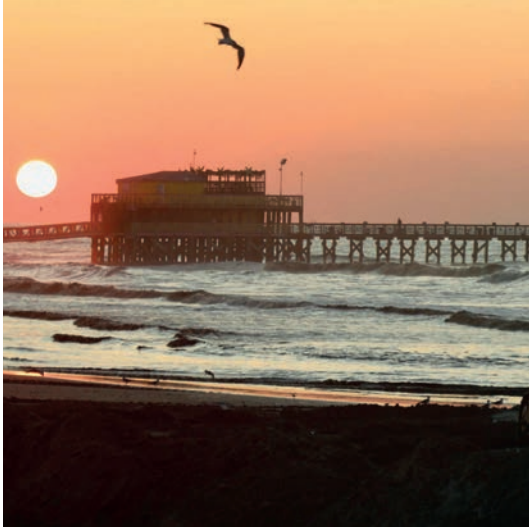

U.S. ARMY CORPS OF ENGINEERS PACESETTER SOUTHWESTERN DIVISION

US Army Corps of Engineers® Little Rock District

TULSA DISTRICT US ARMY CORPS OF ENGINEERS

USACE SOUTHWESTERN DIVISION CIVIL WORKS STRATEGIC PLAN

OCTOBER 22
2020

USACE SOUTHWESTERN DIVISION CIVIL WORKS STRATEGIC PLAN

Developed through a coordinated effort of the USACE Southwestern Division and the Fort Worth, Galveston, Little Rock, and Tulsa Districts.

US Army Corps of Engineers®
Little Rock District

TULSA DISTRICT
US ARMY CORPS OF ENGINEERS

In conjunction with the ILSI/Arcadis Joint Venture and the Water Institute of the Gulf.

ILSI ENGINEERING
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THE WATER INSTITUTE OF THE GULF®

October 22, 2020

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ACRONYMS AND ABBREVIATIONS

A/E	Architect/Engineer
ACS	American Community Survey
AOR	Area of Responsibility
AR	Arkansas
ASCE	American Society of Civil Engineers
BCR	Benefit-Cost Ratio
BEA	Bureau of Economic Analysis
BL	Business Line
BLS	Bureau of Labor Statistics
CAP	Continuing Authorities Program
CIP	Capital Improvement Plan
CO2	Carbon Dioxide
CW	Civil Works
CWMS	Corps Water Management System
CWSP	Civil Works Strategic Plan
DFW	Dallas/Fort Worth
EDA	U.S. Economic Development Administration
EM	Engineer Manual
ER	Ecosystem Restoration
FEMA	Federal Emergency Management Agency
FPMS	Floodplain Management Services
FR	Flood Risk
FRM	Flood Risk Management
GHG	Greenhouse Gas
GI	General Investigation
GIWW	Gulf Intracoastal Waterway
GW	Gigawatt
H&H	Hydrologic and Hydraulic
HP	Hydropower
HQ	Headquarters
HUD	U.S. Department of Housing and Urban Development
HVRI	Hazards & Vulnerability Research Institute
IT	Information Technology
IWRM	Integrated Water Resources Management
KS	Kansas
LA	Louisiana
LULC	Land Use and Land Cover
MKARNS	McClellan-Kerr Arkansas River Navigation System
MO	Missouri
NAV	Navigation
NED	National Economic Development
NEPA	National Environmental Policy Act

ACRONYMS AND ABBREVIATIONS

NNBF	Natural and Nature-Based Features
NOAA	National Oceanic and Atmospheric Administration
NW	Northwest
O&M	Operations and Maintenance
OK	Oklahoma
P3	Public-Private Partnership
PAS	Planning Assistance to States
PM/PL	Project Manager/Project Leader
PPP	Public-Private Partnership
PR&G	Principles, Requirements, and Guidelines
RPEC	Regional Planning and Environmental Center
SLR	Sea Level Rise
SoVI	Social Vulnerability Index
SWD	Southwestern Division
SWF	Fort Worth District
SWG	Galveston District
SWL	Little Rock District
SWOT	Strengths, Weaknesses, Opportunities, and Threats
SWT	Tulsa District
TES	Threatened and Endangered Species
TIS	Technical Innovation Strategy
TX	Texas
TxDOT	Texas Department of Transportation
UHI	Urban Heat Island
USACE	United States Army Corps of Engineers
USC	University of South Carolina
UVA	University of Virginia
VLCC	Very Large Crude Carriers
WS	Water Supply

0

Executive Summary

Change is constant, and the United States Army Corps of Engineers (USACE) Southwestern Division (SWD) has been no exception. In recent decades, SWD has evolved to meet the needs of its area of responsibility (AOR) as the population grows, urbanization and development expand, weather patterns become more variable and extreme, and new threats continue to emerge. The next two decades are critical and will present SWD with increasingly complex water resources challenges that will require innovative and integrated solutions to ensure the Division and its Districts remain poised to execute the USACE Mission, maintain credibility with stakeholders and public, and continue to provide significant value to the Nation.

To achieve these objectives and thrive in an uncertain future, it is critical that SWD prepares today through a proactive Civil Works strategic planning process. In 2019, SWD began developing this Civil Works Strategic Plan (CWSP) to guide its Civil Works (CW) program through 2035. The CWSP articulates the goals of the CW Program; evaluates key drivers of risk and opportunity that will impact the region in the coming decades and the inherent uncertainties associated with them; communicates SWD's strategic direction to USACE leadership and key stakeholders; and provides a nimble and adaptable foundation to implement tactical plans and actions as future conditions evolve.

The SWD approach to developing this CWSP was based on internal assessment and external stakeholder feedback, resulting in a strategic plan that is informative to the Division and its Districts, relevant across Mission Areas and Business Lines, and readily applicable to future implementation planning. Development of the CWSP was primarily led by the SWD Planning and Policy Division (PDP) in close coordination with the Regional Planning and Environmental Center (RPEC) and the Fort Worth (SWF), Galveston (SWG), Little Rock (SWL) and Tulsa (SWT) Districts. To capture the internal USACE perspective on the current and future state of the SWD CW Program, critical information gathering began with an internal Strengths, Weaknesses, Opportunities, Threats (SWOT) and Risk Analysis, as well as with identification and analysis of the primary drivers influencing CW demand in the region:

- **Rapid Population Growth & Urbanization**
- **Changing Regional Landscape**
- **An Extreme Weather: Floods & Drought**
- **Uncertain Future of Energy**
- **Increasing Demand on Water Resources**
- **Aging Infrastructure**

The findings were subsequently validated and benchmarked against the perceptions of external stakeholders.

Too often, well-intentioned strategic planning processes result in plans that lack actionability, especially as conditions change over time. For this reason, SWD deliberately set forth from the onset of the planning process to ensure that this CWSP is actionable, implementable, and adaptable to a variety of future uncertainties. To achieve this, a set of planning scenarios was developed to illustrate future uncertainties and demonstrate how implementation of strategies could result in positive outcomes. These scenarios were used to identify key gaps that, if filled, enable SWD to be better prepared for a range of possible futures.

In order to advance a truly integrated approach to water resources management and reflect the Division's ongoing shift toward this paradigm, this input was synthesized into a comprehensive SWD Civil Works Vision, four (4) supporting cross-cutting Goals, and 25 strategic Objectives that provide a framework for action, informing critical decision making in an uncertain future.

SWD Civil Works Vision

SWD works towards **a safe, reliable, sustainable, and resilient water future** for the communities we serve and the value they provide to the Nation, meeting the increasing challenges and demands on the region's water resources through an **integrated approach** to their management.

- **Goal 1: Enable Innovative Solutions to Complex Challenges.**
- **Goal 2: Shift towards a Proactive Response Mode.**
- **Goal 3: Re-envision Role as a Collaborative Partner.**
- **Goal 4: Adaptively Manage the Full Lifecycle of Water Resources Infrastructure.**

These goals are designed to address the growing challenge of managing water resources today and planning for an uncertain future, accounting for periods of both excess and scarcity. This CWSP will position SWD as a leader in incorporating Integrated Water Resources Management (IRWM) principles into the CW Program, thereby allowing USACE to enhance its value to the Nation through the services it provides.

In addition, this CWSP focuses on laying the groundwork for what comes next—implementation and tactical response planning. Prioritizing implementation will enable SWD to identify the key actions the Division must take now to be prepared to support the AOR regardless of which future scenario is realized, and ultimately to catalyze a new era of IWRM across the SWD Districts and CW Mission Areas.

1

Introduction

A New Era for Civil Works in SWD

In 2019, the U.S. Army Corps of Engineers (USACE) Southwestern Division (SWD/Division) began the development of this strategic plan to provide guidance for its Civil Works Program over the next two decades. The Civil Works Strategic Plan (CWSP) articulates the goals of the Program, provides support for the Division and its Districts in the development of tactical plans that will put strategies into actions, and communicates the direction of SWD to USACE leadership, stakeholders, and partners. The strategic planning exercise is well-timed as SWD is facing a rapidly changing world filled with increasingly complex and emerging challenges in water resource management. These challenges require innovative and integrated solutions to sustainably manage the risks of floods, droughts, and other natural disasters while managing the increasing and often competing demands for water resources driven by population and economic growth throughout the Division's area of responsibility (AOR). These difficulties are magnified by the need to make the most efficient use of limited resources, as well as to respect stakeholder desire for rapid action while safeguarding Federal policies for careful planning and project review. These challenges drive a fierce sense of urgency and SWD must enter a new era of innovation to provide value to the Nation through: creating and maintaining new and existing infrastructure; supporting historically engaged areas along with underserved communities; maintaining access to water supply while mitigating flood risk; and otherwise balancing the multitude of priorities to serve the AOR. The Division's ongoing shift toward operationalizing Integrated Water Resources Management (IWRM) is central to successfully meeting these new challenges head-on. This holistic and cross-sectoral approach to the development and management of water, land, and related resources will help ensure that SWD maximizes economic benefits, ecosystem quality, and public safety for the communities it supports.

SOUTHWESTERN DIVISION MISSION

SWD provides vital public engineering services and stewardship of water resource infrastructure, in peace and war, to strengthen our Nation's security, energize the economy, and reduce risks from disasters.

USACE CIVIL WORKS MISSION

Serve the public by providing the Nation with quality and responsive:

- Development and management of the Nation's water resources
- Support of commercial navigation
- Restoration, protection, and management of aquatic ecosystems
- Flood risk management
- Engineering and technical services in an environmentally sustainable, economic, and technically sound manner with a focus on public safety and collaborative partnerships

1.1 - Overview of SWD and the Civil Works Program

The Southwestern Division has provided support to the Southwestern United States for more than 80 years. SWD encompasses the Fort Worth (SWF), Galveston (SWG), Little Rock (SWL), and Tulsa (SWT) Districts with an AOR including all of Oklahoma and portions of Texas, Arkansas, Kansas, Missouri, and Louisiana (see Figure 1 on the following page). The Division's Civil Works (CW) responsibilities support the Mission Areas of Flood Risk Management, Navigation, Hydropower, Water Supply, Recreation, Regulatory, and Environmental Stewardship:

- **Flood Risk Management.** Over 760 miles of flood protection projects including 74 flood risk reduction reservoirs, **which combined protect more than $190 billion in public and private assets as of 2019**

The SWD Flood Risk Management Program is tasked with reducing the risk to human safety and property damage in the event of floods and coastal storms, through flood risk reduction reservoirs, levees and other infrastructure, and local flood protection projects. Flood risk due to extreme precipitation, tropical cyclones, and rising sea levels/subsidence (in coastal areas) has increased in recent years, and this trend is expected to continue. While annual precipitation rates and flood risk vary in different regions of the Division's AOR, SWD has experienced a noteworthy increase in record-breaking flooding events (see Figure 2). Rapid population growth, changing land-use patterns, and aging infrastructure further compound the problem of increasing flood risk and the Division's challenges in managing it.

- **Navigation. Navigation channels that span more than 1,500 miles and carry more than 500 million tons of commerce annually, second among USACE Divisions.** The SWD Navigation Mission is to ensure that channels are maintained at authorized depths and widths, dredged materials and sites are managed properly, storage capacities are sustainable, and locks are operable and maintained to avoid unscheduled closures. Navigation operations in SWD is typified by the Division's unique and complex coastal and inland navigation resources, the shared and unique risks they face, and their critical interdependencies. SWD operates and maintains three of the top ten Federal channels in the U.S. serving the Ports of Houston, Beaumont and Corpus Christi in Texas; is home to the inland McClellan-Kerr Arkansas River Navigation System (MKARNS), which transports more than 12 million tons of goods annually; and manages a significant portion of the Gulf Intracoastal Waterway, which transports over 91 million tons of goods annually. As the Division's inland and coastal navigation infrastructure continue to face growing threats and pressures associated with extreme weather variability and population growth, addressing their specific needs will require approaches uniquely tailored to them and that depend more on incorporating IWRM principles.

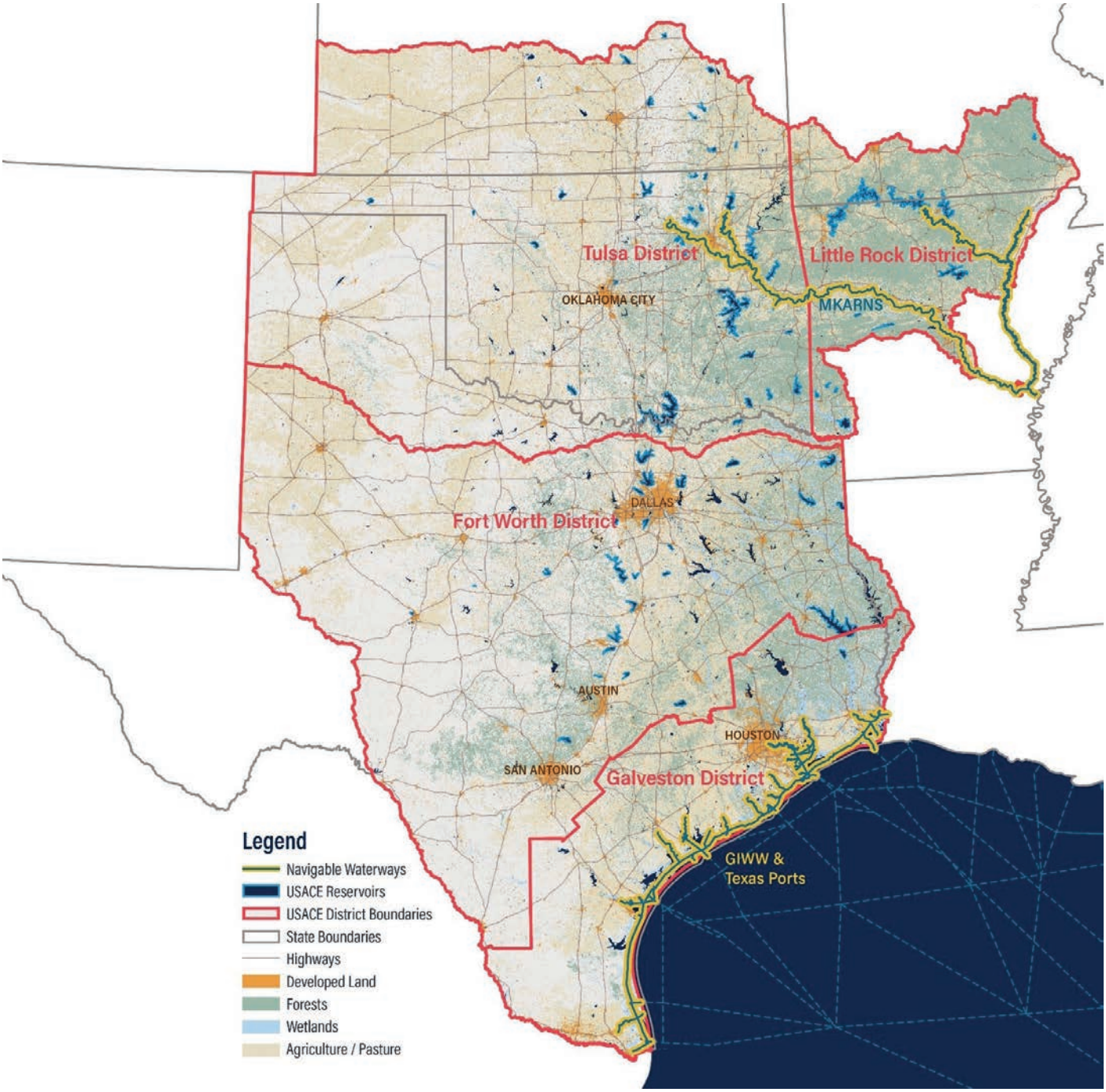


Figure 1- Map of SWD & District Areas of Responsibility

Also highlighted are waterways maintained by SWD as part of the Navigation Mission Area (in yellow) and reservoirs which support the Water Supply, Hydropower, and/or Recreation Mission Areas (in blue). In addition to these projects, SWD has constructed and maintained hundreds of planning and implementation efforts throughout the AOR.

SWD HISTORY

Figure 2 - Wister Lake Spillway within the Tulsa District.

