National Aeronautics and
Space Administration

NASA
WESTERN WATER
ACTION OFFICE

Great Basin
Needs Assessment Report

Tools for managing a precious resource

January 2026

Executive Summary

NASA's Western Water Action Office (WWAO) works to improve water management in the arid western United States by getting NASA science, data, and technology into the hands of water managers and decision makers. This **Great Basin Needs Assessment Report** documents a basin characterization and a practitioner-focused needs assessment workshop intended to surface the most pressing water-management challenges in the Great Basin—and to translate them into actionable Use Cases that can inform future partnerships and potential project opportunities that leverage NASA's Earth Observation data, science and technology. Notably, the Great Basin marks the final basin in the series of major western river basin–focused needs assessments conducted by NASA WWAO.

The Great Basin is a ~200,000-square-mile hydrogeographic region spanning portions of Nevada, Utah, Wyoming, Oregon, Idaho, and California. It is an endorheic (closed-basin) system where precipitation evaporates, infiltrates, or flows to closed-basin (terminal) lakes, and waterways do not drain to the Gulf of Mexico or the Pacific Ocean. **Water supply in the region is highly sensitive to winter snowpack in mountain headwaters. Communities and local economies depend on capturing and storing spring snowmelt in reservoirs for use later in the year. Because the region receives relatively little precipitation, groundwater is also an important component of the water supply.** Agriculture is the predominant water-use category in the basin (over 70% of water use in Nevada and Utah), and the Great Basin faces increasing competition among agricultural, municipal, industrial, and ecological demands. At the same time, major basin features such as the Great Salt Lake have experienced dramatic decline—losing 73% of its water and 60% of its surface area since 1850—illustrating the stakes for public health, ecosystems, and regional economies.

To ground the needs assessment in on-the-ground realities, WWAO and Metropolitan Group conducted a basin characterization effort that combined public information with seventeen interviews representing federal, state, municipal, academic, nonprofit, and Tribal perspectives. Those insights informed the in-person workshop held November 4–6, 2025 in Salt Lake City, Utah, with 19 practitioner participants, 7 NASA representatives/SMEs, and 3 Metropolitan Group facilitators (supported by pre-workshop webinars). The workshop was designed to:

1. generate ~15–20 use cases
2. strengthen relationships between WWAO and Great Basin stakeholders, and
3. gather stakeholder input to improve NASA's future science endeavor.

Across interviews and workshop discussions, a consistent picture emerged: **Great Basin water management is increasingly defined by limited and shifting supplies, mounting variability and extremes, and the need for better information at the right spatial and temporal scales.** For example, stakeholders described ongoing water-availability constraints and documented groundwater declines (e.g., a reported 68.7 km³ decrease between 2002 and

2023), underscoring the challenge of balancing water supply, demand, and allocation across many competing users. Drought and longer-term aridification were repeatedly named as core challenges, complicated by poor data access, limited near–real-time availability, short records for anomalies/climatologies, and gaps in variables that are meaningful for drought decision-making.

Additional cross-cutting needs included stronger understanding of the water quantity–water quality nexus under arid conditions, heightened legal/policy contention around water rights as availability changes, and persistent information gaps in snow monitoring—especially in alpine terrain where in-situ networks are sparse and where Earth observations may help complement ground data.

While the report contains detailed use cases, their themes cluster into a practical set of decision needs that recur across sectors and geographies. Workshop participants produced use cases in five focus areas—**Hydroclimate Extremes/Variability/Risk; Groundwater–Surface Water Interactions; Agriculture/Irrigation & Water Availability/Budget; Water Infrastructure & Measurement; and Watershed Health & Water Quality**—reflecting where practitioners see the biggest gaps and opportunities for improved monitoring, forecasting, accounting, and adaptive management. These themes also intersect with emerging pressures such as expanding mineral development (e.g., water-intensive lithium mining) and associated governance challenges, which can intensify conflicts over scarce water resources.

A central finding is that remote sensing appears to be incorporated into aspects of Great Basin practice—but users want products that are more precise, more consistent, easier to integrate, and more usable. Participants described using remote sensing for water resource management and drought monitoring, evapotranspiration and soil moisture analysis, land-cover change (including wildfire impacts), snow monitoring for hydrologic modeling, and agricultural efficiency (often citing tools/datasets such as MODIS, Landsat, OpenET, and ASO alongside critical in-situ sources like SNOTEL).

Looking forward, stakeholders emphasized high-resolution, spatially and temporally consistent SWE (ideally 800 m–4 km, weekly), better characterization of snowmelt dynamics, stronger precipitation/wind/soil moisture tracking, and long-term datasets for surface and groundwater conditions—paired with improved harmonization and demonstrated accuracy so users can confidently rely on outputs in high-stakes decisions.

Overall, the Great Basin Needs Assessment met its stated objectives by convening practitioners and NASA staff to identify priority needs and develop a set of use cases across the five focus areas, while strengthening relationships and gathering actionable feedback to shape future WWAO efforts. The resulting themes provide a roadmap for where Earth Observation science, end user engagement, and partner-driven decision support could most directly improve Great Basin water management—from drought and extremes to understanding groundwater/surface water interactions, agricultural water budgeting, infrastructure measurement gaps, and watershed health challenges.

It is important to note that because federal agency expertise was limited during the workshop due to a federal government shutdown, some use cases lack detailed information on specific data characteristics needed to fully address the identified problems. However, each use case includes sufficient context to enable researchers to engage directly with end-user partners to refine and capture these details.

Finally, beyond the use cases detailed in this report, insights from pre-workshop interviews on desired remote sensing observations and data gap may reveal additional opportunities. This feedback, collected to help inform workshop planning, is summarized in the sections titled "Remote Sensing Desires" and "Gaps" of Appendix V.

What's New

The Great Basin Needs Assessment is the eighth needs assessment hosted by WWAO over the last decade, bringing new insights to the existing California, Colorado, Columbia, Rio Grande, Missouri, Arkansas/Red/White, and Snow assessments. WWAO is always looking to improve the outcome of these assessments, as well as the techniques to build them.

WWAO embraced a number of innovations along the way:

1. **Interviews -** rather than commissioning an engineering firm to conduct an internal characterization of water resource management challenges and key stakeholders in the basin, WWAO held a series of interviews with leaders across the Great Basin to inform the workshop framing and the identification of five focus areas.

2. **Participant Focused Workshop Format -** this workshop spent less time introducing participants to NASA's particular water-related capabilities, preferring instead to focus on relationship building within the workshop participants. Specifically, in previous workshops a large part of the first day was filled with "sit and get" type presentations covering WWAO's role and activities, use-case concepts, and relevant NASA missions and data. This seminar-style format took a lot of time and was not seen as valuable based on feedback received from previous workshops..

   To encourage dialog between the participants and NASA staff, the format was switched to a "gallery walk" where NASA SMEs stood at stations and discussed different themes of NASA capabilities to small groups of participants, who rotated between the stations. This took under an hour and led to more conversation among the NASA SMEs and participants.

3. **Brainstorming Use Cases on Day One** - with the time saved on presentations, the participants were randomly selected to form breakout groups and went through a round of Use Case brainstorming connected to the five focus areas. This activity allowed for each attendee to participate in two different focus area discussions, as well as evaluate all of the brainstormed ideas in a quick gallery walk review session. These use case brainstorms were a critical piece to jumpstarting the use case creation on day two.

4. **Headline Writing -** in order to help NASA understand how real change comes about in the Great Basin, participants were asked to imagine how one of the Use Cases might actually be pursued and achieved in the specific context of the Great Basin. Though the results of this activity varied, it did give the participants a way to consider the elements of success beyond NASA delivering the needed data for a successful Use Case.

5. **Identification of "Low-Hanging Fruit" -** as part of the post-workshop process, the NASA SMEs and facilitators met virtually to assess which use cases could be considered "low-hanging fruit," e.g. high impact projects that would be relatively easy for NASA to implement. The group mapped each use case by level of impact and ease for NASA to implement, and through this process 7 of the 17 use cases rose to the top as potentially low-hanging fruit:
    - Flood Risk Characterization and Prediction (Use Case A-2)
    - Impacts of Drying of Terminal Lakes, Dust, Air Quality, and Albedo (A-3)
    - Balancing water supply and use by humans and nature (B-1)
    - Irrigation, agriculture, and their interface with surface and groundwater (B-2)
    - Water Budget for Irrigation Water Suppliers (C-4)
    - Understanding Changing Snowpack and SWE to locate new resilience efforts like reservoirs (D-3)

Challenges

The Great Basin Needs Assessment Workshop took place during the 2025 federal government shutdown which was caused by a lapse in appropriations. Consequently, federal agencies that would normally participate were largely unrepresented among attendees, except for one participant from NOAA NIDIS who attended through a dual affiliation. This absence was particularly consequential given that land and water resources in the Great Basin are managed predominantly by federal agencies, including the Bureau of Land Management, U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Reclamation, National Park Service, and multiple Department of Defense sub-agencies. These organizations represent a critical constituency of end users within the Great Basin landscape. Additionally, there were other state government agencies (e.g., Oregon Department of Water Resources) that were also unable to attend due to their own funding constraints or those connected to the lapse in federal appropriations.

While there is little substitute for the presence of these partners and end users at a workshop, this report was distributed to federal and state agency staff who had participated in the run-up to the workshop or had otherwise been engaged in the development of the Great Basin Needs Assessment. Their comments have been captured in the Use Cases and other portions of this report as appropriate.

With respect to workshop staff, personnel consisted primarily of WWAO team members from the NASA Jet Propulsion Laboratory (Caltech) and other non-NASA institutions, along with a limited number of NASA subject matter experts with dual affiliations. NASA civil servants, including those from NASA Headquarters, were unable to participate.

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List of Acronyms

- **ADAF-GIP:** Utah Department of Agriculture and Food - Grazing Improvement Program
- **AERONET:** Aerosol Robotic Network
- **AI:** Artificial Intelligence
- **API:** Application Programming Interface
- **AQ:** Air Quality
- **ASO:** Airborne Snow Observatory
- **ASR:** Aquifer Storage Recovery
- **BIA:** Bureau of Indian Affairs
- **BLM:** Bureau of Land Management
- **BoR / USBR:** United States Bureau of Reclamation
- **CBRFC:** Colorado Basin River Forecast Center
- **CFS:** Cubic Feet per Second
- **DEQ:** Department of Environmental Quality
- **DEWS:** Drought Early Warning System
- **DEM:** Digital Elevation Model
- **DoD:** Department of Defense
- **DOT:** Department of Transportation
- **DRI:** Desert Research Institute
- **DWR:** Department or Division of Water Resources (state dependent definition)
- **EDDI:** Evaporative Demand Drought Index

- **EMIT:** Earth Surface Mineral Dust Source Investigation
- **EMS:** Emergency Medical Services
- **EO:** Earth Observations
- **EPA:** Environmental Protection Agency
- **ET:** Evapotranspiration
- **FEMA:** Federal Emergency Management Agency
- **FS / USFS:** United States Forest Service
- **FWS / USFWS:** United States Fish and Wildlife Service
- **GB:** Great Basin
- **GDE:** Groundwater Dependent Ecosystem
- **GEDI:** Global Ecosystem Dynamics Investigation
- **GLDAS:** Global Land Data Assimilation System
- **GOES:** Geostationary Operational Environmental Satellite
- **GPM:** Global Precipitation Measurement
- **GRACE:** Gravity Recovery and Climate Experiment
- **GSL:** Great Salt Lake
- **HEC-HMS:** Hydrologic Engineering Center's Hydrologic Modeling System
- **HQ:** Headquarters
- **HYSPLIT:** Hybrid Single-Particle Lagrangian Integrated Trajectory
- **ICESat-2:** Ice, Cloud, and Land Elevation Satellite-2
- **InSAR:** Interferometric Synthetic Aperture Radar
- **INSTAAR:** Institute of Arctic and Alpine Research
- **JPL:** Jet Propulsion Laboratory
- **LCLU / LULC:** Land Cover Land Use / Land Use Land Cover
- **LIDAR:** Light Detection and Ranging
- **LTPBR:** Low Tech Process Based Restoration
- **MAR / FloodMAR:** Managed Aquifer Recharge / Flood Managed Aquifer Recharge
- **MG:** Metropolitan Group
- **MODIS:** Moderate Resolution Imaging Spectroradiometer
- **NAIP:** National Agriculture Imagery Program
- **NASA:** National Aeronautics and Space Administration
- **NASS:** National Agricultural Statistics Service
- **NDVI:** Normalized Difference Vegetation Index
- **NGO:** Non-Governmental Organization
- **NICENET:** Nevada Integrated Carbon and Environmental Network
- **NIDIS:** National Integrated Drought Information System
- **NIFC:** National Interagency Fire Center
- **NISAR:** NASA-ISRO Synthetic Aperture Radar
- **NLDAS:** North American Land Data Assimilation System
- **NOAA:** National Oceanic and Atmospheric Administration
- **NRCS:** Natural Resources Conservation Service

- **NSIDC:** National Snow and Ice Data Center
- **NWS:** National Weather Service
- **OPERA:** Observational Products for End-Users from Remote Sensing Analysis
- **PACE:** Plankton, Aerosol, Cloud, ocean Ecosystem
- **PM:** Particulate Matter (e.g., PM2.5, PM10)
- **PRISM:** Parameter-elevation Regressions on Independent Slopes Model
- **RAWS:** Remote Automated Weather Station
- **RFC:** River Forecast Center
- **RFI:** Request for Information
- **ROGER:** Results Oriented Grazing for Ecological Resilience
- **RS:** Remote Sensing
- **S2S:** Subseasonal-to-Seasonal
- **SAR:** Synthetic Aperture Radar
- **SBG:** Surface Biology and Geology
- **SCAN:** Soil Climate Analysis Network
- **SIF:** Solar-Induced Fluorescence
- **SLC:** Salt Lake City
- **SM:** Soil Moisture
- **SMAP:** Soil Moisture Active Passive
- **SME:** Subject Matter Expert
- **SNODAS:** Snow Data Assimilation System
- **SNOTEL:** Snow Telemetry
- **SPEI:** Standardized Precipitation Evapotranspiration Index
- **SUWA:** Southern Utah Wilderness Alliance
- **SWE:** Snow Water Equivalent
- **SWOT:** Surface Water and Ocean Topography
- **TNC:** The Nature Conservancy
- **UAVSAR:** Uninhabited Aerial Vehicle Synthetic Aperture Radar
- **USDA:** United States Department of Agriculture
- **USDM:** United States Drought Monitor
- **USGS:** United States Geological Survey
- **UX:** User Experience
- **VIIRS:** Visible Infrared Imaging Radiometer Suite
- **WaDE:** Western Water Data Exchange
- **WLDAS:** Western Land Data Assimilation System
- **WRF:** Weather Research and Forecasting
- **WWAO:** Western Water Action Office

Introduction

The mission of the National Aeronautics and Space Administration's (NASA) Western Water Action Office (WWAO)[1] is to improve how water is managed in the arid Western United States by getting NASA science, data, and technology into the hands of water managers and decision makers. In support of this mission, WWAO conducted a series of basin assessments in the Western United States, each of which highlighted unique challenges and use cases in water resource management. This report on the Great Basin will mark the culmination of this ten-year effort, having previously completed needs assessments in California, the Colorado River Basin, the Columbia River Basin, Rio Grande River Basin, Arkansas-White-Red River Basin, and the Missouri River Basin.

Metropolitan Group (MG) was tasked with assisting WWAO in this effort by helping plan and conduct a needs assessment workshop and companion pre-workshop webinars for the Great Basin. This report provides an overview of the Great Basin, a description of the pre-workshop efforts including the basin characterization study, and details the needs assessment workshop including methods, participants, and use cases developed during the event.

Description of the Great Basin

The Great Basin covers approximately 200,000 square miles, with portions contained in Nevada, Utah, Wyoming, Oregon, Idaho, and California. This hydrogeographic area is unique in that all precipitation evaporates, sinks underground, or flows into endorheic (closed-basin) lakes, most of which are saline.[2] Creeks, streams, or rivers in the Great Basin find no outlet to either the Gulf of Mexico or the Pacific Ocean. As others have stated, the name is misleading because the Great Basin is not a single basin, but actually a collection of many smaller basins, with some of the most notable draining to the Great Salt Lake in Utah or Pyramid Lake in Nevada.[3] Spatial definitions of the Great Basin vary based on hydrogeography, geology, or plant and animal communities.

Figure 1. Great Basin Map

The topography of the Great Basin consists primarily of mountain ranges that run north to south. The entire

[1] WWAO changed its name from the Western Water Applications Office to the Western Water Action Office in early 2025. Previous basin assessment reports refer to WWAO by that name.
[2] https://www.nps.gov/grba/planyourvisit/the-great-basin.htm
[3] *ibid.*

basin sits in the rain shadow of the Sierra Nevada and Cascade ranges and receives most of its sparse precipitation in the form of snow in the winter in the mountains.[4] Plant and animal life in the Great Basin varies widely based on factors such as elevation and persistence of water on the landscape.[5] The Basin has some of the richest ore deposits on the North American continent, including gold, magnesite, barite, mercury, lithium, silver, diatomite, gemstones, beryllium ore, copper, iron ore, and molybdenum. Agriculture is a major contributor to the economy of the Great Basin; in Nevada, for example, over 50% of agriculture output is in livestock and dairy production, and over 60% of the crop output is hay and other feed crops.[6] Within Nevada, nearly $1 billion in economic activity was created in 2022 by just over 3,100 farms, which included about 5,700 individual farmers.

Precipitation across the Great Basin fluctuates from location to location, as well as year to year: many farms, cities, towns, and industries rely on the efficient use of reservoirs to capture spring snowmelt for distribution later in the year. When snow and rain are insufficient to fill those reservoirs, the impacts are felt across the basin: farm yields are reduced, groundwater aquifers recede, and water restrictions can be imposed.[7] In some ways, this cycle is not unique to the Great Basin compared to other basins in the West; however, the basin as a whole lacks a major river that acts as a "floor" for water supply such as the Colorado, Columbia, or Missouri.

Groundwater aquifers also play a critical role in the region's water supply, buffering surface water shortages, supporting economic production in a water-limited environment, and sustaining unique ecosystems and species.

Water Uses in the Great Basin

Agriculture is the predominant water use category in the Great Basin, accounting for over 70% of water use in Nevada and Utah.[8] As noted above, while the overall agricultural market skews towards raising livestock, most water use in agriculture is associated with growing crops for livestock production, such as alfalfa.[9] Public water supply consumption is not a major factor in Great Basin water use. Major population centers on the basin's periphery—such as Reno and Las Vegas—obtain most of their water from sources outside the Great Basin. Salt Lake City, by contrast, relies primarily on local sources, which account for roughly 70% of its supply.

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[4] https://www.wlfw.org/western-working-lands-snapshot-the-great-basin/
[5] https://www.wlfw.org/western-working-lands-snapshot-the-great-basin/
[6] https://www.nass.usda.gov/Publications/AgCensus/2022/Online_Resources/County_Profiles/Nevada/cp99032.pdf
[7] https://www.fs.usda.gov/rm/pubs/rmrs_gtr204/rmrs_gtr204_020_023.pdf
[8] ibid.
[9] USGS, Estimated Use of Water in the United States 2015, https://pubs.usgs.gov/circ/1441/circ1441.pdf

Taking a look across all uses of water by the state of Nevada, a distinction that stands out is in the amount of surface and groundwater withdrawals. Nevada had 1.7 million acre-feet of surface water withdrawals in 2015 compared to 1.62 million acre-feet of groundwater withdrawals. This near parity stands in contrast to the United States as a whole (where around 25% of all water withdrawals were from groundwater in 2015) and comparable Western states: 23%, Idaho; 35%, Washington. New Mexico stands out as also being nearly equal in groundwater and surface water use.[10] Whether for agriculture irrigation, public supply, or mining, the amount of groundwater being used across the Great Basin is a cause of concern (and study) that cannot be ignored. This is a theme both in policy spaces and among interviewees, cited in this report.

Though not accounted for in the same way as withdrawn, diverted, and/or other managed uses of water, there are also significant ecosystem needs for water across the landscape. In general, the environmental impacts from groundwater extraction are a major concern alongside long-term sustainability of that resource in general. However, the relationship between resource use and impacts to water are not always straightforward. Dewatering of open-pit mines to allow deep mining, for example, has resulted in significant interbasin water transfers in large areas of northeastern Nevada.[11] The Great Salt Lake, in addition to providing 80% of Utah's wetlands habitat and critical flyway support for migrating birds, generates over $2.5 billion in direct economic activity value, simultaneously suppressing toxic dust and providing fertilizer minerals for food production worldwide.[12]

Water Management of the Great Basin

During discussions with interviewees and supplementary desk research, three water management issues emerged as particularly important in the Great Basin: water policies and laws; mining; and depletion of the Great Salt Lake. This does not represent an exhaustive list, but highlights key issues to be aware of for those seeking to better understand the basin.

Water Policies and Law

The Great Basin spans six states, and water rights, like in other areas of the country, are defined by a patchwork of state laws, interstate agreements, Tribal rights, and other policies.[13] All of the states utilize the prior appropriation doctrine ("first in time, first in right") or a hybrid version to determine water rights.[14] Agencies, such as the Utah Division of Water Rights within the Department of Natural Resources or the Nevada Division of Water Resources within the

[10] Data compiled from USGS, Estimated Use of Water in the United States 2015, https://pubs.usgs.gov/circ/1441/circ1441.pdf
[11] https://www.fs.usda.gov/rm/pubs/rmrs_gtr204/rmrs_gtr204_020_023.pdf
[12] https://pws.byu.edu/great-salt-lake
[13] See, for example: https://www.leg.state.nv.us/Division/Research/Documents/water-overview-2019.pdf
[14] https://www.leg.state.nv.us/Division/Research/Documents/water-overview-2019.pdf

Department of Conservation and Natural Resources, are tasked with administering water measurement, appropriation, apportionment, and distribution.[15] [16] Due to the current realities of water availability and use in the Great Basin—specifically, that many states are struggling with addressing the overallocation of finite water resources—discussions about water policies and laws have increased.[17] For example, Nevada debated multiple bills that conserve and protect water resources,[18] including one that buys back and retires unused water rights, also known as SB36.[19] That bill, along with the companion bill AB104, passed in 2025.[20] It is likely that states will continue to modify existing policies and law to address today's needs and the reality that many states have over-appropriated water rights amidst declining future water availability.

Mining[21]

As mentioned previously, the Great Basin is an incredibly mineral-rich area including high concentrations of gold, magnesite, barite, mercury, lithium, silver, diatomite, gemstones, beryllium ore, copper, iron ore, and molybdenum. Several of these minerals—particularly lithium—can require extensive water use to mine. In fact, Nevada is home to 85% of the known lithium deposits in the United States,[22] and the demand for lithium is expected to rapidly increase given that the mineral is critical in electric vehicle batteries and solar panels.[23] The growth of this industry has already created, and will continue to create, water management conflicts between various stakeholders including farmers, cities and towns, and others.[24] These water management concerns are exacerbated by the fact that there are no federal rules governing how much water any type of mine can consume.[25] As re-shoring American industrial production grows as a bipartisan priority, so too will increasing raw industrial production in places like the Great Basin, placing even greater strain on already limited water resources and intensifying tensions over how that water is allocated and regulated. Of note: In Utah, most magnesium was produced by concentrating Great Salt Lake brine into magnesium chloride. A highly polluting chemical process was then used to separate the magnesium and chlorine. Because the manufacturing site is now a Superfund site, magnesium production in Utah has ceased.

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[15] https://waterrights.utah.gov/
[16] https://water.nv.gov/about-us
[17] https://www.westernwaternotes.com/p/unwinding
[18] https://greatbasinwater.org/nv-and-ut-water-conservation-bills-to-watch-in-2025/
[19] https://thenevadaindependent.com/article/in-the-nations-driest-state-two-bills-seek-to-buy-back-and-retire-unused-water-rights
[20] https://www.nature.org/en-us/newsroom/nevada-groundwater-bills/
[21] For additional references, see:https://www.scienceforconservation.org/products/lithium; https://doi.org/10.1016/j.scitotenv.2023.168639 https://doi.org/10.1016/j.gecco.2025.e03974
[22] https://www.dri.edu/wp-content/uploads/41297_v2.pdf
[23] https://www.wri.org/insights/critical-minerals-mining-water-impacts
[24] https://naes.unr.edu/research/project.aspx?GrantID=808#
[25] https://cronkitenews.azpbs.org/howardcenter/lithium/stories/lithium-liabilities.html

Depletion of the Great Salt Lake

The Great Salt Lake—the largest saline lake in North America and a key feature of the Great Basin—has lost 73% of its water and 60% of its surface area since 1850, and currently sits approximately 19 feet below its average level.[26] [Note: The referenced study reported a lake elevation of 4,188.5 feet—the historical low for Great Salt Lake—and estimated the natural lake level (without human influence) at 4,207 feet. As of February 2026, the lake is at 4,191.8 feet, about 15 feet below the estimated natural level.] Since 2020, this decline has accelerated, with an average deficit of 1.2 million acre-feet per year. Excessive water use, compounded by the impacts of climate change, have contributed to this loss. Some advocates are concerned that without drastic shifts in how its water is managed, it could disappear completely.[27] In addition, given the Great Salt Lake's outsized impact on Utah's economy, public health, and environment, water management will be a key topic of discussion in the near and long term. While it is the largest of all the saline lakes in North America, terminal lakes are a common and important feature across the Great Basin, and the importance of managing the increasingly limited water resources that feed them has importance far beyond the Great Salt Lake.

