2018

Connecting Texas Water Data Workshop: Building an Internet for Water

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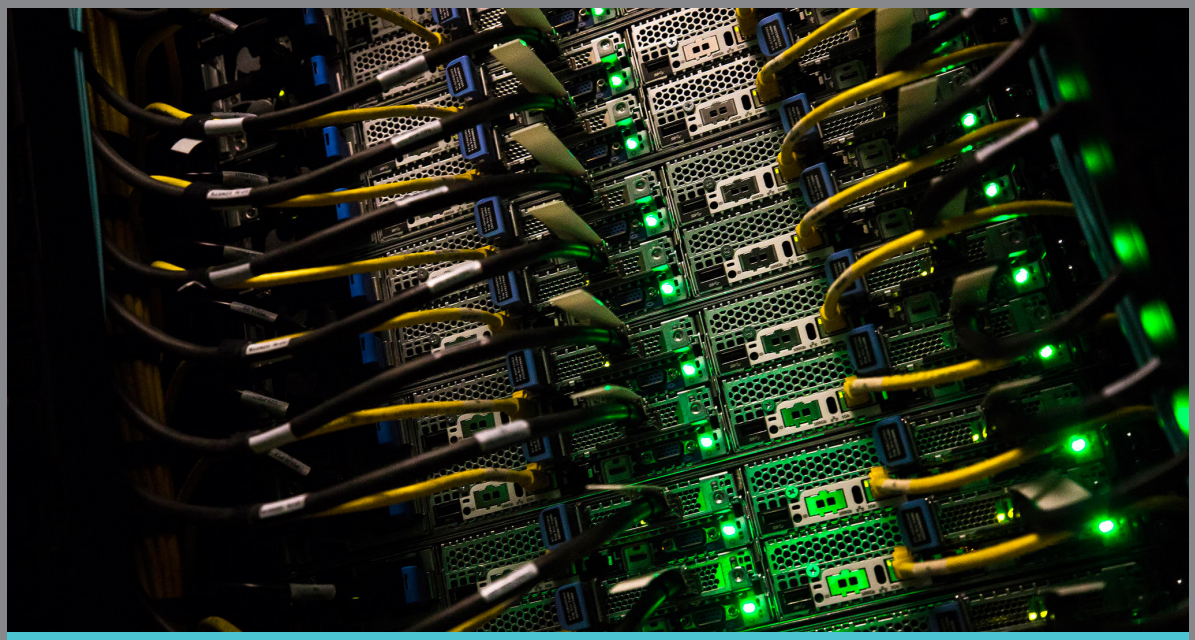

CONNECTING TEXAS WATER DATA WORKSHOP

Workshop Held
April 17, 2018

Location
Texas Advanced Computing Center
University of Texas

Sponsors and Organizers

Texas Water Development Board
The Cynthia and George Mitchell Foundation
Institute for Water Resource Science and Technology, Texas A&M University-San Antonio
Texas Advanced Computing Center, University of Texas
National Science Foundation Research Coordination Network for Climate, Energy, Environment and Engagement in Semiarid Regions

CONNECTING TEXAS WATER DATA WORKSHOP

INTRODUCTION

Texas' public and private companies, organizations, and agencies have collected water data for different purposes and at different scales for many years. These data are scattered across multiple platforms with different standards, often making important data sets inaccessible or incompatible. This leaves Texas' decision makers, industries, landowners, and communities with significant amounts of data of limited use to support real-time decision making, development of opportunities for water security, or for modeling an accurate picture of Texas' water future. To be useful in decision-making, water data must not only be open and transparent, but presented in a way that is relevant to the needs of decision makers.

On April 17, 2018, the Connecting Texas Water Data Workshop was held at the Advanced Computing Center on the J.J. Pickle Research Campus of the University of Texas in Austin. The workshop brought together almost 90 invited experts representative of Texas' government and water agencies, utilities, academia, business, industry, research institutes, and water associations and advocacy organizations.

Our goal was to engage workshop participants – all leading Texas water stakeholders – in the identification of critical data needs and in the design of a data system that facilitates access to and use of water data in Texas.

This report describes the workshop outcomes, presentations, discussions, and facilitated stakeholder sessions.

This report may be cited as: Rosen, Rudolph A. and Susan V. Roberts. 2018. Connecting Texas Water Data Workshop. Institute for Water Resources Science and Technology, Texas A&M University-San Antonio, San Antonio, TX 78224. (ISBN-13: 978-0-9986645-4-5) https://libguides.tamusa.edu/ld.php?content_id=42020932

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On the Cover: Connections carrying data on the Texas Advanced Computing Center's Stampede 2, ranked the 12th most powerful supercomputer in the world. Photo by Martin do Nascimento/KUT Public Radio.

EXECUTIVE SUMMARY

CONNECTING TEXAS WATER DATA

The Connecting Texas Water Data Workshop brought together experts representative of Texas' water sectors to engage in the identification of critical water data needs and discuss the design of a data system that facilitates access to and use of water data in Texas. Participants worked in facilitated sessions to identify, describe, and list 1) who needs, 2) what data, 3) in what form, 4) to inform what decisions about water in Texas. They also worked to identify key data gaps in Texas water data, attributes of a comprehensive open access water data information system capable of informing water management decisions, and use cases or pilot projects illustrating the value of an open access, interoperable water data system.

Participants envisioned the ideal water data system for Texas as one with open access that includes an ability to obtain available water data, including raw data, metadata, and legacy data in a digitized form. The data system should be user friendly, robust, and provide real-time information using web services with source information and built-in visualization tools so that non-experts can use the system. Data and information should be free, and created and kept in consistent reporting formats so that data "talk to each other" as users search and gain access. The ideal form of data system is envisioned as consisting of several integrated data hubs specialized by water sector, with incentives for people to add new data and share existing data through the hubs. There should be adequate funding to sustain the data system over time.

Several steps to develop and promote an open water data system for Texas are recommended. Among these are developing use cases, establishing an advisory task force, designing the network structure for an open data system and hubs, identifying key users of the initial system, naming lead developers and hosts of the system, forming lines of support, and sharing information about open data experiences and best practices.

In Texas today, one needs to be an expert to find data that exist and to access those data and integrate them for practical use. Much of the data that do exist are not actionable. An open water data system for Texas is needed to support access to an accurate accounting of supply, quality, and use of water to better support decision makers in their efforts to enhance sustainable water use. Improved access, standardization, and integration of data will provide water managers and decision makers a better basis for data-driven decisions, enabling them to more confidently meet urban, agricultural, ecological, and industrial needs for water.

CONTENTS

THE WORKSHOP REPORT

Seeking better decisions about water in Texas

"The better the data, the better the science. And the better the science, the better the policy."

-- Kathleen Jackson
Texas Water Development Board

THE BEGINNING

In many parts of Texas the human population is growing rapidly, but water availability and use are affected by frequent droughts in some areas, flooding in others, and multiple human-caused events statewide. The consequences can limit economic growth, business, agriculture, and stable communities. Pressure is placed on public officials and water managers to ensure continued access to dependable safe water supplies, but too often the information needed to steward and manage water for multiple uses is either nonexistent, inaccessible, or unusable. Making better decisions about water will require more data, better data, data that can be universally used (interoperable), and access to all data.

Texas water data is housed at various state and federal agencies, water authorities and districts, local utilities, universities, and throughout the private sector. While the total constitutes considerable data, it exists in many forms, levels of resolution, degrees of temporal value, and states of accessibility and usability that range from open access and user friendly to complete inaccessibility and uselessness. Without access and usability, much of the data that potentially could be used to make better decisions about water is lost to any use.

Access to Texas' water data resources is essential if Texas is to succeed in addressing its growing calls for water conservation and increasing water demand for urban, agricultural, ecological, and industrial uses. Texas data can be made available through open data systems or hubs (see Appendix IV for glossary of terms) that enable networked access designed to be usable and relevant to the needs of data users and decision makers.

Workshop attendees were asked to offer suggestions covering a range of key attributes of an open, interoperable, interconnected, comprehensive, and user relevant data system and networked data hubs. To help organize and focus thinking, workshop participants were led through a series of exercises culminating in identification of possible use cases that may serve as models for open data systems.

This report summarizes the workshop sessions and provides extensive detail in the synthesis text and appendices. The report supports continuing dialogue among workshop participants and involvement of stakeholders who did not attend the workshop. The workshop was intended to be the beginning of an engagement process involving all water stakeholders that use or need water data, especially water decision makers.

The Connecting Texas Water Data Workshop provided an important opportunity for Texas water data experts to join together and offer input essential to improving the state of water data in Texas.

TOWARD AN INTERNET OF WATER

In much of the United States today it can be a complex and time consuming experience to learn something as simple as the safety and quality of water coming from your own tap, according to Dr. Martin Doyle of the Nicholas Institute for Environmental Policy Solutions at Duke University speaking at the workshop. Dr. Doyle's detailed comments can be found in Appendix I.

Many decisions are made today on the basis of instantly available data, but for water, which is the most important ingredient for life on Earth, access to data for most Americans is far from instant.

There is a fracturing of where water data come from and a wide range of organizations that generate and store data. According to Dr. Doyle, the US Geological Survey and associated water science centers in the various states that maintain the data and stream gauge network for the National Water Information System serve as the "gold standard" for nationwide surface water data and open access. This system presents a ready foundation and model for building a nationwide open network for public water data collected for multiple mission-specific sectors and interests such as energy, agriculture, community development, forestry, fisheries, endangered species, watersheds, and so on.

Dr. Doyle and collaborators are seeking a means to have data that come from these various sources made available and viewable on a real-time basis. This has been termed the "internet of water."

The internet of water was described during a water dialogue held by the Aspen Institute. Following the forum, a group of funders came forward to support the initiative. A dialogue series then pulled together water experts from utilities, state and federal government, oil and gas, philanthropy, academia, nongovernmental organizations, software companies, and other sectors. The result was a consensus formed by people with different perspectives around the following key findings:

- The value of open, shared, and integrated water data has not been widely quantified, documented or communicated.
- The most necessary step in using water data for sustainability is making public water data open by default, discoverable, and digitally accessible.
- Water data can be most effectively integrated through an internet of water.

Dr. Doyle offered three suggestions to create an internet of water:

1. Form a vision about how water data will be used, along with a declaration of usefulness and quantification of value.
2. Develop a series of regional pilots, or use cases, that solve real-time, real-world water management problems and demonstrate the value of water data.
3. Start an internet of water by using public water data already collected and curated.

TEXAS WORKSHOP OBJECTIVES

For Texas, basic information was collected at the workshop by focusing participant work on four key objectives:

1. To identify, describe, and list (a) who needs, (b) what data, (c) in what form, (d) to inform what decisions about water in Texas.
2. To define the desired future of water data management and access in Texas by listing data gaps, accessibility options, and key attributes of a comprehensive open access water data information system.
3. To initiate development of use cases for Texas water by identifying critical needs of Texas data providers and consumers.
4. To list ideas on next steps to further define, design, and build a water data system for Texas.

Texas water planning requires access to and use of large amounts of data from many sources, provided in ways decision makers can work with. Texas water plans look out 50 years and are updated every 5 years. The Texas regional water planning process involves more than 450 volunteers across the state representing big cities, small communities, agriculture, manufacturing, and all the other water users. The plans are data- and science-driven, and prepared cooperatively with 16 regional water planning groups. The volunteers in these groups come together to compile strategies to address future water needs and determine how much water we have today, what we need to do for tomorrow, and what strategies or projects we need to put in place to get us where we need to be in the future. We use the best data available and make it transparent and usable on multiple platforms. But in spite of all the work on water plans, we don't plan to plan, we plan to build.

With anywhere from 1,000 to 1,200 people moving to Texas every day, and not one of them bringing any water with them, we seek new supplies not just to ensure current residents have the water they need, but also to supply the needs of a growing population.

-- Kathleen Jackson
Texas Water Development Board

WHO NEEDS WHAT DATA, IN WHAT FORM, TO INFORM DECISIONS

Thousands of decisions about water are made daily in Texas. Many of these decisions use data, and many others would be made better by the decision makers having open and easy access to usable data. To help better understand the scope of who needs data to inform water decisions in Texas, and in what form the data are needed, participants were asked to make lists. They were asked, "Which data must be easily accessible and interoperable?"

Only by understanding how data are used by decision makers can future data systems be built to effectively inform decision making.

In answer to the question, "Who needs data?" the six workgroups provided over 60 different responses, ranging from "everyone" to specific water decision makers, such as the National Weather Service. The relative frequency of listing of users can be readily seen using a word cloud (Figure 1) where the size of each word indicates the frequency of mention in the reporting of the workgroups.

At the top of the list are farmers and researchers. Other groups having multiple mentions by the workgroups included planners, insurers, agencies, oil and gas industry, developers, consultants, and utilities. There are a wide variety of users of water data, ranging from users requiring highly synthesized data to users where only raw data will suffice.

Terms used by one work group to describe who needs data were sometimes different terms that point to the same users, such as the terms "General Public" and "Everyone." In other cases a description for who needs data used by one workgroup was sometimes inclusive of a description used by another workgroup, such as the broad term "Academics" and more restrictive term "Academic Researchers." In still other cases a specific category of data user was associated with a specific user group, such as "Agriculture" and then described as universally associated with all user groups by another workgroup. To help draw meaningful connections, Figure 2 displays how

Figure 1. Who needs data? Size of each word indicates the frequency of mention in the reporting of the workgroups.

many workgroups mentioned users associated with major categories of use, such as for "Agriculture," and which specific users and how many were mentioned for each category. The tie between all water users is indicated by the center circle, with different terms listed in the circle used by the six workgroups that point to "Everyone." Note that the general technical professions, "Resource Managers, Engineers, Planners, and Consultants," were mentioned as "who needs data" for virtually every use.

A complete listing of all responses by each workgroup is provided in Appendix II.

Participants in the workgroups were then asked, "What data do data users need?" (Figure 3). As with who needs data, there are many kinds of data needed. There were over 60 different answers, with some being subcategories of others. There also were several categories of needed data that were mentioned repeatedly by the workgroups. These included soil moisture, stream flow, water rights, water use, and water quality.

The next question focused on the form of data needed. While there were over 50 descriptions of the form of data needed, only two stood out. These were raw data and metadata. They were mentioned most, with many other terms used to describe various degrees of open data, accessible data, usable data, free data, and standardized data. (Figure 4)

Participants were then asked to describe the purposes for which data are most needed. There were about 50 different responses with very little overlap. A wide variety of purposes for which data are needed is not surprising given the wide-diversity of interests of participants and the situational, geographic, and temporal

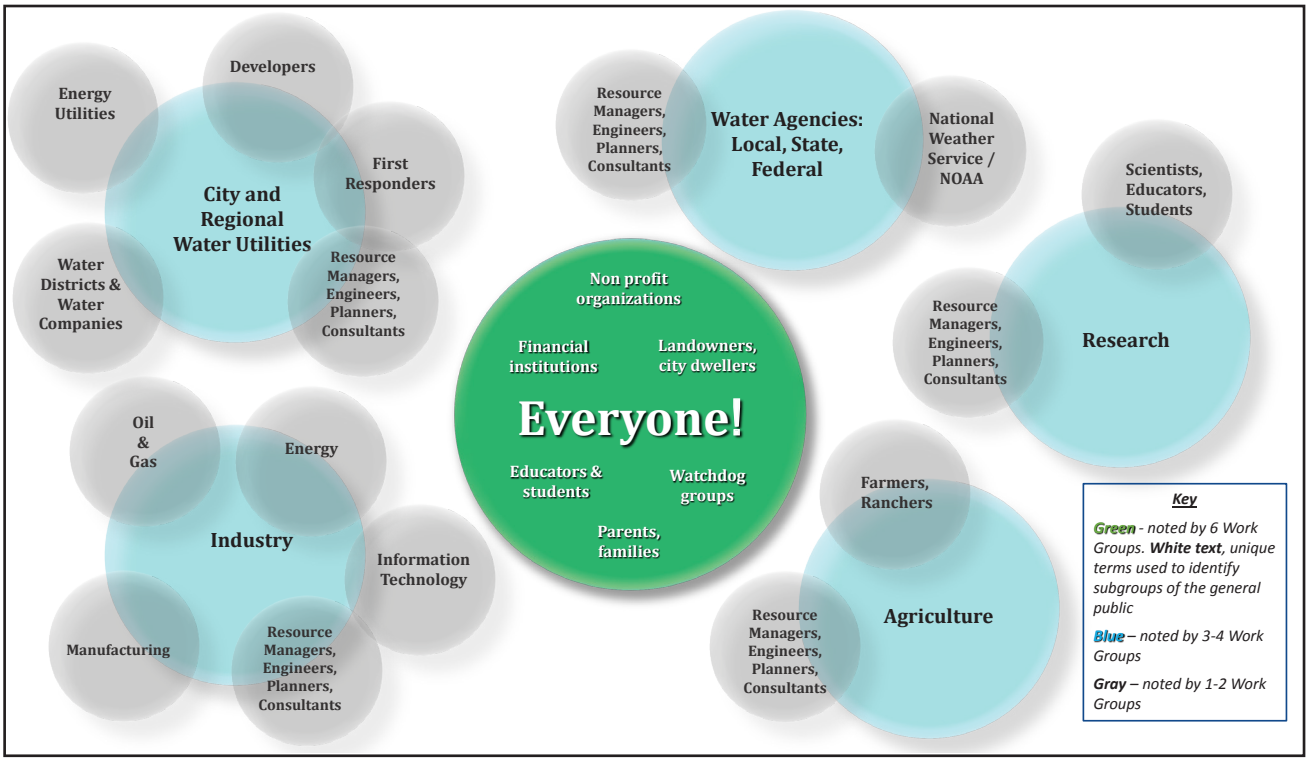


Figure 2. "Who needs data?" aggregated by users associated with major categories of use. (Large circle noted by 6 workgroups, medium by 3-4, and small by 1-2 workgroups.)

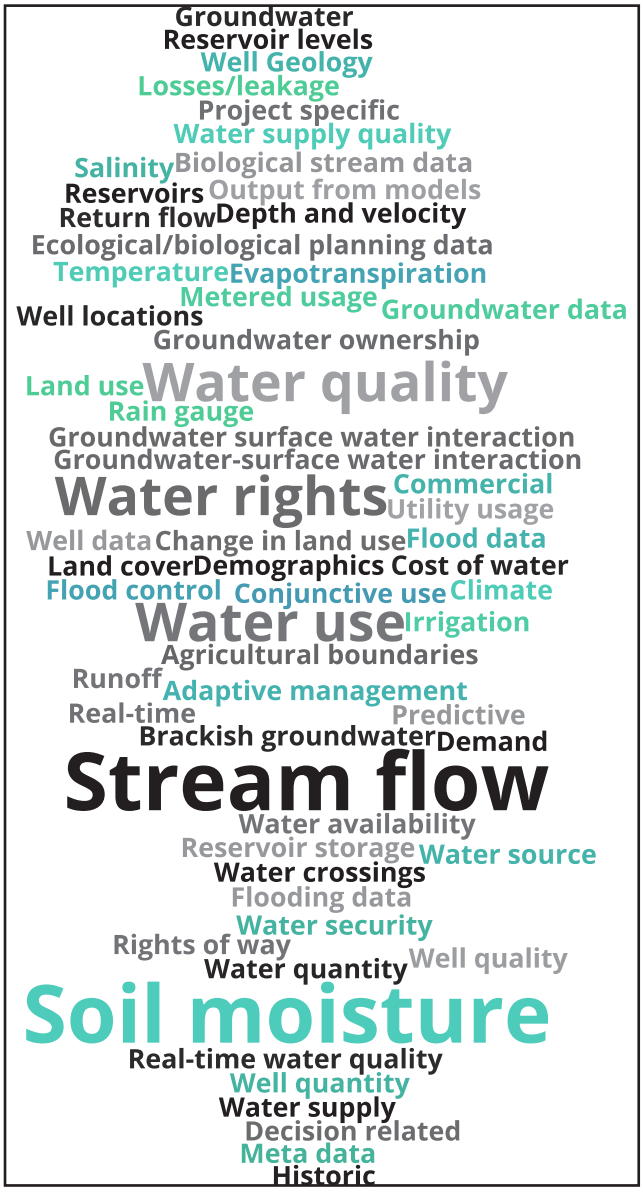


Figure 3. What data are needed.

variability of water-related decisions. Responses ranged from general purposes, such as understanding how much water a person uses or how clean one's water is, to highly technical purposes such as making flood risk determinations and updating water availability models. The full range of recommendations can be seen in the workgroups' results in Appendix II.

Narrowing the questions still further, participants in the workgroups were asked to describe gaps in water data that need to be filled. Not all groups listed gaps, but the data gaps that were noted provide insight into where more data are needed now and for the future. Examples from the list include more data on hydraulic fracturing water, citizen science data, climate forecasting data related to the groundwater-surface water interface, and real-time estuary inflow data.

Data gaps were generally distributed within three main groupings. These groups were (1) gaps in access to and integration of data, (2) gaps in data availability due to insufficient amounts of data or lack of any data at all, and (3) gaps in specific types of data. Data gaps are grouped by category and listed in Figure 5.

Appendix II provides detailed descriptions of data gaps by workgroup.