SWD was created as a Division of USACE in 1937 and includes Districts that were originally established as early as the 1880's. From the 1880's to the 1930's the primary focus was on the expansion of the navigable waterway system, including starting channel maintenance for the Arkansas, White, and Trinity Rivers. The Flood Control Act of 1936 expanded USACE responsibility to include federal flood control measures and initiated the concept of multi-purpose projects. From the 1930's to the 1960's these multi-purpose projects led to the construction of hundreds of miles of levees and dozens of reservoirs to mitigate the flood risk of the Arkansas, White, and Red Rivers and other smaller tributaries. As the system of reservoirs expanded, so did the ways they were utilized by the public, with recreational use added in 1962 as a consideration in project development. The 1960's and 1970's brought legislation such as the National Environmental Policy Act (NEPA), which further expanded USACE responsibility to include more direct authority in environmental stewardship through permitting and regulatory processes. More recently, major environmental and economic drivers of the 21st century including tropical storms, droughts, increased exports, and the lifting of the export ban on oil have brought a renewed focus on maintaining and improving navigation infrastructure and flood control efforts in the region.

1.1

- **Hydropower. Hydroelectric power plants that provide energy to more than 8 million customers across the region, second among all USACE Divisions.** The SWD Hydropower mission is to provide a reliable source of electricity, reduce the amount of greenhouse gases produced, and reduce the dependence on fossil fuels such as coal, oil, and natural gas. Electricity produced at hydroelectric power plants is marketed by the Southwestern Power Administration (SWPA) and is sold to municipal utilities, military installations, and rural electric cooperative for use by the citizens in the Division's AOR as well as Kansas. As rapid population growth continues across the region, demand for hydropower in expected to increase, while the challenges of managing and maintaining aging hydropower resources and the risk presented to them by extreme weather also rise.

- **Water Supply. Water storage capacity sufficient to provide more than 4 billion gallons of water per day to the public and industry during drought conditions, comprising 75% of total USACE water supply storage.** The USACE Water Supply mission is to provide water storage that can help enable Americans to have enough water to meet their needs. SWD is the Planning Center of Expertise (PCX) for Water Management and Reallocation Studies (WMRS), reflecting the substantial skills and expertise that SWD personnel have developed while operating the majority of USACE reservoirs in the country. The SWD Water Supply Business Line provides support for regional water planning initiatives. The Division and its Districts, together with the Kansas City District, work with state water boards in Texas, Oklahoma, and Kansas to identify and resolve challenges for more effective federal-state collaboration. SWD has been experiencing rapid population growth and has the top two fastest-growing metropolitan areas in the nation in Dallas-Fort Worth and Houston, respectively. Population growth and rural-to-urban migration is expected to continue increasing throughout the region, resulting in an increasing demand for water supply and strain on the region's water resources to meet these needs. This challenge is further exacerbated by the Division's aging infrastructure, extreme weather variability, and changing land-use patterns.

1.1

- **Recreation. Recreational facilities that support 83 million visitors annually, first among all USACE Divisions.** SWD Recreation Mission Area supports the Natural Resources Management Mission to manage and conserve those natural resources consistent with ecosystem management principles, while providing quality public outdoor recreation experiences to serve the needs of present and future generations. As the leading Division in the entire USACE for recreational visitors, SWD supports recreational activities including boating, swimming, fishing, and camping (see Figure 3). Moreover, the majority of the Division's recreation areas are located within fifty miles of a major urban center. Rapid population growth in and around these urban centers is increasing the demand for, and the strain on, SWD recreation resources. This strain and challenges in managing recreation resources are further compounded by other key drivers affecting the Civil Works program in the region, especially aging infrastructure, weather extremes and variability, and changing land-use patterns.

- **Regulatory. Over 6,000 regulatory permit decisions annually for protection of waters and wetlands.** The SWD Regulatory Program employs approximately 90 regulatory project managers across its Districts that complete more than 6,000 permit and 5,000 jurisdictional related actions every year. These actions result in the authorization of millions of dollars in development projects that create thousands of jobs and support the Division's various Missions.

  The Regulatory Program executes USACE responsibility for authorizing actions in or affecting navigable waters of the U.S. under the authority of Section 10 of the Rivers and Harbors Act of 1899; actions involving the discharge of dredged or fill material into waters of the U.S., including wetlands, under Section 404 of the Clean Water Act (CWA); and the transportation of dredged material for disposal in the ocean under Section 103 of the Marine Protection, Research, and Sanctuaries Act. Both public and private landowners must obtain permits from USACE prior to beginning any actions that impact navigable waterways.

Figure 3 - Record bass caught at Bull Shoals Lake, MO, in the Little Rock District.

1.1

- **Environmental Stewardship. SWD Ecosystem Restoration and Stewardship efforts supporting at least 17 endangered species.** The role of USACE in environmental stewardship is to incorporate sustainability across the CW Program and to conduct planning and implementation projects that restore damaged or degraded ecosystems. USACE Environmental Operating Principles are incorporated within all planning and implementation projects so that environmentally sustainable practices are used throughout the execution of the other Mission Areas. As mentioned above, management of areas as part of the Recreation Mission Area includes consideration of impacts to natural resources. In addition, SWD restores and protects habitat and species through the planning and execution of restoration projects. One example of an Environmental Stewardship project within the Division is more than 2,800 acres of marsh creation as part of a beneficial use of dredge project using material from the deepening of the Houston Ship Channel.

1.2 - Strategic Plan Development Process: Overview

The SWD approach to developing the CWSP (see Figure 4) was designed to result in a strategic plan that is informative to the SWD Division and each of its Districts (see Figure 1), relevant across Mission Areas and Business Lines, and readily transferable for future implementation planning. The process began from the bottom up with an information gathering phase in which each District conducted a Strengths, Weaknesses, Opportunities, and Threats (SWOT) and Risk Analysis to identify core capabilities and gaps, drivers that influence demand for USACE, and potential opportunities to enhance efficiency or value. Input to the SWOTs and Risk Analysis was first taken from District and Division personnel and then elicited from stakeholders to provide an external perspective. Desktop research on drivers of demand for USACE was then conducted to identify key trends and uncertainties in factors such as extreme weather and regional commerce conditions, which were further compared and benchmarked against USACE perceptions. A series of future scenario planning exercises, grounded in the desktop research and the SWOT and Risk Analysis, provided a framework for dynamically planning for and responding to an uncertain future. In addition, these scenarios were used to identify key gaps that, if filled, enable SWD to be more prepared for multiple possible futures. This input was synthesized into a framework for action that includes a comprehensive Vision for SWD's Civil Works Program, four cross-cutting Goals, and 25 strategic Objectives designed to provide high-level direction to inform decision making in the face of uncertainties in a changing physical and socioeconomic landscape.

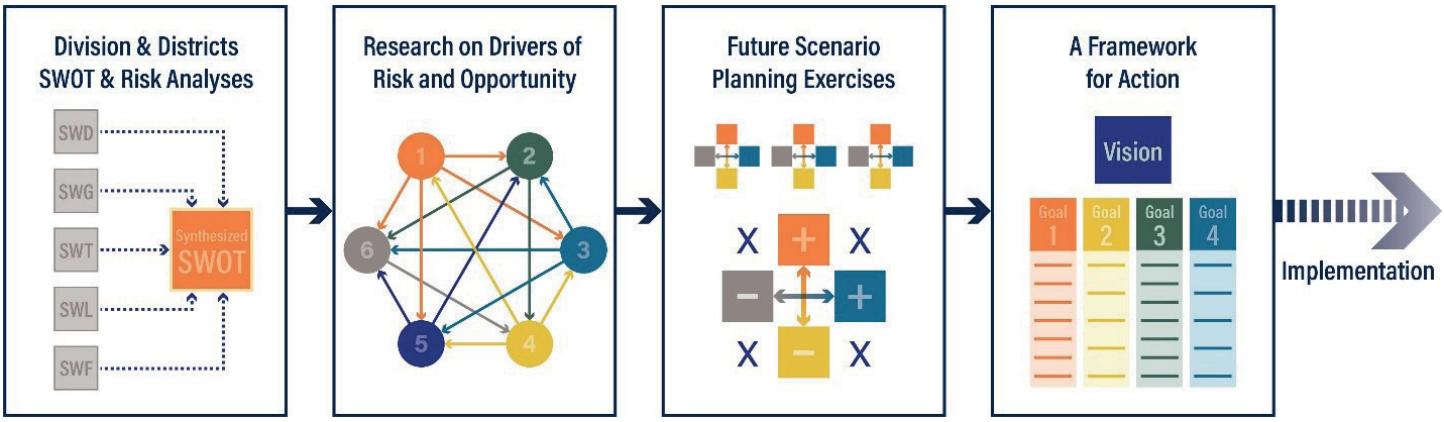


Figure 4 - Conceptual diagram of the SWD Civil Works Strategic Plan Development Process

1.3 - Building on Strengths

SWD and its Districts possess unique strengths that can be maintained, enhanced, and expanded to provide robust support to the region despite the challenges created by evolving conditions and needs. Some of these strengths, identified from the SWOT along with statistics on each District, are highlighted below. Also provided is a brief description of the Division's Area of Responsibility (AOR) and major focus areas of each District under the Civil Works Program. Additional information may be found online at the links provided below.

1.3.1 USACE-SWF (https://www.swf.usace.army.mil/)

The Fort Worth District (SWF) encompasses approximately half of the state of Texas and spans basins from the Rio Grande to the Red River. In addition to managing 685,000 acres of land, 340 recreation areas, and 397,000 acres of water management, SWF has responsibility for the operation and maintenance of 25 multi-use projects and three hydropower plants. Some of the key strengths of SWF are:

- Engaged stakeholders who are eager to work with USACE in enabling solutions
- Effective project management structures, including senior level engagement in project delivery teams
- Significant Corps Water Management System (CWMS) modeling capacity, enabling real-time water management
- Increasing involvement in state-level planning efforts that present opportunities for synergy with, and leveraging of, external entities plans and capabilities

1.3.2 USACE-SWL (https://www.swl.usace.army.mil/)

The Little Rock District (SWL) encompasses a large portion of Arkansas and reaches into southern Missouri. The District plays a major role in regional flood risk management and inland navigation, operating 12 reservoirs, 13 locks and dams, and 308 miles of navigation channels. SWL also provides substantial support in providing water supply and recreation for the area, managing close to 150 public parks and access areas , 25 multi-purpose lakes and navigational pools, and almost 500,000 acres of public land. Some of the key strengths of SWL are:

- Extensive experience partnering with federal, state, local, and tribal agencies to reduce flood risk through the Silver Jackets program
- Strong record of providing technical assistance to the AOR through programs such as the Floodplain Management Services (FPMS), Planning Assistance to States (PAS), and Continuing Authorities (CAP) programs

1.3.3 USACE-SWT (https://www.swt.usace.army.mil/)

The Tulsa District (SWT) spans the entirety of Oklahoma, the southern half of Kansas, and portions of northern Texas, covering more than 160,000 square miles of the southwestern United States. SWT has an extensive operation and maintenance program for multi-use projects, including 33 lakes and reservoirs, 5 locks and dams, 8 hydropower facilities, and more than 250 recreational use areas. In addition, the District is responsible for maintaining significant inland navigation channels, such as portions of the McClellan-Kerr Arkansas Navigation System (MKARNS). Some of the key strengths of SWT are:

- Extensive experience in emergency management, flood risk mitigation, and inland navigation
- Strong relationships with states and tribes within their AOR

1.3.4 USACE-SWG (https://www.swg.usace.army.mil/)

The Galveston District (SWG) AOR includes the coastal region of Texas and a portion of the Louisiana coast. Texas is second in the nation for waterborne commerce and includes major ports such as Houston, Beaumont, and Corpus Christi, as well as numerous other deep and shallow draft ports. Major areas of focus for SWG include dredge maintenance of these ports as well as navigable rivers; flood and coastal storm risk mitigation; coastal habitat restoration; and barrier island shoreline stabilization. Some of the key strengths of SWG are:

- Extensive experience in navigation, flood and coastal storm risk management, and ecosystem restoration
- Strategic partnerships across the public and private sectors, including other federal entities, state agencies, regional planning boards, and port authorities

- Competency in geospatial planning tools for quantitative, data-driven decision making

1.3.5 SWD Synthesis

Beyond expertise spanning CW Mission Areas, one of the key strengths across SWD is excellent relationships with stakeholders and sponsors who are eager to work with SWD in supporting the needs of the region. The Division has complemented this strength with advancement in key internal areas, such as the development of a Regional Planning and Environmental Center (RPEC) to provide centralized, robust support to CW projects across the AOR. In addition, each of the Districts possesses existing capacity for surge that can be leveraged and expanded to meet new challenges, along with vital experience and expertise across varying core CW Mission Areas. With these existing strengths serving as a firm foundation, SWD can be bold in shifting toward more innovative and integrated approaches to project planning and execution. Such a paradigm shift will be essential in addressing the unique challenges that affect the Division's CW Mission Areas in the face of an uncertain future. As a first step in this paradigm shift, the Division and its Districts must adequately understand, anticipate, and plan for the key drivers that affect, and will continue to affect, the region now and into the future.

2

Evolving Risks & Opportunities

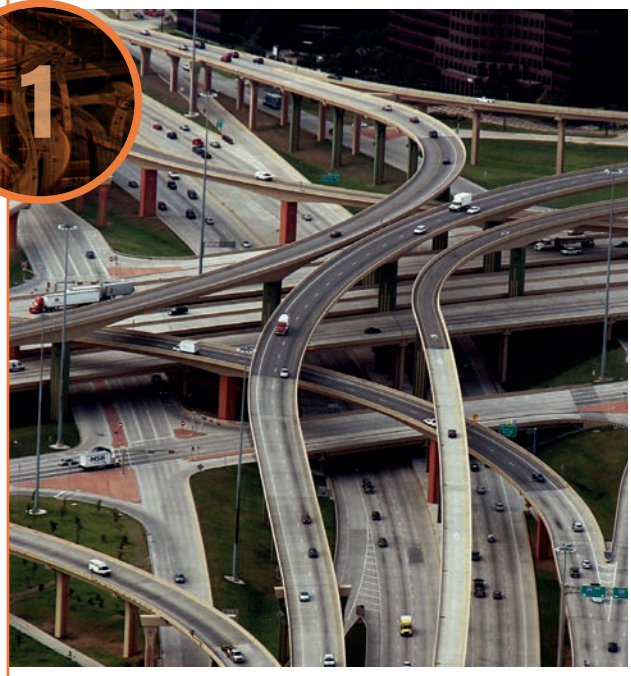
Key Drivers

SWD's AOR is rapidly changing. A series of socio-economic and bio-physical trends with global analogues are manifesting in complex ways at varying scales throughout the region. These trends, and their uncertainty, represent evolving risks and opportunities for the SWD Civil Works program, especially when analyzed in the context of a rapidly growing and urbanizing population, a changing regional landscape, changing extreme weather patterns, a water-food-energy nexus pressured by an uncertain energy future and competing uses, and aging infrastructure. These trends have been identified as key drivers for the Civil Works Program in the region, as their uncertainty and considerable implications for USACE Mission Areas present challenges that can only be met with a movement toward a more integrated and adaptive paradigm of water resources management. Additionally, the societal risks posed by these drivers are likely to disproportionately affect socially vulnerable populations. Therefore, such risks and opportunities cannot be divorced from the inequitable distributional impacts on communities lacking the resources to thrive in and adapt to difficult and changing circumstances.

The COVID-19 pandemic, which took hold across the country in early 2020, may have long-range impacts on global and regional socioeconomic trends, including oil production and demand. This strategic plan considers some volatility of these key drivers. However, this plan is limited in how it can consider COVID-19 impacts specifically without thorough additional study, particularly given the lack of precedent for understanding the full long-term impacts of this pandemic. More evident, however, is the sustained and added pressure this public health crisis imposes on communities already disproportionately vulnerable to the impacts of extreme weather variability and growing resource pressures. For these populations, uninterrupted access to potable water for drinking and sanitation as well as resilience to extreme weather events will be more important than ever in the years to come, especially as changes in habitats and weather patterns drive increases in future vector-, food-, and water-borne infectious disease risk.[1]

2.1 - Driver 1: Rapid Population Growth & Urbanization

Rapid rural-urban out-migration, combined with natural population growth, are driving a population explosion in major metropolitan areas like metro Dallas, Houston, Oklahoma City, and northwest Arkansas.



Source: Dallas High Five Interchange, Austrini

According to the American Community Survey (ACS) 5-year estimates, the total population of all counties contained within SWD's boundaries grew 12.4% from 2010-2018, from about 31.7 million to 35.7 million. Between 2010-2019, the DFW Metropolitan area exhibited the largest growth in population in the nation and was closely followed by the Houston Metropolitan area, which exhibited the second highest increases during this period.2 While the region's population growth is primarily driven by Texas with the highest projected growth rate in the nation through 2040, 3 other areas in the SWD such as northwest Arkansas are also experiencing rapid rates of growth, driven largely by rural-urban migration. 4 As of 2018, at least 60% of the population in the region encompassing Texas, Oklahoma, and Kansas is clustered around metropolitan areas. 5 This reflects a broader global trend in which population growth and urbanization are becoming increasingly synonymous (see Figure 5). 6

Correlated with this trend is increasing regional racial and ethnic diversity, particularly in areas experiencing rapid urbanization. In Texas, for example, the non-Hispanic Asian population is projected to grow at a rate of more than five times the 2010 population by 2050 and both the non-Hispanic black and Hispanic populations are projected to double in size by 2050 compared to 2010, while the non-Hispanic white population grows at a slower relative pace. 7 Many of these populations overlap with socio-economic and demographic indicators strongly correlated with higher levels of vulnerability to severe outcomes due to hazards such as flooding and drought. 8

Population growth and urbanization are also central drivers of economic activity and recent trends in key industries in the region. Many of these industries have significant implications for regional Integrated Water Resources Management (IWRM) and Civil Works, with their viability closely linked with future energy uncertainty and increasing demand on limited water resources. For instance, studies have found a correlation between electricity consumption and population growth, 9 which is likely to be even stronger given projected increases in annual average temperatures. Over the past decade, the oil, gas, and petrochemicals industries in Texas and Oklahoma have seen a boom as demand for energy continues to increase with population growth. However, since 2014, employment and drilling operations in energy production industries have seen a relative decline, possibly correlated with increasing global demand for, and availability of, renewable and diversified energy sources.