Characterization Study

MG worked with WWAO to develop an initial characterization of water management priorities and challenges in the Great Basin using publicly available information. This characterization study was supplemented with additional information gathered through WWAO-conducted interviews with water resource users, managers, and other water practitioners representing federal, state, municipal, academic, nonprofit, and Tribal perspectives in the Great Basin. A total of seventeen discussions were conducted to establish a deeper understanding of water resources responsibilities, needs, concerns, and challenges. Through these efforts, WWAO and MG collaborated to identify a list of workshop participants that represented a broad range of perspectives across the Basin. The result of the research and interviews was an internal Characterization Study report. The characterization report was used to lay the groundwork for a needs assessment workshop for the Great Basin which was held in November 2025.

Needs Assessment Workshop

Utilizing information gathered from the basin characterization study and interviews, WWAO and MG planned the Great Basin Needs Assessment Workshop. **The goal of the workshop was to identify key water resource 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 potential future water projects aimed at addressing key needs in the basin. In

[26] See: https://pws.byu.edu/great-salt-lake
[27] https://pws.byu.edu/great-salt-lake

the past, WWAO has referenced use cases created at the Needs Assessment Workshops in subsequent Requests for Information (RFI), allowing partners and practitioners to propose solutions that utilize NASA data in addressing water-related challenges in a particular region. Though funding for such work is not certain as of publication, it does not change WWAO's ultimate goal of seeing NASA data and technology addressing these challenges.

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 60 additional water practitioners in the Great Basin. A pre-workshop webinar with approximately 30 participants took place on Thursday, October 16, 2025. 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.

An additional webinar was held on Monday, October 27, 2025 for workshop facilitators and subject matter experts (SMEs) to prepare them for their roles during the workshop, including a discussion of the agenda, workshop format, breakout group focus areas, how to capture use cases, and practical tips.

Workshop Participants, Facilitators, and SMEs

The workshop coincided with the October 1–November 12, 2025 federal government shutdown which limited the invitee list, as well as prevented attendance from some confirmed participants from federal agencies such as US Geological Survey (USGS), National Oceanic and Atmospheric Administration (NOAA), and US Department of Agriculture Natural Resources Conservation Service (USDA NRCS).

The initial stakeholder invite list included 29 participants; however, due to the shutdown and last minute conflicts, final attendance was reduced to 19 stakeholder participants. The staff included 7 NASA WWAO representatives and/or subject matter experts and 3 MG 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
Alvaro	Robledano	University of Utah	Postdoctoral Research Associate - Snow Hydrology

Amanda	Sheffield	National Oceanic and Atmospheric Administration National Integrated Drought Information System	Regional Drought Information Coordinator, California-Nevada DEWS Federal
Bjoern	Bingham	Desert Research Institute	Staff Research Scientist
Craig	Miller	Utah Division of Water Resources	Senior Engineer
Dan	McEvoy	Desert Research Institute	Associate Research Professor - Climatology
Hannah	Steele	Oregon State University, College of Earth, Ocean, and Atmospheric Sciences	Ph.D. student
Karl	Rittger	Institute of Arctic and Alpine Research, University of Colorado Boulder	Research Associate
Laura	Taylor	University of Miami, Rosenstiel School of Marine, Atmospheric, and Earth Science	Lecturer
Laurel	Saito	The Nature Conservancy	Nevada Water Strategy Director
Madeline	Greymountain	Goshute Federal Corporation	Chairperson, Board of Directors
Mark	Raleigh	Oregon State University, College of Earth, Ocean, and Atmospheric Sciences	Assistant Professor
Meng	Zhao	University of Idaho, College of Science, Department of Earth and Spatial Sciences	Assistant Professor
Peter	Stanton	Walker Basin Conservancy	Chief Executive Officer
Rick	Forster	University of Utah, School of Environment, Society & Sustainability	Professor

Sonam	Sherpa	University of Utah, School of Environment, Society & Sustainability	Assistant Professor
Tara	Shreve	Utah Geological Survey	Interferometric Synthetic Aperture Radar (InSAR) Specialist
TJ	Ramos	Goshute Federal Corporation	Board Member
Todd	Caldwell	Desert Research Institute	Associate Research Professor - Hydrology
Tony	Richards	Utah Department of Agriculture and Food	Resource Coordinator

Table 2. NASA and Metropolitan Group Staff

Organization	Name	Professional Title	Workshop Role
NASA	AJ Purdy	Senior Research Scientist, WWAO Science Team	SME
NASA	Bailing Li	Research Scientist, WWAO Science Team	Facilitator
NASA	Nikki Tulley	Impact & Transition Lead, WWAO	SME
NASA	Randy Friedl	Director, Space and Earth Science, Jet Propulsion Laboratory (JPL)	SME
NASA	Renato Frasson	Research Scientist, WWAO Science Team	SME
NASA	Sean Fleming	Program Scientist, WWAO	SME
NASA	Sharon Vasquez-Ray	Program Manager, WWAO	Facilitator
MG	Max Friedenwald-Fishman	Senior Associate	Facilitator
MG	Nick Drushella	Senior Director	Facilitator

MG	Paul Tigan	Vice President	Facilitator

Workshop Overview

The Great Basin Needs Assessment workshop was held November 4 through November 6, 2025, in Salt Lake City, Utah at the Commander's House on the University of Utah campus. The three key objectives for the workshop were as follows:

Figure 2. Workshop "Snowball Fight"

1. Generate ~15-20 use cases within identified focus areas that describe water resources needs and challenges in the Great Basin
2. Strengthen relationships between WWAO and stakeholders within the Great Basin (e.g., end users, water managers, decision makers, etc.)
3. Gather information from stakeholders to improve NASA's future science endeavor

Below are summaries of the agendas and daily activities. The workshop activities were designed based on agendas from previous basin assessments and feedback from participants at those assessments. Specifically, the workshop was designed to create more interactive engagement opportunities, build connections among attendees and with NASA WWAO staff, promote more in-person collaboration, and reduce lecture style presentations.

Figure 3. NASA Capabilities Gallery Walk

Day 1 commenced with welcome remarks and an icebreaker "snowball fight" to introduce attendees to one another. This activity involved participants pairing up based on matching terms and following a guided discussion based on a set of prompts. Attendees then formed five small groups and conducted a "gallery walk" that consisted of short poster presentations and discussions of NASA's relevant capabilities that were led by the SMEs.

Next, there was a short presentation on the needs assessment process, focus areas, and use case methodology. From background research and the interviews conducted prior to the workshop, five key water related issues emerged as dominant—these became the focus areas and were as follows:

- Hydroclimate Extremes, Variability, and Risk
- Groundwater–Surface Water Interactions
- Agriculture/Irrigation & Water Availability/Budget
- Water Infrastructure & Measurement
- Watershed Health & Water Quality

Attendees were then randomly assigned to small groups organized by focus area to brainstorm relevant water management or end user challenges, issues, or problems. Following two rounds of brainstorming, attendees conducted a gallery walk to review and discuss the generated ideas. They added dot stickers to ideas that resonated with their experience or looked particularly interesting. A full list of brainstormed ideas can be found in **Appendix I**. This activity enabled the workshop to benefit from the broad expertise of the attendees, as well as provided key fodder for full use case development on Day 2. Day 1 concluded with closing remarks, a survey where participants identified their preferences for which focus area to work in on Day 2, and a social hour.

On Day 2, attendees were welcomed back to the space, engaged in a warm-up activity, and then moved into their assigned focus area groups based on their preferences. Each group reviewed the list of brainstormed ideas with dot stickers, added additional use case ideas, and then determined which use cases to build out on large poster sheets that had been distributed to each table. The remainder of the day was spent filling in use case templates. The day concluded with closing remarks, a brief survey, group photos, and an invitation to an optional no-host social dinner at an off-site location.

Figure 4. Focus Area Group

Day 3 began with a welcome, a brief period of work time for groups to add any outstanding details to their use cases, and gallery walk to review all of the filled out poster sheets from each focus area. Attendees had an opportunity to add dot stickers to ideas that resonated with them or provide feedback on sticky notes. Next, focus areas reconvened for a headline writing exercise in which they selected one use case and followed a series of prompts based on envisioning a future in which the key challenge was resolved, the NASA data that were utilized, and the stakeholders involved. Each focus area then presented to the full group, with an opportunity for questions and answers. **Appendix II** summarizes the headline writing exercise. The workshop closed out with a brief survey and final remarks from WWAO staff.

Additional workshop photos can be found in **Appendix III**.

Below, **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 and to the best of their ability. The Use Case Template utilized in the Great Basin Needs Assessment workshop is slightly modified from previous versions of the template used at other workshops, however the information that was captured remained the same. These modifications were made to provide more clarity to participants and improve the use case buildout process.

Table 4 presents the use cases developed within each focus area, with the prioritization rankings as determined by the workshop participants in that specific area. Following Table 4, the use cases are described in detail.

Table 3. Use Case Template

<table>
<tr><td colspan="2">Use Case Title:</td></tr>
<tr><td colspan="2">Focus Area:</td></tr>
<tr><td colspan="2">Summarizing the Problem - Current State</td></tr>
<tr><td>Current State or Water Management Challenge</td><td>What is the decision-making or water management challenge? Why is this a problem?</td></tr>
<tr><td>Affected Area</td><td>Where, geographically, is the above challenge most significant (specific communities, regions, urban, rural, etc.)?</td></tr>
<tr><td>Who is Impacted</td><td>Who are the primary sectors, groups, organizations, agencies, decision makers etc. who are impacted by this challenge? Who would benefit from better decisions?</td></tr>
<tr><td>Current Data</td><td>What data and/or models are currently being used to support the decision-making/water management challenge?
Who provides/ analyzes the data?</td></tr>
<tr><td colspan="2">Diving Deeper to Know the Problem Better</td></tr>
<tr><td>Decision Context</td><td>What decision(s) needs to be made, how is that decision made, and by whom?
What is being decided?
How are these decisions made?
Who makes these decisions? Who should make these decisions?</td></tr>
<tr><td>Information Requirements</td><td>What are the desired characteristics of the data (spatial/temporal resolution, latency, format, etc.)?
Are there specific characteristics of the information needed to achieve the improvement?
How often do you need the data? e.g., daily, weekly, monthly, etc.?
Is there a specific geographic extent? e.g., statewide, watershed, irrigation district
What spatial resolution is needed? e.g., 1km
How soon is the data needed for decisions after it is collected?
What is the preferred data delivery mechanism? e.g., the cloud
Are there requirements for data accuracy?
Are there data formats that are most useful to you?
Does data need to be modified for input into a model?</td></tr>
</table>

Data Needs and Potential Sources	*What data and information might be helpful to achieve the desired result (SWE, consumptive use, runoff, etc.)?* ● What information is needed to achieve the desired improvement? ● Does this information currently exist (NASA or non-NASA)? ● Who produces and/or interprets this data? ● **For the SME:** What mission data relates most to this challenge?
Potential Partners	*What organizations might collaborate with WWAO to develop and carry out a project?* ● Who is the primary partner who would work with the WWAO on a potential project? ● Names, organization, contact info ● Are there any other organizations who are affected by this information gap and would be willing to partner with WWAO?
Desired Result	*What is the desired improvement to the management or monitoring challenge?* ● Describe the desired outcome or improvement you would like to see if this management or monitoring issue were addressed. What would improvement look like for the challenge described above? In 1, 5, or 10 years? ● Describe how the improvement will assist the challenge (e.g. faster decisions, more confident models, etc.) ● Who could help implement the improvement? Who are the end-users? (e.g., *organizations, agencies, decision makers etc.)*
Additional Information	
Obstacles	*What challenges or barriers could stand in the way of reaching the desired result? (technical, institutional, cultural, financial, etc.)?*
Prioritization of Need	*Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)?* ● What is your rationale for prioritization level?

Table 4. Use Cases by Category with Ranking

Use Case Topic	Impact & Implementation Scoring
Focus Area A: Hydroclimate Extremes, Variability, and Risk	
Use Case A-1: Better Drought Definition and Decision	Impact of Achieving Use Case

Framework	(Scale of 1-8, higher is better): **7** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **2**
Use Case A-2: Flood Risk Characterization and Prediction	Impact of Achieving Use Case (Scale of 1-8, higher is better): **5** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **5**
Use Case A-3: Impacts of Drying of Terminal Lakes, Including Water Resource Loss, Habitat Loss, Airborne Dust, Air Quality, and Snow Albedo	Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **6**
Use Case A-4: Monitoring Wildfire Impacts on Air Quality, Water Quality, and Snow	Impact of Achieving Use Case (Scale of 1-8, higher is better): **5** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **4**
Focus Area B: Groundwater–Surface Water Interaction	
Use Case B-1: Balancing Water Supply and Use by Humans and Nature	Impact of Achieving Use Case (Scale of 1-8, higher is better): **8** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **6**
Use Case B-2: Irrigation, Agriculture, and their Interface with Surface and Groundwater	Impact of Achieving Use Case (Scale of 1-8, higher is better): **7** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **6**
Use Case B-3: Understanding and Mapping Spatio-Temporal Connectivity Between Aquifers and Surface Water	Impact of Achieving Use Case (Scale of 1-8, higher is better): **8** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **1**
Focus Area C: Agriculture/Irrigation and Water Availability/Budget	
Use Case C-1: Gaps in Mid-Elevation Snow Monitoring	Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **4**
Use Case C-2: Monitoring Inventory and Flow of Springs/ Small Streams in the Great Basin	Impact of Achieving Use Case (Scale of 1-8, higher is better): **3** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **6**
Use Case C-3: Water Budget and Scenario Planning for Farmers	Impact of Achieving Use Case (Scale of 1-8, higher is better): **7** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **4**
Use Case C-4: Water Budget for Irrigation Water	Impact of Achieving Use Case

Suppliers	(Scale of 1-8, higher is better): **8** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **5**
Focus Area D: Water Infrastructure and Measurement	
Use Case D-1: Characterizing/Measuring Reservoir Capacity Across the Great Basin	Impact of Achieving Use Case (Scale of 1-8, higher is better): **3** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **7**
Use Case D-2: Closing the Delta Between Diversion Rights and Actual Diversions	Impact of Achieving Use Case (Scale of 1-8, higher is better): **5** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **1**
Use Case D-3: Understanding Changing Snowpack and SWE to Locate New Resilience Efforts Like Reservoirs	Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **5**
Focus Area E: Watershed Health and Water Quality	
Use Case E-1: Identifying Point and Non-Point Source Pollution in Water	Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **2**
Use Case E-2: Improved Access to information for Rangeland Management and Forecasting with Support for Enhancing Understanding of its Connection to Watershed Health and Water Quality	Impact of Achieving Use Case (Scale of 1-8, higher is better): **3** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **5**
Use Case E-3: Post Disturbance Restoration for Ecosystem/Watershed Health	Impact of Achieving Use Case (Scale of 1-8, higher is better): **4** Difficulty for NASA to Implement (Scale of 1-8, lower is harder): **5**

The final set of 17 use cases are described in the following sections and include the completed templates for each use case.

Use Cases

Focus Area A: Hydroclimate Extremes, Variability, and Risk

Facilitator: Sharon Vasquez-Ray, NASA Western Water Action Office
SME: Sean Fleming, NASA Western Water Action Office

Participants:

Participant Name	Organization
Alvaro Robledano	University of Utah
Dan McEvoy	Desert Research Institute
Karl Rittger	Institute of Arctic and Alpine Research, University of Colorado Boulder
Mark Raleigh	Oregon State University, College of Earth, Ocean, and Atmospheric Sciences

Use Case A-1: Better Drought Definition and Decision Framework

This use case seeks to redefine drought management in the Great Basin by moving beyond "one-size-fits-all" geophysical metrics toward nuanced, user-specific indicators that align with the real-time needs of ranchers, wildfire managers, and tribes. By integrating high-resolution NASA satellite data and localized monitoring, the framework aims to close critical information gaps in flash drought detection, fuel moisture, and snowpack variability to ensure equitable resource allocation and long-term climate resilience.

Use Case Title: Better Drought Definition and Decision Framework	
Focus Area: Hydroclimate Extremes, Variability & Risk	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	Current Water Management Challenge: Water managers in the Great Basin face a complex challenge in defining, detecting, and responding to drought because traditional geophysical definitions—meteorological, agricultural, hydrological, socioeconomic, ecological, or snow-based—may not align with the real-time needs of diverse water users. Ranchers, farmers, hydropower operators, wildfire managers, and industrial users all

	require nuanced drought indicators and thresholds tailored to their specific operations and decision timelines. Existing definitions and datasets often fail to capture short-term variability, localized conditions, or the non-stationary impacts of climate change and land-use change. Why This Is a Problem: Decision-making disconnect: Standard drought classifications, such as the U.S. Drought Monitor (USDM), may not reflect conditions critical for local users. For example, in the Great Basin, summer rains can trigger rapid grass growth, so non-drought years can produce the largest wildfires; and ranchers whose activities are guided by the general-purpose USDM may face imposed restrictions despite adequate forage. ● At times, there is a lack of transparency in how drought is portrayed or categorized, and localized conditions—critical for producers and water users—may not be fully reflected. There also appears to be limited public understanding of how snow drought can influence overall drought conditions, in part because available resources often do not make that connection. ● Uncertain drought impacts: Managers often do not know enough about the localized impacts of drought, including effects on water supply, crops, and broader ecosystems. ● Detection and monitoring gaps: Limited in-situ monitoring, uncertain satellite data, and difficulty with rapidly detecting flash droughts create significant data gaps. This makes it hard to understand current conditions, persistence, or triggers for drought events. ● Definition implications: How drought is defined affects decision-making, resource allocation, and federal funding support, yet current definitions often fail to address the timing and duration relevant to specific users. ● Mismatch with emerging risks: Drought interacts with wildfire, dust, and industrial water demand, but current metrics may not capture these linkages, creating risks for public safety, ecosystem health, and economic development. ● Social equity concerns: Communities may perceive unfair targeting for water restrictions when definitions do not reflect local realities. Overall, a central challenge in the Great Basin is the lack of

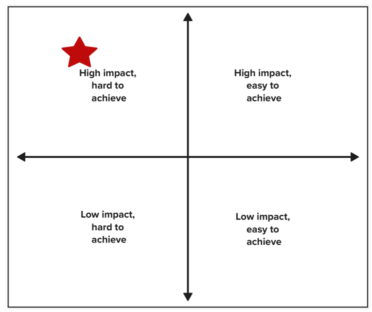
	actionable, user-specific drought definitions and monitoring tools that link geophysical measurements to practical water management needs—including wildfire risk, flash drought detection, and impacts on crops, water supply, and ecosystems. Producer and water user involvement in the drought classification process is limited. Currently, experts rely too heavily on producers to submit CMOR reports or provide local observations, rather than proactively conducting consistent, representative outreach to local water users. Addressing this barrier would build greater trust in the data.
Affected Area	● Populated areas ● Agricultural areas and rangelands ● Ecologically sensitive areas ● Likely the entire basin is affected
Who is Impacted	● Tribes ● Agricultural producers & ranchers ● Conservationists ● Water managers (including public water supply and irrigation districts) ● Industries (e.g., mining, data centers) ● Forest and rangeland managers ● Wildfire managers ● Urban planners ● Public health (impacts from dust) ● Rural homeowners ● Recreation sectors (e.g., water-based, skiing) ● Crop insurance programs
Current Data	U.S. Drought Monitor (USDM): ● Precipitation, soil moisture, air temperature, evaporative demand drought index (EDDI), Standardized Precipitation Evapotranspiration Index (SPEI), long-term streamflow, reservoir levels Snow data: ● Point-based snow measurements like SNOTEL stations ● SNODAS and other gridded snow water equivalent (SWE) datasets (limited confidence in Great Basin) Groundwater & soil moisture data: ● USGS well data ● USDA soil moisture data Vegetation & remote sensing: ● MODIS NDVI (vegetation health) ● Live fuel moisture data for fire management, aggregated from multiple agencies (e.g., BLM) and integrated by NIFC Backbone long-term datasets:

	• Precipitation, temperature, streamflow
Diving Deeper to Know the Problem Better	
Decision Context	Decisions That Need to Be Made: Water managers and stakeholders must make a range of decisions in response to drought, including: • Water allocation & supply: How much surface water to allocate among competing needs; reservoir operations; groundwater pumping and well deepening. • Land and resource management: Where and when grazing is permitted (BLM grazing permits); prescribed burns; fire management (burn bans). • Environmental and ecological considerations: Flow requirements for fish and wildlife habitat; wildlife and fisheries restrictions. • Agricultural and economic decisions: Buying or selling feed and livestock affected by drought. • Recreation and urban decisions: Ski resort operations (snowmaking or closures); home watering restrictions. How These Decisions Are Made: • Plans and protocols: Many states, tribes, and organizations rely on drought management plans, while others make day-to-day decisions using multiple data sources (e.g., USDM, satellite, local monitoring). • Local variation: ◦ Oregon & Nevada: County-level decision-making; water masters manage day-to-day allocations. ◦ California: State-level decisions, including via the Water Resources Control Board; some allocations may also be influenced by court decisions. • Individual decisions: Farmers and ranchers often manage groundwater pumping and livestock-related choices independently. • Fire management: Agencies integrate multiple data sources (fuel moisture, drought indices) for prescribed burns and burn bans. Who Makes These Decisions: • Water allocation: State engineers, watermasters, and courts (for formal allocations). • Agriculture/ranching: Individual farmers and ranchers.

	- Land and wildfire management: BLM, Forest Service, and other fire management agencies. - Environmental management: Fish and wildlife agencies. - Urban and recreation decisions: Local governments, utility providers, and private operators (e.g., ski resorts). - Dam/Reservoir Operators - Courts with Jurisdiction over related matters Key Consideration: Decisions are highly multi-faceted and require integrating nuanced drought definitions and indicators that reflect diverse user needs, supported by robust data sources, including NASA and local monitoring.
Information Requirements	*Not completed; the group did not include members with the relevant expertise to respond.*
Data Needs and Potential Sources	Potential Data Needs: - Soil moisture: Spatially consistent products validated for the Great Basin. - Evapotranspiration (ET): Close the water balance not only in agricultural areas but state-wide - Snow: Snow water equivalent (SWE), snow cover extent, snowmelt timing, temperature, albedo. - Groundwater data - Vegetation stress: NDVI, SIF (Solar-Induced Fluorescence), and other remote sensing-based indices. - Drought impacts data: Currently limited or nonexistent. - Economic and agricultural data: NASS (National Agricultural Statistics Service) data, crop and livestock impacts. - Uncertainty/ensemble data: Ensemble products to support decision-making with quantified uncertainty. Current and Emerging Data Sources: - Existing datasets: - NLDAS-3 - WLDAS (being assimilated into NLDAS-3) - GRACE-DA (GLDAS 2.2) - Emerging NASA or remote sensing sources: - NISAR (SWE, soil moisture, aquifer mapping) - ICESat-2 - SWOT - InSAR - ECOSTRESS

	○ OPENET Overall: While data exist across multiple domains, there is uncertainty about which products are best suited for specific applications in the Great Basin, and additional validation, integration, and emerging data sources are needed. Interpretive Tools and Resources: In addition to data needs, interpretive tools and resources are needed—particularly in cases where a drought monitor author may be unfamiliar with the region or specific areas within it.
Potential Partners	● Academic and other research institutions: Oregon State University, University of Utah, CU Boulder, Desert Research Institute, University of Nevada Reno, and other relevant universities. ● Federal agencies: ○ NRCS (Natural Resources Conservation Service) ○ NIDIS (National Integrated Drought Information System) ○ USGS (U.S. Geological Survey) ○ BLM (Bureau of Land Management) ○ NIFC (National Interagency Fire Center) ○ NOAA ● State and local agencies: ○ State climatologists ○ State-level water management ○ County-level water management ○ Municipal governments, watershed councils, and other local-level agencies and groups ● Tribes and local communities: Tribal governments, agricultural producers, ranchers, rural homeowners. ● Private sector: Ski resorts, utilities, and instrumentation providers. ● Reservoir operators and water managers
Desired Result	Desired Result: The overarching goal is to improve decision-making and management outcomes by providing more nuanced, actionable, and data-informed information. Specifically, the desired improvements include: ● Enhanced drought definitions: Nuanced definitions that better

	reflect diverse user needs and improve access to federal funding. ● Improved planning and economic decisions: Enable stakeholders to reduce financial and operational risks to crops, livestock, and other resources. ● Risk reduction: Lower the risk of wildfire, water shortages, and other environmental hazards. ● Optimized water management: More effective reservoir operations and water allocations. ● Timely and science-based decisions: Faster, streamlined responses supported by spatial mapping, uncertainty estimates, and integrated data. ● Social equity: Increased sense of fairness among stakeholders in resource allocation and restrictions. ● Updated management frameworks: Support for revised water rights, policies, and financial risk mitigation. Overall: The desired result is a more resilient, informed, and equitable water management system in the Great Basin, enabled by improved data, definitions, and decision-support tools.
Additional Information	
Obstacles	● Consensus-building: Developing agreement on drought definitions across diverse users. ● Funding: Securing resources to support monitoring, management, and research. ● Data limitations: The Great Basin is among the most data-sparse regions in the country. ● Understanding subsurface processes: Improving knowledge of groundwater and subsurface connectivity to better integrate into water management efforts. ● Water rights and allocation: Addressing over-allocation and associated management challenges. ● Equity and fairness: Ensuring drought-related decisions are perceived as fair across stakeholders. ● Non-stationarity: Accounting for changes in climate and land-use/land-cover (LULC) in planning and management,

	including consensus-building around distinctions between drought and aridification.
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? **Most Important** (High priority**).** It's the foundation to everything else in the GB. • Impact of Achieving Use Case (Scale of 1-8, higher is better): **7** • NASA Implementation Difficulty (1–8; lower = harder): **2**  For more detail, see **Appendix IV**.

