim Kelley	Kiowa Tribe
Joel Lisonbee	NOAA / NIIDIS / CIRES

Use Case F-1: Identification of Available Water Supply Under all Climatic Conditions (including hydrologic extremes)

Enhanced monitoring of surface and groundwater is needed amid increasing droughts and floods from climate change. Remote sensing can improve data resolution and support the creation of a comprehensive water account at tribal, watershed, and state levels.

Use Case Element	Description
Current State or Water Management Challenge	It is a challenge to determine available water, there is incomplete data for the basin. Groundwater: Need to determine available groundwater, the Arbuckle-Simpson aquifer is complicated. GRACE is a good data source, but the spatial resolution may be too coarse for smaller, more complex aquifers such as the Arbuckle-Simpson. There is a need for improved methods to capture changes in groundwater supply, especially by making data more comprehensive to include smaller aquifers in Oklahoma. Aquifer maps from the USGS Water Science Center could be a valuable resource in this effort. Surface water: USACE provides water surface elevation water supply for their reservoirs, but they are missing some reservoirs. USGS oversees some reservoirs, the OWRB program also has some reservoirs. Data is collected, but it is scattered. Various data sources to determine available water supply are fragmented between many groups. USGS – are adding new streamflow gauges in partnership with local sponsors (NSIP program) The NOAA National Water Model is going to provide information between gauges, it will be including data from SMAP and USGS lake gauges.

Use Case Element	Description
Desired Result(s)	1. Data combined in one tool to better identify the water supply that is available in different parts of the region. 2. Create and maintain a water account (balance?) at Tribal, watershed and state levels.
Need/Gap	Identified needs and gaps include the lack of information on smaller or more complex aquifers, as well as areas without current measurements of streamflow, lakes, and reservoirs.
Information requirements	Information requirements include: Basin-wide data ● Daily data is preferred.
Partner Potential	Potential partners include: ● Internet of Water ● USGS ● NASA ● NOAA Water Office, NOAA/NIDIS ● USACE ● States, communities, Tribes, universities (University of Alabama) with measurements
Affected area or community	The effects could be basin wide and could also affect tribal nations within the AWR River Basin.
Description/Decision Context	There is a need for better monitoring of surface water and groundwater. Climate change is bringing more severe droughts and more severe floods. We need to understand the magnitude of these to better project future conditions. Remote sensing is well-poised to help improve both temporal and spatial resolution of existing monitoring networks.
Obstacles to addressing the need	Accuracy of the remote sensing products may be an obstacle. This is being investigated in the Rio Grande basin.
Current Workflow	Water managers use a fairly limited number of in situ sensors to monitor water levels, providing their end users with updates on the severity of droughts and warnings on impending floods.
Potential Data Sources	Potential data sources include: ● GRACE changes in water by satellite ● USGS Water Science Center has aquifer maps ● USGS Streamflow gauges ○ Adding new gauges in partnership ● NOAA national water model to provide information between gauges ● SMAP mission for water in the area ● For surface water extent, SWOT data or the OPERA Dynamic Surface Water eXtent (DSWx) built with Sentinel 1, 2, Landsat. ● USGS has lake gauges
Participants	State agencies, river authorities and Tribes would be very interested.

Use Case F-2: Rapid Detection of Drought and Drought Impacts

Current drought indices are limited in assessing drought conditions and impacts. There is a need for improved indicators that identify drought onset, incorporate soil classification, and enhance seasonal forecasts of drought and soil moisture.

