Building Resilience in the West for America's Defense, Energy, Environment and Infrastructure through Enhanced Collaboration among Federal, State and Tribal Entities

Report on Outcomes and Findings of WRP Deep Dives for the 2022 WRP Principals' Meeting

December 8-9, 2022 Phoenix, Arizona

Western Regional Partnership

Reliable Outcomes for America's Defense, Energy, Environment, and Infrastructure in the West

WRP provides a proactive and collaborative framework for senior-policy level Federal, State and Tribal leadership to identify common goals and emerging issues in the states of Arizona, California, Colorado, Nevada, New Mexico and Utah and to develop solutions that support WRP Partners and protect natural and cultural resources, while promoting sustainability, homeland security and military readiness.

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Introduction to WRP

At each WRP Principals' Meeting, Principals meet to share information, network, and formally adopt strategic priorities governing collaborative staff-level efforts for WRP action. This report addresses the priority approved by the WRP Principals at their November 2019 Principals' Meeting, focused on *Building Resilience in the West for America's Defense, Energy, Environment and Infrastructure through Enhanced Collaboration among Federal, State and Tribal Entities*. WRP Principals usually meet annually, but COVID-19 and the resultant lockdowns prevented Principals' Meetings in 2020 and 2021. However, the 2019 adopted Priority has proven to be significant and this extra time allowed for needed review. To explore the adopted priority more fully, a brief survey was conducted with WRP leadership after the 2019 WRP Principals' meeting, which identified four deep-dives:

Committee	Deep-Dive
Energy	• Resilient Energy Infrastructure
Military Readiness, Homeland Security, Disaster Preparedness and Aviation (MRHSDP&A)	• Resiliency of Airspace in the WRP Region • Disaster Mitigation
Natural Resources	• Water Security

Each of the three WRP Committees (Energy, Military Readiness, Homeland Security, Disaster Preparedness and Aviation (MRHSDP&A) and Natural Resources) were specifically tasked with addressing pertinent items within their purview. To assist in this critical effort, subject matter experts for each deep-dive were identified and teams formed to address each topic. The deep-dive teams worked to explore tools and resources needed to build resilience to support the diverse missions of Federal, State, and Tribal entities in the WRP Region. This report summarizes WRP efforts since the 2019 meeting and documents actions and recommendations.

WRP History and Overview of the Region

In 2007, representatives of Federal agencies and State and Tribal leadership in Arizona, California, Nevada, New Mexico and Utah partnered with the Department of Defense (DoD) to establish the Western Regional Partnership. Colorado was added in 2015.

WRP provides a proactive and collaborative framework for senior-policy level Federal, State and Tribal leadership to identify common goals and emerging issues in the states of Arizona, California, Colorado, Nevada, New Mexico and Utah and to develop solutions that support WRP Partners and protect natural and cultural resources, while promoting sustainability, homeland security and military readiness.

The WRP Region has 18% of the U.S. population, 19% of the U.S. land mass, considerable state, federal and tribal lands, and various land management processes. These factors and the fact that many land use issues are regional means that WRP Partners' interests may lead to unintended land use conflicts. To work together more effectively across geopolitical boundaries, common and emerging issues in the WRP region must be identified, along with potential conflicts and solutions.

Within the six-state region, there are:

- Significant amounts of federally managed lands (federal land ownership in these states ranges from 34.1% - 84.9%)
- Extensive Training Ranges, Premier Testing Facilities, Unmatched Military Air Space
- Approximately 172 Federally recognized Tribes
- Significant State Trust Landholdings

State	% of Federal Land (not including DoD managed lands)	% of DoD Managed Land	% of Indian Trust Land	Private Land	State Trust Land	Size of State in square miles and ranking by area
Arizona	35.5%	6.6%	27.6%	17.5%	12.7%	114,000; 6th largest state
California	40.2%	4.0%	.5%	50.3%	2.5%	160,000; 3rd largest state
Colorado	38.9%	0.7%	1.1%	54.9%	4.4%	104,100; 8th largest state
Nevada	78.8%	6.1%	1.42%	13.03%	.15%	110,561; 7th largest state
New Mexico	29.7%	4.4%	10.2%	43.9%	11.6%	121, 593; 5th largest state
Utah	63.6%	3.4%	4.5%	21%	7.5%	84,904; 13th largest state

The benefits of participating in WRP include:

- A forum to engage with high-level representatives of states, federal and tribal entities across WRP Region
- Opportunities to enhance situational awareness of policy and emerging issues
- Enable interagency dialogue for identifying, addressing, and avoiding these potential conflicts
- Recommendations and innovative solutions in the gap between real time problems and long-term policy development

- Access to tools and WRP Deliverables

WRP Structure

WRP's Charter delineates the mission, goals, and responsibilities for the Partnership. The Steering Committee (SC) is composed of senior staff members representing WRP Principals; it coordinates with the Co-Chairs of the three WRP Committees:

- Energy
- Military Readiness, Homeland Security, Disaster Preparedness and Aviation
- Natural Resources.

The Committees work to improve regional and interagency cooperation among federal agencies, tribal leadership, states, and non-governmental organizations on critical Western regional issues and provide a forum for information exchange, issue identification, problem solving, and recommendations.

A GIS Support Group works with the WRP SC to assist all Committees.

The WRP Tribal Engagement Temporary Working Group (TETWG) was created by the SC acting under the authorization of the Principals and has been meeting since 2018. TETWG recommendations to address long-term tribal engagement are summarized in this report.

Executive Summary

Introduction

This report addresses the priority approved by the WRP Principals at their November 2019 Principals' Meeting, focused on *Building Resilience in the West for America's Defense, Energy, Environment and Infrastructure through Enhanced Collaboration among Federal, State and Tribal Entities*. Since the last WRP Principals' Meeting, much has happened including a pandemic, global supply chain issues, numerous disasters, and changes in Administrations (federal, state, and Tribal), making the need to build resilience more acutely known. At the same time, record federal funding of over $1 trillion has been allocated through the Infrastructure Investment and Jobs Act more commonly known as the Bipartisan Infrastructure Law (BIL),[1] to address the nation's infrastructure. For details on announced BIL funding throughout the United States please see the BIL Maps Dashboard.[2]

The WRP Steering Committee (SC) had focused conversations on BIL and its potential for the WRP Region. Many of the agencies noted the significant increase in funding will assist operations, but that they also expressed capacity issues. There are many inter-agency coordination opportunities. For example, USFWS received some direct BIL funding and is proactively working with its sister agencies (USFS, BLM, USACE, etc.) to address statutorily required Section 7 consultation under the Endangered Species Act for projects that arose with the additional $1 billion in project funding. They do not want the required consultation to delay projects. It is desired that this funding will address resilience issues described in this document. However, at least one WRP state is planning for a recession and strategizing how to redistribute leftover BIL funding to different projects in case this recession occurs.

WRP Priority and Deep-Dives

This report addresses the priority approved by the WRP Principals at their November 2019 Principals' Meeting, focused on *Building Resilience in the West for America's Defense, Energy, Environment and Infrastructure through Enhanced Collaboration among Federal, State and*

[1] https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf
[2] https://d2d.gsa.gov/report/bipartisan-infrastructure-law-bil-maps-dashboard

Tribal Entities. To explore the adopted priority more fully, a brief survey was conducted with WRP leadership after the 2019 WRP Principals' meeting, which identified four deep-dives:

Committee	Deep-Dive
Energy	• Resilient Energy Infrastructure
Military Readiness, Homeland Security, Disaster Preparedness and Aviation (MRHSDP&A)	• Resiliency of Airspace in the WRP Region • Disaster Mitigation
Natural Resources	• Water Security

The WRP Deep-Dive teams were made up of predominately key federal, state, and tribal leaders. A significant strength of WRP is the forum it provides for ideas to be discussed and shared in a non-threatening way and enhance situational awareness among agencies. They have worked tirelessly and held regular calls to further delve into issues, listen to other subject matter experts share their latest efforts and actions, and from that develop this report with its findings.

There are many commonalities among the deep-dives including:

- The importance of early detection (of the issue) and partnerships in place to work collaboratively. Communication and collaboration remain a priority.
- The West contains many significant resources – and needs.
- Many new policies are being quickly adopted yet there can be policy gaps to knowledge, (i.e., technology can move faster than government funding and action). Policy tends to be behind knowledge and infrastructure.
- Funding has increased significantly, but it can be difficult to leverage and have the necessary capacity/resources to take full advantage of the new resources.
- Aging infrastructure concerns face all four of the deep-dives.
- Impact of more drought, wildfire, extreme heat. There are needs to be more creative and proactive in capturing water and using data to assist policies.
- Cyber and its far-reaching impacts. There is a need to implement cyber resilience solutions across all sectors including water, energy, airspace and disaster.

All agencies are facing great challenges and need to collaborate more fully with state, federal, and tribal entities.

This report documents the in-depth analysis, sharing of information and recommendations by the four WRP deep-dives.

Deep-Dive Summaries

The following summaries are intended to highlight the four WRP deep-dives. Later this report includes detailed information on each of the deep-dives along with many sources for additional information.

Resiliency of Airspace in the WRP Region

Resilient Airspace includes:

- A safe flying environment with the needed flexibility for users to meet complete their missions with the greatest harmony possible with other users.
- All users having reliable communication, navigation, and surveillance.
- All users having a common set of public data that can be shared to enhance situational awareness.
- An opportunity for users to collaborate, share mission needs and concerns, and be able to address them with regulating authorities in an efficient manner.
- The ability to share real-time status to create an 'info-centric' NAS with improved flexibility and airspace access for all users.
- Adapting to new technologies.

Airspace is a finite resource, and is particularly complex and busy in the West. As growth in commercial and general aviation continues, military airspace uses and requirements become more intense, and new uses such as Uncrewed Aircraft Systems and space operations expand, pressures on airspace make resilient airspace ever more important, and requires more flexible and dynamic use of airspace while accommodating the growing need for airspace to include sufficient electromagnetic spectrum resources to serve users.

Among the new or expected entrants into the National Airspace are hypersonic and supersonic commercial aviation, directed energy weapons, satellite links, high altitude balloons and various drone technologies. Additionally, as commercial space operations expand, they create additional areas where launch and re-entry operations must be considered in relation to existing and future aviation operations. Modernization of air traffic control, both civilian and military, including further improvements in artificial intelligence, will enable better coordination of airspace scheduling and management to accommodate this growth in usage. More integration of available data will assist this effort.

Expansion of airspace users has also implicated the need to protect wildland fire suppression tactics, many of which include an aviation aspect, whether through crewed or uncrewed aircraft. Agility in responding to these issues is critical, as the need in a given area may both arise and dissipate quickly.

Identified gaps in airspace resiliency are: ensuring the military has sufficient airspace to meet readiness requirements; integration of uncrewed aircraft systems into the National Airspace System; and the development of counter UAS policies at the state and federal level.

Disaster Mitigation

Disaster Mitigation for the WRP Region means: Having and employing the resources necessary to plan for, prepare for, and avoid impacts on infrastructure systems from natural and manmade hazards and to rapidly reestablish essential functions in the event of unavoidable impacts.

The Deep-Dive Team approached disaster mitigation in three major categories: benefits of mitigation, available resources, and partnership opportunities.

Mitigation planning saves lives, reduces disaster risk, enhances community risk awareness, guides limited mitigation resources to places of highest need and expedites disaster recovery. Disaster mitigation funding, including hardening infrastructure through grant funding or adopting hazard-resistant building codes, can save resources long-term.

Among the available resources are FEMA's Building Resilient Infrastructure in Communities (BRIC) and Flood Mitigation Assistance funding, the Department of Defense Office of Local Defense Community Cooperation's Defense Critical Infrastructure Program, and National interagency Fire Center Predictive Services.

It is important that federal, state, and tribal entities work together as they frequently share the same concerns and have shared stewardship over regions requiring disaster planning.

The Team also makes recommendations to address disaster mitigation issues, including better understanding of the various funding sources, cross-sharing and leveraging programs, additional ways for agencies to partner with one another and thereby leverage their efforts, encouraging tribes to partner with counties, working on drought resilience and earthquake zone building requirements, better coordination on wildland fires, fire-wise construction methods, wildland fuel reduction efforts, addressing post-fire flooding issues, reviewing and implementing more robust cybersecurity practices, and better sharing of data to assist in planning for future disasters.

Resilient Energy Infrastructure

Resilient Energy Infrastructure means an adequate and stable energy system throughout the WRP Region capable of performing during and rebounding from disruptions (e.g., natural

threats, deliberate adversarial actions, terrorism, cyber-attacks, accidents, etc.). Energy infrastructure is a basic requirement for national security and economic vitality, and must be protected from disruptions and rebound quickly and safely when disruptions occur.

The Resilient Energy Infrastructure Deep-Dive Team analyzed the issue in three main parts: an explanation of the importance of resilient energy infrastructure; resources available to assist with resiliency issues, and mitigation strategies, gaps, best practices, and recommendations.

The energy system includes several different and interdependent parts, including various fuels and other generation methods and transmission infrastructure. These different parts create vulnerabilities but can also constitute a strength in their diversity. Threats to energy security include cyberattacks, aging infrastructure, extreme natural events and responding to changes in energy resources.

Resources to address energy infrastructure issues include collaborative efforts with states to address electricity market opportunities; fuel market coordination; Defense Critical Electric Infrastructure; Black Start System Restoration; and tools to share information through a common platform.

Among the mitigation strategies found by the Team were the following: gaps to be filled including data, cybersecurity, communication, and energy resilience; tactics to minimize disruption and its impacts including public safety power shut offs and outage management, the use of microgrids, hardening infrastructure and better communication; best practices such as multi-layered networks and diverse fuel sources, fuel-switching, wildfire threat reduction, and microgrids. The team also made recommendations for more resilient infrastructure including communication, coordination, and planning, metrics, hardening infrastructure, microgrids, and cybersecurity.

Water Security

Water Security means having a reliable supply of water of suitable quality. Elements that assist in the establishment or recognition of water security include: (1) adequate and readily accessible data and predictions on water availability and infrastructure; (2) appropriate policy planning and implementation; (3) laws and regulations to promote water security; and (4) identification of best practices and implementation of new technologies that reduce water demand, increase and protect water quality and quantity, reduce flood risk, and enhance ecosystems.

The future growth and prosperity of the West depend on water. The Water Security Deep-Dive Team analyzed this issue, first by identifying four distinct but overlapping “buckets”:

Water Laws and Regulations, Policy Planning and Implementation; Water Resource Management Strategies; and Data.

Water laws and regulations are complex and fall under different jurisdictions: federal, state, tribal, regional, and local. Although the primary source is state law and many states share basic, historical concepts regarding water rights, nevertheless differences exist, and several federal environmental laws have impacted these longstanding rights and traditions. Additionally, the rights of federal entities, including the federal government's role in protecting tribal claims, further complicates these issues. Frequently, the solution is a basin-wide adjudication of rights; settlement of competing claims short of adjudication is preferable but not always possible. In the WRP region, this is currently illustrated by the effects of drought on the Lower Colorado River and the competing interests of states and others to ensure their share of the remaining available water,

Policy planning and implementation focused on how these laws promote planning for water security. Current issues include population and economic growth, competition for water rights, aging and inadequate infrastructure, changing regulations, unpredictable climate, and extreme events. Each of the WRP states has developed its own plan for dealing with water sustainability, and as would be expected these plans vary according to the challenges faced in each state. Water planning helps determine how the state and federal agencies can best support and empower regions to do effective water management. In the last few years, senior federal policy members formed a "Water Subcabinet" to help federal agencies work together on overlapping water issues and better understand the perspectives of water users.

Water resource management strategies identified practices and technologies to reduce water demand, increase supply reliability, improve quality, reduce flood risk, restore ecosystems and ensure equity. Recommendations include regional/watershed-based planning, co-management by water sectors to plan and implement multi-benefit projects; and (current and future) water technologies to support water security, resilience, and sustainability.

It is also important to develop an understanding of the scientific data to support water availability and infrastructure capacity, and to identify gaps and best practices. Many agencies and others collect water resource data, but that data is not always generally available or consistently organized. Tools have come online to assist in data collection, but many questions remain on how this information can be collected and disseminated.

As the four "Buckets" created a method to sort through the complex water issues, the entire Team observed common challenges, including financing and funding of water projects, implementation and enforcement of projects while acting consistently with regulations, recognition of differences of opinions on key items, particularly as aquifers frequently cross

multiple jurisdictions, and areas of commonality. Among the recommendation of the Team are the need to reduce government silos, continuing to leverage resources, including drought as a disaster in planning documents, aligning planning documents of various government entities, removing barriers to allow for quick federal assistance, implementing policies to alleviate future disasters, addressing tribal water rights, developing a diverse portfolio of water management strategies, conducting watershed assessments, better communication, developing a consistent water security definition, and continuing the water security deep-dive.

Tribal Engagement Temporary Working Group (TETWG)

This group held regular calls to encourage tribal participation in WRP and its committees. The group concluded that the best way to accomplish this would be for the WRP to create a permanent Committee to be called the WRP Tribal Engagement Committee with Co-Chairs who would interface with other committees to ensure representation of tribal perspectives.

Recommended Future WRP Priority

There are significant commonalities among the deep-dives, most notably the need for "*Enhancing resilience to avoid cascading disaster.*" The West has both significant resources and critical needs. Early detection of these needs is important to build effective partnerships to address such issues as: policy gaps, capacity issues, aging infrastructure, drought, cybersecurity, and wildfire. All agencies are facing great challenges and success will depend on greater collaboration among state, federal and tribal entities.

In 2023-2024, WRP will identify best practices and solution sets to address the need for *enhancing resilience to avoid cascading disaster*, thereby supporting the diverse missions of federal, state and tribal entities in the WRP Region.

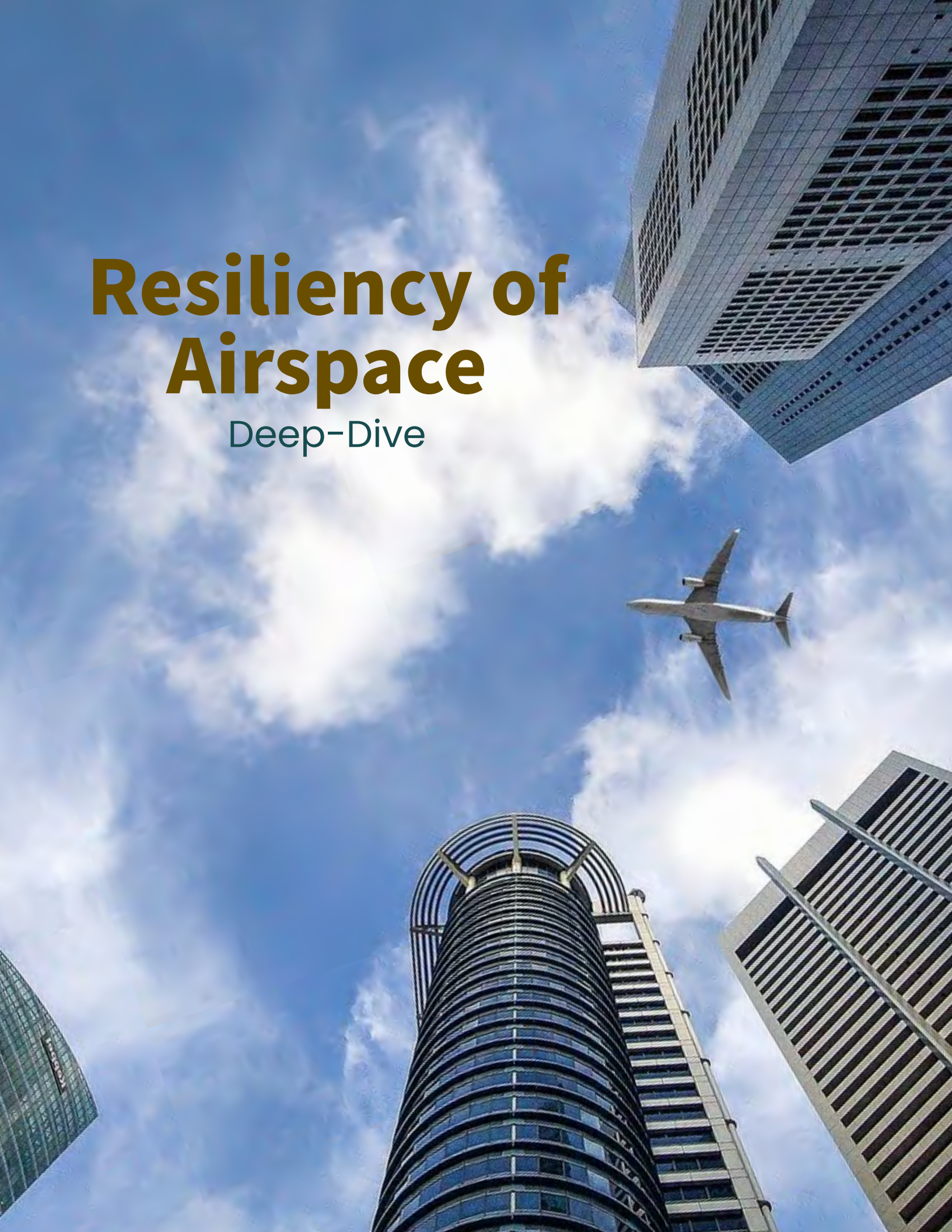
Phase one of this activity is a brief survey to better understand existing federal, state, and tribal priorities and issues. The results of the survey will be consolidated and further analyzed to identify areas of commonality for WRP focus for the year to support WRP Partners' efforts. Potential areas of synergy might include further deep-dives into areas of cybersecurity, wildland fire, water security, aviation/airspace needs, addressing aging infrastructure, etc.

Building Resilience in the West for America's Defense, Energy, Environment and Infrastructure through Enhanced Collaboration among Federal, State and Tribal Entities

Summary of WRP Deep-Dive Efforts

Resiliency of Airspace

Deep-Dive



Resiliency of Airspace in the WRP Region

Overview

Airspace is a finite resource and competition for its use is increasing. There are several types of flight operations underway daily, which include government (federal, state, local, tribal, and law enforcement,) commercial, and general aviation. The WRP Region arguably has the most complex and busiest airspace in the nation. This area has four of the ten largest airports, four of the eleven MetroPlex projects (SoCal is the largest and most complex), and three of nine space ports in the United States, while accounting for 19 percent of the country's landmass and 75 percent of the Department of Defense's (DoD) Special Activity Airspace (SAA).[3] Significant changes are occurring within the region's airspace such as: exponential increase in the use of uncrewed aircraft;[4] implementation of new technology;[5] introduction of military aircraft such as the F-35; and increases in flight operations. Improving access to the National Airspace System (NAS) is critically important for continued economic growth in the west and must support civil, commercial, and military aviation while also integrating uncrewed aircraft.

For purposes of this report, "resilient airspace" for the WRP Region includes:

- A safe flying environment with the needed flexibility for users to complete their missions with the greatest harmony possible with other users.
- All users having reliable communication, navigation, and surveillance.[6]
- All users having a common set of public data that can be shared to enhance situational awareness.
- An opportunity for users to collaborate, share mission needs and concerns, and address them with regulating authorities in an efficient manner.
    - The ability to share real-time status to create an 'info-centric' NAS with improved flexibility and airspace access for all users.
    - Adapting to new technologies.

[3] Previously known as Special Use Airspace (SUA).

[4] Including Uncrewed/unmanned Aircraft Systems (UAS), Advanced Air Mobility (AAM) and Regional Air Mobility (RAM) operations

[5] E.g., NextGen and commercial space operations

[6] E.g., GPS, Data Communications (Data Comm), Area Navigation (RNAV), Required Navigation Performance (RNP)

Emerging Trends/Projections in WRP Region's Airspace

There have been many changes impacting the use of airspace/aviation operations within the WRP Region: commercial, general aviation and DoD projected needs; new aviation technology; commercial space operations; Air Traffic Control Modernization; autonomy/artificial intelligence; electromagnetic spectrum needs; wildland fire response; and the COVID-19 pandemic. Safety is key to securing the public trust.

Commercial, general aviation and DoD projected needs. There will continue to be new entrants and a need for expanding airspace access to accommodate growth in commercial, general aviation, military, and Uncrewed Aircraft Systems (UAS)[7] in the NAS. This increase of airspace needs by new users with the same amount of capacity requires more flexibility and dynamic use of airspace than currently exists. Changes in aviation operations (e.g., new space launches, etc.) should be communicated in advance to allow time for coordination.

The FAA, as steward of the NAS, must provide safe, orderly, and expeditious movement of aircraft in the NAS, including separation, providing access to many different interests, and properly balancing competing needs. Safety remains the first priority. The FAA understands the various needs for airspace and attempts to balance both DoD and civilian needs and modify the ways it protects airspace. Additionally, the U.S. Space Force, the newest branch of the U.S. Armed Forces, must be accommodated. Its mission is to organize, train, and equip space warfighters to maintain and enhance military advantage in space.

New Aviation Technology includes hypersonic and supersonic efforts by business/commercial entities; directed energy; new tethered or non-tethered satellite links hovering around 45,000 feet (and how to maneuver around them); electrically powered planes; biofuel technology; high altitude balloons; and crewed and uncrewed UAS, AAM/RAM. There are many new vehicle types; a key issue is ensuring that the evolving traffic management system will enable more flexible operations in a timely fashion. Some examples of new technology include:

- NASA uses Space Act Agreements[8] to partner with organizations in the public or private sector that provide capabilities beyond NASA's core competency. These partnerships[9] allow for NASA to expand on its aeronautics research and space exploration while furthering the partner's mission. Developmental goals include quiet supersonic aircraft and commercial supersonic flight. NASA's Advanced Air Mobility Missions can be rural or urban and include on-demand air taxi, cargo delivery, airport transfer, inter-city electric conventional takeoff and landing (eCTOL), air ambulance,

[7] More commonly known as Unmanned Aircraft Systems.
[8] https://nsta.jpl.nasa.gov/commercial/saa.php
[9] Partners can be a U.S. or foreign entities, academic institutions, other Federal agencies, state, local or foreign governments, and international organizations, including both for-profit and not-for-profit.

medical transfer, cross-metro transfer, small package delivery, etc. NASA's Low Boom Flight Demonstrator (LBFD) is designed to develop a new shape of supersonic aircraft to collect data on what the new aircraft shape does to reduce sonic boom signatures.[10]

- Development of directed energy weapons that could target many uncrewed threats including UAVs and small craft at the speed of light.
- Sophisticated, transponder-equipped balloons that can fly at altitudes up to 92,000 feet for long durations can offer many functions including intelligence, surveillance, and navigational systems.

Commercial Space Operations in Non-Traditional Locations. Space launches and re-entries in the U.S. have occurred for decades and supported national security, research, and commercial enterprises. Until recently, launches and re-entries have occurred in a limited number of locations. However, with the expansion of private space operations, the number of locations now used for launch and re-entry operations has increased. In 2020, the FAA implemented the Streamlined Launch and Re-entry Licensing Regulation-2 (SLR2) to assist commercial space access for private companies.[11] Within the WRP Region, commercial space launches are taking place at the Mojave Air and Space Port (CA) and Spaceport America (NM). The Colorado Air and Space Port has its spaceport license for horizontal launch vehicles only; launches are not yet occurring and are not projected to for many years. Additionally, there are space launches by the Department of Defense at Vandenberg Space Force Base (SFB) in California.[12]

Airspace resiliency must consider demand versus capacity while providing equal and safe access for all. As new entrants look to access a slice of the airspace capacity, the FAA Air Traffic Organization and other airspace managers must consider the priorities of these new commercial space ventures based in non-traditional locations. Previous space missions were traditionally operated by government-sponsored organizations such as NASA and the DoD for national security purposes or general public benefit, including NOAA satellites, GPS satellites (NAVSTAR), and intelligence gathering objectives.

Private, commercial space enterprises in non-traditional locations seek access to the same airspace for their missions. Government-sponsored missions and launches and re-entry for national security and general public benefit should be given higher priority access to the available airspace than commercial launches and re-entries, which should be treated like other commercial aviation operations.

[10] NASA Aeronautics Research Mission Directorate (ARMD) Airspace Research Overview presentation by Leighton Quon, Deputy Director of Aeronautics, NASA Ames Research Center, to WRP, November 2021.
[11] https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=25400
[12] https://www.faa.gov/space/additional_information/faq/

Due to the vast distances and large swaths of airspace required to be sterilized for launch and recovery of space operations, every effort should be made to maintain a predictable schedule, prioritizing airspace with adequate capacity. Any required changes to the launch schedule need to be communicated early and often until execution. This extremely complex task of de-conflicting airspace to accommodate users because of late unanticipated schedule changes induces compounding negative effects to general and commercial aviation activities requiring re-routing or time delays that are yet to be quantified.

Air Traffic Control Modernization will assist with scheduling, leverage new technologies, and better support the growth in aviation. The FAA is working to better integrate each flight from gate push-back to gate arrival using trajectory-based operations (TBO) while creating an IT infrastructure that more fully integrates into a single system composed of several 'micro-service' elements. Integration of those elements improve the FAA's ability to better manage traffic flow, provide better awareness, and address safety issues for drones with some sort of identification (remote ID) in an increasingly complex NAS.

DoD has invested in scheduling software that provides conflict resolution and achieves as much throughput as possible in airspace. DoD has introduced new tactical aircraft and corresponding tactics that require more airspace to accomplish their mission, effectively shrinking airspace. The large air ranges are at capacity and there may be no way to further increase their capacity without improving airspace flexibility. This makes it difficult to absorb new missions let alone continue existing testing and training missions and may impact the numerous internal and external factors that determine basing decisions. Real-time airspace scheduling and management between FAA and DoD/Supporting Agencies is necessary to address these issues.

Autonomy/Artificial Intelligence (AI). FAA is working to make routes even more efficient to reduce delays, fuel burn, and carbon emissions. One of its biggest problems is that many commercial aircraft are 30 years old and not equipped for Data Comm, therefore restricted to voice communications. The FAA vision of an 'info-centric' NAS may enable new services using the internet, iPads, and similar tools. With automation, they have better track of aircraft and can more easily reroute or efficiently move aircraft, especially in cases of bad weather. Most aircraft are connected to the Internet so there can be full collaboration (among small UAS below 400 feet, Urban Air mobility, and higher altitudes). This will enable better sharing of intent, constraints, weather, and performance and avoid guesswork by using real-time data analytics.[13]

[13] Charting Aviation's' Future: Operations in an Info-Centric NAS presentation by Steve Bradford, Chief Scientific and Technical Advisor, Federal Aviation Administration, February 2022.

AI may have significant impact on airspace management. Migration to performance-based standards as a basis for decision-support across the NAS will allow traffic flow management processes to agree on performance objectives, using data to provide predictive capabilities with a foundation in machine learning. Humans are still making the decisions, but their recommendations can be informed by much of the data that exists. Concepts such as the Air Force's loyal wingman (where UASs and manned aircraft work together), likely require "more airspace" for integration initially until the technology matures. Leveraging technologies will enable data use to improve decisions and performance of the NAS. There is a need for more integration of available data for all stakeholders; wider dissemination of information will assist decision makers (reduce stove pipes) and enhance operations for users. Alternative Position Navigation and Timing (APNT) may prove helpful in the future to assist with navigation.

Electromagnetic Spectrum Needs. Aviation depends on adequate and predictable access to the electromagnetic spectrum for communication, navigation, and air traffic management operations. Aviation (crewed and UAS) impacts from not having sufficient spectrum include loss of mission (flight did not occur), navigation/communication interference, and safety issues. Generally, aviation impacts from spectrum loss occur through spectrum sell-offs/relocations or by attacks. Spectrum is a finite resource that is in increasingly high demand as new generations of networks are created to enable faster speeds and support more sophisticated devices. This is especially true in aviation given the number of new entrants; not all can fly at below 400 feet on 5G. Current threats to the use of spectrum for safe flight operations include malicious actors who can impact operations through jamming or spoofing tactics, and spectrum encroachment by industry which may impact aviation operations, thereby rendering aviation operations vulnerable to attacks, or negatively impacting safety and security. Since 1994, the Federal Communications Commission (FCC) has completed approximately 100 spectrum auctions,[14] raising billions for the U.S. Treasury. Particular bands or frequencies of spectrum are allocated for certain uses and their sale or dynamic sharing can have unintended consequences. Opportunities exist to optimize spectrum use but it is very difficult; it is more likely that commercial spectrum will be used because of their bandwidth access. Private carriers are deploying 5G networks throughout the U.S. Additionally, FCC has adopted rules to open up 6G up to 3 THz.[15] The aviation community[16] has concerns that 5G networks could create interference with radio altimeters in civil and military airplanes and helicopters. The Aviation Cyber Initiative (ACI),[17] an interagency task force chaired by the DoD, FAA, and DHS, championed a quick reaction test

[14] https://www.fcc.gov/auctions-summary

[15] https://www.fcc.gov/document/fcc-opens-spectrum-horizons-new-services-technologies-0; and https://www.fcc.gov/document/fcc-opens-6-ghz-band-wi-fi-and-other-unlicensed-uses

[16] https://www.aopa.org/news-and-media/all-news/2021/december/09/faa-directives-reject-5g-safety-assurances

[17] https://www.faa.gov/air_traffic/technology/cas/aci/

(QRT) with participation from the Interagency, DoD, and industry to study the effects of C-Band 5G on radio/radar altimeters (RADALT) and produce repeatable aviation and 5G issue test procedures.