Use Case A-2: Flood Risk Characterization and Prediction

This use case addresses the critical need for improved flood risk characterization and prediction in the Great Basin by targeting uncertainties in rain-snow partitioning, snowmelt timing, and localized summer thunderstorms. By integrating high-resolution topographic data, real-time soil moisture monitoring, and post-fire landscape analysis, the use case aims to provide water managers and emergency responders with the defensible data necessary for proactive dam safety, reservoir operations, and community evacuation planning.

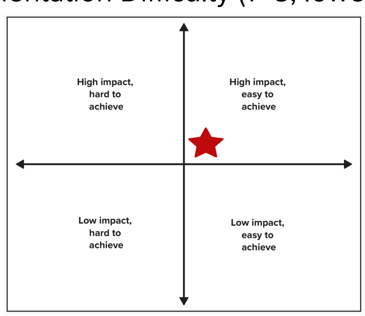
Use Case Title: Flood Risk Characterization and Prediction	
Focus Area: Hydroclimate Extremes, Variability & Risk	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	● Water managers face significant challenges in accurately monitoring and predicting hydrologic conditions, which complicates critical decision-making. Key uncertainties include rain-snow partitioning, snowpack and soil moisture initial conditions, and localized precipitation events such as spatially isolated summer thunderstorms. ● Non-stationary factors—like climate change, wildfires, and shifting land cover—further exacerbate these challenges, altering flood risk and runoff dynamics in unpredictable ways. ● Poor data quality and spatial resolution limit understanding of essential variables like snow line elevation, snow temperature, soil moisture depth, and post-fire landscape susceptibility to floods and debris flows. These uncertainties directly impact dam safety and flood management, as infrastructure may be stressed by unexpected flows or sediment accumulation. ● Overall, the inability to reliably forecast precipitation type, snowmelt timing, and localized storm impacts creates heightened risks for communities and water systems, constraining proactive management and emergency response.
Affected Area	● Winter / Spring: Snow-dominated and snowmelt flooding impacting mountain and foothill communities, with riverbank and overbank flooding along major rivers. ● Summer: Rainfall-driven flash flooding from localized thunderstorms, affecting both urban areas (basements, streets) and rural regions.

	• General: Populated areas are most vulnerable, but flooding risk exists wherever intense storms or rapid snowmelt occur. • Communities with watersheds with flashy streams are more impacted by flooding from extreme events (rain-on-snow, storm, etc.)
Who is Impacted	• General public and communities: Urban, rural, and tribal populations • Water and infrastructure managers: Dam operators, environmental managers • Emergency response and forecasting: EMS/first responders, emergency management, RFC forecasters • Agriculture and recreation: Producers, ranchers, and recreational users • Private sector: Insurance companies
Current Data	• Forecasts: RFC runoff forecasts, NWS forecasts, utilities' internal forecasts (ACE) • Snow / Soil / Precipitation Observations: SNOTEL, SNODAS, NRCS, Agrimet, USGS, Mesowest, USBR • Satellite / Remote Sensing: GOES, MODIS, SAR/optical change detection for debris flows/landslides (Current data?) • Topography / Flood Risk: DEMs, FEMA flood maps, flood hazard maps • Geotechnical / Debris Flow: Soil and geology stability data, sediment/sludge monitoring • Primary Data Providers / Analysts: NOAA (NWS, RFC, COOP), NASA, NRCS (SNOTEL, SCAN/SLAN), USGS, USBR, utilities/dam operators
Diving Deeper to Know the Problem Better	
Decision Context	• Water managers, emergency responders, and other stakeholders must make a range of critical decisions related to flood and runoff risks. Key decisions include issuing evacuation orders, determining zoning regulations, preparing

	for disasters (e.g., sandbag deployment), issuing flood warnings and advisories, managing reservoir releases (pre-spill), assessing dam safety, and setting insurance and mortgage policies. ● These decisions rely on forecasts, observations, and infrastructure assessments, and are made by multiple entities: emergency management agencies and state governments coordinate evacuations and disaster responses; utilities and dam operators manage pre-spill reservoir releases and infrastructure safety; insurance companies and state regulators determine coverage and mortgage eligibility; and weather services (e.g., NWS RFCs) provide the forecasts and advisories that inform these actions ● Effective decision-making requires timely, accurate data and communication between these actors to reduce risk to people, property, and critical infrastructure.
Information Requirements	Forecasting and monitoring frequency: ● More frequent than monthly; short-lead (daily or hourly) forecasts needed for evacuation decisions and reservoir operations ● Operational flood inundation maps Hydrologic and meteorological data: ● High-resolution temporal and spatial precipitation data ● Snow water equivalent (SWE) and soil moisture in real-time ● Vertically pointing radars for snow level and precipitation phase (rain/snow transition) ● Water levels in rivers, lakes, and reservoirs ● Snow volume and cold content Modeling and prediction capabilities: ● Improved numerical weather prediction models for convective summer storms in mountainous terrain ● Better flood extent modeling ● Short-lead reservoir inflow forecasts for dam safety ● Long-term (e.g., 100-year) flood maps for zoning decisions Geospatial and infrastructure data: ● High-quality DEMs

	• Up-to-date land use/land cover (LULC), especially burned areas to capture wildfire impacts • Infrastructure monitoring (dams, diversions, roads) using lidar or other remote sensing • Debris flow and geotechnical information (pore water pressures, slope stability) Operational considerations: • Minimum forecast lead times sufficient for evacuation and emergency response • FloodMAR restrictions due to water quality concerns
Data Needs and Potential Sources	Topography and land cover: • High-quality DEMs (including LIDAR) • Up-to-date land cover/land use (LCLU), especially burned areas to capture wildfire impacts on flooding Hydrologic and meteorological observations: • High-resolution temporal and spatial precipitation data • Snow water equivalent (SWE) and soil moisture with better spatial coverage • Real-time snow volume, cold content, and snow temperature to anticipate melt onset • Vertically pointing radars to capture snow level and precipitation phase (rain/snow transition) Modeling and prediction tools: • Improved numerical weather prediction models for convective summer storms • Better flood extent and runoff modeling • Models that incorporate fire impacts on flooding Infrastructure and geotechnical monitoring: • Real-time monitoring of dams, diversions, and road conditions (e.g., LIDAR) • Geotechnical data: pore water pressures, slope stability, debris flow risk Resolution and timeliness:

<table>
<tr><td></td><td>Very high temporal and spatial resolution for observations and forecasts
Short-lead-time data sufficient for operational decision-making</td></tr>
<tr><td>Potential Partners</td><td>Federal agencies:
NWS
FEMA (e.g., 100-year flood maps)
U.S. Army Corps of Engineers
State and local government:
Emergency responders
Departments of Transportation
Water and dam management agencies
Academic and research institutions:
Universities and research organizations
Private sector / contractors:
Engineering and design firms
Lidar and geospatial service providers
Utility companies (e.g., power)</td></tr>
<tr><td>Desired Result</td><td>The goal is to enable more nimble, evidence-based decision-making for flood and water management, providing longer lead times and improved precision in actions such as reservoir releases, evacuations, and disaster preparations.
Improved forecasting and monitoring would reduce property damage and loss of life, optimize operational outcomes, and enhance cost efficiency both before and after flood events.
By reducing false positives and false negatives in warnings and advisories, public trust in water management decisions would increase.
Additionally, more refined management of floodwaters could support beneficial outcomes such as groundwater recharge through programs like FloodMAR, achieving both risk reduction and resource enhancement.</td></tr>
<tr><td colspan="2">Additional Information</td></tr>
</table>

<table>
<tr><td>Obstacles</td><td>Financial constraints:
Costs of monitoring, modeling, and mitigation
Water quality concerns (e.g., with MAR)
Public perception and engagement:
Public distrust or warning fatigue
Limited understanding of risk and uncertainty
Institutional and organizational challenges:
Siloed solutions across agencies and sectors
Limited capacity to interpret and act on data
Institutional capacity to leverage information effectively
Data and decision-making limitations:
Difficulty translating data into actionable information
Uncertainty in forecasts
Environmental and demographic dynamics:
Non-stationarity (climate, wildfire, and land-use changes)
Floodplains and populations are not static; changing growth areas</td></tr>
<tr><td>Prioritization of Need</td><td>Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = Very Important. Rationale: infrequent but significant impacts in the Great Basin
Impact of Achieving Use Case (Scale of 1-8, higher is better): 5
NASA Implementation Difficulty (1–8; lower = harder): 5


For more detail, see Appendix IV.</td></tr>
</table>

Use Case A-3: Impacts of Drying of Terminal Lakes, Including Water Resource Loss, Habitat Loss, Airborne Dust, Air Quality, and Snow Albedo

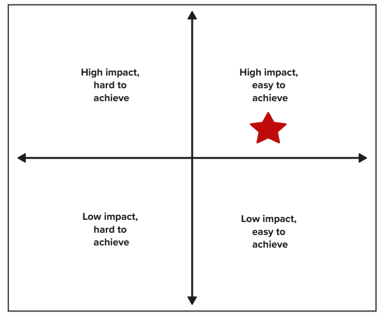
This use case addresses the cascading environmental and public health crises triggered by the drying of terminal lakes, which exposes lakebeds to wind erosion and creates harmful airborne dust. By integrating hyperspectral mineral mapping and satellite-based water level tracking, the use case seeks to quantify how shrinking lakes accelerate habitat loss, degrade air quality, and darken mountain snowpacks, providing the defensible data needed to balance water allocation with regional health and ecological stability.

Use Case Title: Impacts of Drying of Terminal Lakes, Including Water Resource Loss, Habitat Loss, Airborne Dust, Air Quality, and Snow Albedo	
Focus Area: Hydroclimate Extremes, Variability, And Risk	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• The Great Basin and surrounding arid regions face a complex set of water management challenges driven by hydroclimate variability. The endorheic (terminal) lakes characteristic of the GB experience extreme fluctuations: during the 2012–2016 drought, smaller lakes dried out, only to partially refill during the wet 2017 water year. These cycles of drying and refilling highlight uncertainty in water availability and complicate long-term management decisions. Key questions remain about the frequency of these events, and whether observed trends reflect drought, longer-term aridification, or impacts from over-extraction. • The ecological consequences of these changes are significant. Drying lakes lead to habitat loss for migratory birds, wildlife, and tribal resources, and threaten species dependent on these water bodies. Exposed lakebeds produce airborne dust that degrades air quality, affects water quality, and alters albedo in mountain snowpacks, impacting downstream water availability. These hydroclimate effects have cascading implications for ecosystems, recreation, and human health and infrastructure. • Many smaller terminal lakes are currently unmanaged, raising questions about what level of intervention is most appropriate. Decisions around water allocation, land use planning, and environmental protection are complicated by uncertainty in terminology—whether to frame these issues as drought,

	aridification, or over-extraction—and by the interconnected effects on habitat, air quality, and water resources. Understanding dust sources, ecosystem responses, and societal including tribal impacts is critical for developing informed strategies for environment and water management in this region.
Affected Area	• Widespread throughout the basin
Who is Impacted	• Public health • Ecological health • Water managers • Recreation/tourism industry • Urban planning • Airports
Current Data	• Air quality tools - Meteorological back-trajectories • Air quality monitoring stations (particulate matter (PM) 2.5 and/or PM10) • Water quality monitoring (atmospheric deposition) • NOAA GOES data (dust tracking) • Lake level monitoring systems (USGS?) • Streamflow monitoring systems (USGS) • Multi/hyper-spectral data • Data from University of Colorado Boulder (CU Boulder)/INSTAAR/NSIDC - Dust on snow, albedo
Diving Deeper to Know the Problem Better	
Decision Context	• Key decisions include water allocations and management (including whether water is allowed to flow into terminal streams and lakes), when and how to implement mitigation efforts, timing of public health alerts, and environmental restoration and re-vegetation actions. These decisions are made by water managers, public health experts, and weather forecasters (dust storm and AQ warnings), with authority typically held by state departments.
Information Requirements	• Monitoring data: Dust levels/airborne particulates, water level and spatial extent of lakes/streams, and exposure of newly emerged land surfaces. • Dust characterization: Spatial and temporal dynamics, chemical composition, and source identification to assess environmental and public health risks.

	• Knowledge and tools: Process understanding and predictive models to forecast conditions and design, evaluate, and trigger mitigation measures.
Data Needs and Potential Sources	• Satellite observations (water, land, and surface change): NISAR, OPERA, InSAR, multi/hyperspectral (e.g., MODIS, VIIRS, Landsat, Sentinel, PACE), and spaceborne LiDAR (e.g., ICESat-2, GEDI) to track water levels, lake/stream extent, and emerging land surfaces. SWOT as an aspirational data source. • Dust and aerosol monitoring: Satellite-derived aerosol optical depth (e.g., MODIS/MERRA) and visibility products to monitor airborne dust and transport. Other sources in addition to the CU-Boulder source listed in the Current Data section. • Ground-based observations: AERONET sun photometers and surface visibility sensors to validate and complement satellite dust and air quality measurements; conventional AQ monitoring sites. • Dust composition and source characterization: Hyperspectral datasets (e.g., EMIT) to analyze mineralogy and chemical composition of dust and identify source regions.
Potential Partners	• Local + State DEQ & Public health • Conservation groups • Operational weather and AQ forecasters (e.g., NWS) • Academic partners • BLM • Ski resorts/tourism/rec industries
Desired Result	• The desired result is a stronger, integrated capacity to monitor, predict, and mitigate dust generated from drying terminal lakes. This includes improving understanding of dust transport pathways, identifying where dust originates and where it is deposited, and characterizing the chemical composition of dust to better assess health and environmental risks. Enhanced monitoring should support more accurate forecasting of dust events and clearer understanding of how dust affects air quality, water quality, snow processes, and ecosystem function. • In parallel, the goal is to establish better satellite-based tracking of terminal lake water levels, surface extent, and newly exposed lakebeds, particularly for smaller, unmonitored

	systems. By developing a coordinated Great Basin terminal lake level, extent, and dust monitoring program, managers will be better equipped to anticipate loss of water resources, loss of habitat, protect vulnerable species, and design timely, targeted mitigation strategies that reduce risks to human health and ecosystems.
Additional Information	
Obstacles	• Funding constraints: Limited and uncertain funding for monitoring, infrastructure for monitoring, and mitigation. • Data and knowledge gaps: Unknown natural background dust levels, limited historical baselines, and lack of observations to distinguish natural variability from human influence. Knowing natural background levels is crucial, as airborne dust is often a natural characteristic of arid and semi-arid environments that can in fact be a key component of desert ecosystems, but it is also strongly and harmfully amplified by human impacts. • Overallocation of water: Chronic over-extraction of water to support economic growth is a major driver of shrinking terminal lakes in the GB. • Competing interests: Tensions between environmental protection and economic development priorities. • Nonstationarity and changing conditions: Environmental baselines shifting due to local and global climate change, complicating planning and design standards and shifting responsibility for impacts and mitigation between local/regional vs. national/international agencies and groups. • Infrastructure gaps: Lack of dedicated dust monitoring networks and supporting equipment. • Delayed benefits: Mitigation and restoration actions can have long timelines before benefits are realized, reducing short-term incentives and complicating impact-tracking.
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Very Important** • Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** • NASA Implementation Difficulty (1–8; lower = harder): **6**

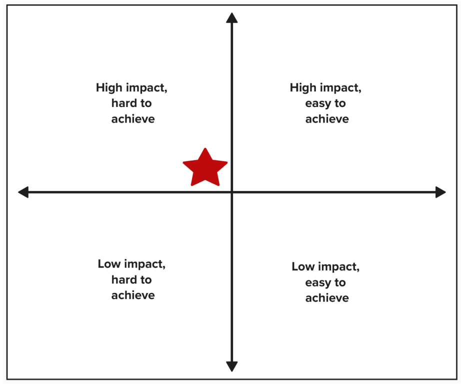
	 For more detail, see **Appendix IV**.

Use Case A-4: Monitoring Wildfire Impacts on Air Quality, Water Quality, and Snow

This use case addresses the unique hydrologic risks posed by wildfires in the Great Basin's grassland and shrubland systems, where fire is often fueled by rapid vegetation growth following wet seasons rather than long-term forest drought. By monitoring how ash, black carbon, and sediment alter snow albedo and water quality, the use case aims to help water utilities and managers predict post-fire runoff timing and treatment needs in ecosystems where these impacts are traditionally less studied than in forested watersheds.

Use Case Title: Monitoring Wildfire Impacts on Air Quality, Water Quality, and Snow	
Focus Area: Hydroclimate Extremes, Variability, And Risk	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• The Great Basin faces growing water management challenges due to the interaction of airborne particulate matter, increased sediment loading in waterways, and altered snowpack processes such as changes in albedo and canopy interception, as a result of wildfire. • In contrast to forested regions, where drought primarily drives wildfires, Great Basin fires often occur in grasslands and are fueled by vegetation that accumulates during wet winters and springs. These fire regimes create a unique and poorly understood risk to water resources, as the post-fire hydrologic impacts in grassland systems—such as changes in runoff, erosion, and water quality—remain less studied, limiting the ability of water managers to predict and mitigate impacts.
Affected Area	• Vegetated and adjacent regions across the Great Basin
Who is Impacted	• Public health • Water supply utilities • Wildfire ecosystems • Water managers / forecasters • Tourism and recreation industries
Current Data	• Air quality monitoring data (more is needed) • Water quality monitoring data to track atmospheric deposition (more data is needed) • Remote sensing data (thermal, multispectral and optical)
Diving Deeper to Know the Problem Better	
Decision Context	• The decision context includes choices around forest and grassland management to reduce fire risk, issuing public

	health advisories, managing water quality treatment plans and expenses, protecting source water, and conducting aquatic habitat remediation. ● These decisions include determining what actions are necessary, how they should be implemented, and who is responsible for carrying them out.
Information Requirements	● Real-time monitoring of stream/lake sediment loads and airborne particulate matter (PM_{10}) ● Snow albedo ● Land cover, with particular attention to burn extent and severity.
Data Needs and Potential Sources	● Aerosol optical depth (AOD) ● Dust composition (e.g., EMIT) ● Higher resolution water quality indicators *(need definition connected to use case)* ● In-situ sensors for groundtruthing remotely sensed and modeled information ● Potential data source: NASA (e.g., PACE, ECOSTRESS)
Potential Partners	● Academia/research ● Ski resorts ● Tribes ● State and local DEQs ● USFS ● BLM ● State forest managers ● NWS RFCs *(NB: CBRFC, HQd in SLC, uses MODIS-derived snow albedo to adjust melt rate parameters in their flood and water supply forecast models)*
Desired Result	● The desired result is enhanced understanding and management of water and air resources, achieved through improved monitoring of water quality and air quality. ● This includes reducing uncertainty in snow accumulation, snowpack evolution, and runoff generation, as well as providing accurate, timely information on the impacts of environmental disturbances, including increased sediment loads in rivers and lakes due to wildfire-driven soil erosion. ● Ultimately, the goal is to deliver a clear and reliable picture of air and water quality conditions and the impacts from wildfire.
Additional Information	
Obstacles	● Cost of ongoing monitoring ● Technical/scientific challenges ● How to effectively and efficiently integrate data into operational prediction, decision-support, and public advisory

	systems
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Important.** • Impact of Achieving Use Case (Scale of 1-8, higher is better): **5** • NASA Implementation Difficulty (1–8; lower = harder): **4**  For more detail, see **Appendix IV**.

Focus Area B: Groundwater–Surface Water Interactions

Facilitator: Bailing Li, NASA Western Water Action Office
SME: Renato Frasson, NASA Western Water Action Office

Participants:

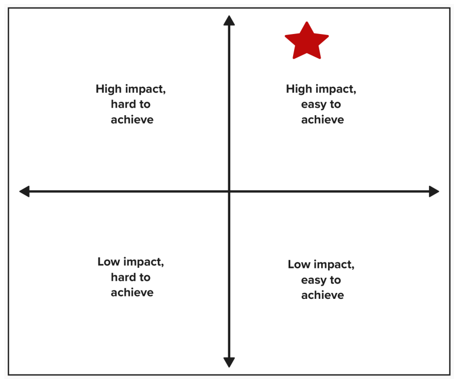
Participant Name	Organization
Craig Miller	Utah Division of Water Resources
Laurel Saito	The Nature Conservancy
Madeline Greymountain	Goshute Federal Corporation
Tara Shreve	Utah Geological Survey

Use Case B-1: Balancing Water Supply and Use by Humans and Nature

This use case addresses the challenge of balancing human and ecological water demands in the Great Basin by quantifying ecosystem needs to avoid environmental and economic collapse. It aims to integrate diverse data and stakeholder interests into a sustainable management framework that ensures long-term water resilience for future generations.

Use Case Title: Balancing Water Supply and Use by Humans and Nature	
Focus Area: Groundwater & Surface Water Interaction	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	● Accounting for ecosystem water needs when balancing demands across users and supplies, including challenges in quantifying ecological requirements and planning for future demand. ● Identifying tipping points in the water supply and demand that could trigger economic or ecological impacts. ● Distinguishing essential needs from discretionary uses to support basin-wide prioritization ● Decision makers may have vested interests that might not lead to sustainable water decisions. ● Managing pressures at the wildlife–urban interface, where competing land and water uses intersect.
Affected Area	Great Basin
Who is Impacted	All systems, including natural systems

Current Data	• Nevada Groundwater Dependent Ecosystems (GDE) Water Needs Explorer Tool (only available in Nevada). https://www.groundwaterresourcehub.org/where-we-work/nevada/gde-water-needs/ • Species population data from US Fish and Wildlife Services. • Ethnographic data on past land use, migration of populations, and others.
Diving Deeper to Know the Problem Better	
Decision Context	Decision makers for licensing economic and population growth based on available water resources: • State Legislators. • Bureau of Land Management. • US Forest Service. • Communities and Cities. • State Engineers office (NV) and Division of Water Rights (UT). Decision makers for forest management treatments and practices: • Tribes • US Forest Service.
Information Requirements	• Basin-scale or site-specific long and short-term data on water use, including natural anthropogenic uses. • Basin scale or site-specific precipitation statistics and patterns to characterize water sources. • Lake cores to extract information on historical land use and environmental conditions that are representative of the area.
Data Needs and Potential Sources	• Natural water use: no adequate known source. • Anthropogenic water use: estimates made available by the USGS and the states. Estimates are often from models, better data is required. • Stable isotope data to identify the water sources used by plants: needs to be collected. • Lake cores to extract information on historical land use and environmental conditions: needs to be collected. • GDE Water use tool: Nature Conservancy but only available in Nevada. • Species Population data: US Fish and Wildlife Services. • Ethnographic data: Department of Defense.
Potential Partners	USGS, DoD USFWS, State Wildlife Agencies, NGOs, State Water Agencies, Department of Energy, NASA.
Desired Result	• Better planning for water use to enable long-term ecological balance, resilience, to avoid tipping points. • Water for future generations for people, plants, and wildlife.