If current trends continue, Texas' urban population will double within 40 years and account for 94.6% of the state's population growth by 2050. Compare this with rural population growth, which at the 2017 rate would take 218 years to double its population.

Source: Texas Rural Funders Collaborative. 2018. The Future of Rural Texas: A Texas Tribune Symposium.

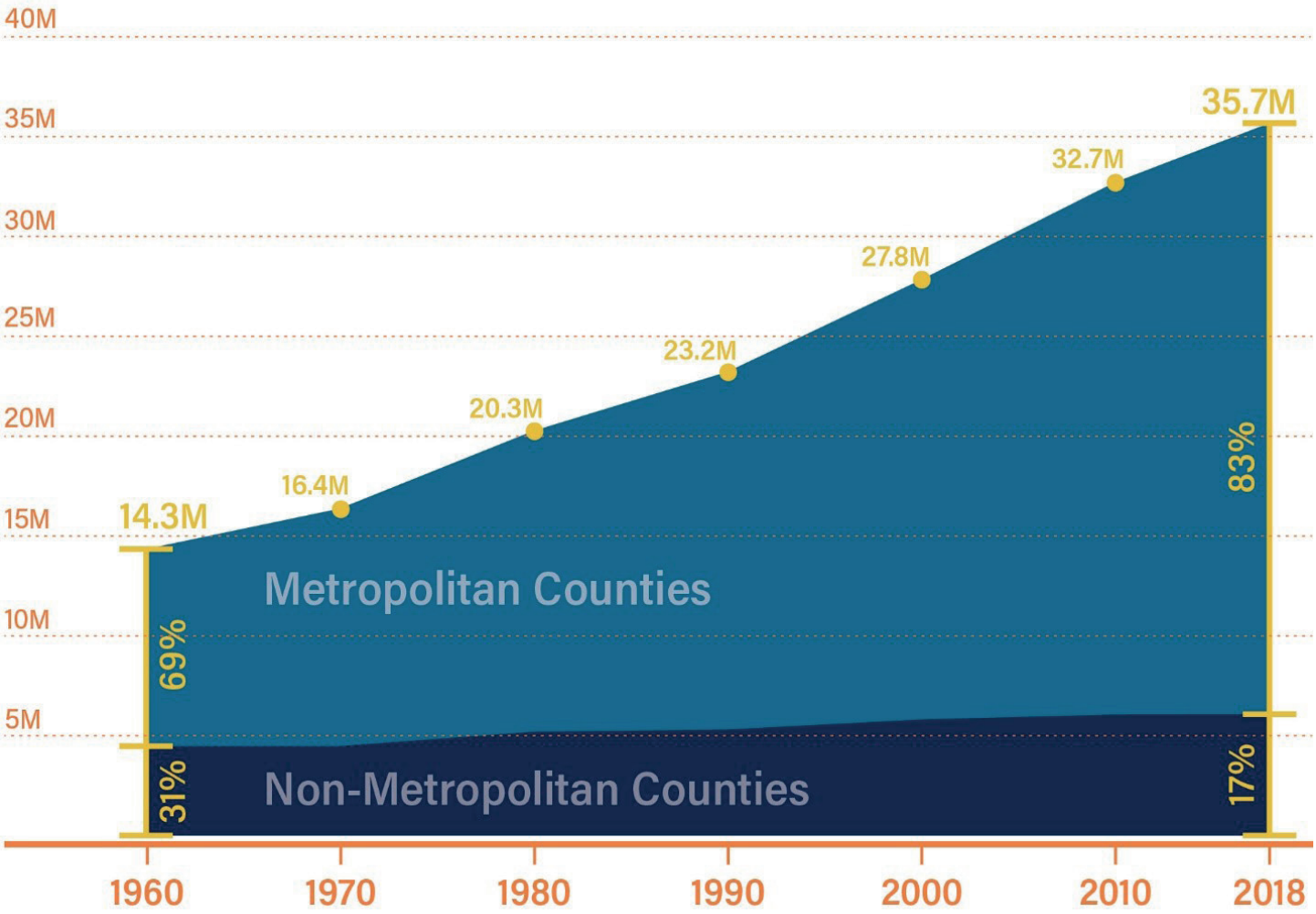


Figure 5 - Population Growth in All Counties in the SWD AOR from 1960 to 2018, by Urban vs. Rural Areas

2.1

The growing wind turbine industry in southwest Oklahoma illustrates that these global changes are influencing the region and highlights the importance of the broader Southern Plains region for energy production even while the distribution of energy sources evolves. Notably, increasing demand for wind and solar energy is also likely to drive increased demand for existing hydropower plants to play a stabilizing role in power generation throughout the region; studies have shown that hydropower can facilitate the integration of wind and solar energy into power grids by compensating for their high variability.10

Similarly, population growth and urbanization are likely driving increased demand for food and agricultural products, timber products, and recreation, all of which represent major, growing industries in the region. Farm and agricultural land represents a substantial amount of landcover throughout Texas, Oklahoma, and Arkansas, and although some places have seen a recent decline in farm-related employment, this may be more a result of increased efficiency than shrinking production. 11 Between the three states, the region produces much of the nation's beef cattle, broilers, sheep and wool, cotton, rice, and other crops and commodities. There is also a heavy concentration of agricultural equipment operators and logging industry workers compared with the rest of the nation, and industries related to forestry, fishing, and related activities have seen a noteworthy increase in employment since 2008. Finally, outdoor recreation-related activities are a major and growing source of economic activity and employment in this area of the country, centered around Texas' coastal economy along with fishing, boating, hiking, and other activities associated with many lakes and waterways throughout the region. Water access and the recreational opportunities it provides raise the values of adjacent lands that are already increasingly valued for recreational usage as urban centers and population grow and expand.12

2.2 - Driver 2: A Changing Regional Landscape

Urbanization, resource demands, extreme weather, and coastal erosion are driving regional land use/cover changes, impacting flood risk, water quality, channel morphology, local water balance, biodiversity, industry & recreation.

2

Source: Northwest Arkansas, Google Maps

2.2.1 - Changing Land Use and Land Cover Dynamics

Rapid urbanization is driving changes to land use and land cover (LULC) in the region (see Figure 6). Accompanying the regional trend of rural-urban migration patterns is the transformation of many rural landscapes, including farmland, forests, and pastures, to more urbanized areas (for example, in Northwest Arkansas). 13 Studies around the world have consistently found that urbanization and increased impervious surface coverage transform fluvial landscapes, habitats, and natural hydrology with broad implications. 14 LULC impacts due to urbanization include impacts to flood discharge, water quality, channel morphology, local water balance, and biodiversity. 15 In particular, multiple studies have demonstrated that expansion of impervious surface coverage reduces an area's infiltration capacity, thereby leading to higher rates of downstream runoff, often carrying pollutants

and debris along the way. 16 Increased runoff can elevate rates of flood peak discharge, rates of total flood volume, as well as debris production, thereby exacerbating the flood risk associated with extreme precipitation while potentially decreasing water quality. 17 In some cases, this may result in USACE flood control projects receiving more runoff than they were designed for, accelerating the need to update outdated flood protection infrastructure downstream of areas experiencing LULC change in order to ensure they continue to meet their intended level of protection. Additionally, these LULC effects can alter channel morphology and riparian habitats in unpredictable ways, including increasing channel dimensions or decreasing headwater stream length. 18 This presents an additional challenge of uncertainty for various USACE Civil Works Mission Areas including Flood Risk Management, Navigation, Water Supply, and Environmental Stewardship, although these effects have not been as thoroughly studied.19

2.2.1

There is also some evidence that suggests urban land itself can directly influence the timing and magnitude of precipitation because of urban heat island (UHI) effect. 20 Such urban-influenced rainfall has been observed, for example, in Houston. 21 Urbanization's impacts to watershed hydrology can also result in changes to groundwater recharge. 22 This, combined with changing agricultural and energy production practices, poses even greater uncertainty to the region's future water supply and demand.

2.2.1

The Texas Gulf Coast is experiencing unique and substantial land cover changes in the form of coastal erosion driving the retreat of the coastline. Rates of beach erosion of up to nearly 10 feet per year are largely driven by storm surge and high tides combined with sea level rise (SLR). The consequent impacts to water quality and water depth are accelerating the disappearance of wetlands, marshes, barrier islands, and other coastal habitats, all of which can play a crucial role in protecting coastal areas against storm surge.23

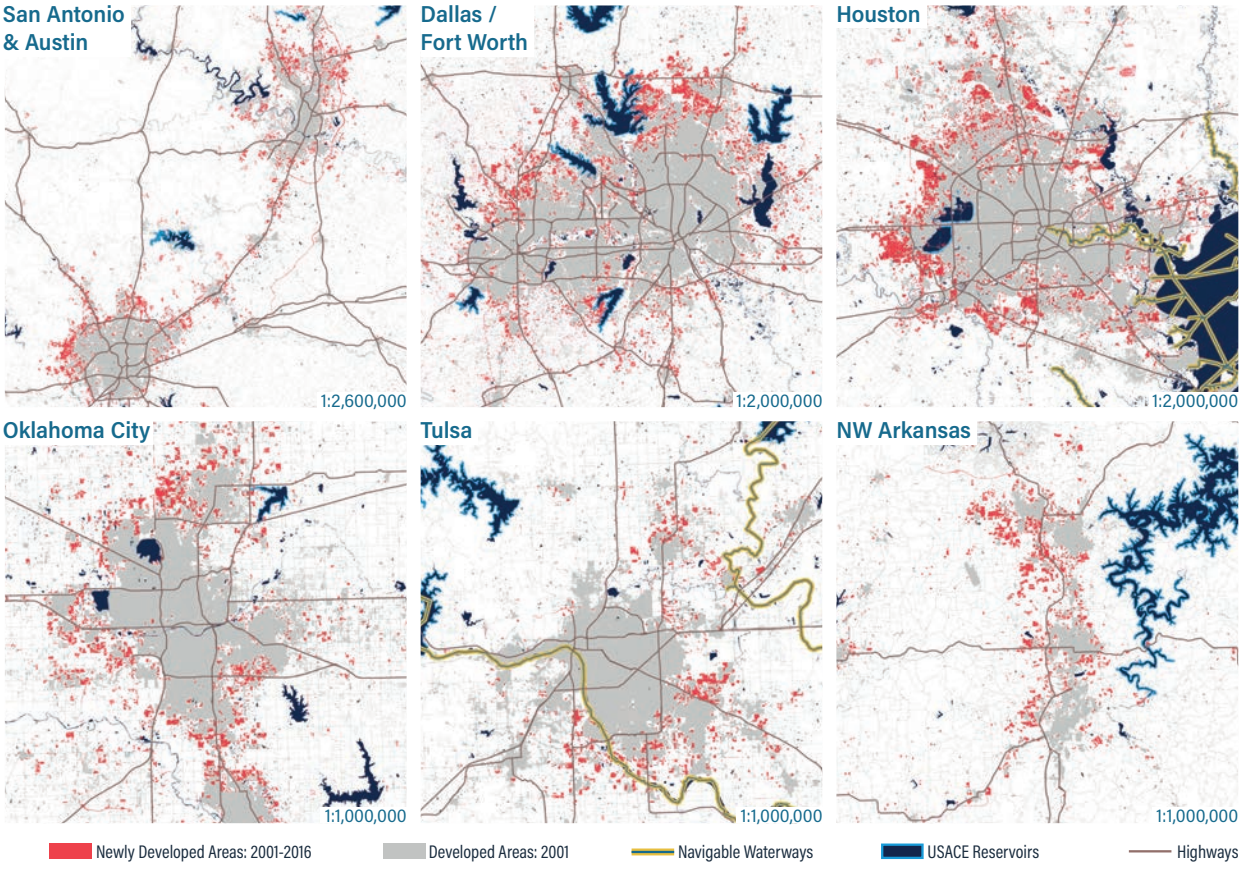


Figure 6 - Maps of New Development in Metropolitan Areas, 2001-2016

2.2.2 - Habitat Change

Many habitats in the region are sensitive to and directly impacted by increased variability in extreme weather; shifting food, energy, and water dynamics; and changing landscapes driven largely by urbanization. For example, as dipole events involving swings between periods of drought and heavy rainfall increase in frequency, length, and intensity, aquatic and estuarine ecosystems, including fish populations, are directly affected both by declining water availability as well as impacts to freshwater inflows. 24 Urbanization-driven changes to natural hydrology, in addition to increased sedimentation, likely exacerbate some of these effects.

Drought is also a key accelerator of habitat change in the region. Some habitats, such as those supported by playa lakes (shallow wetlands that form after rainfall events) and other natural wetlands, have been found to be nonexistent during periods of drought in the region. 25 Others, such as estuarine habitats, are negatively impacted by changes to freshwater inflows that moderate salinities and temperature and provide crucial nutrients. 26 Drought and temperature change also increase water temperatures, which places strain on aquatic habitats, especially in coastal bay waters, causing hypoxia and algal blooms. 27

The continued integrity and stability of these ecosystems is of importance to Civil Works Mission Areas in multiple ways. In a national USACE survey, SWT reported the highest number of threatened and endangered species (TES) effecting on USACE projects of any District, which could include listings of TES present and/or situations in which TES impacted operations. 28 Biodiverse coastal and freshwater ecosystems furthermore play an important role in maintaining good water quality and managing pollutants; providing storm barrier protection to coastal infrastructure, ports, and energy production facilities; supplying fish and other seafood; and providing recreational and ecotourism opportunities. 29 As such, leveraging opportunities to conserve and restore habitat can positively impact multiple USACE Mission Areas.

Additionally, changing habitat patterns have allowed and continue to allow the introduction and establishment of invasive species that may increase risk to agricultural production, biodiversity, ecosystem stability, water quality, and various types of water infrastructure including dams, levees, hydropower systems, navigation channels, and lock chambers. 30 While increasing water temperatures, rising sea levels, and increases in extreme weather can facilitate the success of many aquatic invasive species 31, recent studies have also suggested that urbanization may increase the invasive potential of alien species. 32 Some invasive species of particular concern to USACE Mission Areas include zebra mussels, which can grow on many water infrastructure systems, impeding function; 33 blue-green algae, which pose hazards to water quality and health; 34 and water hyacinth, which negatively impact water quality and impede navigation and fishing.35

2.2.2

2.3 - Driver 3: Increases in Extreme Weather: Droughts & Floods

The frequency and intensity of droughts and inland and tropical storms are projected to increase, as are rapid swings between the two weather extremes. Sea level rise and subsidence will increase the risk of coastal flooding.

3

Source: Hurricane Harvey, Texas Army National Guard photo by 1st Lt. Zachary West

A Decade of Extreme Weather Events: 2010-2020

Rainfall-driven flooding in 2015 caused $2.6 billion in damages in Oklahoma and Texas alone. Other recent extreme weather events in the region exceeding $1 billion nationally in damages include:

- August 2020: Hurricane Laura (LA, TX)
- May 2020: Regional severe weather and flooding (AR, KS, MO, TX)
- April 2020: Regional severe weather and flooding (LA, OK, TX)
- January 2020: Regional severe weather and flooding (AR, LA, MO, TX)
- October 2019: Regional severe weather and flooding (AR, LA, MO, OK)
- September 2019: Tropical Storm Imelda (LA, TX)
- July 2019: Mississippi River and regional flooding (AR, KS, LA, MO, OK, TX)
- June 2019: Arkansas River flooding (AR, OK)
- April-May 2019: Regional severe weather and flooding (KS, MO, OK, LA, TX)
- Summer-Fall 2018: Regional drought (KS, MO, OK, TX)
- July 2018: Regional severe weather and flooding (AR, KS, MO)
- April-May 2018: Regional severe weather and flooding (AR, KS, MO, OK, TX)
- August 2017: Hurricane Harvey (LA, TX)
- May 2017: Regional severe weather and flooding (AR, MO, OK, TX)
- March 2017: Regional severe weather and flooding (OK, TX)
- May 2016: Regional severe weather and flooding (KS, MO, TX)
- March-April 2016: Texas and Louisiana flooding (LA, TX)
- December 2015: Regional severe weather and flooding (AR, MO, LA, TX)
- April-May 2015: Regional severe weather and flooding (AR, KS, MO, OK, TX)
- 2014: Severe regional drought (KS, OK, TX)
- September 2014: Regional severe weather and flooding (KS, TX)
- June 2014: Regional severe weather and flooding (AR, KS)
- April 2014: Regional severe weather and flooding (AR, KS, MO, TX)
- Spring-Fall 2013: Regional drought and heatwave (KS, MO, OK, TX)
- April-May 2013: Regional severe weather and flooding (KS, MO, OK, TX)
- 2012: Historic regional drought (AR, KS, MO, OK, TX)
- April-June 2012: Regional severe weather and flooding (KS, MO, OK, TX)
- Spring-Fall 2011: Regional drought, heatwave, and wildfires (KS, LA, OK, TX)
- May-June 2010: Regional severe weather and flooding (AR, KS, OK, TX)

Key
Extreme Rainfall, Coastal Storm Surge, Drought
Sources: NOAA National Centers for Environmental Information. 2020. Billion-Dollar Weather and Climate Disasters: Events. Available online at: https://www.ncdc.noaa.gov/billions/events. Accessed on September 10, 2020.
U.S. Global Change Research Program (2017b).