Wildfire response need for more streamlined access to airspace. Wildfire response often requires immediate airspace access to large quantities of sterile airspace with minimal itinerant aviation traffic to contend with; emergencies require them to get up and running quickly and safely. UAS/drone intruders are a major problem as they are hard to see and disrupt firefighting operations. Generally, when an unplanned, unidentified UAS is in the fire area, manned aircraft are moved (depending on the size of the fire, they could be moved to another side of the fire or returned to base). It is hoped that Remote ID will assist with identification of such UAS.[18]

Temporary Flight Restrictions (TFRs) may be activated to assist fire response. Airspace deconfliction is critical to ensure safe access to airspace for responding aviation assets that must occur real-time. Memorandums of Understanding (MOUs) and Letters of Agreement (LOAs) that define roles and responsibilities for airspace deconfliction play a significant role in ensuring safety of flight. As DoD seeks expansion of SAA, it helps to have partnerships and MOUs/LOAs[19] in place to work effectively in shared airspace.[20] As UAS technology matures and integrates into the NAS, it is equally important to have the ability to deconflict airspace with the UAS pilot as they are operating in the wildland fire flight environment. Communication is key; there is a need to have dynamic communication platforms. It is also necessary to determine how to relay messages and address the decision-making priority, that is, who is the priority and what is the priority. Transponders can work but they have shadowing issues (e.g., mountains). It is important to produce a solution, so equipment does not need to be retrofitted for the next 10-20 years after implementation.

[18] Cal Fire Tactical Air Operations presentation to WRP by Chris Willson, Division Chief, CAL FIRE, April 2022.

[19] Examples of such MOUs between land management agencies and DoD to assist with coordination, notification, and deconfliction procedures include: MOU between 173 FW Kingsley Field, Oregon and Burns Interagency Communication Center; MOU between the US DOI BLM Idaho State Office, Nevada State Office, Oregon State Office, and California State Office and the Mountain Home Air Force Base 366th Operations Support Squadron; Letter of Agreement between California State Office, BLM Pacific Southwest Region, U.S. Forest Service USFS, Sequoia and Kings Canyon National Parks (NPS), Death Valley National Park, CALFIRE and R-2508 Complex Control Board (CCB); and Letter of Agreement between Hill Air Force Base 388th Fighter Wing (ACC, Headquarters, Utah Test and Training Range (HQ, UTTR), and BLM Nevada State Office, and Utah State Office.

[20] Wildfire Response Need for More Streamlined Access to Airspace presentation to WRP by Kim Owczarzak, National Airspace Program Manager, Washington Office, Fire and Aviation Management, National Interagency Fire Center, July 2022.

The **COVID-19 pandemic** has impacted aviation operations and the long-term effects are not yet fully known. Initial impacts: According to Airlines for America, the first half of 2021 resulted in pre-tax losses of $4.3 billion for the eleven largest U.S. Passenger Airlines.[21] ICAO has categorized COVID-19 impacts into several categories:

- Operational (number of flights, seats offered, segmenting passenger and cargo flights into international and domestic operations);
- Economic (revenue);
- Aircraft utilization (used or grounded); and
- Country-pair traffic (flights traveling internationally).[22]

COVID-19 impacted staffing and back-up facilities. FAA air traffic and facilities were staffed through teams or pods. Air Traffic Controllers cannot tele-work. This underscored the need for sound contingency plans for similar events in the future so that facilities are not as vulnerable to ATC Zero events.[23] Resiliency is a critical issue in all infrastructure, certainly in the aviation community. The pandemic showed that the aviation infrastructure is critically important to keeping the nation's economy moving. The rapid delivery of goods and services, including medical supplies and services, was made possible by the aviation infrastructure.[24]

Resiliency of Airspace Gaps: Addressing Critical Needs

The WRP Resiliency of Airspace team carefully reviewed those issues in the WRP Region most critical to ensure resiliency of airspace and broke into teams to explore and develop recommendations more fully:

- Gap 1: Ensuring the military has sufficient airspace to meet DoD readiness requirements
- Gap 2: Integration of Uncrewed Aircraft Systems (UAS) into the National Airspace System (NAS)
- Gap 3: Development of Counter UAS State and Federal policy

Gap 1: Ensuring the military has sufficient airspace to meet DoD readiness requirements

DoD members held regular calls to discuss DoD Airspace Challenges and provided the following information: brief overview of the DoD aviation mission in the WRP Region; details on not enough airspace for everyone (including for the DoD mission); and next steps.

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[21] https://www.airlines.org/dataset/impact-of-covid19-data-updates/

[22] https://www.icao.int/sustainability/Pages/COVID-19-Air-Traffic-Dashboard.aspx

[23] A situation of FAA ATC facility is not able to provide published ATC services. See: https://www.faa.gov/documentLibrary/media/Order/JO_1900.47_E_chg1.pdf

[24] National Association of State Aviation Officials (NASAO) Update to WRP by Mr. Greg Pecoraro, President, NASAO, August 2022.

Brief Overview of the DoD Aviation Mission in the WRP Region

The mission of the Department of Defense (DoD) is to "*provide the military forces needed to deter war and to protect the security of our country.*" The WRP region is crucial to the success of this mission due to the extensive training ranges, premier testing facilities, and unmatched airspace to meet DoD needs. For the services, it includes:

- Approximately 55% of the Army's landholdings
- Over 33% of Navy's landholdings
- 85% of Marine Corps' Live Fire Ranges and 67% of Marine Corps' airspace
- Four of the largest Air Force range complexes: Edwards Air Force Base (AFB); Nellis AFB/Creech/Nevada Test and Training Range (NTTR); Luke AFB/Barry M. Goldwater Range East; and Utah Test and Training Range (UTTR)
- 75% of DoD Special Activity Airspace (SAA) is located within the WRP Region

As a rule, most aircraft-related military operations are performed in strictly defined airspace, designed to accomplish any of several objectives. Typically, the following types of airspace are employed: Restricted Areas (RAs), Military Operations Areas (MOAs), Military Training Routes (MTRs), Warning Areas, and Air Traffic Control Assigned Airspace (ATCAA). There are basically three types of air events normally conducted by the military in such airspaces: test and evaluation (T&E), training, and operations.

Not Enough Airspace for Everyone

In March 2022, a classified version of the current National Defense Strategy (NDS) was transmitted to Congress[25] and a public version was released in October 2022.[26] The military's requirements are evolving in response to threat adversary capabilities, and there is a need for greater airspace access in support of NDS objectives.

DoD use of airspace has changed over the years to the point that legacy (current) airspace no longer meets DoD requirements (time, proximity, volume, and attributes necessary to meet readiness). SAA is intended to evolve with capabilities and requirements. The current structure was built around WWII to accommodate 4th Gen aircraft weapons systems, and decades-old artillery systems. Today, the military uses longer range weapons, sensors, advanced aircraft, and the ability to network/integrate capabilities over long distances through ground, air, and space-based platforms. Evolving hypersonic, directed energy, uncrewed aircraft, and other weapons systems and associated tactics are forcing DoD to reevaluate its uses of and needs for airspace. There is a requirement for increased access to larger volumes of airspace with greater flexibility (both scheduling and types/criteria of airspace) to meet DoD requirements. These larger volumes of airspace and the necessity for

[25] https://media.defense.gov/2022/Mar/28/2002964702/-1/-1/1/NDS-FACT-SHEET.PDF

[26] https://media.defense.gov/2022/Oct/27/2003103845/-1/-1/1/2022-NATIONAL-DEFENSE-STRATEGY-NPR-MDR.PDF

increased flexibility are vital to match the pace of technological change and to keep pace with adversaries.

DoD readiness includes testing the equipment and training aircrews to be mission ready. To do this, DoD needs sufficient airspace to test and train like they fight against a peer adversary. Although some training can be accomplished in high fidelity simulators, in many cases these cannot replace live flight training in adequately-sized airspace with the proper attributes.

There will be times when it is necessary to sanitize the airspace to operate weapons systems in a manner that could impact or be unsafe for non-participating aircraft. Participating and non-participating aircraft must be deconflicted or integrated with weapons systems operating across all domains; this requires access to large volumes of airspace during development and training.

Integration is robust. As more UASs are introduced into the NAS, it requires delicate integration with other NAS users to ensure safety. To create and maintain robust airspace and range capabilities, there must be strong integration at all levels of government (state, local, regional, federal, and tribal).

Airspace and other DoD Operations Require Electromagnetic Spectrum

Additionally, access to airspace with adequate electromagnetic spectrum (EMS) is necessary for military air power. The Department of Defense requires assured EMS[27] access because it is essential for success in all other domains. According to 2020 Department of Defense Electromagnetic Spectrum Superiority Strategy,[28] *"In modern warfare, EMS superiority is a leading indicator and fundamental component of achieving superiority in air, land, sea, space, or cyberspace."*

Adverse actions against the EMS, commercial development, and regulatory constraints impede the military's ability to sense, command, control, communicate, test, train, protect, and project force effectively. The DoD seeks to maintain military advantage through spectrum, while sharing it with commercial partners. Spectrum shortages limit DoD's ability to test or train for an Anti-Access/Area Denial (A2/AD) environment. DoD is using new weapons systems that tend to need a higher data rate for spectrum. New fighting domains, cyber and space, increase the importance and need for spectrum access for DoD. Federal spectrum will continue to be auctioned, including the expectation that the DoD will be required to share much of the remaining spectrum with other users. Combined with the

[27] https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/ELECTROMAGNETIC_SPECTRUM_SUPERIORITY_STRATEGY.PDF
[28] https://media.defense.gov/2020/Oct/29/2002525927/-1/-1/0/ELECTROMAGNETIC_SPECTRUM_SUPERIORITY_STRATEGY.PDF

reality that the propagation of RF signals used by DoD systems will far exceed the physical boundaries of the DoD airspace, this will put increasing pressure on the usable size of the airspace. The UAS community relies almost exclusively on radio frequency (RF) communications for effective and safe flight operations. The bands currently utilized for those functions are predicted to have significant encroachment and sharing restrictions, which may also limit the areas of the airspace available for UAS operations.

In determining adequate spectrum, factors such as time of day availability, height, width, or length must be considered as these may limit an operation, or spectrum may reconfigure the airspace available. The military's need for spectrum is broader than aviation, and an absolute necessity. All DoD airspaces and ranges should be created with spectrum in mind.

Next Steps:
The DoD continues to work diligently to quantify existing requirements and forecast future shortfalls. Initiatives currently being explored include continued collaboration with the FAA, maximizing efficiencies with the scheduling and use of Special Activity Airspace, developing long range/short duration overland corridors, reviewing airspace modifications, and evaluating dynamic spectrum sharing.

Collaborative Efforts with the FAA: The FAA and DoD have increased collaboration across multiple lines of effort:

- Streamline the National Environmental Policy Act (NEPA) process to conduct environmental reviews of DoD initiatives. Recent Council on Environmental Quality (CEQ) changes authorize the FAA to share Categorical Exclusions (CATEX) for certain NEPA actions with the DoD allowing the FAA to accept DoD NEPA CATEXs without requiring a separate FAA environmental review. FAA is also working to establish additional CATEXs to support faster processing of DoD airspace proposals.
- Formalize FAA requirements for establishing ATCAAs.
- Review and update established FAA timelines for review and processing of airspace proposals.
- Tactical Management of Special Activity Airspace (SAA) including reviewing the differences between ARTCCs in managing SAA; scheduling systems; real time SAA status ('21 NDAA Sec 1085); sub-division of existing SAA, etc.
- Using the FAA System Wide Information Management (SWIM) system to share SAA access availability more efficiently with non-DoD airspace users.
- Addressing Dynamic Airspace to allow for the use of larger volumes of airspace for a short duration on an infrequent basis (see below).
- Considering which space ranges and space ports will support military and commercial interests.

Best practices to more efficiently use SAA and the ability to move aircraft and systems from one area to another during exercises. There is a need for a comprehensive strategy between the DoD and the FAA to determine what areas can be optimized or expanded to meet current and near future requirements. Future DoD airspace expansion opportunities are not likely, and the focus should be on airspace enhancements such as optimizing vertical airspace, partnering with adjacent ranges, developing short term or temporary-use ATCAAs, and working with the FAA to trade space, if available. Using a temporary ATCAA at an individual range extension or to connect joint ranges should be considered. Some altitudes may be better (when working with the FAA). DoD is working to:

- Partner with neighboring ranges on the more challenging airspace requirements
- Providing existing ARTCCs with unified DoD airspace plans/requirements (for each FAA regional center area)
- Schedule and manage the "Joint" airspace cooperatively
- Develop "Scalable" airspace options/solutions (use only what you need – scale up and down)
- Coordinate Joint ATCAA usage and scheduling
- Improve airspace scheduling and management architecture

Development of long-range overland corridors to be used for short durations. Advancements in hypersonic and other long range weapon systems create an urgent need for additional capabilities to support their development. Within the United States, the western region offers some significant opportunities to create routes necessary to support flight operations of these systems. Challenges that must be addressed include:

- Route design that balances long-range system requirements with other operations in the National Airspace System.
- Necessary infrastructure (e.g., communications, instrumentation, etc.).
- Necessary environmental analysis.
- Government coordination (state, federal, etc.)

The Test Resource Management Center (TRMC) is exploring routes into White Sands Missile Range (WSMR) with the Services and other federal agencies that could provide some of the capability to support long-range system development and fielding. Currently they are in the early stages of the Programmatic Environmental Impact Statement (PEIS). There are conversations among western range complexes (including R2508 Complex, NTTR and UTTR, etc.) to link ranges to provide additional capabilities. There is also an informal long-range corridor working group, consisting of Army, Navy, Air Force, TRMC, and NASA representatives, that meets periodically to share information on long-range corridor initiatives and potential future requirements.

Airspace Modifications for More Dynamic Airspace Use. DoD has reviewed airspace requirements to ensure ranges have adequate space to support mission readiness. Over the last ten years, several ranges within the WRP Region (UTTR[29] and Fallon Range Training Complex (FRTC)[30]) have submitted airspace modifications to the FAA to meet readiness requirements. As acknowledged in previous sections, the rollout of 5th generation fighter aircraft, employment of advanced weapons systems, and evolution of current and future tactics have compelled the request for additional airspace to meet national defense objectives. Requesting additional airspace from FAA necessitates the commitment of considerable time and resources and should be used in cases where other options cannot support DoD requirements. Most airspace modification requests are enhancements such as optimizing vertical airspace, partnering with neighboring ranges to fulfill missions, developing short term or temporary-use ATCAAs, and working with the FAA to trade space if available. The future development of a virtual environment as well as exploring possibilities of linking live and virtual elements will be important because airspace is a scarce resource and in high demand.

The paradigm for airspace use must change. Lines on a map, separating military SAA and commercial routing, cannot accommodate all requirements. The military aircraft requirement has expanded exponentially. For example, currently the NTTR is about 110 x150 miles but the current requirement starts at 500 x 500 miles. Several test requirements include the entire western region from Utah to the Pacific Ocean (UTTR, NTTR, FRTC, R2508, Sea Range). The DoD will still need restricted airspace but using a dynamic airspace environment may allow opening up the MOA/ATCAA/Jet Route areas so that both commercial and military aircraft can work together and dynamically open or close that airspace based on the mission.

5G Dynamic Spectrum Sharing. A project at Hill AFB[31] will evaluate spectrum sharing, including with commercial 5G networks and sharing with airborne radar systems. Additionally, DoD is looking at ways to share spectrum.[32, 33]

Gap 2: Integration of UAS into NAS

For the past several years, WRP has recognized the importance of UAS integration into NAS. There are many efforts underway to develop and conduct UAS missions across the WRP

[29] 2017 NDAA (Public Law No: 114-328): https://www.congress.gov/114/plaws/publ328/PLAW-114publ328.pdf
[30] https://frtcmodernization.com
[31] https://www.defense.gov/News/Releases/Release/Article/2859222/dod-kicks-off-5g-dynamic-spectrum-sharing-experimentation-at-hill-afb/
[32] https://www.defense.gov/News/News-Stories/Article/Article/3165774/spectrum-sharing-is-way-ahead-to-maintain-economic-dominance-defense-official-s/
[33] https://www.defense.gov/News/Releases/Release/Article/3114220/three-new-projects-for-dods-innovate-beyond-5g-program/

Region as well as evaluate procedures on how to safely integrate UAS into the National Airspace System. UAS, when flown outdoors, operate in the NAS, and are thereby subject to FAA regulation. This section details background information, emerging trends, approaches to safely integrate UAS Operations into NAS, and gaps/recommendations.

UAS/Drones Background. UAS (also known as unmanned/uncrewed aerial vehicle, remotely piloted vehicle, and drone) consists of an aircraft designed to operate anywhere on a wide spectrum of operations between fully autonomous and piloted remotely and the equipment to control it. Uncrewed aircraft are currently used for government (federal, including military, state, and local law enforcement), recreational (flyers, modeler community-based organizations, certified remote), commercial, and research purposes.[34]

UAS use is growing exponentially; they can perform many roles that manned aircraft cannot and these uses will likely increase in the future. There are currently nearly 870,000 drones (518,397 recreational drones, 346,857 commercial drones and 3,529 paper registrations) registered in the United States. The number of UAS operations is outpacing that of traditionally piloted aircraft.[35] UAS can range in size from micro to 737 airliner. The smaller UAS use line of sight (LOS) communications. Medium and large UAS use both LOS and beyond visual line of sight (BVLOS) for flight. The FAA defined small aircraft as being less than 55 pounds. The most common type of UAS in the NAS is the DJI Phantom Mavic with a weight of 1.65 pounds, speed of 16 m/s (35+ mph), ceiling of 16,000 Feet, flight time of 27 minutes, operational frequencies of 2.4 or 5 GHz, and control range of 4.3 miles.[36] Drones can also be a vertical takeoff and landing aircraft (VTOL) or an electric vertical take-off and landing aircraft (eVTOL); both hover, take off, and land vertically thanks to rotors that allow them to fly almost anywhere. An eVTOL uses electric power.

Lower entry costs and access to equipment and pilot training and certification have made it relatively easy and inexpensive to buy a drone, compared to private plane costs and over 40 hours of flight training needed to earn a private pilot certificate.

UAS/Drone Emerging Trends. The technology of UAS is rapidly evolving and drones are now being tested, deployed, and improved for many uses such as:

- Urban Air Mobility (UAM), Advanced Air Mobility (AAM), and Regional Air Mobility (RAM)
- Enablers of access to remote high-speed internet, infrastructure improvements, etc.
- Drone delivery of products
- Public safety-search and rescue and law enforcement

[34] https://www.faa.gov/uas/

[35] https://www.faa.gov/uas/resources/by_the_numbers/

[36] Federal Aviation Administration, Office of National Security Programs, and Incident Response: Law Enforcement Assistance Program, LEAP UAS Outreach to WRP Airspace Gap#3 call, 5/11/2021

- Agriculture management-smart farms and aerial mapping
- Infrastructure management-inspections of airports, bridges, roads, signs, transmission lines
- Emergency management (disaster response, deliver real-time video of crisis area; UAS training; accident investigation, etc.)
- Airport and aircraft inspections
- Wildfire management and suppression support missions

Within the next ten years, drones are expected to be used in many more ways including fully autonomous drones and cargo aircraft systems. Polices are being implemented or considered to support such operations; for example, in September 2022, the FAA released design guidelines for vertiports (infrastructure that will support AAM aircraft.).[37]

Safe Integration of UAS Operations into NAS. Diverse stakeholders who compete for and share the same airspace are involved with the safe integration of UAS into the NAS, including DoD, DHS, Advanced Aviation Advisory Committee (AAAC),[38] UAS Integration Pilot Program (IIPP), NextGen Advisory Committee (NAC), WRP, airports, modelers, traditional operators, FAA, and state, local, and tribal Governments. The DoD, FAA, and AAAC members from the legacy aviation and drone community are evaluating ways to make the current airspace more dynamic and flexible. Typically, and historically, the more dynamic and flexible airspace is, the less predictable and accessible it is, e.g., Temporary Flight Restriction (TFR) areas. They need more predictable access, rather than reacting to issues as they arise, and to benefit all users of the airspace. There are many factors to consider for safe integration including: speed of drone technology and operations, UAS policies, technology, culture, and outreach.

> Drone manufacturers and operators are moving at light speed and desire regulators and non-drone operators to keep up with their pace. Drone operators are working to obtain approval to operate beyond the visual line of sight. Some of these drones will be small, but some of the larger operators want to operate a network of drones for delivery (e.g., UPS, medical suppliers, etc.). These network operations will need to follow rules and interact with the regulator in real time.
>
> Change in culture (traditionally-piloted vs UAS). The FAA and aviation industry have addressed issues of safety for over 100 years; that culture of safety and how to safely operate within the NAS is the key. There is a need to change culture of UAS operators, so they understand regulatory oversight is needed to ensure safety. Historically, pilots tended to differentiate people who have been in the cockpit, have flight training and flight hours from people who do not. Instead, both crewed and

[37] https://www.faa.gov/sites/faa.gov/files/2022-09/eb-105-vertiports.pdf
[38] Previously called the Drone Advisory Committee (DAC)

uncrewed pilots should be viewed as people who can impact the safety of the NAS. It is not about who has wings but how the safety or privacy of others may be affected.

UAS Policies are changing/evolving. The FAA is working deliberately to ensure the right policies are in place before moving forward to integrate the explosion of package delivery, commercial operation, surveillance, and advanced automation, and on changes in operations from recreational to commercial line of sight, to commercial beyond line of sight, to commercial cargo delivery and package, and to passengers on board. When operators put paying passengers on an autonomous vehicle, there will be much scrutiny to ensure safety and security. FAA is also integrating commercial space into the NAS. Some operations are not traditionally conducted in many places.

For low altitude drones, operating below 400 AGL, operators can reserve airspace through the LAANC (Low Altitude Alert Notification Capability) process. As they move forward to UAS Traffic Management (UTM), it will look different than the ATM world they are familiar with. It was observed that the FAA has done a great job with the LAANC, the UTM, and the identification program. The Military Services have established UAS Facility Maps (UASFM) at most of their airfields, which allows streamlined access for Part 107.

Remote ID is envisioned to work like a license plate on a car. Much remains in development for frequency assignment and whether it will be displayed on Controller scopes. The enforcement part of non-piloted vehicles, UAS in this case, falls on the FAA, but it is being approached with a compliance philosophy based on education instead of punishment. They are still working through this process, but the license plate function of Remote ID is a foundational step for the FAA to move into the future and be able to implement FAA-Recognized Identification Areas (FRIAs) and things that will allow for more effective law enforcement while protecting privacy.

At the state and local levels, governing policies are aimed to address constituent issues such as privacy and, in some cases, controls on drone operations.

Technology is a great enabler (communication, awareness, etc.). Data exchange is the foundation: enhanced stakeholder data exchange; remote ID/tracking; dynamic joint use airspace rules; DoD/DHS/FAA secure link to the NAS; and process, procedures and tools together make for safe operations (with all the parties working collaboratively). The FAA's System Wide Information Management (SWIM) and SWIM Industry-FAA Team (SWIFT) are making great progress to assist aviation users. There is much coordination among the FAA, DoD, and DHS on how to better share data.

This must be solved before it can be more connected to the public. Some lessons recently learned include that if the technology moves too quickly and they are not paying attention, there can be some bad results. If they are not very careful with how they do this, and the public pushes back through Congress, there may be limits on what can be done. Winning the public trust is paramount to achieving success for the future.

Outreach and education to the small, personal, non-commercial, non-military, non-large drone operators of NAS activities, rules, and regulations. At a recent UAV conference, it was observed that the UAS/UAV drone operators did not view themselves as part of aviation, but of technology. Many people are doing things they should not be doing; some are nefarious, and others are clueless and do not know better. They do not know about the importance of the NAS, what NAS is, or about sharing airspace. It is hoped that Remote ID and further education will help. Outreach such as "Know Before You Fly," B4UFLY Mobile App and other 3rd party apps, "No Drone Zone" signage, and individual facility outreach to local operators and hobbyist clubs have been helpful.

Findings. There is a need for dynamic airspace that is integrated, not separated, to enable safe and equitable use shared by diverse users. New technologies, regulations, policies, safety mitigations, etc., should not compromise safety, reduce availability (e.g., airspace), or increase costs for the present and future generation of pilots and operators (e.g., equipment mandates). There is a need for a mosaic rule to accommodate the diverse types of aircraft (old, new, uncrewed, crewed, rockets, etc.) Issues identified include compliance with see and avoid rule; need for standardized procedures and data exchange which support a collaborative, info-centric NAS; everyone to work together; broad stakeholder outreach; spectrum needs; BVLOS operations; and need to detect, sense, and avoid UAS.

- **Compliance with the right of way rules in 14 CFR Part 91.113,** commonly called the "see and avoid' rule, is a challenge for uncrewed aircraft. The rule requires that "*vigilance shall be maintained by each person operating an aircraft so as to see and avoid other aircraft*."
    - Potential impact of civil small UAS (sUAS) operations along MTRs and in MOAs: The FAA ruled that UAS fly under the same 'see and avoid' rules when operating within Military Training Routes (MTRs) and Military Operating Areas (MOAs). The concept of "see and avoid," although part of VFR flight rules, assumes a shared personnel risk between aircraft operators that does not exist with uncrewed aircraft. While military aircraft use MTRs/MOAs to operate low and/or fast for the purposes of tactical training, they expect non-participating pilots who fly through these areas to utilize caution and a high level of vigilance, as underscored by historic incidents. The lack of shared personnel risk has been mitigated by the historic small size of UAS combined

with limited operations. This is no longer the case with a growing number of far-reaching large systems, some weighing more than 1000 pounds. Further exacerbating this issue is the growing number of FAA waivers allowing for Beyond Visual Line of Sight (BVLOS) operations. Those UAS operators may be equipped with detect and avoid (DAA) capabilities but may no longer visually 'see' their aircraft or potential traffic. New policy requiring the avoidance or de-confliction of MTR/MOA is needed to provide a higher level of risk mitigation.

- DoD UAS mitigation options to meet the rule without using chase aircraft or ground observers: To comply with the "see and avoid" rule, UAS pilots rely on two FAA approved mitigations to serve as their "eyes": ground observers and airborne chase aircraft. DoD UAS operations in the NAS outside of Restricted, Warning, or Prohibited Areas, with the exception of Class A operations, require compliance with the see and avoid rule. The FAA allows UAS operations in Class A airspace without chase aircraft because all aircraft operating in Class A are under positive air traffic control and UAS operations are usually at higher altitudes that do not impact commercial operations or in numbers that do not affect the efficiency and safety on the NAS. To reduce the cost of using chase aircraft to comply with the rule and to improve safety, the Military Services have developed and fielded several ground-based detect and avoid (GBDAA) systems to allow military uncrewed aircraft to safely operate in the NAS (usually for transits from military installations to restricted airspace or Class A.) GBDAA systems use radar (single radars for non-complex airspace and multiple radars, including 3D radars, for more complex airspace) to provide the uncrewed aircraft pilot the air picture required to operate the uncrewed aircraft safely. Depending on the GBDAA system used, the air picture can be provided directly to the pilot or through a GBDAA observer, provide system generated advisories, or allow the pilot to make maneuver decisions. In addition to GBDAA, airborne detect and avoid (ABDAA) systems have been developed. Air Force Air National Guard is testing an ABDAA system on two MQ-9 aircraft. NASA proved out the concept several years back and General Atomics (manufacture of the MQ-9) is working to implement the concept on commercial and military MQ-9s (and follow-on aircraft models). While not widely in use today, ABDAA provides another level of safety and awareness; when used with GBDAA, it will be key to ensuring safe transit to and operations in Class A airspace as uncrewed aircraft operations become more prevalent. Both systems require an FAA Certification of Authorization prior to use. Once the FAA fully develops system certification standards and updates 14 CFR Part 91.113 to allow "electronic" means of compliance, manufacturers can build systems to a common industry standard,

and operators can use the systems within FAA-established rules and procedures.

- Operators and controllers **need standardized procedures** for safe integration into the NAS. Controllers need to learn about UAS characteristics and how that is integrated into the terminal and enroute environments.
- **Everyone must work together** and leverage efforts to safely integrate and find common ground; enhance situational awareness and education; and determine/develop true "integration of airspace." There is a need to include all aviation users (e.g., DoD participation opportunities in SWIFT) to improve airspace capability to provide more predictable access.
- **Outreach** and consultation with all airspace and community stakeholders is imperative to ensure cooperation, not accommodation.
- Need for sufficient **access to spectrum** for aviation operations.
- **BVLOS** operations come with big challenges and responsibilities. BVLOS operations need to maintain/control, address fly-aways, and cooperate with manned aircraft around busy airports. Those concerns create specific opportunities using new technology or operational processes to create appropriate policies and procedures allowing for BVLOS operations in busy Class B airspace. Safety cultures of long-standing flying organizations (i.e., DoD, good general aviation and airline partners, NBAA, AOPA, and A4A, etc.) have operated in this environment for years and UAS operations could benefit by these safety cultures. The FAA/Industry Aviation Safety Information Analysis and Sharing (ASIAS) program is an example of how a repository of de-identified safety reports can be used to predict risk areas.
- There remains a continued need to detect, sense, and avoid UAS to ensure safe aviation operations for all. (See Gap #3 summary)

Gap 3: Development of Counter UAS (C-UAS) State and Federal Policy

UAS operations support many functions and continue to evolve, but they can also pose threats/hazards to aviation operations. Airspace cohabitation is an important national security and public safety issue. UAS security concerns were identified by WRP Partners and included:

- Need to mitigate the potential threats/hazards to aviation operations emerging from the proliferation of private and commercial UAS.
- Systemic encroachment on the borders of military installations and ranges inhibits testing, training, and operational activities and increases the potential for mishaps.
- UAS encroachment on wildfire and natural disaster aviation response efforts endanger responders.

Additionally, WRP members have raised issues caused by drone incursions such as:

- Natural Resources: drone over a nature preserve/Bolsa Chica Wetlands frightened then-nesting terns, which abandoned over 300 eggs.

- Impacting fire operations: interference with wildland fire air operations; in one case, a crashed UAS started a forest fire.

This report highlights current efforts regarding C-UAS policy, C-UAS related issues in the WRP Region and associated resources, gaps/recommendations.

Counter-UAS Background. The FAA is committed to UAS integration; however, challenges include UAS security (mostly clueless and careless UAS operators, but potential for nefarious operators as well)) when drones are flown in areas that cause disruptions (safety or economic). The term "counter-UAS system" means a system or device capable of lawfully and safely disabling, disrupting, or seizing control of an unmanned aircraft or unmanned aircraft system.[39]

Policies. FAA has regulatory authority over recreational UAS operators, meaning they can require users to have remote ID and potentially limit their allowed altitude, but it is not a privacy agency. There are many efforts currently in place working to address development of counter UAS policies. DoD, DHS, and DOJ have legal authorities[40] to engage in Counter UAS efforts; much is underway but not all information may be shared given its sensitive nature.

It is debatable what role federal, state, local, and tribal governments have in regulating UAS. Congress is concerned about mitigating threats associated with the increased technology. State and local governments are generally concerned (based on input from constituents) about privacy, nuisance, and security. However, state, and local nuisance laws, Peeping Tom rules, and similar laws can manage some of these issues without the need to address the UAS and airspace, as the FAA wants to maintain control over that. In most cases, these state and local laws are already on the books. Within the WRP Region, according to research[41] by UAVCoach, Arizona, California, Colorado, and Nevada have various local drone laws; New Mexico and Utah did not have any laws noted at this time. It is important to be aware of how local ordinances and state laws work in concert and if any operation requirements are conflicting.

On the positive side, the technology to detect, track and identify, and mitigate is also evolving quickly. UAS mitigation technologies may be kinetic, non-kinetic, or natural. UAS detection technologies include radio frequency, radar, electro-optical/infrared and acoustic.

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[39] 49 U.S. Code § 44801

[40] FAA Reauthorization Act of 2018 (Section 383)

[41] https://uavcoach.com/drone-laws-arizona
https://uavcoach.com/drone-laws-california/
https://uavcoach.com/drone-laws-colorado/
https://uavcoach.com/drone-laws-nevada/

There are aviation safety communication concerns and many legal issues regarding communication interference and public privacy laws.

Technology is a moving target and regulations and polices are catching up. Technology grows and advances posing difficulties for governmental policies to keep pace. Governmental funding of such issues can be scoped out years in advance, which might leave a gap if technology and threats continue to outpace government actions.

There are over 1,000 National Security Flight Restrictions (commonly called No Drone SSIs) over sensitive facilities such as military installations, national landmarks, etc. UAS operators seeking approval to operate in one of the TFRs must contact the facility's designated point of contact and secure permission to operate within the airspace prior to entry.[42]

The National Security Council (NSC) directed Concept of Operations (CONOPs) at Core 30 Airports. FAA worked with TSA, airport sponsors, and DoD in this effort. This provides an interim step if a Gatwick scenario occurs (disruption of aviation operations by a drone).

Drone detections. It is harder to detect smaller radio UAS. There is much technology to assist with drone detections and it continues to become more sophisticated. It is important to prevent, deter, detect, and respond. Congress has determined that a UAS is an aircraft regardless of size, therefore removing a UAS is generally not feasible.

There is a need to quickly identify a possible threat through a robust drone detection system with directional triangulation. Drone detection through electronic notification, pilot reports, or controller observed instances are some key elements to detection and decisive counter UAS mitigation efforts.