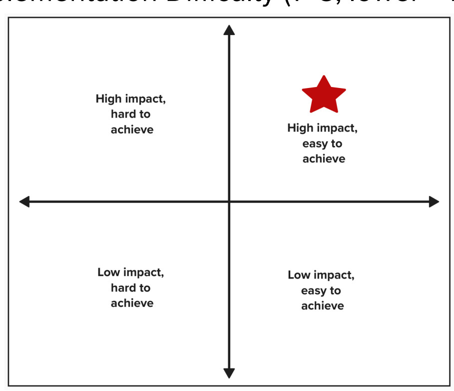
Additional Information	
Obstacles	• Imbalance between short-term financial and economic interests vs long-term water availability. • Limited consideration of nature in water laws. • Unpredictability of nature. • Climate Change, population growth, globalization. • Lack of certainty about ecosystem water needs.
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Important** • Impact of Achieving Use Case (Scale of 1-8, higher is better): **8** • NASA Implementation Difficulty (1–8; lower = harder): **6**  For more detail, see **Appendix IV**.

Use Case B-2: Irrigation, Agriculture, and their Interface with Surface and Groundwater

This use case addresses the need for precise quantification of irrigation consumptive use and return flows to manage water rights and protect vital resources like the Great Salt Lake. By integrating high-resolution data from OpenET, soil moisture sensors, and streamgages, the project aims to create a defensible and transparent framework for water valuation and agricultural decision-making across the Great Basin.

Use Case Title: Irrigation, Agriculture, and their Interface with Surface and Groundwater	
Focus Area: Groundwater & Surface Water Interaction	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• Limited information on irrigation water use and return flows. • Limited information on connectivity of surface water and groundwater • Challenges in accurately quantifying consumptive water use. • Defining depletion has been a challenge. Each state, and often each agency, defines this differently. Consumptive use is a bit simpler to tackle. • Difficulty adapting agricultural practices (e.g., crop choices) due to market constraints and climate suitability. Labor constraints also play a part–pivot irrigated alfalfa requires very little manual labor and can be easily harvested. • Uncertainty in business and farm management planning driven by variable water availability. • Reducing consumptive use to minimize depletion of the Great Salt Lake. • Challenges in accurately valuing water in transactions and markets.
Affected Area	Agricultural areas of the Great Basin.
Who is Impacted	Farmers, ranchers, water management agencies, any water users.
Current Data	• USDA National Agriculture Imagery Program (NAIP) imagery to categorize irrigation type and crop. • Utah DNR uses a hybrid version of Cropscape. Certain crop

<table>
<tr><td></td><td>types are easier to classify accurately, while others require additional verification. Utah DNR conducts their own checks on these more challenging crops and shares the results with the USDA to help refine their algorithms.
OpenET.
Surface Water measurements from USGS and Utah Division of Water Rights water diversion data and river gages for measurement of return flow. Individual Water and Irrigation districts of diversions, flows, and reservoir releases.
Nevada Division of Water Resources measurements of water diversions and groundwater withdrawals.
There is limited groundwater pumping and monitoring data. Utah DNR reports groundwater pumping at some regional levels, but individual well measurements require additional attention.</td></tr>
<tr><td colspan="2">Diving Deeper to Know the Problem Better</td></tr>
<tr><td>Decision Context</td><td>Water rights management, management of allotments, grazing, etc.
Decision makers: Irrigation districts, State Engineers, Bureau of Land Management.</td></tr>
<tr><td>Information Requirements</td><td>Consumptive Water Use:
30 m resolution, daily data preferable.
Long-term records for analysis of trends and understanding how people are making decisions.
Soil moisture, including where the snow is (water producing regions):
Gridded information, basin averages and monthly averages would be helpful, higher spatial resolution, and daily data is desirable.
Snowpack:
High accuracy seasonal to sub-seasonal predictions and current conditions.
Socio-economic data (including models) for valuation of water:
Long-term information for risk assessment, short-term for business decisions (will my farm survive the next season).
Basin specific.
Observations: Longterm:
Multiple decades but at least a decade, crossing through multiple drought events.</td></tr>
<tr><td>Data Needs and Potential Sources</td><td>OpenET, USGS streamgages, local agencies information on diversions, pumping, Western Water Data Exchange (WaDE) for data sharing across states.</td></tr>
</table>

Potential Partners	State engineers, irrigation districts, Bureau of Land Management, Army Corps of Engineers, Bureau of Reclamation, Natural Resources Conservation Service (NRCS), US Geological Survey, and other States.
Desired Result	If measurements were widely available and of high quality, water rights administration would be more reliable and defensible, particularly when determining which rights are valid and which should lapse.
Additional Information	
Obstacles	● Belief by farmers that OpenET (or data in general) will be used to penalize and take away water rights. ● Implementation hurdles in the adoption of OpenET for characterization of agricultural consumptive use. ● Decentralized data collections for diversions cause difficulties in data sharing in the basins. Data sharing across different states is not trivial. ● Data quality inconsistency, e.g. USGS corrects their data as issues are identified, not all agencies do that, causing inconsistencies in quality. Data posting inconsistency causes interpretation issues. ● Groundwater pumping data depend on metering and reporting, which are not required in all areas.
Prioritization of Need	● Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Very Important** ● Impact of Achieving Use Case (Scale of 1-8, higher is better): **7** ● NASA Implementation Difficulty (1–8; lower = harder): **6**  For more detail, see Appendix IV.

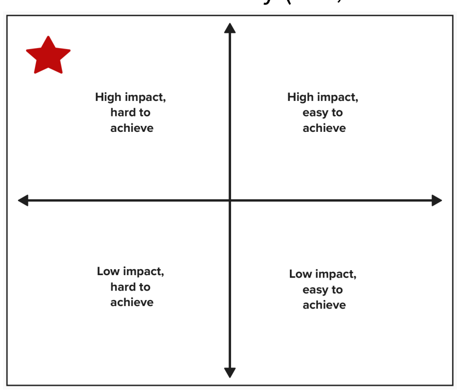
Use Case B-3: Understanding and Mapping Spatio-Temporal Connectivity Between Aquifers and Surface Water

This use case addresses the critical mandate of State Engineers to manage groundwater and surface water as a single connected system, ensuring that groundwater pumping does not unfairly deplete flows for senior water users or harm tribal and ecological resources. By filling persistent gaps in spatio-temporal data across the Great Basin, there is a need to provide the legally defensible scientific evidence required to resolve water rights conflicts and support sustainable economic development.

Use Case Title: Understanding and Mapping Spatio-Temporal Connectivity Between Aquifers and Surface Water	
Focus Area: Groundwater & Surface Water Interaction	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	● State Engineers are mandated to manage water withdrawals. Because groundwater and surface water are often interconnected, pumping groundwater can reduce surface water available to more senior water rights holders. To make informed management decisions, State Engineers require reliable, defensible data. ● Lack of funding for data acquisition and deployment of monitoring systems hinders data acquisition. ● There are great opportunities to collaborate with different disciplines given the widespread interests among different agencies.
Affected Area	● Nevada, Central and Southwest Utah ● Great Salt Lake Basin ● Confederate Tribes of the Goshute Reservation ● Humboldt River Basin
Who is Impacted	Agricultural water users, municipal water users, reservations, ranchers, mining sector, technology and computing sector, NGOs, the Nevada and Utah State Engineer's office, and natural ecosystems.
Current Data	● Gridded and modeled datasets provide surface water and groundwater information, though spatial and temporal coverage is limited. Current datasets in use include: ○ gridMET (gridded surface meteorology) ○ GridET (gridded evapotranspiration; historically based on Daymet, potentially transitioning to PRISM) ○ OpenET ○ PRISM

	- Ground-based monitoring networks, such as Utah's groundwater well network and eddy-covariance–based ET stations. - Ecosystem inventories, including Nevada's inventory of groundwater-dependent ecosystems (GDEs) and global GDE datasets. - Hydrogeologic parameters include the State of Utah's transmissivity estimates, as well as other aquifer properties such as storage coefficients derived from pumping tests or inferred from relationships between Interferometric Synthetic Aperture Radar (InSAR)/GNSS displacement time series and groundwater level changes. - InSAR observations from the past decade will soon provide constraints on cumulative subsidence volumes across Utah. This information will help determine where aquifer compaction, and resulting loss of aquifer storage, is occurring and the magnitude of those impacts. - Note: Limited transferability of data. Much of the information is locally derived and cannot be confidently extrapolated across basins.
Diving Deeper to Know the Problem Better	
Decision Context	- State Engineers are mandated to manage water withdrawals in Nevada. - Hydrologic connectivity between groundwater and surface water means groundwater pumping can deplete surface water, which is often allocated to senior water rights holders. - The Goshute Tribe has an interest in using groundwater to support economic development. - Need to develop best management practices to protect and sustain the Great Salt Lake. - Requirement for defensible data to support implementation of water management plans, particularly for agricultural development.

Information Requirements	Groundwater Dependent Ecosystems: ● 30 m or finer for the characterization of Groundwater Dependent Ecosystems Groundwater Budget: ● 100 m in spatial resolution ● At least more than twice a year, seasonal and sub-seasonal needed ● Long-term trends similar to the record length of Landsat are desirable. Natural system water use (ET): ● Basin scale, customized for the basin, bias removed and improved accuracy than global models. ● Daily is desirable, weekly, at least monthly averages. Intermittent/Ephemeral streams timing and quantity: ● Detect timing and measure flow quantity in streams as small as 1 m wide. ● Daily is desirable.
Data Needs and Potential Sources	● River discharge and flow timing, including flowing/not-flowing timing even for small tributaries (<1 m wide); no known direct spaceborne data source currently exists. Hydrologic models may be viable where high-quality rainfall data are available. The accuracy of precipitation estimates in mountainous regions is often suspect. ● Natural system water use, for which no reliable, accurate measurement source is currently available. ● Accurate rainfall measurements, which remain limited by the lack of sufficiently precise observational data. ● Groundwater characterization, including the location and quantity of pumping; recharge processes (vertical and lateral); flow direction and connectivity; conveyance; and identification of recharge sources. ● Plant species identification and invasive species mapping, using EMIT, future SBG missions, and high-resolution optical imagery (e.g., WorldView).
Potential Partners	Nature Conservancy, Utah Division of Water Resources, Utah Division of Geological Survey, Confederate Tribes of the Goshute Reservation, Utah Department of Natural Resources Division of Water Rights (State Engineers), Nevada Division of Water Resources. Nevada Department of Conservation and Water Resources. Bureau of Land Management, Bureau of Reclamation, Desert Research Institute.
Desired Result	● Sustainable management of water resources. ● Decision-support tools that enable robust water management now and in the future.

	• Reduced uncertainty through improved data accuracy to strengthen decision-making. • Balanced solutions across competing water users and uses. • Economically viable water use and development. • Improved understanding of the water cycle to support better modeling and management decisions.
Additional Information	
Obstacles	• Limited funding, data availability, and appropriate technologies at the scales needed for effective management. • Gaps in capacity and education to support data use and decision-making. • Barriers to collaboration across water users, agencies, and jurisdictions. • Challenges in convening stakeholders, including funding constraints for sustained engagement and collaboration. • Lack of trust among stakeholders and in available data. • Importance of data sovereignty, particularly for Tribal communities.
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Most Important** • Impact of Achieving Use Case (Scale of 1-8, higher is better): **8** • NASA Implementation Difficulty (1–8; lower = harder): **1**  For more detail, see **Appendix IV**.

Focus Area C: Agriculture/Irrigation and Water Availability/Budget

Facilitator: Max Friedenwald-Fishman, Metropolitan Group
SME: AJ Purdy, NASA Western Water Action Office

Participants:

Participant Name	Organization
Amanda Sheffield	National Oceanic and Atmospheric Administration National Integrated Drought Information System
Hannah Steele	Oregon State University, College of Earth, Ocean, and Atmospheric SciencesOregon State University, College of Earth, Ocean, and Atmospheric Sciences
TJ Ramos	Goshute Federal Corporation
Tony Richards	Utah Department of Agriculture and Food

Use Case C-1: Gaps in Mid-Elevation Snow Monitoring

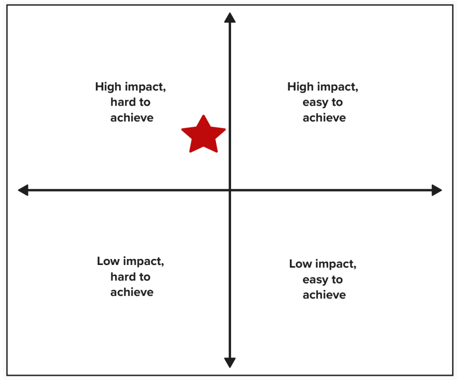
This use case addresses a critical "blind spot" in Great Basin water management: the lack of snow monitoring in mid-elevation zones, which sit below high-altitude SNOTEL stations but above the valley floor. Because these zones are the first to melt and dictate early-season streamflow and soil moisture, this data gap directly impairs the ability of ranchers to secure grazing permits, farmers to plan irrigation, and drought monitors to accurately trigger financial aid.

Use Case Title: Gaps in Mid-Elevation Snow Monitoring	
Focus Area: Agriculture/Irrigation and Water Availability/Budget	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	Currently, snowpack information at mid-elevation is perceived as highly uncertain and limits effective land management. Mid-elevation zones impact water availability downstream, but many SNOTEL stations are placed at higher elevations, limiting information to improve early season runoff and land accessibility. This is a problem because we lose valuable information about how a snowpack is behaving–e.g. timing of mid-elevation snowpack melt and the impacts that has on streamflow and soil moisture.
Affected Area	• Mid-elevation snow zones:

	○ Zone below standard elevation of SNOTEL sites and above benches (the historic shoreline of Lake Boneville) and the toe slope of mountains ○ More specifically, this includes lower-elevation snowpack near or within the rain–snow transition zone. ● The communities that rely on snowmelt: ● Rural communities and other downstream communities
Who is Impacted	● Land managers of rangelands for grazing ○ BLM ○ FS ○ Individual ranchers ● Irrigation districts ● Individual farmers ● Reservoir operators and communities in more flashy drainages (enhanced flood risk)
Current Data	● SNOTEL (most trusted but limited) ● In addition to SNOTEL, the NRCS Snow Survey is expanding the use of SNOLITEs (SNOTEL-lites) in this zone. SNOLITEs currently have no precipitation gauge or snow pillow, requiring less infrastructure, though a snow pillow can be added if desired. ● Snow model products (SNODAS, etc.) ● Snow Today ● ASO (very limited in Great Basin) ● SWE Fusion ● MODIS derived disappearance date and snow persistence ● SnowCloudMetrics
Diving Deeper to Know the Problem Better	
Decision Context	● Overarching ○ Capture snow data in zones with the earliest melt, which are most sensitive to slight temperature changes and rain-on-snow events. ○ Decisions that relate to water budget: decision makers need to understand how much water they will have and when. ○ Help create a more accurate picture of the water budget, especially earlier in the spring. ● Land managers for rangelands for grazing ○ Units of forage (how much grazing is available). BLM and FS are the ones who issue permits to grazers ● Irrigation district ○ Districts that have direct flow irrigation are going to be very impacted by this. This would help them do

	○ forward planning. Seeing a week or two out to determine what water will come down ● Individual farmers ○ Individuals that also have direct flow. Where individuals make decisions on how much of their fields they can irrigate. This impacts their economic calculations ● Drought monitors ○ They need the information to forecast, monitor, and define the drought category. They also need to be able to prove (through data) that a drought is happening. This has implications for insurance and aid and how much is paid out to farmers in the instance of a drought.
Information Requirements	Temporal resolution ● Need for seasonal data ideally earlier in the season and then daily measurements Geographic extent ● Mid-elevation ○ Zone below standard elevation of SNOTEL sites and above benches (the historic shoreline of Lake Boneville) and the toe slope of mountains Spatial resolution ● Resolution fine enough to distinguish between North facing and South facing slopes. <500m Preferred data delivery mechanism ● Potentially integrated into existing NRCS tool
Data Needs and Potential Sources	● Information is needed to achieve the desired improvement ○ SWE ○ Snow disappearance date ○ Snow persistence ○ Land cover information (open vs forested) ○ Soil moisture ○ ASO, SNOW Today, other RS products ● While snow water equivalent (SWE) data are extremely valuable, maintaining a station that measures SWE is not always feasible, especially in resource-constrained settings. Even in-situ snow depth measurements alone, when combined with local knowledge of snow presence and potential flow, can enable more informed decisions. A single additional snow-depth measurement, paired with observations from local producers, can provide actionable insights. Although

	expanding SWE monitoring is desirable, prioritizing in-situ snow depth measurements—even without full SWE data—offers a practical way to quickly expand coverage in this zone.
Potential Partners	• Society of Range Management • BLM • State cattleman associations • Private grazing associations • Extension offices • NRCS (people already go here for information about snow) • NWS (they might not be technical experts but they would want to see the results) • Citizen scientists taking photos of the mountains • Farm Service Agency (state and county offices) • Ski resorts
Desired Result	• More adaptive management activities • More accurate soil moisture measurements • Spatial data related to snowmelt and SWE is readily available to end users • More locally accurate drought determination • Remote sensing is capable of doing this • Informs permitting decisions.
Additional Information	
Obstacles	• Instrumentation: limitation of temporal and spatial resolution • Complex terrain in the Great Basin could be difficult to remote sense (intense slopes, thick forests) • Integration of data into existing tools and systems • Expanding in-situ monitoring is resource-intensive, requiring significant time, staff, and funding. While partnerships can help, they also introduce unique challenges and complexities.
Prioritization of Need	• Medium difficulty to implement slightly towards difficult; Medium impact, slightly towards higher • Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** • NASA Implementation Difficulty (1–8; lower = harder): **4**

	 For more detail, see **Appendix IV**.

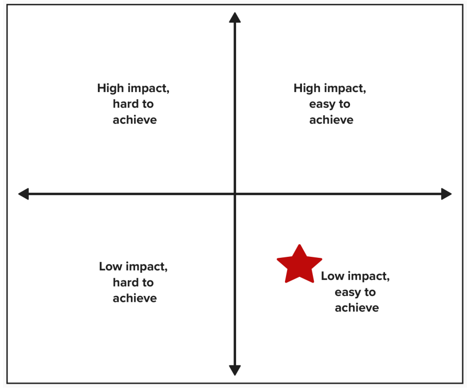
Use Case C-2: Monitoring Inventory and Flow of Springs/ Small Streams in the Great Basin

This use case addresses the critical need for a comprehensive inventory and flow monitoring system for the Great Basin's springs and small streams, which serve as vital water sources for wildlife, tribal communities, and rangeland grazing. By leveraging high-resolution satellite imagery and NISAR wetness detection to overcome the limitations of sparse ground-based monitoring, this use case aims to identify "lost" or dried-up water sources and provide the defensible data necessary for sustainable groundwater planning and herd management.

Use Case Title: Monitoring Inventory and Flow of Springs/ Small Streams in the Great Basin	
Focus Area: Agriculture/Irrigation and Water Availability/Budget	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• In an extremely arid basin, where water is a precious commodity, accounting for all water is critically important. Springs and spring-fed streams in the Great Basin are critical resources for humans and wildlife, yet we know little about this water resource. • Springs and streams are critical for the millions of acres of grazing rangeland in the Great Basin, yet, there is not a comprehensive inventory of springs in the Great Basin. • There is a lack of information about the flow of springs and small streams. We are not certain about the interconnectivity between small surface streams/ springs and groundwater. There could be springs that were identified on historic surveys/ reports that may no longer be flowing. We could have ‘lost’ water and not even know it.
Affected Area	• Spring-fed regions in the Great Basin • More arid rangelands with fewer surface water resources and fewer tributaries • Rangeland for cattle/ mule deer/ elk • Cultural sites for Tribes
Who is Impacted	• Wildlife (birds, cattle, elk, deer, fish) • Tribal communities • Rural communities/ low density population areas • Ranchers • Rec/ tourism
Current Data	• Historic and disparate USGS surveys and reports • Historic topographic maps

	● Water rights data ● Community knowledge (people living near perennial and ephemeral springs) Ex: tribal elders will say that the spring is still good or not where it used to be ● Images from Drought Impact Reporter (this would disparate) ● SWOT, MODIS, OPERA (all too coarse to monitor water extent) ● Persistent vegetation monitoring (Landsat) ● Springs online: springdata.org ● BLM has spring data ● natural heritage programs (Nevada division) ● NV-UT Spring Snail
Diving Deeper to Know the Problem Better	
Decision Context	● Preservation/ management ○ Pertains to allocation of resources. Knowing the amount of water flowing out of springs gives an idea of the amount of water that can be protected / used. ● Wildlife management ○ How many animals, like elk can, be added to an ecosystem reliant on springs? What is the impact on wildlife? What is the impact on the springs? ● Groundwater planning ○ Where to pump groundwater and the impact on springs
Information Requirements	● Specific characteristics of the information needed to achieve the improvement ○ Need an updated inventory of the existing springs (annually?) ○ Flow rate of springs (both ephemeral and perennial) ● Temporal Resolution ○ Weekly for some (maybe range managers) ○ Annually (groundwater planners) ● Spatial Resolution ○ High resolution to measure surface water extent of streams (1m)
Data Needs and Potential Sources	● What information is needed to achieve the desired improvement? ○ High resolution satellites like Planet Labs to monitor surface water extent of springs ○ NISAR (to detect wetness anomalies and locate/ map springs) ○ Historic Landsat data to map vegetation around potential springs

<table>
<tr><td></td><td>○ Aggregation of historic data on spring location and flow
○ Cattle/ wildlife tracking and monitoring. Can we see where animals are congregating around springs?</td></tr>
<tr><td>Potential Partners</td><td>Great Basin National Park
Western States Water Council (could potentially help pull together disparate data sets)
USGS
Universities (could help with inventory)
Rural communities
Ranching communities (ranch managers)
Tribal communities
Nevada Water Resources Association
Great Basin Water Network (CEO Kyle)
Spring Stewardship Institute
Great Salt Lake commissioners office
State engineers
US Fish and Wildlife Service
State Wildlife Agencies
State Natural Heritage programs</td></tr>
<tr><td>Desired Result</td><td>Continued flow of existing springs
Improved wildlife / herd management
More efficient resource allocation and management
Better/ more comprehensive groundwater planning
Increased understanding of land management on small springs and streams</td></tr>
<tr><td colspan="2">Additional Information</td></tr>
<tr><td>Obstacles</td><td>Potential issues around privacy and trust in sharing data e.g. Private landowners might not want to share which springs are on their land, rural communities, companies, Tribes, etc.
The number of people it would take the monitor springs on the ground could be an obstacle. If remote sensing is possible then we would overcome this obstacle
A fine enough spatial scale of remotely sensed data</td></tr>
<tr><td>Prioritization of Need</td><td>Low hanging fruit, medium low impact
Impact of Achieving Use Case (Scale of 1-8, higher is better): 3
NASA Implementation Difficulty (1–8; lower = harder): 6</td></tr>
</table>

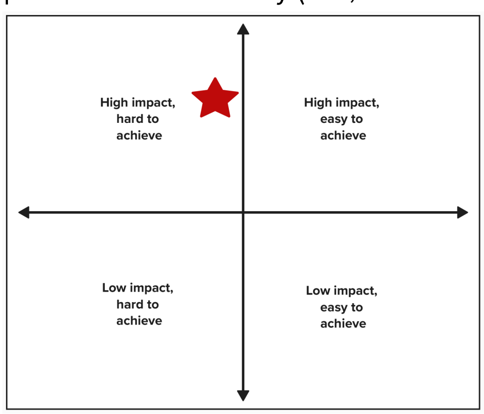
	 For more detail, see **Appendix IV**.

Use Case C-3: Water Budget and Scenario Planning for Farmers

This use case addresses the economic instability farmers and ranchers face due to year-to-year water variability, which often prevents long-term investment in equipment and sustainable infrastructure. By proposing a simplified scenario-planning interface that integrates OpenET data, soil characteristics, and historical crop performance, the use case aims to empower producers to "test" different planting strategies and conservation programs against their specific water limitations before a single seed is sown.