2.3.1 Severe Droughts

Combined with increasing annual average temperatures and increasing evaporation rates affecting soil moisture, precipitation change is causing droughts to become more frequent and more intense. Periods of drought are also increasing in length.

Increasing weather variability—driven by annual global temperature increases associated with elevated greenhouse gas (GHG) emissions—is linked to unpredictable swings, or dipole events, in precipitation patterns experienced in recent decades. Projections under the high GHG emissions scenario suggest

an overall decrease in spring and summer precipitation in the region of 10-30% by the end of the century, 36 despite increases in the intensity of such events. Increasing intensity of precipitation events elevates flood risk, even during periods of drought. 37

Projections indicate an 80% chance that the region will experience a decade-long or multi-decadal drought in the latter half of this century.

Source: Cook, Bi.I., T. R. Ault, and J. E. Smerdon. 2015. Unprecedented 21st century drought risk in the American Southwest and Central Plains. Science Advances. 1(1).

Drought is exacerbated by, and often inseparable from, historical and projected increases in annual average temperatures in this region. Texas, Oklahoma, and Kansas together have seen an increase in annual average temperatures of 1-2°F over the past century, with the highest average warming experienced in winter months. 38 The Fourth National Climate Assessment projects an increase in annual average temperatures in the region of 4.4-8.4°F by the late 21st century. 39 Under the business-as-usual GHG emissions scenario, this would entail an additional 30-60 days per year above 100°F. This implies an increase in both overall average temperatures (e.g., in the winter months), as well as in the intensity and frequency of extreme multi-day heatwave events. Similar projections also hold in the state of Arkansas. 40

2.3.1

Increases in the severity, frequency, and duration of drought in the region will continue to strain the region's available sources of water supply. As the strain on water resources is further exacerbated by increasing tradeoffs for different uses, risk to food and energy production will grow as rapid population growth and rural-urban shifts increase demand.

Reservoir storage capacity is being lost due to increased sedimentation in the region, often as a result of flooding events. In conjunction with that loss, it is likely that drought-stressed surface water availability (see Figure 7) will increase the pressure to reallocate water storage at multi-purpose reservoirs to water supply purposes, 41 especially as overall demand for water is projected to increase significantly in the region over the next 50 years. These challenges to multi-purpose reservoir operations are consistent with USACE policy and guidance for drought contingency plans. 42

A drought in 2060 would put an estimated half of Texas' population at risk of a water shortage.

Source: U.S. Global Change Research Program (2017b).

Figure 7 - O.C . Fisher Reservoir during a period of extreme drought.

2.3.1

Water scarcity during drought increases the reliance of groundwater resources in the region, driven in part by the needs of the agriculture and energy production industries. Increased dependence on irrigation under drought conditions, for example, has also caused a shift toward less efficient agricultural practices such as center pivot irrigation for groundwater mining, which has been depleting the High Plains Aquifer System and changing natural hydrology and downstream runoff patterns. 43 In Arkansas, water levels in the Alluvial Aquifer, which is the state's primary source of groundwater, declined almost 4 feet from 2004-2014. 44

Reduced irrigation water in Oklahoma may result in as much as 69% lower crop productivity.

Source: Oklahoma Water Resources Board (2011).

In general, drought and increased heat, especially warmer winter night temperatures, have made winter crop productivity less dependable, increased soil moisture stress, and a exacerbated proliferation of invasive species, insects, and pests in some areas. 45 This not only has negative impacts to agricultural food production, but on stable regional biodiversity at large.

Higher temperatures are also driving growing demand for electricity for cooling purposes, especially in urban areas where the UHI effect is elevated. As demand for these resources grow, more intense and frequent heatwaves are likely to significantly strain energy utilities, potentially leading to failures and an inability to meet demand.46 Limited water resources for power plant cooling and thermoelectric power generation will intensify these challenges and associated tradeoffs.

Drought and water scarcity also have direct impacts on freshwater inflows that support a variety of habitats, including wetlands habitats for migrating waterfowl and a variety of coastal species.47 Warmer temperatures also impact water temperature and water quality. 48

2.3.2 - Extreme Rainfall and Tropical Storms

Although overall average annual precipitation is largely projected to decrease across most of the region, especially in the summer, both the frequency and intensity of extreme rainfall events and major tropical cyclones are projected to increase. 49

Flooding due to extreme rainfall events and tropical cyclones has been severely disruptive in the region, and this flood risk is expected to continue increasing. Tropical cyclones are associated with extraordinarily heavy rainfall rates, with the heaviest rainfall amounts from such events up 5%-7% over the past century. 50 Moreover, most rivers in the region are not fed from mountain snowpack and are therefore highly sensitive to flooding caused by seasonal rainfall (see Figure 8). 51

Significant rainfall followed periods of drought in the Southern Plains region approximately one third of the time over the past 50 years, compared to half that rate over the 50 years prior.

Source: Christian, J., K. Christian, and J. B. Basara. 2015. Drought and Pluvial Dipole Events within the Great Plains of the United States. Journal of Applied Meteorology and Climatology. 54(9):1886-1898

Figure 8 - MKARNS during a flooding event

Existing regional average annual precipitation trends vary widely from the western part of the region, with areas receiving less than 10 inches on average, to the eastern part of the region, with areas receiving more than 60 inches on average. 52 In general, the Fourth National Climate Assessment anticipates slightly wetter winters on average in the region, especially in the north, and drier summers with the increasing specter of drought. Nevertheless, dipole events, or rapid swings between severe drought and heavy precipitation, are on the rise, such as in 2015 when a period of drought abruptly ended with the onset of severe flash flooding and multiple episodes of extreme rainfall. 53 In the past 30 years, there has been a noteworthy increase in record-breaking flooding events despite an overall decrease in the frequency of flooding, 54 highlighting the seeming discrepancy between annual average trends and the reality of acute events. For example, according to updated National Oceanic and Atmospheric Administration (NOAA) Atlas 14 rainfall frequency values for Texas, the amount

of rainfall in Houston that previously constituted a 100-year event is now considered a 25-year event. 55

Extreme rainfall events directly threaten lives, livelihoods, agriculture and energy production, and critical services and infrastructure, while also placing a heavy strain on aging infrastructure such as older dams and levees.

2.3.2

Rapid population growth and urbanization also increase exposure to the hazards posed by heavy flood events while exacerbating flood hazard itself via increased stormwater runoff. Indeed, loss of life due to flooding in the region is higher, on average, than in much of the rest of the country. Texas in particular has experienced substantially more flood fatalities over the past decade than any other state. 56 Flood fatalities in the period 2010-2020 for Texas, Oklahoma, Arkansas, Missouri, Kansas, and Louisiana can be found in Table 1.

State	Flood Fatalities 2010-2020 57
Texas	225
Arkansas	67
Missouri	66
Oklahoma	58
Louisiana	27
Kansas	10

Table 1 - Flood Fatalities 2010-2020

Further, extreme flood events can exceed a reservoir's storage capacity, especially for those that have exceeded the analysis period for which they were designed and were constructed before extreme weather events began occurring more frequently. 58 This challenge is further complicated by a trend of increasing sedimentation buildup in reservoirs, affecting their ability to meet intended storage capacity. Many of these reservoirs may require recapitalization, updates to their operating plans, and improved sedimentation management to minimize the risk of catastrophic downstream releases of stored water (see Figure 9). 59 Hurricanes and rainfall events similarly impact coastal navigation, requiring significant post-storm dredging. 60

Given these rapidly changing conditions and increasing risk and uncertainty, it is essential that USACE SWD utilize existing guidance and tools, notably the USACE Engineering and Construction Bulletin (ECB) 2018-14 Guidance for Incorporating Climate Change Impacts to Inland Hydrology in Civil Works Studies, Designs, and Projects, and rely on best-available science in determining whether existing and future projects should consider the effects of increased climate variability during planning, designing, and re-evaluation. 61

Figure 9 - Water being released from the Lake Eufaula Dam, May 13, 2015

2.3.3 - Storm Surge and Sea Level Rise

Extreme storm surge events combined with relative sea level rise (RSLR) increase flood and life safety risks along the Texas Gulf Coast. Over the past century, relative sea levels in the region have risen 5-17 inches. 62 The rates of relative SLR along the Texas Coast have shown substantial variability, from 0.08 inches per year from 1957-2011 at Port Mansfield to 0.26 inches per year at Galveston Pleasure Pier. 63 These variations are driven in large part by varying levels of vertical land movement, or subsidence, combined with global, or eustatic, sea level changes. 64 Upwards of 1,000 square miles of land along the Texas Coast are now within five feet of the high tide line. 65 Projections of these trends into the future vary due to uncertainties in weather and climate patterns, but are in general agreement that RSLR is expected to continue in this region. RSLR increases both the risk of severe storm surge from extreme weather events and the ongoing risk of chronic tidal flooding which, while having less catastrophic acute impacts, can drive major socio-economic shifts and impacts to existing facilities and infrastructure in the long-term.

SLR is also partially driving the retreat of the Gulf coastline, which is exacerbated by land-surface subsidence and beach erosion that pose their own risks while also intensifying the risk of flooding to populations and infrastructure. Subsidence is partially driven by activities such as the extraction of fossil fuels, for which the Texas Coast is a major hub, in addition to the extraction of groundwater, driven largely by energy-producing industries in the region facing water supply shortages. 66 The dynamics between coastal SLR, subsidence, and water supply resources are indeed complex; the former also drives substantial saltwater intrusion of major aquifers such as the Gulf Coast Aquifer. 67 Additionally, in some areas, such as the Addicks and Barker Reservoirs in Houston, subsidence due to groundwater withdrawal negatively impacts reservoir storage capacity, exacerbating flood risk.

2.3.3

Rapid rates of beach erosion along the Texas Coast, meanwhile, are largely driven by storm surge and high tides combined with RSLR. The consequent impacts to water quality and water depth are causing a reduction in the extent of wetlands, marshes, barrier islands, and other coastal habitats, all of which play a role in protecting coastal areas against storm surge. 68

Relative sea level rise along the Texas Coast is 2x the global average, driving rates of beach erosion of almost 10 feet per year.

Source: U.S. Global Change Research Program (2017b).

Populations, critical infrastructure, port terminals, and petroleum and natural gas refining facilities along the Texas Coast are therefore highly vulnerable to both acute and chronic flooding events, and these risks will continue to grow. Oil and gas production and transportation facilities along the Texas Coast are directly exposed to extreme coastal events wind and flooding events and the effects of sea level rise and subsidence. 69

2.4 - Driver 4: Uncertain Future of Energy

The region has experienced a recent boom in oil and gas exports, but this boom may not last. Economic downturns and shifts to renewables may reduce global demand, while strained resources and risks to infrastructure may impact supply.

Source: Port of Houston, Colleen McHugh

2.4.1 - Global Energy Demand and Local Supply

In recent years, the oil and gas industry in Texas has seen a boom, driving fossil fuel exports. Nevertheless, downturns in global demand and falling oil and natural gas prices at an annualized rate of 6.9% from 2014-2019 have slowed this rate of growth. 70 This slowdown is corroborated by employment data produced by the Bureau of Economic Analysis (BEA), which shows a 12.9% drop in employment in the mining, quarrying, and oil and gas extraction industries between 2013-2018 compared with the 40.3% rise in the five years prior (2008-2013). 71 Simultaneously, global demand for renewable energy sources has increased, and there are signs that this industry may be growing significantly in Texas.72

Long-term energy production and local supply capacity is under pressure due to the combination of increased weather variability,

limited supply of fossil fuels and water, and increasing demand due to population growth and urbanization. For example, increases in annual average temperatures and heatwaves drive demand for energy and water while increasing strain on energy infrastructure cooling systems and available surface water. 73 During the 2011 Texas drought, electricity demand and generation increased by 6% and water consumption for electricity increased by 9%. 74 Under such circumstances, peak electricity demand is increasing while increased air and water temperatures and limited water supply reduce capacity and efficiency of production for both electric and thermoelectric power generation, the latter of which produced 87% of Texas' net energy in 2011. 75 In the same year, studies showed a 30% decline in available reservoir storage for power plant cooling, a trend which has driven the energy industry to increasingly rely on groundwater resources 76 leading at times to unintended consequences, such as the need for emergency groundwater pipelines when primary water sources run dry. 77 Groundwater is also the primary water source for 90% of hydraulic fracturing industry in Texas. This reliance on groundwater has caused some aquifers to deplete at a rate of 2.5 times their rate of recharge, potentially threatening the sustainability this water supply solution. 78

Simultaneously, the increasing risk of extreme storm surge along America's Energy Coast in Texas places nearly 40% of national petroleum and natural gas refining capacity, in addition to port infrastructure critical for export, at risk. 79 An estimated 76% of anthropogenic GHG emissions in the U.S. come from carbon dioxide (CO_2) emissions due to the burning of fossil fuels. 80 Current global scientific consensus identifies GHG emissions as the primary driver of extreme weather variability including heatwaves, droughts, and tropical storms. 81 Therefore, it is likely that oil and gas-driven energy production will increasingly enter into a positive (exacerbating) feedback loop with increasing energy demand and limited supply capacity due to extreme weather exposure and strained water resources.

2.4.1

2.4.2 - Demand on Exports

Demand for energy, food, and various primary and intermediate products is expected to continue growing as populations and urbanization expand, even as risks increase and new and emerging threats materialize. As such, demand for USACE channel deepening will likely continue to grow, especially for very large crude carriers (VLCC) and fully loaded deep-draft container vessels. The Gulf Intercoastal Waterway (GIWW), Texas' myriad of ports, and the McClellan-Kerr Arkansas River Navigation System (MKARNS) are paramount to the transportation of energy products, agriculture supplies, and food in and out of the region (see Figure 10 and Figure 11 on the following page).

The GIWW links ports along the Gulf Coast and 50% of its commercial traffic runs through the state of Texas. 82 The GIWW allows Texas' ports to serve as major shipping hubs for North America 83 and supports Texas' status as the nation's leading exporter of goods, with $330 billion of exports in 2019. 84 These ports, in turn, represent more than $82.8 billion in economic value to the state of Texas. 85 Further, many of these ports are also home to major hubs of energy production and export. In 2017, 72.5 million tons, or 91%, of the Texas portion of the GIWW's traffic by weight consisted of petroleum and chemical products 86 in a region that houses the 2nd-largest petrochemical complex in the world at the Port of Houston. 87

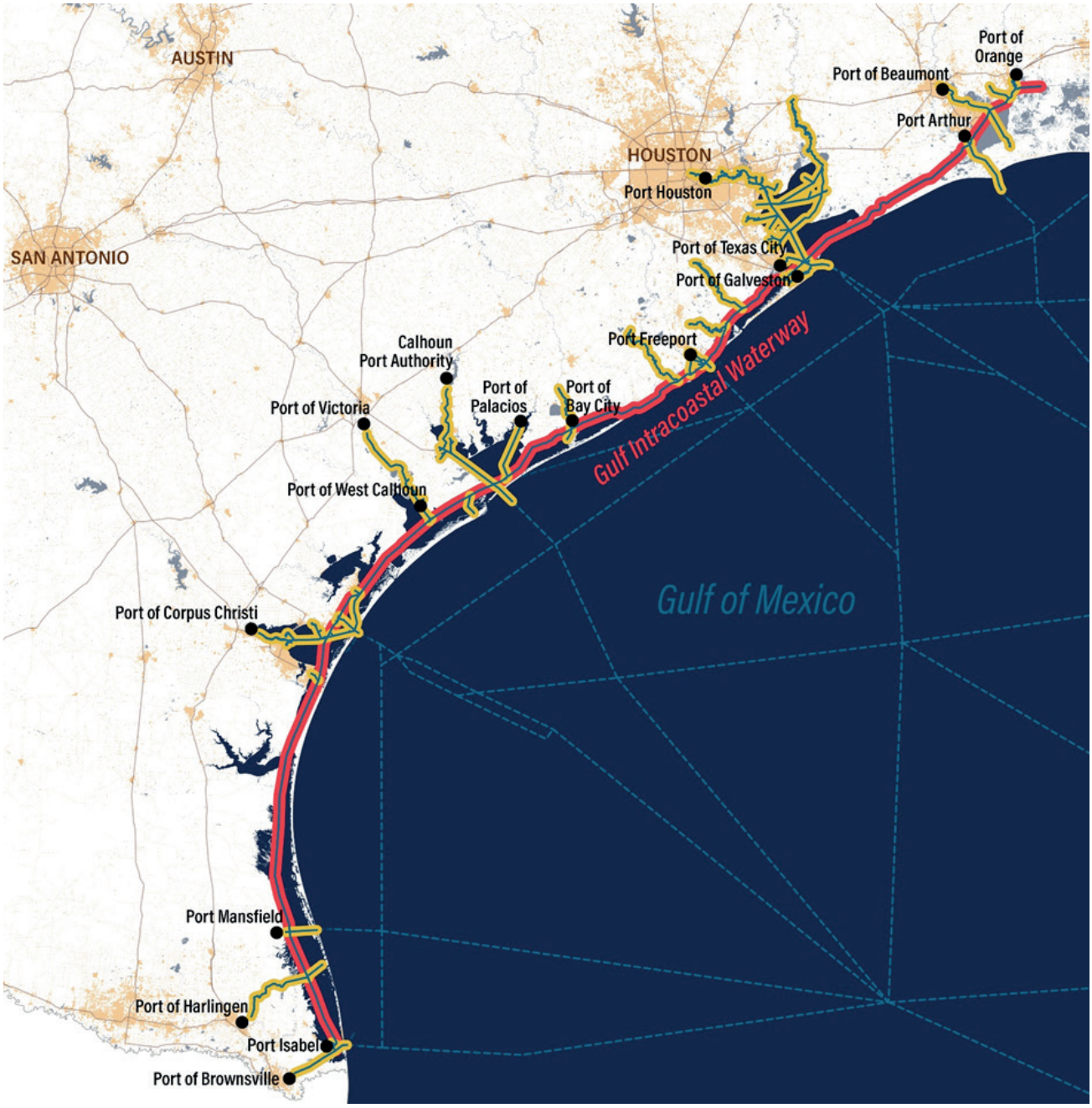


Figure 10 - Map of Texas Ports and the Gulf Intracoastal Waterway

More than 12.2 million tons of goods were also transported in 2017 via the MKARNS. 88 These goods include sand, rock, fertilizer, wheat, raw steel, petroleum products, and petrochemical processing equipment, demonstrating the MKARNS' central importance to the energy, chemicals, and agricultural industries in Arkansas, Oklahoma, Texas, and Kansas. 89 Activities along the MKARNS are also themselves significant drivers of economic output, employment, and tax revenue, collectively contributing approximately $8.5 billion to nationwide sales revenue and employing nearly 56,000 people in Oklahoma and Arkansas. 90