Threat and Prevailing Safety and Security Challenges. UAS pose safety and security challenges. UAS security issues can occur due to operator error, by a clueless/careless operator, or intentionally by someone seeking to do harm. Even with C-UAS authority, the challenge of threat discrimination remains due to lack of remote ID and other considerations. Appropriate regulation of UAS, particularly small UAS, is essential to threat discrimination and mitigation of the overall risk to the National Airspace System.

DoD is working closely with DHS and DoJ to share lessons learned, best practices, and most effective technological solutions. The threat UAS pose to DoD installations and the associated risk to DoD missions is real and increasing. DoD is working closely with the FAA to mitigate this risk in a complex legal and regulatory environment. DoD is proceeding deliberately, in close cooperation with the FAA and other Federal partners, to navigate the

[42] https://udds-faa.opendata.arcgis.com

complex legal and regulatory environment to implement its legal authorities to counter UAS threats.

According to a recent DHS witness to Congress[43], the Transportation Security Administration reported nearly 2,000 drone sightings near U.S. airports since 2021. Many included incursions at major airports, which occur virtually every day. For 2021 and 2022, 63 drone incidents required pilots to take evasive action. Four involved commercial aircraft. There have been reports of UAS colliding with helicopters used by police, first responders, and the military. Since 2019, UAS incidents have caused U.S. airports to fully halt operations three times. In 2021, there were over 30 partial suspensions of operations at U.S. airports.[44]

A few notable C-UAS Resources Include:

- FAA's Law Enforcement Assistance Program (LEAP): Reporting and handling unsafe UAS activity
- Temporary Flight Restriction (TFR) have been typically used to ensure aviation safety around forest fires/wildfire fighting, major sporting events, and national special security events (NSSE), etc. The FAA provides a list of current TFRs.[45]
- FAA[46] has selected the following five airports to test and evaluate C-UAS systems:
    - Atlantic City International Airport in Atlantic City, New Jersey
    - Syracuse Hancock International Airport in Syracuse, New York
    - Rickenbacker International Airport in Columbus, Ohio
    - Huntsville International Airport in Huntsville, Alabama
    - Seattle-Tacoma International Airport in Seattle, Washington
- TSA C-UAS Technology Test Bed Program: Objectives include determining the effectiveness and suitability of C-UAS technology by validating/verifying technologies performance in differing airport environments; identifying the most crucial operational factors in determining technology effectiveness, to further requirements development and communicating enhancements to vendors; and developing an annual C-UAS Technology Security Catalog to summarize current C-UAS commercial marketplace options, operational testing data, and emerging market trends.[47] The testing process ensures equipment is effective and has no impacts on the National Airspace System. Key data is shared with airports. C-UAS

[43] Senate Committee on Homeland Security and Government Affairs July 14, 2022, hearing on "Protecting the Homeland from Unmanned Aircraft Systems."

[44] Protecting the Homeland from Unmanned Aircraft Systems" to WRP by Mr. Christopher Bidwell, Senior Vice President, Security, Airports Council International – North America, August 2022.

[45] https://tfr.faa.gov/tfr2/list.html

[46] https://www.faa.gov/newsroom/faa-selects-five-host-airports-test-and-evaluate-unmanned-aircraft-detection-and?newsId=25780

[47] C-UAS Test Bed Technology Overview to WRP by Captain Jim Bamberger, Branch Chief, Public Area Security and Infrastructure Protection, Requirements and Capabilities Analysis, Department of Homeland Security – TSA, October 2022.

technology may be impacted by a variety of elements such as geography, type of aircraft, communications, and spectrum. TSA is working to find technology that fits and seamlessly addresses issues. It works through the C-UAS Technology Working Group with 30 agencies including the DoD, FAA, most of the DHS components, the FBI, and 200 members, focusing on technology, testing, evaluation, and sharing data to get to the point of collaborating. TSA's test bed locations are Miami International Airport and Los Angeles International Airport.[48] The testing will be ongoing.

Findings:

The following needs were identified: standards for C-UAS technology; early identification of a UAS threat to the NAS; ability to rapidly deploy; and collaboration, communication, and coordination. Additionally, C-UAS systems must be agile/nimble and response at an airport could be improved through better addressing reporting and communication; understanding of roles and responsibilities; addressing federal, state, and local laws.

- There is a recognition that many efforts are underway to create/refine new policies to better address C-UAS challenges. However, this proves to be challenging giving the rapid nature of UAS technology development. Governmental funding of such issues can be scoped out years in advance, which might leave a gap if technology and threats continue to outpace government actions. This highlights the need for **standards for C-UAS technology**.[49]
- There is a need for **early identification of a UAS threat to the NAS**. State and local entities can contribute their unique expertise by providing feedback to national authorities on what they see as the potentially high-risk targets not only of the local population but aviation interests as well. These could be sports arenas, political conventions, known conflict areas like recreational uses, and Special Activity Airspace. Preplanning would help identify the biggest threats to aviation, identify solutions, modify procedures, and enhance protection. There may be a good process already in place by the Department of Defense to use technology and processes for identifying potential threats domestically.
- Authorized entities need the **ability to rapidly deploy** approved C-UAS systems to meet and defuse the threat. This ties with the need for agile/nimble C-UAS systems because not only must the response meet the threat, but it needs to be a rapid response. Drones come and go; depending on the type of threat, it may be there for only 15 minutes, so rapid response is vital. It is important who develops the policy, who enacts that policy, and who provides leadership and management. State and local law Enforcement and the military are all going to be key to identifying the threat and partnering with the federal government as necessary. A drone does not need to get very high before it is on the approach path for landing aircraft. The primary area of concern for counter UAS elimination most likely should start with the focus of threats near

[48] LAX test bed will commence Q4 FY22.

[49] https://www.rtca.org/sc-238/

airports, DoD installations, and critical infrastructure (water, power, nuclear, etc.) and should be defined with lateral/range dimensions that keeps in mind a desired response time with local agencies. Any process and training for airport managers, law enforcement, and anti-terrorism/force protection officers should be an all-inclusive response toolkit with processes for UAS procedures and actions separate from traditional aircraft. Not every location will be the same, but the basic guidelines provide the necessary framework for each location. Any protection plan and its processes should include collaborative "Suspicious UAS Activity and Notification procedures": identify, detect, and notify; employ UAS Counter measures/mitigation; and neutralize (IDENT) during any suspicious UAS activity.

- There is a need for further **collaboration, coordination, and communication**. There is support for affording state and local officials' opportunities to collaborate in UAS detection and, if legislation is in place, engage in mitigation efforts. It would be helpful to have clearer delineation of C-UAS rules and responsibilities (e.g., local law). Only a few federal agencies have C-UAS authorities and capabilities. Policies governing drone defense are needed given the proliferation of drones and their impacts.
- Approved (those designated as safe and effective) **C-UAS systems must be agile/nimble** as no UAS event is identical to another. There is a need to have something flexible. Threats are not going to be the same at every location or come from the same type of drone or operator. For example, it may be related to domestic terrorism, an uneducated recreational flyer or, as happened at London Gatwick, where somebody wants to create havoc, not harm, to make a point or political statement. Whatever the threat, authorities must be able to engage the threat with the appropriate response, without violating any federal laws, the constitutional rights of drone operators, or privacy. At the same time, policy cannot be constrained by too much regulation. Finding the right balance ensures they can be flexible and address the threat properly without spending hours figuring out what is authorized, which may mean the threat has already subsided and the opportunity is lost. If authorities can quickly identify these threats and defuse them appropriately, it will demonstrate they have the capability to counter these threats, which will be a deterrent to others. Arrests and convictions when appropriate should also help.
- **Response at an airport:**
    - Reporting and communication: Where an incident is reported to FAA Traffic Control by pilots, occasionally the FAA goes through its call-chain and the airport operator might not receive notification until long after. In a few incidents, state police were already dispatched to look for the operator before the airport operator was notified. Since FAA is not required to notify the airport owner/operator, a federal policy would need to be implemented to support this change.
    - Understanding roles and responsibilities within the call-chain and of their individual authorities. This is not to be confused with the broader issue of

authorities, which varies significantly depending on the entity. This happens particularly to airports with very limited authority to act. The Federal authority is broader in certain areas and varies depending on the agency.

- Federal, state, and local laws may limit the authority of airport operators to respond. Some may have the unintended consequences of minimizing response efforts. The FAA Reauthorization Act of 2018 (Section 383) specifically authorized DHS, DoD, and DOJ to use counter UAS against those posing a credible threat to a covered facility or asset. Unfortunately, it did not include airports despite those agencies having established operations at airports. Airports have very limited authority to respond to UAS incursion and in most cases the extent of their authority involves the deployment of airport law enforcement officers to identify the operator. Their ability to go much further than that depends on local laws. Some have evaluated whether they can use trespass statutes to arrest the operator if they are identified and found. This is limited and may vary among states. The challenge is that most agencies think that airport operators have more authority than they do. At some point, the laws governing UAS operations will be broken for one reason or another, through ignorance or carelessness. As with any other law, while it is important for the various jurisdictions to establish laws that will help mitigate or give them the action to enforce, the problem will remain without educational outreach for the rank-and-file users, so they may become aware of the law and its consequences. Even if they try to enforce the law, it does not stop the ignorant from creating the problem in the first place. What they are trying to do is address these situations whether intentional or not in an area where it is creating harm or could cause harm. The question is, "*how to get that out of there so the danger has been abated*." There are laws in most states, and what is needed now is an effort to educate law enforcement on what to look for, and teaching communities through signage and other efforts to raise awareness. Without the education side of it or communication side of it, they can run into frustration. Technologies are being developed with Remote ID and similar things that would assist law enforcement, once it sees a drone, to track where the person is on the ground. Those technologies are coming and should be available to law enforcement in the future but for now they have "*we can watch where the drone lands and then get the person.*" What questions do they ask so they do not violate a person's privacy or what are they allowed to do? When something is going wrong, they must be trained in what is right, what is wrong, and how to engage the pilot.

Disaster Mitigation

Deep-Dive

Disaster Mitigation in the WRP Region

Overview

Numerous significant and costly disasters occur in the WRP Region each year. According to the General Accountability Office (GAO), since 2017 over thirty million people nationally have been affected by disasters. Federal funding for disaster assistance has been almost $500 billion since 2005; in 2017-2019, federal supplemental disaster appropriations were $139 billion. [50] Since 1980, there have been over 300 cases of weather and climate disasters causing at least $1 billion in losses each, with total damages exceeding $2.1 trillion.[51]

Whether these hazards are natural, such as earthquakes, flooding, high winds, drought, mudslides, or other weather-caused hazards, human caused, such as cyber or physical attacks on infrastructure, or perhaps either, such as wildfires, emergency managers in the region must be ready to avoid or mitigate the risks associated with these events. For purposes of this report, "Disaster Mitigation for the WRP Region" means: *Having and employing the resources necessary to plan for, prepare for, and avoid impacts on infrastructure systems from natural and manmade hazards and to rapidly reestablish essential functions in the event of unavoidable impacts.*

The Disaster Mitigation Deep-Dive Team held working calls and facilitated key webinars with subject matter experts to explore this critical topic more fully. This report is organized into three main sections:

- Introduction on the benefits of disaster mitigation.
- Highlights of some resources available to assist with disaster mitigation issues.
- Identifies partnership opportunities to improve disaster mitigation.

Benefits of Disaster Mitigation

Vulnerabilities become larger and more complicated after a disaster; therefore, pre-disaster assessments and preparations prove helpful. Hazard Mitigation includes any long-term solution that reduces the impact of disasters in the future. Mitigation planning saves lives, reduces disaster risk, enhances community risk awareness, guides limited mitigation resources to places of highest need, and expedites disaster recovery. Federal agencies,

[50] Mitigating the Risks of Costly Disaster Recoveries presentation by Chris Currie, Director, Homeland Security and Justice Team, U.S. Government Accountability Office (GAO), June 2020.
[51] https://www.ncdc.noaa.gov/billions/

states, and tribes support hazard mitigation across the nation by understanding risk, planning for that risk, preventing risk, buying down risk, and insuring risk. Part of the federal, state, and tribal governmental role is to support local governments in reducing their risks from natural hazards to break the cycle of disaster: damage, reconstruction, repeated damage, and more reconstruction.

Disaster mitigation funding can save resources long-term. A recent Federal Emergency Management Agency (FEMA) funded study suggests that $13 is saved for every $1 spent on federal mitigation grants.[52] Adopting modern, hazard-resistant building codes can save $11 for every $1 invested in comparison to previous building codes.[53]

Although federal assistance is considered supportive of local efforts, the availability of these federal resources makes it important to consider the federal disaster resilience framework, which includes three broad and overlapping principles:

- Decision makers need reliable information
- Agencies, governments, and sectors must coordinate
- Appropriate incentives and removal of barriers can encourage risk reduction investments[54]

Tools and Resources available to Promote Pre- and Post-Disaster Mitigation

The emergency management landscape is changing. Disasters happen more frequently, are more intense, and affect more people. Addressing these disasters requires a keen sense of collaboration, integration of technology, and situational awareness to pull together the information needed for informed decision-making. There are many tools and resources available to assist with pre- and post-disaster mitigation. This section highlights the importance of partnerships, and various programs and resources of note.

Partnerships

Disaster response and mitigation is a shared responsibility among numerous entities. Issues of disaster mitigation are far reaching and impact all lifelines. The Disaster Mitigation Deep-Dive Team repeatedly noted the importance of having established partners before something happens. Partnerships will not prevent a forest fire but will help set up systems to allow for mitigation. Agencies need to communicate and work with each other to navigate complex situations because technology cannot take the place of relationships and

[52] Multi-Hazard Mitigation Council (2019.). Natural Hazard *Mitigation Saves: 2019 Report*. https://www.nibs.org/files/pdfs/NIBS_MMC_MitigationSaves_2019.pdf

[53] Building Codes Save: A Nationwide Study ES-1 November 2020. https://www.fema.gov/sites/default/files/2020-11/fema_building-codes-save_study.pdf

[54] Mitigating the Risks of Costly Disaster Recoveries presentation by Chris Currie, Director, Homeland Security and Justice Team, U.S. Government Accountability Office (GAO), June 2020.

partnerships. FEMA and the Homeland Security Operational Analysis Center released a research report titled "Streamlining Emergency Management: Issues, Impacts, and Options for Improvement," to improve efficiencies in emergency management.[55]
Additional keys for success identified[56] are:

- Knowing state mitigation programs, personnel, and priorities.
- Maintain a current Hazard Mitigation Plan for project identification.
- Front-load project identification and technical documentation for application submittal.
- Stay current on FEMA guidance and trainings (e.g., BRIC).
- Be aware of funding requirements and processes. For example, the Housing Mitigation and Fire Management Assistance Grants have prerequisites and although the end user may be a county, application may be through the state and preference will be given to impacted communities.
- Have good data, a champion to address, advocate, and communicate for your issues, partnerships (particularly with the private sector), and a comprehensive package/perspective.
- Be creative for non-federal match, such as in-kind services.
- Maximize project scoping and management costs funding.
- Determine whether your community qualifies for a lower cost-share, as the federal share has increased for small, impoverished areas to 90%, with 10% non-federal.

Programs and Resources
Numerous agencies have similar and complementary programs as well as extensive expertise and potential funding opportunities. For example, in 2021, the Infrastructure Investment and Jobs Act was signed and provides $1.2 trillion over five fiscal years (2022-2026) to address resilience issues in the United States including: $3.5 billion in Flood Mitigation Assistance (FMA) grants ($700 million per year) and an additional $1 billion in Building Resilient Infrastructure in Communities (BRIC) funding.[57]

This section highlights FEMA's BRIC and Flood Mitigation Assistance (FMA) program; U.S. Department of Defense Office of Local Defense Community Cooperation (OLDCC); and the National Interagency Fire Center (NIFC) Predictive Services.

FEMA BRIC Program[58] Section 1234 of the 2018 Disaster Recovery Relief Act allowed FEMA to set aside 6% of estimated disaster expenses for each major disaster to fund

[55] https://www.rand.org/pubs/research_reports/RRA1440-5.html
[56] State and Federal Relationships for Hazard Mitigation Assistance presentation to WRP by Lucrecia Vargas, State Hazard Mitigation Officer and Arizona Department of Emergency Management and Military Affairs, Alison Kearns, Risk Analysis Branch Chief, FEMA Region 9, June 2021.
[57] https://www.fema.gov/grants/mitigation
[58] https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities

a new pre-disaster mitigation program (PDM). Annually, BRIC allocates funding for states and territories; a tribal set-aside; and a national mitigation project competition. There is a 75% (FEMA) – 25% (non-federal) cost share. BRIC priorities include encouraging public infrastructure projects; increasing projects that mitigate risk to one or more lifelines; promoting projects that incorporate nature-based solutions; enhancing climate resilience and adaptation; and incentivizing adoption and enforcement of modern building codes. BRIC project eligibility criteria: reduce/eliminate risk and damage from future natural hazards; be cost-effective; align with Hazard Mitigation Plan; meet latest two consensus codes (i.e., 2015 or 2018 International Building Code); and meet all environmental and historic preservation requirements.

BRIC is envisioned to reduce risk to Community Lifelines via pre-disaster mitigation. Lifelines provide services to enable critical business and government functions to continue. Disruption of lifelines leads to cascading impacts on the public.

For the inaugural FY20 BRIC Cycle, $500 Million was available ($3.6 Billion Requested). California was the only WRP state to have a FY20 BRIC competition project selected. Two of the California selected projects address flood control issues (Walnut Creek/Grayson Creek Levee Project - $2.46 Million and Copeland Creek Detention Basin - $6 Million) and one project addresses wildfire management (Nature-Based Mitigation for Megafires – $36.98 Million).[59]

In FY21, BRIC funding availability was increased to $1 Billion (i.e., $56,000,000 for State/Territory Allocation, $25,000,000 Tribal Set-Aside, and $919,000,000 for the National Competition). For this cycle, $4.16 Billion in federal funding was requested. Of the 788 subapplications, FEMA selected 316 for further review as part of the state and tribal set-aside.[60] Additionally, FEMA selected 53 large competitive projects to be funded until the total amount available has been reached. BRIC is prioritizing assistance that benefits disadvantaged communities under the Justice40 initiative.[61] In FY22, BRIC funding increased again to $2.295 billion, which is more than double what it was last year.[62]

[59] https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/after-apply/fy-2020-summary-competitive-projects-selections

[60] https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/after-apply/fy-2021-subapplication-status#round-one

[61] See https://www.whitehouse.gov/omb/briefing-room/2021/07/20/the-path-to-achieving-justice40/ and https://www.fema.gov/about/strategic-plan/goal-1/objective-1-3

[62] https://www.fema.gov/sites/default/files/documents/fema_fy22-bric-nofo-fact-sheet_08122022.pdf

FEMA Flood Mitigation Assistance Funding[63] The Flood Mitigation Assistance (FMA) program makes federal funds available to states, territories, federally recognized tribes, and local communities to reduce or eliminate the risk of repetitive flood damage to structures insured under the National Flood Insurance Program (NFIP). In FY21, available funding is $160,000,000. FEMA received 194 subapplications, of which, 22 have been chosen for further review.[64] In FY22, FMA also received a very substantial increase to $800 million in eligible funding.[65]

Defense Critical Infrastructure Program (DCIP)[66,67] is a ten-year pilot competitive grant program, administered by the Office of Local Defense Community Cooperation (OLDCC). It is "designed to address deficiencies in community infrastructure, supportive of a military installation to enhance military value, installation resilience, and military family quality of life, (for example, roads, bridges, utilities, and medical facilities.) In its first year (FY2020) it funded sixteen projects totaling $50 million; its FY 2021 budget was increased to $60 million. State and local governments and rural electric cooperatives are eligible. The OLDCC also has a planning grant Military Installation Resilience Program "designed to help communities make informed decisions by enabling states and communities to partner with local commands to respond to, address, and mitigate activities that are either impairing or likely to impair the use of the installation."[68]

National Interagency Fire Center's (NIFC) Predictive Services mission is to provide decision support (briefings and products), with the goal of providing actionable intelligence and is focused on the strategic (large-scale, long-term outlook) perspective. The primary focus is on fire activity; resource tracking and intelligence; fire weather and climate; and fuels and fire danger. This information, along with the U.S. Drought Monitor, assists fire planning efforts.[69]

Partnership Opportunities to Improve Disaster Mitigation

Areas of commonality/shared stewardship in which WRP Partners can improve pre- and post-disaster mitigation in the WRP Region through action and collaboration were identified. Given the significant increase in resilience funding provided through the

[63] https://www.fema.gov/grants/mitigation/floods
[64] Ibid.
[65] https://www.fema.gov/sites/default/files/documents/fema_fy22-fma-nofo-fact-sheet_092022.pdf
[66] https://oldcc.gov/defense-community-infrastructure-program-dcip
[67] https://oldcc.gov/defense-community-infrastructure-program-dcip and https://pubs.naruc.org/pub.cfm?id=2B94EB6B-1866-DAAC-99FB-290897194F07 pp. 36-39
[68] https://oldcc.gov/community-military-installation-resilience-nomination-process
[69] 2021 Fall Fire Outlook: Predictive Services presentation by Jim Wallmann, Meteorologist, USFS, National Interagency Fire Center, October 2021.

Infrastructure Investment and Jobs Act, there are opportunities to identify future tools and policy changes to improve issues faster (e.g., streamline flood mitigation). It is crucial that state, federal, and tribal entities work together to best prepare for times of disaster. Each governing body has its own unique set of criteria, timelines, and policy. Cultural traditions need to be discussed and appropriately accounted for (e.g., preservation of sacred sites). In disaster response, people may try one or two new things, but will usually do what they have always done. Increased awareness of the funding, resources, partners, or technical assistance programs helps, recognizing that none of these programs can mitigate all risk. Many of these are implemented at a local level.

Much remains to be done to address disaster preparedness, recovery, and resilience. Areas identified for potential focus: funding; aging infrastructure; fire disaster mitigation; fire post-disaster mitigation; cybersecurity; pandemic issues; and geo-spatial data sharing.

Funding. Addressing disaster mitigation issues (planning, feasibility studies, construction, etc.) requires resources. Specific issues identified include:

- Twenty federal agencies[70] fund ninety programs to address disasters[71] and it can be difficult to navigate the many disaster mitigation programs.
    - Recommend: Information to compare programs and collectively address resources across multiple landscapes in order to use the various funding sources, and cross-share with or leverage other programs (e.g., state, FEMA, etc.).
- The FEMA BRIC program is helpful; however, during the first round of funding only a handful of states received significant funding. Projects must be prioritized and ranked, but there appear opportunities for more equitable funding across states to encourage future applicants, especially for western states, which did not receive much funding in the first round.
- Economic justification can be difficult for many funding programs for rural areas, as it is difficult to quantify a reduction in economic damages, especially with Army Corps and flood prevention projects. Many rural areas cannot economically justify a large levy project, or ecosystem restoration project, because cost share is unavailable, or they do not have the staff to manage such a project or the tax base to pay for it on their own.
- Sometimes the law disincentivizes proper mitigation. Having adequate insurance causes the insured to not meet the threshold to receive disaster mitigation dollars, ultimately costing them more money.
- WRP Partners involved in disaster mitigation noted that as more responsibility is placed on state, local, and tribal entities, more capacity is needed to build resiliency and adapt to and alleviate future risk.

[70] https://www.fema.gov/pdf/recoveryframework/ndrf.pdf

- Recommend: Federal agencies look for additional ways to partner with state, local, and tribal entities to leverage efforts and better ensure areas are prepared for, and can respond to, disasters.

Aging infrastructure. Historically, issues of aging infrastructure, either for lack of funding or authority, has caused challenges in the WRP Region. The 2021 Infrastructure Investment and Jobs Act provides over $1 Billion to strengthen the nation's resilience. This substantial funding could assist in retrofitting or rebuilding areas that are not secure. The Safeguarding Tomorrow Through Ongoing Risk Mitigation (STORM) Act[72] authorizes FEMA grants to states or tribes to reduce risks from disasters and natural hazards by financing water, wastewater, infrastructure, disaster recovery, community, and small business development projects. The Infrastructure Act provides $500 million over five years to the STORM Act, which offers successful applicants low interest rate loans and the funds will be replenished, thereby allowing for in perpetuity funding to keep spurring mitigation options.[73]

The Disaster Mitigation team identified specific focus areas for potential aging infrastructure:

- Tribal infrastructure needs. Tribes in remote areas with minimal development and communication lines need additional evacuation routes, especially because some are in earthquake zones or high-risk fire areas.
  - Recommend: Tribes are encouraged to partner with nearby counties to ensure they are included in any future disaster planning.
- Seismic Zone infrastructure needs. Water lines, gas lines and other types of underground infrastructure frequently were not made from the best materials for a seismic zone. Many buildings in the western earthquake zones were built with unreinforced masonry and have not yet been required to meet a higher building standard.
  - Recommend: Work with FEMA and other federal partners on issues of drought and drought resilience. Water security is a significant issue in the WRP Region and includes water supply and resource concern. Identify what is real mitigation, what is fundable/non-fundable, actions across the federal landscape, and different available programs.
  - Recommend: Buildings in earthquake zones should be evaluated to determine whether retrofits or repairs should be conducted. Building codes for construction in such zones should include guidance for seismic activities.
- Best practices in this area: Wasatch Range Earthquake Response Plan, issued by FEMA in October 2021, focuses on rapid lifesaving support in the event of a catastrophic, Magnitude 7.0 earthquake along the Wasatch Fault in Utah. The Plan

[72] Public Law No: 116-284 (2021)

[73] FEMA Mitigation Planning Updates to WRP by Mr. Rob Pressly and Mr. Parker Crowe, Community Planners, FEMA R8, July 2022.

was developed in cooperation with the Utah Division of Emergency Management, with additional input from state, local, private, and other federal agency partners, and provides guidance on federal readiness, response, and initial recovery actions. About 80% of Utah's population lives along the fault, and the area is hundreds of miles from the nearest metropolitan area from which support could be received. Because many utility lines traverse the seismic zone, a catastrophic event will impact other parts of the country.

Note: Energy issues with aging infrastructure are covered in the Resilient Energy Infrastructure chapter, and wastewater and water supply programs issues are addressed in the Water Security Chapter.

Fire Disaster Mitigation. There is a need to enhance long term resilience, such as using fire-wise construction and addressing invasive species. It is not so much knowing how to prepare for things, but how to implement those things that should be done ahead of time. Considerations include:

- Land Management. In many WRP states, the biggest land manager is the federal government. When there are wildfires, many start on federal lands, making federal mitigation efforts important. These efforts impact downstream communities with debris flow or post-fire flooding, etc.
    - Recommend:
        - Consideration should be given to working closely among federal, state, local, and tribal authorities on fires that start on federal lands and on mitigation post-fire.
        - FEMA's U.S. Fire Administration report "Wildland Urban Interface: A Look at Issues and Resolutions" highlights many of the challenges.[74]
        - Participating in the Wildland Fire Mitigation and Management Commission, which recommends prevention, management, suppression (including aerial firefighting equipment) and recovery from wildfires.[75]
- Prescribed fires that have an aerial ignition component need a sterile environment.
    - Recommend: Allow the use of a 91.137(a)(1) TFR that would be defined with small lateral and low vertical dimensions, and short duration.
- Homes that use fire-wise construction are extremely resilient. In some communities where 70-80% of structures were destroyed, remaining structures were built with defensible space and fire-wise construction methods.
    - Recommend:
        - Rebuilding using fire-wise construction methodology and defensible space to build resiliency.

[74] https://www.usfa.fema.gov/stories/wui-report/index.html

[75] https://www.usda.gov/topics/disaster-resource-center/wildland-fire/commission; and https://www.doi.gov/pressreleases/biden-harris-wildland-fire-mitigation-and-management-commission-charts-path-forward

        - Pre-planning in areas of high-risk fire to address control and deforestation. Consider use of controlled burns and traditional fire burns. Allocate resources proactively, pre-disaster, treating non-native grasses that are making desert eco-systems susceptible to fire. It is no different than treating communities in the wildland/urban interface and avoids fighting uncharacteristic fires in those eco-systems, then needing to install erosion-control features addressing flooding.
        - Use safe fire-suppression chemicals that do not impact watersheds and drinking water.
        - Use mass timber as a construction material to help create market incentives to get the "fuel" off landscapes and decrease the risk of catastrophic wildfire, and pull low-diameter, typically "low-value" timber (by conventional standards) off the forests. Blast testing has demonstrated the capability of using mass timber for base military housing and other military uses.[76,77,78]
- Best practices in this area:
    - Arizona large buffelgrass projects for fuel reduction. Buffelgrass is a non-native species introduced beginning in the 1940s for cattle forage and erosion control. Among other things, it increases the frequency of wildfires. The National Park Service has implemented a successful project to control buffelgrass to reduce this wildfire fuel.[79]
    - Colorado Post-fire Playbook, which addresses multiple agencies: who does what, ways to prepare pre-disaster, and how to request federal assistance. The Playbook includes information on types of land management (federal, state, Tribal etc.) and an appendix on "key sources of funding."
    - Cross-laminated timber to address landscape and wildfire issues with a superior construction product. Strength in blast testing with DoD and its potential widespread use in DoD contracting as a material of choice to incentivize industry to pull low-diameter, typically "low-value" (by conventional standards) timber off the AZ and NM forests. Blast testing was conducted to support the expansion of mass timber into base military housing and other military uses and help create market incentives to get the "fuel" off landscapes and decrease the risk of catastrophic wildfire.[80]

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[76] https://www.woodworks.org/publications-media/blast-testing-research/
[77] https://www.nordic.ca/en/projects/structures/hotel-candlewood-suites
[78] https://www.bdcnetwork.com/hotel-made-clt-opens-fort-jackson-sc
[79] https://www.nps.gov/articles/buffelgrass-management-saguaro.htm; see also https://www.frontiersin.org/articles/10.3389/fevo.2021.655561/full
[80] Information: https://www.woodworks.org/publications-media/blast-testing-research/; Hotel examples: https://www.nordic.ca/en/projects/structures/hotel-candlewood-suites; and https://www.bdcnetwork.com/hotel-made-clt-opens-fort-jackson-sc

Fire post-disaster mitigation. Within the WRP Region, areas that were not treated properly after a fire have caused additional disasters. It is important to proactively address such areas to reduce flooding potential. Mechanisms to identify post-fire hazards and risk have been in place for years. Army Corps of Engineers mitigates floods through the civil works program, which takes many years to go from concept to constructed project that reduces the risk of flooding in the designed area. Post-fire debris-flow inundation modeling and mapping is lacking. Best available guidance on potential inundation is FEMA Flood Insurance Rate Maps, but these do not account for fundamental differences in flow dynamics between clear water floods and debris flows, blockage, or small drainages. The traditional approach based on clear water movement may not adequately delineate post-wildfire flood events where debris-flows could occur.

- Recommend:
  - Agencies review the USACE debris flow model for debris-flow mapping and accounting for non-Newtonian debris-flows. HMS is an effective tool to estimate sediment yield and debris basin sizing and design. Implementing innovative debris-flow models improves emergency managers' planning and response (possible blockages, flood height, and access points). This approach can be used for channel optimization to reduce the risk of damage resulting from debris-flow and potential loss of life.[81]
  - Address evacuation routes after fires and proper mitigation.
  - Work with U.S. Army Corps of Engineers to determine if any areas are at risk of flooding and, if so, begin the process to secure funding.
- Best Practices in this area:
  - Morongo Band of Mission Indians emergency response coordination. They have four to five fires a year. In 2020, the Apple Fire in California burned nearly 30,000 acres including a portion of the tribe's reservation and entire ridges above them. The Tribe was credited for their helpful fire response. FEMA FMAG was authorized. After the fire, the Tribe worked with the U.S. Forest Service Burned Area Emergency Response (BAER) Team to mitigate debris flow in the wildland and forestry areas and minimize future fire risk.
  - Utah Division of Emergency Management (DEM) partnered with the National Weather Service to purchase eight weather stations (with intentions to add two more) that have been placed on wildland fire burn scars when there has been a concern for post-fire debris flows or impacts on communities downstream or below the mountainside. Each weather station reports hourly, or more frequently if it receives a particular level of precipitation to the National Weather Service (NWS). Forecasters are advised of these

[81] An Innovative Approach to Quantify Risk Associated with Post-Fire Debris Flow in Watersheds by Utilizing USACE HEC-RAS 6.0 BETA presentation by Morteza S. Majd, Climate Action Team, ODASD Environment and Energy Resilience, Water Resilience and Climate Specialist, August 2021.

precipitation events and flash flood warnings are then sent to the communities affected, providing additional lead time for warnings of potential mudslides on the post-fire landscape.
    - NRCS and BIA purchase Scan Stations, soil moisture scans, working with Tribes that request them. NRCS has an Emergency Watershed Protection Program (EWPP)[82] that helps private and Tribal lands recover from natural disasters like flood, fire, debris removal and restoration to the state the land was in pre-disaster. EWPP provides emergency repair and restoration recovery assistance when sudden watershed impairments create an imminent threat to life or property.[83]

Cybersecurity and mitigation and resilience against cyber-attacks. America remains at risk from a variety of threats: acts of terrorism; cyber-attacks; extreme weather; pandemics; and accidents/technical failures. It is critical that teams responding to and addressing disaster mitigation issues have safe and secure communications. Resilience may be different in different regions and for different types of hazards; therefore, planning and solutions must be different as well.