Use Case Element	Description
Current State or Water Management Challenge	Drought impacts are being detected after they happen with NDVI, among others, with some exceptions. Existing tool: Evaporative Demand Drought Index (EDDI). Many drought indices are not helpful in describing the current state of drought and identifying the impacts of drought. The U.S. Drought Monitor includes impacts, but it can lag by a week or more. It uses data but also relies on human input and is a snapshot of an instant in time. Existing satellite data are spatially continuous but provide limited soil moisture depth. Existing observations are spatially discontinuous, but continuous in time and multi-depth. General projected changes of soil moisture and evapotranspiration under climate change can be found here, but these projections need to be improved in order to improve drought forecasting. :https://nca2023.globalchange.gov/chapter/4/ Seasonal forecasts are useful for drought forecasting but lack the ability to influence big decisions (e.g. crop type). Precipitation effectiveness – monitor how much rain is absorbed versus runs off. Soil Web Survey contains inaccuracies. Grass-Cast is a tool only available for points in the Western U.S., and therefore the western portion of the AWR Basin. (Northern Plain USDA Hub): https://grasscast.unl.edu/
Desired Result(s)	1. Improved drought indicators that can identify the start of a drought, incorporate soil classification, and show soil health and the absorption of water 2. No "new" or unconventional drought indices. 3. Improved seasonal forecasts of drought and soil moisture.
Need/Gap	Data needs and gaps include: • Streamflow data • Reservoir storage • Identification of soil moisture trends ahead of droughts, including flash droughts, long droughts, and aridification • Surface soil moisture vs. root zone soil moisture

Use Case Element	Description
	• Forecasting soil moisture changes and using it to forecast drought • Soil moisture deficit • Soil type information • Forecasting drought • Stock pond levels or extents, can be used as early indicator • Direct measures of photosynthetic capacity of plants, such as solar-induced fluorescence (SIF) for plant stress • Monitoring of drought development
Information requirements	Information requirements include: • Soil moisture trend differentials, preferably at the root zone • Cross-basin soil moisture trends • Daily soil moisture trends (ability to aggregate to coarser temporal resolution) • Achieve the finest resolution possible (at least county level resolution)
Partner Potential	Possible partners include: • State Mesonets • NOAA stations • Local ranchers and farmers • Tribal nations • Northern Plains Hub • NIDIS (National Coordinated Soil Moisture Monitoring Network) • NEON • NOAA/Climate Prediction Center
Affected area or community	The effect can be basin wide.
Description/Decision Context	NIDIS as a potential provider.
Obstacles to addressing the need	Obstacles include: • Funding • Research to answer fundamental questions regarding soil moisture trends related to drought • Difficult to calculate supply vs. Demand • Research needed to translate surface soil moisture to root zone soil moisture • Lack of clarity over usefulness of fluorescent and stock ponds to identify drought
Current Workflow	Droughts are typically identified too late for useful decision-making. Once a reservoir is empty it is too late to conserve. Drought indicators are used across the basin for a variety of purposes – they just need to be better!
Potential Data Sources	Potential data sources include optical, radar, and SIF.
Participants	NOAA-NIDIS, SCCASC, and others.

Use Case F-3: Drought-Flood Whiplash Likelihood and Area Identification

The absence of a standard definition for drought and flood whiplash hinders effective planning. Users need vulnerability assessments to identify resilient areas and better climatology and land use data to understand whiplash events.

Use Case Element	Description
Current State or Water Management Challenge	There is no standard definition of drought and flood whiplash, but people need information about these types of events for planning purposes. Whiplash is a known issue, but it's very difficult to define and plan for. Existing data focuses on drought or flood independently, but not on compound events (e.g. flood to drought, drought to flood, flood to drought to flood, drought to flood to drought, or floods within ongoing drought conditions). Areas experiencing extreme drought are more vulnerable to flooding because the lack of vegetation leads to faster runoff and increased erosion when rain does occur. Similarly, regions that have recently gone through a prolonged wet period are more susceptible to drought effects, as the resulting increase in vegetation becomes dry and are more prone to fire.
Desired Result(s)	1. The ability to identify areas that are less resilient to a whiplash event. End users would like the ability to establish management, planning, and resource allocation for assistance. They would like to identify areas that are able to absorb the shock of the event. This could be done by conducting vulnerability assessments. 2. The ability to identify when and where whiplash is more or less likely to occur. Climatologies can be used to determine the typical time between opposite hydroclimate extremes.
Need/Gap	Gaps include the need for combined flood and drought information and the need for improved land use/land cover mapping.
Information requirements	• Information requirements include climatology of whiplashes of various types. • Standard rate of change from wet to dry and dry to wet • Time of year with the greatest rate of change.
Partner Potential	Partner potential depends on the applications and beneficiaries. Possible partners include: • Natural Hazards Center – University of Colorado Boulder • NIDIS • Oka Institute • Climate Adaptation Science Centers • Tribal Nations
Affected area or community	The effect of whiplash events can be basin wide and can affect the following: • Fire managers • Agriculture, ranchers • Infrastructure (reservoirs)