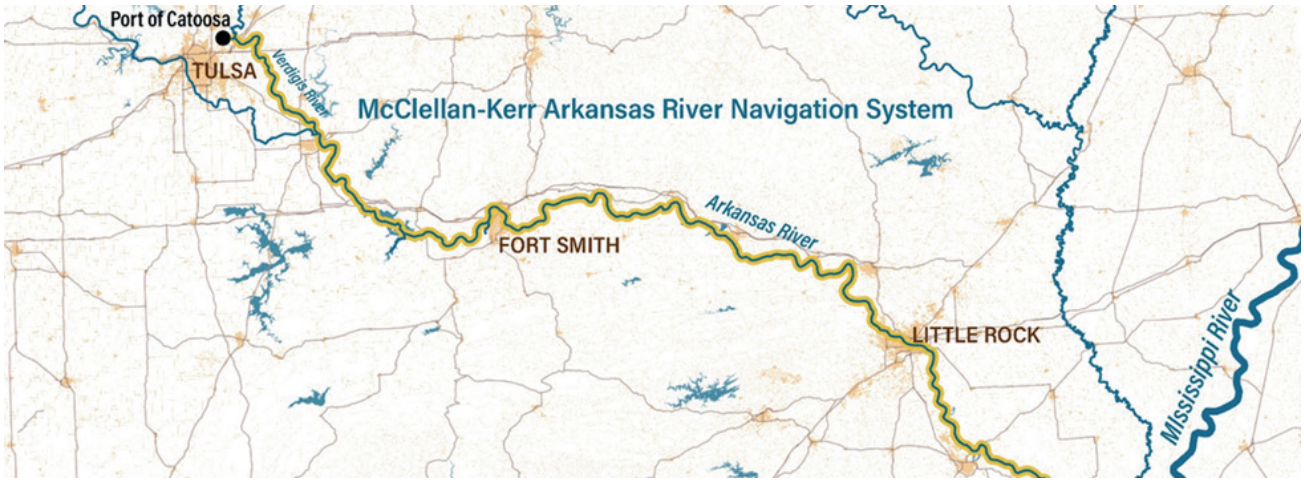


Figure 11 - Map of the McClellan-Kerr Arkansas River Navigation System

Despite uncertainties in the future of energy and future U.S. trade policy, Texas maintains a global competitive advantage in exports of energy products and various intermediate goods, 91 and represents a high 20.1% share of total U.S. exports in 2019. 92 Recent trends such as growing production of materials for wind energy in Texas demonstrate the region's adaptability as a locus of global energy production even in the face of changes in global demand. 93 Although representing a smaller proportion of nationwide exports, 2019 exports out of Oklahoma and Arkansas also demonstrate an upward trend of 14% and 12% over 2010 94 and 2008 95 levels, respectively. In all, demand for exports may continue growing despite uncertainties in future global energy demand and local supply and may require deeper channels in the GIWW and MKARNS to accommodate projected growth.

2.4.2

As demand for dredging and similar services increase in accordance with global energy demand, these activities will need to be carefully balanced with management of sediment suspension and contaminant releases. 96 Lock and dam structures will continue to play an important role in easing shipping access to portions of waterways where water elevation is impacted by precipitation changes. 97 Managing water levels will also need to be adaptively considered in the context of inevitable tradeoffs across SWD Business Lines. Decisions regarding the width and depth of channels also have implications across Mission Areas. For instance, larger navigation channels may be managed more adaptively in response to flood events, but simultaneously provide less opportunity for less adaptability to periods of drought.

2.5 - Driver 5: Increasing Demand on Limited Water Resources

Regional water supply is under severe pressure from drought and environmental change. Simultaneously, regional demand is increasing for water resources as well as water-dependent food and energy resources.

Source: Irrigation, Texas A&M AgriLife Research photo by Kay Ledbetter

2.5.1 - Water-Food-Energy Nexus

As suggested above, agricultural and energy production, both representing key industries in the SWD region, are highly interdependent with water availability. Water supply is crucial both for agricultural uses and irrigation as well as for energy generation activities such as oil and gas operations, power plant cooling, and thermoelectric and hydropower generation; in addition, the agriculture industry relies on adequate sources of energy. 98 Population growth and urbanization are therefore driving a redistribution of demand at the nexus of food, energy, and water, with urbanization-driven changes in consumption patterns linked to growing global demand for all three. 99 For instance, the current consensus is that, at its current pace, global population growth will likely require 70-100% more food production in the next several decades, 100 which will directly affect the extensive agricultural industries and exports in the region. Water demand for municipal, agricultural, and energy uses is therefore projected to increase substantially in the region over the next 50 years. 101 Further, rural-urban population shifts increase pressure to allocate limited water supply resources from traditional centers of agriculture and toward growing metropolitan centers. 102

Changes in extreme weather variability, in complex interaction with geomorphological and ecological changes, are simultaneously introducing challenges in meeting increasing and interdependent demand for food, energy, and water.

Water demand for municipal, agricultural, and energy uses over the next 50 years is expected to increase by:

- *17% in Texas*
- *21% in Oklahoma*
- *20% in Kansas*

Source: U.S. Global Change Research Program (2017b).

The dependence of agricultural and energy production on water availability has also led to the extraction of and increasing reliance on groundwater resources, thus rapidly depleting aquifers. 103 Pressure to shift supply of natural resources toward growing urban centers coupled with projected increases in food and energy production to meet growing demand are likely to strain water availability already threatened by drought. During the 2010-2011 drought, water demand in some Texas communities is reported to have already approached or exceeded maximum available freshwater supply. 104

Water supply is a relatively important Mission Area for SWD, comprising 75% of all USACE water supply storage. 105 SWD operates and maintains 50 major lakes providing one-third of all surface water supplies for Texas and Oklahoma and 20% of all supplies for Kansas, in addition to 10 lakes which provide significant water supplies in Arkansas. 106 As water demand for municipal, agricultural, and energy uses continues to climb in the context of increasingly strained water resources driving competition for water, SWD decisions regarding water availability will become increasingly consequential. This is especially true in multi-purpose reservoirs in which water allocation and releases must be carefully balanced with other Mission Area needs and as changing needs in regional water supply turn increasingly away from surface water and toward groundwater. Conflicts may especially arise with increases in dipole events of drought and flooding, wherein the threat of extreme rainfall events introduces challenges in managing reservoirs to decrease flood risk even as the increasing threat of drought stresses the region's water supply. It is challenging to optimize the reservoir operations under these conditions, entailing decisions such as when and how much water to release. These decisions will have significant positive and negative potential consequences across the Flood Risk Management, Water Supply, and Hydropower Mission Areas. In addition, these challenges can increase the need to construct new reservoirs or for inter- and intra-basin transfers, increasing USACE Regulatory demands.

2.5.2 - Recreational Land

Outdoor and water recreation across the region support a thriving ecotourism economy along the Texas Coast and the MKARNS system, both of which depend on water availability and freshwater flows. 107 Many popular water-related outdoor recreation activities in the region are made accessible by USACE projects and

depend on biodiverse ecosystems supported by USACE. In addition, the USACE Environmental Restoration Mission Area plays a critical role in managing water releases to help maintain the stability of these ecosystems. For example, minimum flow and downstream thermal requirements for fish habitat as well as to prevent algal issues are included in management practice. 108 There is a growing challenge in managing these ecosystems due to uncertainties posed by increased demand for water resources in conjunction with increases in drought and other extreme weather events, changes in natural hydrology, ecological changes, and demand for non-federal hydropower facilities at USACE dams. 109

2.6 - Driver 6: Aging Infrastructure

Degrading water infrastructure conditions across the region pose a threat to a growing population's safety, exacerbate limited water resources in the context of competing demands, and threaten the vitality of local industries.

Source: Keystone Dam construction, USACE-SWT

Every USACE Civil Works Mission Area is faced with challenges related to aging infrastructure and a backlog of operations and maintenance. The majority of USACE dams throughout the country were constructed over 50 years ago and are beyond the planning life initially used in their design. 110 These dams play a central role in providing multiple benefits at USACE reservoirs related to Water Supply, Hydropower, Navigation, Flood Risk Management, Recreation, and Environmental Stewardship. Most federal reservoir storage projects are in need of substantial recapitalization and updates to their operating plans. 111 Further, changing trends such as population growth, drought, inland and coastal flooding, and habitat loss intensify competing water demands and the careful tradeoffs needed to balance multiple uses under future conditions.

Degrading water infrastructure conditions across the region pose a threat to a growing population's safety; exacerbate limited water availability in the context of competing demands; and threaten the continued vitality of the industries dependent on hydroelectric power generation, navigable waterways, recreational land, and ecosystem services provided by biodiverse habitats.

The American Society of Civil Engineers' (ASCE) 2017 infrastructure report card highlights issues endemic to the region, such as the prevalence of high hazard dams lacking regular maintenance and inspections, uncontrolled spillways, decreasing USACE funding for major flood reduction projects, inordinate timelines, and other challenges to planning, designing, and constructing new capital projects. 112 Inadequate maintenance heightens the threat of catastrophic downstream releases of stored flood water from critical infrastructure failure, an issue exacerbated by limited and decreasing flood storage capacity at reservoirs due to sediment accumulation as well as worsening degradation from heavy rainfall stress and downstream sedimentation. 113

Lack of regular maintenance for sedimentation also limits the water available in reservoirs for Water Supply and Hydropower, and significantly impacts channel depth and width at inland waterways and ports. Aging navigation infrastructure, coupled with maintenance backlogs, also present a major challenge for the future viability of navigable waterways. Inconsistent maintenance at many ports and locks often lead to unscheduled outages, significant delays, and difficulties in adequately meeting traffic demand. 114

As of April 2019, the MKARNS has a $235 million backlog of critical needs projects with a high chance of failure over the next several years.

Source: State Chamber Research Foundation. 2019. Issue Brief: The McClellan-Kerr Waterway.

2.6

Finally, recreational facilities such as boat launches, marinas, campground facilities, roads, parking lots, and other structures under the management of the Recreation Mission Area are degrading, threatening the continued vitality of the recreation and ecotourism industries. 115

2.7 - Inequitable Risk and Impacts

The societal risks posed by the six drivers described above will disproportionately affect socially vulnerable populations, especially those that have been historically marginalized and subject to structural inequities that have restricted their adaptive capacity. Existing disparities are likely to be further exacerbated by the direct and indirect impacts of increasingly extreme weather and competition for natural resources such as water, including cascading effects due to trends such as aging infrastructure and habitat loss. Presently, many of these existing disparities fall along racial lines, and the disproportionate risks incurred are likely to fall most heavily on the poor, the working class, communities of color, immigrant communities, and indigenous populations. Research on the relationship between community resilience and social vulnerability have demonstrated that the severity of outcomes of a disaster or disturbance for a community correlate with circumstances that either limit or enhance a community's ability to respond and adapt, as well as to the severity of the hazard and the level of exposure. 116 A community with little income and lack of ready access to robust infrastructure, food, energy, water, and other essential goods and services is more likely to experience devastating impacts that will further limit the resources and time required to recover and improve quality of life.

As urban populations grow, overall exposure of the population to the impacts of some hazards—especially flooding and the cascading hazards it causes—is likely to increase. Socially vulnerable communities, including many in historically marginalized racial and ethnic categories and those with lower levels of household income, will increasingly concentrate in particularly hazard-prone areas. Such areas may, for example, include aging public housing, limited evacuation routes, proximity to hazardous materials storage, lack of access to strong infrastructure, and direct exposure to flooding and extreme urban heat. 117

Additionally, many of the most socially vulnerable counties in the region are in heavily rural areas which comprise some of the highest rates of household poverty (see Table 2) and food insecurity in the nation. 118 As urban demand for water and water scarcity simultaneously increase, pre-existing issues of inequitable access to safe drinking water and sanitation, particularly concentrated in rural areas, will only get worse. Poverty and race have both been found to be strong indicators of lack of access to water and sanitation. For example, Native American households—of which there are a large concentration in the region, especially in rural Oklahoma—are 19 times more likely than white households to lack access to complete plumbing. 119 These populations are likely to experience the most direct and immediate impacts of drought, in addition to the pressures on water and other natural resources precipitated by rural-urban migration and the needs of a growing population to adapt to changing climate conditions. These communities and socially vulnerable urban populations will disproportionately bear the burden of the most severe impacts of increasingly extreme weather events and the increasingly strained water-food-energy nexus.

Table 2 - Percent of Households Living in Poverty, 2018 120

Percent of Households Living in Poverty, 2018 121				
Texas Rural	**Oklahoma Rural**	**Arkansas Rural**	**National Rural**	**National Urban**
18.1%	17.9%	19.5%	16.1%	12.6%

Poor and historically marginalized populations in the region are therefore experiencing a complex variety of challenges at the intersection of their overall higher levels of socio-economic vulnerability, increasing demand for the natural resources that rural areas in particular produce and depend on, high and increasing exposure and vulnerability to hazards such as drought and flooding, inequitable access to high-quality

drinking water and sanitation, and land use and land cover (LULC) challenges posed by rapid population growth and urbanization, including increased flood and heat hazard and an explosion in development and urban sprawl, especially impacting rural areas. 122 Additionally, the region's many federally- and state-recognized indigenous tribes are known to be especially vulnerable to the changing water-food-energy and habitat change dynamics in the region driven by population shifts and extreme weather variability. Drought and water scarcity as well as increasing strains on natural resources and habitats will disproportionately impact these Native American communities in the coming decades. 123 In this context, addressing the water infrastructure needs of the 21st-century must consider and prioritize access to robust water infrastructure for populations at high risk.

2.8 - Increasingly Complex Regional Challenges

Significantly, the six drivers outlined in the previous sections are interconnected, with one driving or exacerbating another, often further amplified by positive feedback loops (see Figure 12). For example, increasingly extreme weather plays a large role in driving changes to the regional landscape, especially in its impacts to habitats and biological communities that are sensitive to drought and flooding. As these habitats change and in some cases disappear, various processes ensue that further exacerbate the hazards posed by extreme weather, such as disappearance of natural storm barriers and impacts of erosion and invasive species on water infrastructure—especially when combined with other changes to the natural landscape driven by urbanization. As such, these six drivers should not be considered independent of one another, but as part of one and the same unfolding process, integral with USACE Water Supply, Navigation, Flood Risk Management, Hydropower, Environmental Stewardship, and Recreation activities (see Figure 12 and Table 3). At the same time, there is considerable uncertainty associated with many of the future trends, as illustrated by the significant economic and human health impacts associated with the COVID19 pandemic. The interconnectivity of the drivers further magnifies the impacts of this uncertainty, creating a wide range of potential outcomes that SWD and its Districts must be prepared for and necessitating that the development of strategies that are both robust and adaptable in an uncertain future.

These challenges are interconnected, with one driving or exacerbating another, often further amplified by feedback loops.