The Infrastructure Investment and Jobs Act[84] apportioned $1 billion over 5 years to fund grants to States and tribes to "address cybersecurity risks and cybersecurity threats to information systems owned or operated by, or on behalf of, State, local, or Tribal governments." These funds are administered under FEMA.[85]

- Recommend:
    - Agencies review their cybersecurity practices and contact U.S. Department of Homeland Security for assistance. If any cyber gaps exist, apply for grants or seek technical assistance. Be proactive.
    - Practice a Business Continuity Plan, ensure that the ITT team is engaged to provide instant response, and practice incident recovery often. Many organizations have a Business Continuity Plan, but the framework or emphasis of their organization has shifted since its adoption, hindering their recovery from a cyber incident. Plans should be made up-to-date and exercised often, especially at a senior level, not just technical or middle management level.

[82] https://www.nrcs.usda.gov/wps/portal/nrcs/main/national/programs/landscape/ewpp/ and https://www.bing.com/videos/search?q=nrcs+ewp&qpvt=nrcs+ewp&FORM=VDRE
[83] NRCS Watershed Programs presentation by Kevin L. Farmer, PE Watershed Programs Branch Chief, NRCS, December 2020.
[84] Public Law No: 117-58 (2021), Sec. 70611 and 70612.
[85] https://www.dhs.gov/news/2022/09/16/biden-harris-administration-announces-1-billion-funding-first-ever-state-and-local

- Use multiple factor authentication and strong passwords to protect Remote Desktop Protocol (RDP) credentials, and ensuring anti-virus, spam filters, and firewalls are up to date, properly configured, and secure.
- Contact your local Fusion Center to understand who the players are, both physical and cyber, and the type of training opportunities they provide that the organization can leverage to provide further training for employees. Fusion Centers have historically provided state, local, tribal, and territorial partners access to the FBI's InfraGard, a partnership between the FBI and the private sector with various critical infrastructure sectors. The InfraGard POC for the local area is usually an FBI agent, making this an opportunity to meet entities outside of the organization in their training environment and to be exposed to their best practices. It can open a community of individuals, agencies, and other entities outside the government that are willing to assist

- Best practice in this area:
  - Cybersecurity and Infrastructure Security Agency (CISA), U.S. Department of Homeland Security efforts. CISA, considered the Nation's Risk Advisor, endeavors to ensure the security and resilience of infrastructure from all-hazards. CISA works through partnerships with industries, states, local, tribal, and territorial governments to make sure they have the resources necessary to prepare, mitigate, and, if necessary, recover. CISA works with local governments and industries to protect critical infrastructure. Regional offices align directly with the FEMA regions so outreach and work can happen in the same space as the stakeholders. CISA has Cybersecurity Advisors (CSA) and Physical Security Advisors (PSA) located throughout the states, poised to support government and industry.[86] Sharing information helps better understand how a specific attack is part of a larger campaign; being able to pass details of tactics, techniques, and procedures helps CISA understand how the hack happened, which can assist in mitigation and providing a plan forward for similar organizations. This builds better resiliency based upon the lessons learned from other incidents.[87]

Pandemic Issues. COVID has implications for future planning. COVID is not a traditional threat, but it has provided an opportunity for this group to solicit and share for discussion the lessons learned across the WRP states on COVID response to be ready for future pandemics.

- Recommend: Sharing of After-Action Reviews and Lessons Learned to serve as a useful tool for WRP partners.

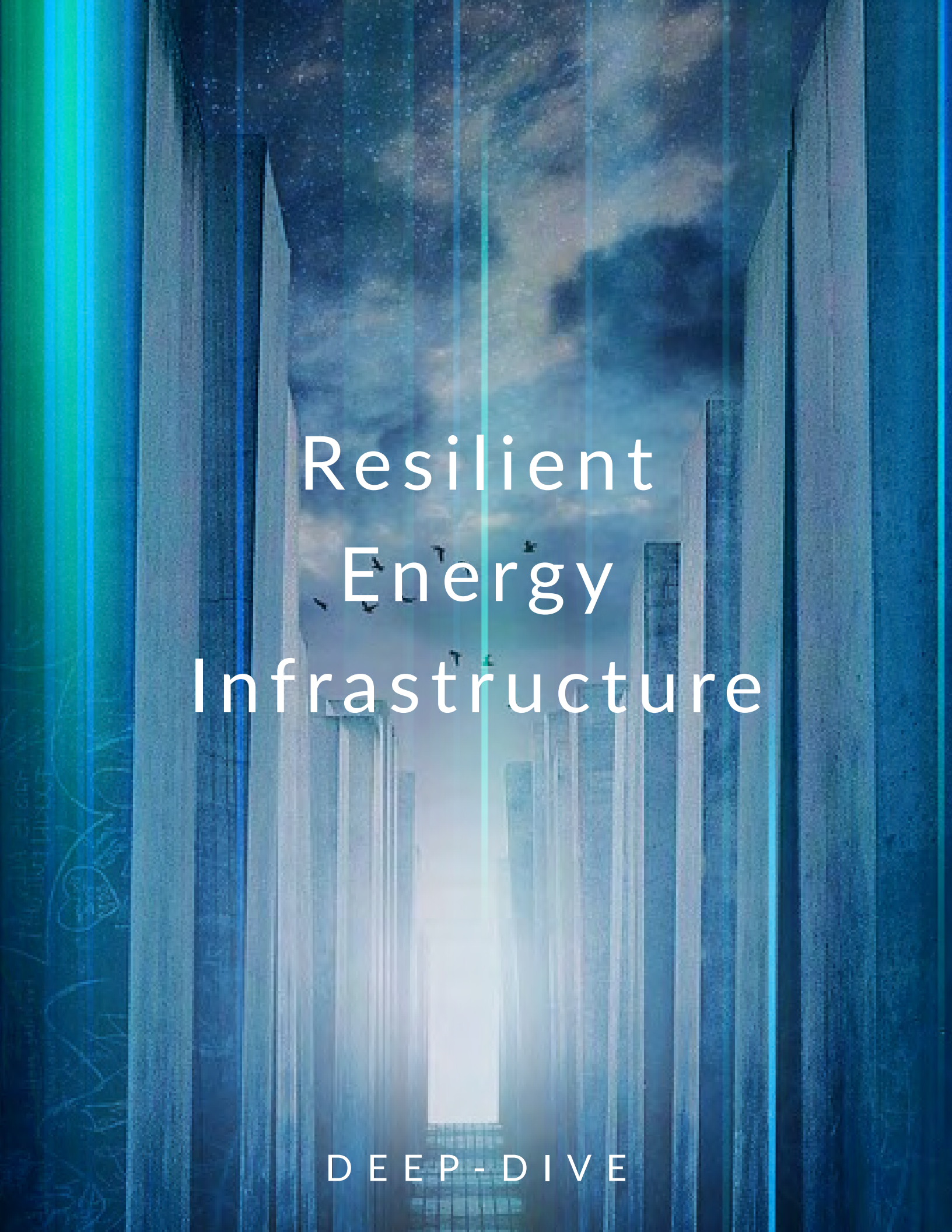
[86] For more information about CISA personnel in each state, see https://www.cisa.gov/cisa-regional-offices
[87] Cybersecurity, Mitigation and Resilience Against Cyber-attacks presentation by Joseph Oregón, (A) Chief Cybersecurity Advisor Region IX: CA, NV, AZ, HI, GU, CNMI, Cybersecurity and Infrastructure Security Agency (CISA), U.S. Department of Homeland Security, February 2021.

Geo-spatial data sharing is an effective tool to assist with disaster preparedness, response, recovery, and mitigation efforts. There are challenges with setting up data sharing agreements that must be in place for state and federal sharing, DHS, etc. Data integration, especially when automated, improves disaster management.

- Recommend: Setting up data sharing agreements in place with appropriate state, federal, tribal, and local entities so there will not be a last-minute scramble when needed.
- Best practice:
    - NASA Disasters Mapping Portal[88] is a hub of geospatially enabled NASA disaster products. The uniform format allows easy ingestion. All data is free and openly available with no login requirements and have REST and WMS endpoints. There are two types of products: event-based products (non-routine) and near real-time products (routine). It includes featured story maps (tells the disaster's story), near real-time dashboards, hazard type tiles and recent events.[89]

[88] https://maps.disasters.nasa.gov

[89] NASA Disasters Program Response to the Western US Fires and Mapping Portal Demo presentation by Don Sullivan, NASA Ames Research Center, August 2021.



Resilient Energy Infrastructure

DEEP-DIVE

Resilient Energy Infrastructure

Overview

Major disruptions to energy infrastructure pose significant threats to the Nation. As a basic requirement for national security[90] and economic vitality, energy infrastructure must be protected from disruptions and, if the hazard is unavoidable, rebound quickly and safely. WRP Partners recognize the need for strengthening resiliency and reliability of energy infrastructure across the west. For purposes of this report, "Resilient Energy Infrastructure" means an adequate and stable energy system throughout the WRP Region capable of performing during and rebounding from disruptions (e.g., natural threats, deliberate adversarial actions, terrorism, cyber-attacks, accidents, etc.).

The WRP Region contains diverse energy generation resources and a significant transmission network for its delivery. The region benefits from climates conducive to energy production, including wind, solar, nuclear, and geothermal, hydroelectric resources, and oil and gas. Energy planning in the West includes ensuring electric grid resilience, sharing of renewable energy resources across large areas, and transmission systems to reduce costs, achieve public policy goals, and maintain system reliability. Many issues influence energy planning: resource adequacy, cybersecurity risks, integration of renewable energy, energy storage, climate, and the impact of extreme weather events. Federal, state, and tribal entities must work cooperatively across jurisdictional lines to ensure that the planning process leads to ensuring an adequate and stable energy supply throughout the WRP Region that is sustainable in times of disaster, while addressing intrastate and interstate implications.

The Resilient Energy Infrastructure Deep-Dive Team held calls and webinars with subject matter experts to explore this critical topic more fully. The results are analyzed in this section and presented in three main parts:

- **Introduction** on the importance of energy security preparedness and response planning and provides a high-level overview of various types of resilient energy infrastructure issues WRP Partners have encountered.

[90] PPD-21 (Presidential Policy Directive -- Critical Infrastructure Security and Resilience), notes, the term *"resilience" means the ability to prepare for and adapt to changing conditions and withstand and recover rapidly from disruptions. Resilience includes the ability to withstand and recover from deliberate attacks, accidents, or naturally occurring threats or incidents.*

- **Resources** available to assist with resilient energy infrastructure issues
- **Mitigation strategies, gaps, best practices, and recommendations** to improve the resiliency of energy infrastructure.

Energy Security Preparedness and Response Planning

This section highlights the importance of energy security preparedness, resiliency, and response planning. A summary of current challenges is provided.

Energy security and resiliency: To ensure power and fuel availability 24-7-365 and the ability to rebound quickly from outages, there is a need to be proactive. The prevailing method of maintaining resilience has been reactive by looking back on disruptive events to determine what should have been done. While learning from the past is still valuable, this method no longer is sufficient given the increase in resilience challenges. Issues in the energy generation or transmission sectors can have widespread consequences and implications across all critical infrastructure sectors.

Collaboration and planning can increase energy resiliency and support hazard mitigation investments that can lessen the impact of future events. Hazard Mitigation and the importance of addressing issues proactively is detailed in the Disaster Mitigation Chapter. However, it is important to note that there are many federal funding opportunities, such as FEMA's Building Resilient Infrastructure in Communities (BRIC),[91] that allow for energy resilience projects. Some examples of projects include transmission line hardening, microgrid design and feasibility, and utility infrastructure upgrades. This is detailed in Guidebook: Federal Funding Opportunities for Pre- and Post-Disaster Resilience.[92] There are no defined criteria for resilience requirements for new infrastructure (although some agency grants prescribe criteria that must be met), which makes planning a challenge, but having the conversation is important. Another helpful reference is the BLM WestWide Energy Corridor Guidebook, which includes chapters on interagency operating procedures, land use planning and infrastructure design and construction (BMPs).[93]

The various parts of the energy system, including electricity, oil and natural gas transmission, distribution, generation, and storage for residential, commercial, industrial, and agricultural uses, are all interconnected. These interdependencies lead to vulnerability but, also a strength. The "resilience cycle" consists of preparing for outages, responding to energy emergencies, recovery and system restoration, and long-term resilience investments and planning. There are many operational models and analyses for infrastructure. Larger

[91] https://www.fema.gov/grants/mitigation/building-resilient-infrastructure-communities/about
[92] https://pubs.naruc.org/pub/2B94EB6B-1866-DAAC-99FB-290897194F07
[93] https://www.blm.gov/sites/blm.gov/files/docs/2020-12/BLM_WestWideEnergyCorridor_Guidebook.pdf and https://www.corridoreis.anl.gov/documents/

models require more partners to develop more creative strategies. Transmission path redundancy and grid inter-dependencies are also important and typically built into the network and planning operations. Pre-identification and hardening efforts all require planning. Real-time communication is important during outages. A community of public and private sector stakeholders, even with competing viewpoints, perspectives, interests and perceptions of cost and risk, is necessary. It offers an opportunity to build community connectivity, a collective strength between public and private sector. For example, identifying gaps, and building strategies to close those gaps, requires the right people and institutions across multiple sectors setting initial milestones. During an energy emergency, state agencies such as State Energy Offices and Public Utility Commissions provide energy expertise to emergency agencies. They can facilitate required waivers and coordinate restoration efforts with the private sector, which owns and operates most energy infrastructure.

Current Challenges. Threats to energy security include cyberattacks, aging infrastructure, extreme natural events such as wildfire, drought, and ice storms, and responding to the changing energy resources mix. For example, hydropower has been a reliable energy source, but it is currently vulnerable given drought conditions.[94] Overall, the task is to maintain reliable energy service and avoid cascading outages or other significant system failure. Maintaining electricity availability within acceptable limits throughout the system is a constant challenge for a grid that was designed and built for steady and predictable base load generators (coal, nuclear, gas).

Capital investment and operational costs will also always be a concern: consumers desire maximum risk reduction for any given cost. Determining effectiveness in these risk management measures and implementing those that provide the greatest risk reduction per dollar invested contributes to resilience. Numerous agencies have similar and complementary programs and expertise relevant to the WRP.

Insufficient cybersecurity and cyber-threats can have a profound impact on resilient energy operations. The number, complexity and variety of cyber-attacks are ever increasing and can have a profound impact on energy operations. Energy organizations face increased cyber threats from sophisticated threat actors (cybercriminals, insiders, hactivists, and nation-state actors). Utilities may operate over a vast geographic footprint, making them vulnerable to cyber-attacks. One remote section may be attacked and compromise the remaining system because it is integrated. Cyberattacks on operational technology (OT) or Industrial Control Systems (ICS) could cause loss of grid control, loss of power, equipment failure, electrical blackouts, or damage to the grid. Risk assessments help better understand the components (i.e., generation, transmission, and distribution) that are vulnerable to cyber security attacks and how that might impact energy infrastructure. Vulnerabilities are primarily related to an

[94] https://www.drought.gov/sectors/energy

energy organizations' Information Technology (IT) systems, their Operational Technology (OT) systems including Industrial Controls Systems (ICS), and their supply chain. This becomes more acute as more devices are connected to an Internet of Things (IoT) platform.

Threat actors are increasingly conducting cyber-attacks and becoming more sophisticated and harder to find. Recent cyber incidents, like the cyberattack on Colonial Pipeline's IT system (the largest publicly disclosed cyber-attack against critical infrastructure in the United States thus far), demonstrate the power of malicious actors to shut down our nation's critical energy infrastructure and disrupt energy supplies.

DoD is working with states to establish legislation that promotes energy production or development conducive to military operations. DoD has growing concerns with foreign investment and products near installations and ranges that could allow foreign actors to collect intelligence.

Aging infrastructure. Owners of energy infrastructure need to consider upgrading infrastructure and perform necessary regular maintenance to make it less susceptible to the various other risks mentioned elsewhere in this report. Upgrading equipment and hardening the transmission and distribution systems from high wildfire risk is critical. Converting overhead facilities to underground might be a viable means of increasing resilience if economically feasible. However, addressing aging infrastructure can be more challenging with increasing costs and supply chain issues.

Extreme Natural Events – Extreme natural events impact the resilience of energy infrastructure. Large and catastrophic wildfires threaten transmission infrastructure, interrupting service to distribution networks that extends to customers serving urban areas, encouraging cities to adopt land use planning strategies to mitigate the risk.[95, 96] According to DoE, about 10 percent of wildfires are caused by electric infrastructure or equipment failure, and there is an increasing risk of power shutoffs because of the threat of wildfires to the energy infrastructure.[97] Western Electricity Coordinating Council (WECC) creates various reliability assessments to understand major reliability risks in the future. Based on their extreme natural events analysis, they recommend planning and operating entities and transmission planners consider extreme events as part of planning studies, in their analysis of reserves and ramping requirements, in-depth studies of transmission congestion,

[95] https://energysafety.ca.gov/wp-content/uploads/docs/strategic-roadmap/final_report_wildfiremitigationstrategy_wsd.pdf
[96] https://electra.cigre.org/323-august-2022/technology-e2e/enhancing-the-infrastructure-and-operational-resilience-of-power-systems-against-wildfires.html
[97] https://www.energy.gov/oe/wildfire-mitigation-webinar-series

monitoring system voltage, and frequency performance.[98] The Southwest's current drought impacts energy production as production requires water, and water extraction, conveyance and delivery require energy. This interdependence means that availability and predictability of water resources affect energy systems.[99] There is an interplay between drought and how the power grid is operated, especially with the limitations it creates for hydroelectric resources. Reduced volume in reservoirs during drought can reduce energy generation by hydroelectric dams as water is needed to run through the turbines. The May EIA outlook on "Drought Effects on California Electricity Generation and Western Power Markets"[100] estimated the effect of California's drought on the state and the western power market, predicting a reduction in hydroelectric generation altering the generation mix in California and increased wholesale power prices in the West, leading to higher carbon emissions. For further details on water security please see that section in this report.

Changing energy resources mix. Renewable resources continue to provide greater amounts of generation each year. In 2020, renewables produced more electricity than either nuclear or coal and in the future the U.S. will see a steady increase in wind and solar generation.[101] Changes include approval by Federal Energy Regulatory Commission (FERC) in August 2022 to approve the nation's largest dam-removal project, removing the Lower Klamath Project's four hydroelectric dams and the 686,000 megawatt-hours of hydroelectricity that they generate.[102] Additionally, FERC and DOE contemplate rulemaking to expedite approval of interconnection processes for renewables.[103] The U.S. added 17 Gigawatts (GW) of wind capacity and 15.5 GW solar capacity in 2021 and is expected to add another 7.5 GW of wind and 21 GW of solar in 2022.[104] Results of the Western Flexibility Assessment[105] include that, without major changes to system flexibility and only small curtailments, the West can achieve near-term policy targets, but longer-term targets are more difficult to achieve. Transmission will likely need to be expanded to provide capacity and flexibility for long term

[98] Extreme Natural Events presentation by Bhavana Katyal Sr. Engineer, WECC; Enoch Davies, Manager of the System Stability Planning Group, WECC; and Byron Woertz, Manager, System Adequacy Planning, WECC, June 2022 to WRP.

[99] https://www.drought.gov/sectors/energy/interactive-map

[100] https://www.eia.gov/outlooks/steo/special/supplements/2022/2022_sp_02.pdf

[101] https://www.eia.gov/todayinenergy/detail.php?id=48896

[102] https://klamathrenewal.org/wp-content/uploads/2022/08/22_0826-3006_P-14803-Final-EIS-Lower-Klamath-Hydrpelectric-Project.pdf

[103] https://www.reutersevents.com/renewables/solar-pv/us-grid-data-needed-faster-solar-wind-build?utm_campaign=NEP%20PV%2031AUG22%20Newsletter&utm_medium=email&utm_source=Eloqua

[104] U.S. Energy Information Administration (EIA) State of Battery Storage presentation by Glenn McGrath, Team Lead, EIA, November 2020 – and update on statistics since the briefing.

[105] https://westernenergyboard.org/wp-content/uploads/2019/12/12-10-19-ES-WIEB-Western-Flexibility-Assessment-Final-Report.pdf

goals.[106] Participation in the Western Energy Imbalance Market[107] continues to expand; membership currently includes 15 members with 7 more expected over the next year. [108]

Operating a grid with increasing levels of variable energy resources (VER) usually requires integrated energy storage. Multiple days of low solar production hinder the ability of battery storage to recharge, and most battery storage systems are designed to provide energy for 4 to 8 hours. Storage remains a comparatively small part of the capacity portfolio. There are 1,135,000 Megawatt (MW) of utility scale generating capacity in the U.S.; batteries account for 3,750 MW (expected to grow to over 17,180 MW by 2024). California has the most battery storage of any state with 3,025 MW planned as of the end of 2021. The significant growth in batteries has driven costs down and created arbitrage opportunities. Pumped hydro storage accounts for 22,800 MW in the country and about 4,000 MW in California. Other storage technologies such as flywheels and compressed air exist but not on a large scale. Batteries are used as system level support rather than to back up or manage load. Batteries are increasingly being paired with conventional generating technologies, predominantly renewables. Utility-scale battery storage costs decreased nearly 70% between 2015-2018. New batteries have longer duration with more energy capacity, providing greater ability to support more sustained output. Batteries will get larger; currently the average battery capacity is roughly 12.5 MW, but the average capacity of planned commercial units is 58 MW. Larger batteries are being installed on both coasts. Battery durations are also increasing. The median duration has gone up, from one hour to almost 2 hours, in a two-year period. Batteries need to have about four hours' duration to act as a capacity resource. The longest duration known is 8 hours.[109]

Issues of fuel planning also emerged. For example, there was a jet fuel shortage issue in northern Nevada given several airlines did not anticipate the summer 2021 resurgence in travel; this was further exacerbated by pressures on fuel delivery with wildfires. Most of the natural gas resources have a great deal of demand in the summer for air conditioning.

Highlight of Resources to Address Resilient Energy Infrastructure Issues

The following resources were identified for consideration to assist WRP Partners with resilient energy infrastructure issues: collaborative efforts with states to address electricity

[106] Western Flexibility Assessment and Implications of Regional Resource Adequacy Program presentation by Thomas Carr, Program Manager for Electric System Planning and Grid Transformation, Western Interstate Energy Board (WIEB) part of the Energy Planning in the West Webinar, January 2021.
[107] https://www.westerneim.com/Pages/About/default.aspx
[108] Energy Planning in the West presentation by Phil Pettingill, P.E., Director, Regional Integration, California Independent System Operator Corporation (ISO), part of the Energy Planning in the West Webinar, January 2021.
[109] U.S. Energy Information Administration (EIA) State of Battery Storage presentation by Glenn McGrath, Team Lead, EIA, November 2020.

market opportunities; fuel market coordination; Defense Critical Electric Infrastructure; Black Start System Restoration; and tools to share information through a common platform. Details below.

Examples of collaborative efforts with states to address electricity market opportunities:

- The Western Interconnect Regional Electricity Dialogue (WIRED) Initiative[110] looks at issues around transmission, resource adequacy, commonality of Green House Gas (GHG) accounting, etc., to foster a conversation at the Governors' level in the West around future markets, the grid, and how to work together.
- The National Association of State Energy Officials (NASEO) and the National Association of Regulatory Utility Commissioners (NARUC) Cybersecurity Advisory Team for State Solar (CATSS) intends to engage, educate, and share actionable solar cybersecurity strategies and tools for State Energy Officials and Public Utility Commissioners; create collaborative frameworks and model approaches that can be easily replicated by other states; identify and enable pathways for state decision-makers to enhance the security of behind-the-meter solar systems; and facilitate the creation of stronger intra- and interstate relationships, stakeholder communities, collaborative frameworks, and model approaches.[111]
- California Independent System Operator (CAISO) has electricity planning standards that address some resilience issues, including both those identified to mitigate risks by NERC and WECC, such as planning for High Density Urban Load Centers, and others including an extreme event reliability standard for a high-density urban load area, considering its geography and system configuration, potential risks (seismic, third parties, facility colocation), and challenging restoration times.
- The Western Governors' Association Policy Resolution 2022-01 titled *Energy in the West*[112] sets forth the Governors' policy statements on energy priorities; grid modernization and resilience; innovation and technology; and economic and workforce development.
- NASEO and National Governors' Association report on *State Governance, Planning, and Financing to Enhance Energy Resilience*[113] describes governance structures, plans, and funding mechanisms states use to improve energy resilience.

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[110] https://www.westernenergyboard.org/wp-content/uploads/Fall-2020-Joint-CREPC-WIRAB-Webinar-Series-update-western-interconnect-regional-electricity-dialogue.pdf

[111] National Association of State Energy Officials (NASEO) National Association of Regulatory Utility Commissioners (NARUC) Cybersecurity Advisory Team for State Solar (CATSS) presentation by Kirsten Verclas, Senior Program Director, Electricity NASEO and Campbell Delahoyde, Senior Program Manager, NASEO, February 2021 to WRP.

[112] https://westgov.org/images/editor/WGA-PR-2022-01-Energy-in-the-West.pdf

[113] https://naseo.org/data/sites/1/documents/publications/NASEO%20NGA%20Resilience_Guide_21Dec2021 2.pdf

- NASEO produced a report[114] designed to assist State Energy Offices in developing plans, policies, and programs, including energy security and state energy plans, and encourages states to have a holistic perspective and address the interdependencies between the electric and water/wastewater sectors.

Fuel market coordination: NASEO and NEMA (National Emergency Management Association), with support from DOE's Office of Cybersecurity, Energy Security, and Emergency Response (CESER), have stood up a joint Western Petroleum Shortage Response Collaborative that supports states in coordinating a more efficient response to petroleum shortages during significant or catastrophic field emergencies.[115, 116, 117]

Defense Critical Electric Infrastructure (DCEI):[118] The Secretary of the U.S. Department of Energy (DOE), in consultation with other Federal agencies and DCEI owners, users, or operators, is responsible for designating Critical Defense Facilities (CDFs), those that are critical to national defense and vulnerable to a disruption of the supply of electric energy provided to such facility by an external provider. DCEI is any electric infrastructure located in the 48 contiguous states or Washington, DC, that serves a CDF but is not owned or operated by the facility owner or operator.

DOE has already designated the CDFs and engaged in outreach to each DCEI owner. The enhanced resilience and risk mitigation of DCEI is paramount to ensuring the CDFs can execute their mission plans when needed. DOE, in partnership with the U.S. Department of Defense (DoD) and DCEI owners, is working to identify potential single points of failure as well as infrastructure that is susceptible to failure caused by people or natural events. These risks may include effects from climate change, suboptimal infrastructure planning, and the installation or use of firmware or hardware manufactured by entities under the foreign ownership, control, or influence of adversarial nations. DOE is working with DoD to develop a risk assessment framework and identifying replicable mitigation strategies for DCEI.

[114] https://naseo.org/data/sites/1/documents/publications/NASEO%20Electricity-Water%20Critical%20Infrastructure%20Interdependencies%20December%202021%20FINAL.pdf

[115] https://www.naseo.org/data/sites/1/documents/publications/Western%20Petroleum%20Shortage%20Response%20Collaborative%20Regional%20Framework_FINAL_09302021.pdf

[116] https://www.naseo.org/data/sites/1/documents/publications/Collaborative%20Development%20Guide_FINAL_09302021.pdf

[117] https://www.energy.gov/sites/default/files/2021-07/CESER_SLTT_2020_Year_in_Review.pdf

[118] https://uscode.house.gov/view.xhtml?req=(title:16%20section:824o-1%20edition:prelim)

In 2020, DOE issued a Prohibition Order[119] pursuant to Executive Order 13920, *Securing the United States Bulk-Power System*[120], to address the risk of equipment installed supporting CDFs that was supplied by adversarial nations. E.O. 13920 was allowed to lapse and the Prohibition Order revoked as the Department creates a" Whole of Government" approach to these risks and challenges that will be implementable by industry and have long lasting effect. To that end, DOE released a Request for Information in 2021 seeking information from industry and other stakeholders as the Department considers a replacement for E.O. 13920.

The primary challenge to mitigating risks to DCEI will be the cost of any improvements. As DCEI is not owned by the CDFs through DoD, the cost will be borne by the DCEI owners. There are several potential ways to fund such investments, including by DCEI owners seeking rate recovery from customers, Federal grant funding through DoD, the U.S. Department of Housing and Urban Development, the Federal Emergency Management Agency, and the Bipartisan Infrastructure Law (especially for cooperative and municipalities.)

Black Start System Restoration:[121,122]: Major power disturbances (caused by people or natural hazards) may cause multiple power plants to go offline. Black Start refers to the restarting of electric power plants without offsite power (the grid) as part of the system restoration process following a partial or complete shutdown. While large-scale blackouts requiring Black Start resources to restart are rare, they have significant economic and societal consequences, creating a need for planning and investments in Black Start resources. Utilities subject to NERC regulation are required to have Black Start plans as part of their overall restoration plans.

Black Start capability is critical for electric system resilience. Characteristics of Black Start generators include relatively small capacity; can be started without any external assistance; can be ramped up and down with ease/flexibility; and can be paired with local load to create balanced islands. They need to bring energy back without depending on other resources.

[119] https://www.federalregister.gov/documents/2021/01/06/2020-28773/prohibition-order-securing-critical-defense-facilities

[120] https://www.federalregister.gov/documents/2020/05/04/2020-09695/securing-the-united-states-bulk-power-system

[121] The Importance of Black Start Generation presentation by Chris Beck, Chief Scientist and Vice President for Policy, EIS Council (Electric Infrastructure Security); and Frank Koza, Electric Subsector Coordinator, EIS Council, December 2021 to WRP.

[122] The Importance of Black Start Generation presentation by Brigadier General (Retired) John W. Heltzel, Director of Resilience Planning; Chris Beck, Ph.D., Chief Scientist and Vice President for Policy, and Frank Koza, Electric Sector Coordinator, Electric Infrastructure Security (EIS) Council, part of the Black Start and Black Sky/catastrophic events, September 2021 to WRP.

Current economic and technical trends are eroding this capability. (Financial compensation is inadequate, so responsibility for maintaining Black Start capability is "not worth the downside"). It is necessary to update financial incentives to achieve adequate Black Start capability. Black Start units are typically small and can start without any outside electricity. Next Start units are the next generators in the Black Start cranking path and are larger than Black Start units. Their function is also critical. Black Start and Next Start units[123] must be flexible in their output, so that they can "follow load" as the system is re-energized and more load is added.

Currently, renewables such as solar and wind are not good candidates for Black Start or Next Start, because they are intermittent sources. Enhanced storage may change this situation. Expanding renewable energy generation is also driving retirements of coal and gas generation that are better suited to Black Start. Current Black Start plans assume minimal system damage/disruption, and this is how they are practiced. In a Black Sky event, large system damage/disruption should be expected, and therefore Black Sky capable Black Start plans are recommended going forward. The first step is to identify "minimum grid" assets that **must** function, and to prioritize those assets in the Black Start plans and cranking paths (determine which energy sources get turned on when). The System Restoration Process includes seven main restoration steps.[124]

Data Tools available for WRP Partners to share information through common platform: Accurate and timely data is a prerequisite for energy planning. The Resilient Energy Infrastructure team recognized there are numerous resources, which are captured in the accompanying Resilient Energy Infrastructure Resources. In this chapter the following selected resources are cited: Argonne National Laboratory, Energy Information Administration (EIA) and the U.S. Department of Energy (DOE).

National Renewable Energy Laboratory (NREL) developed metrics for assessing reliability and resilience. These metrics are outlined in the report: "Resilience Metrics for Informing Decisions Associated with the Planning and Operation of the North American Energy System:"[125, 126]

[123] Next Start is the next group of generation that comes online after the Black Start generation comes up and is stabilized

[124] Restoration Steps: "System Assessment; Isolate equipment: Start black start units; Create balanced (generation=load) islands; Connect stable islands, maintain voltage and frequency; Start "next" units; Keep system balanced and bring larger generators on line with increasing load" per The Importance of Black Start Generation presentation by Chris Beck, Chief Scientist and Vice President for Policy, EIS Council (Electric Infrastructure Security); and Frank Koza, Electric Subsector Coordinator, EIS Council, December 2021.

[125] Castillo et al. 2020.

[126] See https://www.nrel.gov/docs/fy21osti/78943.pdf

- National Security: Through a multi-lab effort led by Sandia National Laboratories, the ERMA (Energy Resilience for Mission Assurance) project is building tools and approaches to inform policy decisions at the intersection of mission assurance and energy investment (both sides of fence line.)
- Social Impacts: Sandia National Laboratories, with collaboration across the labs and academia, has developed performance-based methodologies to calculate the social impacts of multi-day outages. The Social Burden metric is evolving through multiple efforts.
- Economic Impacts: Lawrence Berkeley National Laboratory, with collaboration across the labs and academia, has developed an approach to modernize the Interruption Cost Estimation tool (ICE calculator).[127] For longer-duration outages, the team has developed a methodology to calculate economic losses more precisely.