Use Case Title: Water Budget and Scenario Planning for Farmers	
Focus Area: Agriculture/Irrigation and Water Availability/Budget	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• Year-to-year variability and uncertainty makes it difficult for farmers to invest in equipment and supplies for farming (economic impact). Outside of economics, for a farmer to successfully plant, they need to understand their water limitations in any given season. This makes it difficult to plan on a longer time horizon. • Additionally, users lack the ability to play around with water budget scenarios in their approach for planning. Without this, there is high risk to adopt new practices. Inability to adapt can impact longevity of a farmer's / rancher's operations. • Due to decisions happening at a higher level, farmers may be told to reduce water use. • An often-overlooked challenge is the abundance of available resources, most of which are decentralized or buried across multiple websites, making them difficult to access and limiting awareness of what exists. In addition, there is a lack of interpretive material that helps the general public understand these products and use them effectively for decision-making. Agencies often assume that simply providing data is sufficient, but this is only the first step toward truly supporting water users and other stakeholders.
Affected Area	• Irrigated agriculture (farms and ranches)
Who is Impacted	• Farmers • Ranchers • Small/ disadvantages/ family owned/ resource limited farms • Warparound industries (supply and commodities) • Rural communities dependent on agriculture
Current Data	• OpenET • AgMet stations

	● USDA-NASS crop reports ● Lived experiences of farmers and ranchers ● Extension production data ● SNOTEL
Diving Deeper to Know the Problem Better	
Decision Context	● Federal/ state investment in conservation ● Annual operational decisions ○ How many people are employ ○ Materials to purchase ○ Equipment to lease/ purchase ● Investment in farm infrastructure ● Do people want to participate in voluntary and temporary conservation programs ● Knowing how much water one has and where to apply it
Information Requirements	● Specific characteristics of the information needed to achieve the improvement ○ Updated crop water use curves ○ Seasonal consumptive use ○ Leasing/ economic viability of certain crops with certain amount of water ○ Data on historical water years (wet, dry, normal) ● Temporal Resolution ○ Only would update if there was a drastic change in crop compositions ● Spatial Resolution ○ Field level or ranch/ farm level
Data Needs and Potential Sources	● What information is needed to achieve the desired improvement? ○ ET with field based boundaries ○ Soil characteristics (water holding capacity) ○ Historical crop type information and historical ET data ○ Updated crop water use curves ○ Relationships with farmers in order to get information from them about their decision making and their historical crop ● What mission data relates most to this challenge? ○ OpenET, ECOSTRESS, field/ crop type info.

Potential Partners	● Extension programs ● USDA-Farm Services Agency ● State Ag. Agencies ● Farm Bureau ● Farmers
Desired Result	● Farmers have a simplified interface that allows them to "test" crop types to plant during a given season based on data and have a better idea of if they will have enough water. Can give them better planning. Ideally this is a simple UX that anyone can use without training ● Improved economic prosperity of farmers. They do not miss new opportunities ● Improved drought mitigation ● There is better decision making under uncertainty
Additional Information	
Obstacles	● Risk aversion of ranchers and farmers ● Building new tools has associated costs ● Someone needs to own, store, and maintain the data ● Technological accessibility ● Shifting federal priorities can create low expectations for long-term consistency in program support or monitoring—a challenge that can also occur at the state level.
Prioritization of Need	● Medium high difficulty to implement, medium high impact ● Impact of Achieving Use Case (Scale of 1-8, higher is better): **7** ● NASA Implementation Difficulty (1–8; lower = harder): **4**  For more detail, see Appendix IV.

Use Case C-4: Water Budget for Irrigation Water Suppliers

This use case addresses the critical need for irrigation water suppliers to accurately quantify water budgets, including system-wide demand and conveyance losses from aging infrastructure. By integrating high-resolution data from OpenET and SNOTEL with local ecological knowledge, the use case aims to provide a transparent, science-based framework for daily operations and seasonal forecasting, ensuring that water rights and releases are managed effectively to support livelihoods, tribal ceremonial needs, and the health of terminal lakes.

<table>
<tr><td colspan="2">Use Case Title: Water Budget for Irrigation Water Suppliers
*indicates element specific to irrigation water suppliers</td></tr>
<tr><td colspan="2">Focus Area: Agriculture/Irrigation and Water Availability/Budget</td></tr>
<tr><td colspan="2">Summarizing the Problem - Current State</td></tr>
<tr><td>Current State or Water Management Challenge</td><td>● Water availability and use: Irrigation water suppliers must understand how much water is present on the landscape and how it is being used, including both demand and system losses.
● Livelihoods and economic dependence: Reliable water information is critical because many livelihoods depend on water for agriculture, economic activity, development, and regional growth.
● Water as a foundational resource: In the Great Basin, water sustains communities, ecosystems, and wildlife, and holds ceremonial and cultural significance for many communities.
● Aging infrastructure and losses: Much of the water infrastructure is old, contributing to unnecessary losses and making it difficult to accurately quantify the overall water budget.
● Complex decision-making: Water management decisions are complex and must account for rigorous planning, competing needs, and a wide range of water users and stakeholders.</td></tr>
<tr><td>Affected Area</td><td>● Great Basin
● Individual watersheds in the basin
● Municipal/ industrial areas
● Agriculture areas
● Water conservation districts
● Local communities
● Great Basin National Park
● Dugway Proving Grounds
● Tribal communities (multiple states/ counties)
    ○ Important places like the Swamp Cedar for the</td></tr>
</table>

	Goshute ○ Pyramid Lake ● The Great Salt Lake (other terminal lakes)
Who is Impacted	● *Irrigation water suppliers ○ Private irrigation companies ■ Farmers usually under this ○ Irrigation districts ○ Water conservancies ● Water managers who need to decide when to release water (river managers, reservoir managers, etc.) ● Individual users like farmers need to make choices about where to put water and when. ● Energy companies ● State agencies ● Tribal nations ● Wildlife of the Great Salt Lake / terminal lakes (birds, elk, antelope)
Current Data	● * OpenET ● * Weather stations (Agrimet, Nicenet) ● * Private modeling products from irrigation suppliers (FieldNet) ● SNOTEL (NRCS) ● Lived experience/ multigenerational experience/ local ecological knowledge of people who live on the landscape ● Streamflow/ diversion measurement (gages, flow meters) - USGS ● Some data comes from state DWRs ● Forecasting systems for reservoir operations (NRCS) ● Other snow data sets other than SNOTEL ● Public portals
Diving Deeper to Know the Problem Better	
Decision Context	● Irrigation districts ○ They have a right to X amount of water. It depends if their supply is reservoir based or direct flow (mother nature makes the decision). If there is reservoir storage they might work with the Bureau of Reclamation to make a decision of how much to release. They need to know how much they have. ● Agriculture/ individual users ○ Water right holder ■ They need to know how much water they have and they have the ability to make the decision of where to put that water and when. Get to decide best use for water individually

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Can make decisions on a year to year basis
Water shareholder
They are beholden to the irrigation agency to decide when to release water and when.
Might need to be more flexible making decisions in the short-term
* State level compacts
States have agreements that define decision making based on variables like storage levels.
Internal agreements between irrigation suppliers
The general public
Their perspective can drive decision making. For example, people have the desire to save the Great Salt Lake which drives policy making
The media picks up issues and provides information to the public
Decision making timing
For example, Bear Lake holds two years of water so the water managers need to think ahead when making management plans and decisions.
Historical records
Understanding how landscapes act (eg farmland that might have high yield with lower water application). Historical yield information and crop composition
</td>
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<tr>
<td>Information Requirements</td>
<td>
Specific characteristics of the information needed
*Losses:
Conveyance
Individual sources
Infrastructure
Local hydrology
Historical yield
Acreage
Type/ stage of crop
When and how much to irrigate (AI)
Temporal Resolution
* Individuals need
* Whole season resolution/ forecasting
Monthly resolution
and daily/ weekly resolution (how much did they lose in the last 7 days and how much do they expect to lose in the next 14 days?)
* Daily ET in relation to land surface temperature
*Timeframes
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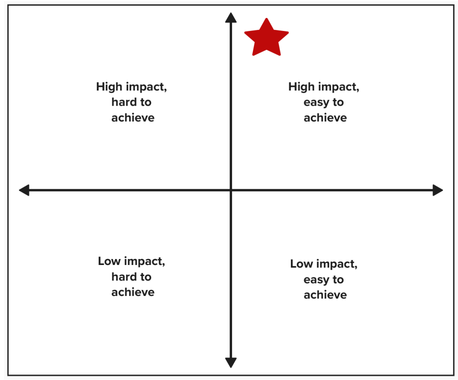
	○ Seasonal ○ Monthly ○ Weekly - irrigation decisions before + ahead) ○ Ex: fluid inv. → 14 days Spatial resolution ● <100m resolution to look at streams ● Reservoir level loss and conveyance loss data ● Field level soil moisture information ● Flood ground → 150k acres ● 3-5 day 50k acres How soon is the data needed for decisions after it is collected ● Daily ● Weekly ● Monthly Preferred data delivery mechanism ● Individual users: Web based applications/ dashboards with a simple UX where decision makers can choose the information they want to see. For farmers, having information on the phone ● Geographically based information systems for higher level water managers ● For public, storyboard style infographics (eg clicking on a picture of a mountain with information that comes up) ○ Tribes also could find this useful to visualize information
Data Needs and Potential Sources	● What information is needed to achieve the desired improvement? ○ Precipitation data ○ Soil moisture ○ * Surface water loss estimates ○ Solar radiation forecasting ○ Wind forecasting ○ Drought forecasting ○ Snowpack storage ○ All parts of the water budget equations ■ Inflows, outflows, loss ○ What crops are growing where and how much ○ Ag statistics ○ Watershed scale crop inventories

<table>
<tr><td>Potential Partners</td><td>The Great Basin Water Network
Utah Water Users Association
State Engineers of Utah and Nevada
State Dept. of Natural Resources
State Dept. of Water Resources
State Dept. of Food and Ag
Federally recognized tribes
Irrigation districts/ conservancies
Central Valley Irrigations
Great Salt Lake Commissioner's Office
USBR Water Smart grantees
Oregon Watershed Enhancement Board who provide grants for projects
Local watershed councils
Bear River
Weaver
Provo</td></tr>
<tr><td>Desired Result</td><td>Irrigation water suppliers have more accurate information to maximize economic impact. They are better able to forecast seasons ahead and more accurately lease water.
Data is transparent and available.
Drought is better forecasted and therefore mitigated.
There will be better internal agreements.
From groundwater budget, able to estimate aquifer storage changing in confined and unconfined aquifers.</td></tr>
<tr><td colspan="2">Additional Information</td></tr>
<tr><td>Obstacles</td><td>Resource limitation of collecting higher amounts of data (limitation of people and financials). Lack of spatial coverage
Format of the data
Who is responsible for storing and maintaining the data
Crop type limitations (historical data and current crops)
Integrating data into an existing decision making process
Trust from these entrenched groups in order to pick this data up
Trust in data but also systems and others
Uncertainty</td></tr>
<tr><td>Prioritization of Need</td><td>High impact and high difficulty of implementation
Impact of Achieving Use Case (Scale of 1-8, higher is better): 8
NASA Implementation Difficulty (1–8; lower = harder): 5</td></tr>
</table>

	 For more detail, see **Appendix IV**.

Focus Area D: Water Infrastructure and Measurement

Facilitator: Paul Tigan, Metropolitan Group
SME: Randy Friedl, Jet Propulsion Laboratory

Participants:

Participant Name	Organization
Bjoern Bingham	Desert Research Institute
Peter Stanton	Walker Basin Conservancy
Rick Forster	University of Utah, School of Environment, Society & Sustainability
Sonam Sherpa	University of Utah, School of Environment, Society & Sustainability

Use Case D-1: Characterizing/Measuring Reservoir Capacity Across the Great Basin

This use case addresses the lack of critical volume and capacity data for the thousands of remote, smaller reservoirs across the Great Basin that are currently unmonitored. By leveraging high-resolution satellite missions like SWOT and NISAR alongside bathymetric modeling, the use case aims to provide water managers with real-time insights into absolute storage, future capacity, and snowmelt-driven inflows to optimize irrigation, municipal planning, and flood risk mitigation.

Use Case Title: Characterizing/Measuring Reservoir Capacity Across the Great Basin	
Focus Area: Water Infrastructure and Measurement	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	Water users have trouble understanding certain characteristics of remote reservoirs, including how long the reservoir will be useful, because of lack of information about: 1. Current Absolute Volume of water in the reservoir; 2. What is the future capacity of the reservoir; 3. How much water will come into the reservoir; 4. Timing of filling the reservoir based on snowmelt, etc.

	Therefore: ● Irrigation planning is not as efficient as it could be; ● Municipal water planning can be a challenge; ● Recreation/habitat of the larger reservoirs themselves is not understood; and ● Flood management - what kind of capacity is needed for flash flooding, overtopping, rain on snow is less effective than it could otherwise be.
Affected Area	● This is true Great Basin wide. The most understood reservoirs are also the most developed reservoirs on the most developed rivers (Tahoe, Reclamation projects); the Wasatch Front is well understood. However, smaller reservoirs (100s? 1000s?) are less well understood). ● But even irrigation districts don't have a great understanding of changing water storage above their operations. The more remote the location, the more difficult it is to manage and maintain.
Who is Impacted	● Irrigation Districts (larger reservoirs) ● Individual irrigators ● Cities ● Federal Land Managers (habitat/smaller stock tanks) ● Department of Transportation (flooding/roads/power/Fiber) ● Recreation Industry/habitat ● Understanding flooding potential in near-real time (e.g., from rain on snow) ● Emergency Managers
Current Data	● Historic Water Use Records: tell us how much water can be held in the reservoir based on how much has come out. (information held by local districts, etc.) ○ Maybe with the NV Water Initiative (better understand the water budget and use across the state). ○ Probably not a "max capacity" number, but a more practical "how much can be used." ● Bathymetry of the reservoir is measured in person/on the ground ("shot" when the reservoir is frozen) ○ Not clear how static volume is. Does it change over time? ○ Time consuming, expensive, limited in practice. ● Confidence in seasonal, sub-seasonal data products is greater the more coarse level. ○ Decisionmakers in more rural areas rely on impressions of the precipitation season (e.g., "Wet" / "kinda wet" / "dry" / "Very dry") rather than quantitative measurements.

<table>
<tr><td></td><td><li style="list-style-type:circle">Timing of information for decisions is not great at the local level.
Wrinkle: For flooding/flood management it's not just the capacity of the reservoirs to hold "extra" flood water, it's the capacity of the entire infrastructure (ditches, canals, floodplains, the actual river) to receive extra water without damaging vulnerable resources.
As a percentage of reservoir capacity? Not known.</td></tr>
<tr><td colspan="2">Diving Deeper to Know the Problem Better</td></tr>
<tr><td>Decision Context</td><td>Irrigation Districts (larger reservoirs)
Releasing water from a reservoir
Crop Production, timing release
General Manager of an Irrigation District
No consulting, just when an indicator is hit (date of the month, etc.)
Larger organizations might be working with the emergency managers, county, etc.
Individual irrigators
The individual farmer or rancher
Cities
Public Works Director, Water Department staff
Federal Land Managers (habitat/smaller stock tanks)
Field Manager/District Ranger/Range Conservationist
Department of Transportation (flooding/roads/power/Fiber)
Utility companies
Recreation Industry/habitat
Flooding (rain on snow)
Emergency Managers
Releasing water from a reservoir
Note: Larger organizations (Reclamation, Utilities, etc) might also use decision support tools (HEC-HMS, Riverware, etc.) in order to make those decisions, but this doesn't solve the smaller reservoir problem identified above.</td></tr>
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<td>Information Requirements</td>
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What are the desired characteristics of the data (spatial/temporal resolution, latency, format, etc.)?

Shorthand classification of reservoirs:
Small - 10acres = 50-100af of water stored (5-10 feet deep)
Medium - 100 acre
Large - 1,000 acres?

Are there specific characteristics of the information needed to achieve the improvement?

Not identified

How often do you need the data? e.g., daily, weekly, monthly, etc.?

Depends on the size and use: the bigger the reservoir, the more often you care.

Is there a specific geographic extent? e.g., statewide, watershed, irrigation district

Across the basin, but the bigger question is with larger reservoirs that aren’t connected to the large systems (Truckee, Walker, etc.)

What spatial resolution is needed? e.g., 1km

The more the better; 100ac - 1000ac

How soon is the data needed for decisions after it is collected?

For storms/disaster mitigation - quickly - hours, not days.
More immediate - direct precip or rain on snow that present flooding risks at reservoirs or below them.

These are decisions irrigators make on a daily basis during times of high water

Seasonal-ish - when there is 30 feet of snow on the ground in the eastern sierras, you have some time to make a mitigation decision.
Seasonal - understanding the max storage capacity over the course of the season. Uncertainty of inflows reduces how much water you can store because you are always holding water for potential melt.

What is the preferred data delivery mechanism? e.g., the cloud

Internet connected dashboard.
Public communication of the information v. the operational API

Are there requirements for data accuracy?

Not Identified

Are there data formats that are most useful to you?

Not identified

Does data need to be modified for input into a model?

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HEC-HMS
Riverware
Hydromapper

</td></tr>
<tr><td>Data Needs and Potential Sources</td><td>

What information is needed to achieve the desired improvement?

SWE above reservoirs
Precip in general
Precip as snow / precip as rian
Bathymetry of the reservoirs
Capacity for capturing floodwaters
Watershed runoff efficiency (absorption v. what keeps running off)

Does this information currently exist (NASA or non-NASA)?

SWE above reservoirs (no)
Precip in general (not really)
Precip as snow / precip as rain (not really)
Bathymetry of the reservoirs (if it’s done)
Infrastructure Capacity for capturing floodwaters (not currently)
Watershed runoff efficiency (absorption v. what keeps running off) (no)

What mission data relates most to this challenge?

SWE above reservoirs (MODIS, NISAR(?)
Precip in general (GPM)
Precip as snow / precip as rain (NISAR?)
Bathymetry of the reservoirs (SWOT? - Volume)
Capacity for capturing floodwaters (DEM models from commercial data buy)
Watershed runoff efficiency (absorption v. what keeps running off) (SMAP, NISAR)

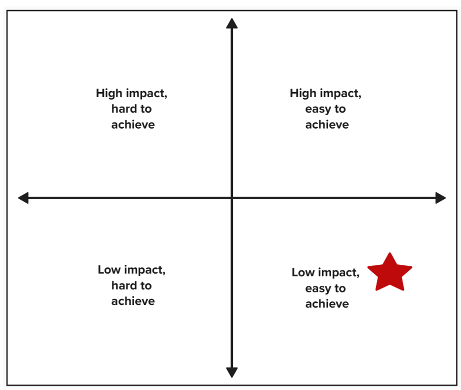
</td></tr>
<tr><td>Potential Partners</td><td>

NRCS
DRI (Sean McKenna, Justin Huntington)
Irrigation Districts
Utah Geological Survey
Bureau of Reclamation
Water Masters in the District Court
DWR
Great Salt Lake Commissioner’s Office
TNC - Utah and NV

</td></tr>
<tr><td>Desired Result</td><td>
More efficient water use

Scheduling releases of water from reservoirs would lead to more efficient use of water - storing the maximum amount possible and also releasing the correct amount so less water is

</td></tr>
</table>

	sent into the system and wasted. ● Would add more flexibility in mid-sized reservoir management (could fill it more or empty it more) ● Resource development for infrastructure development. ○ Quantify the need for resiliency investments. ○ Which reservoirs are capable of more fully supporting their users? Which reservoirs need to be expanded, repaired, etc. ● Better understanding of the water market with more data. ○ Improvement of downstream relationships when there is less perception of waste in the system.
Additional Information	
Obstacles	*Not completed by the workshop group.*
Prioritization of Need	● Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Better than "nice to have" - but not quite "Most important"**. ○ By comparison, other needs are more critical. Snowpack data, for example, is more important. ○ For the larger reservoirs not connected to the biggest systems in the basin, however, more accessible characterization of their reservoirs would be very helpful. ● Impact of Achieving Use Case (Scale of 1-8, higher is better): **3** ● NASA Implementation Difficulty (1–8; lower = harder): **7**  For more detail, see Appendix IV.

Use Case D-2: Closing the Delta between Diversion Rights and Actual Diversions

This use case addresses the critical transparency gap between legal water diversion rights and actual field-level use, a discrepancy that currently fuels system-wide inefficiency and social conflict. By leveraging high-resolution radar and thermal missions such as NISAR and ECOSTRESS to estimate flow and field wetness, this use case aims to provide watermasters with the defensible, real-time data needed to move beyond anecdotal management and ensure equitable, data-driven water distribution across the Great Basin.

Use Case Title: Closing the Delta between Diversion Rights and Actual Diversions	
Focus Area: Water Infrastructure and Measurement	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	Watermasters/Ditchriders don't have a true understanding of how much water is actually being diverted in a system at any one time. This leads to inefficient water use at the individual field level, degraded trust in the water management system (because legal rights don't match actual use), and resource hoarding.
Affected Area	Great Basin surface water systems, though some systems have "more perfect" data and transparency than others. (In general, the more economic activity, municipal water users on a system, etc., the more likely diversions are better understood).
Who is Impacted	Agriculture and other surface water users that might get more water if the system operated more efficiently.
Current Data	• There is a paper system of rights that shows what *should* be happening. There is also anecdotal data held by individual water users in the system (long-time ranchers, farmers and land owners). • USGS Gauges are the primary support for allocation decisions. Those get matched against the paper rights. Ditchriders also collect information about the system through individual observations. USGS analyzes the data.
Diving Deeper to Know the Problem Better	
Decision Context	• The "first in time, first in right" system for allocating water rights and water use is the overall decision context. These rights are administered by the state at the stream/river level. • Ditchriders allow use based on priority dates and the available water flow at the USGS gauges.

<table>
<tr><td></td><td>

Also, the irrigators tell the water master when they are out of water.
The ditchrider makes the water allocation decision on a daily - basis.
How are these decisions made?

By telephone - notifying irrigators that they are in or out of priority.
By hand - irrigators turn on and off diversion structures after communicating with the ditchrider.

Who makes these decisions? Who should make these decisions?

The decision maker is the watermasters/ditchrider
The watermaster/ditchrider
There is significant pressure on this individual from users.

</td></tr>
<tr><td>Information Requirements</td><td>

Are there specific characteristics of the information needed to achieve the improvement?

Water volume across an entire irrigation system, above and below points of diversion would be helpful.

How often do you need the data? e.g., daily, weekly, monthly, etc.?

The decisions are made daily at the height of the season

Is there a specific geographic extent? e.g., statewide, watershed, irrigation district

Great Basin wide.
The districts/rivers/ditchers

50k-100k acres on average for a district.
Smaller districts with more farmers have more of a need than larger districts with better resourced water users (Cities, etc.)

What spatial resolution is needed? e.g., 1km

Water moving through ditches, streams, sitting on fields.

3-5 meters. The Walker River is 10ft across.

How soon is the data needed for decisions after it is collected?

Immediate to be most effective.

What is the preferred data delivery mechanism? e.g., the cloud

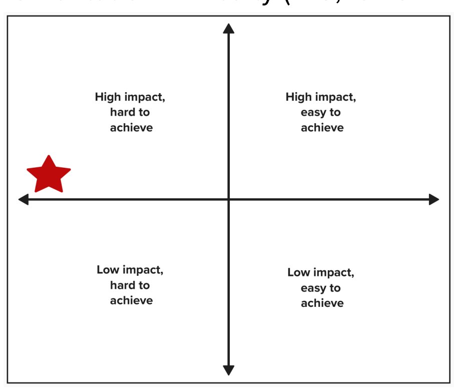
The cloud/mobile app.

Are there requirements for data accuracy?

Probably the amount needed to hold an irrigator accountable - how much do they divert on average?
This is going to depend on the system. Some users have less than 1 cfs rights.