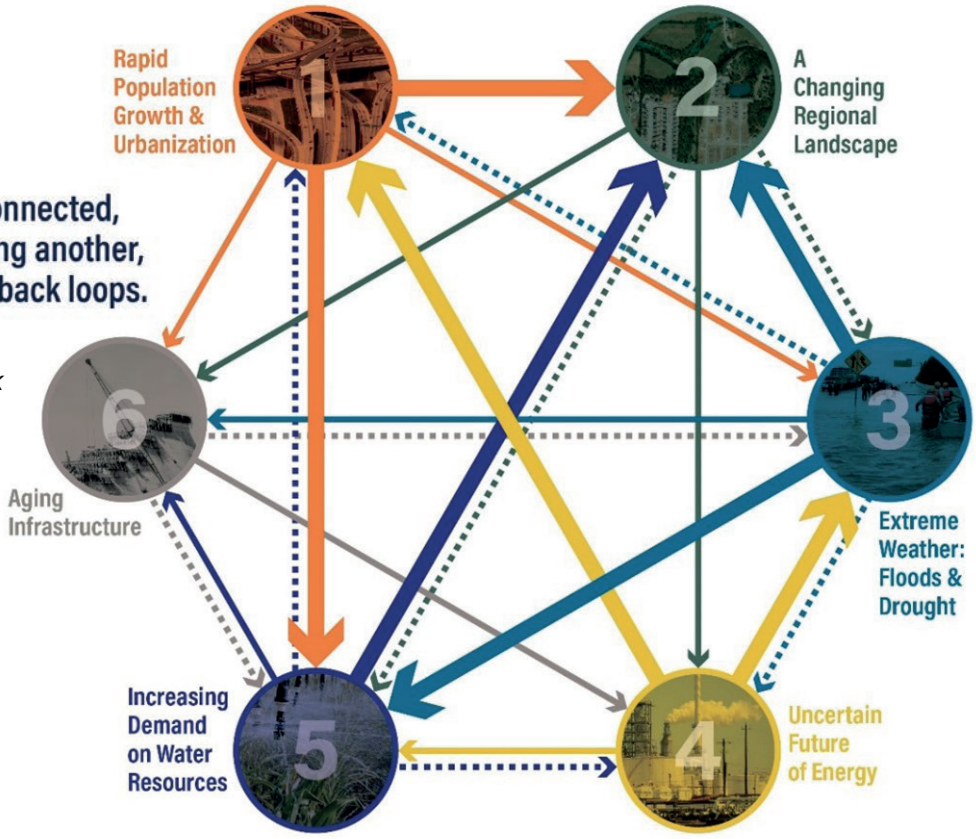


Figure 12 - Complex Interactions and Feedback Loops between Drivers

Table 3 - Drivers Impacts to Civil Works Business Lines

Driver	Water Supply	Navigation	Flood Risk Management	Coastal Storm Risk Management	Hydropower	Environmental Restoration	Recreation
	X	X	X	X	x	x	X
 **Rapid Population Growth & Urbanization**	Increased demand for water, in addition to food and energy production which rely on water availability.	Increased demand for natural resources driving increased demand for navigable waterways, channel deepening, and larger, more efficient vessels in international shipping to coastal ports.	Increased exposure to extreme rainfall and flooding, particularly socially vulnerable populations.	Increased exposure to coastal storm surge and tidal flooding, particularly socially vulnerable populations.	Increased demand for energy production with growing demand for renewables, including increased reliance on hydropower for stability.	Landscape-level impacts of urbanization-driven LULC.	Increased demand for outdoor and water-related recreational opportunities.
	X	x	X	X	x	X	X
 **A Changing Regional Landscape**	Impacts to water quality, local water balance, and groundwater.	Impacts to channel morphology and infrastructure operations.	Increased flood discharge peak and volume rates as well as debris hazard.	Beach erosion and sea level rise cause coastal habitats to disappear. This also eliminates natural coastal protection to storm surge.	Impacts to natural hydrology and channel morphology.	Pressures on natural resource boundaries, habitats, biodiversity, and ecosystem health.	Declining biodiversity and ecosystem health in waterways potentially leading to decrease in recreational use.
	X	x	X	X	X	X	x
 **Extreme Weather Droughts & Floods**	Drought impacts to water levels and quality. Flooding straining reservoir storage capacity.	Drought impacts to water levels. Increased exposure of navigation infrastructure and port terminals to flood risk, especially storm surge. Extreme storm impacts to channel conditions and vessel restrictions.	Increased demand for more structural and nonstructural flood mitigation measures, and increased strain on existing flood control infrastructure.	Increased risk of coastal storm surge and tidal flooding.	Drought impacts to water levels, straining competing resource demands. Dependence on hydropower for power and first responder radio communications during major storm events.	Impacts to water quality, salinity levels, water temperatures, sedimentation, and invasive species—threating ecosystem health and habitats.	Increased exposure of recreation infrastructure to flood risk.

Table 3 - Drivers Impacts to Civil Works Business Lines

Driver	Water Supply	Navigation	Flood Risk Management	Coastal Storm Risk Management	Hydropower	Environmental Restoration	Recreation
 **Uncertain Future of Energy**	X Increasing global demand for energy increases water demand for energy production purposes.	X Larger channels may be needed to meet demand for energy exports. Ports serving as hubs of energy production at risk of extreme storm surge.	N/A	X Extreme storm surge threatens 40% of national petroleum and natural gas refining capacity and port infrastructure for exports in Texas.	x Increases in global demand for renewable energy sources could lead to increased demand for hydropower.	X Pollution and other environmental impacts from continued reliance on hydraulic fracturing and fossil fuel extraction to meet growing demand.	N/A
 **Increasing Demand on Water Resources**	X Pressure to reallocate water storage at multi-purpose reservoirs to meet water supply demand.	x Low water levels can interrupt shipping and waterborne commerce.	x Pressure to reallocate water storage at multi-purpose reservoirs to water supply, while flood storage threatened by reduced reservoir capacity.		x Low water levels can interrupt hydropower generation. Pressure to reallocate water storage at multi-purpose reservoirs to water supply.	X Trade-offs in freshwater flows which moderate salinities and temperature and provide crucial nutrients.	X Trade-offs in freshwater flows which support a variety of habitats.
 **Aging Infrastructure**	X Most dams more than 50 years old. Dam safety is an issue.	x Aging navigation infrastructure and O&M, including channel depths, lack capacity or redundancy to meet growing demand.	X Aging dams, levees, and flood control structures with outdated policies, levels of protection, and planning life. Dam/levee safety is an issue.	x Aging levees and flood control structures with outdated policies, levels of protection, and planning life. Levee safety is an issue.	X Most dams more than 50 years. Dam safety is an issue.	x Aging levees and associated facilities require maintenance or upgrades to minimize impacts to the environment.	X Degrading facilities. Many recreation-related facilities constructed 50-70 years ago. Need for routine O&M.

3

Future Scenarios

The interconnected regional risks and opportunities identified in the previous chapter provide a baseline understanding of trends that may drive future demand for water resources in the region over the coming decades. However, the future is inherently uncertain, and the high degree of interdependence and volatility within each of regional drivers of Civil Works demand only adds to this uncertainty. Addressing the uncertainties of the future requires a planning process that lays the groundwork for identifying and implementing flexible and adaptable response strategies that lead to positive outcomes across a range of potential futures. In doing so, SWD can identify gaps that must be filled to enable positive outcomes regardless of what the future specifically holds. Doing so requires understanding the key uncertainties associated with important drivers of Civil Works (CW) demand and linking them to actions SWD and its Districts can take now to build capacity, update policies and procedures, and improve operations to meet the challenges the region will face in the future.

A scenario planning process was utilized in CWSP development to address these uncertainties and inform the building blocks and strategic actions that will help lead to positive outcomes in 2035 and beyond. While not intended to predict the future, scenario planning provides USACE with a structure to support clear communication and decision making on the possible choices and outcomes for CW in the face of future of uncertainty. USACE has previously utilized this approach successfully as part of its Scenario-based Strategic Planning Process. For the development of the CWSP, future scenario planning provided a crucial link between the external trends and drivers affecting the region and the potential choices SWD can make now to best position the Division to operate effectively under future conditions while maximizing delivery of value to its communities, customers, and the Nation.

For each scenario theme, there are four component scenarios presented in a quadrant format. These scenarios are not explicitly intended to represent a simplified depiction of ideal, non-ideal, or intermediary states. Rather, they explore the nuance, complexities, and opportunities for SWD action that may be present in each scenario and the interaction between SWD response strategies and scenario outcomes.

Three focused scenario themes were selected based on identifying drivers that have substantial potential impact on the SWD Civil Works Program and are also associated with significant uncertainty in future trends. Each theme includes a set of four scenarios capturing the range of future outcomes considering both the uncertainty in the underlying drivers and the potential strategies USACE could take to influence those outcomes. These strategies include direct actions (e.g., through infrastructure development and capacity building) and indirect actions (e.g., working with partners to reduce infrastructure demands). In addition, each scenario set identifies key gaps that could be filled to further enable the Division and Districts to influence optimal outcomes, such as technology advancements and revisions to national policies or authorities. The three focused future scenario themes considered were:

- **Future Population Growth and Water Supply**
- **Future of Energy**
- **Future Extreme Weather Variability**

In addition, a set of overarching scenarios was developed to broadly connect trends in drivers with regional impacts and the potential strategies SWD can take to right-size capacity for the future. This final set of scenarios builds on the focused themes and captures the complex interconnectivity among drivers, uncertainties, direct USACE action, and partner involvement across the landscape of water resource management issues. These scenarios explore the feedbacks between, for example, population growth, increase in impervious surface land cover, changing weather patterns, flood risk, and water supply. In doing so, they illustrate the overarching potential and benefits of Integrated Water Resource Management (IWRM) and the most likely paths to SWD providing maximum value to the Nation through both direct USACE action and partnering opportunities.

3.1 - Focused Future Scenarios 1: Future Population Growth & Water Supply

The Challenge

The region has been experiencing rapid population growth and diversification throughout its jurisdiction. The Dallas-Fort Worth metropolitan area exhibited the largest growth in population in the nation between 2010-2019 and was closely followed by the Houston metropolitan area, which exhibited the second highest increases during this period. This population growth is expected to continue, with Texas projected to have the highest growth rate in the nation through 2040. Other urban areas in the region, such as northwest Arkansas, are also experiencing rapid rates of growth, and the region at large is experiencing an increasing pattern of rural to urban migration. This rapid urban growth and associated expanded development intensifies stormwater runoff, flood risk, and urban heat island impacts, in addition to placing more people and assets in harm's way from the more intense, extreme weather events the region has experienced and is projected to continue to experience in the future.

As these growth trends continue and accelerate, there is an increasing demand for water supply and strain on the region's water resources to meet these needs. In Texas alone, municipal water use as a percentage of overall water use is projected to increase to 41% by 2060, from 9% in 2010. SWD faces significant and growing challenges in balancing water supply demand and allocations to meet the growing demand for other uses. This challenge is further exacerbated as the Division's aging infrastructure is increasingly unable to cope with current climate variability impacts and development-driven increases in flood risk. (See Figure 13). In addition, COVID-19 has introduced new uncertainty into regional population trends and urban/rural migration patterns, and the long-term impacts of the pandemic are difficult to predict.

Key External Drivers and Uncertainties

Population/development growth rates; regional economic conditions; climate variability; funding & authorities.

Key Internal Response Opportunities

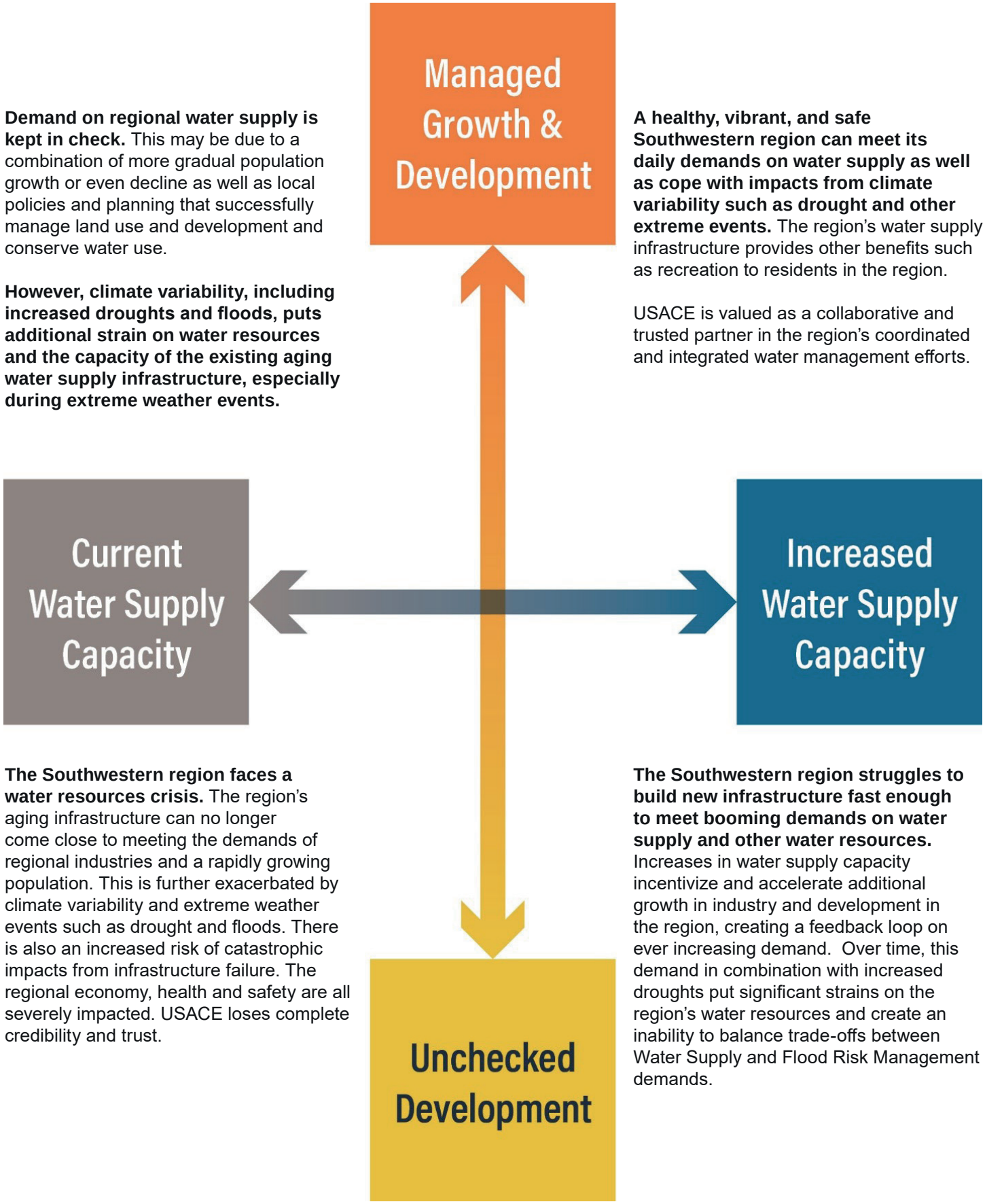
Division-wide policy and guidelines for water supply contracts; water control operations; water supply storage and reallocation studies; regional watershed and climate variability studies; infrastructure and new starts.

Key Partner and Local Stakeholder Response Opportunities

Land use and development policies; water conservation policies; local sponsorship of USACE Civil Works projects.

Demand on regional water supply is kept in check. This may be due to a combination of more gradual population growth or even decline as well as local policies and planning that successfully manage land use and development and conserve water use.

However, climate variability, including increased droughts and floods, puts additional strain on water resources and the capacity of the existing aging water supply infrastructure, especially during extreme weather events.



A healthy, vibrant, and safe Southwestern region can meet its daily demands on water supply as well as cope with impacts from climate variability such as drought and other extreme events. The region's water supply infrastructure provides other benefits such as recreation to residents in the region.

USACE is valued as a collaborative and trusted partner in the region's coordinated and integrated water management efforts.

The Southwestern region faces a water resources crisis. The region's aging infrastructure can no longer come close to meeting the demands of regional industries and a rapidly growing population. This is further exacerbated by climate variability and extreme weather events such as drought and floods. There is also an increased risk of catastrophic impacts from infrastructure failure. The regional economy, health and safety are all severely impacted. USACE loses complete credibility and trust.

The Southwestern region struggles to build new infrastructure fast enough to meet booming demands on water supply and other water resources. Increases in water supply capacity incentivize and accelerate additional growth in industry and development in the region, creating a feedback loop on ever increasing demand. Over time, this demand in combination with increased droughts put significant strains on the region's water resources and create an inability to balance trade-offs between Water Supply and Flood Risk Management demands.

Figure 13 - Future Population Growth and Water Supply Focused Future Scenario

3.1

Strategic Implications

This set of potential future scenarios highlights the risks of planning for water supply capacity within a vacuum. The drivers of water supply demand include a complex equation of industry and population growth, coupled with the impacts of local policy and planning actions aimed at managing development and conserving water resources. Focusing purely on the first part of the equation risks exacerbating further unchecked development and water use by industrial, commercial, and residential users in the region. While USACE authority in addressing water supply challenges is limited, partner response opportunities may be able to more broadly address issues related to water supply demand. Opportunities for a more comprehensive approach to managing regional capacity may be enabled through partnering, such as coordinating water use across all USACE and non-USACE reservoirs in the state and expanding the distribution of safe potable water to vulnerable areas that will be most impacted by scarcity. As SWD looks at ways to meet increasing demands on water supply within the region over the next 15-30 years while also achieving its primary missions, the USACE CW Program should be planned in close coordination with local, regional, and state entities.

This scenario also exposes the importance of planning holistically for water supply together with flood risk management. With more extreme flooding and drought anticipated in the future, demands on both functions will increase and trade-offs between the two will need to be more closely and dynamically managed. Additionally, efforts like sediment management can maximize reservoir storage capacity during periods of droughts.

While this scenario is focused on the Water Supply Mission Area, a similar set of strategic implications exists for a set of scenarios focused on Flood Risk Management in combination with growth and development. Reducing future flood risk in the region requires a combination of smarter land use practices as well as investments in existing and new Civil Works. As is the case with this set of scenarios related to water supply, there is a need for coordinated management of local, state, and federal tools to address regional flood risk comprehensively.

EXAMPLE GAPS & ENABLERS

Implementation of this Strategic Plan will require a granular identification of the potential roadblocks that may hinder action (gaps) and the potential catalysts or tools to propel action (enablers). Below are example gaps and enablers that have been identified through this scenario planning exercise. This is intended to be illustrative. A more comprehensive approach to identifying gaps and enablers will be taken during implementation planning.