The U.S. Department of Energy offers significant data resources including:

- Argonne National Laboratory developed the Energy Zone Mapping Tool,[128] a public web-based energy analysis tool with a large catalog of more than 350 layers of energy resources, energy infrastructure, and siting factors. It also has a versatile modeling capability designed to create maps where particular energy technologies (ranging from nuclear power plants to electric vehicle charging stations) are most suitable, and routes for energy corridors. Argonne has several other public web-based mapping tools such as: Section 368 Energy Corridor Mapping Tool;[129] Solar Energy Environmental Mapper;[130] and Wind Mapper.[131]
- The North American Energy Resiliency model[132] is a multi-national laboratory effort to model the electricity grid.
- U.S. Energy Atlas,[133] created by EIA, includes data and interactive maps of U.S. energy infrastructure and resources. It is a robust tool that allows experts and novices to search, explore, and use energy data that is open and public in one location. There are over 140 data series (or data layers) in the Energy Atlas. EIA created 77; the other datasets are links to over government agencies, GeoPlatform, and ESRI Living Atlas. There are 15 interactive, web map applications covering energy infrastructure and resources and potential energy disruptions, and users can overlay energy

[127] https://icecalculator.com/home
[128] https://ezmt.anl.gov
[129] https://bogi.evs.anl.gov/section368/portal/; https://www.blm.gov/sites/blm.gov/files/docs/2020-12/BLM_WestWideEnergyCorridor_Guidebook.pdf and https://www.corridoreis.anl.gov/documents/
[130] https://solarmapper.anl.gov/
[131] https://bogi.evs.anl.gov/wwmp/portal/
[132] https://www.energy.gov/sites/default/files/2020/05/f75/Bindewald-Yuan_NAERM-EAC-May2020.pdf
[133] https://atlas.eia.gov/

infrastructure with current and historical hazards – including hurricanes, cyclones, typhoons, wildfires, and flooding.[134]

- DOE's Tribal Energy Atlas is an interactive geospatial application enabling analyses of energy projects and resource potential on tribal lands.[135]it includes the most current technical and economic tribal energy potential estimates: energy resource data, infrastructure, environmental, energy efficiency, electricity, and natural gas prices.[136]
- DOE's EAGLE-I™ is an interactive geographic information system[137] that allows for viewing and mapping U.S. energy infrastructure (electric, petroleum, and natural gas) and obtaining informational updates on a single visual platform. The tool is accessible by approved users, including federal agency personnel, Emergency Support Function (ESF) 12 responders, and state, local, tribal, and territorial energy and emergency management officials.

Mitigation Strategies: Gaps, Tactics, Best Practices and Recommendations

The WRP Resilient Energy Infrastructure Deep-Dive team offers the following identification of gaps, tactics, best practices, and recommendations to improve the resiliency of energy infrastructure. Identified Resilient Energy Infrastructure Gaps fall into the following categories: data, cybersecurity, communication, and energy-resilience.

Data-related Gaps:

- There is a need to identify tools and data to make assessments. EIA already publishes and collects much information. The complexity of energy resilience makes it critical to have GIS mapping tools highlighting the available data and to measure and track progress.
- Standardizing outage data would provide greater consistency in applying metrics. According to NERC's standards there are 11,000-13,000 outages a year, but only a few hundred result in loss of load due to system responses to outages of bulk system assets. SAIDI/SAIFI (system average interruption duration index/system average interruption frequency index) benchmarks used by utilities must be distinguished from bulk electrical system outages.
- "Data availability" and "data usability" are current topics of discussion. Most people use free data, so much climate data, typically "statistically downscaled data," can only project a couple of climate impacts into the future. A gap exists between available

[134] U.S. Energy Atlas: Overview of features and information relating to energy infrastructure presentation by Jim O'Sullivan, Industry Economist, Office of Petroleum, Natural Gas & Biofuels Analysis, U.S. Energy Information Administration (EIA), August 2021 to WRP.
[135] https://www.energy.gov/indianenergy/projects/tribal-energy-atlas
[136] DOE Indian Energy Program Overview by Lizana Pierce, Deployment Supervisor, DOE Office of Indian Energy, part of the Tribal Resilient Energy Infrastructure Webinar, December 2020.
[137] https://eagle-i.doe.gov/login

climate data and understanding what is useful and actionable at a local scale. Providing useable data for use in models would be a major contribution. Data is imperfect and perfect data will never be available, but there is good data upon which to base proactive decisions today. Obtaining new/current energy numbers is problematic and can result in causing a liability.[138]

- Some data is sensitive or proprietary. For example, some scenarios are sensitive, and that data should not be publicly available. More importantly, what is a useful output of an interdependency or contingency model and how is that data actionable before an incident, not for long-term preparedness, but immediate preparedness, although it also offers some long-term or exercise or use cases.[139]

Cybersecurity-Related Gaps:

- Energy cyber defense requires resources, active engagement, and partnerships to stand up protections and rapid response to ensure integrity of the grid and connected networks.
- There is a need to meet energy security responsibilities and to safeguard critical energy infrastructure against growing and evolving cyber and physical threats. Cyber vulnerabilities include OT infrastructure, IT systems, and supply chain partners. IT systems include software, hardware, and technologies used to gather and process data needed to run the business side of the enterprise. OT infrastructure includes the systems that control pumps, motors, valves, and switches. Supply chain sabotage may be unintentional (elements not meeting current security standards) or intentional (part of a covert effort to facilitate a future attack.) Cyber-attacks may include the introduction of compromised components into a system or network. Attacks can come through software downloaded by the energy organization or firmware that bad actors can manipulate to include malicious codes for exploitation later or compromise energy company hardware. Examining attacks and breaches that have occurred in the energy industry illustrates the importance of securing the industry's vast supply chain ecosystem.
- There is a need to value resilience and ensure that plans address identified gaps, set cross-sector milestones, and involve the right subject matter experts. A top-down approach for resilience budgeting is preferable to bottom-up models that tend to inflate the cost in the long run. Cost can be a stumbling block for some projects to be considered. It is critical to determine a cost optimization strategy and across

[138] Planning for Resilience with Regional Climate Modeling presentation by Dr. Thomas Wall, Program Lead, Engineering and Applied Resilience Decision and Infrastructure Sciences Division, Argonne National Laboratory, February 2022 to WRP.

[139] Eagle-I presentation to WRP by Matthew Tarduogno, Program Manager for Situational Awareness, Analysis, and Reporting - Office of Cybersecurity, Energy Security, & Emergency Response at the U.S. Department of Energy, August 2022.

interdependent, interconnected sectors and includes such items as hardening distributed energy, etc.

Communication-related gaps:

- Some technology developed in the military and other countries provides ad hoc self-healing, deployable communications systems for these types of scenarios. It is also built for geomagnetic disturbances or an electromagnetic pulse, perhaps from an improvised nuclear device or something larger that is anticipated to take out communications for a localized area. It is necessary to be able to set up communications infrastructure where there is nothing really to build on. It must be dynamic because of the cost and time required to install a fixed solution. Some technologies can provide a solution for repair crews and operations teams that deploy in those scenarios. Availability of real-time communications is vital. This includes the deployable self-healing systems, and communication between plant operators, regulators, and system operators. Different levels of communication are needed at different times.

Energy-Resilience Gaps:

- Reliability and resilience need to be considered together. However, reliability metrics do not adequately quantify resilience as they are often for localized, short-duration disruptions. In contrast, resilience metrics are widespread, long-duration disruptions.
- Black Sky/long term power outage*:* There is a need to prepare by prioritizing restoration. Customers may be willing to conserve energy to avoid a Black Sky event. However, without effective communications, it is unlikely to get the benefit of such conservation as customers will not know that the conservation effort is necessary and ongoing.

Tactics are used to minimize likelihood of serious disruption and the impacts of any disruption. Some examples include Public Safety Shut Offs, creating microgrids, hardening/improving of infrastructure and addressing cyber security.

- Public Safety Power Shut offs[140]/Public Safety Outage Management[141]: Given the power shut offs experienced in California over the last year or so, there is greater interest in micro grids and how they are integrated into the larger operating system. Grid monitors identify the effects of a shut off. The grid monitor has limitations because several balancing authorities cover such large areas that interruptions can be difficult to discern.
- Microgrids provide security in areas at risk of disruption and separation from the grid and in remote areas where diesel fuel supplies might be at risk.

[140] https://www.cpuc.ca.gov/psps/

[141] https://www.nvenergy.com/safety/psom

- Hardening/improving infrastructure: Technical upgrades at existing generation plants improve system reliability (enhancing output, efficiency, and flexibility). Potential technology upgrades at existing generation plants would help increase their resiliency by hardening infrastructure. There is an opportunity to increase the efficiency of existing generation plants to improve reliability, enhance resiliency, and increase peak supply, and a need to address transmission lines given fire concerns. Hardening infrastructure (both electric and oil and natural gas) via wind-resistant technologies, elevating from flood risk, upgrading equipment (wood to concrete poles), and undergrounding power lines can all help prevent or mitigate impacts.
- Communication, organizational, and process structures can reduce cyber risks. Security considerations must be included in energy infrastructure. A high-functioning utility security plan should ensure organizational awareness of threats with robust processes to report potential vulnerabilities and emerging incidents. The workforce should also have basic digital literacy and cyber hygiene. Those with first-hand experience with new technologies and vulnerabilities should work to secure physical and virtual infrastructure, networks, and ICS.[142]

Best Practices to minimize likelihood of serious disruption and the effect from any disruption include having a multi-layered network and diverse fuel sources; having the ability to switch fuel; MOUs; Federal efforts to reduce wildfire threats; and microgrids.

- A multi-layered production/transmission/storage network that combines the scale efficiencies of large generation and storage facilities with the control and redundancy of small-scale initiatives such as distributed generation (particularly of renewables and co/tri-generation), localized storage, and micro-grids, enabling continued operations including during Black Sky conditions.
- Diverse fuel sources: Fuel security analysis and the fuel systems they depend on support restoration. Everyone has a different fuel mix and there must be some accounting for diversity, both from a financial and operational perspective.
- Fuel switching capability: Reliability can also be improved by generators that can fuel switch. Examples include coal boilers that can operate on natural gas in the event of a coal supply disruption and natural gas generators that can operate on petroleum liquids in the event of natural gas restriction, although there is no current use of these in the West nor is this likely in the future.
- Since 2016, the Department of Agriculture, Department of the Interior, Environmental Protection Agency, Edison Electric Institute, and the Utility Arborist Association have been collaborating under a Memorandum of Understanding (MOU)[143] that addresses

[142] McKinsey & Company. November 2020. Bailey, Maruyama, Wallance. "The energy-sector threat: How to address cybersecurity vulnerabilities"

[143] https://www.epa.gov/pesp/integrated-vegetation-management-practices-memorandum-understanding

vegetation management for electric transmission and distribution line rights-of-way on Federal lands.

- The Bureau of Land Management and the U.S. Forest Service are reducing wildfire threats through expedited approvals of utility vegetation management on electric transmission and distribution rights-of-way as directed in the Consolidated Appropriations Act of 2018 (Public Law 115-141 Title 2, Sec 512).
- Case study/best practice: Blue Lake Rancheria is a federally recognized tribe located in Humboldt County in Northern California on about 100 acres of trust land. In 2013, it formed its Tribal Utility Authority. Various factors led to worsening nuisance power outages and other larger outages, including public safety power shutoffs, and concerns of further disruptions. They began decarbonized resilience solutions with microgrids: mini-electrical grids that can operate either connected to the larger grid or disconnected using their own power. In normal times, microgrids reduce and level operational energy costs, lower carbon, and pollutant emissions (depending on type of generation) and ride through nuisance power outages. In emergencies, the microgrids can support lifeline sectors. The community scale microgrid is a public/private partnership among the Rancheria and many others, funded by the tribe and a CEC grant. It powers the central campus of tribal offices and economic enterprises, emergency operations, critical infrastructure, lifeline sectors, and EV charging, and can seamlessly island from and reconnect to the main grid. It has 420KW of solar photovoltaic, with 1 to 2 MWh of battery storage and diesel generators for emergencies. The facility scale microgrid is a similar public/private partnership, powering the fuel station/convenience store complex and EV charging station. It has 60kW of solar photovoltaic generation, 106 kw/169kwh of battery storage, and can also island from and reconnect to the larger grid. In emergencies, it can supply lifeline sectors and emergency responders. During the October 2019 Public Safety Power Shutoff, the microgrid served over 10,000 people (about 10% of the county), providing power for medical housing, communications, EV charging, fuels, supplies, internet, and cellular access among other things to the region. The Tribe has produced a report describing its work.[144]

Recommendations

Recommendations for more resilient energy infrastructure fall into the following categories: communication, coordination, and planning; metrics; hardening infrastructure; microgrids and cybersecurity.

Communication, Coordination and Planning:

- Partners need effective and reliable communication both prior to and during an outage event. Grid-independent communications are necessary in the event of

[144] https://resilientca.org/projects/f767d226-e74c-408d-b7d9-ec7cb9949d21/

widespread energy outage. Accurate and timely forecasting and sharing of extreme weather is critical.

- WRP Partners should collaborate on After-Action Reviews and Lessons Learned to improve planning, execution, and post-disaster mitigation. It is important to have common language and terminology, including standardized outage data on a common platform based on some outage data initiative work (e.g., Eagle-I). There are many different lines of effort, and it would be useful to have a common framework of best practices with common terms to help unify efforts and make it more efficient, so they are not reinventing the wheel or duplicating efforts.
- Resilience should be a strategic priority utilizing top-down approach for budgeting.
- There is a need for additional coordination among sectors (water, cyber, electricity, telecommunications, fuel sector (everyone has a different fuel mix), etc.)

Metrics:

- Resilience metrics should include the size, duration, and impact on customers, focus on individual events and impacts on critical sectors, and measure system performance against the severity of the consequences.[145]

Hardening Infrastructure:

- Hardening electric system infrastructure: Transmission and distribution lines may not only be subject to wildfires, but the cause of them. It is therefore necessary to harden that infrastructure as part of wildfire risk management, including the use of insulated electrical lines in high-risk areas, using metal rather than wood supports, monitoring equipment, implementing new spark-reduction technologies, or undergrounding lines when necessary and economically feasible.[146]

Microgrids:

- Microgrids: Feasibility for Tribes, States and other WRP Partners to work with the DoD to enhance energy security. For example, both tribal lands and military bases tend to be in remote areas, and tribal lands frequently possess energy resources. Military bases and tribes could collaboratively create a regional micro-grid, effectively providing distributed deployment of energy and enhancing energy resilience.
- Microgrids can be installed at key locations that are vulnerable to separation from the grid. Organizing virtual power plants is a way to secure generation assets for serving loads that may be interrupted. The system can be segmented to proactively create islands on the fly using aggregated distributed generations, match it with the

[145] Resiliency Metrics for the North American Energy Resilience Model presentation by Robert F. Jeffers, Ph.D., Principal Systems Scientist, Sandia National Laboratories, December 2020 to WRP.

[146] https://www.gov.ca.gov/wp-content/uploads/2019/04/Wildfires-and-Climate-Change-California's-Energy-Future.pdf

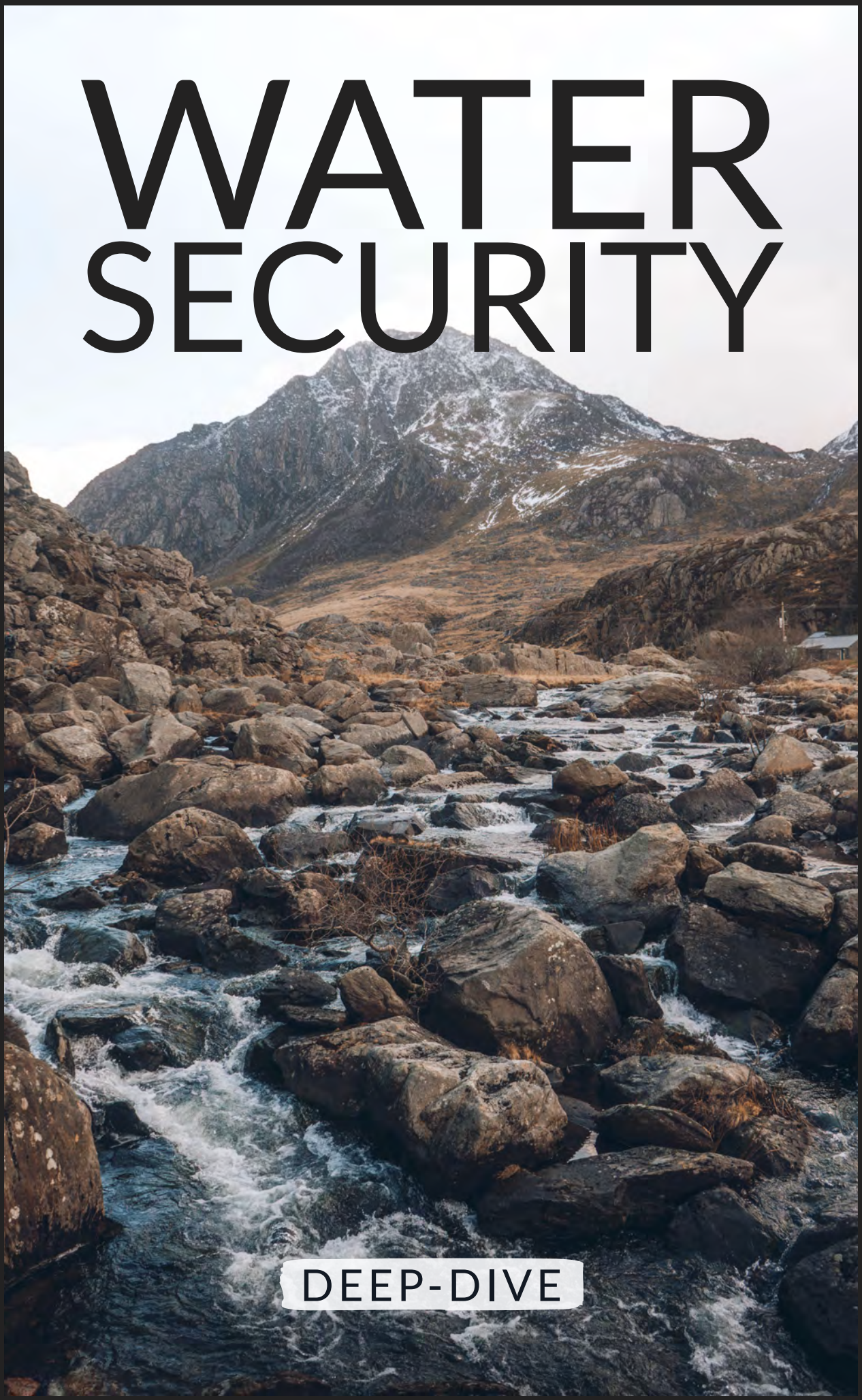
loads, and prevent it from being affected by any other disturbances in the system, thereby preventing cascading outages. Additional security could be had with having diverse fuel sources (fossil fuel, renewable, etc.)[147]

Cybersecurity:

- Enhance the cybersecurity of utilities' industrial control systems (ICS): Help energy sector organizations understand cyber risks to their IT and OT systems. Measure the maturity of their cybersecurity capabilities, and ultimately support energy sector organizations in strengthening their operational resilience.

[147] Microgrids - A Perspective on Resiliency in the Power Delivery System presentation by James T Reilly, Consultant, June 2022 to WRP.

WATER SECURITY



DEEP-DIVE

WRP Water Security Deep-Dive

Overview

The Western United States is one of the fastest growing regions of the country, and the future growth and prosperity of the West depend on the availability of adequate quantities of water of suitable quality to meet various needs. Many efforts have been made to address water security in the West, but more work is needed. In particular, drought and its effect on the Lower Colorado River have become critical for states in the West. Last year's Infrastructure Investment and Jobs Act[148] provides billions of federal funding for water infrastructure; many states have also earmarked funding for infrastructure. Because the need for additional funding remains, any opportunities to leverage or integrate federal, state, and tribal efforts are most welcome.

For purposes of this report "Water Security" means having a reliable supply of water of suitable quality. Elements that assist in the establishment or recognition of water security include: (1) adequate and readily accessible data and predictions on water availability and infrastructure; (2) appropriate policy planning and implementation; (3) laws and regulations to promote water security; and (4) identification of best practices and implementation of new technologies that reduce water demand, increase and protect water quality and quantity, reduce flood risk, and enhance ecosystems.

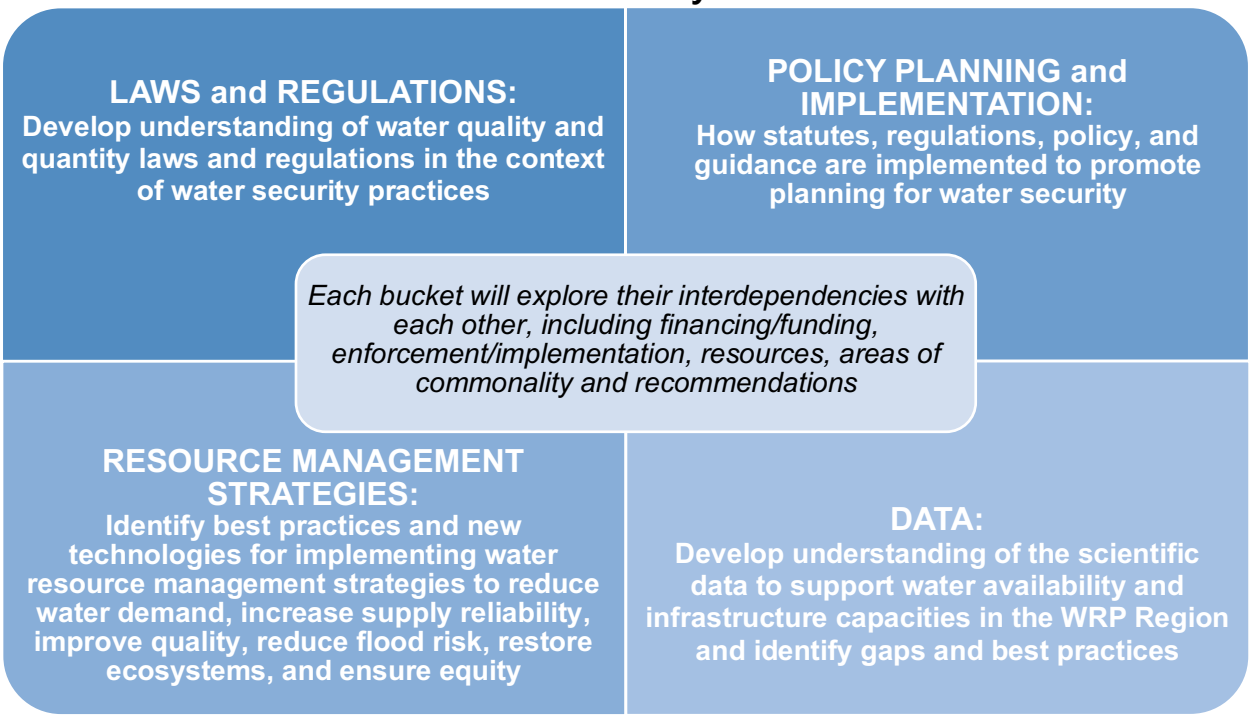
The Water Security Deep-Dive Team held working calls and facilitated key webinars with subject matter experts to explore this critical topic more fully. This report identifies water security issues in the West and highlights studies and conclusions from various subject-matter experts in the field. To assist with this analysis, the Team identified four Water Security "Buckets" as distinct but overlapping aspects of water security. This report summarizes the Team's findings and efforts for the four buckets, organized into the following main sections:

- Water Laws and Regulations;
- Policy Planning and Implementation;
- Water Resource Management Strategies; and
- Data.

[148] Public Law No: 117-58; H.R.3684

Finally, the Team also offers observations on cross-cutting areas of commonality and recommendations across the buckets.

WRP Water Security Buckets



Water Laws and Regulations Bucket

The focus of the Water Laws and Regulations Bucket was to develop a general understanding of water quality and quantity laws and regulations in the context of water security. Water laws and regulations are complex and fall under various jurisdictions: state, tribal, federal, regional, and local. To resolve water related issues and improve relations, it is important to gain a basic understanding of the legal framework that governs water across the West.

States: States have the primary role in regulating and managing water rights. The Prior Appropriation Doctrine[149] generally governs water rights in most Western States, where precipitation is limited and water resources are scarce. In many of those states, water rights are treated as individual property rights (usufructuary rights) that may be lost only through non-use. States oversee the administration of water rights, processing applications for the development of new water rights or changes to existing rights. States generally hold

[149] The Prior Appropriation Doctrine establishes that the first person to place water to a beneficial use has the best legal right to the continued use of the water. Subsequent, or junior, users of the water system may be required to cease use during times where insufficient water is available to serve all users.

administrative hearings regarding interference with a water user's ability to exercise those rights and have the authority to curtail water use when there are insufficient water resources available to fulfill existing or senior water rights. In some states, where water rights have been granted or developed over decades or centuries under varying degrees of oversight, a basin-wide adjudication is needed to quantify water right amounts and determine priority. Basin-wide general stream adjudications are judicial determinations of the amounts and priorities of the rights to the use of water in a watershed. As a general proposition, courts do not create water rights, but merely confirm rights that have been created by actions of the appropriator. These adjudications typically take place in state courts. States frequently have compact agreements to manage surface water resources that cross state boundaries, and unresolved disputes over compact interpretation are often resolved in federal court. Interstate disputes over surface and groundwater are resolved by the U.S. Supreme Court through original actions by the equitable apportionment doctrine.

While quantification of western water is largely governed under state procedures, the federal government plays an important role in the distribution of water associated with its reservoirs and dams and for federal purposes such as for parks, military, forests, species, and tribes. Tribal water rights, which are federal, may be quantified through basin-wide adjudications in state courts, by federal courts, or by settlement negotiations with states and federal agencies that generally must by authorized by an act of Congress. Once quantified, some tribal water rights are implemented through Memorandums of Understanding (MOUs) with state and federal agencies. For states, addressing issues such as quantifying water rights for federal lands, including the National Park Service (NPS), Forest Service (USFS), the Bureau of Land Management (BLM), Department of Defense (DoD) facilities, and other federal lands, is important, as federally-managed lands make up a significant percentage of lands across the West and include vast amounts of water.

State water allocation concepts:[150]

- *Prior Appropriation*: "First in time, first in right" – the water user who diverts water and puts it to continuous beneficial use has a water right with a priority date associated with the time of the diversion and beneficial use.
- *Fully Appropriated Streams/Basins*: Streams or basins in which all waters are allocated to users through water rights, and often no new water rights will be authorized.
- *Senior/Junior Appropriator*: In times of water shortage, the water users with senior or earlier priority dates will receive the full amount of their water right, whereas junior users with later priority dates may not receive any water at all.
- *Minimal Amount Necessary*: The least amount of water that is reasonably necessary to meet statutorily-approved—sometimes judicially-approved—needs without waste

[150] Water Security in the West, presentation by Michelle Bushman, Assistant Director and General Counsel, Western States Water Council, October 2020 to WRP.

(e.g., water used for mining, ranching, domestic, municipal, industrial, and environmental purposes.)

- *Forfeiture*: The water right can be lost (in part or in whole) through non-use over a statutorily determined period, or through wasteful use. (Federal reserved water rights may not be lost through non-use.) In California, the doctrine of forfeiture does not apply to appropriative water rights holders that save water such as through water use efficiency or conservation measures, incentivizing conservation.

California Example: Water rights can be very complex, and throughout a single State, water security can look very different (e.g., Southern California compared to Northern California). The Sustainable Groundwater Management Act (SGMA)[151] was enacted by the California legislature in 2015 to halt aquifer overdraft and bring the pumping and recharge in groundwater basins into balance. It is a significant new water policy for California, requiring local agencies to adopt sustainability plans for high- and medium-priority groundwater basins. It took California over one hundred years after its surface water rights system to provide State oversight of groundwater management. In 2018, California also passed water conservation legislation that sets new targets for urban water use and more requirements for urban and agricultural water management and water shortage contingency planning, including small systems and small communities. SGMA recognized federal reserved groundwater rights.[152]

Tribal: Under the *Winter's* Doctrine,[153] tribes and Indian allottees generally have federal reserved water rights with a priority date corresponding to the date of the reservation, or in some cases reaching back to time immemorial. Consequently, tribal water rights may be the earliest water rights with the highest priority. Unlike state-based water rights, federal reserved water rights may not be lost through non-use. Water is a federal trust resource – it is held in trust for the tribes and individual Indian allottees by the federal government, which means that the federal government must protect tribal water resources. The quantification of tribal water rights may be determined in federal or state courts, and under the McCarran Amendment, 43 U.S.C. § 666, (1952), the sovereign immunity of the United States was waived for adjudications under certain circumstances. The *Winter's* case concerns

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151 https://leginfo.legislature.ca.gov/faces/codes_displayexpandedbranch.xhtml?tocCode=WAT&division=6.&title=&part=2.74.&chapter=&article

152 California Water Code 10720.3(d): "In an adjudication of rights to the use of groundwater, and in the management of a groundwater basin or subbasin by a groundwater sustainability agency or by the board, federally reserved water rights to groundwater shall be respected in full. In case of conflict between federal and state law in that adjudication or management, federal law shall prevail. The voluntary or involuntary participation of a holder of rights in that adjudication or management shall not subject that holder to state law regarding other proceedings or matters not authorized by federal law. This subdivision is declaratory of existing law."

153 *Winters v. United States*, 207 U.S. 564 (1908)

surface water, but the 9th Circuit recently applied the *Winter's* doctrine to groundwater in the *Agua Caliente*[154] case.

Some tribal water rights are resolved by settlements authorized by Congress, with many of those settlements funding water infrastructure in exchange for tribes waiving their claims against the federal government for federal trust and treaty violations. Once quantified, tribal water rights may be managed by the tribe under a tribal water code. Some tribes have agreements with state governments for the tribe's water rights to be administered under the state system. Tribes and states may also enter agreements or create special commissions to address cross-boundary water resource concerns.

Tribes have several specific challenges:

- Tribes that do not yet have their water rights quantified do not know their water allocation or rights available for future uses.
- Tribal water rights settlements can lead to a quantification of water rights as well as infrastructure improvements.
- Tribes with water settlements often have Congressionally-authorized water use projects that are not fully funded or are unfunded and therefore are incomplete or do not exist. The Investments in Infrastructure and Jobs Act attempts to provide funding for authorized settlement projects (see below), but implementation of the funds under federal procedures are being developed.
- Hopi water issues, for example, include dryland farming, addressing arsenic, and not being part of the Little Colorado River settlement negotiations.
- As another example, a sizable portion of the Navajo Nation has experienced drought. The Nation also continues in its efforts to obtain water for farmers and ranchers on the Reservation. The Navajo-Gallup Water Supply project will provide municipal and industrial water supply to the eastern section of the Navajo Nation, southwestern region of the Jicarilla Apache Nation, and the city of Gallup, New Mexico. Though the project is not complete, water deliveries to Navajo communities along the Cutter Lateral began in 2020. The Bureau of Reclamation is overseeing the design and construction of the project.[155]

Improving communications and finding better ways to address disputes, potential disputes, or conflicts, particularly between the tribes, federal government, and states, is beneficial for all, improves relationships, and can help to avoid litigation. A key component of communication and collaboration is understanding the motivation and interests of each party, allowing the parties to work towards amicable resolutions of disputes. The completion time has been a challenge for tribal water rights settlements. The average tribal settlement has taken nearly 11 years to negotiate; some have taken as few as five or as long as 25

[154] *Agua Caliente Band of Cahuilla Indians v. Coachella Valley Water Dist.*, 849 F.3d 1262 (9th Cir. 2017)
[155] https://www.usbr.gov/uc/progact/navajo-gallup/index.html

years.[156] The Infrastructure Investment and Jobs Act[157] appropriated $2.5 billion for the "Indian Water Rights Settlement Completion Fund" to address Indian water rights settlements authorized before the passage of the bill.

Benefits of Negotiated Settlements include:

- Resolving federal reserved water rights claims with the least disruption to existing water uses;
- Crafting solutions specific to each situation (hydrology, water needs, funding, etc.);
- Promoting conservation and sound water management practices;
- Developing partnerships;
- Providing greater certainty allowing for better planning; and
- Addressing future needs and expected changes in water rights needs (e.g., non-traditional, unappropriated brackish and saline waters that may require attention through new water laws.)

Federal: The United States holds title to a significant amount of property in Western States, and various federal agencies have statutory and regulatory responsibilities that require water rights to fulfill. Federal interests that require water include firefighting, road construction and maintenance, administrative sites and campgrounds, military purposes, watering livestock on federal grazing allotments, and recreation.

When federal lands are set aside or reserved by Congress, or through Executive Order, for present and future uses, that reservation comes with either implicit or explicit federal reserved water rights. Generally, those reserved water rights are not quantified at the time the lands are reserved but are measured by the amount of water necessary to fulfill the purposes of the reservation as stated in the originating statute, including both consumptive and non-consumptive uses. The date of the land reservation serves as the priority date for the associated water right, and some of those dates may create a very early priority that displaces later, or more junior, water rights under state law. Similar to tribes, the federal reserved water rights cannot be lost through non-use. A federal agency in need of additional water rights to fulfill its statutory obligations that cannot be met by reserved water rights may also seek additional water rights through the state administrative process as any other water user.