Use Case Element	Description
	• Ecologists, natural resource management
Description/Decision Context	At present this phenomenon does not appear to be a priority for emergency managers, but it would be useful information.
Obstacles to addressing the need	There is a lack of both a formal definition and climatology information regarding "whiplash". The definition may be different based on the need of the sector (time scales of information – e.g., reservoir managers (need data sooner) vs farmers (less temporal constraint). There may be a need to develop a new tool for analysis, and a plan to communicate whiplash to users.
Current Workflow	Current assessments of vulnerability to, and the consequences of, floods and droughts typically do not account for the broader impacts of past hydro-climatology on the region, aside from factors like water levels in lakes and antecedent conditions. Whiplash potentially could, and perhaps should, be part of the risk assessment of every watershed.
Potential Data Sources	Landsat, SWOT, multispectral imagery, etc.
Participants	FEMA and emergency managers.

Additional Hydroclimate Extreme Use Case Ideas

The Hydroclimate Extremes Focus Area Group came up with other potential ideas for future use cases that they were unable to develop during the workshop. Those included:

1. Identifying increased fire risk from drought.
2. Identifying water quality changes under drought and flood conditions.
3. Identifying sediment flow changes under drought and flood conditions.

Original Use Cases Combined Above:

Because use case A-2 and B-3 were so similar, they were combined into one use case noted as A-2 above. Below are the A-2 and B-3 in their original form.

Original Use Case A-2: Aquifer Recharge

Use Case Element	Description
Current State or Water Management Challenge	Ground water withdrawal permit decisions are based on outdated data and policies. Very little information is known about critical water recharge zones (where recharge rates are potentially larger). The U.S. Environmental Protection Agency has designated the Arbuckle-Simpson Aquifer's (ASA) eastern portion as a Sole Source Aquifer, a mechanism to protect drinking water supplies in areas with limited water supply alternatives. The ASA is also part of both the Chickasaw and Choctaw Nation treaty area.

Use Case Element	Description
Desired Result(s)	1. Groundwater recharge impact would be minimized because users would have more information related to water recharge zones 2. Users could better track groundwater recharge 3. Allocation could be based on analysis of the availability of groundwater, the recharge rate, the recharge zones. What becomes recharged, what becomes surface water 4. Land development, industrial development, tribal water sovereignty, sustainability, cultural and ecological conservations
Need/Gap	Know where the recharge rate is high (soil condition, percolation, rainfall distribution, and geomorphology).
Information requirements	Needed information includes: • Rainfall, terrain • Surface hydrology • Soil condition (soil moisture, infiltration capacity) • Land management • Industry development • Evapotranspiration
Partner Potential	Potential partners include: • USGS • EPA • OSU • OU • OWRB • Oka Institute • Chickasaw Nation • Choctaw Nation of Oklahoma • NASA • USDA • Energy • Environmental NGO • Non-profits (e.g. NEON) • Municipalities
Affected area or community	The Arbuckle-Simpson aquifer, which underlies more than 500 square miles in south central Oklahoma, is the principal water source for approximately 39,000 people in Ada, Sulphur, and others in the region. The aquifer is also the source of several important springs in the region, including Byrds Mill Spring, Ada's primary drinking water source, and those in the Chickasaw National Recreation Area, the destination for approximately 3.4 million visitors each year.
Description/Decision Context	Groundwater recharge is notoriously difficult to estimate but is crucially important to the water balance, which in turn governs spring flow and

Use Case Element	Description
	regulations related to use. A better understanding of recharge rates would help water managers make more informed decisions and regulations related to management of the aquifer.
Obstacles to addressing the need	The GRACE product has a very coarse scale – it may not be suitable for a complex aquifer like the ASA. However, downscaling techniques are promising. Other measurements such as soil moisture and precipitation are directly related to recharge and may work as a surrogate. There would be a lot of enthusiasm (and partners) for this project!
Current Workflow	Aquifer recharge rate is typically back calculated from known or estimated water use and spring flow data. However, these estimates are poor. The current ASA groundwater model is about to be refined and any more information on recharge rates would be very valuable.
Potential Data Sources	● GPM-IMERG ● WLDAS ● DEM (SRTM, TanDEM) ● Land Cover and Land Use data (Landsat, MODIS) ● Soil Condition: Texture, composition
Participants	Chickasaw Nation, USGS, OWRB, mining companies (possibly), Oka Institute, EPA Kerr Lab, OSU, and others.