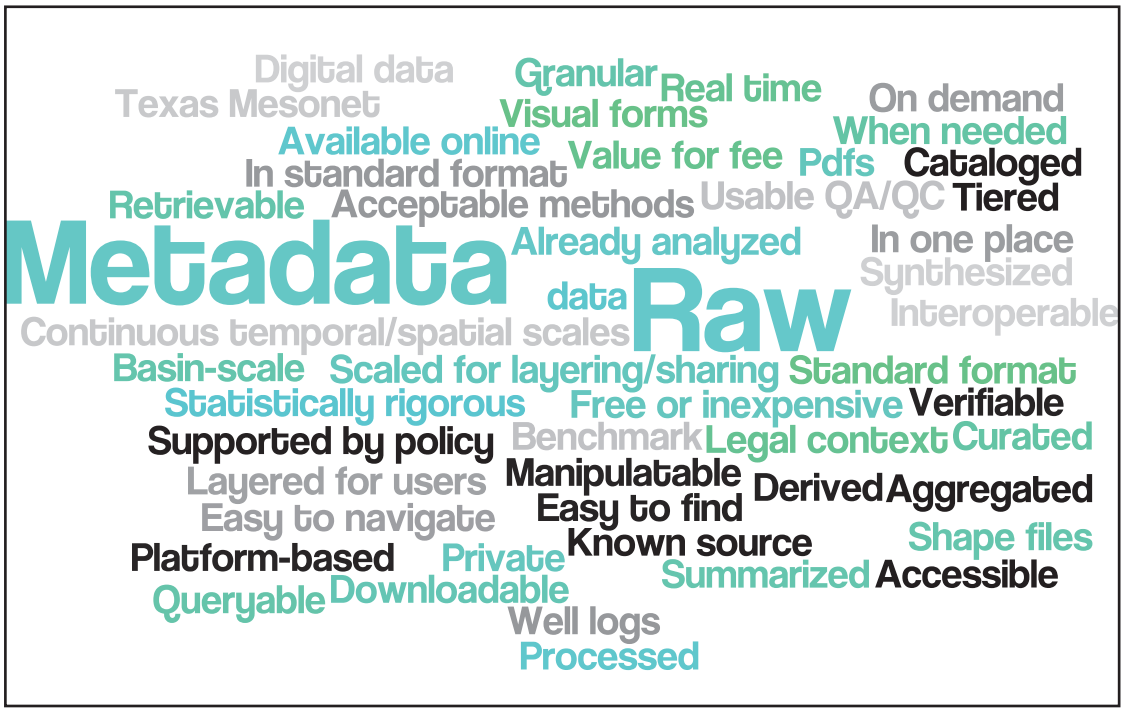


Figure 4. What form of data is most needed.

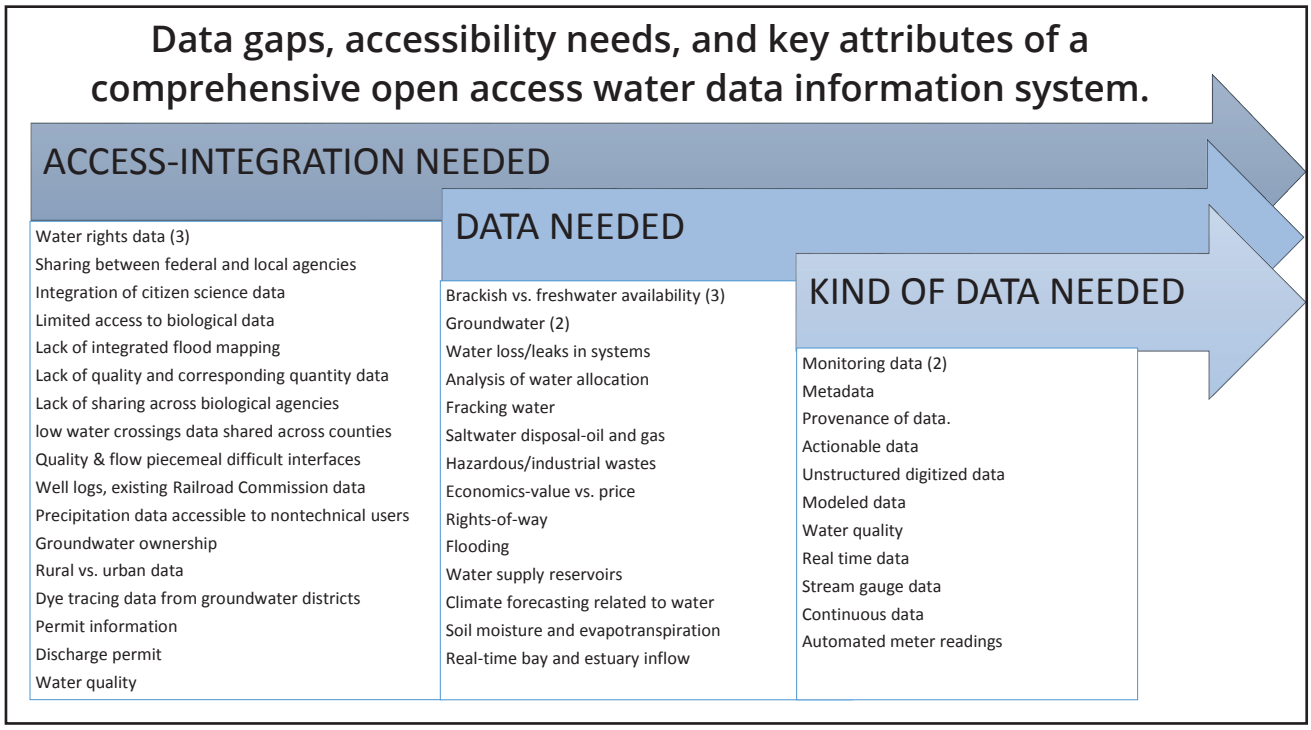


Figure 5. Data gaps by category.

THE IDEAL WATER DATA SYSTEM

The ideal data system was described as a series of integrated data hubs or nodes – with more added over time – specialized by water sector and application (i.e., ranging from expert to general public water stakeholder), with incentives for adding data into the hubs.

Following the workshop, participants were asked to respond to a survey and describe the ideal hosting option for open data hubs or systems. Respondents were almost evenly split in recommending (1) a Texas state agency, (2) a consortium of Texas state agencies and universities, and (3) a consortium of Texas state agencies, universities, and the private sector. A summary and complete responses to the survey are available in Appendix VII.

Overwhelmingly the most critical data needed to be included in an open data system are (1) raw data or data as close to raw data as possible, and (2) metadata.

Researchers and other highly technical users of data have the greatest need for such data. Several participants represented such interests at the workshop. However, such data may also be among the most difficult to access in general without an open system due to the likelihood of it being proprietary or difficult to access readily due to matters of interoperability or quantity.

Data needed by the full diversity of users must be easily accessible and interoperable to serve a wide variety of user needs. This includes needs for data at various geographic, spatial, and temporal scales, and in formats that conform to standards generally employed by the various users of data. Participants also identified qualities of data essential to ensuring data usefulness, such as data being findable, accessible, universally usable, and reusable. They suggested these qualities should exist in the ideal water data system.

One group used the acronym “FAIR” to underscore these qualities.

Water data should be **FAIR**:

F - Findable

A - Accessible

I - Interoperable

R - Reusable

RECOMMENDED USE CASES

To help organize and make a clear case for improved access to usable data to manage water supplies in the future, workshop attendees were asked to identify potential "use cases" that may serve as ready models for open data systems.

A use case is a short summary organizing in a concise and consistent format the data gaps, needs, uses, users, regulatory requirements, and workflow for a particular objective. Use cases serve as a tool for organizing and assessing stakeholder data needs, and communicating those needs to decision makers in water industries, utilities, and governments. They are developed to demonstrate the value of improved data for decision making.

Participants identified 35 potential use cases (Appendix III). Use cases varied greatly, without a single use case idea recommended by one group repeated by any other group. Several major categories of use case emerged, along with a general "water use case" category. Major categories were (1) groundwater, (2) water rights, and (3) event planning, which included two subcategories: (a) drought planning, and (b) flood planning (Figure 6). For example, in the four instances in which flooding was the general topic, the context was for (1) prediction and emergency response, (2) managing ephemeral streams, (3) impacts, and (4) crowd-sourcing observations in different water sources and for water quality.

Five of the workgroups each arrived at a consensus on a single use case for potential future development (Table 1). All five of the use cases recommended focus heavily on data needs for direct water use and management, including environmental management. These use cases involve technical water database management as well as socio-economic and policy data challenges. They are what are arguably among the most pressing data use challenges facing Texas decision makers.

We hope work on these agreed-upon use cases will proceed to illustrate the value of data in past decision making or to form a pilot for future decisions using data and data systems. We envision that these use cases will be responsive to stakeholder data needs, as well as useful for technical developers seeking to better understand the data needs of system users. Beyond the workshop, we hope to engage stakeholders in completing a set of use cases that help demonstrate the need for and use of data hubs for water and decision making.

Table 1. Top use cases recommended for Texas by consensus in five of the workgroups.
• Water utility reporting to the Texas Water Development Board
• Environmental flow transactions
• Flood water management in ephemeral streams
• Integrate and update the Texas Water Availability Models (WAM) and Groundwater Availability Models (GAM)
• Risk management of the probability of reservoir water supplies falling below criteria at 3, 6, 9, and 12 months

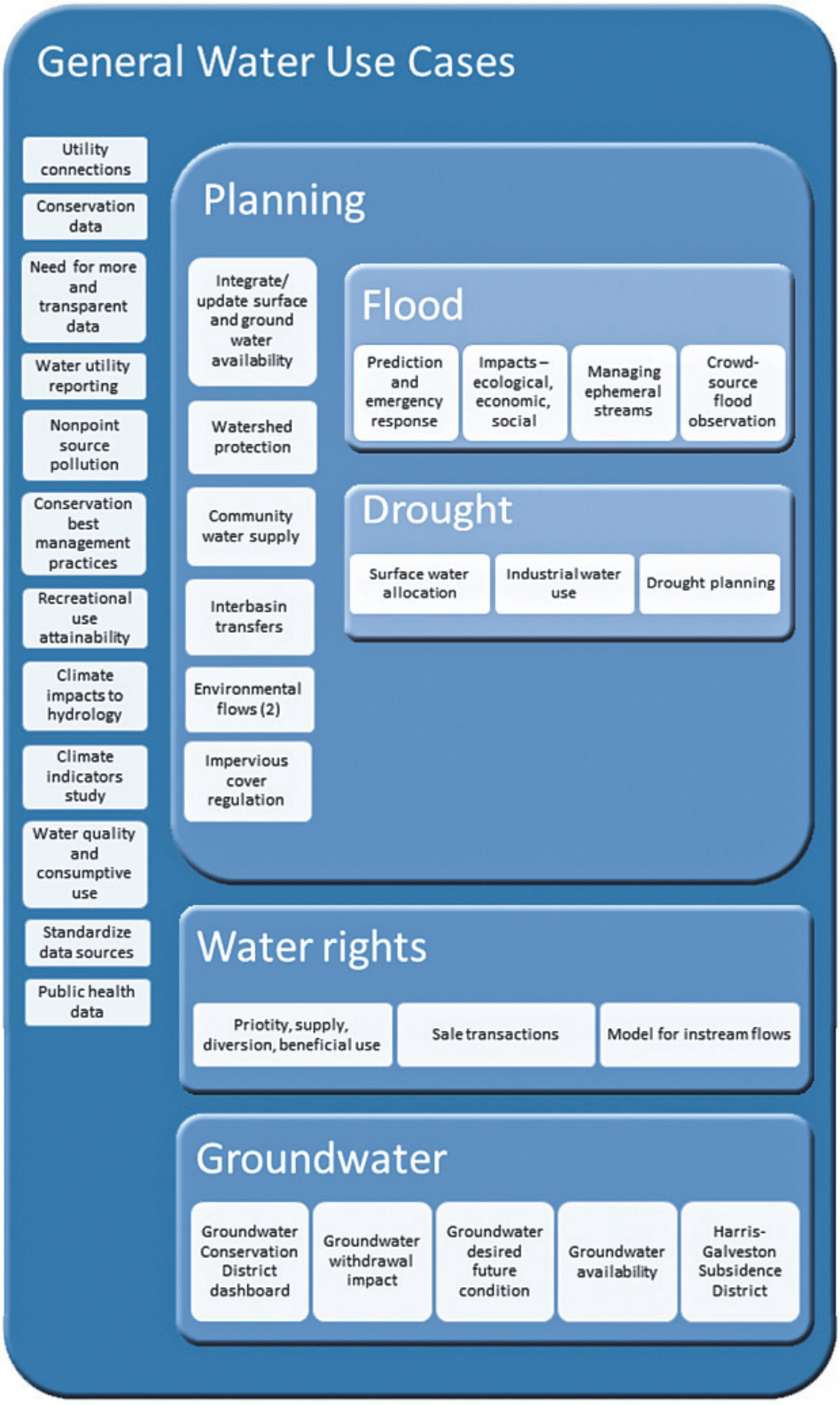


Figure 6. Use cases by categories and subcategories.

IMAGINE THE FUTURE

Work group participants consistently expressed an overarching belief that in Texas today, one needs to be an expert to find data that exist and to access those data and integrate them for practical use. They stated that much of the data that do exist are not actionable. This situation need not stand in Texas for water data. Participants created a better vision for the future and outlined a series of paths and actions to get there, including use cases as examples and pilots to achieve the desired outcomes.

Participants described a vision for the ideal water data system for Texas as one with open access that includes an ability to obtain available water data, including raw data, metadata, and legacy data in a digitized form. The data system will be user friendly, robust, and provide real-time information using web services with source information and built in visualization tools so that non-experts can use the system. Data and information will be free, and created and kept in consistent reporting formats so that data will "talk to each other" as users search and gain access. The ideal form of data system is envisioned as consisting of several integrated data hubs specialized by water sector, with incentives for people to add new data and share existing data through the hubs. There will be adequate funding to sustain the data system over time.

SPRINGBOARD TO THE FUTURE

Potential classes of use cases for future development

1. ***Events***, such as floods, droughts, and water supply ups and downs.
2. ***Markets***, can market forces be used directly or indirectly to drive new data and more access?
3. ***Unusual to the water sector, but important users,*** such as insurance companies, real estate developers, and banks.
4. ***Better decisions on costs or investments***, such as building new infrastructure and timing of reservoir releases.
5. ***Public engagement***, such as user-friendly dashboards and delivery of personal or neighborhood water usage information.
6. ***Uses already underway*** where improvements or additions to existing data will provide quick results.
7. ***Conflicts*** emerging or ongoing, including a use case associated with legal action contemplated or ongoing.
8. ***Locally-relevant successes*** showing where a small amount of data was used to change decisions affecting a local area or group.

Work on use cases was a centerpiece of the workshop and there was a consensus that work should proceed on one or more use cases. Recommendations varied. Several suggestions involved picking a use case or two that came from the workshop, and then forming pilot projects around the use cases to actually do something that shows the value of an open data system. One group suggested focusing on drought, because in Texas drought tends to be a key driver of innovation. Another suggestion focused on past decision making, to show how people have used data for practical real-world decisions benefiting people.

In providing synthesis of sessions, Dr. Doyle suggested building a use case centered around a high-profile action taken in Texas where available data were used in decision making, but where results would have been more beneficial if additional data had been available and accessible.

He suggested considering classes of use cases and possible advantages of developing use cases to illustrate classes of water data usage. Among advantages of this kind of approach is the potential to evaluate the costs and benefits of putting resources into one class of use case versus another. Through strategic consideration of action, Texas can be intentional about creating forces that push and pull data systems and understanding such systems in a defined fashion.

NEXT STEPS

Participants were asked to envision concrete next steps as a final part of their "springboard to the future" discussions. This was the end phase of workgroup discussion as the main discussion topic among participants at the final plenary session.

The following list aggregates the key recommendations into common categories and a sequence for action. There was considerable excitement among participants when presenting this final and perhaps most direct action-focused part of the workshop.

Start With Consensus

- Establish areas of agreement on standards for open data sources.
- Find out who has what data already.
- Find out who agrees with the idea of open data sources and hubs.

Plant a Flag

- Initiate one or more use cases.
- Establish an advisory task force to identify and support next steps.
- Establish the network structure for an open data system.
- Establish who will be "anchor tenants." These will be the key users of the initial data hubs.
- Establish which agency(s) or "who" will lead in developing and hosting the initial data hub(s). (Note: A general consensus of work groups is that the agency best suited to lead in developing and hosting the initial data hub is the TWDB's through the Texas Natural Resources Information System.

Tell Everyone

- Share information about open data experiences and best practices.
- Publish articles about the internet of water in media outlets such as Texas+Water and the Texas Water Journal.

Establish Lines of Support

- Identify funding sources.
- Develop incentives for sharing data.
- Gain legislative support, and seek funding and a policy mandate.

CONCLUSION AND THANK YOU

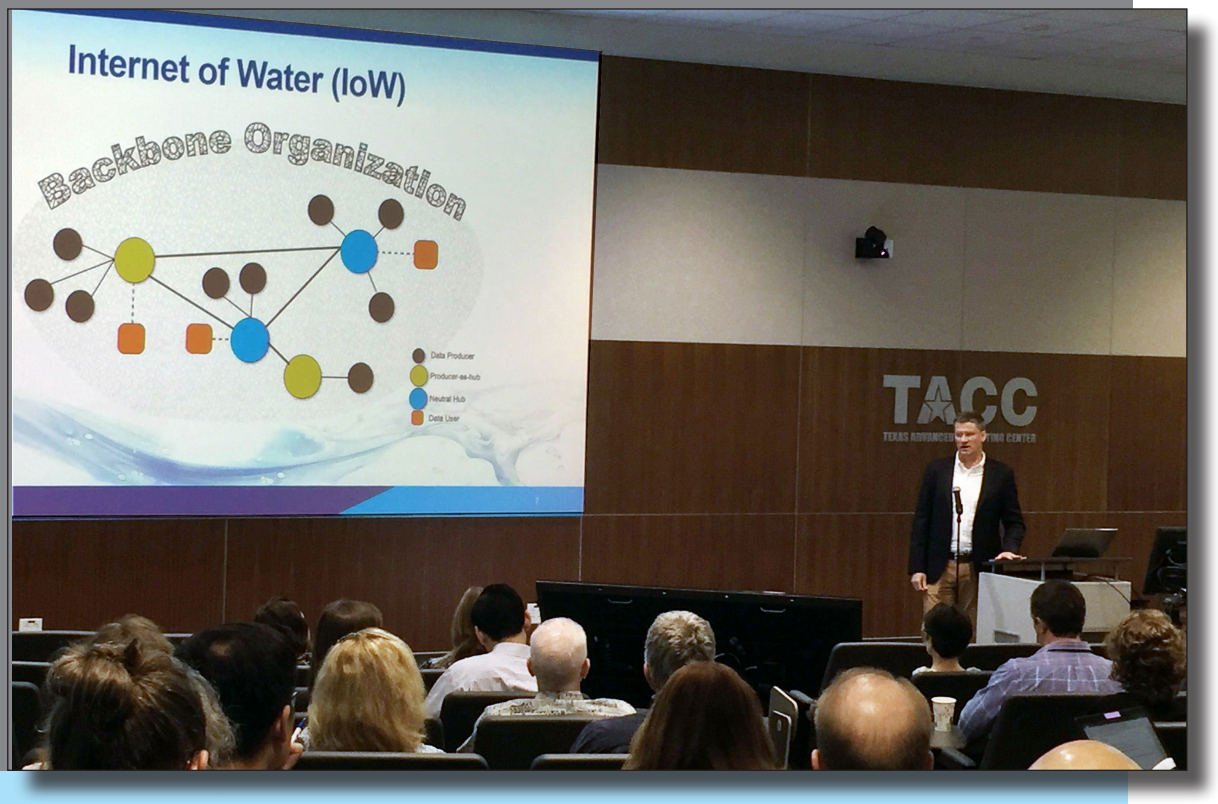
Most participants expressed satisfaction with the workshop (Appendix VII). The workshop achieved its objectives, with anticipated outcomes well covered by participant dialogue. Results of the workshop will help align ideas, underpin development of use cases, educate decision makers, and promote other first steps toward building a comprehensive, open access, water data information system capable of informing comprehensive water management decisions.

The sponsors and organizers are grateful to all participants for taking their time to meet with us and join with each other to help create a better vision for the future of data management and access in Texas and nationally. This dialogue must continue in various forms for work at the workshop to be relevant and useful. We thank all who participated and intend to follow up with all participants in the future.

APPENDICES

APPENDIX I

PROCEEDINGS, PROCESS, SYNTHESIS



"While it may not make sense to have a national water policy, participants at the Aspen Institute dialogue series concluded that it does make sense to have a national water data policy.." -- Dr. Martin Doyle

AGENDA

Opening Plenary Session. (9:00 AM – 10:00 AM)

- Welcome and introduction: Sam Hermitte, Assistant Deputy Executive Administrator, Texas Water Development Board.
- Introduction to the Texas Advanced Computing Center: Dan Stanzione, Executive Director of TACC and Assistant VP for Research at UT-Austin.
- Background/Orientation to the Internet of Water Initiative: Martin Doyle, Director of Water Policy Program, Nicholas Institute for Environmental Policy.
- Instructions/Workshop Process: Rudy Rosen and Susan Roberts, Director, Institute for Water Resources Science and Technology, Texas A&M University-San Antonio and Director, Water Systems Division, Texas Center for Applied Technology.

Breakout (Small Group) Work Sessions. (10:00 AM - 11:00 AM)

- **Big Picture:** Identify, describe, and list 1) who needs, 2) what data, 3) in what form, 4) to inform what decisions about water in Texas, including water supply, water quality, and environmental resources.
- **Data Gaps and Access:** Define the desired future water data management and access in Texas, by listing key attributes of a comprehensive open access water data information system capable of informing comprehensive water management decisions.