Like tribes, the United States also participates in basin-wide general stream adjudications in state courts under the terms of the McCarran Amendment. The McCarran Amendment consents to joinder of the United States in general stream adjudications to determine the validity of historic water rights claims under state law and the quantification of federal

[156] United States Indian Water Rights Settlement Program presentation by Tracy Goodluck, Deputy Director, DOI Secretary's Indian Water Rights Office, December 2020 to WRP.
[157] Public Law No: 117-58; H.R. H.R.3684

reserved water rights. Unlike tribes, the federal agencies may not administer their own quantified water rights but must protect their water rights from other water users through the state system of administration. Federal water projects operated pursuant to the Reclamation Act must also acquire water rights pursuant to State law.[158]

Apart from the quantification and administration of water rights, other state and federal laws impact water resource management. Federal laws, such as the Clean Water Act, the Endangered Species Act, the Reclamation Act, the Federal Power Act, and the Flood Control Act, play a role in the management of water quality and water resources in the West. The relationship between the federal government and the states continues to evolve regarding water laws. For example, Congress has deferred to state primacy in the Reclamation Act, the Federal Power Act, and the Clean Water Act, and consultation with states and tribes is often required or at least advisable before federal agencies promulgate rules that may conflict with state and tribal laws, treaties, and compacts, and disrupt established systems of water management. Tribes and states also frequently rely on federal resources available at the national level for technical assistance, standards to ensure human health, the collection and coordination of data to improve water management on a regional scale, and funding for programs that fulfill federal mandates.

Significant Federal court cases:[159]

- *Winters v. United States*, 207 U.S. 564 (1908), implied reserved rights for an Indian reservation.
- *Arizona v. California,* 373 U.S. 546 (1963), implied reserved water rights for a national forest, two wildlife refuges, the Lake Mead National Recreation Area, and Indian reservations.
- *Cappaert v. United States*, 426 U.S. 128 (1976), the reserved rights doctrine applies to subsurface water and is limited to that amount necessary to fulfill the purposes of the reservation.
- *United States v. New Mexico,* 438 U.S. 696 (1978), water was reserved in a National Forest only for timber needs and favorable conditions of surface flow.
- *Agua Caliente Band of Cahuilla Indians v. Coachella Valley Water District*, 849 F.3d 1262 (9th Cir. 2017) *Winters* doctrine logically encompasses both surface water and groundwater appurtenant to reserved land.
- *Mississippi v. Tennessee,* 595 U.S. ___ (2021) In November 2021, the Supreme Court struck down an attempt by Mississippi to claim sole ownership of the groundwater beneath its surface in an aquifer that straddles the Tennessee border. Mississippi argued that equitable apportionment should not apply in its case because groundwater has different properties than river flows and because Tennessee's

[158] *California v. United States*, 438 U.S. 645 (1978).

[159] Water Rights, Adjudications, and the United States' Needs for Water Security, presentation to the WRP by Stephen Bartell, U.S. Department of Justice, ENRD, October 2020 to WRP.

Memphis Light, Gas and Water Division had already depleted the aquifer's water before there was a chance to fairly divide it. The Court held that such claims had to be considered through a claim for equitable apportionment.

Historical: It is important to understand the historical context of water management in the West and how it has changed over time before attempting to address water security issues. Water management in communities in the West has evolved slowly, from prioritizing water for mining and agriculture to making room for competing interests such as municipal, industrial, recreational, and environmental needs. For example, what was once considered wasteful—leaving scarce fresh water in the stream to empty into the ocean or terminal lakes—has gradually become a positive conservation practice with multiple environmental and recreational benefits in some regions.

The scope and purpose of some water projects has changed over time. Each federal water project has authorizing legislation, which identifies the purposes of the project, which can only be formally changed by Congress. When many federal projects were initially built, urban water use and demand were lower today. For instance, Los Angeles and Las Vegas were much less populated when the Colorado River Aqueduct and Hoover Dam were built. The Salt River Project, originally an agricultural project, now delivers water to the Phoenix metropolitan area as the uses of the area served by the project have converted from agricultural to urban. For many federal infrastructure projects, agriculture had the senior right as the first use and, in some cases, the only recognized use of water stored or diverted by the infrastructure.

Some factors that led to the development of Western States' water laws over the past 150 years included:

- Water uses are often far from supply sources; diversions were built to move water to areas of need.
- The "first in time/first in right" principles from mining activities carried over to water rights, although not necessarily to groundwater rights.
- The doctrine of "prior appropriation" of water began in the mid to late 1800s, while much of the West was still divided into Territories.
- Reclamation and Army Corps of Engineers efforts brought large-scale water storage and water diversion infrastructure to permit farming, hydropower, flood control, and other purposes specific to each implementing law.
- Courts recognized the implied or express promise of water resources, including for fish and wildlife, in tribal treaties and reservations, and later in other federal land reservations.
- Environmental laws of the 1970's brought significant changes related to water. (Endangered Species Act, Clean Water Act, National Environmental Policy Act (NEPA), etc.)

- Submersible pumps and reliable electricity made groundwater in deeper aquifers an accessible resource.
- Industrial and municipal expansion required more water.
- Instream regulation became more common.
- Multi-year droughts became more common.
- Water recycling and conservation became more common.

Challenges: In many cases, today's water policies, laws, regulations, data, and tools are frequently developed in isolation from one another. This creates a systemic challenge and inefficient use of time for project proponents trying to plan, fund, permit, and implement multi-sector, multi-benefit projects. Water policies are often based on historical hydrology and do not account for changes in climate and extreme events (such as more frequent floods, and longer and deeper droughts). These changes create challenges and opportunities for managing the quantity and quality of surface water, groundwater, and ecosystems. Management of groundwater may be limited by adequacy of information on aquifer characteristics, groundwater levels and management activities. There are many tools for groundwater resilience including managed aquifer recharge (dedicated recharge basins, on-farm recharge, in-lieu, and floodplain inundation); water trading programs; zonal management; and strategic land repurposing.[160]

In the West, tension among water users is not uncommon. For example, the federal government is required to safeguard the water rights it has on federal lands as water rights are generally considered to be property rights and are needed for federal purposes. The federal government is also required to claim its historic water rights when properly joined in general stream adjudications. Other users or claimants to water rights may be skeptical of the federal government doing so. For example, some ranchers who graze livestock on federal grazing allotments claim stock water rights in their own name under state law, challenging federal ownership of such rights.

Policy Planning and Implementation "Bucket"

The Policy Planning and Implementation Bucket focused its efforts on how statutes, regulations, policy, and guidance are implemented to promote planning for water security. Issues in the West include addressing population and economic growth; competing or poorly defined water rights; aging and often inadequate infrastructure; constantly evolving regulatory landscape; and unpredictable climate and extreme events.

[160] Resilience from Below Sustaining communities and nature through proactive groundwater management presentation by Maurice Hall, PhD, PE, Vice President, Resilient Water Systems, Environmental Defense Fund to October 2021 to WRP.

Water has both consumptive and non-consumptive uses. In some cases, there are protected private property rights; in others, it is a public use. For example, water for hydropower in the West has been used to make irrigation possible, generating revenues for development that agriculture alone would not have been able to finance. There are many such multi-purpose projects. As for water security, it is not only about the traditional means of securing supplies (dams and reservoirs), but alternatives that are becoming less expensive, such as water recycling, reuse, and brackish and seawater desalination. In the Colorado River Basin, some states are promoting flow augmentation through weather modification, such as snow augmentation operations (e.g., cloud seeding) in the Upper Basin. Other prospects include interstate transfers of water, the Arizona Water Bank, the importance of diversifying water supplies so as not to be dependent on one supply, and the consideration of non-traditional waters, including their monitoring and allocation.

Many of the current programs aimed at water security were written over 20 years ago during a different climate not experiencing the current trends. A current regional planning challenge is preparing for and responding to water shortages and drought in the Colorado River Basin. It is an issue of understanding the size of the bucket (water that is available) and matching policies to this information.

Current federal regulatory issues include:

- Clean Water Act Sec. 401 State Certification
- Defining Waters of the United States (WOTUS)

Other water security challenges include (for potential future action)

- U.S. Army Corps of Engineers Res. Operations Rule Curve
- U.S. EPA Water Transfers Rule
- U.S. Forest Service ground Water Directive
- BLM Hydraulic Fracturing
- U.S. Army Corps of Engineers Water Supply Rule

There is a need to address tribal water rights. Fewer than 50 federally recognized tribes in the lower 48 states have resolved water rights, leaving hundreds of tribes with unresolved water rights.[161] These tribes that have a need for water supplies and infrastructure face increasing competition for federal funds and water supplies due to supply limitations and population growth outside tribal lands. There are also concerns about the ability to revisit and renegotiate pacts as conditions change, such as the Colorado River compact, which is based on flow conditions measured in the 1920s that do not reflect current conditions. The completion of tribal water rights settlements can help with these issues.

[161] United States Indian Water Rights Settlement Program presentation by Tracy Goodluck, Deputy Director, DOI Secretary's Indian Water Rights Office, December 2020 to WRP.

Congress must approve, authorize, and fund tribal water settlements, but Congress has had much turnover in recent years. Previously, most settlements involved a waiver of rights to a certain amount of water by the tribes, but also involve funding an infrastructure component so water can get to the tribe. Completion of these projects can take decades. The federal government has a tribal trust responsibility for these natural resources.

Regarding tribal reserve rights to groundwater, in the *Agua Caliente* case in California,[162] the Ninth Circuit recognized a tribal reserved right to groundwater. Protecting groundwater quality is an important state priority. It is interconnected, but there are legal distinctions that are important. As with most areas of water policy, working proactively to negotiate a solution and avoid litigation is the preferable outcome.

Regarding interstate water compacts, there are concerns across the West about the durability of these compacts as climate and hydrologic conditions change. One example of this is the Colorado River Compact.[163] The Department of the Interior and Bureau of Reclamation are working with tribes, the seven Colorado River basin states, and other stakeholders on updating the 2007 Interim Guidelines[164] as they expire in 2026. This effort follows completion of the Upper and Lower Colorado River basins drought contingency plans,[165] as well as other water conservation initiatives by the basin states.

Reclamation continues to work on protecting the long-term sustainability of the Colorado River System. An example of this is the Lower Colorado River Basin System Conservation and Efficiency Program. Funded with an initial allocation from the Inflation Reduction Act,[166] the program was announced on October 12, 2022, and will "select projects for funding by Colorado River water delivery contract or entitlement holders that mitigate drought, protect important natural resources, and ensure a reliable source of water and power for those who live in communities across the West."[167]

Since the late 1990s, Executive Order 13132[168] has required the federal government to consult with the states. The Western Governors' Association (WGA) and states contend this requires meaningful consultation. States frequently cite this consultation requirement with federal agencies during rulemaking, and this is a significant policy tool that might be considered under policies that impact water security.

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[162] *Agua Caliente Band of Cahuilla Indians v. Coachella Valley Water Dist.*, 849 F.3d 1262 (9th Cir. 2017)
[163] https://www.usbr.gov/uc/rm/crsp/index.html#law
[164] https://www.usbr.gov/lc/region/programs/strategies/RecordofDecision.pdf
[165] https://www.usbr.gov/dcp/finaldocs.html
[166] https://www.congress.gov/bill/117th-congress/house-bill/5376/text
[167] https://www.usbr.gov/newsroom/news-release/4353. More information on this program can be found at Reclamation's Inflation Reduction Act website at https://www.usbr.gov/inflation-reduction-act/
[168] https://www.govinfo.gov/content/pkg/FR-1999-08-10/pdf/99-20729.pdf

More states are studying plan implementation to shore up existing supplies. Whereas each state has individual statutory processes, procedures, and boundaries in which they must operate, shared information can help address water security and sustainability issues. Ensuring proper data collection, use of best available science, and identifying and including the right entities are all critical to solving water security issues. These efforts take time, and changes in federal and state governments can disrupt continuity. People previously invested can help inform those new to the issue to carry the effort through. One example of this effort in action is the Bureau of Reclamation WaterSMART program.[169]

There are challenges in implementing many government planning and policy documents. Much time and effort are put into developing plans, and it is important to have a similar focus on implementation to ensure successes, so that the plans are not simply filed away unread without recognition or action on the identified issues. There are plans on groundwater sustainability and proposed implementation, but implementation is fraught with pitfalls, legal challenges, and emotions. There was a push in the 1970's for state water plans; these vary in their comprehensiveness. Most plans recognize water is scarce in the region and growing demands for different purposes are putting pressures on it. Examples of State plans in the WRP region include:

- Arizona: Arizona has a bifurcated system for managing surface water and groundwater. The 1980 Groundwater Management Act requires developers to demonstrate a 100-year assured water supply before selling lots in those areas of the state known as Active Management Areas. [170]
- California: The California Water Plan is updated every five years by the Department of Water Resources (DWR) in collaboration with other State agencies, Tribes, and stakeholders. With the Sustainable Groundwater Management Act, the State has oversight of groundwater management with continued local control. Because of the size, scale, and diverse characteristics in the state, an effective approach is integrated watershed management. The California Water Plan's toolbox of 30+ resource management strategies is intended to address various watersheds through a collaborative process. Some strategies will work in some areas but not in others. The Integrated Regional Water Management State grant program was implemented to incentivize more collaborative water planning, project selection, and implementation. To receive State funding, applicants need to collaboratively develop an integrated plan and identify actions or projects consistent with the Water Plan's resource management strategies.

[169] https://usbr.gov/watersmart/ The program is discussed in further detail under the Water Resource Management Strategies "Bucket."

[170] Surface Water/Groundwater Relationship in Arizona presentation by Jennifer Heim, Deputy Counsel, Arizona Department of Water Resources, October 2021 to WRP.

- Colorado: Colorado has a round table approach focused on basin planning. Colorado's surface and groundwater administration has been integrated per statute since 1969.[171]
- Nevada: Nevada recently established a water planning and drought resiliency section within the Division of Water Resources to update the state's more than 20-year-old water plan. Through the process, Nevada intends to update its basin-scale water budgets, engage in a collaborative process of taking and considering input from the public, local, and tribal communities and state and federal partners, and will utilize that input for the purpose of developing a contemporary framework for the management of the state's water resources.
- New Mexico: The Interstate Stream Commission is currently developing a 50-year Water Plan[172] with focus on water resiliency considering projected regional climate impacts on reduction of current water supplies, which is playing into ways to manage increasingly limited water resources to improve overall water supply resiliency and security.
- Utah: Utah has a rotating update of its state water plan focused on the major river basins in the state.

For water management strategies, project implementation often occurs at the local level. Strategic water planning between the local project sponsor and other federal and/or state agencies can help demonstrate the type of support needed and empower local regions to implement effective water management. This support, at times, can be provided through technical assistance, financial assistance, or both.

Best practices for policy planning and implementation that can be applied in the WRP Region. Key to this are the many MOUs, compacts and agreements, both existing and being negotiated, that impact who gets water, when and in what priority. These agreements are a major tool for implementing policy. Most project implementation occurs at the local level. Water planning helps determine how the state and federal agencies can best support and empower regions to do effective water management (i.e., technical assistance and/or financial assistance). Practices include:

- Increasing water security cost-effectively by leveraging funds across multiple water sectors.
- Understanding water demands and implementing policies to diversify water supplies.
- Co-managing surface and groundwater.
- Promoting multi-sector, multiple-benefit projects using built and natural infrastructure.
- Streamlining approval processes for plans/projects that create incentives.

[171] Colorado Legal Surface & Groundwater Interaction presentation by Tracy Kosloff, Deputy State Engineer, October 2021 to WRP.
[172] https://www.ose.state.nm.us/Planning/50YWP/index.php

- Tracking and reporting water security implementation successes.
- Addressing turnover among policy makers (new administrations etc.)
- Creating a water sub-cabinet.
- Strengthening federal-tribal-state-local partnerships.
- Aligning planning efforts to leverage resources. For example, aligning state planning documents and efforts such as a FEMA State Hazard mitigation plan that includes drought as a disaster so that the state may receive FEMA disaster funding for drought. FEMA funded drought mitigation projects include aquifer storage and recovery; retrofit water systems; and floodwater diversion and storage.[173]

From 2017-2018 forward, senior federal policy members have formed a "Water Subcabinet."[174] The Water Subcabinet can help solidify efforts that are occurring on several levels within federal agencies to work closely together on overlapping issues. States, tribes, and local entities can help federal agencies have a better understanding of the issues from their perspective. One example is the National Water Reuse Action Plan.[175]

Water Resource Management Strategies "Bucket"

The Water Resource Management Strategies Bucket worked to identify best practices and new technologies for implementing water resource management strategies to reduce water demand, increase supply reliability, improve quality, reduce flood risk (levee reinforcement/retrofit, overflow ponds/fields, etc.,) restore ecosystems, and ensure equity. The team recommends such strategies as regional/watershed-based planning; co-management by water sectors to plan and implement multi-benefit projects; and (current and future) water technologies to support water security, resilience, and sustainability.

Implementing water security efforts (e.g., conservation, efficiency, stormwater capture, reuse, etc.) based on the location, resources, and priorities of the impacted communities helps create water security in the most cost-effective means. Increasing water efficiency and conservation is a good starting point when evaluating how to meet water demands.

Water reuse is an important tool in areas facing water supply challenges, providing flexibility and helping to diversify water supplies. Reuse creates new water supplies which are often more drought-resistant than other water sources due to the continued availability of municipal wastewater even in times of drought. Although water reuse exists in a few Western states, it could be expanded to help address water supply issues.

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[173] FEMA Hazard Mitigation Assistance: Drought Resources, Funding and Projects by Mr. John Powderly, Grants and Planning Outreach Specialist, FEMA Region 9, March 2022.
[174] https://www.federalregister.gov/documents/2020/10/16/2020-23116/modernizing-americas-water-resource-management-and-water-infrastructure
[175] https://www.epa.gov/waterreuse/water-reuse-action-plan

Cost-effectiveness drives many decisions, including those made at a watershed or regional scale. Government can assist by providing technical and financial assistance and by empowering regional and watershed decisions. However, it is important to recognize that at inland locations water reuse generally reduces the volume of water returned to a stream which will the diminish the water supply for downstream users. Reduced in-stream flows may also negatively impact the aquatic environment in arid regions.[176]

As water scarcity issues continue, desalination, the removal of salts from brackish and sea water, can provide additional opportunities to create new water supplies. While desalination still faces challenges such as cost, energy intensity, and brine disposal, it is an important tool for stretching limited water supplies, especially in Western states.

This water management strategy is already in use in the WRP Region with facilities that desalinate sea water for coastal communities and brackish groundwater for inland water users. California, for example, has had desalination facilities for more than 10 years, and the Carlsbad Desalination Plant,[177] the largest seawater plant in the United States, delivers nearly 50 million gallons of desalinated water to San Diego County. There are several brackish desalination projects within the WRP Region, including the City of Camarillo's North Pleasant Valley Desalter Facility, the City of Oceanside's Mission Basin Groundwater Purification Facility, and the Water Replenishment District of Southern California's Regional Brackish Water Reclamation Program. The largest inland brackish water desalination plant in the world is the Kay Bailey Hutchison water treatment plant[178] in El Paso, Texas, which can produce 27.5 million gallons of water per day. The Brackish Groundwater National Desalination Research Facility[179] located in Alamogordo, New Mexico, brings together federal, state, and local agencies, private entities, universities, and other research organizations to work on desalination of brackish and impaired groundwater in inland states. Investments into operational desalination facilities could reduce requirements from freshwater sources.[180]

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[176] Thomson, B., Shomaker, J. (2009). Municipal Water Reuse Isn't Necessarily Conservation, New Mexico Water Dialogue, Santa Fe, NM, NM Water Dialogue, fall 2009 issue, pp. 3-4. https://nmwaterdialogue.org/wp-content/uploads/2019/11/dialog-fall-09.pdf).

[177] https://www.carlsbaddesal.com

[178] https://www.epwater.org/our_water/plants/kay_bailey_hutchison_wtp

[179] https://www.usbr.gov/research/bgndrf/#:~:text=The%20Brackish%20Groundwater%20National%20Desalination,opened%20on%20August%2016%2C%202007

[180] See California Water Plan Desalination Resource Management Strategy (2016) https://water.ca.gov/-/media/DWR-Website/Web-Pages/Programs/California-Water-Plan/Docs/RMS/2016/09_Desalination_July2016.pdf

Programs such as the Bureau of Reclamation's Desalination and Water Purification Research Program[181] and Desalination Construction Project Funding Opportunity provide grants to help advance water desalination methods and technologies, address challenges, and implement full scale desalination projects to provide new local water supplies.

An essential tool for improving water security is a comprehensive and authoritative water budget accounting system to quantify and track water uses, surface water and groundwater supplies/storage, water transport and transfers, and water markets/banking. USGS, NASA, Dartmouth Flood Observatory and Global Surface Water Explorer have created models of surface water based on catalogs of satellite imagery; their next challenge is connecting those maps to drivers (precipitation, diversions, etc.). To improve water security while managing water resources for sustainability and resilience, water policies, laws, regulations, data, and tools need to be better aligned and integrated to support and incentivize the management of water sectors from headwater to groundwater and implement multi-benefit projects that may cross regional and state boundaries.

Conservation practices do not always equate with significant savings and easing of water security issues if not combined with other water strategies such as repurposing of agriculture. Water-saving toilets required by a municipal code will not be adequate to overcome heavy pumping or surface water uses from industries that are not meaningfully curtailing water use.

Extreme events, both wet and dry, drive the need to plan and manage water systems and requires a watershed-scale approach for assessing vulnerability and risk and finding solutions. In addition to water conservation and efficiency, other strategies that can help are co-management of flood management systems, groundwater systems, and ecosystems, and developing projects that can benefit multiple sectors concurrently. Flood Managed Aquifer Recharge (Flood-MAR) is an example of this multi-sector approach. It safely applies flood flows on agricultural and working lands for groundwater recharge so they are more water secure during drier periods and droughts. Capturing and storing stormwater for subsequent reuse in most locations requires new infrastructure that is expensive and may be difficult to site. Further, in most states, stormwater runoff is an important component of a region's total water resources, and its capture and reuse may require acquisition of water rights.[182]

Conversion of land and water uses impacts water resources. According to an American Farmland Trust Report,[183] over the past two decades millions of acres of agricultural lands

[181] https://www.usbr.gov/research/dwpr/

[182] See Thomson, B. (2021). Stormwater Capture in the Arid Southwest: Flood Protection vs Water Supply, J. Water Resources Planning and Management, Am. Soc. Of Civil Engineers. 147(5): 02521003, 8 pp., https://doi.org/10.1061/(ASCE)WR.1943-5452.0001346)

[183] https://farmlandinfo.org/publications/farms-under-threat-the-state-of-the-states/

converted to urban and highly developed land use or low-density residential land use. Such changes typically require local zoning changes. A recent U.S. Geological Survey report[184] noted agricultural land's relatively greater use of ground and surface water; for example, irrigation accounted for 42 percent of freshwater withdrawals in 2015. In California, strategies[185] are under review to repurpose agricultural land that may not have sufficient supply as SGMA is implemented. The goal is to keep landowners on the land and manage the land for other private or public benefits, such as solar farms and groundwater recharge basins.

The water savings that can be realized through increased conservation measures provides more flexibility in many communities' water portfolios. For example, Nevada has new legislation on "non-functional grass"[186] and California has "Cash for Grass,"[187] where several water suppliers and agencies have provided incentive programs to provide funding to residents who replace grass with more native, drought-resistant landscaping.

The Water Resource Management Strategies team recognized that having a diverse portfolio of cost-effective water management strategies (for example, California Water Plan 30+ Resource Management Strategies, described below) assists to reduce demand, reduce flood risk, increase supply reliability, improve quality, and restore ecosystems. The California Water Plan strategies could serve as a platform for other entities to consider and serve as a catalyst to advance their efforts.

Additional State of California Examples:
Over the last 15-20 years, California has compiled various resource management strategies. The current California Water Plan identified 30 plus resource management strategies to address diversifying regional water portfolios. Efforts should be tailored to regions/watersheds, given their uniqueness. Water sector multi-benefit projects need funding. Navigation and sediment management strategy need to be added as they are unique subject matters.

California Department of Water Resources is expediting ground water recharge, including those that would reduce flood risks (i.e., flood managed aquifer recharge or flood-MAR) to take advantage of potential wet periods in this upcoming winter season. Successful project

[184] https://www.ers.usda.gov/topics/farm-practices-management/irrigation-water-use/
[185] http://blogs.edf.org/growingreturns/2021/03/25/land-repurposing-california-farmland-groundwater-sustainability/?utm_source=mailchimp&utm_campaign=growing-returns_none_upd_dmt&utm_medium=email&utm_id=1535390022
[186] https://www.leg.state.nv.us/App/NELIS/REL/81st2021/Bill/7910/Overview
[187] www.water.ca.gov/Work-With-Us/Grants-And-Loans/Turf-Replacement

components can implement flood-MAR and waive the CEQA (the California Environmental Quality Act) for that particular action.[188]

The California Water Resilience Portfolio is a joint roadmap by three agencies: California Natural Resources Agency, California Environmental Protection Agency, and Department of Food and Agriculture, as directed by the Governor's 2020 executive order. The principles for developing the Portfolio are[189]:

- Prioritize multi-benefit approaches that meet several needs at once
- Utilize natural infrastructure such as forests and floodplains
- Embrace innovation and new technologies
- Encourage regional approaches among water users sharing watersheds
- Incorporate successful approaches from other parts of the world
- Integrate investments, policies, and programs across state government
- Strengthen partnerships with local, federal, and tribal governments, water agencies and irrigation districts, and other stakeholders.

In 2013, the California Council on Science and Technology (California Council on Science and Technology (CCST) published a water technology roadmap identifying information gaps and needed research/studies to advance an array of water technologies Achieving a Sustainable California Water Future through Innovations in Science and Technology - California Council on Science & Technology (CCST). Their key recommendations are included in CA Water Plan Update 2013. It is recommended that additional research and pilot projects would assist to fill the information gaps:

- Transferability of the reviewed strategies
- Limitations/barriers to existing strategies and technologies
- Whether identified strategies meet the needs for water security
- How to identify persistent gaps

The use of modeling tools can help with the development and implementation of water management strategies, including management of non-traditional water. For example, Nevada is partnering with the Desert Research Institute (DRI) and U.S. Geological Survey (USGS)[190] to create a groundwater model for the Humboldt River region, which encompasses roughly a third of the state. This will help account for groundwater and surface water, provide better understanding of where groundwater use captures surface water flow and aide decision-making . Recognizing the connectivity of groundwater and surface water has driven Nevada to develop the science to make informed management decisions. Analyzing the interaction between surface water and groundwater could lead to

[188] Noted during August 10, 2022, WRP Water Security Deep-Dive Call.
[189] https://waterresilience.ca.gov/ and https://water.ca.gov/Programs/California-Water-Plan/Update-2018
[190] https://www.usgs.gov/centers/nevada-water-science-center/science/science-humboldt-river-basin

improvements in water management as previously overlooked opportunities are recognized, such as using flood waters to replenish depleted aquifers.

Federal agency examples

The U.S. Department of Agriculture's (USDA) National Resources Conservation Service (NRCS)[191] is working on an Interim Practice Standard (conservation practice standards) where farmers and ranchers could be eligible for payments for adopting and implementing groundwater recharge practices. USDA works to help private landowners, farmers, ranchers, and foresters specifically implement conservation practices and approaches that help preserve water resources. They do this in cover crops conservation, center-pivot irrigation, and prescribed grazing in other areas. The NRCS addresses cover crops; it implemented plans for 3.1 million acres just for fiscal year 2020. In 2020, they had more than 600,000 acres in no-till status, more than 400,000 in reduced-till status, and more than 3.6 million acres of prescribed grazing. With various conservation practices, especially water support work, farmers have been able to produce a bushel of corn with less irrigation water, energy, erosion, and greenhouse gas emissions.

Reclamation's WaterSMART Program offers grant opportunities for states, tribes, irrigation districts, municipalities, and others who manage and deliver water to improve their water delivery systems, to better prepare for drought or to plan for or construct water reuse projects, etc. The WaterSMART Program website provides access to lists and descriptions of projects[192] that have been funded through WaterSMART. The size and scope of these projects range from $75,000 to $2 million or more. The Infrastructure Investment and Jobs Act[193] appropriated $1.65 billion for WaterSMART activities.

Reclamation's Basin Study Program[194] cost shares with non-federal partners to evaluate water supply and demands. Through the program Reclamation works with stakeholders to identify strategies to address water supply and demand imbalances and help ensure reliable water supplies. To perform this analysis, Basin Studies include: 1) state-of-the-art projections of future supply and demand, 2) an analysis of how the basin's existing water and power operations and infrastructure will perform in the face of changing water realities, 3) development of strategies to meet current and future water demand, and 4) a trade-off analysis of strategies identified. The program is organized under WaterSMART.

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[191] Presentation by Gloria Montaño Greene, Deputy Under Secretary for Farm Production and Conservation, U.S. Department of Agriculture to WRP, October 2021.

[192] https://usbr.maps.arcgis.com/apps/MapJournal/index.html?appid=043fe91887ac4ddc92a4c0f427e38ab0

[193] Public Law No: 117-58; H.R. H.R.3684

[194] https://usbr.gov/watersmart/bsp/index.html

Another example from Reclamation is the Native American Affairs Technical Assistance Program.[195] The program provides technical assistance through cooperative partnerships with Indian tribes and tribal organizations. Work under the program can be carried out in different ways, including by Reclamation under a cooperative agreement, by tribes under Public Law 93-638, or in the form of training in the use, protection, and development of water resources. To be eligible activities must satisfy program criteria, and applications are accepted annually through funding opportunity announcements. Total funding for the program ranges between $2 and $3 million per year.

As the sole science agency for the Department of the Interior, the U.S. Geological Survey (USGS) works with Federal, Tribal, State, and local partner agencies "to monitor, assess, conduct targeted research, and deliver information on a wide range of water resources and conditions including streamflow, groundwater, water quality, and water use and availability."[196]

Much of this work in the West is carried out by USGS Water Science Centers (WSCs), with additional contributions from other science centers in the Southwest Region.[197] The data, information, and decision support tools provided by USGS are used every day by water managers to enhance and protect water security in all regions of the nation. For example, the USGS California WSC[198] partners with more than a hundred agencies on a very broad range of topics related to securing water quantity and quality for human and environmental uses at multiple spatial and temporal scales throughout California. This includes: streamflow monitoring providing real-time data used by water managers to address water security issues associated with floods and droughts, extensive "physics to fish" monitoring, studies in the California Bay-Delta informing Federal and State water project operations and ecosystem restoration in this critical water infrastructure hub, reservoir storage assessments, and watershed monitoring, modeling, and research studies providing information on watershed management challenges including drought and wildfires, climate change, ecosystem restoration, and dam removal. The California WSC also conducts state-wide groundwater quality assessment programs providing data and information needed by partner agencies to protect groundwater supplies from pollution and basin-scale groundwater availability and use assessments informing California's Groundwater Sustainability Plans and Agencies. These assessments often include integrated hydrologic modeling of surface and groundwater flow systems and consideration of management

[195] https://www.usbr.gov/native/programs/TAPprogram.html
[196] Water Resources | U.S. Geological Survey (usgs.gov)
[197] Water Resources Mission Area: Science Centers and Regions | U.S. Geological Survey (usgs.gov)
[198] California Water Science Center | U.S. Geological Survey (usgs.gov)
[5] Scanlon, B.R., Reedy, R.C., Faunt, C.C., Pool, D. and Uhlman, K., 2016. Enhancing drought resilience with conjunctive use and managed aquifer recharge in California and Arizona. Environmental Research Letters, 11(3), p.035013.

strategies such as managed aquifer recharge and conjunctive water and management challenges such as land subsidence from groundwater overdraft. Recently published efforts have focused on aquifer overdraft during drought and the application of managed aquifer recharge to mitigate drought effects. [199,200]

The USGS Western Geographic Science Center also leads multiple projects focused on a variety of water security issues. The USGS Aridland Water Harvesting Study conducts research on natural infrastructure being used to create water security and mitigate the impacts of climate change.[201] People living in water-limited environments have used rock detention structures to conserve water resources for food production for millennia. More recently, these same structures are being installed to restore dryland channels with multiple long-term benefits and can help achieve sustainable development goals with socio-environmental impartiality.[202, 203] Rock detention structures can increase carbon storage and

[199] Levy, Z.F., Jurgens, B.C., Burow, K.R., Voss, S.A., Faulkner, K.E., Arroyo-Lopez, J.A. and Fram, M.S., 2021. Critical aquifer overdraft accelerates degradation of groundwater quality in California's Central Valley during drought. Geophysical Research Letters, 48(17), p.e2021GL094398.

[200] Scanlon, B.R., Reedy, R.C., Faunt, C.C., Pool, D. and Uhlman, K., 2016. Enhancing drought resilience with conjunctive use and managed aquifer recharge in California and Arizona. Environmental Research Letters, 11(3), p.035013.

[201] Norman, L.M. Ecosystem Services of Riparian Restoration: A Review of Rock Detention Structures in the Madrean Archipelago Ecoregion. *Air, Soil and Water Research* 2020, *13*, 117862212094633, doi:10.1177/1178622120946337.

[202] See note 36.

[203] Norman, L.M. Invited Commentary: Dryland Watershed Restoration with Rock Detention Structures: A Nature-Based Solution to Mitigate Drought, Erosion, Flooding, and Atmospheric Carbon. *Front. Environ. Sci.* 2022, *9*.

sequestration,[204] increase water quality and quantity,[205, 206, 207, 208] buffer flood events,[209, 210, 211] improve vegetation health and longevity,[212, 213] reduce erosion and NPS pollution[214, 215] and help address global warming.[216]

These low-tech, low-cost rock detention structures are sustainable, nature-based solutions to address climate change.[217] One option to consider is using tradeoffs among ecosystem services to safeguard ephemeral riparian areas and promote conservation of wetlands (i.e., to offset footprints of groundwater pumping downstream through the investment of rock

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[204] Callegary, J.B.; Norman, L.M.; Eastoe, C.J.; Sankey, J.B.; Youberg, A. Preliminary Assessment of Carbon and Nitrogen Sequestration Potential of Wildfire-Derived Sediments Stored by Erosion Control Structures in Forest Ecosystems, Southwest USA. *Air, Soil and Water Research* 2021, *14*, 117862212110017, doi:10.1177/11786221211001768.