Original Use Case B-3: Improving Estimates of Natural Groundwater Recharge

Use Case Element	Description
Current State or Water Management Challenge	Groundwater recharge is part of the groundwater balance models that inform permitting for withdrawals. Recharge cannot currently be measured directly. All current models rely on 1 km Daymet precipitation data (based on weather station interpolation) as an input. This precipitation data might be missing local-scale precipitation events. Soil type, land cover, and evapotranspiration data are also inputs. The evapotranspiration data need improvement and are based on interpolation. More detail is needed. Soil type data are coarse, and assumptions about the relationships between soil type and hydrologic conductivity could be improved. Soil moisture is considered as well, but not as a direct input (either from in situ or EO data).
Desired Result(s)	● More accurate reporting on the groundwater budget ● Better informed groundwater withdrawal quantity permitting
Need/Gap	Accurate estimates of natural groundwater recharge
Information requirements	Needed information includes: ● Temporal extent: 30 years to present ● Temporal resolution: Annual at a minimum; monthly would be great ● Spatial extent: Regional based on the extent of the large relevant unconfined aquifers ● Spatial resolution: 1 km ● Accuracy: Aquifer-dependent, likely on the order of feet (vertical) ● Latency: <1 year

Use Case Element	Description
	• Data formats: NetCDF, ASCII
Partner Potential	Potential partners include: • US Geological Survey • Oklahoma Water Resources Board • Texas Water Development Board • US Bureau of Reclamation • US Army Corps of Engineers
Affected area or community	The affected area includes Oklahoma and Texas.
Description/Decision Context	The Oklahoma Water Resources Board issues permits for landowner groundwater withdrawals.
Obstacles to addressing the need	It is currently impossible to directly measure recharge, and estimating runoff is difficult. Identifying sensitive areas for recharge might create tension around land ownership and management.
Current Workflow	Identifying workload is currently difficult due to the obstacles to addressing the need.
Potential Data Sources	• Evapotranspiration products (OpenET may be useful) • SMAP • NISAR • Landcover and vegetation types
Participants	• Tribes—interested parties • Agricultural communities • Irrigation districts • Groundwater conservation districts

Report Review Process

In preparing this Needs Assessment Report, WWAO took the following approach. Initially, HDR and Aqua Strategies collaborated to create the first draft, integrating the use cases developed during the workshop and submitted by facilitators and subject matter experts. Subsequently, the draft underwent review by the WWAO Engagement Lead and WWAO Program Manager, who provided revisions to enhance its clarity and substance.

After these revisions, the revised draft was distributed to all workshop participants, subject matter experts, and facilitators, encouraging them to review the entire document or concentrate on the use cases they had contributed to in their breakout groups. This approach allowed participants to enhance and refine the use case descriptions while maintaining active engagement with the workshop's outcomes.

Furthermore, NASA WWAO consulted with the leaders of two other NASA initiatives—NASA Acres (focused on agriculture) and NASA FireSense (focused on wildfire management)—recognizing the significant relevance of water use cases to both programs. This outreach enabled WWAO to gather valuable insights from Acres and FireSense. Consequently, their constructive feedback was integrated, leading to the inclusion of an additional groundwater use case from the NASA Acres initiative, specifically use case B-5, which is detailed in the Groundwater section of this report.

Summary and Conclusions

Use Case Development

The NASA WWAO Arkansas-White-Red (AWR) River Basin Needs Assessment Workshop took place in person in June 2024. This report provides an overview of the AWR River Basin along with a summary of the workshop and its outcomes. During the workshop, practitioner participants collaborated to identify key water management needs and develop detailed use cases to describe these needs. After the workshop, the report was shared with all participants for review, resulting in approximately 32 comments from reviewers.