Plenary Synthesis Session and Group Discussion. (11:15 AM – 11:45 AM)

- Reporting of breakout session results. Facilitators.
- Synthesis and perspectives on morning sessions. Martin Doyle.

Keynote Address and Data Collaboration Networking Lunch. (11:45 PM – 1:00 PM)

- Keynote address. Kathleen Jackson, Board Member, Texas Water Development Board.
- Data Collaboration Networking lunch.

Breakout (Small Group) Work Sessions. (1:00 PM - 2:45 PM)

- **Texas Use Cases:** To initiate development of use cases for Texas water by identifying critical needs of Texas data providers and consumers. Following a template, facilitators will lead workshop participants in developing draft use cases across water topics and objectives.
- **Springboard to the Future**: Speed-list ideas on next steps to further define, design, and build a water data system for Texas.

Plenary Synthesis Session and Group Discussion. (3:00 PM – 4:00 PM)

- Reporting of breakout session results. Facilitators.
- Synthesis and perspectives on sessions. Martin Doyle.
- Open discussion: consensus building ideas and “next steps.” Rudy Rosen.
- Summary and closing statements: Sam Hermitte.

Guided Tours of the Texas Advanced Computing Center (4:00, 4:15, 4:30 PM)

CONNECTING TEXAS WATER DATA

WORKSHOP TEAM

ORGANIZING COMMITTEE

Sam Marie Hermitte - Texas Water Development Board

Suzanne Pierce - Texas Advanced Computing Center, University of Texas

Sarah Richards - The Cynthia and George Mitchell Foundation

Rudolph Rosen - Institute for Water Resources Science and Technology, Texas A&M Univ.-San Antonio

Susan Roberts - Texas Center for Applied Technology, Texas A&M Engineering Experiment Station

FACILITATION TEAMS

Group A
Mike Myatt - Water Foundation
Emily Warren - Meadows Center for Water and the Environment, Texas State University

Group B
John Tracy - Texas Water Resources Institute, Texas A&M University
Lauren Patterson - Nicholas Institute for Environmental Policy Solutions, Duke University

Group C
Robert Mace - Meadows Center for Water and the Environment, Texas State University
Natalie Freed - Texas Advanced Computing Center, University of Texas

Group D
Todd Votteler - Collaborative Water Resolution
Carrie Thompson - Water Table Consulting

Group E
Glen Low - The Earth Genome
Corinne Wong - Environmental Science Institute, University of Texas

Group F
Dorina Murgulet - Texas A&M University-Corpus Christi
Susan Roberts - Texas Center for Applied Technology, Texas A&M Engineering Experiment Station

WORKSHOP OVERVIEW

THE OBJECTIVES

1. **Big Picture**: To identify, describe, and list 1) who needs, 2) what data, 3) in what form, 4) to inform what decisions about water in Texas, including water supply, water quality, and environmental resources.
2. **Data Gaps, Management, and Access**: To define the desired future of water data management and access in Texas by listing data gaps, accessibility options, and key attributes of a comprehensive open access water data information system.
3. **Texas Use Cases**: To initiate development of use cases for Texas water by identifying critical needs of Texas data providers and consumers. Following a template, facilitators will lead workshop participants in developing draft use cases across water topics and objectives.
4. **Springboard to the Future**: To speed-list ideas on next steps to further define, design, and build a water data system for Texas.

THE PROCESS

CONNECTING TEXAS WATER DATA

A VISION

A water data system for Texas will support access to an accurate accounting of supply, quality, and use of water to better support decision makers in their efforts to enhance sustainable water use. Improved access to and standardization and integration of data, will provide water managers and decision makers a better basis for data-driven decisions, enabling them to more confidently meet urban, agricultural, ecological, and industrial needs for water.

Workshop planning was conducted by a team of organizers representing the following sponsors: Texas Water Development Board; The Cynthia and George Mitchell Foundation; Institute for Water Resources Science and Technology, Texas A&M University-San Antonio; Texas Advanced Computing Center, and; National Science Foundation Research Coordination Network for Climate, Energy, Environment and Engagement in Semiarid Regions. Representatives of The Aspen Institute and Texas Water Research Network also supported the planning team.

A dedicated website supported registration and communication between registrants and organizers. The website also presented background information, reference materials, interactive templates, the agenda, and details about the workshop.

Upon arrival at the workshop, participants were welcomed with an overview of objectives, an introduction to the Texas Advanced Computing Center, and a history of recent work nationally on the concept of developing an "internet of water." Participants then heard about the facilitation process to be followed in morning and afternoon small group sessions, and were introduced to the twelve facilitators who worked in teams of two. Participants received a package of templates, a glossary for use during facilitated sessions (Appendices IV and VIII), and a link to interactive templates. During a networking lunch, participants heard from a member of the board of the Texas Water Development Board about the Board's interest in making water data more accessible.

A post-workshop survey was conducted to allow for follow-up questions and input, as well as gauge participant opinion and satisfaction of the workshop and results. A final report of workshop transactions, results, recommendations, survey results, and proposed actions was published. This document is that publication.

OPENING SESSION

WELCOME

The workshop opened with a welcoming address by Sam Marie Hermitte of the Texas Water Development Board (TWDB). Ms. Hermitte described the reasons behind the workshop and expectations for attendees. After briefly describing early initiatives to create an "Internet of Water" in a few other states, she welcomed participants from the Aspen Institute and the State of California where an open data initiative is already underway. She indicated that participation at today's workshop by water data experts who have experience dealing with development of open data systems elsewhere may help add some perspective to the day's outcomes. Finally she thanked the sponsors and attendees for supporting the ambitious goals for the day.

THE TACC

Workshop participants were welcomed and introduced to the Texas Advanced Computing Center by Dr. Dan Stanzione, center director and Assistant Vice-President for Research at the University of Texas. The center designs and operates some of the world's most powerful computing resources. He stated that the center's mission is to enable discoveries that advance science and society through the application of advanced computing technologies. Dr. Stanzione emphasized the availability of the center's resources to researchers and invited all participants to tour the facility at the end of the day.

INTERNET OF WATER INITIATIVE

Dr. Martin Doyle of the Nicholas Institute for Environmental Policy Solutions at Duke University started his presentation with a story that illustrates in clear language the great importance to water users of open and easy access to existing water data. He stated the difficulty in terms of complexity and time spent that one encounters throughout most of the United States today when seeking information about the safety and exact quality of water coming from one's own tap. Today so much decision is made on the basis of instantly available data, but for water, which is the most important ingredient for life on Earth, access to data for most Americans is far from instant.

One of the primary drivers of access to water data is the fracturing of where water data come from and the diversity of organizations behind generating and storing data. He mentioned the US Geological Survey (USGS) and the associated water science centers in the various states that maintain the database and stream gauge network for the National Water Information System (NWIS). Dr. Doyle described that as the "gold standard" for surface water data and open access. This system presents a ready foundation for building a nationwide open network for water data. But the policy driver behind the NWIS is the mission and mandate of the USGS. Those data are foundational to how we think about surface water availability in the US. However, water quality data are collected for different purposes than to provide understanding about flows and quantities. These water quality data are generally used to address regulatory requirements for monitoring water and meeting set standards to remain in compliance with water discharge permits administered by environmental protection agencies. Pending on the industry reporting, data are collected and managed by different federal, state,

and local agencies with different purposes. Examples include agencies responsible for energy, agriculture, community development, forestry, fisheries, endangered species, watersheds, and so on.

Dr. Doyle and collaborators are seeking a means to have data that come from all of these various sources made available and viewable on a real-time basis. This has been termed, the "internet of water."

The internet of water was initially formed in the course of a water forum held by the Aspen Institute involving about 50 people who came together to talk about water and big data. Following the forum, a group of funders came forward to support the initiative, in particular to seek means to make water data more useful to society. A dialogue series then pulled together a highly diverse group of water experts from utilities, state and federal government, oil and gas, philanthropy, academia, nongovernmental organizations, software companies, and other sectors. The result was a consensus formed by people with very different perspectives around key findings and recommendations for going forward. While it may not make sense to have a national water policy, participants at the Aspen Institute dialogue series concluded that it does make sense to have a national water data policy.

The complete findings of the dialogue series were included in reference materials made available to all participants in today's workshop (Appendix V). There were three key findings:

First, there needs to be a vision about how water data will be used, a notion of usefulness, and a quantification of its value. Water is commonly known to be undervalued, but water data are generally even less valued. Without a sound value proposition for water and water data, it is hard to obtain sustained financial investment in water data infrastructure. The group recommended prioritizing value propositions and understanding how water data can help various sectors meet their mission and gain a return on investment.

Second, there needs to be a series of regional pilots, or use cases, that solve real-time real-world water management problems. This is also a way to show the value of water data. Decisions are being made without data, so pilots will bring data and their value in front of decision makers and to the forefront of underpinning solutions. The group agreed that public or government curated data should be a priority for attention by the data initiative's proponents. These data are collected using taxpayer dollars, should already be publicly available, and the federal government has expressed a commitment to make its public data more open and discoverable. Public data historically have been trusted and seen as authoritative, providing a framework on which other data may be leveraged or validated. Yet large portions of government water data remain inaccessible and lack interoperability. This public data can form a common framework for building a comprehensive open data system. Such government data combined with data from other sources represent a huge store of water data. While much of the non-governmental data also remain undiscoverable and inaccessible, with access that too could be used to build an open data network and help improve the nation's water security.

Third, there needs to be created an internet of water using these data. This would be a framework that enables data systems to talk with one another. However, participants at the Aspen Institute dialogue series concluded that this not be done through a centralized system or a system managed by any one governmental agency. They recommended networking through a federated system of data producers, users, and hubs such as the USGS National

Water Information System and National Ground-Water Monitoring Network. This allows data producers to maintain control over their own data, which proved to be of paramount importance. This concept was called "The Internet of Water."

Dr. Doyle stated that once data hubs are up and running, new water users and water data uses will emerge, and new kinds of data hubs will form. He specifically mentioned new proprietary and private data hubs forming that would provide targeted access and support the needs of validated users. The network will grow organically, with the value of the data and new accessibility increasing as people discover its existence.

One of the key ideas to be explored by today's workshop is the development of use cases, tied to specific beneficial uses of data to solve problems. Dr. Doyle urged participants to think about management decisions made that could have been made better with better access to data on a real-time basis.

Finally, Dr. Doyle explained that the day's workshop will fit well into the series of roundtable discussions that the Aspen Institute is supporting in a few other states and locations. So far roundtables have been held in Texas, California where there was a focus on water policy, Detroit with an emphasis on the Great Lakes, and St. Louis where agriculture received greatest attention. Roundtables in Colorado and Seattle are scheduled for the near future. In selecting sites for roundtables, there has been an effort to include a diversity of geographies, economies, and sector demographics.

WORKSHOP INSTRUCTIONS

Drs. Rudy Rosen and Susan Roberts of the Institute for Water Resources Science and Technology and Texas Center for Applied Technology, Texas A&M University System, introduced workshop participants to the agenda for the day. Participants heard that workshop activities will take place in small group facilitated work sessions in the morning and afternoon, immediately followed by plenary sessions where facilitators will report on the work of the small groups and a summarizer will add perspective to the reports. Participants also heard that at noon there will be a keynote presentation by TWDB board member Kathleen Jackson followed by a networking lunch. After hearing about the agenda, participants were introduced to members of the facilitation team and assigned to one of six groups for work sessions.

KEYNOTE ADDRESS

Kathleen Jackson
Texas Water Development Board

"The better the data, the better the science. And the better the science, the better the policy." -- Kathleen Jackson

To kick off the keynote address, TWDB Board member Kathleen Jackson introduced a former TWDB Board chair in attendance, Carlos Rubinstein, and several former and current members of the TWDB staff. She thanked them for their contributions and recognized staff's important role in contributing to the agency's success. Ms. Jackson then described her engineering background and former work with ExxonMobil. She explained how this background often motivates her to focus on objective measurement of success. She shared examples of TWDB success and how that success has been measured.

Her work in the oil and gas industry often involved managing risk. She related that to current efforts by the TWDB and the state, in general, to manage risk associated with water availability in the face of Texas' recurring droughts. She said, "It seems as though Texas is in a state of perpetual drought punctuated by brief periods of extreme flooding."

She then turned to demand for water supply. The TWDB works in an environment in which groundwater supplies are being depleted as the agency works hard to research and potentially identify new water sources for communities. We seek new supplies not just to ensure current residents have the water they need, but also to supply the needs of a growing population. She said, "Anywhere from 1,000 to 1,200 people are moving to Texas every day and not one of them is bringing any water with them." She continued, "The TWDB plans for drought and to meet the needs of a growing population."

Director Jackson then spoke of her experience traveling around Texas talking to people with "boots on the ground." She shares what the TWDB is and does and always makes the point that the TWDB is the data repository for all water data for Texas. She considers that role vitally important, especially from the standpoint of supporting the science mission of the agency and the use of those data by others. She emphasized that it is important to make raw data available so people can access and use the data for new purposes and reach their own conclusions.

Ms. Jackson also spoke of the TWDB's role as a bank and lender. She stated, "We have money to loan, and you won't get a better interest rate for water project funding than at the TWDB. This is a message delivered all around the state."

Much of what the TWDB does is water planning. The regional water planning process involves more than 450 volunteers across the state with diverse backgrounds, representing big cities, small communities, agriculture, manufacturing, and all the other water users. The volunteers come together to compile strategies to address future water needs and determine "how much water we have today, what we need to do for tomorrow, and what strategies or projects we need to put in place to get us where we need to be in the future." Director Jackson spoke of the TWDB's extensive water planning and regional water plans that come together to form the state water plan, looking out 50 years and updated every 5 years. She spoke of how the plans are data- and science-driven and done cooperatively with the 16 regional water planning groups. She said, "We use the best data available and make the data transparent and usable on multiple platforms." But in spite of all the work on water plans, "We don't plan to plan, we plan to build."

She said that if you look at where we are today, our success is measured by the quality of projects that are moving forward in Texas. At this time, the TWDB has committed $6.2 billion for projects in the SWIFT program. These include projects such as the $3.3 billion Houston-area water supply project, one of the largest water infrastructure projects underway in the nation.

Director Jackson also described her affinity to the land, having been involved in rice farming as a family business. As a result, she understands the critical role water conservation plays in Texas' water past, present, and future. The TWDB's role in managing and sharing state water data reaches across all water initiatives, including water conservation. She emphasized that role in helping to create a culture of conservation among people throughout the state, as well as funding big construction projects. She stated, "We need to instill a culture of conservation so it's an everyday part of what we do." To make this happen, she emphasized that we need to empower people by providing access to data about their own water usage so they can take personal action based on sound data. When people understand where their water comes from and learn what it takes to get water to them, they are more likely to conserve.

Ms. Jackson used a data-sharing initiative with the oil and gas industry as a final example of the TWDB's ongoing efforts to develop open water data systems. House Bill 30, passed by the Texas Legislature in 2015, created a charge to develop brackish groundwater productivity zones and determine ways Texas' brackish groundwater can be harvested. The first step for the TWDB was to review available information. While some data sets were already available to the TWDB, the agency staff understood that other valuable data might have been collected elsewhere but were not readily accessible. Staff believed that the oil and gas industry, in particular, had additional data because of its extensive use of brackish groundwater in production activities and was uniquely positioned to provide well log and corresponding brackish water quality data. Through a collaborative effort, the initiative gained momentum and moved forward successfully after identifying targeted technical objectives, ensuring the data transfer was not burdensome to industry personnel, and determining there were no adverse unintended outcomes as a result of opening access to these data. While directly addressing the charge of House Bill 30, opening access to this set of raw data also directly benefited the oil and gas industry. Once aggregated, the raw data formed a larger database than any one company had access to and can now be used to further the use of brackish groundwater by industry and the public. The TWDB gained additional data and strengthened a continuing collaborative relationship with the Texas oil and gas industry.

Finally, Ms. Jackson stated that the workshop brought together key players and then urged participants to form enduring collaborative relationships during the day, in addition to sharing information and ideas about open data systems for Texas. She thanked all attendees for participating and commended them for their engagement and support, which allows Texas to continue to be an economic leader in this nation and the world.

SYNTHESIS

DR. MARTIN DOYLE

MORNING SESSIONS

During morning group sessions participants consistently expressed an overarching belief that in Texas today one needs to be an expert to find data that exist and to access those data and integrate them for practical use. They stated that much of the data that do exist are not actionable. They defined water data in a highly broad comprehensive fashion, because it was apparent from the participants' long list of data users, needs, and uses that the primary user or "audience" is not clearly in focus. Virtually every need, possible use, and everyone made the list at one time or another in discussion. Some groups simply described the user as "everyone" or "the public." All needs, all uses, were at one point or another expressed as possible additions to the list of water uses. In synthesizing the session, Dr. Doyle stated that, "if you are speaking to everybody about everything, then you aren't speaking to anybody about anything."

One group was an exception. Participants in that discussion made it clear that for them the key user of water data is the water resources expert. Researchers, analysts, managers, and water decision makers fit into the category of expert.

There is a need to segregate work on data systems to focus on the type of user expected to access the system or particular data sets, whether that's for an average citizen or for a water analyst. Dr. Doyle reminded participants that as we begin to form plans for building data hubs and accessible data systems, that we need to be explicit about the end user. It's simply not realistic to build a single water data system for use by the average citizen and the water expert.

Dr. Doyle used the Weather Channel as an illustration. He stated, "while the average citizen can access and use the Weather Channel and accompanying online resources, the average citizen can't use the USGS stream gauge network in the same way."

Consider the different technical resources and investments required to form up an equivalent to the Weather Channel for a particular data set versus forming something like the USGS stream gauge network. The investment in technology and human resources differs in developing a system for average citizens with a heavy emphasis on synthesis and visualization dashboards versus a data system for water experts who may desire raw and accompanying metadata.

Dr. Doyle stated that almost every group mentioned a Google of water, but what they really meant was a Google of water databases. This would be an open source for links to and information about databases that exist. Such a system would be seen as a desired first step toward a comprehensive open data system.

He also mentioned an emerging realization that time delay in use of one data set versus another would greatly influence data applicability in decision making and thus interest by one group of users versus another. For example, decision making such as, "how many acres should I plant?" will require data collected over a different time scale than decisions about changing the way a major utility is operating to meet projected population increases. Participants talked about near real-time data providing early indicators that can be used to make near instant decisions of immediate consequence. They stated that data useful for "hour-by-hour" and day-by-day" decision making are probably beyond the scope of current discussion. However "week-to-week" and "month-to-month" data and decision making seem to be an immediately attainable sweet spot.

AFTERNOON SESSIONS

While there was consistency in discussion from group to group during the morning sessions, session summarizer Dr. Doyle sensed that discussion by afternoon groups started out in somewhat similar directions, but by the end of the sessions discussions varied greatly from group to group. That prompted Dr. Doyle to suggest that as we start thinking about how to proceed in developing use cases, where we begin considering where to apply resources, and when designing data systems that we consider who is in the room. Why? Because who is in the room and party to discussions and decisions matters greatly. It did at the workshop and it will wherever a group of individuals with diverse backgrounds who represent varied interests is convened. This advice was not offered as a value judgment on outcomes, it was just a recognition of the reality of group dynamics.

There was considerable discussion about incentives and policy requirements that may support the evolution of data systems and markets. These may also help further drive data system use and expansion. Dr. Doyle suggested that through strategic consideration of our actions, we can be intentional about creating forces that push and pull data systems in a defined desired fashion and direction.

While observing groups in the afternoon as they developed use case ideas, one idea in particular captured Dr. Doyle's imagination. This was to build a use case centered around a high-profile action taken in Texas within the past year where available data were used in decision making, but where results would have been different and better if additional data had been available and accessible.

Dr. Doyle also suggested to participants that when experts, such as attendees at the workshop, get together and consider questions such as those posed during the day's sessions that they have a strong tendency to identify and discuss items in a top down fashion. That may overly complicate understanding. He suggested an alternative approach is to ask people in the trenches of day-to-day decision making, "what are you now doing with water data and how are you actually making decisions with those data." This would cast a wider net in a search for instances of Texas' water managers taking action using data that are already available.

Moving from an assessment of the day's group discussions and thinking more broadly had Dr. Doyle compare the discussions in Texas with similar activities in California, Missouri, and Michigan. He suggested that in addition to considering isolated use cases illustrating an action taken or desired, that we think more broadly. He suggested considering classes of use cases and possible advantages of developing use cases to illustrate classes of use. Among possible advantages of this kind of approach, it may be possible to evaluate the costs and benefits of putting resources into one class of use case versus another.

Here are examples of possible classes that Dr. Doyle suggested could be used to categorize possible use cases:

1. Events, such as floods, droughts, and water supply ups and downs.
2. Markets, can market forces be used directly or indirectly to drive new data and more access?
3. Unusual but important users, such as insurance companies, real estate developers, and banks.
4. Better decisions on costs or investments, such as building new infrastructure and timing of reservoir releases.
5. Public engagement, such as user-friendly dashboards, delivery of personal or neighborhood water usage information, and public shaming campaigns.
6. Already happening uses where improvements or additions to existing data will provide quick results.
7. Conflicts coming or ongoing, including a use case associated with legal action contemplated or ongoing.
8. Locally-relevant successes showing where a small amount of data were used to change decisions affecting a local area or limited group.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APPENDIX II

The Big Picture

Data Gaps and Desired Future

Breakout Session Details

ACTIVITY 1
BIG PICTURE

Identify, describe, and list 1) who needs, 2) what data, 3) in what form, 4) to inform what decisions about water in Texas.