</td></tr>
</table>

<table>
<tr><td></td><td><li style="list-style:none">
There may be value in understanding the overall health of the system, though, even if the individual irrigator can't be separated out.
Are there data formats that are most useful to you?
Does data need to be modified for input into a model?
The only current data being used in the process are the USGS stream gauges, so being able to connect with those would be important</td></tr>
<tr><td>Data Needs and Potential Sources</td><td>What information is needed to achieve the desired improvement?
Data on flow rates
Water flow through ditches
Water flow across fields
Does this information currently exist (NASA or non-NASA)?
USGS gauging
The farmers know how much they are using at the diversion structures (unlikely to share, might not even write it down).
Who produces and/or interprets this data?
It doesn't often exist as data.
What mission data relates most to this challenge?
Interesting test case for NISAR (Ditches over 7m?)
Estimates of flow from height
16 day return interval not great)
SWOT
Some variables might be able to help
SWOT Airborne simulator
Airborne
UAVSAR - very small changes in levees
Very small
Commercial Satellites
Soil Moisture/ET and Diversion - what kind of corollary
ECOSTRESS & Simulator (30-60m)
SMAP is too big (9km)</td></tr>
<tr><td>Potential Partners</td><td>State Engineer's Office
Water Users (Transparency Portal)
Reservoir Operators</td></tr>
<tr><td>Desired Result</td><td>Describe the desired outcome or improvement you would like to see if this management or monitoring issue were addressed. What would improvement look like for the challenge described above? In 1, 5, or 10 years?
Water is more efficiently distributed across the system</td></tr>
</table>

	as the amount of input (snowpack) is falling. ○ Reduction in conflict across the basin ○ Data driven decisions rather than who is the loudest. ○ Can help drive infrastructure investments in the system • Describe how the improvement will assist the challenge (e.g. faster decisions, more confident models, etc.) ○ Key element of improved decision making • Who could help implement the improvement? Who are the end-users? (e.g., *organizations, agencies, decision makers etc.)* ○ Watermasters, state engineers office, irrigators.
Additional Information	
Obstacles	There's a cultural/political barrier to accepting a more regulated system.
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Most Important** - while this would upset the apple cart of how water is currently being managed, it would be critical to balancing out the water across these systems. • Impact of Achieving Use Case (Scale of 1-8, higher is better): **5** • NASA Implementation Difficulty (1–8; lower = harder): **1**  For more detail, see **Appendix IV**.

Use Case D-3: Understanding Changing Snowpack and SWE to locate new resilience efforts like reservoirs

This use case addresses the critical need to quantify changing snowpack and Snow Water Equivalent (SWE) to inform long-term infrastructure investments, such as the strategic siting of new reservoirs. By leveraging NASA high-resolution data to model declining snowpack storage and shifting runoff timing, the use case aims to help water managers and federal agencies identify catchments with the highest resilience potential over a 50-year horizon, ensuring that future water storage projects are placed where they can best capture increasingly volatile and rain-dominant precipitation.

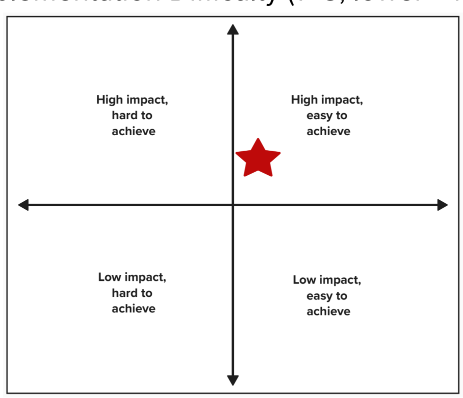
Use Case Title: Understanding Changing Snowpack and SWE to locate new resilience efforts like reservoirs	
Focus Area: Water Infrastructure and Measurement	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• How much water is there in snowpack above reservoirs, and when will it be available? Where is it going? We know there is snow, but we just don't know how much. This problem statement is a combination of how much snow we will have and the timing of when it is delivered. • Water managers may not know how much snow is stored above reservoirs or when it will be delivered for use. Snowpack storage in the region is currently lower than ever before. • Next Level: Can we model/project/quantify the decrease in available volume into the future? How can this information be used to make resilience investments to counter those anticipated changes in snow/SWE?
Affected Area	• This is a basin-wide problem because the entire basin is (perhaps uniquely) snowpack dependent. • It's an even bigger problem the less available data there is today (snow-tel sites…). There are few SNOTEL sites in the Great basin for how large of an area it is, and how many sub-basins there are on the landscape. The north-south orientation of the mountain ranges, and the west-to-east orientation of most weather systems mean there is less consistency from one basin to the next.
Who is Impacted	While all water users would benefit from more accurate estimates of SWE across the Great Basin, the ability to model changes in potential snowpack at spatial and temporal scales relevant to water managers

<table>
<tr><td></td><td>over the next 10, 20, or 50 years would particularly support:
Long-term planning and decision-making
Reclamation and other major water management agencies
Investments in infrastructure for climate resilience
Irrigation districts and land managers with multi-decade planning horizons</td></tr>
<tr><td>Current Data</td><td>Who provides/ analyzes the data?
Snow Water Equivalent (SWE) is primarily a measured parameter.
Very few sites—such as aerial markers—provide SWE estimates.
NRCS produces some SWE estimates based on ground-based SNOTEL sites and other measurements, though coverage in the Great Basin is limited.
SWE is highly place-dependent, due to variability in mountain precipitation.
Additional snow information comes from:
Airborne Snow Observatory (ASO) – mapping snow extent and high-resolution SWE
MODIS satellite imagery (where purchased)
River Forecast Centers distribute snow and SWE information to basin managers.
Unanswered: Which organizations are providing longer-term snowpack projections that could address these questions?</td></tr>
<tr><td colspan="2">Diving Deeper to Know the Problem Better</td></tr>
<tr><td>Decision Context</td><td>Resilience
How are these decisions made?
Depends on the decision maker. Who owns the land (public land, etc.)
If the decision is building new dams/reservoirs, it’s all about what happens behind/above it.
Who makes these decisions? Who should make these decisions?
The federal government makes the decisions about the building of reservoirs on federal land
Project proponents.
Funding decisions for large projects might be made by legislators (state/federal) on the recommendation from community advocates or natural resource management staff (Reclamation, etc.)
What’s the resolution needed?</td></tr>
</table>

	○ The catchment sizes of the potential reservoirs that need to be built. For example: What is the total volume of water contained in the snowpack across a 16,000-acre catchment basin?

Information Requirements	*Note: These requirements exist in SOME areas in the Great Basin (higher use basins) but not the basin as a whole.*
	
	● Are there specific characteristics of the information needed to achieve the improvement?
	    ○ More SWE Data
	    ○ High-quality model projections with greater confidence in future SWE estimates.
	    ○ Not just SWE as a static measurement, but also information on spatial extent, timing of runoff, and related dynamics.
	● How often do you need the data? e.g., daily, weekly, monthly, etc.?
	    ○ This is a planning scale question.
	    ○ Annually is good.
	    ○ SWE changes on a more rapid basis than this, of course.
	● Is there a specific geographic extent? e.g., statewide, watershed, irrigation district
	    ○ Basin wide
	● What spatial resolution is needed? e.g., 1km
	    ○ The information should match the kind of basin that we are thinking about building a reservoir in.
	● How soon is the data needed for decisions after it is collected?
	    ○ Longer tail is ok for planning decisions
	● What is the preferred data delivery mechanism? e.g., the cloud
	    ○ Maps - doesn't need to be a
	● Are there requirements for data accuracy?
	    ○ Appropriate for the use. If the goal is SWE estimates over a 20-year period, this can be a coarsest scale than what is needed for making diversion decisions.
	● Are there data formats that are most useful to you?
	    ○ Not identified.
	● Does data need to be modified for input into a model?
	    ○ Not identified.

Data Needs and Potential Sources	● What information is needed to achieve the desired improvement? ○ SWE, either directly measured or by model. ● Does this information currently exist (NASA or non-NASA)?

	○ Not at the extent that it is currently needed. ● Who produces and/or interprets this data? ○ n/a, though it may be worth investigating if another source exists that could be used as a proxy, or flag this project if one is developed via NISAR. ● What mission data are most relevant to this challenge? ● Digital elevation models (DEMs) to understand runoff and support hydrologic modeling (e.g., NISAR <7 m). ● Snowpack observations: not yet available from current missions.
Potential Partners	● NRCS; Reclamation; NV DWR; USGS, Desert Research Institute ● State Wildlife Agencies (habitat questions with snowpack) ● Who is a project proponent: irrigators, cities, other users.
Desired Result	*No response provided.*
Additional Information	
Obstacles	*No response provided.*
Prioritization of Need	● Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Most important!!** Understanding the snowpack is the existential element of the Great Basin. ● Impact of Achieving Use Case (Scale of 1-8, higher is better): **6** ● NASA Implementation Difficulty (1–8; lower = harder): **5**  For more detail, see Appendix IV.

Focus Area E: Watershed Health and Water Quality

Facilitator: Nick Drushella, Metropolitan Group
SME: Nikki Tulley, NASA Western Water Action Office

Participants:

Participant Name	Organization
Laura Taylor	University of Miami, Rosenstiel School of Marine, Atmospheric, and Earth Science
Meng Zhao	University of Idaho, College of Science, Department of Earth and Spatial Sciences
Todd Caldwell	Desert Research Institute

Use Case E-1: Identifying Point and Non-Point Source Pollution in Water

This use case addresses the critical need for a standardized, basin-wide water quality monitoring system to replace inconsistent and reactionary ground-based sampling in the Great Basin. By leveraging advanced hyperspectral and radar missions like PACE and SWOT, the use case aims to provide high-frequency, uniform data on turbidity, temperature, and algal blooms, enabling water managers to identify pollution anomalies early and make defensible decisions on ecosystem restoration, mining regulations, and public health closures.

Use Case Title: Identifying Point and Non-Point Source Pollution in Water	
Focus Area: Watershed Health and Water Quality	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• Current measures of water quality are based on discrete ground samples that are inconsistent over time and space. Decisions that are made on the basis of water quality or with the intention to understand clear costs and benefits of policy or behavior on the natural ecosystem, water resources, and watershed, are beholden to or limited by this limited scope over time and space. • Information has also been collected by various agencies and entities using diverse methods, and it is not harmonized. The data that exists is very difficult to use and interpret and because it's based on idiosyncratic need, samples are reactionary in many cases, start and stop over time, and not

	consistent and are based on costly sampling. ● Access to this information is limited. There is a great need for uniformly distributing measures of water quality over regular and frequent time periods. ● Until we have this, our research in water quality, and its interaction with broader systems, industry, development, human behavior and health will be limited to only areas and time frames that there had been monitoring activity in the past, placing a stronghold in depth and breadth of our understanding of water quality and how pollutants move through the system.
Affected Area	The Great Basin
Who is Impacted	● All water users ● Policy makers ● Federal, state, and local governments ● Tribal nations ● Recreationists ● FWS ● BoR ● BLM ● Mining bureaus ● Flora + fauna ● Fishing ● Fish
Current Data	● Water quality samples from rivers, lakes, groundwater samples, in-stream sensors. ● Point source monitoring, especially in routine locations. Nearly all ground measures.
Diving Deeper to Know the Problem Better	
Decision Context	● Where to invest in water quality restoration or rehabilitation efforts ● Where, how, and for how long to regulate activity that produces pollutants in water (e.g. pit lakes) ● Where and when to close lakes to the public for fishing and recreation. ● Knowing when to deploy emergency response sampling or investigations for sudden changes ● Where to allocate resources for predicted/ possible future mitigation needs or prevention. ● When and where and how much to rely on remote sensing in place of ground measure ● The ability to access easily robust and standardized information about water quality.

	Having an understanding of how and where groundwater quality influences surface water quality (such as salinity released with reservoir flow, can't put surface flow through certain areas.)
Information Requirements	- Data accuracy doesn't need to be extremely precise – can be blunt - Anomaly screening - Emergency response etc. weekly monitoring of water clarity (turbidity, existence of algal blooms, etc.) during relevant seasons 5m resolution 14 day frequency - Low latency - Est. accuracy/ error - Remote data v. ground - Other measurement for water quality - Grid raster
Data Needs and Potential Sources	- Water quality Measures - Temp of surface water - Salinity - turbidity/ clarity - erosion/ bank/ river extent - Biochemical oxygen demand - Dissolved oxygen - pH - Streamflow - Wave height - Sources - Sentinel - Satellites - Error: the existing ground data compared with remote
Potential Partners	- EPA - Army Corps of Engineers - BoR - USGS - Universities - State and local environmental and water agencies - Tribal governments - DoD
Desired Result	- Uniform, accessible, and regularly updated water-quality data to inform regulatory, management, and policy decisions - Understanding of the limitations and uncertainties of remote data in water-quality assessments

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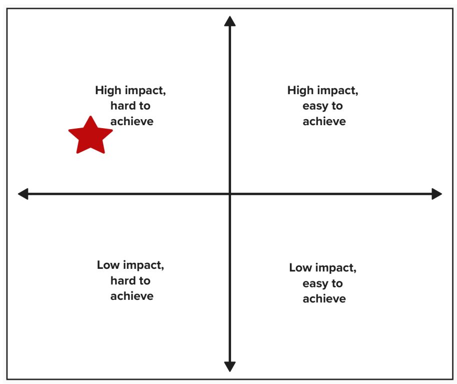
- In the next 5 years develop a system for detecting water quality anomalies (these can be high -cost event to help control + stop early on)

</td></tr>
<tr><td colspan="2">Additional Information</td></tr>
<tr><td>Obstacles</td><td>

- Financial
- Technical. Can we make these measurements from space?
- Spatial resolution is often too course for streams and rivers
  - Coarseness of spatial resolution needs is somewhat unknown—maybe airborne missions may be able to help gage what is necessary

</td></tr>
<tr><td>Prioritization of Need</td><td>

- Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Most important.** This is foundational and so far unobtainable.
- Impact of Achieving Use Case (Scale of 1-8, higher is better): **6**
- NASA Implementation Difficulty (1–8; lower = harder): **2**



For more detail, see [Appendix IV](#).

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Use Case E-2: Improved Access to Information for Rangeland Management and Forecasting with Support for Enhancing Understanding of its Connection to Watershed Health and Water Quality

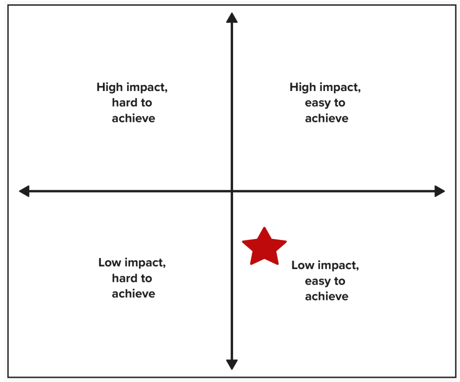
This use case addresses the need for a holistic, proactive management framework for Great Basin rangelands by integrating traditional Bureau of Land Management (BLM) ground surveys with high-resolution NASA satellite data. By moving away from reactive assessments and utilizing predictive modeling for forage yield, soil moisture, and riparian health, this use case seeks to forecast grazing capacity and mitigate the negative impacts of overgrazing on watershed quality and ecosystem resilience.

Use Case Title: Improved Access to information for Rangeland Management and Forecasting with Support for Enhancing Understanding of its Connection to Watershed Health and Water Quality

Focus Area: Watershed Health and Water Quality	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	● Currently, rangeland is not holistically managed in a timely manner that takes into consideration the rangeland and riparian health. Ranch leasing/rangeland management is reactionary and this is based on ground based data and previous year's data; forecasting is not done; forecasting rangeland management. There is a lack of observational information on point/non-point pollution. ● We are constrained by more narrow objectives by land management agencies (e.g., BLM); it doesn't leave room to understand more holistic health of riparian areas/ecosystems. ● Managing cattle grazing on rangeland needs to happen in a more timely manner, and taking into consideration rangeland health but also riparian health. ● (Theory) Right now, watershed health is negatively impacted by the lack of forecasting ability about where to effectively put cattle.
Affected Area	Rangelands in the Great Basin
Who is Impacted	● Ranchers, ● Land managers ● Future rangeland managers ● Water users ● Politicians ● Policy makers ● Fauna + flora
Current Data	● BLM rangeland health surveys; very granular and parcel by parcel. Include vegetation and soil quality, etc. ● Survey meant to be annual but really are every 5-10 years
Diving Deeper to Know the Problem Better	
Decision Context	● BLM determines parcel-by-parcel where cattle can graze, based on surveys, and sets prices to manage overgrazing for grazing leases. ● Currently: focuses on grasses, no so much on overall ecosystem health including groundwater, streams, rivers, and lakes (riparian zones)

Information Requirements	● Current: ○ Grassland species, erosion, cattle numbers ● Desired: ○ More timely estimates of grassland species and “yield” for foraging. ○ For forecasting, not just reactive parcel change availability. Capability to make seasonal forecasts before cattle are brought in. ○ Better and more timely (and uniform) measurements of soil moisture, forage production, erosion, species health, streamflows, fish species and/ or spawning areas where “fertilizers” (waste) is applied, where burns are, and any possible measurements of water quality like algal blooms/ erosion/ etc. ○ This last part about ecosystem measures is more for assessing impacts of range policies in a timely manner ○ Resolution should be the most granular to match BLM transaction data. 30m or 10m if possible.
Data Needs and Potential Sources	● The data exists in disparate forms (BLM, NASA products) but not in an integrated way. ● BLM survey data should be paired with NASA data to help build more robust interstitial estimates, and values add both ways]. ● NASA surveys.
Potential Partners	● BLM ● Farmers/ ranchers (farm practices/ fertilizer) ● NRCS (predictors for streamflow/ snow) ● NOAA ● USGS (vegetation index) ● Western Ecological Research Center ● USDA ● DOD ● Western Governor’s Association ● TNC/ other NGOs ● Universities ● Tribal nations ● ADAF- GIP program
Desired Result	● Better way to manage rangeland and grazing practices. We should be able to, in five years time, know if we are making improvements in rangeland productivity (for stakeholder objectives) and also track patterns of how rangeland practices correlate with change in water quality and watershed quality. From this, we should be able to know (forecast) patterns of algal blooms and how they change with changing rangeland

	practices. ● We will be better able to quantify externalities on resource health from rangeland behavior and build cost/ benefit into lease price to incorporate incentives for overall ecosystem health. ● We also hope to have better knowledge of the error bounds/ accuracy of remote sensing info by "ground truthing" with BLM surveys. This actually provides a unique opportunity to do this. ● This information will help both on the ground levels and bigger picture challenges such as adapting watershed changes. ● In five years we hope that all ranchers, BLM, and stakeholders have easy access to gridded , and temporal information on these integrated aspects. This will help quantify notoriously difficult-to-measure patterns like those related to post source pollution that is uniform in measurement distribution and not subject to political/m constituent practices.
Additional Information	
Obstacles	● Time and money to integrate data, making it accessible, and combining surveys ● Adoption: Will improved management practices drive uptake? ● Process of getting federal agencies to incorporate new information to augment their surveys (implementation administratively). ● Access to existing BLM survey data ● Uncertainty at the outset to whether remote sensing data is "good". How big is the potential error? We will find out, which is a [bet? Or boon?] either way to science, but could be an obstacle if not usable in the short term.
Prioritization of Need	● Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Very Important**. Potential for high impact, easy to use and deploy, and wide ranging use. Saving a need that exists specifically stemming from cattle, but can be applied in any ways in measuring and understanding ecosystem health. ● Impact of Achieving Use Case (Scale of 1-8, higher is better): **3** ● NASA Implementation Difficulty (1–8; lower = harder): **5**

	 For more detail, see **Appendix IV**.

Use Case E-3: Post Disturbance Restoration for Ecosystem/Watershed Health

This use case addresses the lack of a standardized baseline for landscape health, which currently hinders the ability of land managers to quantify damage from wildfires, mining, and flash floods or measure the success of restoration efforts. By utilizing NASA OPERA data and high-resolution vegetation mapping, this use case aims to retroactively establish ecological baselines and provide empirical, monthly monitoring of plant recovery and soil stability to ensure restoration investments are effective and evidence-based.

Use Case Title: Post Disturbance Restoration for Ecosystem/Watershed Health	
Focus Area: Watershed Health and Water Quality	
Summarizing the Problem - Current State	
Current State or Water Management Challenge	• There is not a standardized baseline of landscape characteristics, type, species, ecosystem health to compare post disaster impacts and measure impacts of restoration efforts • A challenge is to effectively implement restoration and know the impact of disasters on ecosystem health.
Affected Area	• Areas affected by disturbances or post disturbance (wildfire, solar fields, mining) • Flash floods
Who is Impacted	• Land management agencies • Landowners • Insurance companies • Ecosystem
Current Data	• On-the-ground surveys post fire (costly to deploy, safety issues) • Burned area emergency response • Disparate land use satellite data • (USFS + BLM)
Diving Deeper to Know the Problem Better	

Decision Context	• Where and how much to rehabilitate landscape
	    ○ What is the baseline we are trying to get back to
	    ○ How has the ecosystem changed pre-post

Information Requirements	• Landscape characteristics • 5m- 10m resolution • Monthly • High accuracy

	• Latency not super important

Data Needs and Potential Sources	• Landscape and land use attributes
	• Vegetation coverage and type (and complexity)
	• Species identification and density (flora + fauna)
	• Soil characteristics (quality, temp, moisture)
	• Chemical measurements in soil or water
	• Pair this info with classifications
	  ○ Type of landscape
	  ○ Type of forest
	  ○ Type of ecosystem
	  ○ Disturbance amount/ intensity
	• NASA OPERA data (meets most requirements)

Potential Partners	• USGS • BLM • NGOS • Landowners • DOD • US Fish and Wildlife Service • State Wildlife Agencies • State Forestry Agencies • USDA NRCS
Desired Result	• To be able to restore ecosystems and watersheds; monitor recovery • Know the extent and nature of damage and/or contamination. • To be able to empirically track restoration methods, intensity on how successfully they are compared to no restoration. • Retroactively estimate gridded landscape and ecosystem characteristics and study historic events
Additional Information	
Obstacles	• Regulation for restoration • Financial • Post-restoration monitoring • How do we quantify plant recovery and can it be remotely sensed? (basal cover, NDVI, heights?)
Prioritization of Need	• Is this use case regarded as Most Important (MI), Very Important (VI), or Important (I)? = **Very Important**. To effectively and efficiently develop and baseline for post disturbance restoration • Impact of Achieving Use Case (Scale of 1-8, higher is better): **4** • NASA Implementation Difficulty (1–8; lower = harder): **5**

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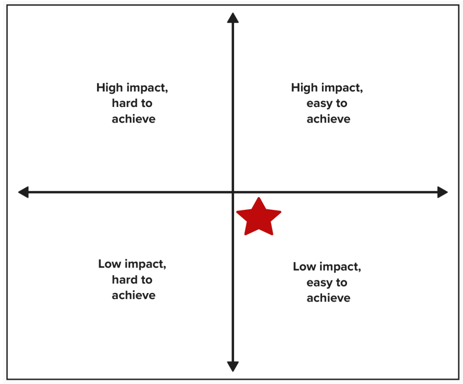

For more detail, see Appendix IV.
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Report Review Process

Following the workshop, each breakout group facilitator entered notes from the use case discussions into the corresponding use case template and drafted the initial text. The group's subject matter expert then reviewed and refined the content. While the approach varied slightly among groups, this was the general process. The WWAO Program Manager subsequently reviewed the full report, making edits, adding content where needed, and ensuring consistency in formatting and presentation across all use cases. The draft report was circulated to workshop participants, facilitators, and subject matter experts for review, with particular emphasis on the use cases they helped develop. It was also shared with federal agency representatives who were unable to attend due to the government shutdown, as well as with NASA Acres and NASA FireSense to identify any additional needs that should be documented. Six reviewers provided comments, which the WWAO Program Manager incorporated into the final text.

Summary and Conclusions

Use Case Development

The NASA WWAO Great Basin Needs Assessment Workshop took place in person in November 2025. This report provides an overview of the Great 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 and SMEs for review, and comments were received from 6 reviewers.

The workshop's overarching goals were to:

1. Generate ~15-20 use cases within identified focus areas that describe water resources needs and challenges in the Great Basin
2. Strengthen relationships between WWAO and stakeholders within the Great Basin (e.g., end users, water managers, decision makers, etc.)
3. Collect stakeholder input to help inform NASA's future science priorities and support the improvement of the relevance and impact of NASA research and data.

During the workshop, five 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:

- Hydroclimate Extremes, Variability, and Risk
- Groundwater–Surface Water Interactions
- Agriculture/Irrigation & Water Availability/Budget
- Water Infrastructure & Measurement
- Watershed Health & Water Quality

The workshop met all 3 of its goals: a total of 17 use cases were developed, relationships were strengthened between WWAO and stakeholders within the Great Basin, and WWAO gathered information from stakeholders to improve NASA's future science endeavors.

Appendix I: Use Case Topic Brainstorm

As part of the Use Case creation process, on Day 1 of the Great Basin Needs Assessment participants brainstormed potential use case ideas in two concurrent sessions. These brainstorms were then posted for the entire workshop group to review and "vote" on which ideas struck them as particularly intriguing. The voting was based on the titles alone, though the group was engaged in conversation as they conducted the gallery walk/review session. What follows below are the dozens of use case ideas and the number of sticker dot "votes" each idea received. The focus area groups used these brainstorms as a potential starting point for their more detailed work on Day 2.