Policies

- **Gap:** USACE Water Supply mission/ authority is limited to selling storage – tools to address challenges are primarily limited to reservoir reallocations
- **Enabler:** opportunity at federal level to redefine USACE role in water supply, such as providing more flexibility in considering water supply as part of an IWRM approach to reservoir management

Processes

- **Gap:** no dedicated funding stream for water supply mission area outside of O&M account creates delay and limitations in USACE ability to provide clear answers to communities looking to buy water storage
- **Enabler:** advanced coordination and awareness-building of USACE reallocation opportunities with local partners so that they can provide input on needs early, giving time for studies and budget modifications

Projects

- **Gap:** no capacity to look at all reservoirs (managed by USACE and others) within a state holistically
- **Enabler:** Planning Assistance to States (PAS) studies to rebalance the purpose of a project, including greater consideration of water supply

Partnerships

- **Gap:** partnerships limited to contracting storage in USACE reservoirs, with limited collaboration beyond this role
- **Enabler:** engagement with state partners that have a large leadership role in water supply planning to identify a broader set of gaps and enablers and identify comprehensive planning approaches

3.2 - Focused Future Scenarios 2: Future of Energy

The Challenge

The future of global energy and demand for oil and gas resources from America's Energy Coast is highly uncertain and potentially volatile over time. Simultaneously, population growth, combined with increases in average temperatures, drive increasing need for energy production. Questions of long-term sustainability of fossil fuel-driven energy production may lead to shifts in global demand for oil and gas resources. Strained natural resources and vulnerability of infrastructure may also limit local supply. (See Figure 14).

Key External Drivers and Uncertainties

- Potential Drivers of Global Demand
  - Transition towards renewable energy sources (increasing global demand and increasing importance of sustainability)
  - Macro-economic trends (local/global recession / boom)
  - Competition with supply / costs elsewhere
- Potential Drivers of Local Supply
  - Domestic policy
  - Damage to local infrastructure (due to catastrophic event)
  - Strained resources (e.g., rapidly depleting groundwater aquifers)

Key Internal Response Opportunities

New starts for navigation channel improvements, process efficiencies to meet current demand/backlog.

Key Partner and Local Stakeholder Response Opportunities

Investment in port and navigation infrastructure, investments in transition/adaptation of local oil and gas industries.

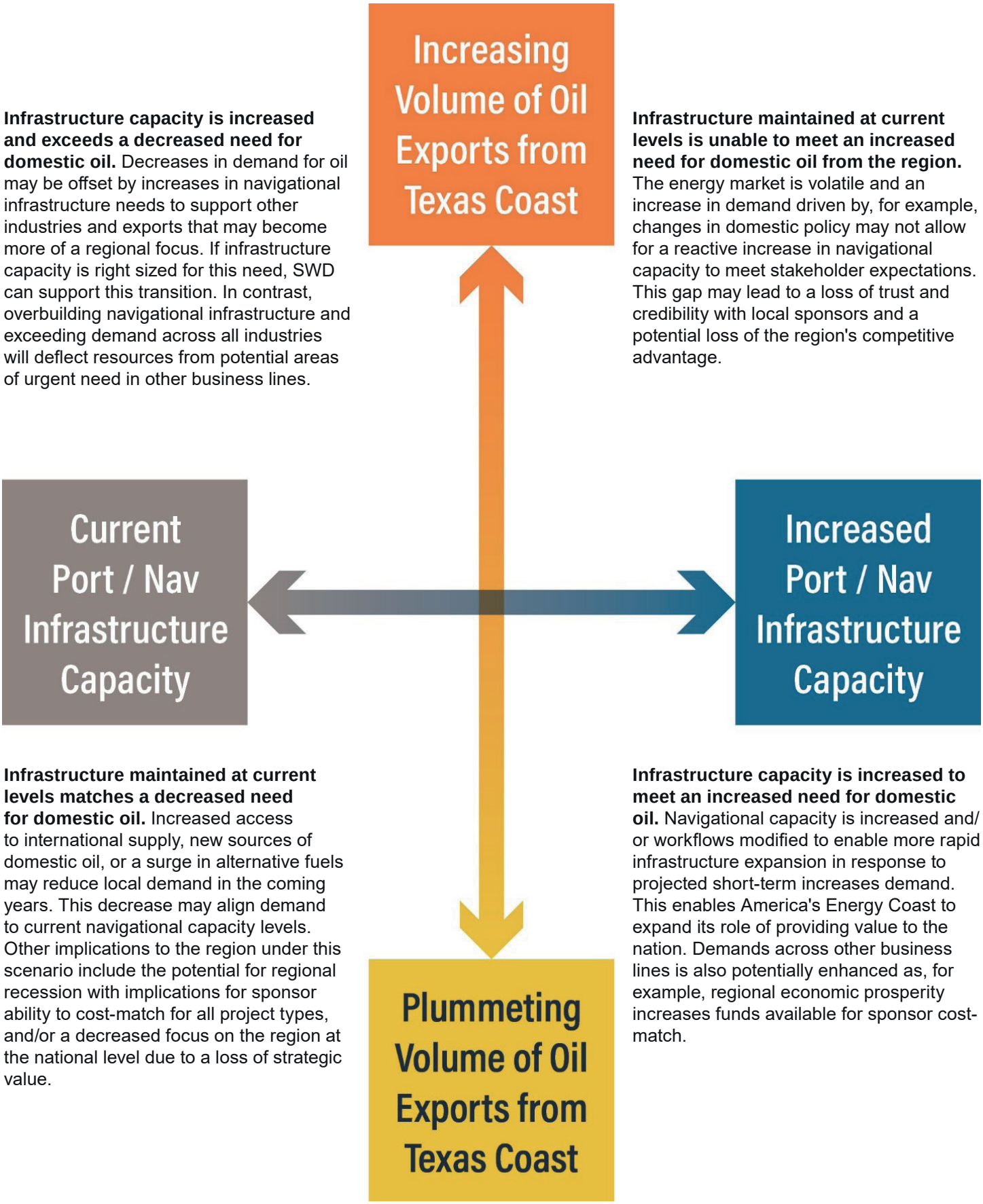


Figure 14 - Future of Energy Focused Future Scenario

3.2 Strategic Implications

The energy sector is key to the strategic importance of the region. The value to the Nation provided by SWD's Navigation projects, especially those along the Texas coast, is closely tied to the oil and gas economy. Volatility or long-term decline in oil exports from the Texas coast—whether due to an economic recession, damage to local infrastructure, or a transition of global demand towards renewable energy sources—not only will have significant impacts on the regional economy, but will also have national impacts.

The lifting of the oil export ban in 2016 led to a boom in oil export that has driven increased demand for Navigation projects along the Texas coast. At the same time, the need for channel deepening and other navigation improvements is also important to maintaining a competitive advantage and ensuring the Texas coast can accommodate the cargo vessels of the future. In periods of declining oil exports, such as the current one driven by the COVID-19 pandemic, investments in navigation infrastructure may become even more important for local ports to maintain a competitive advantage. While there should be consideration of right-sizing of investments to demand, port and navigation improvements could support and enable a transition to other industries and exports and ensure readiness for potential surges in future demand.

Volatility and uncertainty are inherent within the energy economy that drives much of the navigation demand in coastal Texas. Adaptability is key to increasing USACE responsiveness to industry demand to ensure that resources are directed in a timely manner where they are needed most.

Additionally, this area has a potential competitive advantage as a hub for renewable energy production. Parts of the region's geography may be well suited for solar and wind energy, and hydropower supply at SWD reservoirs may see a corresponding increase in importance. This may include exports of materials/machinery for renewable energy production; for example, wind energy materials production has been rising in Texas in recent years.

EXAMPLE GAPS & ENABLERS

Implementation of this Strategic Plan will require a granular identification of the potential roadblocks that may hinder action (gaps) and the potential catalysts or tools to propel action (enablers). Below are example gaps and enablers that have been identified through this scenario planning exercise. This is intended to be illustrative. A more comprehensive approach to identifying gaps and enablers will be taken during implementation planning.

Policies

- **Gap:** no federal funding mechanism to be more proactive or nimbly respond to need

Processes

- **Gap:** time lag between market drivers and modification or initiation of projects to support the industry, in part driven by two-year time delay in USACE receiving updated commodities data
- **Enabler:** inherent adaptability of the navigation maintenance program. O&M dredging of channels can be managed dynamically (driven by where there is the most economic activity) after initial construction with timely data and need projections

Projects

- **Enabler:** rapidly advancing real-time technology for monitoring channel depths and traffic; if USACE is prepared to be responsive to those capabilities, they can be leveraged to improve SWD adaptability and nimbleness to meet changing demands

Partnerships

- **Gap:** partner needs and expectations for timeline of project execution is often out of sync with USACE approval and implementation process
- **Enabler:** more dynamic and flexible cost sharing rules, more partnership engagement, and more public-private partnerships to enable partners to move forward with higher risk projects if they are willing to take on more of that risk

3.3 - Focused Future Scenarios 3: Future Extreme Weather Variability

The Challenge

Recent and projected increases in frequency and intensity of droughts, extreme precipitation and coastal flooding events severely stress aging infrastructure and present Mission Area tradeoffs for Integrated Water Resource Management. Population growth and development trends compound this challenge by driving increasing multi-purpose demand for water, and contribute to increasing flood and drought risk within the region. (See Figure 15).

Key External Drivers and Uncertainties

- Precipitation rates, temperature increases, sea level rise & subsidence rates (coastal Texas)
- Population growth, development and land use/cover changes, and changes to natural hydrology
- Dipole swings in occurrence, intensity, frequency and duration of drought and extreme precipitation events
- Damage to local infrastructure (due to catastrophic event, e.g., hurricanes)

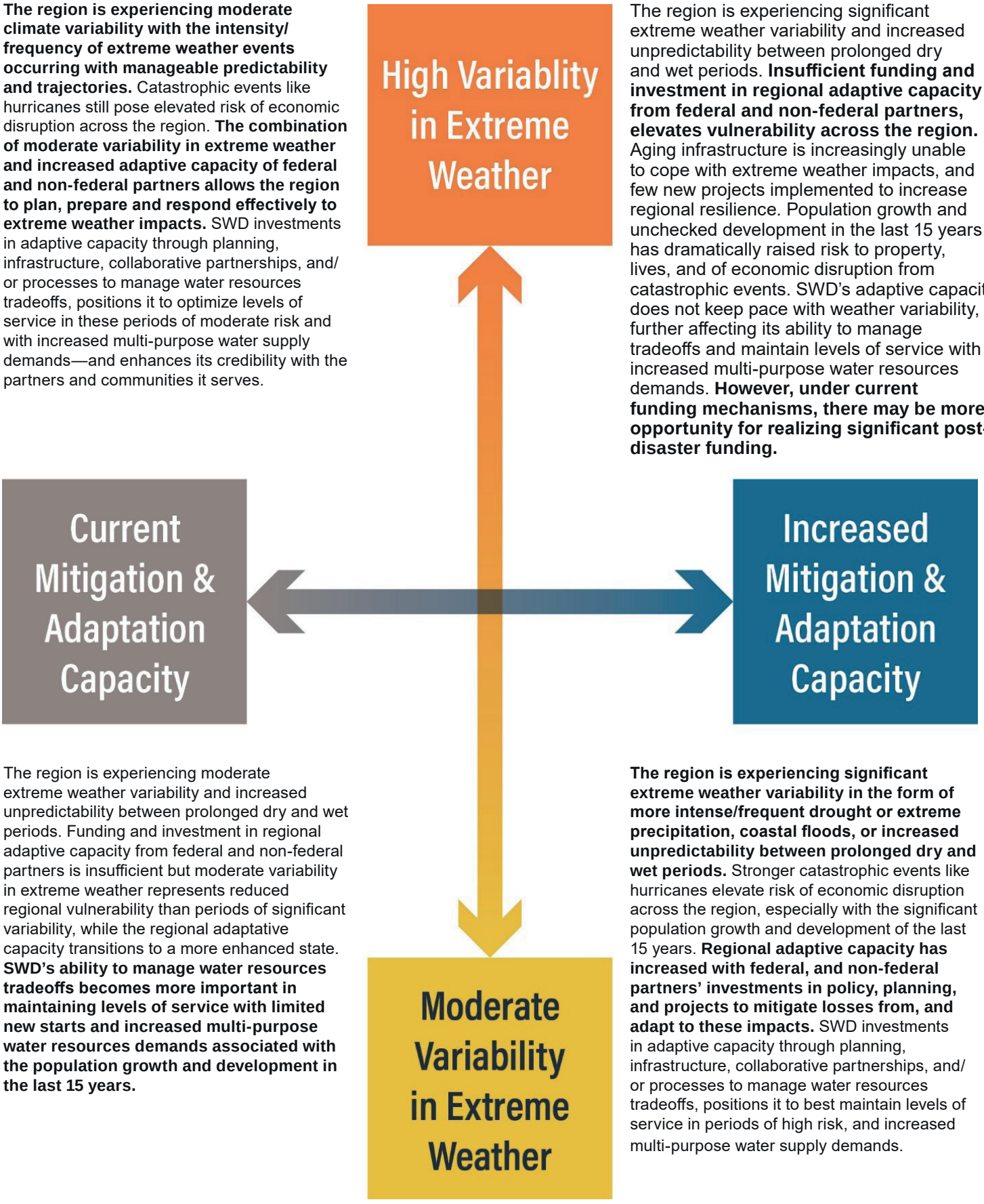
Key Internal Response Opportunities

Water reallocation, water supply, watershed, and adaptation planning studies and policies; new starts for channel and reservoir improvements and storage capacity improvements.

Key Partner and Local Stakeholder Response Opportunities

Regional inter-agency collaboration and planning; enhanced stakeholder engagement; proactive shift in federal disaster funding protocols.

The region is experiencing moderate climate variability with the intensity/ frequency of extreme weather events occurring with manageable predictability and trajectories. Catastrophic events like hurricanes still pose elevated risk of economic disruption across the region. **The combination of moderate variability in extreme weather and increased adaptive capacity of federal and non-federal partners allows the region to plan, prepare and respond effectively to extreme weather impacts.** SWD investments in adaptive capacity through planning, infrastructure, collaborative partnerships, and/ or processes to manage water resources tradeoffs, positions it to optimize levels of service in these periods of moderate risk and with increased multi-purpose water supply demands—and enhances its credibility with the partners and communities it serves.



The region is experiencing significant extreme weather variability and increased unpredictability between prolonged dry and wet periods. **Insufficient funding and investment in regional adaptive capacity from federal and non-federal partners, elevates vulnerability across the region.** Aging infrastructure is increasingly unable to cope with extreme weather impacts, and few new projects implemented to increase regional resilience. Population growth and unchecked development in the last 15 years has dramatically raised risk to property, lives, and of economic disruption from catastrophic events. SWD's adaptive capacity does not keep pace with weather variability, further affecting its ability to manage tradeoffs and maintain levels of service with increased multi-purpose water resources demands. **However, under current funding mechanisms, there may be more opportunity for realizing significant post-disaster funding.**

The region is experiencing moderate extreme weather variability and increased unpredictability between prolonged dry and wet periods. Funding and investment in regional adaptive capacity from federal and non-federal partners is insufficient but moderate variability in extreme weather represents reduced regional vulnerability than periods of significant variability, while the regional adaptative capacity transitions to a more enhanced state. **SWD's ability to manage water resources tradeoffs becomes more important in maintaining levels of service with limited new starts and increased multi-purpose water resources demands associated with the population growth and development in the last 15 years.**

The region is experiencing significant extreme weather variability in the form of more intense/frequent drought or extreme precipitation, coastal floods, or increased unpredictability between prolonged dry and wet periods. Stronger catastrophic events like hurricanes elevate risk of economic disruption across the region, especially with the significant population growth and development of the last 15 years. **Regional adaptive capacity has increased with federal, and non-federal partners' investments in policy, planning, and projects to mitigate losses from, and adapt to these impacts.** SWD investments in adaptive capacity through planning, infrastructure, collaborative partnerships, and/ or processes to manage water resources tradeoffs, positions it to best maintain levels of service in periods of high risk, and increased multi-purpose water supply demands.

Figure 15 - Future Extreme Weather Variability Focused Future Scenario

Strategic Implications

Investing in mitigation and adaptation in advance of an extreme weather event saves lives, protects important community assets, and saves money in the long run. It can also create additional benefits in the short term, such as local economic development and jobs.

3.3 The region has experienced major extreme weather events, both droughts and floods, in the past decade. While the science on climate trends points towards more frequent and intense floods and droughts in the future, the next decade may not be as extreme as the last for the region. There will always be periods of surge and of wane. A proactive response mode is key.

However, the USACE role has historically been to respond to disasters as they occur. This role is reflected throughout the organization, including in the emphasis on economic benefit in project prioritization (vs. risk mitigation) and a funding model where resources often do not flow until after a disaster occurs. While this approach may be relatively successful in supporting communities in responding to isolated storms or droughts, it will leave SWD unprepared to support the region under scenarios where the frequency and severity of major extreme weather events increases. In those cases, the cumulative value of pre-disaster investment to mitigate the economic impact of future events increases considerably. In addition, failure to adequately account for risk to human life and other social impacts can result in significant loss in the region under increasing frequency or severity of extreme weather.

It is important to understand, through investments in advanced modeling and science, what is likely to happen, who and what may be impacted and how (including disproportionate impacts to vulnerable communities), then prepare and subsequently respond. Grounded in the science of multi-hazard risk and working with regional partners, a regional approach to the prioritization of projects can help SWD pivot from a reactive response mode to a proactive one. Similarly, it is helpful to have mitigation projects and plans on the shelf and ready to go for when funding is available, such as through post-disaster supplementals. By having these plans prepared, funds can be nimbly directed towards vetted projects that will reduce risk in the future. The unpredictability and potential for high variability in extreme weather and the impacts of droughts and floods across CW Mission Areas requires an integrated approach to water resources management. Further operationalizing IWRM as a central approach will position SWD to manage impacts and tradeoffs across Mission Areas, projects, and regions.