ACTIVITY 2
DATA GAPS & FUTURE

Define the desired future water data management and access in Texas, by listing key attributes of a comprehensive open access water data information system capable of informing comprehensive water management decisions.

GROUP A

BIG PICTURE

WHO NEEDS ?

- Academic researchers
- Engineering firms
- Regulatory agencies
- Oil and gas companies
- Farmers
- General public
- Regional water plans

WHAT DATA?

- Water use
- Groundwater
- Brackish groundwater
- Flooding information (pre, during, and post event)
- Groundwater ownership
- Rights of way

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

GAPS IN WATER DATA

- Water loss/leaks in systems
- Analysis of water allocation
- Fracking water
- Unstructured digitized data
  - Water rights
  - Discharge permits
- Groundwater
- Saltwater disposal-oil and gas
- Alternative water sources
- Economics-value vs. price
- Modeled data
- Monitoring data
- Brackish vs. freshwater availability
- Groundwater ownership
- Rights-of-way
- Flooding
- Water quality
- Hazardous/industrial wastes
- Water supply reservoirs
- Monitoring sites
- Groundwater
- Sharing between federal and local agencies
- Integration of citizen science data

IMAGINE THE FUTURE

Participants imagined a future of open access and ease of accessibility that included an ability to access lots of information, including legacy data in a digitized form. That information would be user friendly, robust, complete with metadata, and moving more to real-time information available on web services with visualization tools built in so that the average person can actually get something useful out of it. They perceived that data and information would be free, and in consistent reporting formats so that the data would "talk to each other" as its being accessed by the user. They also envisioned a future where there would be adequate funding to sustain the data systems over time. Participants also got into a discussion about citizen science. There were deferring opinions on the value of data derived from citizen scientists, especially on matters of quality control of data for it to be safe and useful. They believed that there would need to be a way to place such data into a context for viable use. Finally, participants discussed the ideal form of a data system. They suggested that several integrated data hubs specialized by sector was most preferable, with incentives for people to add to and share data into the hubs.

GROUP B

BIG PICTURE

WHO NEEDS ?

- Water experts
- Analysts
- General Public

WHAT DATA?

- Project specific
- Decision related

WHAT FORM?

- Raw
- Meta
- Cataloged

FOR WHAT?

- Curated
- Derived

- Analysis
- Synthesis
- Decision making

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

The data that would be most useful in any data hub would be the metadata, associated with who has what data, for what purpose, and the provenance of the data. Participants stated that the users of the data would be individuals involved in research studies and analysts seeking to access specific data or studies. They would benefit simply by having a source to be able to find data by subject and by having a data hub that would provide them with a catalog or curated listing that directs them to a location in a data hub where they could access appropriate raw data or curated data. Participants believed that this would aid research and synthesis of activities related to water and providing input and planning advice to decision makers.

Participant discussion focused on gaining access to and a critical need for raw data, or data as close to raw data as possible. However, participants cautioned that it's not always possible to obtain all data in a raw state, but they emphasized access to data as unaltered as possible. Who would use this? It would be used in the course of work by experts for analysis and synthesis, and passed on to others for decision making on water resources, including water users, water utility managers, and so on. They felt that this would be focused on the water resources professional, but not the general public.

Participants also discussed existing data hubs. They mentioned the US Geological Survey's National Water Information System (NWIS)as an example that participants' access. However, participants mentioned that even though the NWIS is useful, it is limited in use in the built environment, i.e., where water has been removed from the environment and modified by treatment or use). Participants then used the built environment as an area where there is a data gap and an area for future focus on providing access to or more quantitative data that would be useful for people in the water resources profession addressing questions in the built environment.

Participants used a common acronym to describe the desirable state of water data. Water data should be FAIR:

F - Findable
R - Reusable
A - Accessible
I - Interoperable

GROUP C

BIG PICTURE

WHO NEEDS ?

- The public
- Researchers
- Emergency responders
- Regulators
  - State
  - Federal
- Teachers
- Real-estate developers
- Farmers
- Ranchers
- Insurers
- News media
- Water districts
- Industries
  - Oil and gas
  - Technology
  - Energy
- Cities/communities

WHAT DATA?

- Where does MY water come from?
- Historic
- Real-time
- Predictive
- Metadata

WHAT FORM?

- Scale:
  - Individual
  - Community
  - Local
  - State
  - Federal
- Detail/granularity:
  - Raw
  - Tiered
- Access:
  - Easy to find
  - Easy to navigate
  - Available online
  - Summarized
  - Ability to drill down and disaggregate

FOR WHAT?

- To understand:
  - How much water I can use
  - How much water I am using
  - How clean is my water
  - Where is my water
  - My cost of water
  - Local restrictions
- Determine flooding risks
- Rainwater collection

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

GAPS IN WATER DATA

- Real time data:
  - Missing stream gauge data
  - Infrequency of observation
  - Automated meter readings
- Rural vs. urban
- Permit information
- Water quality
- Disparity between needing both water quality and quantity data for use, but having only one or the other
- Continuous data and privacy/liability issues
- Limited access to biological data

Participants agreed that data should be accessible, easily navigable, interoperable, and failure safe. Participants spent considerable time talking about multiple levels of granularity and the quality of data, from broad data to distilled data, geographic indexing, sources, credits for who generated data, historic context, metadata, and curated quality. No agreement was reached on what should be done is data is of poor quality. Suggestions included allowing for users to add information or comments into the data" on the side" as well as to provide feedback to data mangers of the data hub on problems and, if possible, how to address problems with the data.

GROUP D

BIG PICTURE

WHO NEEDS ?

- Parents
- Natural resource managers
- Farmers
- Producers
- Flood control districts
- Everyone
- Groundwater districts: Utilities, Well owners, Agencies
- First responders
- Planners
- Developers
- Weather Service

WHAT DATA?

- Stream flow
- Water quality and quantity
- Salinity
- Temperature
- Soil moisture
- Evapotranspiration
- Rain gauge
- Well data
- Water crossings
- Flood data
- Depth and velocity
- Reservoir storage
- Agricultural fields
- Land use
- Land cover
- Conjunctive use
- Return flow

WHAT FORM?

- When needed
- Real time
- On demand
- Universally scaled for layering/sharing

FOR WHAT?

- To explain/educate: Recreation, Safety, Quality, Flooding
- Resource management
- To protect sensitive ecosystems
- Flood control districts

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

GAPS IN WATER DATA

- Lack of integrated flood mapping, for emergency response, low water crossings, and shared across counties
- Climate forecasting related to groundwater-surface water interface, recharge, temporal/ spatial variability
- Precipitation data that is accessible to nontechnical users
- Soil moisture and evapotranspiration
- Real-time bay and estuary inflow
- Biological, agencies need to share
- Quality & flow piecemeal difficult interfaces
- Water rights, needs to be online and accessible
- Water availability
- Dye tracing data from groundwater districts
- Well logs, existing Railroad Commission data needs to be made accessible

IMAGINE THE FUTURE

Participants Participants suggested possibly downscaling the USGS national water model for application in Texas by adding state data to it. That would fill out the model for Texas, with added state water quality data creating a clearing house for Texas water information.

Participants also talked about integrating into the model remote sensing data available through the National Aeronautics and Space Administration (NASA).. Participants mentioned a series of satellites producing different data sets that could provide a source of data for a Texas water model.

GROUP E

BIG PICTURE

WHO NEEDS ?

- Utilities
- Consultants
- Agencies
- Legislators
- Agriculture producers
- Water users
- Public
- Watch-dog groups
- Courts/people in court
- Permit applicants
- Industry
- Financial institutions
- Insurers
- Researchers
- National Weather Service
- First Responders
- Oil and gas
- Public health agencies
- City planners
- Rights-of-way
- Flooding
  - Water quality
  - Hazardous/industrial wastes
  - Water supply reservoirs

WHAT DATA?

- Metered usage:
  - Reservoirs
  - Irrigation
  - Commercial
- Utility usage
- Losses/leakage
- Water source
  - Cost of water
- Stream flow
- Reservoir levels
- Water rights
- Water availability
- Wells:
  - Location
  - Quality
  - Quantity
  - Geology
- Groundwater surface water interaction
- Real-time water quality
- Output from models
- Future scenarios:
  - Climate
  - Demographics
  - Water security
  - Demand
- Trends:
  - Change in land use
  - Runoff
  - Precipitation soil moisture

WHAT FORM?

- Free or inexpensive
- Queryable
- Manipulatable
- Accessible
- From known source
- Verifiable
- Metadata
- Supported by a policy framework
- In one place
- In standard format
- Downloadable
- Includes legal context
- Layered for different users

FOR WHAT?

- Update water availability models
- Public access to models
- Emergency response
- Recreation decisions
- Border protection
- Property valuation
- Use prioritization
- Address unintended consequences of water decisions
- Food security
- Know water footprint
- Access alternate sources of water
- Understand energy needs
- Mitigation decisions
- Environmental impact assessment
- Water availability and allocation
- Understand regulatory successes and failures
- Conservation
- Protection
- Funding decisions
- Infrastructure decisions
- Know water quality

GROUP E (CONT'D)

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

Participants were asked, "On a scale from 1 to 7, with 7 being the highest, where is Texas today on overall water data availability for decision making?" The answers scattered around 3 to 4.

A second follow-on question was asked, "How easy will it be for Texas to get to 7?" Answers were more scattered, but trended a bit higher with the midpoint between 4 and 5. Participants felt the key challenges to getting to 7 are the heterogeneity of data and the human component (i.e., the political will and ability to make data sharable).

Participants divided users into four general meta categories. (1) legislators and policy makers, (2) government agencies, (3) researches who help inform legislators and policy makers in the agencies, and (4) planners and the people who are actual users of water.

Participants stated that the most critical water decisions that would require new data or better access to existing data mostly had to do with the best use of water in the state. There was a strong focus on gaining access to actionable data. There was discussion on the relative value of raw data versus data from models, also expressed as raw data versus processed data. They stated that some end users require insights, not actual data. There was also considerable conversation about future scenarios, especially regarding data that will allow users to predict what might happen in the future. Data from the past may be indicative of what may happen in the future. There was also discussion about trends as indicators, and aggregating available information in a fashion that ensured it is not just data, but that it is actionable information.

Participants identified four areas or instances where data gaps -- lack of data and/or access to data – have created problems in the state:

1. Actual events like Hurricane Harvey.
2. Lawsuits, and how data can help inform understanding and decisions.
3. Suboptimal decision making at almost every level throughout the state, whether involving a utility, agency, or other.
4. For much decision making on water, not only do we often not have data to know what the problem is, we don't have the data to know how to make the right investments to fix the problem.

Participants' vision for the future for data is that it be open, real-time, accessible, free, interoperable, simple, user friendly, and fully integrated.

GROUP F

BIG PICTURE

WHO NEEDS ?

- Water conservation managers and decision makers
- Water Utilities
- Consultants – watershed, permitting
- Counties
- Educators
- Planners
- Developers
- Agriculture
- Nonprofits
- Groundwater Conservation Districts
- Landowners
- Land use planners
- Water resource managers
- Academics
- Research Community

WHAT DATA?

- surface water and groundwater quality
- Groundwater level data per aquifer
- Groundwater-surface water interaction (gaining or loosing water systems)
- Water supply quality
- Water use (surface water and groundwater)
- Stream-flow gauge data (i.e. flooding)
- Soil moisture throughout the state
- Biological stream data
- Water rights, ecological/ biological planning, adaptive management
- Water supply & flood control:
  - Reliable
  - How much supply is available
  - Change WAM from monthly to daily
  - Change models to deterministic
  - Analytical methods
  - Water & transportation infrastructure
  - Establish needs based on the type of problem: dynamic versus static

• WHAT FORM?

- Granular
- Platform-based
- Benchmark
- Agreed-upon structures & standards
- Agreed-upon and acceptable methods & measurements
- Pdfs and digital data
- Raw
- Processed & synthesized
- Already analyzed
- Visual forms (graphs, images)
- Retrievable
- Shape files
- Well logs
- “Private” data
- Texas Mesonet
- Value/quality for a fee
- Usable QA/QC
- Interoperable
- Determine what can be aggregated
- Statistically rigorous
- With metadata
- Continuous at temporal and spatial scales
- Basin-scale

FOR WHAT?

- Long-range planning
- Drought
- Prediction
- Real-time needs
- Public & policy visualization
- Improved analysis
- Responsiveness to regulations
- Access for specific uses such as permits
- Alerts/emergency detection
- Research
- Improve capacity to integrate data
- Hub for connectivity and improvements; address protection & risk
- Information to sectors by use
- Move from static to dynamic monitoring
- Ecologic responses to water quality and availability
- Monitor water rights and see results
- Better decisions
- Scalable actions
- Leverage other data sets
- Cost of data sets

GROUP F (CONT'D)

GAPS, DESIRED FUTURE, ADDITIONAL POINTS

Participants were asked about gaps in Texas water data and implications to management decisions and their visions of future data systems to begin bridging those gaps, and key attributes of open access data systems.

Gaps included the knowledge of available data and the ability to access connected, real-time water management data sets. Sufficient time to update databases was also felt to be a gap. Achieving granularity of data sets could be better accomplished via aggregation. At the river basin scale, lack of real-time views into the state of the basin, and access to connected data sets, are missing. Participants defined other gaps in the relative ease of using data and models for any basin.

Vision: Real-time data sets and databases will be dynamically linked. Data catalog(s) and viewers will be available in a central platform that also allows decentralized input. Water data management can learn from other sectors; for example, use of a "GitHub" type of open, community-wide management will also open transparency. Community-wide involvement and management of shared data sets will ensure that users can see origins of data and actions in view. An annotated collection of data about water derived from existing and heterogeneous databases/datasets with the goal of uniformity and coherence. A virtual data set/database to transparently view and query other databases?

APPENDIX III

Texas Use Cases Springboard to the Future

Breakout Session Details

ACTIVITY 1
TEXAS USE CASES

Identify critical needs of Texas data providers and consumers, describe, and list as potential use cases for Texas water across topics and objectives.

ACTIVITY 2
SPRINGBOARD TO THE FUTURE

Next steps to further define, design, and build a water data system for Texas

GROUP A

TEXAS USE CASE

WATERSHED PLANNING, WATER ALLOCATION, FLOODING

Participants formed three subgroups to work on Group A's top three recommendations.

Subject	**Watershed planning**
Objective	To develop a water budget for a river basin using science-based planning
Participants	TWDB, public utilities
Data	Land use over time and water use, actual groundwater and surface water use, metered data, water quality, endangered species data, surface water diversions, discharges, stream gauges, geologic data, soil moisture
Sources	Cities, counties, Natural Resources Conservation Service, Texas Natural Resources Information System, Google Earth, planning firms/organizations

Subject	**Water allocation**
Objective	To ensure that basic water needs are met, then use above that will be charged at full cost
Participants	Groundwater Conservation Districts, Texas Water Development Board, Texas Commission on Environmental Quality, businesses
Description	The more one pays, the more one cares

Subject	**Flooding**
Objective	To develop a collection of data sets that can be used to reduce risk, increase response, and set priorities on projects
Participants	Federal Emergency Management Agency, US Environmental Protection Agency, Texas Water Development Board, local public works agencies
Description	Flood mapping, reservoir levels and discharge

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Next steps to move toward open data for Texas were listed. First is to gain legislative support, such as gain funding support or a policy mandate. Next is to identify the network structure, who will do what, determine partners, who will pay, and who will take leadership roles. Another is to pick an interesting use case or two that came from the workshop, and then form pilot projects around the use cases and actually do something that shows the value an open data system. The participants also recognized that Texas does have existing open data sources in place and operating. They suggested sharing information about the existing open data experiences and best practices, thus getting the word out about the value of open data sources. Finally, participants discussed establishing standards or guidance for open data sources so that people understand how and in what form to make data available, so it can be integrated better, and so people who may be apprehensive about open data can better understand what it means. This could help reduce barriers, along with meeting opponents of open data to help address fears.

GROUP B

TEXAS USE CASE

WATER UTILITY REPORTING TO THE TWDB

Subject	**Water utility reporting to the Texas Water Development Board (TWDB)**
Objective	To provide enhanced open access to water utility reporting data already sent to and logged into databases by the TWDB.
Description	Water utilities are legally required to submit three reports to TWDB: (1) Water use Survey, (2) Water Loss Audit, and (3) a Conservation Report. Those data are reviewed and processed, and entered in database format on the TWDB website. A PDF is then generated. However, if anyone wants to use the data across Texas they need to get all of the reports, read through the relevant ones and select desired data, and then reprocess the information into digital data for any kind of actionable use (i.e., data that were originally actionable, actionable again). This use case will be to make these data sets searchable and downloadable. There will be no privacy issues because all the data are public information to start with, it goes directly to a public agency, and it's being collected in database format. The use case project would make this data readily accessible through an open interface or interactive application. Emphasis will be on raw data, as opposed to exact uses of the data. Then those who access the data would synthesize the data as they felt most appropriate to meet their own needs.
Uses	• Industrial water use during drought • Better decision making on water-related investments • Higher visibility for addressing water loss and conservation actions • Explore utility billing structures • Many users for general research into and analysis of water use in Texas: o Innovation; Target setting for science and policy; Real-time data source; Engagement for education and consumer information sharing
Participants	TWDB, public utilities
Regulatory	• Legislative statutes and agency rules trigger reporting • Standardized by regulation
Workflow	• Utilities upload reports online • Design-build open access user interface • Determine extent of historical data to include for access • Translate data from forms to new accessible interface
Sources	• Public utilities, Texas Commission on Environmental Quality, water rights use, water sales, water flows, climate related, recharge rates • TWDB Water Use Survey, Water Loss Audit, and Conservation Report

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Participants had several ideas for moving forward, including the recognition that droughts are a key driver of innovation, that an inventory of where data now resides would be a natural first step, that an advisory task force for next steps could be useful, and that a clearing house for water quality information would be welcome. A final idea was mentioned by participants that may be implemented immediately. This was taking immediate initiative to write editorial and opinion items to the public and water community stakeholders about the internet of water. In discussing the idea, use of Texas+Water and the Texas Water Journal, were suggested as currently available venues for such outreach and communication to stakeholders.

GROUP C

TEXAS USE CASE

ENVIRONMENTAL FLOW TRANSACTIONS

Subject	**Environmental flow transactions**
Objective	To have the greatest positive impact on environmental flows at the lowest cost
Data Gaps	Environmental flow study raw data, cost data for transactions, biological data, water availability (what's on the market), historical data at temporal and spatial levels
Participants	Lawyers, Texas Commission on Environmental Quality (TCEQ), Texas Water Development Board (TWDB), Texas Parks and Wildlife, river authorities, purchasers, sellers
Workflow	1. Identify potential funding sources 2. Identify possible sellers 3. Identify areas of need, e.g., threatened species 4. Compare historic to current flows Additional actions in no order that may be taken: • Review water rights seniority • Do cost-benefit analysis • Study prior cases • Assess water quality and impacts • Review predictive models • Review TCEQ process for amending water rights • Identify existing environmental flow rights • Estimate flows needed to make a difference
Sources	US Geological Survey, TCEQ, regulations/requirements, river authorities, wa-ter rights, environmental flow studies, stream flow including historical data (SB 2), water quality, existing environmental flow rights, water availability models, threatened species

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Participants had a series of potential next steps, lead off by a need to identify funding sources for establishing the data hub, followed by an identification of "anchor tenants" which would be the key users and supporters of the hub. There was also discussion about creating an initial support group called, "Cooperating Agencies for the Temporal and Spatial Management of Environmental Occurrences of Water," or as participants affectionately labeled it, the CATS MEOW. But whatever it may be called, the idea participants voiced is to create a group or organization to work on data standards and communicate on data in Texas. Related to that was the notion of creating a users' forum to allow for feedback discussions between super users, help with general education, and use it to create a community of users at all levels. Participants also discussed the need to address barriers to participation for certain institutions, better understand what the barriers are, identify resistance (including who may be opposed), and address the barriers. This effort may include identifying a neutral broker for data to support whichever entity takes the lead on the overall effort, and find and motivate political champions so that some barriers may be reduced or removed by statute, for example by requiting some kinds of data from some sources be openly available.

Finally, participants considered which agency, or "who," would be best suited to lead in developing and hosting the key data hub. The conclusion of the group was that the TWDB's Texas Natural Resources Information System (TNRIS). Reasons for the choice included that TNRIS is neutral, public, supported by statute, and has a stable source of funding.