[205] Norman, L.M.; Brinkerhoff, F.; Gwilliam, E.; Guertin, D.P.; Callegary, J.; Goodrich, D.C.; Nagler, P.L.; Gray, F. Hydrologic Response of Streams Restored with Check Dams in the Chiricahua Mountains, Arizona. *River Res. Applic.* 2016, *32*, 519–527, doi:10.1002/rra.2895.

[206] Norman, L.M.; Villarreal, M.L.; Pulliam, H.R.; Minckley, R.; Gass, L.; Tolle, C.; Coe, M. Remote Sensing Analysis of Riparian Vegetation Response to Desert Marsh Restoration in the Mexican Highlands. *Ecological Engineering* 2014, *70C*, 241–254, doi:10.1016/j.ecoleng.2014.05.012.

[207] Norman, L.M.; Callegary, J.; Lacher, L.; Wilson, N.; Fandel, C.; Forbes, B.; Swetnam, T. Modeling Riparian Restoration Impacts on the Hydrologic Cycle at the Babacomari Ranch, SE Arizona, USA. *Water* 2019, *11*, 381, doi:10.3390/w11020381.

[208] Norman, L.M.; Niraula, R. Model Analysis of Check Dam Impacts on Long-Term Sediment and Water Budgets in Southeast Arizona, USA. *Ecohydrology and Hydrobiology* 2016, *16*, 125–137, doi:10.1016/j.ecohyd.2015.12.001.

[209] See note 40.

[210] Norman, L.M.; Huth, H.; Levick, L.; Shea Burns, I.; Phillip Guertin, D.; Lara-Valencia, F.; Semmens, D. Flood Hazard Awareness and Hydrologic Modelling at AmbosNogales, United States-Mexico Border. *Journal of Flood Risk Management*2010, *3*, 151–165, doi:10.1111/j.1753-318X.2010.01066.x.

[211] Norman, L.M.; Levick, L.R.; Guertin, D.P.; Callegary, J.B.; Quintanar Guadarrama, J.; Zulema Gil Anaya, C.; Prichard, A.; Gray, F.; Castellanos, E.; Tepezano, E.; et al. Nogales Flood Detention Study. *U.S. Geological Survey Open-File Report*2010, *2010–1262*, 112, doi:https://doi.org/10.3133/ofr20101262.

[212] See note 41.

[213] Wilson, N.R.; Norman, L.M. Analysis of Vegetation Recovery Surrounding a Restored Wetland Using the Normalized Difference Infrared Index (NDII) and Normalized Difference Vegetation Index (NDVI). *International Journal of Remote Sensing*2018, *39*, 3243–3274, doi:10.1080/01431161.2018.1437297.

[214] Norman, L.M.; Niraula, R. Model Analysis of Check Dam Impacts on Long-Term Sediment and Water Budgets in Southeast Arizona, USA. *Ecohydrology and Hydrobiology* 2016, *16*, 125–137, doi:10.1016/j.ecohyd.2015.12.001.

[215] See note 43.

[216] Norman, L.M.; Ruddell, B.L.; Tosline, D.J.; Fell, M.K.; Greimann, B.P.; Cederberg, J.R. Developing Climate Resilience in Aridlands Using Rock Detention Structures as Green Infrastructure. *Sustainability* 2021, *13*, 11268, doi:10.3390/su132011268.

[217] See note 38.

detention infrastructure or to compensate practitioners if they can be used to offset greenhouse gas emissions).[218]

The U.S. Environmental Protection Agency facilitated the development of the National Water Reuse and Action Plan (WRAP).[219] The WRAP, meant to be a collaborative effort, brings together different sectors: federal, state, and local government, industry, non-profit, etc. The WRAP includes a significant amount of work around storm water capture, aquifer storage and recovery, and water reuse. It defined approximately fifty actions and addresses policies, practices, regulations, fit-for-use specifications, research, financing, public outreach, and education. For example, the plan includes how to deal with pharmaceuticals in water, so people have a place to take their unused pharmaceuticals and avoid wastewater treatment challenges.

DoD has focused on tying water specifically to mission and cannot look outside that lens. It is addressing basic questions such as "Where are your water sources? What is your use rate? What are your present and future needs? What is or will be available?" The DoD threat assessment includes looking at water, energy, cyber, etc. DoD is trying to work outside of their fence line, working with privatized water and utility providers.

Additional DoD/military examples include:

Fort Huachuca: A military installation in southeast Arizona, Fort Huachuca has quantified its water rights while also considering endangered species issues and critical habitat for several species. They pursued and cut their per capita water usage down to the point that in some parts of the installation, they are using less than 100 gallons per person, per day. They now pump about 1,100 acre-feet a day on the installation proper, down about two-thirds from what they pumped in 1995. This shows the tremendous job of conserving water they have accomplished. In further assisting the community, the Fort paid for a sewage pipeline from nearby Huachuca City and treats that effluent and its own and pumps the treated water into recharge wells to enhance the aquifer. Even with the use of a local town's wastewater, the Fort will be upgrading their water treatment plant to treat more concentrated effluent. This is one of the unintended consequences of conservation.

Indian Wells Valley Groundwater: Past Kern County General Plan revisions allowed for areas zoned for agriculture to pump groundwater without any control or management, to the point where the Indian Wells Valley is now considered by California's DWR as a critically over-drafted basin. Citizen challenges and a 2014 engineering report validated the overdraft as a significant issue. In 2015, Kern County rezoned agriculture from 32,000 to 7,000 acres. Since California passed SGMA in 2014, the Indian Wells Valley Groundwater Authority has

[218] See note 36.

[219] https://www.epa.gov/waterreuse/water-reuse-action-plan

developed a groundwater sustainability plan that was recently approved by DWR. The plan consists of drawdown of agricultural pumping and a reliance on imported water. There are currently multiple lawsuits underway, including a comprehensive adjudication. There is much at stake. In particular, the Navy's mission at Naval Air Weapons Station China Lake is critical and if the sustainability plan fails, and groundwater continues to be depleted, the ability of the Navy to conduct its mission at China Lake could be severely impacted.

Data "Bucket"

The Data Bucket team worked to develop an understanding of scientific data to support water availability and infrastructure capacities in the WRP Region and identify gaps and best practices. Data are lacking, not readily available, inaccessible, not machine-readable/interoperable, or uncommunicated or known. Data are essential in managing water resource systems and are used in operations, modeling, forecasting, planning, and other disciplines. Many federal, state, and local governments collect and provide water resource data for both agency and public use. Non-government organizations, consulting firms, and others also collect water resource data. Data stewards manage data to meet the needs of their organization. Since organizations have different needs, there can be inconsistencies between organizations on the collection and sharing of these data. Entities often will work together to leverage each other's programs and improve the final product. Individuals working in water resources need to understand the attributes of the data they are working with to successfully implement their policies and programs. The following provides some examples of both government and non-government data collection efforts.[220]

The Western States Water Council's Water Data Exchange Program (WaDE)[221] was created to provide better access to water allocation, supply, and demand data maintained by state and other governmental agencies under a complex system of water rights. These data provide information on water rights sites, aggregated area water use, site specific time series, and regulatory area overlay.

The Infrastructure Investment and Jobs Act[222] recognized the Internet of Water Principles to improve water data sharing and better inform water management decisions.[223] A new EPA

[220] The team captured a helpful list of currently available data; some are highlighted in this chapter. For further details including examples of effective open water data networks and systems, please see attached Excel spreadsheet.
[221] https://www.westernstateswater.org/wade/
[222] Public Law No: 117-58; H.R. H.R.3684
[223] https://internetofwater.org/internet-of-water-principles/

grant program will initiate state-based water data-sharing pilot programs[224] using the Internet of Water Principles.

The National Oceanic and Atmospheric Administration (NOAA) has established two River Forecast Centers serving the WRP Region: one for the Colorado Basin, and one for California and Nevada. They provide water supply and water availability forecasts for significant reservoirs and river locations to inform water security decisions across the West that allocate precious water resources.[225]

High-level National Aeronautics and Space Administration (NASA) data sets have been developed in partnership with several state partners in the West, including improved products on snow water equivalent, both satellite and airborne. These include infrared satellite images of changes in groundwater levels, in very coarse spatial scales. NASA is partnering with the California DWR to support the expansion of airborne information snow pack and aquifer structure using airborne electromagnetic (AEM) surveys. NASA is also conducting joint research with Stanford to incorporate data from satellites and airborne platforms to improve modeling of changes in water levels using well data, satellite, and airborne data together.

USGS collects hydrologic data and conducts focused studies in cooperation with other Federal and State entities. The integration of natural-science disciplines produces extensive, comprehensive, peer-reviewed science and actionable data. The USGS is uniquely positioned to develop and manage the leading edge of institutional mechanisms to promote co-production of knowledge processes while ensuring that agencies maintain appropriate validation standards for data quality and dissemination. The National Water Information System (NWIS) is the USGS enterprise system supporting the storage, processing, and delivery of real-time and historic water data. In 2022, the USGS is focused on rebuilding water use databases into a single streamlined data system, building a new storage and delivery system for discrete groundwater and water-quality data, and enhancing user centered data delivery in NWIS and other major data repositories such ScienceBase.[226]

The NRCS Snow Survey and Water Supply Forecasting (SSWSF) Program is the foremost collector of high-elevation snow data in the Western United States. Snowmelt irrigates the West, delivering nearly 75 percent of the region's water supply. SSWSF provides snowpack information, water supply forecasts, and other climatic data to water users and managers throughout the West. NRCS field staff and cooperators gather snow depth, snow water

[224] https://www.congress.gov/117/plaws/publ58/PLAW-117publ58.pdf
[225] NOAA Precipitation and Water Supply Services presentation by Jeffrey R. Zimmerman, NOAA/National Weather Service/Western Region, Deputy Regional Director, May 2021 to WRP.
[226] www.sciencebase.gov/about/

equivalent, and other parameters such as precipitation, temperature, and soil conditions at thousands of remote mountain sites. These data are analyzed to provide estimates of water availability, drought conditions, and flooding potential. The snow data and water supply forecasts are used by farmers, ranchers, irrigation districts, and soil and water conservation districts; municipal and industrial water providers; hydroelectric power utilities; fish and wildlife management; reservoir managers; recreationists; tribal nations; federal, state, and local government agencies; and the countries of Canada and Mexico.

The SSWSF Program has been operating since 1935 and is designated as a cooperative effort because it operates with assistance from, and in cooperation with, public and private entities that rely on consistent and accurate water supply and hydrograph timing forecasts. Although most funding and field efforts are through the agency, the partners and cooperators provide a share of the financial burden and contribute to data-collection activities. The SSWSF Program collects and distributes data from over 1,300 manually measured snow courses, aerial markers, and cooperator sites in the United States and in watersheds that drain into the United States. The SSWSF also maintains 923 automated Snow Telemetry (SNOTEL), SnoLite, and hydromet sites. Finally, the National Water and Climate Center operates 217 automated Soil Climate Analysis Network (SCAN) stations across the United States.

The Bureau of Reclamation developed the Reclamation Information Sharing Environment (RISE), an open data system for viewing, accessing, and downloading water-related data from a centralized data portal and in machine-readable formats. RISE replaces the Reclamation Water Information System, which was retired in 2020.

Data Observations: The Data team noted there is much fragmented data and recommend the following areas need additional interoperable data to assist with water monitoring, forecasting, and planning:

- Groundwater and surface water delivery, quantity, quality, and use
- Improve forecasts of water availability and demand
- Environmental flow requirements
- How to measure consumptive use. OpenET[227] released a Data Explorer providing accessible satellite-based estimates of evapotranspiration (ET) for improved water management across the Western United States.

The Data team recognizes that no data provider can provide access to all needed water data, but offers the following data-related questions (use-cases) needed to inform water management decisions for consideration of future design of data services and portals:

- How many water rights are available in the X area, what are their priority dates, owners, permitted flow and volume, and for what beneficial uses?

[227] https://openetdata.org

- How much water is available in streams and reservoirs in the Y area over the past T years?
- What is the water quality in streams and wells in the R area?
- What is the available or planned water infrastructure in the D area?
- What is the cost of water for urban and agriculture use over the past T years in the W area?
- What is the per capita water use in the C area over the past T years?
- What is the consumptive use for agriculture in the E area?
- What are the major water users in the U area?
- What is the water budget in the X watershed?
- How are non-traditional waters to be accounted for?

WRP Water Security Deep-Dive Observations

Conducting the Water Security Deep-dive with focus on the four buckets allowed for a more in-depth consideration of issues and identifying cross-cutting areas of commonality and recommendations. This section includes observations on financing/funding, enforcement/implementation, challenges and areas of potential WRP Partner commonality to better address Water Security efforts.

Financing/funding: When thinking about multi-sector management, and combining projects that provide multiple benefits, invariably the issue of funding comes up. While there is already coordination among Federal agencies to implement projects with multiple benefits, additional work can be done to enable agencies to fund these types of projects.

Implementation/Enforcement: Aligning regulatory implementation provides for improved coordination among agencies so that the projects may be developed in a more efficient way without weakening regulations.[228] Some states face challenges administering water resources within the Prior Appropriations Doctrine and court decisions may complicate the matter. Proactive implementation should be practiced encouraging voluntary implementation of water security measures. Court ordered and statutory enforcement can be difficult for a variety of reasons (including staffing) but may be necessary. Mechanisms should be in place to ensure compliance with water rights and statutes like the Clean Water Act.

Challenges. The WRP Water Security Deep-Dive team through this effort has increased awareness of the water security issues through the "bucket" analysis and better understand their independencies and commonalities. However, water issues are complex and there remain differences of opinions on key items such as management of transboundary waters

[228] https://resources.ca.gov/Initiatives/Cutting-the-Green-Tape and https://calandscapestewardshipnetwork.org/cutting-green-tape

(including ground water). Many aquifers cover multiple jurisdictions, may be called different things, and may be subject to different water laws governing development of the water resource.

Areas of Potential WRP Partner Commonality to better address Water Security efforts.

Understanding how much water is available, matching polices with this information, and diversifying water supplies are critical tasks. Within government (tribal, local, state, and federal), best practices and good information sharing will continue to address water security and provide for sustainable water supplies. A desire to continue to improve these practices between government agencies could improve future results. Some areas WRP has identified for increased collaboration include recognizing the driver between water and economics, evaluating water security at a watershed level, continued strengthening of partnerships, and looking at projects that provide multiple benefits to different sectors and promote diversification.

A holistic guide that highlights how to write water policy planning documents would be helpful. It should incorporate how to plan, what should be included in a planning document, how to finance a project, and who should be involved. One of the foundations of water planning is estimating how much water is available, both in terms of hydrology and water rights, and the inclusion of non-traditional waters as those become a greater part of the water supply. *The Principles and Requirements for Federal Investment in Water Resources*[229] provides a framework for evaluating water resource investments. Federal agencies should continue to use this report, along with complementary agency-specific policies, with the goal of implementing successful water resource projects. As part of this process, agencies should continue working with local project sponsors, management entities, and communities as they play an integral part in watershed management.

Recommendations

The WRP Water Security Team felt this exercise helped demonstrate the importance of good communication and exchange of information. Recognizing that there will be that next big flood and other droughts and trying to develop a holistic approach can help state, federal and tribal authorities and private parties prepare and utilize these extremes for mutual benefit. Drought is one of those disasters that must be constantly monitored, and improvements considered. There remain opportunities to leverage federal funding in conjunction with state funding programs and identifying how authorities and planning can be more synergistic. Federal and state funding that connects with the strategies and recommendations in this report will greatly assist water security efforts in the WRP Region.

[229] https://www.doi.gov/sites/doi.gov/files/migrated/ppa/upload/PR-G-FAQ-draft021220.pdf

- **Reduce government silos** and always think about drought. More collaboration could identify opportunities to help leverage efforts, for example, flood flow studies combined with water supply and conservation projects. Planning multi-benefit projects with multiple sectors working together should be encouraged.
- **Continue efforts to leverage resources.** There is already much coordination among many agencies on such items as data networks or other water security projects. Agencies frequently use and depend on another agency's data resources such as the NRCS Snow Survey and Water Supply Forecasting (SSWSF) Program uses USGS Streamflow gauges for forecasts. Most states have soil moisture networks that contribute to the National Coordinated Soil Moisture Monitoring Network. If one agency has budget cuts or decides not to fund their part of a long-term project or network, it impacts other agencies (E.g., data and multiple agency projects). As it relates to water security, the budgets of each agency are important to other agencies, so it is important to coordinate efforts, networks, and projects to support water security development more fully.
- **Include drought as a disaster in state planning documents** (e.g., State Forest Action Plan, Hazard Mitigation Plans, etc.) so that the state may receive federal (e.g., FEMA disaster) funding for drought.
- **Align federal, state, tribal and local planning documents so that efforts are cohesive and coordinated.** Proactively address conflicts that arise in the planning documents. Look for opportunities to augment efforts.
- **Removing barriers so federal agencies can assist quickly.** The record-setting drought in the West highlights the importance of water security. Watershed assessments throughout the West will improve our understanding of what to expect with climate change. Future drought studies will need to evaluate future climate and hydrologic scenarios to determine what issues exist and how they can be alleviated. It would be helpful to identify if any additional mechanisms are needed to provide rapid response assistance for communities experiencing drought. **The best drought responses will be in alleviating the immediate problems and laying the groundwork to become better prepared for the next drought. Work today on water security is very consequential and will position Western states for more effective drought responses.**
- **Implement policies to help alleviate future disasters.** For example, California Department of Water Resources' expediting ground water recharge, including those that would reduce flood risks (i.e., flood managed aquafer recharge or flood-MAR) to take advantage of potential wet periods in this upcoming winter season, and streamlining processes to get this done quickly.
- **There is a need to address tribal water rights to provide certainty for all water users**. Fewer than 50 federally recognized tribes in the lower 48 have resolved water rights, leaving hundreds of tribes with unresolved water rights. Individual Indian allotments are also entitled to settled water rights under the *Winters* doctrine. Some

allotments are not on reservations. These often do not clearly allocate water rights. Benefits of negotiated settlements include resolving federal reserved water rights claims with the least disruption to existing water uses and providing greater certainty allowing for better planning.

- **Develop a diverse portfolio of cost-effective water management strategies** (for example, California Water Plan 30+ Resource Management Strategies) assists to reduce demand, reduce flood risk, increase supply reliability, improve quality, and restore ecosystems. The California Water Plan strategies could serve as a platform for other entities to consider and as a catalyst to advance their efforts.
- **Conduct Watershed Assessments throughout the West to improve our understanding of what to expect with climate change.** For example, according to the California Department of Water Resources, the Merced River flood capacity is 6,000 cubic feet per second (cfs), and their analysis shows that by 2070, at a 50% likelihood (not worse case), peak flood flow could be over 42,000 cfs (seven-fold above flood capacity). Adapting to this level of climate vulnerability requires strategies that are well outside what has been done so far. It will require watershed-scale strategies (from headwaters to groundwater) that are multi-sector and multi-benefit in nature, such as using flood waters to recharge depleted aquifers (Flood-MAR).
- **Better communication** is needed to create understanding of efforts such as with the White House Drought Resilience Interagency Working Group[230, 231] and the National Drought Resiliency Partnership (NDRP)[232]. The NDRP works on designated items of long-term thinking and mid-term planning for drought resiliency and support work, from data to action to coordination. The White House Drought Interagency Working Group is co-chaired by the Departments of Interior and Agriculture and provides short-term relief and short-term plans. There appear to be opportunities to leverage efforts and not duplicate, improving the effectiveness of these efforts. Different entities have different needs, but it is useful for those groups to communicate with one another.
- **Develop a water security definition.** A Federal government-wide definition would be helpful. Perhaps the Water Subcabinet could address this issue. In preparation of developing the WRP Water Security definition, team members submitted their respective agency's water security definition (Exhibit X). Despite the critical issue of water security, many agencies do not have a definition.

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[230] https://www.doi.gov/pressreleases/white-house-launches-drought-relief-working-group-address-urgency-western-water-crisis

[231] https://www.whitehouse.gov/wp-content/uploads/2022/05/DroughtIWGReport_Final_Embargoed-Until-June-1-at-6AM-ET.pdf

[232] https://www.drought.gov/about/partners#:~:text=With%20a%20focus%20on%20building%20long-term%20drought%20resilience%2C,of%20drought%20events%20on%20livelihoods%20and%20the%20economy.

- **Continue WRP Water Security Deep-Dive.** Finally, the WRP Water Security Team recommends that they continue their efforts in 2023. Water Security is a very complicated, critical, and difficult topic. This team represents subject matter experts in the areas of water planning, legal, data, best practices, funding/financing and management from state, federal and tribal entities. Over the next year the team will continue to collaborate on water security with focus on the recommendations in this report.

WRP Tribal Engagement Temporary Working Group

Tribal Engagement Temporary Working Group (TETWG)

TETWG Recommendation for 2022 WRP Principals' Meeting Action:

Given the tremendous forum provided by the WRP TETWG, by consensus the WRP TETWG recommended that it become a permanent Committee called the WRP Tribal Engagement Committee. Tribal members are still encouraged to participate in all WRP Committees. Their expertise is needed and sought. It is hoped that making a Tribal Committee permanent will encourage more tribal participation in WRP. Co-Chairs should interface with other committees to ensure representation on cross-cutting topics once this new Tribal committee is established.

Background

Within the WRP Region there are 172 Federally Recognized Tribes.[233, 234] Federally Recognized Tribes "*are acknowledged to have the immunities and privileges available to federally recognized Indian Tribes by virtue of their government-to-government relationship with the United States as well as the responsibilities, powers, limitations, and obligations of such Tribes*."[235] The percentage of Indian Trust land within each of the WRP States ranges from 0.5% to 27.6%. At the 2017 WRP Principals' Meeting, a Tribal Caucus was held, and a brief drafted outlining the request to stand up a WRP Tribal Engagement Temporary Working Group (TETWG). This was not intended to supplant any existing forums for tribal-agency engagement.

TETWG Focus

The TETWG held regular calls that have facilitated information-sharing among tribal members and state and federal agencies in the WRP Region; sought tribal input on WRP efforts; and received updates on timely and important issues. The TETWG served as an effective forum to empower technical staffs from multiple agencies to find innovative, cross-program solutions to identified tribal issues. As expressed by one long-time tribal representative in WRP, the WRP provides another level of communication among tribal leadership, tribal staff, tribal organizations, federal or state leadership, and specialists

[233] Some States recognize tribes that are not Federally Recognized.
[234] The latest list of Federally recognized Tribes is found at 87 FR 4636, https://www.govinfo.gov/content/pkg/FR-2022-01-28/pdf/2022-01789.pdf
[235] *Id.*

working to achieve effective outcomes, and this Working Group has assisted to promote outreach to tribes to obtain greater engagement in WRP. TETWG guiding principles and areas of collaboration included:

- WRP seeks to increase tribal participation
- WRP is a forum that empowers technical staffs from multiple agencies to find innovative, cross-program solutions to identified tribal issues
- WRP continues to honor the government-to-government relationship unique to tribal sovereign nations, and to foster a collaborative atmosphere that generates solutions to tribal issues, while recognizing that no tribal entity speaks for another
- WRP does not supplant or usurp federal agencies' responsibilities to consult with tribes
- Tribes engaged in WRP have identified and applied solutions to priority issues that would not have been possible but for WRP. Many WRP Partners provide technical support and assistance.

WRP TETWG Subcommittee Actions

To delve into issues more fully, the WRP TETWG established two subcommittees: funding and outreach. The outreach subcommittee goal was to develop communication/outreach plan to encourage additional Tribal participation in WRP; as much as possible, it will leverage existing structures. Given the profound impact of Covid on tribal nations the outreach subcommittee took a hiatus for a time. Current solution sets they are working through are:

- Continue communications to TETWG and seek input on ways to augment efforts
- Continue to hold TETWG outreach subcommittee calls; seek additional input and participation
- Empower TETWG members to reach out to their colleagues and invite them to participate in WRP
- Present WRP to existing Tribal organizations
- Ask Regional, State and National Tribal Organizations and State/Federal agencies for information on Tribal events to share with the TETWG

The Funding Subcommittee completed its duties and offered this Report Out that was delivered to the WRP TETWG:

In 2021, the WRP TETWG established a funding subcommittee to explore availability and accessibility of grants and resources available for tribal projects and provide recommendations. This document highlights the subcommittee's findings, resources identified, and recommendations that were presented and accepted by the WRP TETWG for action.

WRP TETWG Funding Subcommittee Findings:

- Although there are many resources available to Tribes in a variety of categories (i.e., natural resources, energy, training, etc.), finding them can be difficult and sometimes burdensome to apply for or to meet non-federal cost-share requirements.
- Significant resources would be required to create and maintain a new system to find grants searchable by tribal set-asides, cost-share requirements, etc.
- Some Tribes are very sophisticated in leveraging funds for projects and there are training resources to assist tribes.
- It helps for federal and state agencies to work together in a cohesive fashion to provide information on grants and funding opportunities and how funds might be matched.
- Tribal needs remain, including additional funding, knowledge of funds, capacity building, etc.

Available Funding Related Resources:

- Federal Agency Information: Contact information for U.S. federal government departments and agencies.[236]
- Executive Order 13175 Consultation and Coordination with Indian Tribal Governments (authority for federal executive agencies). The stated purposes of this Executive Order are *"to establish regular and meaningful consultation and collaboration with tribal officials in the development of Federal policies that have tribal implications, to strengthen the United States government-to-government relationships with Indian tribes, and to reduce the imposition of unfunded mandates upon Indian tribes."* To carry this out, agencies are required to seek ways in which to streamline processes for tribal waivers of statutory and regulatory requirements where appropriate. [237]
- Grants Learning Center for general information about federal grants[238]
- Grants.gov is a searchable database designed to enable federal grant-making agencies to create funding opportunities and applicants to find and apply for these federal grants.[239]
- Online Catalog of Federal Domestic Assistance (CFDA) - Official U.S. government website for people who make, receive, and manage federal awards.[240]
- Federal Grant Resources[241]

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[236] https://www.usa.gov/federal-agencies/

[237] See Section 6: Federal Register: Consultation and Coordination With Indian Tribal Governments

[238] https://www.grants.gov/web/grants/learn-grants.html

[239] https://www.grants.gov/web/grants/search-grants.html

[240] See: https://beta.sam.gov/ and https://beta.sam.gov/search?index=cfda

[241] http://opr.ca.gov/clearinghouse/ceqa/federal-grants/resources.html

- CA Federal Grant Administrator at the Office of Planning and Research provides technical assistance to state agencies, local governments, institutions of higher learning, and nonprofit organizations on how to find, apply and manage federal grants[242]
- Tribal Training Grant Assistance: Congress authorized a demonstration project (477 initiative) which allows Federally recognized tribes to integrate Federal grants into a single plan (477 plan) with a single budget, which proves to be a much more efficient way to conduct tribal training. This allows money to be provided up front and continue for three years. Bureau of Indian Affairs is the lead federal agency for implementing the Demonstration Project created by Public Law 102-477, the Indian Employment, Training and Related Services Act, 25 U.S.C. section 3401 et seq. Under Public Law 102-477 Demonstration Project, Tribes have the authority to integrate Federal employment, training, and related services that they provide to their members.[243]

WRP TETWG Funding Subcommittee Recommendations (presented and accepted by the WRP TETWG):

- **Federal and state agencies** are encouraged to:
    - Invite other agencies to workshops/meetings with tribal members to share information more fully on funding opportunities and, if possible, cross-walked; and to co-locate meetings to address regional geographic areas and hold separate sessions with tribes on their project ideas and applicable resources.
    - Share with other agencies their successful efforts with funding workshops to build capacity among Federal/state agencies.
- **Tribal governments** are encouraged to:
    - Identify their needs, develop a one-page summary of needs, and have projects ready for potential funding opportunities (such as end of year money, etc.).
    - Develop contacts with various agencies that might have funding to meet identified needs and seek assistance from them.
    - Contact their congressional staff to determine whether funding exists for a certain project.
    - Build capacity with other Tribes (find out innovative best practices and work together).
- **WRP TETWG** to:
    - On Tribal Engagement calls, ask tribal members what categories of funding needs they have and ask state and federal agencies for information on their available funding opportunities.

[242] http://opr.ca.gov/clearinghouse/ceqa/federal-grants/
[243] https://www.bia.gov/bia/ois/dwd

- Continue to serve as a forum to enhance communication among tribes (and potentially opportunities to work together on grants, etc.) and between tribes and federal/state agencies.
- Continue to seek existing links/databases of funding for tribal projects and circulate via email to WRP Tribal Engagement members. WRP should not create a database.
- Encourage additional tribal participation in WRP. WRP honors the government-to-government relationship unique to sovereign tribal nations and fosters a collaborative atmosphere that generates solutions to tribal issues. WRP does not supplant or usurp federal agencies' responsibilities to consult with Tribes. Tribes engaged in WRP have identified and applied solutions to priority issues that would not have been possible but for WRP.