Use Case Topic	# of Sticker Dots
Focus Area A: Hydroclimate Extremes, Variability, and Risk	
Connections to Soil Moisture + snow distributions + how it relates to runoff efficiency.	4
Spring snowmelt flood forecasting in ephemeral regions. Challenging for localized snowmelt flooding.	3
Spatially distributed snow temp or cold content of the snowpack for runoff timing prediction. Would inform communities and ranchers on the timing of the melt.	2
Understanding hydrological impacts of snow drought. (veg health, soil moisture, fuel moisture)	2
Need better definition of flash drought for the GB and snowdrought for water resource management applications	2
Need more climate science capacity: Streamflow, crop demand, groundwater, storage capacity in snow. Concern: decreases in water supply.	2
Risk - flooding + streamchannel change.	2
Risk - Dust on snow impacts.	2
Lack of spatially distributed soil moisture observations	1
Basin is such a broad area to measure SWE / airborne snow obs. Lots of data in the Sierras, not much in the Great Basin	1
Better understanding of precip type (rain vs. snow) / and what elevation the phase change occurs.	1
Groundwater response, season to season.	1
Aquifer storage recharge (ASR) - need more people that understand how to do this.	1
Need better insight into how much groundwater we have + use.	1
Variable/uncertain teleconnection patterns.	1
Models aren't using observations for snow temperature	
Improved understanding of spillover precip. (a big forecasting challenge) Spillover-precip on the leeward side of the mountain range.	
Spatially distributed precip observations in complex terrain.	
(Fire) fuel moisture monitoring, lack of spatial FM estimates + species dependence.	
Post-fire changing of soil properties (Water runs out of the burnt ground).	
Connection between long term drought → forest health→ wildfire AND infestations (ex pine beetle).	
Flash flood risk mapping (from both flooding and erosion concerns) (Mostly summer time events).	

High resolution measurement of air quality (particulate matter, opacity) air chemistry would be great!	
Timing of streamflows is huge.	
As streamflow timing changes, it can be less useful for farmers causing them to use groundwater more.	
No interaction between groundwater consumption and drought conditions.	
Frequency of fire + water quality conditions.	
The biggest flood risk comes from rain on snow events (in Sierras). In other areas it's precip.	
Water storage affected by wildfire (sediment loads).	
Risk - flooding destroys infrastructure + inhibits ability to respond.	
Risk - post wildfire increase in debris flow.	
Risk - drying out of terminal lakes >dust on health, real estate, ecosystem + economic impacts, hydrological impacts, reduced lake effect snow, snow albedo.	
Better S2S (subseasonal-to-seasonal) forecasts would allow for much improved reservoir operations.	
Focus Area B: Groundwater–Surface Water Interactions	
Measure, map connectivity of groundwater aquifers and surface water.	9
How much water ecosystems and humans use? Is there a tipping point as water availability decreases.	5
Quantify changes between surface water and groundwater.	5
Improve connectivity between groundwater and ecosystem health.	4
How much irrigation becomes return water.	4
How groundwater changes with diff irrigation practices and/or land use changes - land development or conversion to urban areas.	3
Water budget.	3
Ground water measurement and prediction: Quantity, Recharge, Quality.	2
Mapping connectivity of groundwater aquifers.	1
Understanding water use from surface and ground waters particularly where measurements are absent.	1
Quantify transport of pollutants across aquifers and Surface Water-Groundwater .	1
Locating Mines/Mining activity: Heavy water users and Impact to water quality.	
Measure water storage in lakes and/or other Surface Water bodies.	
Soil Moisture is a predictor of flows. Measure SM - surface, root zone, vertical profiles.	
Measure grazing fields to decide grazing permits, detect over grazing.	

Where can we recharge snow melt injection wells, measure the effectiveness of ground water recharge.	
Extend current Satellite data into the past. Retroactive analysis, etc.	
Focus Area C: Agriculture/Irrigation and Water Availability/Budget	
Correction/adjustment of soil moisture products. There is a need to validate especially in ag settings.	4
Testing scenarios for different water budgets. This is something farmers want. There are not accessible tools that integrate data in a format that landowners can use.	4
Accessibility of data. Easier to access, more timely. There is a perceived high bar. Technically challenging. NASA products use a lot of acronyms, use of plain language, etc. This includes access to historic data.	4
Understanding water use in natural systems/landscapes. e.g. understanding ET on non-ag landscapes.	4
Need better and more precipitation measurement in ag areas. Also need finer resolution.	3
What measurement(s) relate to uncertainty? How do we quantify uncertainty?	2
Improving understanding/assessing contribution of springs.	2
Limited understanding of carbon sequestration as relates to soil characteristics. Connects to how water is managed.	1
Regenerative ag: quantifying benefits & discerning tradeoffs.	1
Making crop inventory more accurate (what crop & how much). Important for water budgeting purposes.	1
Understanding soil management and how that impacts consumption and ET.	1
Improving understanding of how runoff efficiencies vary across the Great Basin. What are the drivers of runoff efficiency?	1
Irrigation forecasting + monitoring for farmers needs a longer time horizon, and needs to be adaptable to irrigation methods.	1
Lack of observations (meteorological/hydrological) at mid-elevation rangeland. Determining grazing.	1
Remotely measuring plant-water stress.	1
Timing of water deliveries. Water is coming down earlier.	1
Predicting extent of field/crop loss during surface water droughts.	
A lot of data is old. AG needs more complex data. Need to understand consumption under different agricultural conditions.	
What is the impact of wildfire on hydrological response/system?	
Higher resolution gridded weather data for reference ET.	
LTPBR (Low Tech Process Based Restoration)(beaver dams, beaver dam analogs, post assisted log structures) What is the impact? Where to implement? Where will it work? Is it resolving issues or making them?	

Water quality - pollution runoff, salinity. Understanding behavior of different pollutants during runoff. Lack of uniform measurement.	
Pollinator migration (insects + birds) mismatch when plant/crop is at point to be pollinated. Impacted by climate variability including water.	
Finer spatial resolution in non-ag setting e.g. small streams, tributaries. Look at streamflow at a finer scale. They are often not gaged. These tributaries contribute to larger streamflow.	
Higher resolution snow measurement (higher spatial + temporal resolution) - Improved Water forecast. Including ephemeral snow zones.	
Measurement of water supply + use. Need better understanding, more accessible data.	
Risk alternatives & tradeoffs. Mapping conveyance loss & quantifying that tradeoff.	
Translate climate uncertainty on water availability.	
Measuring resiliency to drought at a crop level.	
Overuse and over-allocation of water (poor measurement of supply + people building livelihoods, etc...)	
Focus Area D: Water Infrastructure and Measurement	
There are large gaps in precip measurement across the Great Basin; also between Snow and rain.	9
There is an acknowledged gap in knowing where surface water is being diverted for beneficial and/or ecological use.	5
Why are streamflows decreasing when inputs/outputs are constant?	5
Measuring groundwater depletion between adjacent competing users!	4
Measuring ungaged water systems and reservoirs and distribution systems (many <10 in width) across the GB.	3
Characterizing subsurface geological formations to understand Managed Aquifer Recharge potential.	3
Forecasting the value of snow as it is stored as snowpack (Coming later, melting earlier).	3
Measurement: Absolute quantities of groundwater into sub-aquifer levels.	2
Measuring Canal leakage/Aging infrastructure (City of Fenlee example).	2
It's too expensive/time-consuming to complete groundwater unit budgets (Only 2 of 256 have been completed).	2
Detecting/Inspecting water infrastructure condition.	1
Paper Water v. Wet Water.	1
What are the intersections of fault lines and existing infrastructure?	
Groundwater measurements?	
Water Quality: where do treated or overflows go?	

Key theme: Uncertainty in decision support data.	
Lack of reservoirs on Humboldt River + Conflicts b/w groundwater & surface conjunctive mgmt + Uncertainty of timing of precip.	
Pump Storage Battery Projects.	
Measuring effectiveness & future site selection of Managed Aquifer Recharge.	
Focus Area E: Watershed Health and Water Quality	
We don't know how to accurately measure riparian health (and it's not done consistently).	7
We don't know how long ecosystem recovery takes downstream from a snow drought.	5
Dissipating water streams. We don't know where the water is coming from (within the Great Basin + on reservations) and where the water is going.	3
Impacts of cattle on watershed health + water quality. we don't know enough. Moving livestock from summer camps to winter camps (when should we do this? Do cattle have areas to graze, naturally? Or do we need to bring in hay, etc.	3
We don't know how aquifers/ground water are connecting + how it impacts water quality.	3
Stream temperature impacts on salmon: - there isn't a way to measure this now + this has implications on fish, etc.	1
We don't know where we should plant trees (for reforestation to improve watershed health (how will land cover change impact watershed health?)	1
We don't know the origins of certain water sources (including springs, etc.)	1
We don't know where we should focus our restoration projects. What are the sustainable necessary water requirements for supporting the sustainable ecosystems?	1
How much water do we lose to the climate (drought, etc.)?	1
Salinity measurements - it's not consistently measured right now. It could have a big impact on the saline lakes in the basin.	
Global picture of stream flow; there isn't high enough resolution (in some places) We can't measure tributaries accurately to give us a better picture of watershed health (including how much water farmers/etc are using) who might be polluting.	
Impacts of wildfires on watershed health + water quality. we don't know how wildfires impact watershed health.	
What are the impacts of fertilizer, runoff on watershed health + quality?	
Why is there a loss of water in lakes (+ impacts on birds, fish, etc) - we don't know why water is disappearing.	
We don't know how fracking impacts water quality.	
How does declining water quality in the basin (at different scales) impact migrating birds, other animals, etc?	

We don't know how wildfires impact water quality.	
We don't know how dust emissions impact air/water quality.	

Appendix II: Headline Writing

A new exercise for this Needs Assessment workshop, participants were asked to imagine how one of the Use Cases they developed might actually be pursued and achieved in the specific context of the Great Basin. Though the results of this activity varied, it did give the participants a way to consider the elements of success beyond NASA delivering the needed data for a successful Use Case.

The results below are ***imagined possibilities*** that were designed to be a creative break from the analysis of the earlier portions of the assessment and perhaps foster creative ways to see the possibility for change within the Basin. What follows below is an overview of the activity from each of the focus area groups.

Hydroclimate Extremes, Variability, and Risk

GROUP EXERCISE - Imagining this future headline:
"Our Terminal Lakes are Disappearing: We now know Why, How, and What it Means"

The Big Change: The stark reality that our Great Basin terminal lakes are disappearing is no longer a mystery, thanks to a pioneering initiative that has revealed why, how, and what this catastrophic shift means for the region. The launch of a new terminal lakes dust monitoring program, **leveraging space-based observations,** now provides a profound new understanding that these lakes are shrinking dramatically, impacting everything from water and air quality to local snow processes and dust emissions. This allows us to track changes in lake size and assess their regional impact in near-real-time.

The Data + Partners: This breakthrough is powered by data and partners utilizing an impressive suite of satellite assets. OPERA SWOT and space-based Lidar provide daily, 10-meter resolution data on water recession, depth, and area; EMIT and future sensors offer hourly, 1-kilometer resolution on dust chemistry; and private-sector, NASA-funded sensors track dust movement using HYSPLIT and WRF models. Furthermore, daily, 30-meter, highly accurate measurements of dust deposition—including snow darkening and radiative forcing from hyperspectral sensors—now inform snowmelt predictions. This wealth of information is driven by a diverse coalition of partners, including Ski Resorts, Water Managers, Forecast Agencies, and the DEQ.

The Story/Stakeholder: The resulting story for stakeholders is one of newfound empowerment: the DEQ now possesses unprecedented information for better planning, public health warnings, and prioritization of mitigation and remediation efforts, leading to a clearer understanding of water quality. The data also supports eco-conservation by ensuring lake levels for birds and fish are well-managed, aids ski resorts in season-closure planning, and enables better socio-cultural management to buffer negative effects on communities and tribes.

The Next Challenge: With this knowledge in hand, the next challenge is to translate tracking into action. This involves securing improved water allocations, exploring geo-engineering for re-vegetation, developing a new water rights approach, sustaining and utilizing existing terminal lakes in partnership with local communities, and ultimately, using the data we now have to fix the problem we can finally track.

Groundwater–Surface Water Interactions

GROUP EXERCISE - Imagining this future headline:
"Water Crisis Avoided: The Great Salt Lake Commissioner can sleep at night!"

The Big Change: In a significant win for conservation and policy, a monumental effort to restore and maintain the critical functions of the Great Salt Lake (GSL) has shifted the narrative from impending collapse to cautious optimism, allowing the Great Salt Lake Commissioner to finally sleep at night. This turnaround stems from an unprecedented, unified strategy to stabilize the lake's threatened water levels and ecosystem.

The Data + Partners: This success is underpinned by cutting-edge NASA data and a massive coalition of partners. The effort relies on a specialized suite of satellite tools: SWOT measures discharge, GRACE tracks the groundwater budget, satellite-based ET (evapotranspiration) quantifies water loss, SMAP monitors salinity, Landsat/ECOSTRESS tracks surface temperature, EMIT measures dust, and PACE assesses water quality and algal blooms. This powerful data is guided by partners spanning government, conservation, and industry, including NASA, the UT GSL Commission, the GSL Advisory Council, the USGS, US Bureau of Reclamation, The Nature Conservancy, Audubon, and key industrial players like US Magnesium and Compass Minerals.

The Story/Stakeholder: The achievement is a testament to stakeholder cooperation, as evidenced by the GSL Commissioner's statement: "Ground water contributions to the GSL have been stabilized because agriculture has cooperated to balance water use with water supply." This crucial collaboration with the agricultural sector demonstrates that economic viability and environmental health can be achieved through shared responsibility and data-informed decision-making.

The Next Challenge: While the immediate crisis is averted, the work is far from over. The next challenge remains significant: the need to effectively address climate change, which is predicted to increase evaporation and regional water needs, all while managing sustained population growth in the surrounding areas.

Agriculture/Irrigation and Water Availability/Budget

GROUP EXERCISE - Imagining this future headline:

"Every drop counts! In the Nation's Driest Basin, new Science Partnerships Spring Knowledge Forward"

The Big Change: In the Great Basin, where water is a vital and scarce resource, stakeholders came together in 2025 and realized there was a gap in inventorying the thousands of freshwater springs across the 135 million acres of the basin. After five years, we now know where all 2,600 springs are.

The Data + Partners: NASA's Western Water Action Office partnered with University of Utah, the Spring Stewardship Institute, and the Goshute Tribe to map springs across the Great Basin. Data from NISAR and Landsat were used to identify and expand spring inventory, and monitor the health of springs and spring-fed streams.

The Story/ Stakeholder: Goshute Water Ecologist, JT Standing Bear says, "These springs and spring-fed streams are critically important resources. They provide water for people, wildlife, ranches, and communities–and they hold immense cultural importance for our tribe. I feel more comfortable knowing more about these sources that are critical for the longevity and preservation of land and wildlife"

The Next Challenge: Now that we know where these springs are, stakeholders and scientists want to understand how these springs and spring-fed streams are interconnected by mapping and modeling groundwater connectivity.

Water Infrastructure and Measurement

GROUP EXERCISE - Imagining this future headline:

"NASA Data Keeps 100% of Farms Operating on House River as Water Supply Crashes"

The Big Change: In the face of a catastrophic decline in water availability, the House River system achieved a monumental feat: keeping every single farm operational. This success was driven by a NASA-powered dashboard developed in collaboration with local partners, which empowered the ultra-efficient use of every drop of water across the system. This unprecedented level of control was made possible by new NASA capabilities that measure local level streamflow, reservoir levels, and points of diversion with complete transparency for all users. This initiative crystallized a unique partnership between the State Engineer, the Irrigation District, and individual farmers, all committed to trying the new tool when certain shutoffs loomed, united by the goal of keeping every farm online.

The Story/Stakeholder: The shift to data-driven management produced immediate and measurable results, serving as powerful indicators of success. The most notable outcome was the dramatic reduction in Complaints & Conflicts as experienced by the Water Master; court disputes and law enforcement calls plummeted. The tangible relief was perhaps best captured by Gary Glass, the House River Ditch Rider, who remarked: "Two months into the season, I called Verizon four times because I was convinced my phone was broken." This efficiency has fostered resilience, as an Impacted Community member noted: "Everyone knows there's less water than before. What's amazing is that our community keeps going because we've found a way to make the most of what we have."

The Next Challenge: Looking ahead, the success on the House River is shaping the future economic landscape. State and local communities are now finding new ways to co-develop economic engines that link high-tech industries with agricultural industries, all relying on the foundation of efficient water use practices driven by comprehensive supply data. The ultimate challenge now is utilizing these accurate water availability forecasts to guide responsible policy, specifically by putting realistic limits on growth to ensure long-term sustainability for the entire region.

Watershed Health and Water Quality

GROUP EXERCISE - Imagining this future headline:

"Daily pixel to point Satellite Water Quality Monitoring has the Great Basin Thriving" OR "From Poop to Prosperity: The Great Basin Swims Again"

The Big Change: The Great Basin has undergone a "big change" thanks to a landmark initiative that allows for daily, pixel-to-point monitoring and measurement of water quality across all its reservoirs and streams. This new capability has been instrumental in mitigating potential ecological disasters and driving a significant improvement in overall riparian health.

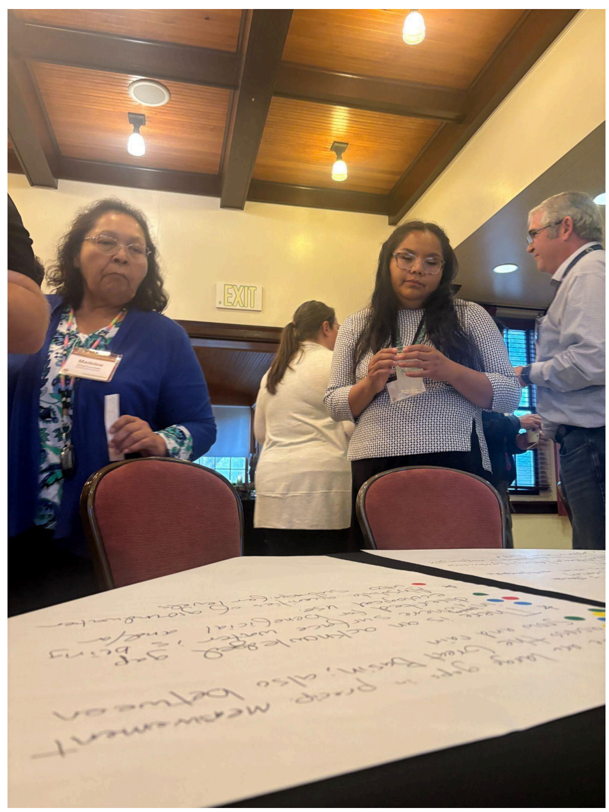
The success hinges on the first-ever standardized mapping of both point and non-point source water pollution, providing managers with the precise data needed to safeguard the entire watershed.

The Data + Partners: This revolution is powered by NASA's advanced satellite tools that provide crucial daily measurements of key contaminants, including salinity, stream temperature, turbidity, and dissolved oxygen. The system achieves its precision by harmonizing data from the SWOT, NISAR, and GRACE missions, working in close collaboration with USGS ground samples. This integrated new tool doesn't just measure; it forms a robust early warning system for potential disasters, providing partners with the lead time necessary to act.

The Story/Stakeholder: The real-world impact is best told through the actions of local leaders. As the story goes, Sheriff Brody—tasked with safeguarding the region—was able to quickly contain several potential disasters by using the new data. He could rapidly identify pollutants within the watershed and mobilize on-the-ground actors for targeted clean-up efforts, leading directly to improved overall riparian health.

The Next Challenge: While the current system is already improving management, scientists recognize that the next challenge lies in achieving truly comprehensive water quality assessments. This is hampered by technical challenges associated with existing NASA missions. The path forward involves future satellites and instruments that will provide even more detailed information, delivered faster and better, ensuring the longevity and prosperity of the Great Basin's water resources.

Appendix III: Workshop Photos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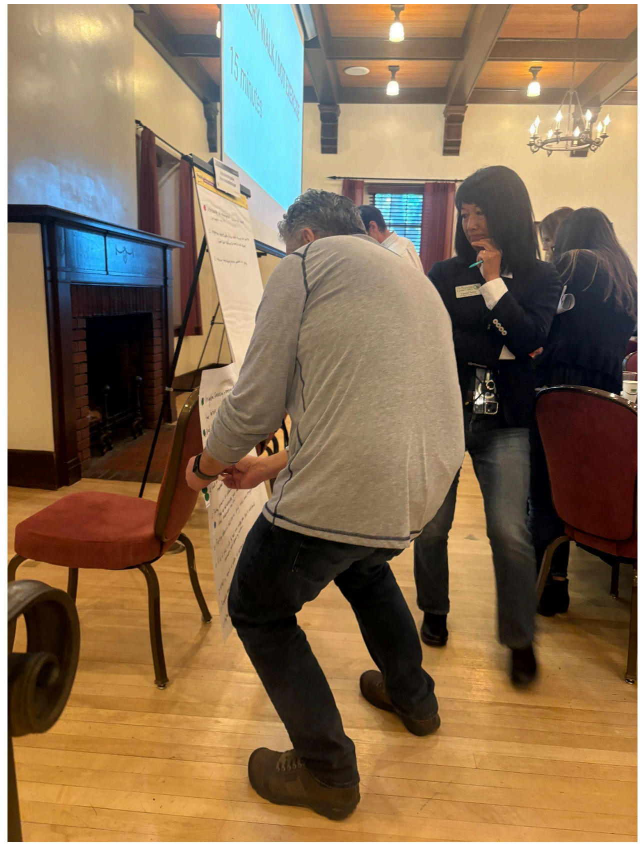


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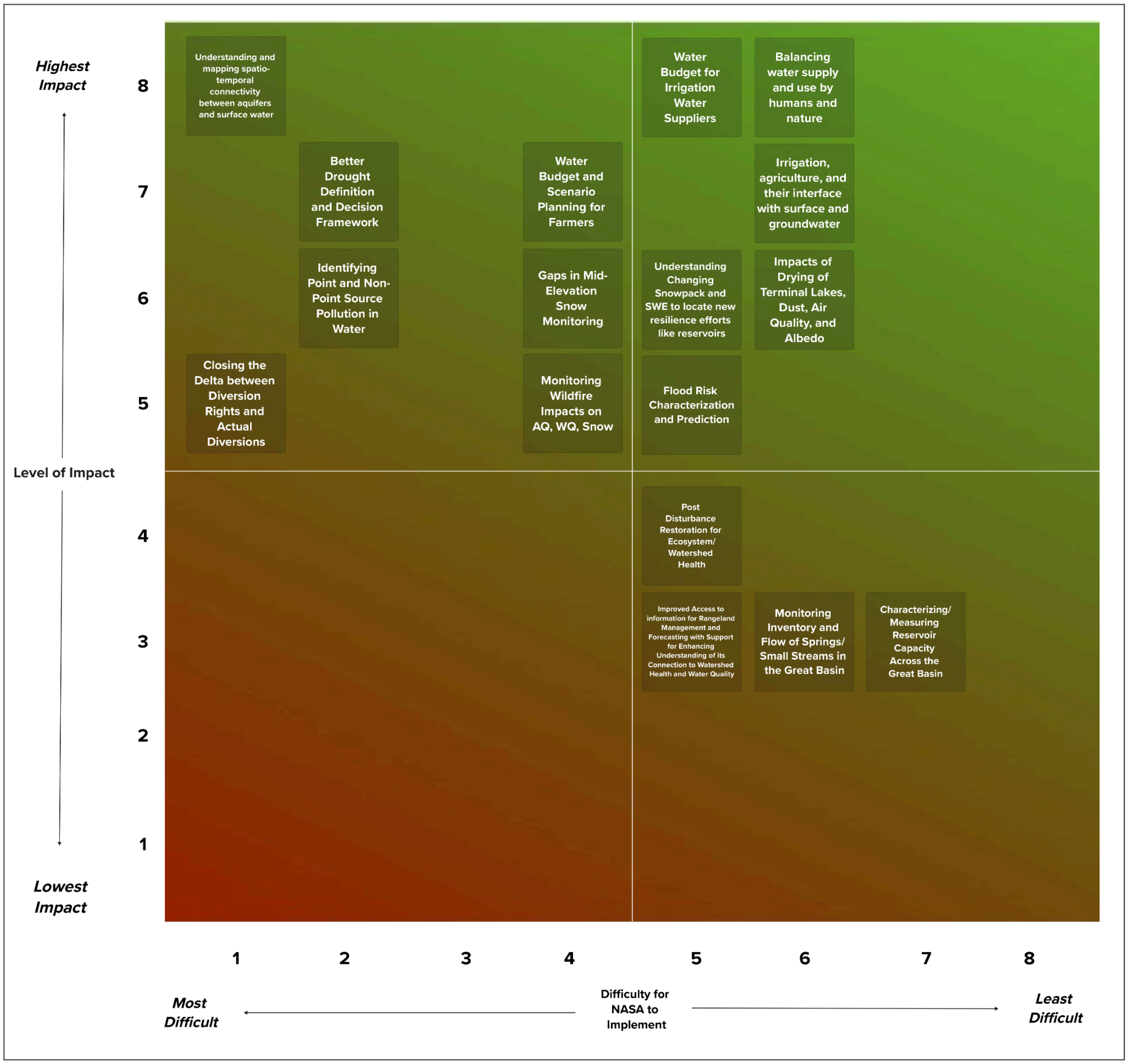
Appendix IV: Use Case Prioritization Matrix

After the Great Basin Needs Assessment workshop, WWAO staff, facilitators, and subject matter experts scored each use case based on their potential impact and difficulty for NASA to achieve. The results, detailed below, show a balance of use cases that could have more than nominal impact but will require some degree of continued effort. Each use case report also contains this scoring metric. This exercise may help identify potential “low-hanging fruit” (opportunities that are relatively easy to implement and can deliver near-term benefits) and, in doing so, highlight solutions that are more achievable in the near term using NASA capabilities. ***Please note: This exercise was meant to provide quick insight only and was not rigorous.***



Appendix V: Interviewee Source Material

Major Water Management Challenges Facing the Basin

Ahead of the workshop, and as part of an internal basin characterization study informing its design, off-the-record interviews by the WWAO program manager with subject-matter experts across the Great Basin identified six dominant water-related issues. Many of the challenges listed below intersect with one another; all water challenges brought up by interviewees are listed in Appendix IV of this report.