GROUP D

TEXAS USE CASE

FLOOD WATER MANAGEMENT IN EPHEMERAL STREAMS

Subject	**Flood water management in ephemeral streams**
Objective	To better prepare for flood water management and emergency response in ephemeral streams in Texas
Description	Flash floods occur in ephemeral streams, sometimes even at low levels of rainfall. Emergency and natural resource managers need to prepare of unanticipated flood scenarios.
Data Gaps	Need rain map for the ground (i.e., how water moves and accumulates once it hits ground)
Uses	• Produce data for immediate use in emergency • Many data resources must work together immediately and flawlessly on public health and safety • Way to access real-time inundation conditions, spatially and temporally • Understand how waters will recede • Determine opportunities to divert water off-channel for storage and flood reduction • Placement of flood control structures • Identify biological areas that benefit from flooding • Post-flood damage assessment • Baseline data on impacts on soils (erosion) and nutrients
Participants	County government, National Weather Service, US Geological Survey, citizens, local media, first responders, Texas Water Development Board, Texas Water Development Board, Texas Division of Emergency Management, Federal Emergency Management Agency, flood management districts, Natural Resources Conservation Service, cities, landowners, nongovernmental organizations, conservation districts, engineering consulting firms, river authorities, water utilities, wastewater facilities, resorts
Regulatory	• FEMA flood plain mapping drives insurance • Tort law • Federal and state designation of "State of Emergency" • Legally required reporting, including industrial spills from treatment facilities • Local codes and ordnances • Local, state and federal determinations of evacuation and other orders for health and safety
Workflow	• Need a mechanism to bring together data from many sources immediately • Need an organization (assigned or created) to answer data questions for Texas flood emergencies
Sources	Same as Participants (above)

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Participants emphasized developing examples of how people have used data for practical decisions, i.e., real world examples of benefits to people. The suggested conducting a survey to determine, "who has what data already." Participants stated that there may be more data available than generally assumed, possibly because there may be few or no incentives for collectors of data to share with others what data they have and to support making data sets available. Participants asked, "what are the incentives for organizations to share given already strained budgets and a lack of time to do basic work?" They also asked about disincentives to sharing access to data, especially for the private sector. There was even discussion about how some public organizations may be reluctant to open and share data because of fear of legal action against the agency. All this discussion focused on addressing incentives and disincentives as an important step forward. One idea even involved awarding a prize, or public challenge, to use TWDB data and demonstrate positive impacts to decision making for a project in Texas.

Finally, participants concluded that the agency in Texas best suited to lead in developing and hosting the key data hub is the TWDB's Texas Natural Resources Information System.

GROUP E

TEXAS USE CASE

INTEGRATE AND UPDATE THE TEXAS WAM AND GAM

Subject	**Integrate and update the Texas Water Availability Models (WAM) and Groundwater Availability Models (GAM)**
Objective	To integrate and update the WAM and GAM to better understand water availability across surface water and groundwater, and across the interface between the two.
Description	Separate models are often outdated, sometimes reverse engineered, and lead to suboptimal results by design. Current models for surface water and groundwater in Texas can be integrated for better results leading to better decision making about water in Texas.
Data Gaps	Need rain map for the ground (i.e., how water moves and accumulates once it hits ground)
Users	All users of state, regional, and local water management plans
Uses	• Provide better tools for decision making and reduce/avoid some costs • Improve state water planning and plans • Provide for more adaptive management • Assist real-estate planning and reduce costs
Participants	See sources
Regulatory	State, regional, and local water management planning
Workflow	• Need a mechanism to bring together data from many sources immediately • Need an organization (assigned or created) to answer data questions for Texas flood emergencies
Sources	Groundwater conservation districts, Texas Water Development Board State Water Plan and Texas Natural Resources Information System, US Geological Survey, floodplain mapping, US Geological Survey Texas water dashboard, Texas Commission on Environmental Quality, The Nature Conservancy Living Waters, Texas Railroad Commission, Texas General Land Office, Texas Department of Licensing and Regulation well licensing, Lower Colorado River Authority Hydromet, TexMesonet, National Weather Service river forecast, US Bureau of Reclamation, US Army Corps of Engineers
Characteristics	Data are available and ready for use today dispersed across many agencies and organizations. These data may be hard to find for most potential users.

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Participants first listed existing data sources and then, considering the list, asked, "what can we do to or with this existing data to improve outcomes for Texans the most." Their answer was to integrate and update the Texas Water Availability Models (WAM) and Groundwater Availability Models (GAM). Participants summed up their reasoning with a problem statement: separate models are often outdated, sometimes reverse engineered, and lead to suboptimal results by design. Thus, the key for the group was not to just have more data, but to have more research, more models, better models, better data sets, maps, and a tool. That tool will allow people to see water availability across surface water and groundwater, and across the interface between the two. This interface is where the greatest optimization of the models will be achieved. With that, the data sets will be optimized and the improvement sought by the participants will be achieved.

The end result is that there will be updated WAM and GAM, and with better models over time the end users, including policy makers, regulators, and water rights holders, will be served better. Participants stated that it is important that this effort be positioned as not changing how water is regulated in Texas. This project would be framed to honor and protect property rights and how water is already being managed in Texas. The tool would allow for better evaluations and decisions; better state, regional, and local water planning and plans; more adaptive and integrated management, and; better tools to avoid costs. This would be a tool that serves a specific purpose. It would also drive traffic to existing data portals from which data will be drawn.

GROUP F

TEXAS USE CASE

PROBABILITY OF RESERVOIR WATER SUPPLIES FALLING

Subject	**Risk management of the probability of reservoir water supplies falling below criteria at 3, 6 , 9, and 12 months**
Objective	Risk management: identify risk of communities' water supplies falling below critical levels
Participants	Primary users: Water Resource Managers, utilities, power agencies – any group that may need to take action based on risk and "triggers"
Regulatory	Water rights in reservoirs and placed in Water Management Plan. The plan is stochastic with water rights defined by TCEQ oversight of court-based adjudication. Focus on permission with constraints.
Workflow	1. Identify potential funding sources 2. Identify possible sellers 3. Identify areas of need, e.g., threatened species 4. Compare historic to current flows Additional actions in no order that may be taken: • Review water rights seniority • Do cost-benefit analysis • Study prior cases • Assess water quality and impacts • Review predictive models • Review TCEQ process for amending water rights • Identify existing environmental flow rights • Estimate flows needed to make a difference
Sources	Texas Commission on Environmental Quality, water rights use, water State river flows and related data sets. Water sources = run of river data

SPRINGBOARD TO THE FUTURE – NEXT STEPS

Participants observed that two key questions need to be addressed in order to form a "springboard" to the future of Texas water data management:

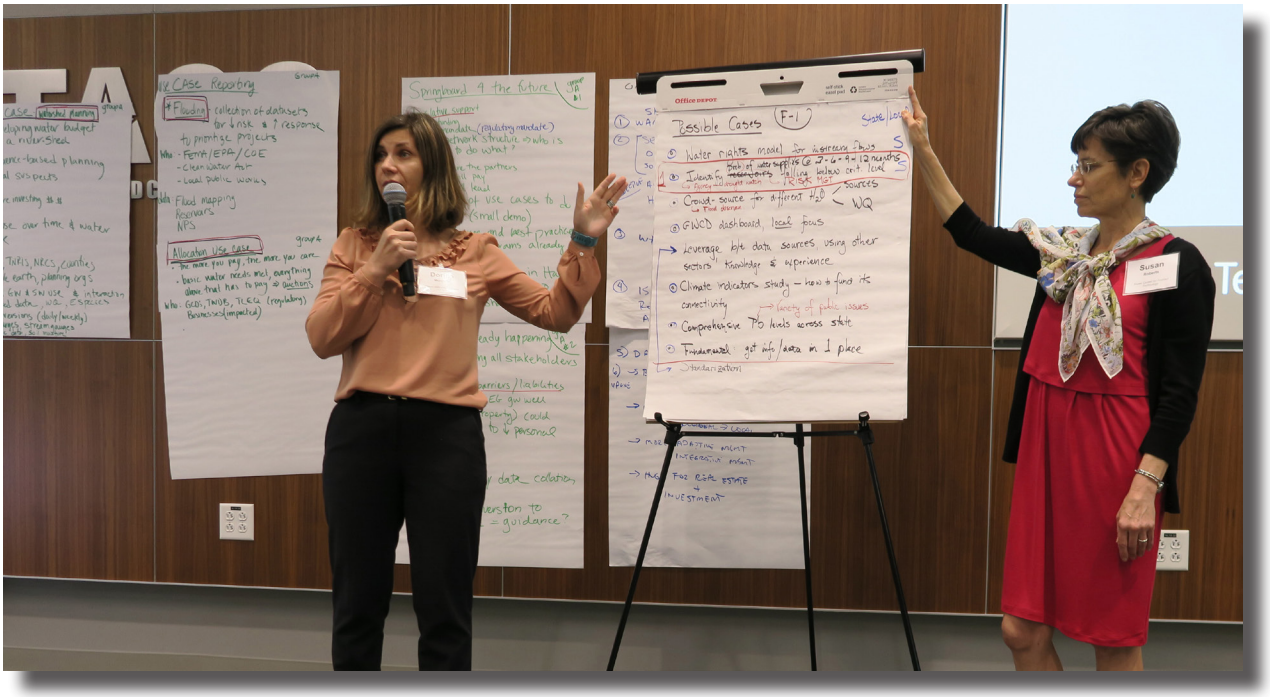
- What agency will be the overseeing entity?
- What entity is going to pay for changes to the existing data management systems?

Participants discussed TWDB and TCEQ, with TWDB's Texas Natural Resources Information System (TNRIS), to lead in developing and hosting the key data hub. USGS was also suggested.

Possible process to form the "springboard" might entail the following:

- Pick one topic / one need that drives an open, connected system.
- Start with the current responsible data agency.
- Build data and metadata of similar quality.
- Survey Texas water agencies and users to find coalescing point and "bundle" an approach to connecting currently unconnected data sets and databases.

COMPLETE LIST OF POTENTIAL USE CASE SUBJECTS



GROUP A

1. Regional water planning
2. Allocation of surface water during drought
3. Flooding (catastrophic) impacts – ecological, economic, social
4. Watershed protection planning (e.g., Rio Grande and interboundary)
5. Options for community water supplies
6. Interbasin water transfer (i.e., San Antonio Water Systems Vista Ridge Project) vs. brackish groundwater desalination vs. new reservoirs
7. Industrial water use during drought
8. Need for more data and transparency of data
9. Water rights - priority of contracts, seniority of right, supply variability, diversion, beneficial use
10. Sales transactions
11. Harris-Galveston Subsidence District and integrated support from regulatory agencies
12. Conservation data
13. Utilities connections

GROUP B

1. Water utility reporting to the Texas Water Development Board (TWDB)

GROUP C

1. Environmental flow transactions
2. Nonpoint source pollution
3. Determination of appropriate groundwater withdrawal and impact on aquifers
4. Best management practices for conservation
5. Recreational use attainability analysis
6. Flood prediction and emergency response
7. Desired future condition for groundwater and predictions
8. Estimation of groundwater availability
9. Impervious cover and regulation

GROUP D

1. Flood water management in ephemeral streams
2. Planning for drought
3. Environmental flows
4. Climate impacts to Texas hydrology
5. Water quality in the context of consumptive use

GROUP E

1. Integrate and update the Texas Water Availability Models (WAM) and Groundwater Availability Models (GAM)

GROUP F

1. Water rights model for instream flows
2. Flood observations: crowd-source for different water sources and water quality
3. Groundwater Conservation District dashboard
4. Standardization - leverage between data sources using other sectors' knowledge and experience
5. Climate indicators study – how to fund its connectivity to statewide water resources concerns
6. Comprehensive lead (or other potential contaminants) across the state

WATER DATA WORKSHOP

APPENDIX IV

GLOSSARY

GLOSSARY

Data-driven decision making - The practice of making choices based on analysis of data rather than on experience or intuition.

Data hub - An independent location or system where data is stored that connects to data from multiple sources, while maintaining the autonomy of the independent location or system.

Data gap - Where information critical to decision making is either not available at all, or where information exists or is available but is not in a suitable format or accessible for decision making processes or other uses.

Data system - Software or hardware that is used to collect, organize, archive, distribute, or integrate data.

Decision support system - A modelling or analytic tool used to help guide decisions by processing and synthesizing data into information.

Information - Data that have been processed, analyzed, or synthesized so they can be used to answer questions.

Information system - Software or hardware that is used in the processing, analysis, or synthesis of data so they can be used to answer questions.

Interoperability, interoperable - The ability of multiple computing or other information management systems to operate on the same data and produce the same analysis or results.

Metadata - Data that describe and give information about other data.

Open - The ability to have access to data using open-source and open-architecture protocols and methods.

Stakeholder - Anyone with an interest in the outcomes of Texas' progress on water data, including data users and data producers from relevant sectors of government, industry and civil society.

Water security - The ability to access water at sufficient quantity and quality to sustainably meet agricultural, ecological, industrial, military, public health, sanitary, and urban needs.

Water data - Quantitative or qualitative representations or measurements of properties of water or water related measurements.

Use case - A short summary organized in a fashion that helps list in a concise and consistent format the data gaps, needs, and uses for a particular objective. The objective is what decision, action, or other thing needs to be accomplished. For the workshop this can be a need of data managers, providers and/or data consumers. A use case communicates a set of answers to the question of, *who* needs *what type* of data in *what form* to make *what decision*(s). Use cases will support display of a water decision making process and the data needs associated with that process.

WATER DATA WORKSHOP

APPENDIX V

REFERENCES

Reference Material

Imagine an Internet of Water

If we've learned anything from the Internet, it is that we are not likely to imagine how it will be used nor what people will find valuable and important. In the same way, it is more likely that the Internet of Water will enable innovations that are not imaginable now, hopefully toward a far more sustainable water future.

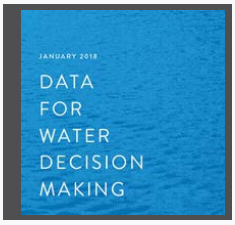
This web article sheds light on what the future may hold.

Click to Read Web Article

https://www.aspeninstitute.org/aspen-journal-of-ideas/imagine-internet-water/

Data for Water Decision Making:

Informing the Implementation of California's Open and Transparent Water Data Act through Research and Engagement



A lack of data and information has limited our ability to understand, let alone better manage, all aspects of our water resources. This report and case studies published in January 2018 support California's efforts to develop modern water data systems. It argues that simply providing more data is not enough, and that generating useful and useable information hinges on the development of data systems based on end users' needs. The report describes lessons learned from a process of stakeholder engagement focused on defining and clarifying uses of water data, and how knowledge of these uses can inform the development of water data systems.

Click to Download the Report

Click to Download Use Cases

Report -- https://www.law.berkeley.edu/wp-content/uploads/2018/01/DataForWaterDecisionMaking.pdf
Use Cases -- https://www.law.berkeley.edu/wp-content/uploads/2018/01/DFWD-Use-Cases.pdf

Aspen Institute Report – Internet of Water:

Sharing and Integrating Water Data for Sustainability

Between May 2016 and February 2017, the Aspen Institute Dialogue Series hosted several roundtables with a select group of water experts, managers, policy makers, regulators, and representatives from the private and social sectors to focus on how to create better water data infrastructure to access and connect publicly collected and reported sources for data, beginning with quantity, quality, and use information.

This report highlights and provides a principle-based blueprint recommending a 3-step plan for how to design and launch a feasible and operable "Internet of Water."

Click to Download the Aspen Report

https://assets.aspeninstitute.org/content/uploads/2017/05/Internet-of-Water-Report-May-2017.pdf

Texas Water Roadmap Forum:

Workforce Education, Data, and Research

Three forums were held between February 2015 and November 2016, bringing together Texas water experts from business, industry, government, academia, research, and the investment community in impartially facilitated sessions to determine ways to secure Texas' water future through accelerating growth of infrastructure, technologies, research, education, and sustainable use. The final forum focused in on data access and management, with recommendations and a suggested path forward.

This report details the findings of Texas water experts.

Click to Download the Water Forum Report

http://libguides.tamusa.edu/ld.php?content_id=28446621

WATER DATA WORKSHOP

APPENDIX VI

WORKSHOP PARTICIPANTS

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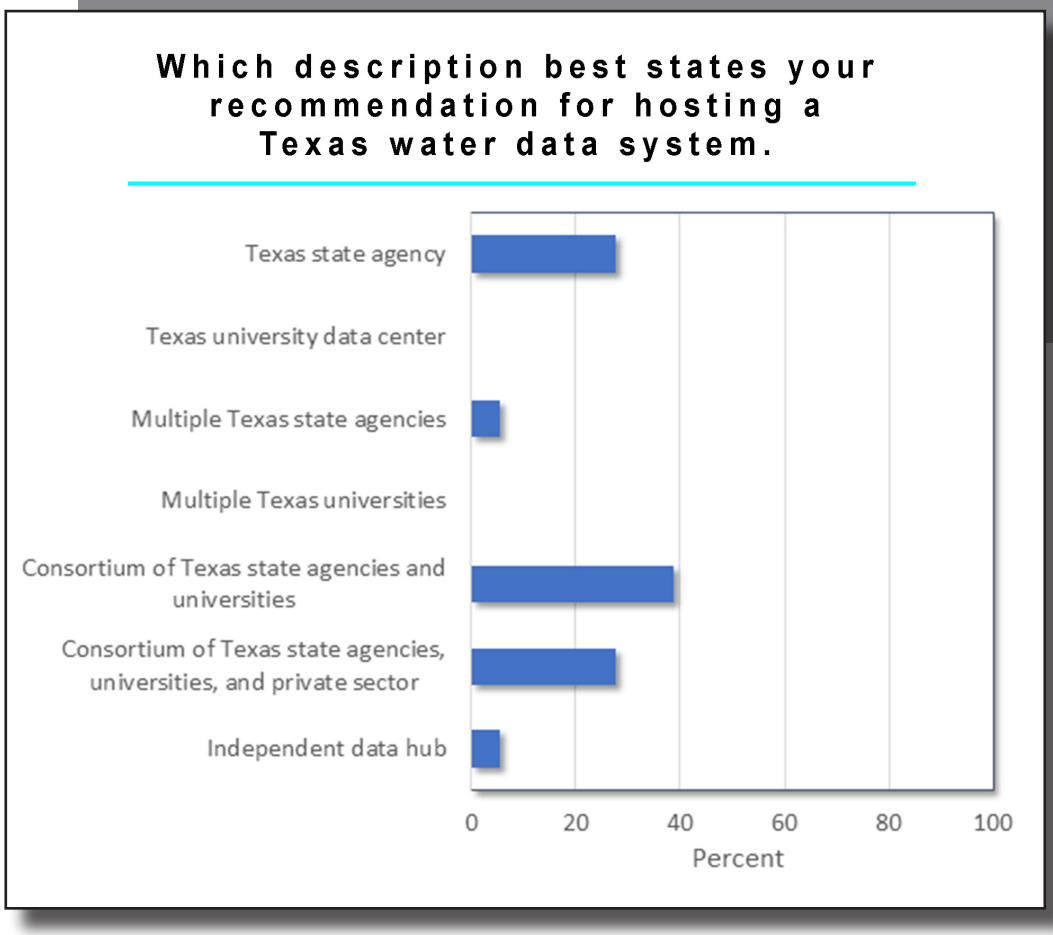
Justin	McInnis	Hays County	justin.mcinnis@co.hays.tx.us
Jordan	Merson	San Antonio River Authority	jmerson@sara-tx.org
Binayak	Mohanty	Texas A&M University	bmohanty@tamu.edu
Stephanie	Moore	Daniel B. Stephens & Associates	smoore@dbstephens.com
Dan	Mueller	Environmental Defense Fund	dmueller@edf.org
Dorina	Murgulet	Texas A&M Univ. - Corpus Chraisti	dorina.murgulet@tamucc.edu
Mike	Myatt	Water Foundation	Mmyatt@waterfdn.org
Mike	Ouimet	Texas Department of Public Safety	michael.ouimet@dps.texas.gov
Lauren	Patterson	Duke University	lauren.patterson@duke.edu
Leslie	Patterson	Texas Commission on Environmental Quality	leslie.patterson@tceq.texas.gov
Maguel	Pavon	Texas Water Development Board	miguel.pavon@twdb.texas.gov
Daniel	Pearson	US Geological Survey	dpearson@usgs.gov
Trino	Pedraza	New Braunfels Utilities	tpedraza@nbutexas.com
Suzanne	Pierce	Texas Water Research Network	spierce@tacc.utexas.edu

Herman	Ramsden	UT Rio Grande Valley	herman.ramsden1@utrgv.edu
Ruthie	Redmond	Sierra Club	ruthie.redmond@sierraclub.org
Sarah	Richards	Cynthia & George Mitchell Found.	srichards@cgmf.org
Susan	Roberts	Texas Center for Applied Technology	svroberts@tamu.edu
Rudolph	Rosen	Inst. Water Resource Science and Tech.	rudy.rosen@tamusa.edu
Carlos	Rubinstein	RSAH2O	carlos@rsah2o.com
Leslie	Savage	Railroad Commission of Texas	leslie.savage@rrc.texas.gov
Sarah	Schlessinger	Texas Alliance of Groundwater Districts	sarah@texasgroundwater.org
Spencer	Schnier	Freese and Nichols	spencer.schnier@freese.com
Stefan	Schuster	SWCA Environmental Consultants	sschuster@swca.com
Julie	Sommerfeld	Bastrop County	julie.sommerfeld@co.bastrop.tx.us
Robert	Stefani	Austin Water Utility	Robert.Stefani@austintexas.gov
Carrie	Thompson	Collaborative Water Resolution	carrie@watertbl.com
Ernest	To	Alan Plummer Associates	eto@apaienv.com
John	Tracy	Texas Water Research Institute	john.tracy@ag.tamu.edu
Mark	Treviño	Bureau of Reclamation	mtrevino@usbr.gov
Joe	Trungale	Trungale Engineering & Science	joe@trungaleengineering.com
Charlie	Upshaw	Webber Energy Group	crupshaw@utexas.edu
Michael	Urrutia	Guadalupe-Blanco RIver Authoirty	murrutia@gbra.org
Anastasia	Valdes	Water Markets LLC	anastasia@watermarkets.us
Todd	Votteler	Collaborative Water Resolution	votteler@waterdisputes.org
David	Walker	Lower Colorado River Authority	david.walker@lcra.org
Jennifer	Walker	Texas Living Waters Project	jennifermwalker@earthlink.net
Emily	Warren	Meadows Center	EmilyW@txstate.edu
Carl	Westergard	Guadalupe-Blanco RIver Authotity	cwestergard@gbra.org
Jennifer	White	Texas Water Development Board	Jennifer.White@twdb.texas.gov
June	Wolfe	Texas A&M AgriLife Research-Blackland	jwolfe@brc.tamus.edu
Corinne	Wong	Univ. of Texas - Austin	ciwong@austin.utexas.edu
Mike	Woodside	U.S. Geological Survey	mdwoodsi@usgs.gov
Michael	Young	Bureau of Economic Geology - UT	michael.young@beg.utexas.edu

APPENDIX VII

PARTICIPANT SURVEY

Summary



Following the workshop, participants were invited to participate in a survey where they were presented three questions.