The workshop's overarching goals were to:

- Discuss data needs and information gaps in the AWR River Basin.
- Develop use case scenarios for the basin.
- Identify opportunities where remote sensing data could complement existing systems and facilitate key water management decisions.

During the workshop, six breakout groups were formed, each focused on a distinct area of water management. Participants had the flexibility to join a different group for one working session, allowing them to contribute to a broader range of use cases. This structure, which combined large group discussions with smaller, more focused sessions, enabled attendees to develop well-considered use cases and prioritize them based on their importance.

Participants collaborated on focus areas associated with:

- Watershed health
- Groundwater
- Surface water and water quality
- Agriculture and land use
- Water infrastructure
- Hydroclimate extremes

During the workshop, a total of 26 use cases were initially developed. Subsequently, two use cases were merged, and an additional use case was included through collaboration with NASA's Acres Initiative, resulting in a final count of 26 use cases. Throughout the sessions, several prevalent themes emerged, with a significant focus on water supply issues, particularly concerning groundwater monitoring, recharge processes, and balancing surface water requirements within basins. Water quality monitoring also emerged as a recurring topic across the various focus areas, underscoring its vital role in effective regional water resource management across the basin.

Participant Feedback

Participants enthusiastically rated the workshop, averaging 4.7 out of 5 in their post-event evaluations. They lauded multiple aspects including the venue, event platform, speakers, session quality, number and timing of sessions. The well-balanced breaks, structured workshop format, and effective time management were also highlighted for praise. Many participants valued the chance to collaborate with both NASA subject matter experts and representatives from a variety of agencies and organizations, appreciating the environment designed to encourage idea-sharing. Tribal participants specifically appreciated reduced financial barriers that facilitated their participation.

One of the most frequently suggested improvements for future workshops was to increase practitioner representation. Participants expressed a desire for greater involvement from researchers and professionals across a variety of economic sectors. There was also a call for more balanced representation from across the AWR River Basin, with some attendees noting an overrepresentation of Oklahoma and a heavy focus on karst aquifers in discussions. The geographic location of Oklahoma City, where the workshop was held, may have contributed to this imbalance by potentially limiting participation from other parts of the basin. While WWAO made efforts to invite a broad range of participants, this feedback emphasizes the importance of striving for more range in representation in future workshops.

Furthermore, many participants emphasized the need for more advanced notice of future workshops to facilitate better planning and participation. While thirty-five practitioners attended the in-person event, it was noted that Texas, the largest state in the watershed, was notably absent, potentially affecting the development of use cases. Hosting another workshop in a different location within the basin could help gather input from water managers in regions unable to travel to Oklahoma City, promoting broader participation. Overall, most participants expressed keen interest in ongoing collaboration with NASA and its Western Water Applications Office (WWAO).

Another common suggestion, voiced both during the workshop and in the subsequent report review period, was the need for increased outreach to support the development of use cases, coupled with additional background information on NASA's capabilities. Offering more resources could facilitate better collaboration between scientists and practitioners focused on water issues. Although NASA WWAO has previously been asked for project one-pagers or similar resources, there has been hesitation to provide such documents before workshops to avoid potentially stifling participants' creativity and brainstorming.

In response to feedback, HDR and Aqua Strategies explored the idea of developing a guide that outlines various NASA datasets and programs in a format accessible to water managers and resource planners. This guide, shared before workshops, would aim to prompt participants to consider potential use cases or applications in advance of the workshop. Providing a brief overview of these resources during the workshop could also assist non-technical staff in understanding their relevance. Additionally, such a document could serve as a long-term resource for WWAO staff presentations, websites, and other materials.

References

i) SECURE Water Act Section 9503(c) Report to Congress, Chapter 10: Other Western River Basins. US Department of the Interior, Bureau of Reclamation. March 2016. https://americaswatershed.org/reportcard/the-basins/arkansas-river-and-red-river/

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iii) PRISM Climate Group, Oregon State U. (n.d.). Prism.oregonstate.edu. https://prism.oregonstate.edu/normals/

NASA Western Water Applications Office
wwao.jpl.nasa.gov