In total, 17 interviews were conducted with water practitioners representing federal, state, municipal, academic, nonprofit, and Tribal perspectives. While interviewees did not necessarily provide citations for their assertions, they were accepted as true for the purposes of understanding perceptions across the Basin.

Interviewees were told to reply to questions based on their personal experience and day-to-day work rather than trying to provide a comprehensive answer. This approach proved to be a better way to capture their authentic experiences and perspectives. Additional desk research has been cited where it overlapped with general research to support the characterization study.

Water Availability, Use, and Allocation

Challenge: When asked about the most critical water-related challenges facing the Great Basin, many of the interviewees brought up three interrelated issues: 1) the supply, quantity, or availability of water; 2) the demand or use of water; and 3) how water is allocated. The Great Basin is becoming more arid; as climate change increases average land surface temperatures, snowpack levels decline and more water is lost due to evaporation and sublimation. These conditions, combined with water diversions, have led to a decrease in groundwater by 68.7 km^3 in the Great Basin between 2002 and 2023[28] and a decline in surface water, especially endorheic lakes.[29] Beyond the variability of water availability, demand for water in the Great Basin is increasing. Consistent with water use trends in the rest of the United States,[30] water in the Great Basin is primarily used for agricultural purposes like irrigation.[31] The last factor that complicates the balancing act between water supply and demand is how water is allocated. Interviewees brought up how stakeholders in the Great Basin have diverse and often competing needs for water.

[28] https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2023GL107913
[29] https://agupubs.onlinelibrary.wiley.com/doi/full/10.1029/2022EA002630
[30] https://www.usgs.gov/mission-areas/water-resources/science/trends-water-use?qt-science_center_objects=0#qt-science_center_objects
[31] https://research.fs.usda.gov/treesearch/29297

Key Stakeholders: State water resource departments, conservation districts, cities/municipalities, Tribes, landowners, utilities, and the recreation industry.

Gaps: Because of uncertainty in future water supplies, there needs to be improvement in forecasts.

Drought and Increased Aridification

Challenge: The Great Basin is one of the driest basins in the United States and one that is highly impacted by drought. Nevada, which constitutes a large portion of the basin, is the most arid state in the country and is in the region that is most frequently impacted by drought. In addition, the basin is a **closed hydrologic system**, meaning it receives **few, if any, external water transfers** that could help offset the impacts of drought.[32] [33] Multiple interviewees named drought and increased aridification as key challenges facing the basin, and noted that climate change has severe short- and long-term drought implications. Despite these known challenges, accurate drought monitoring is difficult within the basin due to "poor data access, data not available in near real-time, data not available in user-friendly formats, short periods of record (limiting the calculation of climatologies and anomalies), and lack of variables that pertain to drought."[34] In addition, much of the basin's water is underground, and this has historically made it difficult to understand drought impact on overall water content.[35]

Key Stakeholders: Local entities/cities (including Salt Lake City Public Utilities, Las Vegas, Reno, small towns, electrical co-ops, water districts (Wasatch Side), Jordan Valley Water District); ranchers and those using public lands for grazing/grazing permittees; and the Western Governors Association, Central Utah Water Conservancy District (possibly the largest water provider in Utah).

Gaps: Key gaps identified from interviewees included assessing and differentiating between drought and aridification, as well as a lack of available data for standardizing drought assessments.

Water Quality and Water Quantity Nexus

32 https://wrcc.dri.edu/Projects/nidis/nidis_report.php
33 https://naes.unr.edu/research/project.aspx?GrantID=808
34 https://wrcc.dri.edu/Projects/nidis/nidis_report.php
35 https://www.nasa.gov/science-research/earth-science/nasa-satellites-find-snow-didnt-offset-southwest-us-groundwater-loss/

Challenge: When speaking about the aforementioned issue of water quantity in the Great Basin, many of the same interviewees also brought up water quality. These two issues are interconnected: as drought reduces water quantity, so too does it degrade water quality necessary for farming, grazing, and domestic use.[36] Additionally, arid environments create conditions that leave surface water more vulnerable to contamination, as impacts from industrial practices, agriculture, and variable pH and salinity are magnified.[37]

Key Stakeholders: Federal government agencies including the Environmental Protection Agency (EPA), state water resource departments, cities/municipalities, Tribes, and the recreation industry.

Gaps: Collecting water quality data remains field-intensive, as satellite observations are not yet viable for reliably monitoring most water quality parameters. Additionally, there is a growing need to better understand the impacts of energy development and mining on both water quantity and quality.

Water Law, Policy, and Rights

Challenge: Water rights in the Great Basin have become particularly contentious as drought and changing water availability have increasingly impacted the region.[38] High-profile discussions at the state level within the last several years exemplify the complexity of these legal issues (e.g., in 2022, Utah Governor Spencer Cox closed the Great Salt Lake Basin to new water rights appropriations due to historic low lake levels[39]). Multiple interviewees directly and indirectly identified challenges with water rights and allocation. There are competing priorities from various sectors and entities including from agriculture, mining (including lithium mining), Tribal nations, cities and towns, and others. One interviewee noted that much of the existing water policy was developed during a relatively stable climate period and isn't well-suited to prolonged drought. The system was designed to withstand a single dry year, but the multiyear drought from 2021 to 2023 exposed its limitations—reservoirs and groundwater systems were not able to be adequately recharged.

Key Stakeholders: Western Governors Association, state governments, Tribal governments

Gaps: No specific gaps identified from interviews

[36] https://www.drought.gov/sectors/agriculture
[37] https://naes.unr.edu/research/project.aspx?GrantID=808
[38] See, for example: https://www.leg.state.nv.us/Division/Research/Documents/water-overview-2019.pdf
[39] https://www.sltrib.com/news/environment/2022/11/03/gov-cox-has-closed-great-salt/

Gaps in Information About Snow

Challenge: Nevada, the state that makes up the majority of the Great Basin, gets over 80% of its water from snowmelt.[40] In a region with low levels of precipitation, snow accumulation at high elevations in the winter provides runoff in the spring and summer, which is critical. As mentioned in the preceding section on water availability, snowpack levels are expected to decline as the Great Basin becomes more arid. Interviewees highlighted the importance of being able to better forecast snowfall and conditions of snowpack like snow water equivalent (SWE) and forecasted runoff.

Key Stakeholders: The recreation industry and water managers.

Gaps: Snow Telemetry (SNOTEL) data is good for estimating SWE, but there are not enough sensors placed at higher elevations, especially in mountain terrain. Additionally, there is potential for Earth observations (EO) to be used to measure snowpack, SWE, and model runoff.

Habitat and Ecosystem Health

Challenge: Interviewees brought up how uncertainty in water quantity and quality raises concerns for species in the Great Basin that are reliant on healthy water ecosystems and habitat. The Pacific Flyway, a north-south migratory bird route, goes through the Great Basin, and an estimated 10 million migratory birds rely on the region for food and shelter. Around the Great Salt Lake alone, there are more than 350 bird species dependent on the lake's ecosystem.[41] Of the challenges relating to species brought up by interviewees, the majority were concerned about water quality and quantity for bird species, spotted frogs, and Lahontan cutthroat trout.

Key Stakeholders: Federal land agencies like the Fish and Wildlife Service (FWS) and Department of Defense (DOD) were mentioned as interested players. The FWS wants to be able to understand how many birds can be accommodated in a given habitat, and the DOD is interested in where to run military drills/bombing runs that will have least impact on the ecosystem and where birds are in order to reduce bird strikes. State fish and wildlife departments were also part of this conversation, and interviewees said they were most concerned about how water quality, quantity, and allocation impact habitat for fish spawning. One interviewee said farmers were a key stakeholder in this area, because at times their

40 https://naes.unr.edu/research/project.aspx?GrantID=743#:~:text=General%20Information,%20Snowmelt%20provides%20water%20for%20over,water%20resources%20for%20the%20State%20of%20Nevada.

41 https://pws.byu.edu/great-salt-lake

demand for water can be at odds with the objectives of conservation groups. Lastly, conservation groups have an interest in preserving and restoring habitats for species.

Gaps: No specific gaps were brought up relating to habitat and ecosystem health.

Use of Remote Sensing

The majority of stakeholders interviewed already used remote sensing data in their work: building data into tools for water resource management, tracking conveyance and snow runoff, and gaining better understanding of streamflow forecasting, to name a few. Of the interviewees that do not currently use remote sensing data, all of them expressed interest in further conversations with NASA about remote sensing capabilities. Below is a summary of the active uses of remote sensing brought up by interviewees in the Great Basin, datasets currently being used, and desired datasets. See Appendix VI for additional information.

Remote Sensing Uses in the Great Basin

- **Water Resource Management:** Remote sensing is employed to monitor water bodies, assess water volume, and forecast drought conditions.
    - Datasets used: MODIS, OpenET

- **Evapotranspiration and Soil Moisture:** Remote sensing is used to analyze evapotranspiration rates and soil moisture, which are essential for understanding agricultural and ecological dynamics.
    - Datasets used: ASO, OpenET

- **Land Cover Change Detection:** Stakeholders utilize remote sensing to monitor changes in land cover, including the impacts of disturbances such as wildfires.
    - Datasets used: Landsat, MODIS

- **Snow and Ice Monitoring:** Remote sensing is applied to track snowpack characteristics and snow cover, which are critical for hydrological modeling, such as streamflow forecasting.
    - Datasets used: MODIS, SNOTEL (not remote sensing, but was brought up as a critical in-situ data source)

- **Agricultural Efficiency:** Remote sensing is used to evaluate crop health and efficiency, particularly in relation to water usage.
    - Datasets used: MODIS, OpenET

Desired Datasets

Both stakeholders that already utilize or would like to utilize remote sensing data expressed desires for future remote sensing capabilities to improve their work around water and land resources management. A primary focus was on acquiring higher-resolution datasets that would enable more precise monitoring and modeling of environmental changes, such as land use, vegetation health, and water availability. A major priority in this area is obtaining spatially and temporally consistent SWE data across entire states, ideally at resolutions of 800 m to 4 km on a weekly basis. They emphasized the importance of snowpack melt dynamics, real-time melting layer height, and projected streamflow information, noting limitations with current ground-based tools. Water managers also seek better tracking of precipitation, wind conditions, and soil moisture, with an emphasis on long-term datasets for surface and groundwater conditions, groundwater discharge and evapotranspiration, and understanding the surface and groundwater interactions.

Interviewees brought up interest in using remote sensing to monitor finer-scale ecosystem features in the Great Basin such as playas, pools, and stream reach gradients, which are critical for habitat monitoring. Additionally, stakeholders underscored the need for remote sensing products that can accurately detect lake edges, shallow waters, and bare ground, as well as enable better grazing impact assessments. Finally, trust in data was a recurring theme. Users are hesitant to rely on remote sensing data outputs unless accuracy, resolution, and data harmonization are improved and proven.

Recommendations for Workshop Focus Areas

As with the identification of major water issues in the Great Basin, the 17 interviews and supporting research led to the initial recommendation of six topical focus areas. These were proposed as starting points for identifying and documenting key water resource management needs during the Needs Assessment Workshop. Each focus area was to have its own breakout group and serve as a framework for organizing and developing the needs-based use cases. These candidate focus areas would be reviewed and refined by workshop participants, who may choose to adopt them or modify them. WWAO shared the candidate focus areas with participants in advance of the workshop, giving them time to consider the topics and come prepared to discuss and assess their relevance and alignment during the event.

Please note: The original six focus areas are outlined below. These were ultimately consolidated into five focus areas, which guided the workshop and are described in the section titled “Workshop Overview.”

1. **Water Availability**

- Water availability is the most critical challenge in the Great Basin, where limited supplies must be allocated among competing users amid climate change and evolving societal water use.
- This focus area encompasses broad-scale issues such as allocations, inflows, storage, timing, and balancing ecological and human demands—viewing the basin as a unified hydrologic system rather than a collection of individual users.
- Use case prompts could include sector-wide allocation tradeoffs, long-term supply planning, and basin-scale water management strategies.

2. **Hydroclimate Extremes and Variability**
    - Increasingly frequent and intense droughts and floods are transforming water reliability and driving new planning needs.
    - This focus area covers drought, snow drought, and flash flooding—major sources of uncertainty—and explores extremes of too much or too little water. It highlights the decisions water managers must make and the data they need to support those decisions.
    - Use case prompts could include forecasting extremes, drought and flood preparedness, snow drought monitoring, and subseasonal-to-seasonal (S2S) decision support tools.

3. **Groundwater–Surface Water Interaction and Relationship**
    - Hydrologic and legal disconnections between groundwater and surface water are significant sources of conflict and overuse, especially in closed sub-basins and terminal lakes. Further insights are needed on their relationship within the basin.
    - In regions with limited conjunctive management, the disconnect between groundwater and surface water systems poses critical threats to ecosystems and human water use. This issue is of West-wide concern, with the unique landscape of the Great Basin offering insights into groundwater use cases identified in WWAO's previous needs assessments. This focus area also highlights ongoing policy considerations.
    - Potential use case scenarios include conjunctive management (coordinated planning between groundwater and surface water users), connectivity modeling, and policy-relevant monitoring.

4. **Agriculture/Irrigation and Water Budget**
    - Agriculture is the dominant water use sector in the basin and a major driver of rural economies. Improving efficiency and balancing use are critical for long-term sustainability.

- This focus area offers significant potential for enhanced conservation and reuse practices—such as fallowing, optimized irrigation timing, and evapotranspiration (ET) tracking—and is likely to intersect with other focus areas. It spans use cases ranging from individual producers to coordinated efforts across sub-basins.
- Use case prompts could include irrigation modernization, ET tracking, fallowing strategies, and agricultural demand forecasting.

5. **Water Infrastructure and Measurement**
    - Aging infrastructure and limited operational flexibility are major barriers to adapting to changing hydrologic conditions.
    - It emphasizes both the need to update physical infrastructure and to improve measurement capabilities (e.g., diversions, depletions, reservoir levels, soil moisture) to enable smarter, more adaptive management.
    - Use case prompts could include reservoir operations, recharge infrastructure, measurement gaps, and climate-resilient retrofits—key elements for modernizing water management systems.

6. **Watershed Health and Water Quality**
    - Ecosystem degradation, fire-impacted watersheds, and riparian habitat loss are reducing watershed resilience and threatening long-term water reliability..
    - Watershed health and water quality are closely interlinked, especially in the context of degraded flows, dust, salinity, algal blooms, and habitat loss. Framing these issues together can support more integrated solutions.
    - Use case prompts could include forest management, source water protection, ecological flow planning, and nature-based solutions.

Additional Challenges

The challenges listed below are those identified by the 17 interviewees.

- Acknowledgement of the climate crisis
- Agriculture
- Basin is big
- Balancing the water budget
- Buybacks
- Competing uses/demand
- Continued/increased aridification
- Dam removal
- Drought
- Flood control
- Groundwater
- Heat
- Hydropower
- Legislators that do not understand water
- Loss of experience in agencies due to retirement
- Loss of federal funding
- Managed aquifer recharge and how to optimize storage in surface and groundwater and take advantage of wet years
- Philosophical disconnect
- Population increase
- Spotted frog habitat
- Transbasin water
- Water allocation
- Water budget myth around sustainable yield and perennial yield
- Water quality
- Water rights
- Water supply
- Water supply forecasts

Great Basin Successes

The comments below reflect successes identified by interviewees.

Improved relationships / collaboration / communication
ROGER group - Results Oriented Grazing for Ecological Resilience
Collaboration related to Truckee River water management

Good relationships with our stakeholders.
The Tribe has been moving in the right direction with our relationships and funding. Concern about what will happen with funding going forward.
Watershed and landscape modeling.
We have some great relationships with our stakeholders. We can call a bunch of folks if we have questions about things. If something doesn't make sense, some of our stakeholders will go out into the field to find out for us.
The Central UT Water Conservation District hosts us and introduces us to people. They take us to their reservoirs. PacifiCorp has also been great, Provo has been great.
Collaboration with the DRI is going well.
Despite some tensions, many individuals and organizations have voluntarily contributed temporary water rights to benefit the Great Salt Lake. Notably, the LDS Church has also participated in these efforts.
There’s been a lot more coordination and collaboration. In some of these imperiled areas, there's a lot of conflict. But the big players within the GSL basin tend to work together. Federal, NGOs, environment groups, are tending to come together in a productive way.
We’re starting to hear more openness to lake management. What can be political is lake levels.
The federal collaborations to develop solutions to address aspects of the GB are a success. When the federal agencies work together to row in the same direction as states and Tribes, good things happen. (ex. National Estuary Program, Urban Waters - feds work with local folks)
EPA acting as a hub, building relationships, getting orgs and agencies together that don’t normally get together in one room to solve something. EPA working with the local communities.
Building relationships. You build them now and they pay off later.
Wasatch side: Relationships and communications with other stakeholders and water districts are going well.
“Place-based planning”.
The way we communicate to the stakeholders is improving.
The USGS approach spans multiple disciplines!
Tribal and non-Tribal collaborations.
Improved products, tools, and data
Fantastic products from the Western Regional Climate Center.
Virtual grazing tool.
Climate Engine (climateengine.org) – Introduced by Paula; had a BLM-wide demo in the fall.

Quality of the data gets better and better as new programs and technology come out.
We're creating probabilistic forecasts, and end users are using this more and more.
Low-tech process-based restoration.
CBRFC and NRCS forecasts are really good.
Improved budgets / plans / policies / agreements
Sensitive species conservation agreements.
Develop climate adaptation plan with university and funding from BIA.
Community-led groundwater management plans.
OR is doing a better job in implementing up to date water policies especially around drought.
Water conservancy districts are highly focused on planning for the future. Without their forward focus there won't be water, they are doing a good job. Prep 60 is planning for the next 60 years.
Improved recognition of water's importance
State agencies and state legislature for water (water is recognized as a critical resource).
Getting broad support for updating the groundwater budget.
The Governor came here a couple months ago to see how we do forecasts, he tweets about our forecasts. The resource managers and higher ups see our value.
Growing awareness of the Great Salt Lake's ecological importance.

Remote Sensing Desires

The remote sensing desires listed below are those identified by interviewees.

- Agriculture
  - Field level water use
  - Field boundary data to compute losses around canals and conveyance systems
  - OpenET crop efficiency to identify reductions in water
- Bare ground
  - Determining how much ground has been grazed on by cattle
- Consumptive use
  - Data that is trusted and persuasive
- Drought
  - Better integration of data into forecasting and monitoring tools
- Ecosystem services
  - Monitoring habitat of Lahontan cutthroat trout (requires fine scale)
  - Detection of shallow water for wading birds

    - Mapping invasive flora species that use a lot of water (phragmites and tamarisk)
- Evapotranspiration
    - Better systems to understand ET in forests and wetlands
- Frequency of data
    - SWE at 800m resolution weekly
- Geographic scale of data
    - RS scale can be challenging for monitoring small springs
    - Higher resolution about where the water masses are in the basin (4km resolution)
- Groundwater
    - Statewide groundwater discharge
    - Statewide groundwater ET rates and volume
    - Longterm dataset
    - Groundwater mapping
    - Groundwater recharge
    - Groundwater quality
    - Groundwater/surface water nexus
- Lakes
    - Lake edge detection
    - Bathymetry of Summit Lake, volume, surface area, and contour over time
- Playas (dry lake beds)
    - Extent of playas and flows, mapping their boundaries
- Precipitation
    - NWS radars do good but have limited coverage; TRIMM has attempted this, but only gives a snapshot but this doesn't cover it. In mountain regions this is hard to do with satellites. There's a lot of opportunity here
- Snow
    - High resolution snowpack information (snowpack extent and decline)
    - Statewide SWE information
    - Real time melting layer height
    - Snow level
    - Snowpack melt, runoff, and projected streamflow
- Soil moisture
    - Ongoing monitoring of soil moisture
- Streams
    - Stream reach gradient: monitoring remote locations that make it hard to bring in-situ monitoring tools
    - Measuring stream quality and quantity
- Surface water
    - Long-term dataset
    - Tracking surface extent of pools
    - Surface water quality

    - Surface water/groundwater nexus
    - Sub-pixel level water detection
- Wind
    - There are existing networks that provide wind conditions—this would be a game changer if we could get this from satellites

Gaps

The gaps listed below are those identified by interviewees.

Water Flow / Measurement Gaps
Flow data
We need more gauges: USGS stream gauges are going away
Natural flow data set for all of the GB
Need more hydrogeochemical tracer studies to understand interbasin flow
High quality magnetic flow meter data (no meters on wells)
More water data (Gauge locations are far and we don't have enough people to measure them.)
GSL water data and water intake and release schedules
Measurements from gauges and diversions
Streamflow measurements
Major gaps in precip measurement (There are networks in place, but not a lot of vegetation and a lot of wind, so gauges are not protected)
Ephemeral streams near the headwaters, we don't have information.
Ability to measure scattered thunderstorm (due to microclimates)
Early assist "RAWS" station (USDA/BLM work together on this) (Fire station gauges; Do a bad job of measuring frozen precip)
Snow Gaps
Snow data - More SNOTEL stations - Snowpack - Runoff data
We know very little at higher elevations (Bulk of the precip is falling in the alpine area, not much SNOTEL sensor here; Instrumentation limitations)
Groundwater Gaps
Groundwater levels in the GB
Monitoring shallow groundwater and how it correlates to deeper groundwater or water at the surface.
Groundwater influence on the GSL

Water Use / Consumption Gaps
Water use data
Consumptive use data
Water use, vegetation condition, productivity, and how it changes over time
Incidental use of water beyond irrigation
Modeling Gaps
Hydro models of the entire GB (of all the water resources in the basin)
Future climate downscaled to our watershed area on the reservation
Groundwater-surface water model
Water Supply Gaps
Uncertainty in the future water supply
Water supply forecast improvement
Water Quality Gaps
Water quality is the most field intensive thing, we are waiting for satellite data to become viable.
Understanding energy and mining impacts to water supply and quality
General Monitoring Gaps
Longer-term monitoring
Trend data continuity
Other
Soil moisture (top 2 inches or 3 feet)
How to deal with invasive species
What are the water requirements for different energy technologies? (fracking, etc.) And how do we make sure their estimates for water are legit?
Drought assessment and characteristic reports - use data to standardize the reports
How do we differentiate between drought and aridification? This is the question that no-one is asking
Evaporation studies are needed
Municipal (wastewater reuse)
Trying to graph how the basin functions as an integrated system for birds and wildlife

Data quality: Data from SLC and SL County are not always high quality
Surface water: Surface water hydrology data
Dust: what's in it, where is it coming from? (Is it coming from the West Desert? What is in that dust?) If we could pinpoint this it would be great

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