The first sought recommendations on the next steps we should take as a group or as individuals, agencies, companies, or institutions. There were 19 responses. Participants gave varied answers ranging from keeping the workshop group together and refining or organizing what was initiated, to involving more participants from agencies, more computer scientists, more private sector representation, and having agencies form water data working groups. Some participants stated that better defining or a narrowing of the intended audience is needed, while others suggested starting with small steps and expanding over time. Several participants stated that proper planning processes needs to begin with reviews conducted and goals, measurable benchmarks, and protocols set. A need for funding was mentioned by several participants. Recommendations on technical aspects of creating data hubs were given.

Continuing the development of use cases and initiating example projects to demonstrate the value of open data hubs came up in several recommendations. One participant stated, "Develop a program that directly involves and engages all stakeholders in a way where sharing data provide benefits to all. Start small on a project(s) that are doable and show value in broader data collation and distribution." Another stated, "I felt that the use cases discussed at the workshop are very insightful and I think it would be helpful to take a closer [look] on the technical side of how agencies are implementing data-sharing." One simply stated, "Pilot a couple of use cases to show the value."

The second question sought to assess opinion on hosting options for open data hubs or systems. The results clearly show respondents rejected hosting by a single university or multiple universities. Instead, respondents were almost evenly spilt over hosing by (1) a Texas state agency, (2) a consortium of Texas state agencies and universities, and (3) a consortium of Texas state agencies, universities and the private sector.

Respondents were also invited to explain their choice should they desire. Of the 18 participants who answered this question, 13 added an explanation. Many stated that state and federal agencies already serve to host data, thus any answer to this question must include agencies as a host. This may explain why universities alone were not selected as the preferred host by any respondent. Following is a response that supports that conclusion: "My opinion is that each data provider needs to maintain the fidelity of their own information on an ongoing basis." Please refer to the raw answers for listings of data hosting agencies mentioned. This response may further explain the rationale, "I think a state agency such as TNRIS would be the natural choice. Data-sharing involves curation and database maintenance and may not fit into the research agenda of universities. Universities can however serve as a technological partner."

Finally, participants were asked for additional thoughts on any matter they felt appropriate. One respondent reiterated continuing on with development of use cases. Others suggested expanding participation, especially involving members of the general public, and carrying the workshop to other areas of the state. There were several comments accompanied by a sense of urgency to carry on.

Finally, several respondents simply stated their appreciation for the workshop and the organized manner in which the workshop proceeded.

WATER DATA WORKSHOP

PARTICIPANT SURVEY RESPONSES

SURVEY QUESTION 1

What comes next is of critical importance to furthering efforts to connect water data in Texas, and all workshop participants may not have had the opportunity to share all their ideas. Please offer your recommendations on what we – as a group or as individuals, agencies, companies, or institutions – should do next.

RESPONSES

1. The workshop gave a few excellent answers to that question. Since the workshop was well organized to get such answers, continue with the group and narrow down the suggestions, then organize to try it.
2. As a group, we need to make sure we have clearly defined the intended audience(s) for the data and then consider the ways in which the data should/must be presented to each audience. While raw data is great for those that understand it, raw data is useless to an audience that requires context and a bit of interpretation. We may find that we need to provide the same data in multiple ways, depending on the audience. As a group, data collection methods will need to be determined. Will only existing data be harvested from their sources to create the new repository? Will we ask/require individuals, agencies, companies, and/or institutions to begin submitting data in a new format? Or, maybe the existing data isn't harvested at all and instead, API's are written to query the data already out there and present it in a meaningful way to the audience? With an API-only approach, the hosting question is solved. The data stays where it is already located. The comment, raised during the workshop, that "you have to be a data expert to get to the data now" would be absorbed with an all API approach. However, that would require a ton of sophisticated code to be written.
3. We need to involve computer scientists. Instead of trying to roll out an "internet of water" all at once, it is prudent to start small and imminently doable. For example, a simple webpage with links to where to download existing datasets. This doesn't require much technical know-how. The very first websites on the internet were no more complicated than this. Once we start scratching the surface, the next steps become easier to envision and execute. This also guarantees that the undertaking is not an all-or-nothing proposition; we will get usable results from the 'Connecting Texas Water Data' project immediately.
4. My suggestion would be to query the agencies in Texas that provide the most water-related natural resource information on whether or not they would be amenable to forming an "open water data" workgroup that could lay the groundwork for more discussion and greater integration of efforts on this front. Everyone seems to be coming around to the notion of transparency, but it's getting a meaningful conversation going that is the hard part. I bet TWDB, TCEQ, et al., would be willing to convene on some ongoing basis on this topic and jointly address the issue.
5. Continue having open conversations but work towards a goal. Have measurable benchmarks to meet.

6. Recommend: 1) Identify key datasets and hubs. Inventory 2) Understand which agencies/ institutions are essential for create a scale effort on water data in Texas and have them be a founding coalition
7. TCEQ and TWDB should work on systems to automate the submittal of annual Water Use Reports to TCEQ and annual Water Use Surveys to TWDB by water users so that data can be automatically loaded into agency databases. The state should look at ways to cross reference data from the two reports to get a better picture of what sources and uses of water in the state.
8. The hosting groups should help narrow the top 5 needs for Texas water data that were presented during the workshop. From there, subcommittees could be formed for each topic and those groups could focus on one particular issue to address. Participants could express interest in working on a subcommittee and rank their first-fifth choice.
9. Develop guidelines/protocols for integrating data, to allow for federation among datasets; pilot a couple of use cases to show the value.
10. I'm struck by how much of the discussion was public policy driven. Any solution needs to go beyond government only and actively seek participation from the private sector.
11. Expand/improve existing state water data hubs at TWDB/TNRIS/TCEQ. Link information between these agencies. Provide a dashboard portal for other agencies (GCDs, River Authorities, universities, etc.) to upload data to existing hub and include some primary level of data quality review.
12. I think there should be a review of what technologies have been developed in sharing data, e.g. web services, interactive maps, etc. Advances have been made in the past decade through organizations like CUAHSI, ESRI, etc. Even though the general public may not be aware of those technologies, many agencies have been adopting them. I felt that the use cases discussed at the workshop are very insightful and I think it would be helpful to take a closer on the technical side of how agencies are implementing data-sharing. This can help audience understand what everyone else is doing, where the low hanging fruits are, and how to prioritize strategies for data-sharing.
13. Texas Agencies and Universities should be funded and spearhead the effort. Consistent and long-term funding must be available to collect specific data across Texas and process all kinds of water data.
14. Develop a program that directly involves and engages all stakeholders in a way where sharing data provides benefits to all. Start small on a project(s) that are doable and show value in broader data collation and distribution. A single warehouse of data will extremely difficult to manage and indeed those data are already housed at different state agencies. Perhaps a web-based system would work, in which agencies keep their data, but in a format that's accessible to anybody with internet and correct scripting languages.
15. Identify early wins - prioritize action items.
16. Create a crosssectional committee to review the recommendations produced by the meeting and propose the next steps.
17. Link all available data through one portal. Include critical metadata describing data source, range, quality, appropriate uses, and cautions; note question 2.
18. How can we increase the water supply in unconventional ways?

SURVEY QUESTION 2

Several participants suggested hosting a data system at the Texas Water Development Board, such as through the TWDB's Texas Natural Resources Information System, or through the Texas Commission on Environmental Quality, or at a university data center such as the Texas Advanced Computing Center, or through some combination of state agencies and universities. Others suggested a much more distributed approach to hosting. Which description(s) below best states your recommendation?

ANSWER CHOICES	RESPONSES	
Texas state agency (If so, which one or ones? Please specify.)	27.78%	5
Texas university data center (If so, which one or ones? Please specify.)	0.00%	0
Shared responsibilities between Texas state agencies	5.56%	1
Shared responsibilities between Texas universities	0.00%	0
Consortium of Texas state agencies and universities	38.89%	7
Consortium of Texas state agencies, universities, and private sector	27.78%	5
An independent data hub (If so, please describe the nature of such a hub.)	5.56%	1
Total Respondents: 18		

ADDED SUGGESTIONS

1. I am uncomfortable suggesting a data host until a full understanding of the intended audience is presented. The data host should somehow be aligned with, and responsible to, the audience.
2. Of all the state agencies providing data in Texas, the TWDB does the best job in terms of ease of accessing the data (finding it, downloading it, and getting it in a usable format). But even within the TWDB, the data is stored in disparate places and can be difficult to find if you don't know exactly what you're looking for. The data storage mechanism for the "internet of water" should mirror the internet itself, as distributed as possible. There are many concerns with storing the data at a centralized site such as a state agency, not least of which is vulnerability to political whims (as we have seen recently at the national level).
3. My opinion is that each data provider needs to maintain the fidelity of their own information on an ongoing basis. They can do this in many ways, including hosting from each

agency/university and making the data accessible to inclusion in other hubs via web services. Other alternatives can include provisioning of a "shared space" for data with the TACC (or other), or a trusted cloud vendor (although this brings with it other concerns). It helps to have a governmental body or advisory body that is viewed as a trusted partner to assemble the different options and present them to the data providing parties.

4. Use the brand and the backing of the State by using agencies like TWDB/TNRIS with the power of TACC.
5. Many different agencies and organizations already host their own datasets. That's unlikely to change, especially since many of them may have already invested or are considered the 'authoritative' source for that info. Better to connect these in a federated approach
6. Federal - EPA, FEMA, USGS, NOAA State - TWDB, TCEQ. Any university and private sector entity that is interested in participating. Probably other agencies/entities that I am not aware of.
7. Some sort of coordinated effort between TWDB (quantity) and TCEQ (quality)
8. Raw data can be hosted and supported by a public entity (state agency, university), they are public records after all. The key challenge is not in an index of public raw data it's in the processing and standardizing of the data which effectively takes the data from public to proprietary. It's a lot of work to standardize data, which is essential for comparable study. I'd be surprised if any private venture would participate if providing data would make it effectively available to anyone via an open records request. An independent data hub could be more successful at attracting data wrangling and analytic solutions with contractual clauses limiting access. There may be a tendency of agencies and universities to view this as unimportant when measured against the public resources available to subsidize this kind of effort. I suggest 2 reasons to consider proprietary data. First, if the data doesn't have a market then it begs the question why spend the money to host it in the first place. Second, some of the most critically needed information will come from private actors and they will need the confidence that sharing the data will not produce liability for them, for example water quality. Only an independent data hub can satisfy these needs...
9. TWDB/TNRIS. They already have systems in place. These systems can be expanded/improved, but already have a foundation to build from.
10. I think a state agency such as TNRIS would be the natural choice. Data-sharing involves curation and database maintenance and may not fit into the research agenda of universities. Universities can however serve as a technological partner.
11. TWDB - they will need to staff-up to do this. Having one unbiased place that already receives some of the data will minimize overlap and provide focus direction.
12. TNRIS
13. Texas Water Development Board Already represents most complete and best documented source. Seek to expand both scope and funding support.

SURVEY QUESTION 3

Please share any additional thoughts or suggestions that you may have regarding the topics discussed at the workshop.

ADDITIONAL THOUGHTS

1. If members of the general public are going to use the Internet of Water, should they be represented in and of the workshops going forward?
2. Would very much like to see additional and fleshed-out documentation for the case studies that were identified in the workshop. It would be good to identify 2-3 top priority or low-hanging-fruit use cases that could be jointly worked on by Texas data providers to show interest and momentum. They don't have to be terribly complex, and can take advantage of existing data sources if they're available, just need to demonstrate that working together to satisfy a use case or two is possible.
3. For such a short period of time a lot happened. Well organized and focused, unlike so many meetings. Looking forward to promised follow up or report.
4. Great job. Thanks for putting this together.
5. Need very clear next steps and clarity on participants, roles, and funding. Need concrete progress to keep the momentum going.
6. A contact list of all who attended would be very helpful as this event was very much a networking and brainstorming workshop. Also, a summary of discussion topics would be great.
7. I was very impressed with the summit. Thank you for allowing me to participate.
8. Texas water is critical and so investment must be made to preserve and utilize it for future purposes.
9. Start simple; show value; broaden the engagement of groups across the state.
10. Much work needs to be planned out and set in motion. TWDB will be a good data repository. Still need to build the framework to make data-driven decisions possible.
11. Reiteration: build a data portal that links to other data sources and provides strong descriptions of data available at the linked site; note answer one.
12. Perhaps to hold in Houston?

WATER DATA WORKSHOP

APPENDIX VIII

PARTICIPANT WORKSHOP TEMPLATES, USE CASE GUIDANCE

Workshop Templates

Use Case Guidance

Texas Water Data Workshop

- Work Group Templates
  Download Interactive Templates Here:
  https://data.water-texas.org/interactivetemplates.pdf

BIG PICTURE

Participant Name	_____		
Who Needs	**What Data**	**In What Form**	**For What Decision**

DATA GAPS & ACCESS

Participant Name _____

Your experience with situations in Texas water that arise from lack of data, or lack of accessible data?

Your vision for desired future of water data management in Texas:

Your list: key attribute of an open access data / information system:

Use Case Template

To help organize and make a clear case for improved access and use of data to manage water supplies in the future, efforts of the Aspen Institute and others have developed a "use case" model that serves as a useful tool for organizing and assessing stakeholder data needs and communicating those needs to decision makers.

To begin working in this direction, participants in the Connecting Texas Water Data Workshop will begin the process of building use cases by helping identify the top ten or twenty possible examples of gaps in data availability, access, and integration that impede decision-making. To achieve this, workshop participants should have a good conceptual understanding of use cases designed to inform decision making. Participants will be supplied with a model template to build a well-organized use case and will have opportunity to look through samples of use cases already developed for application elsewhere.

Definition, Model, Examples, and Template

A use case is a short summary organized in a fashion that helps list in a concise and consistent format the data gaps, needs, and uses for a particular objective. It communicates a set of answers to the question of, who needs what type of data in what form to make what decision(s)? They also provide a way to identify critical data sources or sets where interoperability is important. We envision that use cases will be responsive to stakeholder data needs, as well as useful for technical developers seeking to better understand the data needs of system users. While there can be numerous ways to display a use case, we will follow the model below and provide a blank use case template for use by participants at the workshop.

Examples

https://www.law.berkeley.edu/wp-content/uploads/2018/01/DFWD-Use-Cases.pdf)

Model use Case Template and Explanation (see following pages)

<table>
<tr><td>Objective</td><td>The objective is the decision, goal, or desired action to be achieved. The objective describes what is to be accomplished.</td></tr>
<tr><td>Description</td><td>The description is any defining information about context and background that might help a reader understand the objective or added details of the topic in general.</td></tr>
<tr><td>Participants</td><td>The participants section provides a list of the main decision-maker (s) and other key parties involved or affected. Attributes or contact information for participants may be listed here, if desired.</td></tr>
<tr><td>Regulatory Context</td><td>The regulatory context lists any laws, statutes, rules, regulations, reporting requirements, legal operational constraints, and governmental agency programs either existing or under development. This category may also include boundaries, for example geographic borders, time-based reporting requirements, and financial limits.</td></tr>
<tr><td>Workflow</td><td>Workflow describes the steps, listed as specific actions and in order of occurrence if possible, to be taken by the participants in order to accomplish the objective.</td></tr>
<tr><td>Data Sources</td><td>Data sources are the repositories, locations and holders of recorded measurements or properties collected and assembled about water. Data sources may be well defined and assembled or largely unconsolidated. Data gaps desired to be filled may be listed here as well as existing data. The sources should be listed in sufficient detail to be identified and located. Here is a table format that can be used for this purpose and nested here or added as a separate table.
<table>
<tr><th>Data Category</th><th>Description</th><th>Data source</th><th>Access Method</th></tr>
<tr><td>Water</td><td>Water availability</td><td>USGS web site for gage data</td><td>https://wdr.water.usgs.gov/</td></tr>
<tr><td>Agriculture</td><td>Evapotranspiration</td><td>Texas Water Development Board Precipitation and Lake Evaporation Data</td><td>http://www.twdb.texas.gov/ surface water/conditions/evaporation/</td></tr>
<tr><td>Infrastructure and utilities</td><td>Records of electricity used for pumping</td><td>Data collected by permittee</td><td>Not available at aggregate level—data collected for each individual case</td></tr>
<tr><td>Land use</td><td>Aerial photos</td><td>Satellite imagery - Google Earth</td><td>https://www.google.com/earth/</td></tr>
</table></td></tr>
<tr><td>Data Characteristics</td><td>Data characteristics includes notes about the type, form, and format of data that would be most useful for making decisions, including anything out of the ordinary about the data.</td></tr>
</table>

Workshop Participant Name	
Objective	
Description	
Participants	
Regulatory Context	
Workflow	
Data Sources	
Data Characteristics	

Data Category	Description	Data source	Access

SPRINGBOARD TO THE FUTURE

Participant Name _____

In your view, what are the next steps for water data management in Texas?