Thank you to the following members for sharing of their time and expertise in WRP TETWG Funding Subcommittee:

- Pam Adams, Native American Affairs Program Manager, Bureau of Reclamation, Lower Colorado Basin
- Adel M. Abdallah, Ph.D., WaDE Program Manager, Western States Water Council
- Jessica Asbill-Case, Water Resources Program Manager, Bureau of Reclamation
- Kathryn Becker, Assist. General Counsel and Tribal Liaison, New Mexico Environment Department
- Larry Davis, Chair of the NACD Tribal Resource Policy Group (RPG)
- Hoa Ly, Engineer, California Department of Water Resources
- David Munro Ph.D., Director of Tribal Affairs, U.S. Department of Homeland Security
- Melissa Weymiller, Project Manager, USACE

TETWG Acknowledgements:

TETWG members would like to acknowledge and thank the numerous agencies for their presentations, information sharing and collaborative efforts since the last WRP Principals' Meeting. Some of the topics addressed included natural resources, disaster, energy, better planning, funding opportunities, Tribal-State/Federal relations and addressing Tribal infrastructure. Presentations shared include:

2022

- Update on WRP Strategic Priority and supporting deep-dives (Resilient Energy Infrastructure; Resiliency of Airspace in the WRP Region; Disaster Mitigation; and Water Security)
- Tribal Energy and Mineral Development Grant Opportunities by Jennifer Reimann, Branch Chief, Renewable and Distributed Generation, Division of Energy and Mineral Development, BIA

- Current and future impacts of a changing climate in agriculture, forests and water resources of the Southwestern United States by Dr. Emile Elias, Director, USDA Southwest Climate Hub and Dr. Steven Ostoja, Director, USDA California Climate Hub
- Featured presentations on the Bipartisan Infrastructure Law (Infrastructure Investment and Jobs Act):
    - U.S. Forest Service: Jacqueline A. Buchanan, Deputy Regional Forester, United States Department of Agriculture, Rocky Mountain Region
    - Federal Aviation Administration: Steve L. Engebrecht, P.E., and Desiree Davis, FAA Airports BIL Implementation Team
    - Federal Highway Administration: Manuel Enrique Sánchez, MPA, Senior Tribal Transportation Program Coordinator, Office of Tribal Transportation, Federal Highway Administration
    - Natural Resources Conservation Service: Greg Norris, NRCS California State Conservation Engineer
    - Bureau of Reclamation: Melissa Smith, Financial Analyst and Travis D. Yonts, Management Analyst, Office of the Deputy Commissioner – Operations
- Department of Treasury Programs by Jeffrey Sural, Senior Broadband Policy Advisor, Office of Recovery Programs, Department of Treasury
- USGS Water Data for the Nation: Modernizing Access to Water Data by Dr. Emily Read, Chief of Web Communications for the United States Geological Survey Water Resources Mission
- Disaster Related Topics:
    - 2022 Spring- Summer Fire Outlook by Jim Wallmann, Meteorologist, USFS, National Interagency Fire Center
    - FEMA Update by John Powderly, Grants and Planning Outreach Specialist | Planning & Implementation Branch | Mitigation Division | FEMA Region 9
- California's Sustainable Groundwater Management Act (SGMA); How are Tribal Governments in California participating in GSAs and GSPs by Anecita Agustinez, Tribal Policy Advisor, CA Department of Water Resources
- Seeking collaborators for a proposed NASA field campaign to study carbon dioxide emissions and thermal signals related to Salton Sea seismicity by Dr. Laura Iraci, Research Scientist, NASA Ames Research Center
- National Telecommunications and Information Administration (NTIA) Update by Adam Geisler, Director, Tribal Connectivity & Nation to Nation Coordination
- Update on Department of Homeland Security Tribal Efforts by Miriam E. Enriquez, Deputy Assistant Secretary, Office of Intergovernmental Affairs, Department of Homeland Security
- Back brief on outcomes from WRP Steering Committee Planning Meeting
- Alert and Warning Alternatives by David W. Benoit, Regional Emergency Communications Coordinator, AS, AZ, CA, CNMI/MP, GU, HI, NV, Disaster Response Division, U.S. Department of Homeland Security, FEMA Region IX

- USACE Programs for Small Water Resources Projects by Melissa Weymiller, Project Manager, US Army Corps of Engineers
- Planning calls to prepare for WRP Principals' Meeting

2021

- Cybersecurity and Infrastructure Security Agency (CISA): Overview of the agency; Tribal Emergency Communications Program; and Priority Telecommunications Services by Larry Clutts (CTR), Priority Telecommunications Service Area Representative, CISA Region VI & Region IX, Emergency Communications Division / Cybersecurity and Infrastructure Security Agency; Cathy Orcutt, Priority Telecommunications Service Area Representative, CISA Regions VIII and X; Artena Moon, Western Sector Coordinator (CA, NV, AZ); and Jessica Kaputa, Tribal Emergency Communications Program Lead
- Strengthening USACE Collaboration With Tribal Nations by Ron Kneebone, Ph.D., Director, Tribal Nations Technical Center of Expertise and Mark Gilfillan, District Tribal Liaison, US Army Corps of Engineers-Sacramento District
- Overview and discussion of Federal Permitting Infrastructure Steering Council (FPISC) tribal collaboration and conflict resolution for large, complex infrastructure projects. John S. McCain III National Center for Environmental Conflict Resolution will share details on the National Center's role in FPISC's initiative and seek Input on identifying existing challenges, success stories, and recommendations for identifying and operationalizing best practices. Presentation by Stephanie Lucero, JD, LLM, Senior Program Manager.
- Updates from the Affiliated Tribes of Northwest Indians by Margie Schaff, Affiliated Tribes of NW Indians
- USACE Section 404-Clean Water Act permitting and Section 401 WQC processes by Mark Gilfillan, Tribal Liaison, Tribal Nations Technical Center of Expertise
- Overview of mission and efforts of the Navajo Tribal Utility Authority (NTUA) by Donavan Begay, Supervisor, Electrical Engineering, NTUA; Derrick Terry, NTUA Renewable Energy Specialist; and JoDonna John, NTUA Renewable Engineer
- The Nature Conservancy: Western climate and clean energy pathways study by Erica Brand, California Energy Strategy Director, The Nature Conservancy
- Arlando Teller, Deputy Assistant Secretary for Tribal Affairs USDOT
- NTIA Broadband Infrastructure Grant Program by Jennifer Duane, Senior Broadband Program Specialist, BroadbandUSA, DOC/NTIA
- Tribal Broadband Infrastructure Program by Adam Geisler, National Tribal Government Liaison, First Responder Network Authority
- Proactive Wildfire Management Approaches by Dr. Ilkay Altintas, Chief Data Science Officer and the Director for the WIFIRE Lab at the San Diego Supercomputer Center, UCSD
- WRP TETWG Funding Subcommittee Update

- Indigenous Considerations in Project Development and Permitting Consultation, Treaty Rights, EJ, and ESG by Maranda S. Compton, Esq.
- Tribal Consultation by Honorable Juana Majel-Dixon, Ph.D, Secretary, National Congress of American Indians Executive Board; Natural Resource Director and Pauma Tribal Traditional Legislative Council, Pauma Band of Luiseno Indians
- TNTCX Ecosystem Restoration Program: Integrating Indigenous and Traditional Ecological Knowledge into USACE Water Resources Projects on a Peer to Peer basis by Brian Zettle, Senior Biologist/Tribal Liaison, USACE Tribal Nations Technical Center of Expertise (TNTCX)
- California Broadband Update by Robert Tse, Senior Policy Advisor, Assistant Administrator's Office, Telecommunications Program, Rural Utilities Service, Rural Development USDA
- Tribal-DHS Homeland Security Summit Update by Dr. David Munro, Director, Tribal Government Affairs, Department of Homeland Security
- Brief Overview of Federal Indian Reserved Water Rights by Margaret J. Vick, JSD
- Tribal Energy and Climate Change Resiliency – California Energy Commission by Dr. Thomas Gates, Tribal Liaison, California Energy Commission
- US Senate Committee on Indian Affairs Efforts by Jennifer Romero, Chief of Staff, US Senate Committee on Indian Affairs
- Overview of the Broadband effort on the Navajo Nation by Ms. Velena Tsosie, General Manager, Choice NTUA Wireless

2019-2020

- NASA Tribal-related efforts by Cindy Schmidt, Ph.D., Associate Program Manager, NASA Ecological Forecasting Program
- UAS Update by John "JC" Coffey, Cherokee Nation Company supporting: NOAA OAR Program Manager, National Oceanic and Atmospheric Administration
- Update on NRCS Tribal Efforts/Funding by Mr. Carlos Suarez, State Conservationist, and Ms. Gayle Norman Barry, Special Assistant to the State Conservationist, USDA--Natural Resources Conservation Service, California and Mr. Keir Johnson-Reyes, Osage Nation of Oklahoma, Intertribal Agriculture Council National Technical Assistance Program Lead and Pacific Region Technical Assistance Specialist and Ms. Meagen Baldy, Hupa Tribe, Klamath Trinity Resource Conservation District Coordinator.
- 2.5 GHz Rural Tribal Window by Ms. Nadja S. Sodos-Wallace and Ms. Erin Fitzgerald, Federal Communications Commission, Wireless Telecommunications Bureau, Broadband Division
- Native American Fish & Wildlife Society Update by Dr. Julie Thorstenson, Executive Director
- Update on Federal Highway Administration (FWHA) Tribal Office by Jaime F. Torres González, Office of Tribal Transportation, FHWA

- California Energy Commission (CEC) Tribal Grants Program by Dr. Thomas Gates, Tribal Liaison, Supervisor, Cultural Resources Unit, Siting, Transmission, and Environmental Protection, CEC
- Update by DoD Senior Advisor by Alicia Madalena Sylvester, Senior Advisor and Liaison for Native American Affairs, Department of Defense, OASD (Sustainment)/ODASD Environment
- Strengthening collaboration and cooperation between USACE and native American Tribes for water resource management by Dr. Seth B Cohen, USACE Collaboration & Public Participation Center of Expertise (CPCX), Institute for Water Resources
- BIA, USFS, and BLM Presentation on Fires Impacting Watersheds and Post Wildfire Recovery Program by: Darryl Martinez, National Post Wildfire Recovery Coordinator, Bureau of Indian Affairs, Division of Forestry & Wildland Fire Management; Cara Farr, National BAER Program Leader, Forest Service, Washington Office – Watershed, Fish, Wildlife, Air & Rare Plants; and Douglas Havlina, BLM Fire Ecologist and Fire and Invasive Species Assessment Team Lead.
- Broadband Presentation by Robert Tse, Senior Policy Advisor, Assistant Administrator's Office, Telecommunications Program, Rural Utilities Service, Rural Development, USDA
- Rural Energy Savings Program Update by Robert Coates, Rural Development, RUS, Electric Program; and Luis Bernal, Energy Efficiency Advisor, RUS, Electric Program.
- Colorado River Basin Ten Tribes Partnership Tribal Water Study by Ms. Pam Adams, Native American Affairs Program Manager, Bureau of Reclamation, Lower Colorado Basin Region
- From land to space: Understanding water on the Navajo Nation by Dr. Crystal Tulley-Cordova, M.W.R., Principal Hydrologist, Navajo Nation Department of Water Resources, and Ms. Nikki Tulley, M.W.R., member of the Navajo Nation.
- Update on EPA's Office of Water: National Tribal Water Program by Roger Gorke, Senior Policy Advisor, Office of Water, U.S. Environmental Protection Agency
- Brief Overview of the WRP Disaster Mitigation Deep-Dive and Introductions to the Disaster Relief Challenge by Conor McClintock, Regional Innovation Officer, Office of the Regional Administrator, FEMA Region VIII – and WRP MRHSDP&A Committee Co-Chair
- Overview of the Disaster Relief Challenge by Dallas Blaney, PhD, Executive Director
- Bureau of Reclamation Native American and International Affairs Office Update by Jeff Morris, Bureau of Reclamation, Native American and International Affairs Office, Program Manager
- Overview of the Department of Transportation's (DOT) Tribal Transportation Self Governance Program by Milo Booth, Director of Tribal Affairs, Office of the Secretary – Governmental Affairs, Department of Transportation

Appendices

Resiliency of Airspace: Aviation Laws

The National Airspace System (NAS)

- Sovereignty and use of airspace. 49 U.S. Code § 40103.
  - The United States Government has exclusive sovereignty of airspace of the United States. 49 U.S.C. 40103(a)(1)
  - A citizen of the United States has a public right of transit through the navigable airspace. 49 U.S.C. 40103(a)(2)

Unmanned/Uncrewed Air Systems (UAS)

- UAS are "aircraft" subject to regulation. An aircraft is any device used, or intended to be used, for flight. 49 U.S.C. 40102(a)(6). 14 CFR 1.1
- UAS flown outdoors operate in the National Airspace System (NAS)
- UAS Detection and Mitigation Constraints. U.S. Code Titles 18 and 49
- FAA Reauthorization Act, 2018, Section 349, established new conditions for recreational UAS use and repealed the Model Aircraft Special Rule (FAA Modernization and Reform Act, 2012, Section 336 of Pub. L. 112-95)
- 14 CFR Federal Aviation Regulations
  - Part 91 General Operating and Flight Rules
  - Part 99.7 Special Security Instructions (SSI)
  - Part 107 Small Unmanned Aircraft Systems
    - Common UAS Rules for Both 14 CFR Part 107 and Recreational Operators
      - Do not fly over 400 feet in uncontrolled airspace
      - Obtain authorization before flying in controlled airspace (Class B, C, D, and E)
      - Keep your drone in visual line of sight of pilot or visual observer
      - Never fly near aircraft
      - Never fly under the influence of drugs or alcohol
      - Never fly near emergencies or public safety activities
      - Register all drones between .55 lbs. and 55 lbs.**
    - **14 CFR Part 107 Aircraft Registration Requirement

- **Operations Over People and Moving Vehicles**. Federal Register, Vol. 86, No. 45, pp. 13630-13631
  - Four additional categories of UAS
  - Each has different equipment requirements for incidental flight or sustained flight over people
  - UAS must be marked according to category
  - Night Operations

        - Pilot requirement: Updated training and knowledge test to include operations at night
        - Equipment requirement: UA must be equipped with proper lighting
- Remote Identification (RID), 14 CFR Part 89

Executive Summary and Federal Register documents available at https://www.faa.gov/uas/

- **FAA Orders**, including JO 7110.65,[244], Sections 2-1-22 (UAS Activity Information) and 5-2-6 (UAS) Lost Link and JO 7610.4[245] Paragraph 7-3-1 (suspicious UAS operations.)

- **Title 10 U.S., Part 130i Authorities**
  § 130i. Protection of certain facilities and assets from unmanned aircraft
  Authority.— Notwithstanding section 46502 of title 49, or any provision of title 18, the Secretary of Defense may take, and may authorize members of the armed forces and officers and civilian employees of the Department of Defense with assigned duties that include safety, security, or protection of personnel, facilities, or assets, to take, such actions described in subsection (b)(1) that are necessary to mitigate the threat (as defined by the Secretary of Defense, in consultation with the Secretary of Transportation) that an unmanned aircraft system or unmanned aircraft poses to the safety or security of a covered facility or asset.

FCC Authority on radio interference[246]

- Operating on a frequency allocated for licensed private-sector use (such as on the bands used by mobile phones) is subject to licensing requirements and other regulation at the federal level. 47 U.S.C. § 301.
- Marketing, Sale, or Operation of Jammers. 47 U.S.C. § 302a prohibits most non-federal entities from manufacturing, importing, shipping, selling, or using devices that fail to comply with FCC regulations regarding devices that can interfere with radio reception, including transmitters designed to block, jam, or interfere with wireless communications. 47 U.S.C. § 302a(b).
- Interference with Radio Communications. 47 U.S.C. § 333 prohibits "willfully or maliciously interfer[ing] with or caus[ing] interference to any radio communications of any station licensed or authorized by [the FCC] or operated by the United States Government."

Relevant Criminal Procedures

- Detection capabilities are restricted by:
    - Pen/Trap Statute, Title 18 USC §§ 3121-3127

[244] https://www.faa.gov/documentLibrary/media/Order/7110.65Y.pdf
[245] https://vatguard.com/faao-jo-76104-59/
[246] Taken from: https://docs.fcc.gov/public/attachments/DOC-366222A1.pdf

- Wiretap Act, Title 18 USC § 2511

Note: just merely monitoring known UAS frequencies can kick in Federal law and felonies.

U.S. Law Enforcement Guidance[247]

- Role of state and local law enforcement
  - Best position to respond quickly to public safety issues
  - Front line in detecting/reporting UAS violations
  - Better able to secure evidence and identify witnesses
  - Public interest best served by coordination and cooperation between FAA and state/local law enforcement
  - Always keep in mind the underlying activity of the operator
  - Applicable Code
  - FAA CFRs – Civil Code
  - State Criminal Code (Aviation)
  - Federal Criminal Code (Aviation)
  - U.S. Forest Service, U.S. National Park Service, etc. USCs and CFRs - Civil and/or Criminal Code
  - Local Ordinances - Civil and/or Criminal Code
  - State Criminal Code (Non-Aviation)
  - Federal Criminal Code (Non-Aviation)

[247] https://www.faa.gov/uas/public_safety_gov/

Resiliency of Airspace: Acknowledgements

Thank you to the following experts who presented to the Resiliency of Airspace in the WRP Region:

Presentations to full team:

- C-UAS Test Bed Technology Overview by Captain Jim Bamberger, Branch Chief, Public Area Security and Infrastructure Protection, Requirements and Capabilities Analysis, Department of Homeland Security – TSA, October 2022.
- National Association of State Aviation Officials (NASAO) Update by Mr. Greg Pecoraro, President, NASAO, August 2022.
- Protecting the Homeland from Unmanned Aircraft Systems" to WRP by Mr. Christopher Bidwell, Senior Vice President, Security, Airports Council International – North America, August 2022.
- Wildfire Response Need for More Streamlined Access to Airspace presentation by Kim Owczarzak, National Airspace Program Manager, Washington Office, Fire and Aviation Management, National Interagency Fire Center, July 2022.
- Cal Fire Tactical Air Operations presentation by Chris Willson, Division Chief, CAL FIRE, April 2022.
- Advanced Aviation Advisory Committee (AAAC)/Drone Advisory Committee (DAC) Update by Lorne Cass, Member of the FAA Drone Advisory Committee, and President of Aero NowGen Solutions, LLC, July 2022, May 2022, April 2022, January 2022, August 2021, and January 2021.
- Charting Aviation's' Future: Operations in an Info-Centric NAS presentation by Steve Bradford, Chief Scientific and Technical Advisor, Federal Aviation Administration, February 2022.
- Overview of NASA Airspace Research by Leighton Quon, Deputy Director of Aeronautics, NASA Ames Research Center, November 2021.
- The Information-Centric NAS: A vision for the future of the NAS by Dr. Stéphane Mondoloni, Department Chief Engineer for the NAS Future Vision and Research Department, MITRE Corporation, August 2021
- Briefing on the DoD insights on Gap #1 by Lt Col Geoff Roche, USAF Branch Chief, Airspace Plans and Policy AF/A3TI, HQ USAF, January 2021.
- Briefing on the DoD insights on Gap #1 by Edward Chupein, GS-15, DAFC, Deputy Chief, Operational Training Infrastructure Division (AF/A3TI), HQ USAF, August 2020.

Presentations to Gap 1 Team:

- FRTC Airspace Modernization by LCDR Dan "DD" Hilligrass, Naval Aviation Warfighting Development Center, June 2022.

- Charting Aviation's' Future: Operations in an Info-Centric NAS presentation by Steve Bradford, Chief Scientific and Technical Advisor, Federal Aviation Administration, January 2022.
- Fallon Range Training Complex Modernization presentation by CDR Kristopher "Penguin" Nastro, NAWDC Operations Officer, September 2021.
- Nevada Test and Training Range (NTTR) Mission Brief and Airspace by Colonel Cameron Dadgar, Commander of the NTTR, Nellis Air Force Base, Nevada, April 2021.
- The Air Force Industrial Installation Concept, Plant 42 presentation by David Smith, Ph.D., Director of the Air Force Production Facility, Plant 42, March 2021.
- Utah Test and Training Range (UTTR) briefing by Chris Robinson, Range Director, UTTR, February 2021.
- Updated Council on Environmental Quality NEPA regulations presentation by Andrea Pahlevanpour, Environmental Compliance Team Lead, Department of the Army, Office of the Deputy Chief of Staff, G-9, December 2020.
- Spectrum Encroachment Awareness and Challenges for T&E Ranges presentation by Jeffrey Conaway, Deputy Program Manager for Spectrum Reallocation (NAVAIR), November 2020.
- R-2508 presentation by Mike Roberts, R-2508 CCB and NAWCWD RAC, September 2020.
- Long Range Airspace Corridor (LRAC) by Steve Pennix, Branch Head, Range Sustainability Office, Naval Air Warfare Center, Weapons Division, China Lake Ranges, August 2020.
- Test Resource Management Center (TRMC) update on Mountain Desert Corridor (MDC) initiative by Chris Mazur and Gerry Madigan, DoD T&E Range Sustainability, TRMC, August 2020.
- LRAC Joint proposal Involving NTTR and China Lake Ranges - and West Coast Airspace Background by Lynn Tawney (LT), August 2020.
- NextGen SAA to Meet NDS Readiness Requirements by Ed Chupein, GS-15, DAFC Deputy Chief, Operational Training Infrastructure Division (AF/A3TI), HQ USAF, July 2020.

<u>Presentations to Gap 2 Team:</u>

- The BNSF Railway RPA (Drone) Program Update by Nick Dryer, Field Operations Manager, BNSF Railway UAS Program, October 2021.
- FedEx Air Operations Innovation presentation by Michael Sheffield, Chief Aircraft Engineer, Strategic Projects, FedEx Air Operations, September 2021.
- AOPA and the Future of Aviation: How the General Aviation Community is Working to Safely and Equitably Integrate AAM and Drones by Christopher J. Cooper, Sr. Director, Regulatory Affairs, Aircraft Owners & Pilots Association (AOPA), September 2021.

- ASSURE Regulatory Research Update by Col (Ret) Stephen P. Luxion "LUX," Executive Director, Alliance for System Safety of UAS through Research Excellence (ASSURE) FAA Center of Excellence for UAS, July 2021.
- Views on wildfire management tools and integration of UAS into the NAS by Todd Spain, Executive Director, Advance Mobility Collective, July 2021.
- NavCanada efforts regarding the integration of Remotely Piloted Aircraft Systems (RPAS / UAS) into Canada's national airspace system by Alan Chapman, Director Remote Traffic Management (RTM), NAV CANADA, June 2021.
- The Evolving Role of Community-Based Organizations for UAS Integration by Chad Budreau, Executive Director, Academy of Model Aeronautics (AMA), June 2021.
- SWIM Industry-FAA Team (SWIFT)/System Wide Information Management (SWIM) Industry-FAA Team Collaboration presentation by Stefanie Calabrese, Member of the SWIM Program Office and SWIFT Chair; Xavier Pratt, Operational Issues Focus Group, and Ray Mitchell, Communications, Information and Network Programs, AJM-31, SWIFT Team, FAA, March 2021.
- NAS Service Registry/Repository (NSRR) presentation by Mark Kaplun, SWIM Governance Lead, FAA, March 2021.
- SWIM Industry-FAA Team (SWIFT) Overview/SWIM Industry-FAA Team Collaboration presentation by Stefanie Calabrese, Member of the SWIM Program Office and SWIFT Chair and Ray Mitchell, lead engineers for SWIFT, February 2021.
- Drone Advisory (DAC) Committee update by Paul Amen, Air Traffic Management and Airfield Operations Manager Europe, North Atlantic, Asia-Pacific, and Western US, American Airlines, December 2020.
- Drone Advisory Committee (DAC) Update by Lorne Cass, Member of the FAA Drone Advisory Committee, and President of Aero NowGen Solutions, LLC, November 2020, March 2021, May 2021, July 2021, and October 2021.
- Safe UAS Integration by Lorne Cass, Member of the FAA Drone Advisory Committee, and President of Aero NowGen Solutions, LLC, October 2020.

<u>Presentations to Gap 3 Team:</u>

- LEAP UAS Outreach briefing by Special Agent Scott Harris, FAA - Office of National Security Programs and Incident Response, Law Enforcement Assistance Program (LEAP), May 2021.
- One Perspective on Development of Counter UAS State and Federal Policy Presentation by Paul Amen, Air Traffic Management (ATM) and Airfield Operations Manager Europe, North Atlantic, Asia-Pacific, and Western US, American Airlines, March 2021.
- Airports Council International – North America presentation by Christopher Bidwell, Senior Vice President, Security, Airports Council International – North America, March 2021.

- Transportation Security Administration (TSA) UAS Efforts by Captain Jim Bamberger, Branch Chief, Public Area Security & Infrastructure Protection, Requirements & Capabilities Analysis, Department of Homeland Security – TSA, January 2021.
- Department of Defense Title 10 U.S. Code, §130i and cUAS Authorities by Tony Militello, UAS/NexGen Analyst, Military and Civilian Aviation Integration Division (AF/A3OJ), January 2021.

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- Mike Beauvais, ATREP, Federal Aviation Administration
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Disaster Mitigation: Acknowledgements

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- FEMA Mitigation Planning Updates by Mr. Rob Pressly and Mr. Parker Crowe, Community Planners, FEMA R8, July 2022.
- 2022 Spring- Summer Fire Outlook by Jim Wallmann, Meteorologist, USFS, National Interagency Fire Center, May 2022.
- 2021 Fall Fire Outlook: Predictive Services presentation by Jim Wallmann, Meteorologist, USFS, National Interagency Fire Center, October 2021.
- An Innovative Approach to Quantify Risk Associated with Post-Fire Debris Flow in Watersheds by Utilizing USACE HEC-RAS 6.0 BETA presentation by Morteza S. Majd, Climate Action Team, ODASD Environment and Energy Resilience, Water Resilience and Climate Specialist, August 2021.
- NASA presentations on: Disaster Lifecycle Cluster Meeting, Example Issues - Feedback from Summer ESIP Meeting; OGC Disaster Pilot 2021 Update; and NASA Disasters Program Response to the Western US Fires and Mapping Portal Demo by Don Sullivan, NASA Ames Research Center, August 2021.
- State and Federal Relationships for Hazard Mitigation Assistance presentation by Lucrecia Vargas, State Hazard Mitigation Officer and Arizona Department of Emergency Management and Military Affairs, Alison Kearns, Risk Analysis Branch Chief, FEMA Region 9, June 2021.
- Cybersecurity, Mitigation and Resilience Against Cyber-attacks presentation by Joseph Oregón, (A) Chief Cybersecurity Advisor Region IX: CA, NV, AZ, HI, GU, CNMI, Cybersecurity and Infrastructure Security Agency (CISA), U.S. Department of Homeland Security, February 2021.
- NRCS Watershed Programs presentation by Kevin L. Farmer, PE Watershed Programs Branch Chief, NRCS, December 2020.

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- Mitigating the Risks of Costly Disaster Recoveries by Chris Currie, Director, Homeland Security and Justice Team, U.S. Government Accountability Office (GAO)
- Mitigation Investment by Joan Huston, Senior Federal Grants Manager and Rich Hansen, Senior Specialist, Hazard Mitigation Assistance program, FEMA
- Military Installation Sustainability by Margit Myers, Project Manager, Department of Defense, Office of Local Defense Community Cooperation (previously the Office of Economic Adjustment)

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- Justin Gay, Chief, Interagency and International Services, US Army Corps of Engineers, Los Angeles District
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Resilient Energy Infrastructure: Acknowledgements

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- Eagle-I Presentation by Matthew Tarduogno, Program Manager for Situational Awareness, Analysis, and Reporting - Office of Cybersecurity, Energy Security, & Emergency Response at the U.S. Department of Energy, August 2022.
- NASEO Energy Security and Resilience Update by Campbell Delahoyde, Program Director, Energy Security, National Association of State Energy Officials, August 2022.
- Extreme Natural Events by Bhavana Katyal Sr. Engineer, WECC; Enoch Davies, Manager of the System Stability Planning Group, WECC; and Byron Woertz, Manager, System Adequacy Planning, WECC, June 2022.
- Microgrids - A Perspective on Resiliency in the Power Delivery System by James T Reilly, Consultant, June 2022.
- Planning for Resilience with Regional Climate Modeling by Dr. Thomas Wall, Program Lead, Engineering and Applied Resilience Decision and Infrastructure Sciences Division, Argonne National Laboratory, February 2022.
- The Importance of Black Start Generation presentation by Chris Beck, Chief Scientist and Vice President for Policy, EIS Council (Electric Infrastructure Security); and Frank Koza, Electric Subsector Coordinator, EIS Council, December 2021.
- U.S. Energy Atlas: Overview of features and information relating to energy infrastructure presentation by Jim O'Sullivan, Industry Economist, Office of Petroleum, Natural Gas & Biofuels Analysis, U.S. Energy Information Administration (EIA), August 2021.
- FAST-41: Your Tailored Roadmap for Infrastructure Project Permitting/Update on the Federal Permitting Improvement Steering Council (FPISC) by Amber Levofsky, Executive Operations Manager, FPISC, April 2021.
- National Association of State Energy Officials (NASEO) National Association of Regulatory Utility Commissioners (NARUC) Cybersecurity Advisory Team for State Solar (CATSS) presentation by Kirsten Verclas, Senior Program Director, Electricity NASEO and Campbell Delahoyde, Senior Program Manager, NASEO, February 2021.
- U.S. Energy Information Administration (EIA) State of Battery Storage presentation by Glenn McGrath, Team Lead, EIA, November 2020.
- Update on BLM Energy Efforts by Jeremy Bluma, Acting Branch Chief, Rights-of-Way, and Renewable Energy – PMP, Headquarters – BLM– DoI, November 2020.
- Resiliency Metrics for the North American Energy Resilience Model by Robert F. Jeffers, Ph.D., Principal Systems Scientist, Sandia National Laboratories, December 2020.
- Energy Resilience Perspectives from a State Emergency Management Preparedness Perspective by Matt Heckard, Assistant Director, Emergency

Management/Preparedness, AZ Dept of Emergency and Military Affairs, November 2020.

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- Casey Cathey, Director of Planning, Southwest Power Pool
- Thomas Carr, Program Manager for Electric System Planning and Grid Transformation, Western Interstate Energy Board (WIEB)
- Phil Pettingill, P.E., Director, Regional Integration, California Independent System Operator Corporation (ISO)
- Erica Pionke, JD, PMP, Transmission and Corridor Program Lead, Bureau of Land Management
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- Lizana Pierce, Deployment Supervisor, DOE Office of Indian Energy
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- Christian Bato, Southwest Regional Intergovernmental and External Affairs Specialist, Department of Energy
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Presentations to full team:

- USGS Water Data for the Nation: Modernizing Access to Water Data by Dr. Emily Read, Chief, Web Communications Branch, USGS Water Mission Area, June 2022.
- FEMA Hazard Mitigation Assistance: Drought Resources, Funding and Projects by Mr. John Powderly, Grants and Planning Outreach Specialist, FEMA Region 9, March 2022.
- Presentation by Gloria Montaño Greene, Deputy Under Secretary for Farm Production and Conservation, U.S. Department of Agriculture, October 2021.

Presentations to Water Laws and Regulations "Bucket":

- Indian Wells Valley Groundwater presentation by Steve Pennix, Branch Head, Range Sustainability Office, Naval Air Warfare Center, Weapons Division, China Lake Ranges, September 2020.

Presentations to Water Resource Management Strategies "Bucket":

- Water Security Conservation Best Practices by Laura Norman, Ph.D., Supervisory Research Physical Scientist, Western Geographic Science Center, USGS, February 2021.
- California Water Plan and Drought and Water Shortage Contingency Planning for Small Systems and Small Communities by Kamyar Guivetchi, P.E. Manager, Division of Planning, California Department of Water Resources, August 2020.
- EPA's National Water Reuse and Action Plan by Roger Gorke, Senior Policy Advisor, Office of Water, U.S. Environmental Protection Agency, August 2020.
- Overview of Dashboards by Adel Abdallah, Ph.D., WaDE Program Manager, Western States Water Council, August 2020.

Presentations to Data "Bucket":

- USGS Data Access for Water Security with focus on the National Water Information System presentation by Ryan Rowland, Data Chief, USGS Utah Water Science Center, and Allison Shipp, Deputy Regional Director for Science, Rocky Mountain Region, August 2020.

Thank you to the following experts who presented to the Groundwater-Surface Water Interface Webinar, sponsored by the WRP Natural Resources Committee, October 2021:

- (Arizona): Surface Water/Groundwater Relationship in Arizona presentation by Jennifer Heim, Deputy Counsel, Arizona Department of Water Resources
- (California): Resilience from Below - Sustaining communities and nature through proactive groundwater management by Maurice Hall, Ph.D., PE, Vice President, Water, Environmental Defense Fund.
- (Colorado): Colorado Legal Surface & Groundwater Interaction by Tracy Kosloff, Deputy State Engineer, Colorado Division of Water Resources
- (New Mexico): Surface & Ground Water Interactions in NM: The Good, The Promising, & The Ugly by Bruce M. Thomson, Ph.D., Regents Professor of Civil Engineering at the University of New Mexico
- (Nevada): Conjunctive Management, Water Rights, and the Groundwater-Surface Water Interface: A Nevada Perspective by Jon Benedict, Hydrogeologist, Nevada Division of Water Resources, Department of Conservation and Natural Resources and Micheline Fairbank, Deputy Administrator, Nevada, Division of Water Resources
- (Utah): Water Right Permits for Aquifer Recharge and Recovery in Utah by Jim Reese, Assistant State Engineer for our Technical Services Section, Department of Natural Resources, Division of Water Rights

Thank you to the following experts who presented to the Water Security Data Webinar, sponsored by the WRP Natural Resources Committee, May 2021:

- USGS's Next Generation Water Observing System (NGWOS) Upper Colorado River Basin by Suzanne Paschke, Ph. D, Associate Director for Hydrologic Studies, Colorado Water Science Center.
- NOAA's predictions on variability of precipitation and the impacts on water availability and water management by Jeffrey R. Zimmerman, NOAA/National Weather Service/Western Region, Deputy Regional Director.
- Western States Water Council (WSWC) Water Data Exchange (WaDE) by Adel M. Abdallah, Ph.D., WaDE Program Manager, WSWC.
- Reclamation Information Sharing Environment (RISE)[251] by Allison Odell, PE, Civil Engineer, Open Water Data Coordinator, Research & Development Office, Bureau of Reclamation, Denver Office, U.S. Department of the Interior.
- National Water and Climate Science Center by Cara McCarthy, Team Leader for Water and Climate Services.
- Internet of Water Mission and Efforts to Build Water Data Infrastructure to Support Water Data Management by Providing Tools by Peter Colohan, Executive Director, Internet of Water (IoW).

[251] https://data.usbr.gov/

Thank you to the following experts who presented to the Water Resource Management Strategies Webinar, sponsored by the WRP Natural Resources Committee, February 2021:

- Managing Water Resources for Sustainability & Resilience in California by Kamyar Guivetchi, P.E., Manager, Division of Planning, California Department of Water Resources.
- Produced Water Treatment and Reuse for Water, Energy, and Environmental Security and Resiliency by Mike Hightower, Program Director, New Mexico Produced Water Research Consortium.
- National Water Reuse Action Plan by Sharon Nappier, EPA Office of Water, National Program Leader for Water Reuse.
- WaterSMART program by Amanda Erath, Program Coordinator for Title XVI Water Reclamation and Reuse Program and Basin Studies and Josh German, WaterSMART Grants Coordinator.

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- Water Security Policy Planning & Implementation by Tony Willardson, Executive Director, Western States Water Council.
- United States Indian Water Rights Settlement Program by Tracy L. Goodluck, Deputy Director, Secretary's Indian Water Rights Office.
- Executive Order on Modernizing America's Water Resource Management and Water Infrastructure by Jessica Kramer, Senior Policy Counsel to the Assistant Administrator for Water, U.S. Environmental Protection Agency.
- Tribal Water Security in the Southwest - History, Politics, Barriers to Implementation by Adam Ringia, Executive Director, SWTFC, Tribal Liaison, National Fish Habitat Partnership, and Water Rights Office Manager, Pueblo of Laguna.
- "Wicked Water Problems" and the Need for Long-Term Concerted Efforts to Address Them by Sharon B. Megdal, Ph.D., Director, Water Resources Research Center, U of A.

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- Water Rights, Adjudications, and the United States' Needs for Water Security by Stephen Bartell, Assistant Chief, Natural Resources Section, Environment & Natural Resources Division, United States Department of Justice.
- Water Security in the West by Michelle Bushman, Assistant Director/Legal Counsel, Western States Water Council.
- Native American Rights Fund by John Echohawk, Executive Director, Native American Rights Fund.

- Roadmap to a Train Wreck - A brief history of conflict, resolution, and litigation regarding the division of the resources on the Upper Rio Grande Basin by Chris Rich, Attorney Advisor, Regional Solicitor's Office, Intermountain Region.

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- WRP Southeastern Arizona/New Mexico (SoAZ/NM) Project by Colonel Tom Finnegan, Army (Retired), WRP Natural Resources Committee Co-Chair and Project Lead for the completed WRP Southeastern Arizona/New Mexico Project.
- Water Resilience: Upper San Pedro River Basin, Arizona by Holly Richter, Ph.D., Arizona Water Projects Director for The Nature Conservancy in Arizona and founding member of both the Upper San Pedro Partnership and the Cochise Conservation and Recharge Network.

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[252] Names are listed with their title and affiliation applicable during their participation.

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