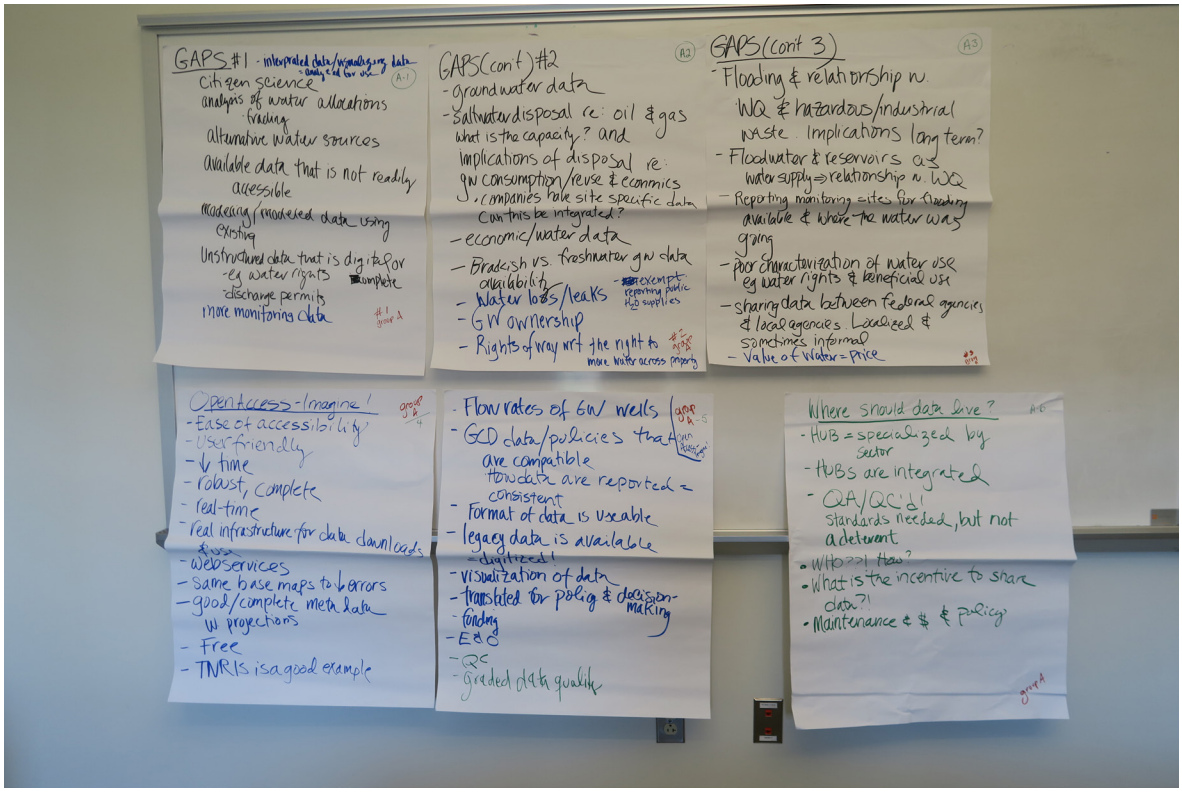
WATER DATA WORKSHOP

APPENDIX IX

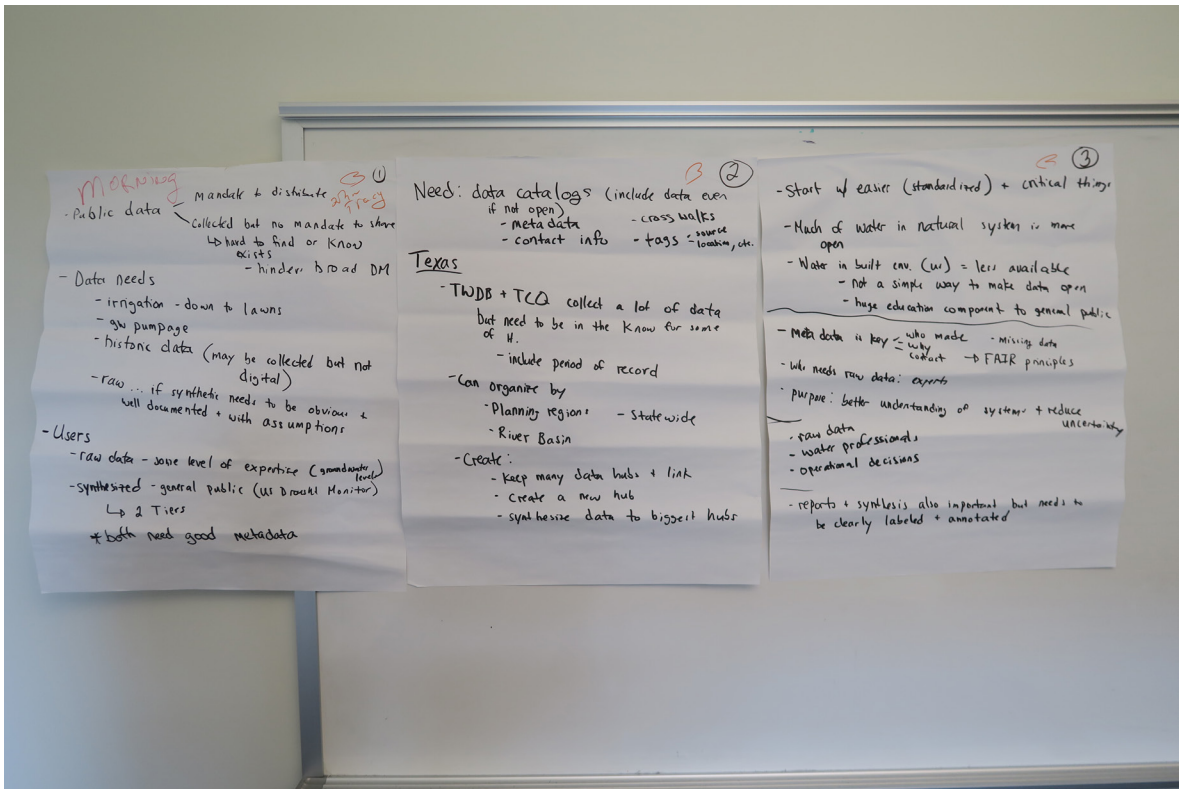
RAW DATA FROM BREAKOUT SESSIONS

GROUP SESSIONS I

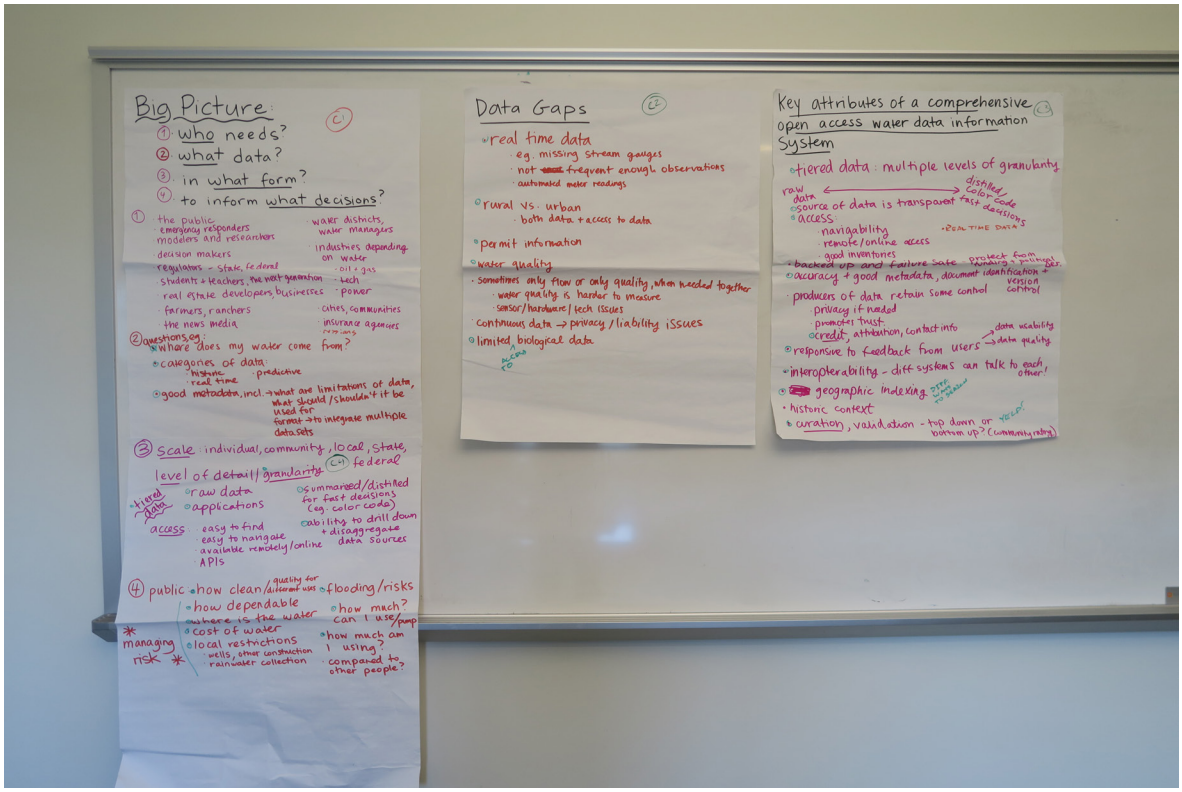
A



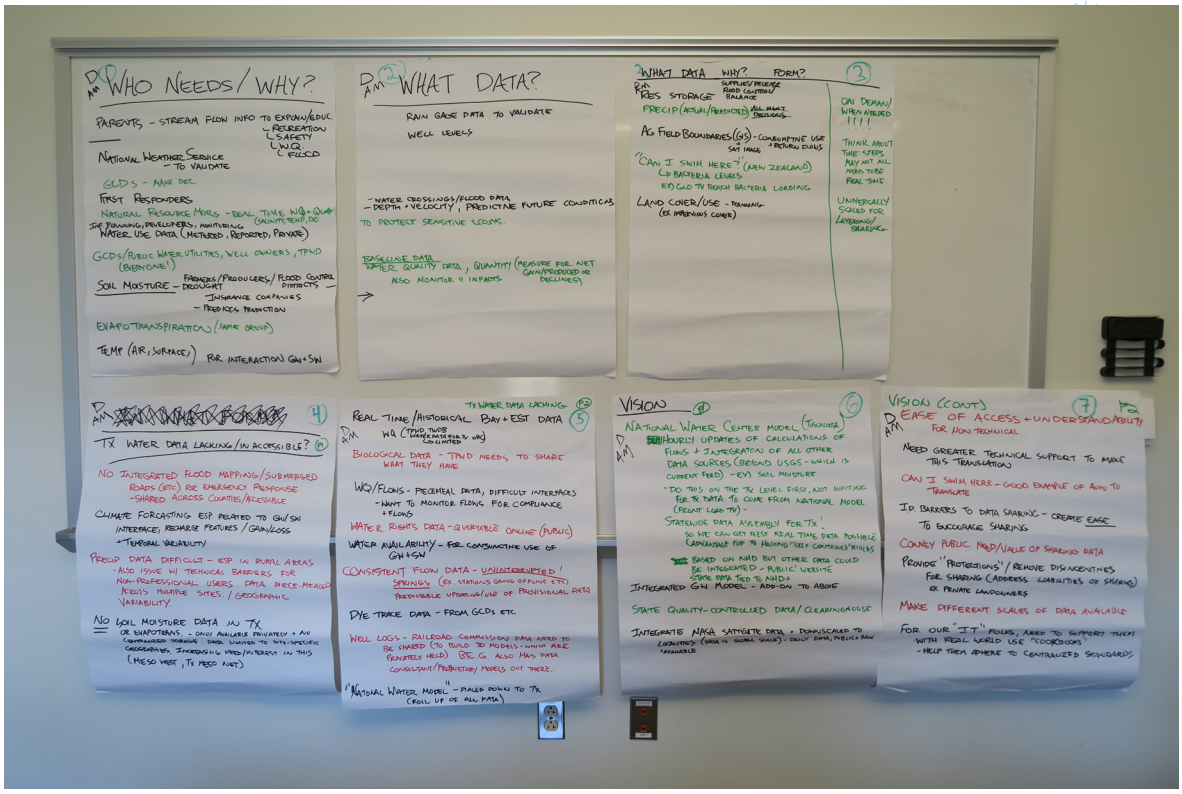
B



C

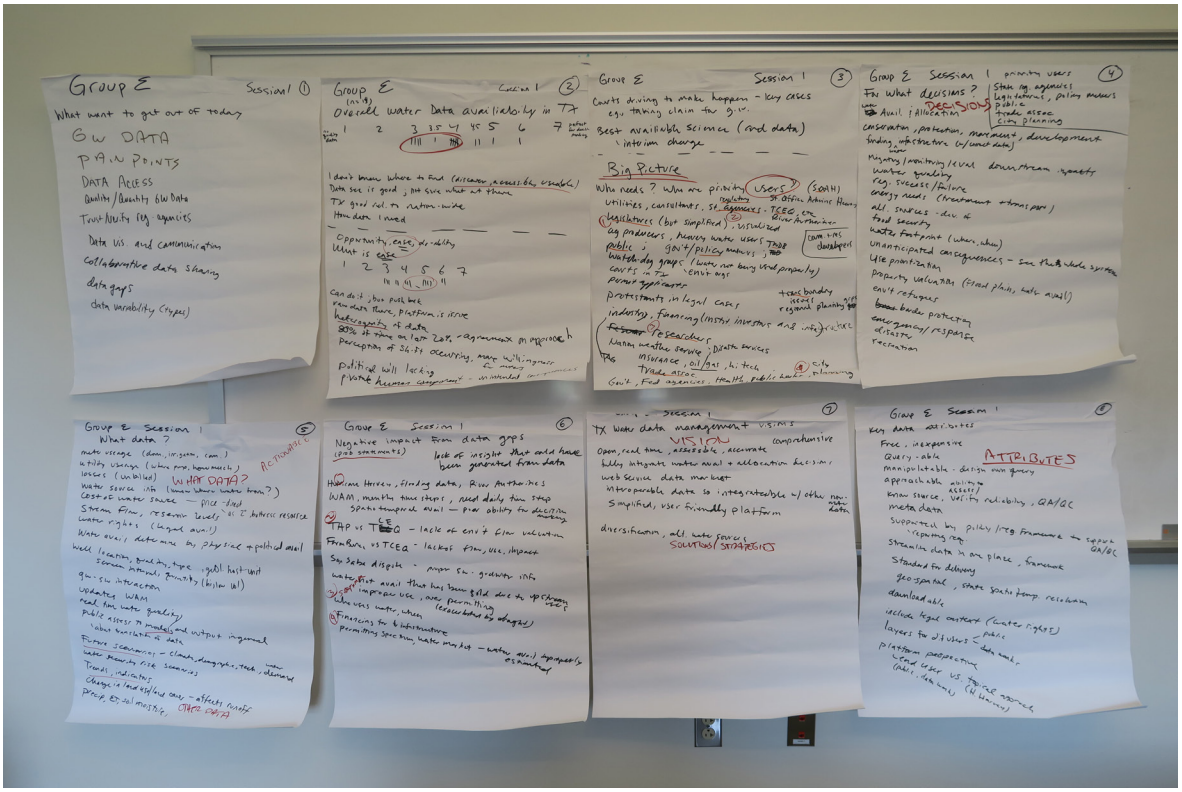

Big Picture:
① who needs?
② what data?
③ in what form?
④ to inform what decisions?
Data Gaps
real time data
eg. missing stream gauges
not frequent enough observations
automated meter readings
rural vs. urban
both data + access to data
permit information
water quality
Sometimes only flow or only quality, when needed together
water quality is harder to measure
sensor/hardware/tech issues
continuous data → privacy/liability issues
limited biological data
Key attributes of a comprehensive open access water data information System
tiered data: multiple levels of granularity
access:
navigability
remote/online access
good inventories
accuracy + good metadata, document identification + version control
producers of data retain some control
privacy if needed
promotes trust
credit, attribution, contact info
responsive to feedback from users
interoperability - diff systems can talk to each other!
geographic indexing
historic context
curation, validation - top down or bottom up?

D

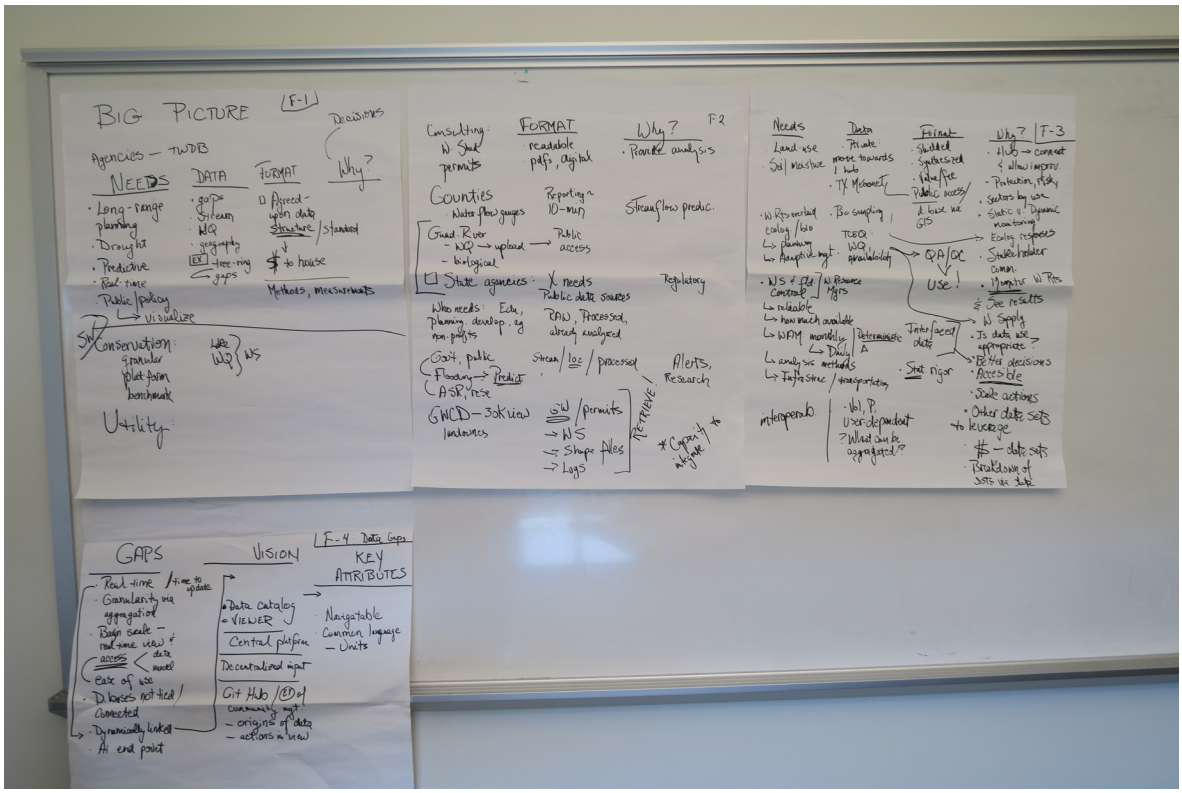

WHO NEEDS/WHY?
WHAT DATA?
WHAT DATA WHY? FORM?
VISION
VISION (CONT)
EASE OF ACCESS + UNDERSTANDABILITY

GROUP SESSIONS I

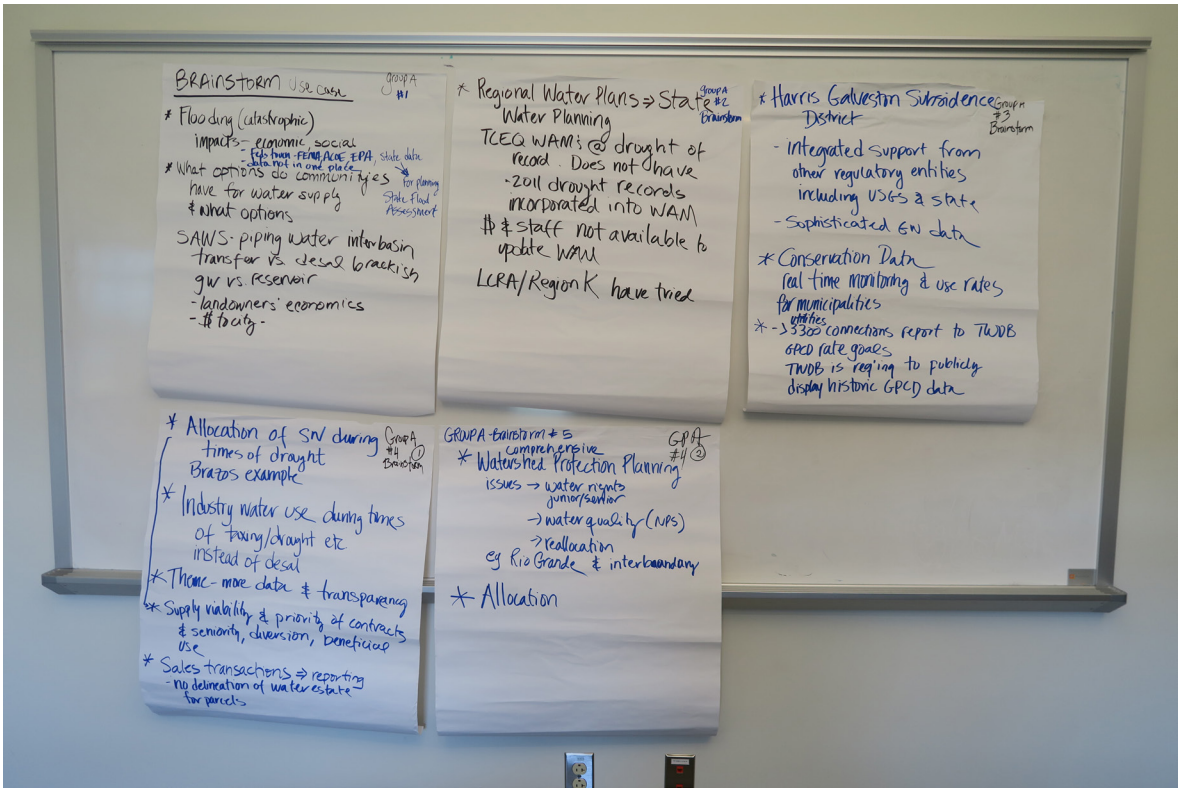
E



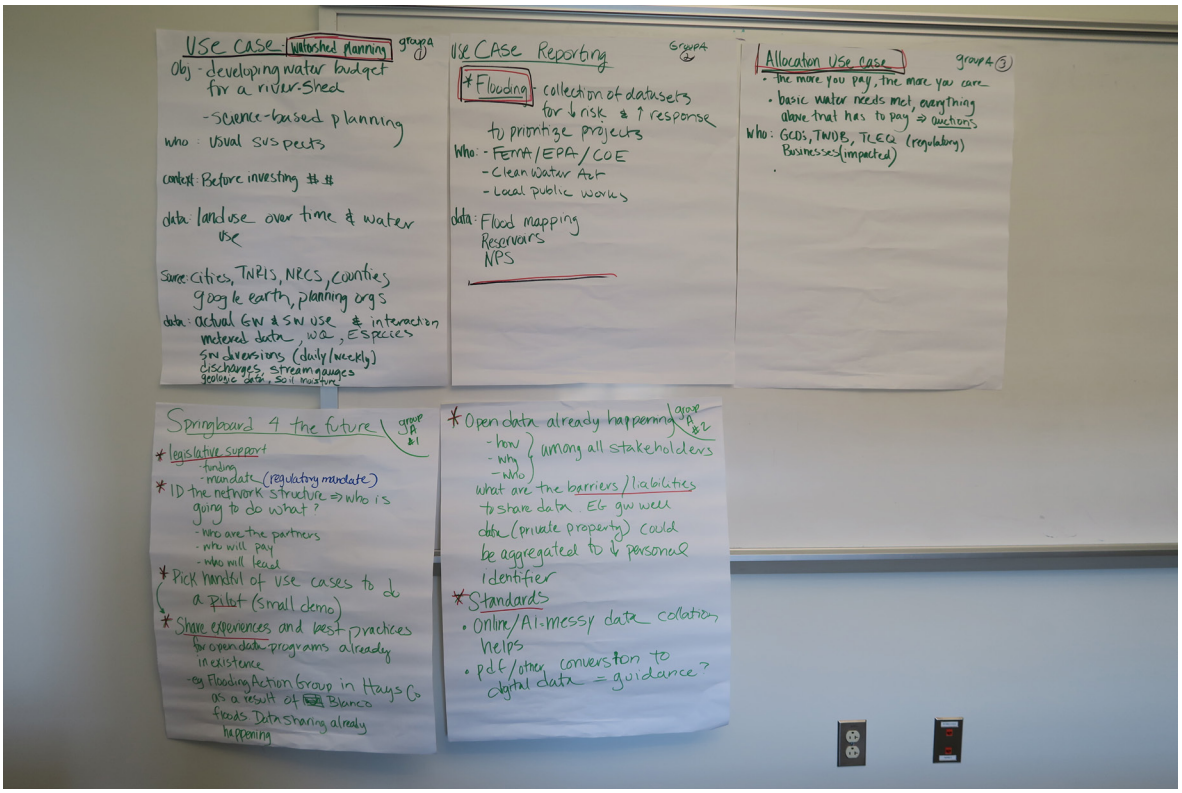
F



A1

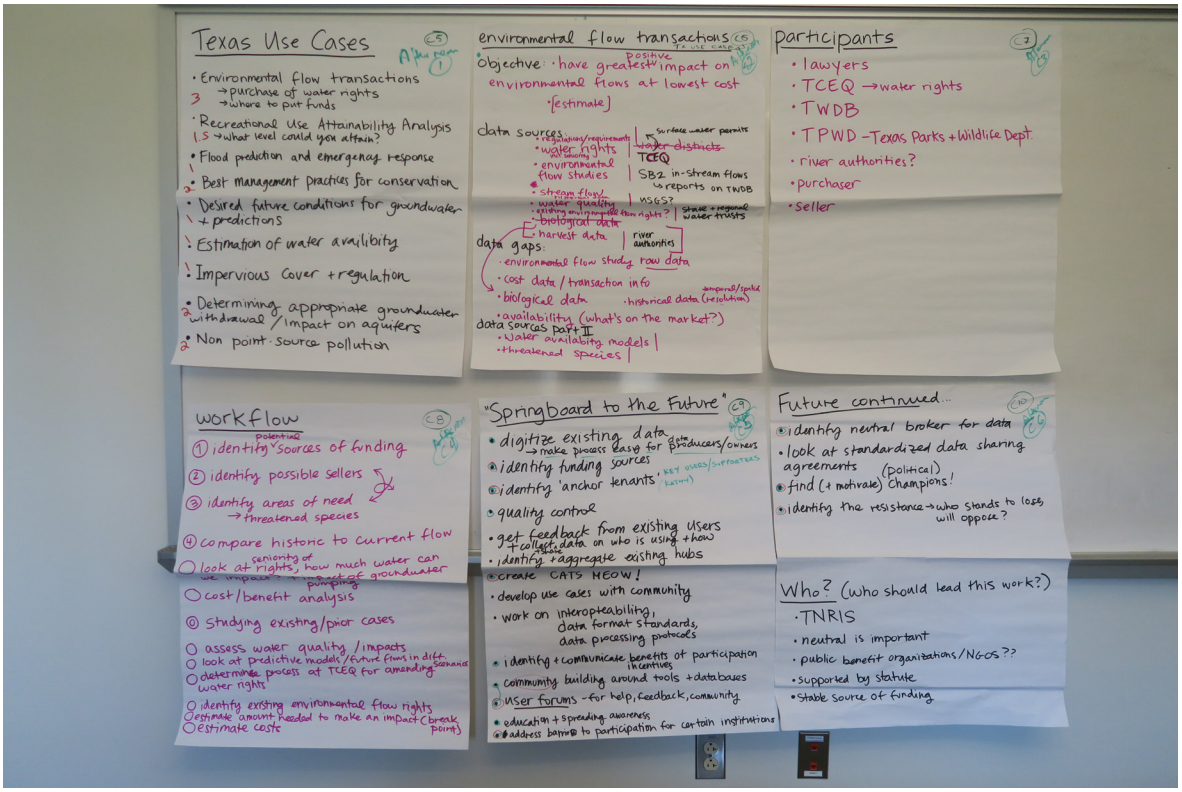

BRAINSTORM Use Case
group A #1
* Flooding (catastrophic)
impacts - economic social
- fed from FEMA/ACE EPA, state data - data not in one place
* What options do communities have for water supply & what options
for planning
State Flood Assessment
SAWS - piping water inter basin transfer vs. desal brackish gw vs. reservoir
- landowners' economics
- $ to city -
* Regional Water Plans ⇒ State Water Planning
group A #2 Brainstorm
TCEQ WAM: @ drought of record. Does not have -2011 drought records incorporated into WAM
$ & staff not available to update WAM
LCRA/Region K have tried
* Harris Galveston Subsidence District
Group A #3 Brainstorm
- Integrated support from other regulatory entities including USGS & state
- Sophisticated GW data
* Conservation Data
real time monitoring & use rates for municipalities
utilities
* ~3300 connections report to TWDB
GPCD rate goals
TWDB is req'ing to publicly display historic GPCD data
* Allocation of SW during times of drought
Group A #1 Brainstorm
Brazos example
* Industry water use during times of boring/drought etc instead of desal
* Theme - more data & transparency
* Supply viability & priority of contracts & seniority, diversion, beneficial use
* Sales transactions ⇒ reporting
- no delineation of water estate for parcels
GROUP A brainstorm # 5
Group A #1 (2)
* Watershed Protection Planning
comprehensive
issues → water rights junior/senior
→ water quality (NPS)
→ reallocation
eg Rio Grande & interboundary
* Allocation

A2

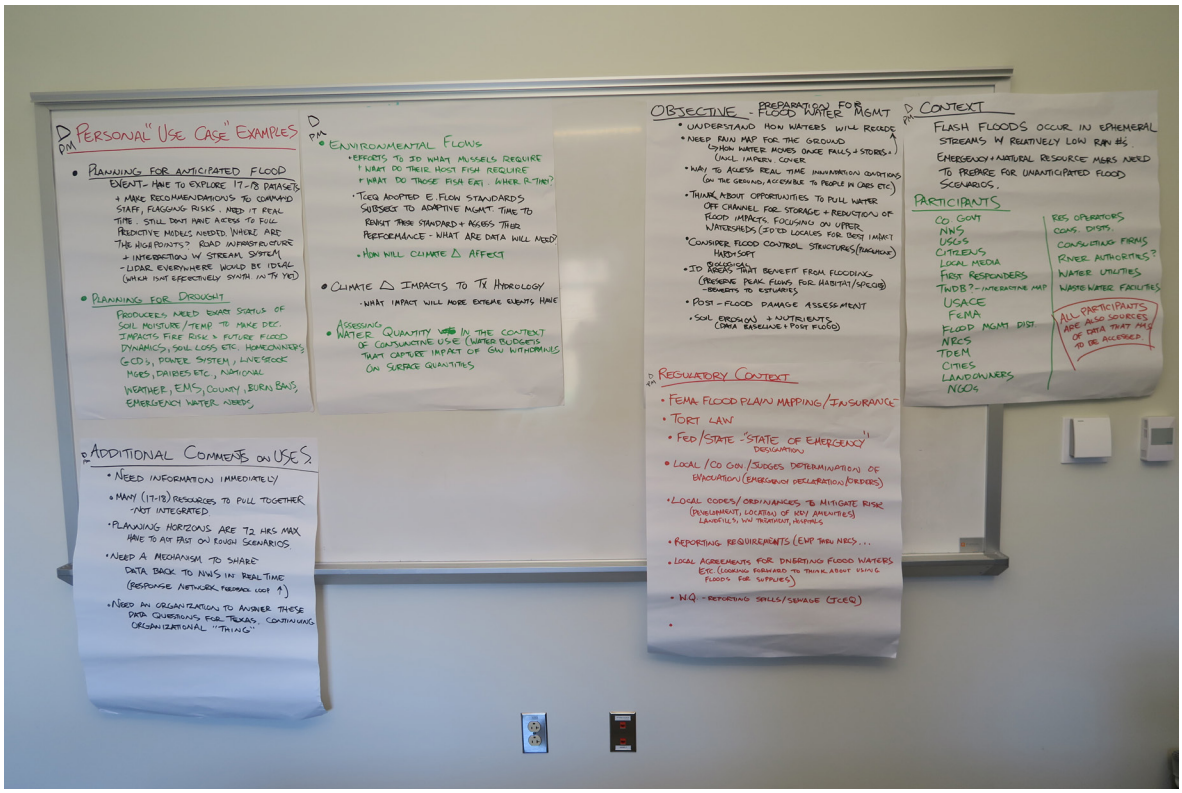

Use case - Watershed planning
group A
Obj - developing water budget for a river-shed
- science-based planning
who: usual suspects
context: Before investing $ $
data: land use over time & water use
Source: cities, TNRIS, NRCS, counties google earth, planning orgs
data: actual GW & SW use & interaction metered data WAS, ESPECIES SW diversions (daily/weekly) discharges, stream gauges geologic data, soil moisture
Use Case Reporting
Group A #2
* Flooding collection of datasets for ↓ risk & ↑ response to prioritize projects
Who: - FEMA/EPA/COE
- Clean Water Act
- Local public works
data: Flood mapping
Reservoirs
NPS
Allocation Use case
group A #3
- the more you pay, the more you care
- basic water needs met, everything above that has to pay ⇒ auctions
Who: GCDs, TWDB, TCEQ (regulatory) Businesses (impacted)
Springboard 4 the future
group A #1
* legislative support
- funding
- mandate (regulatory mandate)
* ID the network structure ⇒ who is going to do what?
- who are the partners
- who will pay
- who will lead
* Pick handful of use cases to do a Pilot (small demo)
* Share experiences and best practices for open data programs already in existence
- eg Flooding Action Group in Hays Co as a result of Blanco
Floods Data Sharing already happening
* Open data already happening
group A #2
- how
- why
- who
among all stakeholders
what are the barriers/liabilities to share data. Eg gw well data (private property) could be aggregated to ↓ personal identifier
* Standards
• Online/AI - messy data collation helps
• pdf/other conversion to digital data = guidance?

GROUP SESSIONS II

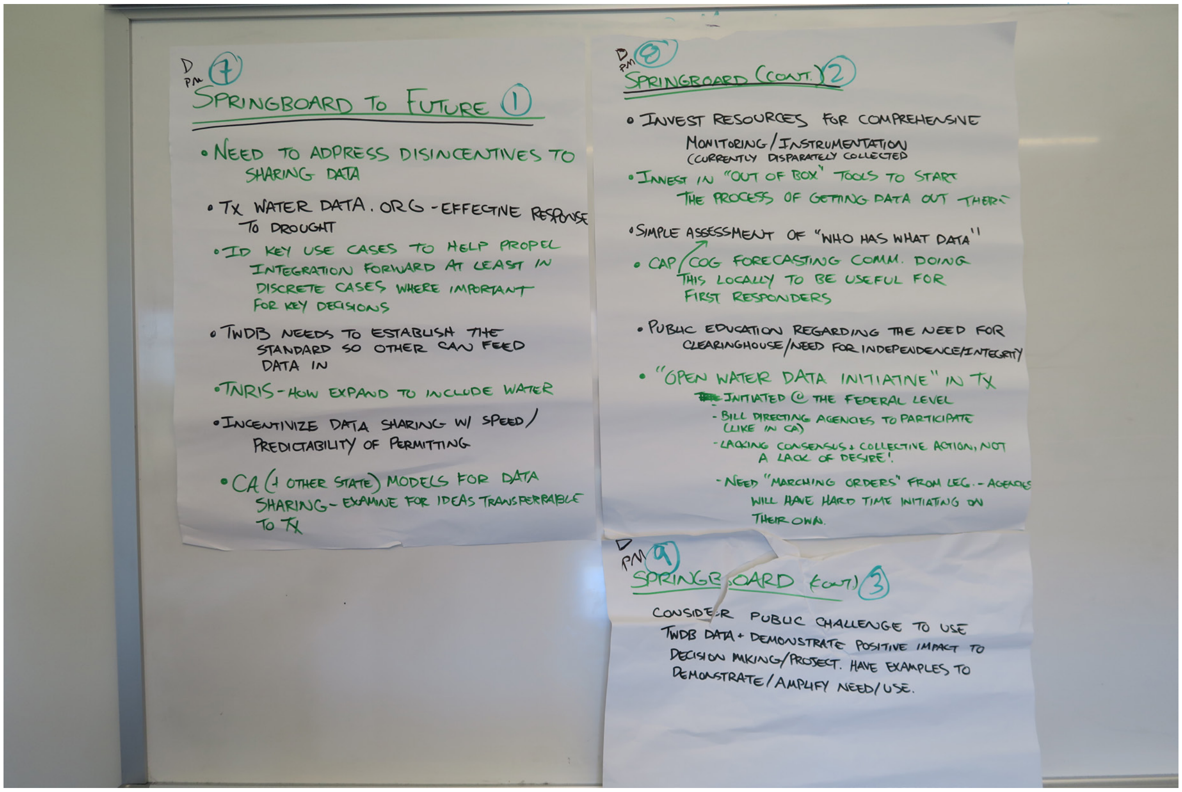
C



D1

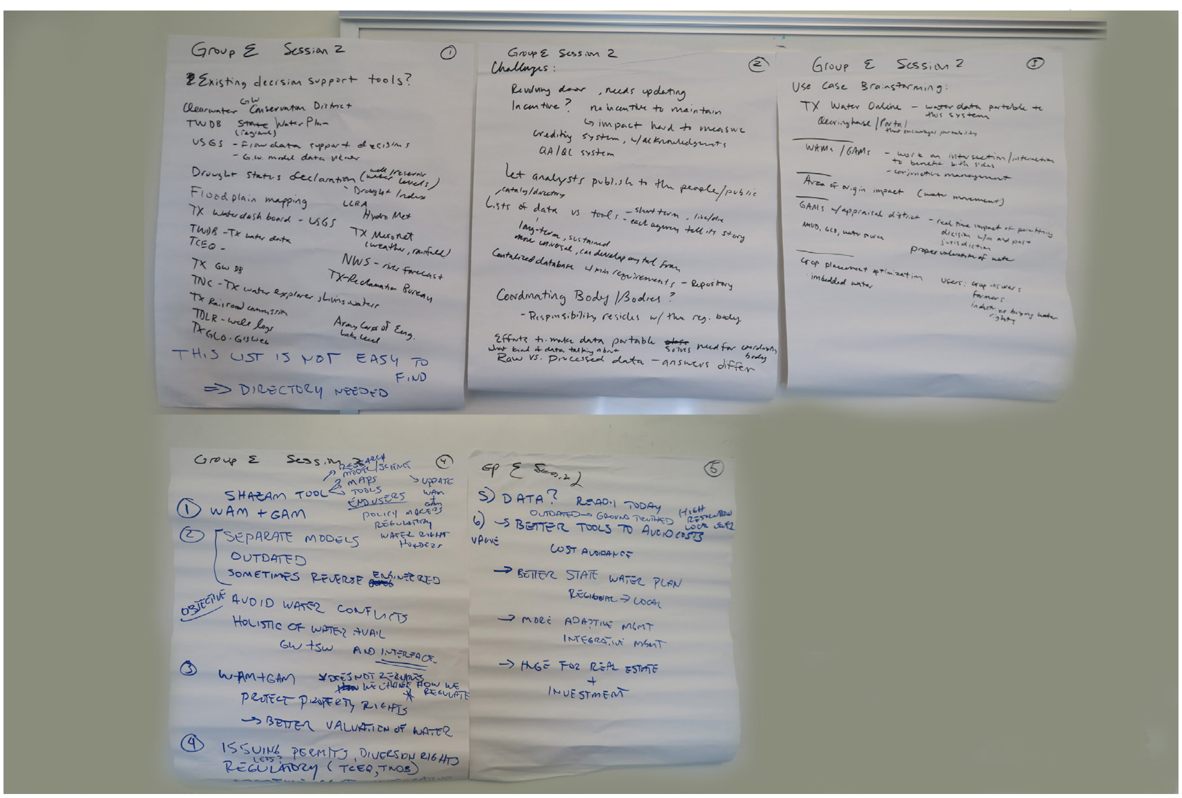


D2



D PM (7)
SPRINGBOARD TO FUTURE (1)
• NEED TO ADDRESS DISINCENTIVES TO SHARING DATA
• TX WATER DATA.ORG - EFFECTIVE RESPONSE TO DROUGHT
• ID KEY USE CASES TO HELP PROPEL INTEGRATION FORWARD AT LEAST IN DISCRETE CASES WHERE IMPORTANT FOR KEY DECISIONS
• TWDB NEEDS TO ESTABLISH THE STANDARD SO OTHER CAN FEED DATA IN
• TNRIS - HOW EXPAND TO INCLUDE WATER
• INCENTIVIZE DATA SHARING W/ SPEED/ PREDICTABILITY OF PERMITTING
• CA (+ OTHER STATE) MODELS FOR DATA SHARING - EXAMINE FOR IDEAS TRANSFERRABLE TO TX
D PM (8)
SPRINGBOARD (CONT.) (2)
• INVEST RESOURCES FOR COMPREHENSIVE MONITORING/INSTRUMENTATION (CURRENTLY DISPARATELY COLLECTED)
• INVEST IN "OUT OF BOX" TOOLS TO START THE PROCESS OF GETTING DATA OUT THERE
• SIMPLE ASSESSMENT OF "WHO HAS WHAT DATA"
• CAP/COG FORECASTING COMM. DOING THIS LOCALLY TO BE USEFUL FOR FIRST RESPONDERS
• PUBLIC EDUCATION REGARDING THE NEED FOR CLEARINGHOUSE/NEED FOR INDEPENDENCE/INTEGRITY
• "OPEN WATER DATA INITIATIVE" IN TX
INITIATED @ THE FEDERAL LEVEL
- BILL DIRECTING AGENCIES TO PARTICIPATE (LIKE IN CA)
- LACKING CONSENSUS + COLLECTIVE ACTION, NOT A LACK OF DESIRE!
- NEED "MARCHING ORDERS" FROM LEG. - AGENCIES WILL HAVE HARD TIME INITIATING ON THEIR OWN
D PM (9)
SPRINGBOARD (CONT.) (3)
CONSIDER PUBLIC CHALLENGE TO USE TWDB DATA + DEMONSTRATE POSITIVE IMPACT TO DECISION MAKING/PROJECT. HAVE EXAMPLES TO DEMONSTRATE/AMPLIFY NEED/USE.

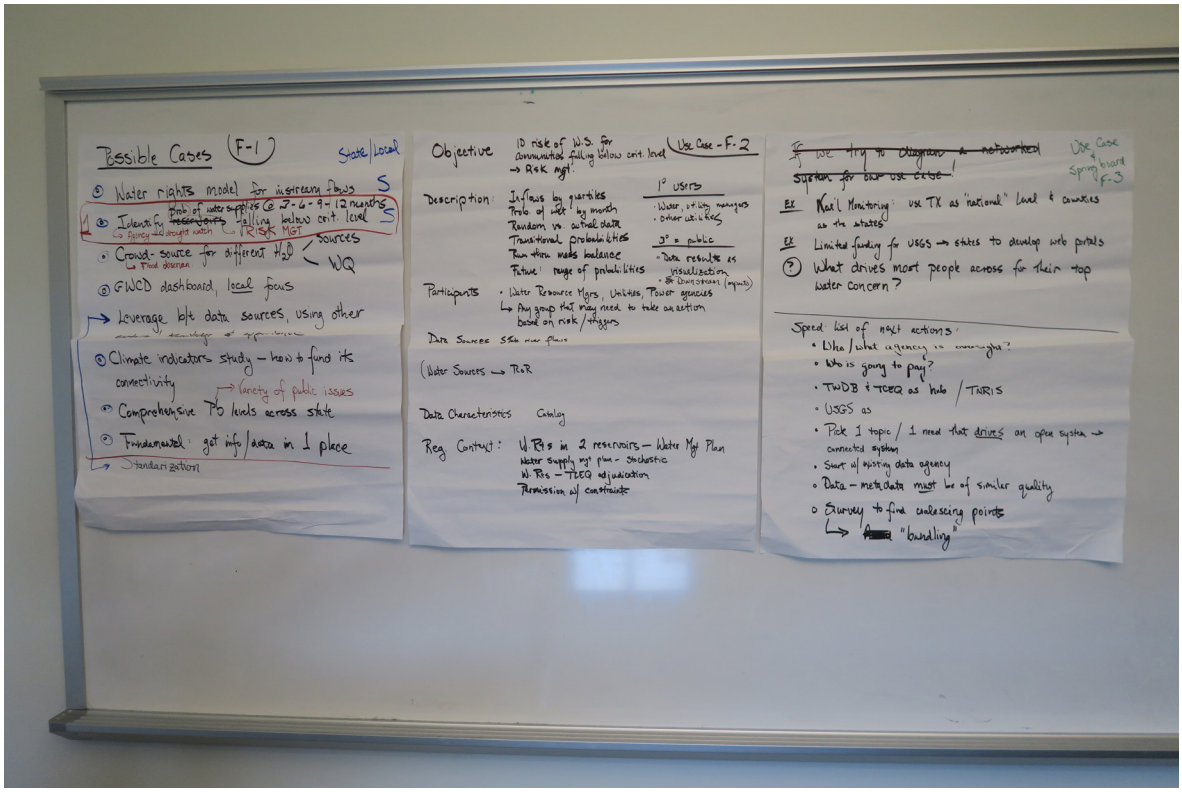
E



Group E Session 2
Existing decision support tools?
THIS LIST IS NOT EASY TO FIND
=> DIRECTORY NEEDED
Group E Session 2
Challenges:
Coordinating Body/Bodies?
Group E Session 2
Use Case Brainstorming:
Group E Session 2
SHAZAM TOOL
WAM + GAM
SEPARATE MODELS
OUTDATED
AVOID WATER CONFLICTS
PROTECT PROPERTY RIGHTS
-> BETTER VALUATION OF WATER
-> BETTER STATE WATER PLAN
-> MORE ADAPTIVE MGMT
INTEGRATIVE MGMT
INVESTMENT

GROUP SESSIONS II

F



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