As highlighted in the water supply and development scenarios, a comprehensive approach to hazard mitigation and adaptation in coordination with local, state, and federal partners is also key. There is a complex interplay of extreme weather trends and population and land use trends, such as the feedback loop between impervious surfaces and their impacts on flood risk and extreme heat. The tools and actions of partners must be coordinated closely with those of USACE.

EXAMPLE GAPS & ENABLERS

Implementation of this Strategic Plan will require a granular identification of the potential roadblocks that may hinder action (gaps) and the potential catalysts or tools to propel action (enablers). Below are example gaps and enablers that have been identified through this scenario planning exercise. This is intended to be illustrative. A more comprehensive approach to identifying gaps and enablers will be taken during implementation planning.

Policies

- **Gap:** need for a clearer vision of being proactive (disaster mitigation role) vs reactive (purely disaster response role) as an agency

Processes

- **Gap:** lack of risk-based mentality to planning and prioritization that comprehensively addresses the benefits of IWRM projects in future disaster mitigation
- **Enabler:** science, data, and tools to identify the biggest multi-hazard risks across different weather drivers and identify national/regional priorities that inform a prioritized portfolio of federal involvement as part of comprehensive portfolio of IWRM projects

Projects

- **Gap:** limited flexibility for planning projects to account for benefits and impacts across business lines, such as reservoir capacity to contribute to regional drought resilience as well as flood risk management
- **Enabler:** mitigation projects that are planned and ready for implementation so that, as funds become available, they can be quickly directed towards vetted risk reduction projects

Partnerships

- **Gap:** mechanisms for coordinating and funding risk mitigation projects across local, regional, state, and federal partners
- **Enabler:** increased SWD involvement in and technical support for regional mitigation planning exercises and initiatives led by partners

3.4 - Overarching Future Scenarios

A rapidly changing world means several possible futures for SWD in 2035. Analysis of the key trends, drivers, and external uncertainties allow for identification of more likely eventualities, inform the choices SWD can make to influence these futures, and facilitate the development of response opportunities to ensure the Division and Districts can meet future conditions and pivot quickly as needed. SWD's ability to continually analyze and, when possible, right-size capacity is critical to meeting future conditions and changing demand. Moreover, its ability to monitor and analyze changing data is vital to ensuring the Division can proactively realign the CW Program with the most probable emerging future(s) and acute risks that may cause rapid change.

This section presents an illustrative depiction of four possible overarching futures/themes (see Figure 16) for the Southwestern region and lays the groundwork for how SWD can: identify current gaps to function effectively in specific future scenarios; address those gaps to enable positive outcomes; and begin to implement nimble and adaptable strategies for meeting these futures. These themes were informed by the combined findings of the three focused scenarios and the underlying trends, drivers, uncertainties, and priorities that fed into them. The four future scenarios (see Figure 17) also explore the feedbacks between drivers and the pressures they can exert on the region to fluctuate the demand for Civil Works across Mission Areas, including the challenges of short-term demand volatility (for example, following a shock such as a flooding event or a global recession). These **demand pressures (y-axis)** are juxtaposed against SWD **capacity** to meet them and **adapt** to volatile and changing needs **(x-axis)**. The four future scenarios for 2035 are presented here as:

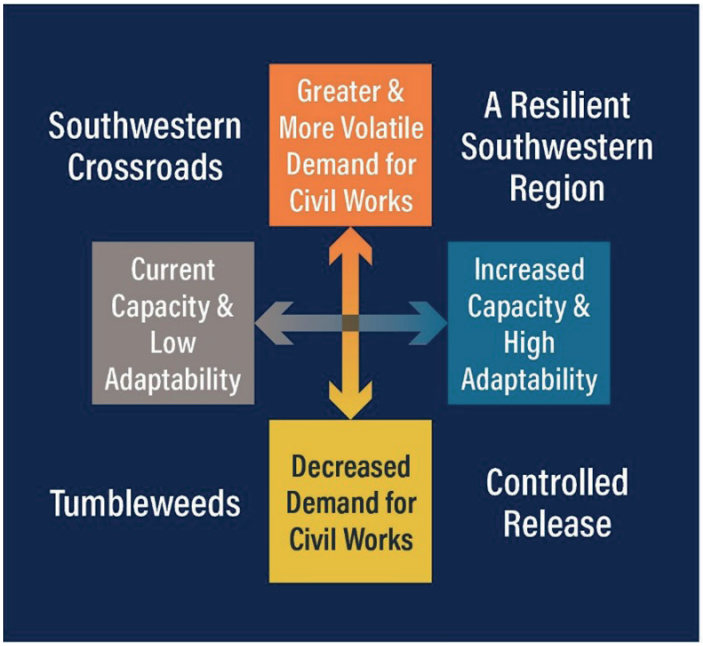


Figure 16 - Future Scenarios for 2035

3.4.1 - Tumbleweeds

Lower Demand + Current Capacity & Low Adaptability

In this future (see Figure 18), external drivers have combined to reduce demand for Civil Works and existing capacity is appropriately scaled for this period of reduced need. However, this capacity is maintained with limited flexibility and adaptability to significant changes in trends and conditions that may affect Civil Works. This leaves SWD unable to adequately and effectively meet surges in demand or shifts in need and with limited options for responding to change in the absence of significant investment to increase capacity.

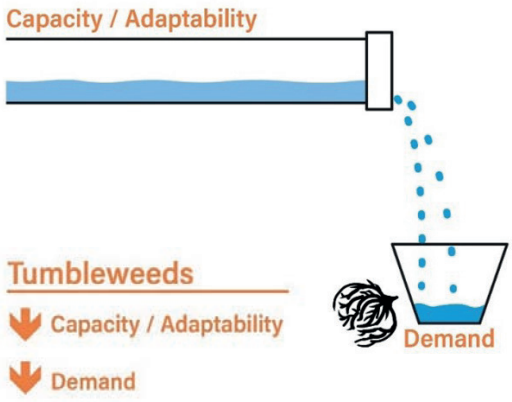


Figure 18 - Future Scenario: Tumbleweeds

Potential factors driving reduced demand could include declining populations and economic contraction over time, major shifts in energy sectors that may alter the regional economic landscape and associated funding for civil works for SWD and regional partners, or prolonged periods of reduced extremes in weather variability and catastrophic natural disasters. Moreover, the limited investment in Civil Works capacity is perpetuated by reductions in available funding, and capacity may start to further decline as a result. In this future scenario, SWD is in a reactive mode and is less prepared to adapt to shifts in demand or need, leaving the region is increasingly vulnerable to catastrophic events and the emerging threats of an uncertain and likely volatile future.

3.4.2 - Southwestern Crossroads

Greater Demand + Current Capacity & Low Adaptability

In this future (see Figure 19), the region continues to experience economic and population growth, and high demand for Civil Works. However, while demand has grown, SWD has seen limited growth in Civil Works investments, with few new starts and limited resources for ongoing operations and maintenance. As a result, the Division faces ever-increasing challenges to maintain level of service while managing tradeoffs in water resources uses and allocations to meet the demands of a growing region. Furthermore, aging SWD infrastructure is increasingly vulnerable to elevated risks from natural hazards and extreme weather variability, and the region as a whole is extremely vulnerable to widespread economic disruption from catastrophic events (e.g. hurricanes) as capacity to meet changing conditions is stagnant or in decline. In addition, limited investment in water resources infrastructure means SWD is not adequately positioned to proactively and efficiently adapt operations to changing trends or respond to rapid change—resulting in a Division that is ill-prepared to execute the USACE Mission and risks losing credibility in the region.

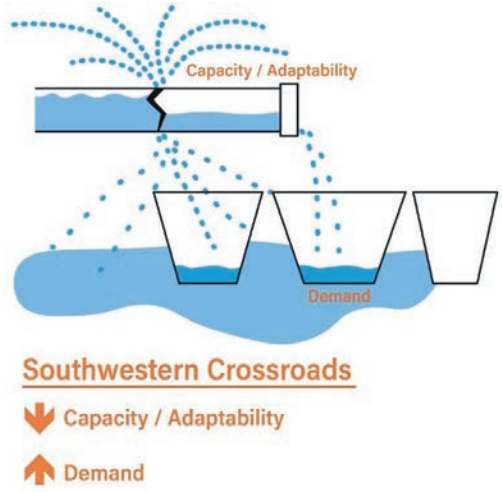


Figure 19 - Future Scenario: Southwestern Crossroad

However, the growing demand for Civil Works in the region due to continued growth and/or catastrophic hazards combined with the clear gap in capacity to meet that demand may attract a surge of resources to SWD (for example, in the form of post-disaster grants). In this scenario, short-term solutions may allow the Division to temporarily cope with conditions in the future, potentially masking a long-term trend of a gap between Civil Works demand and capacity. A threshold may also exist where lack of effective capitalization on these short-term investments may compromise the SWD's ability to execute the USACE Mission in the region. Insufficient USACE capacity can negatively impact the region's resilience in a future of elevated risks and uncertainties, thereby threatening the economic prosperity that is a major driver of demand for Civil Works in the region and reducing the pool of potential local sponsors for projects.

3.4.3 - Controlled Release

Lower Demand + Greater Capacity & High Adaptability

In this future (see Figure 20), SWD has invested in increasing Civil Works capacity to meet and adapt to changes in risk, trends, and drivers and to prepare for an uncertain future. The region and its stakeholders have invested in capacity to mitigate and adapt to risk from natural hazards and extreme weather variability through advancements in planning, land use, infrastructure, and partnerships. Regional drivers and trends have combined to lower demand for Civil Works with possible factors including population and economic contraction, major shifts in energy sectors affecting the regional economic landscape, prolonged periods of reduced extremes in weather variability/catastrophic natural disasters, or restoration of natural systems and advancements in land use and water management practices.

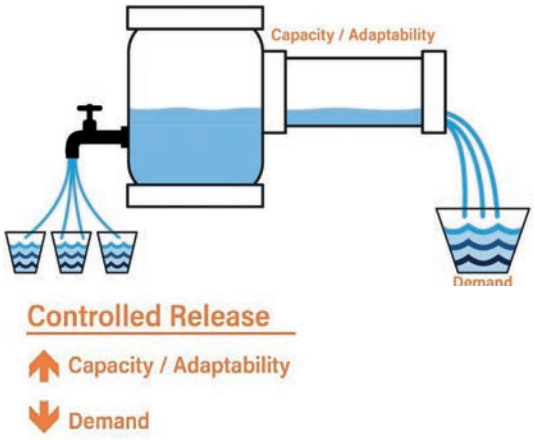


Figure 20 - Future Scenario: Controlled Release

Adaptability is a key component to a successful future under this scenario, wherein a nimble and proactive SWD is: prepared to effectively manage tradeoffs for water resources uses and allocations; well positioned to analyze trends and drivers and use that information to prepare for changes in demand; and enabled with a broader range of future responses to potential surges in demand. Prolonged periods of reduced Civil Works demand may result in the potential for SWD to be over-built and over-resourced. However, as the Division is highly adaptable to changing conditions and shifts in need, it allows SWD to proactively right-size resources and, in a controlled manner during times of surge, redirect them appropriately within the region and potentially beyond as conditions change. This future presents a potential feedback loop where SWD is positioned as a center of expertise and innovation that supports Integrated Water Resources Management at the national level.

3.4.4 - A Resilient Southwestern Region

Greater Demand + Greater Capacity & Adaptability

A prosperous region and growing population drives increased regional demand for water resource infrastructure, which is efficiently met by a robust SWD providing maximum value to the Nation (see Figure 21). While development and growth continue across the region in urban and suburban centers especially, the region and its stakeholders—benefiting from streamlined processes that strengthen collaboration with USACE—have invested in their capacity to mitigate and adapt to growing risk from natural hazards through advancements in planning, land use, infrastructure, and partnerships. SWD has increased Civil Works capacity to: meet growing demand; nimbly and proactively adjust to changes in regional drivers and trends; better manage tradeoffs for water resources uses and allocations; and better withstand and respond to elevated risk from natural hazards and extreme whether variability. As a result, the region's collective resilience to heightened risk and volatility provides a potential feedback loop that contributes to investor and public confidence and desirability, that in-turn continues driving regional economic growth and ultimately increasing demand for IWRM.

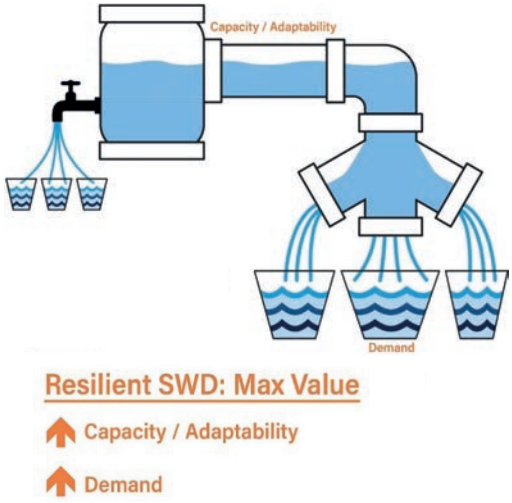


Figure 21 - Future Scenario: A Resilient Southwestern Region

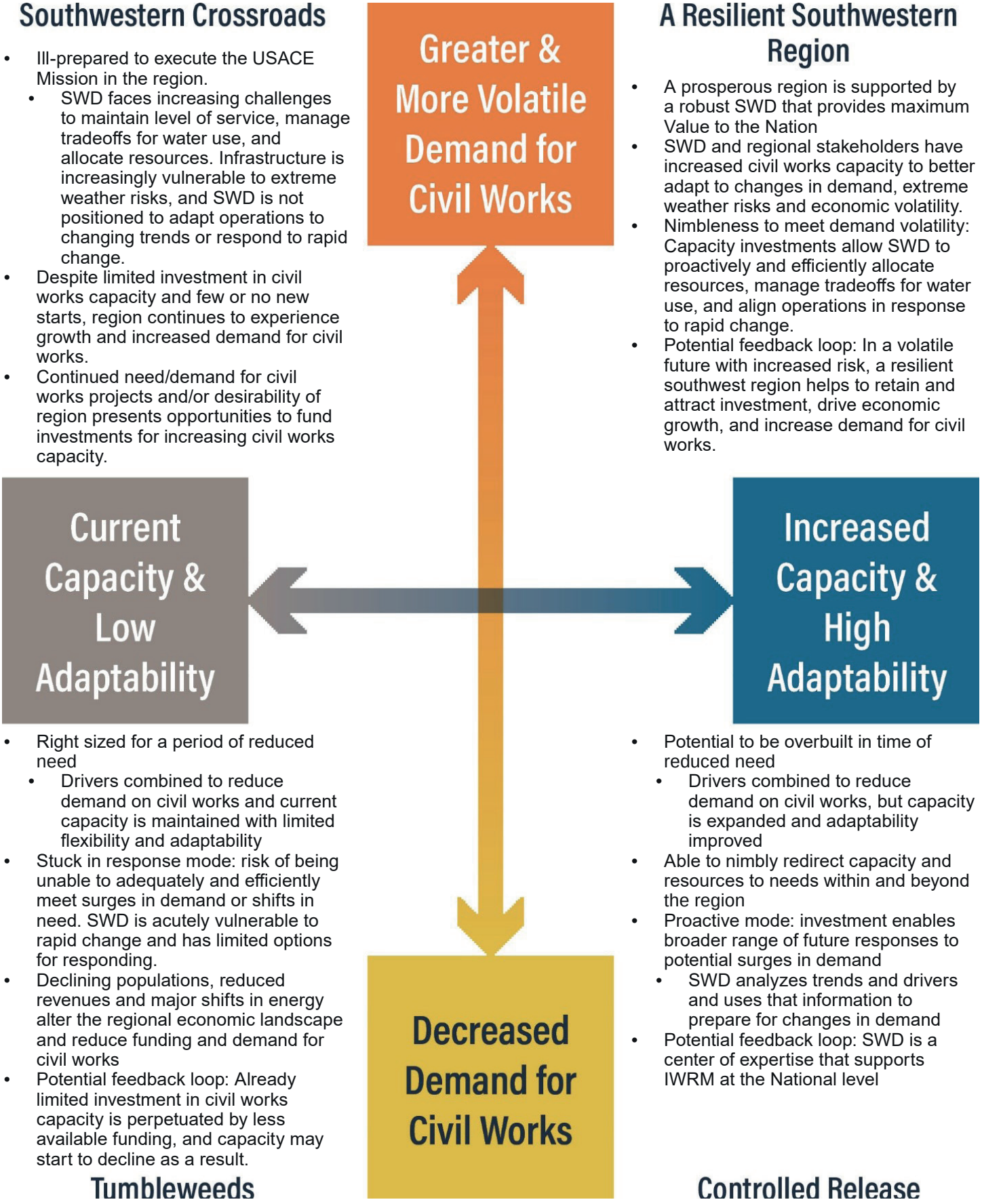
SWD's capacity and adaptability to future volatility require proactive planning and continuous evaluation to ensure appropriate capacity exists to maintain level of service as conditions and demand change. As risks grow in this future, the region and SWD are better prepared and more resilient yet remain vulnerable to impacts from catastrophic hazard events, economic volatility and changing macroeconomic conditions, and other possible threats associated with a volatile future. For example, while risks from extreme weather variability are projected to grow, the region may experience prolonged periods of drought and periods of increased precipitation and flooding, or it may experience accelerated or volatile shifts between these extreme weather events. To address this uncertainty, SWD balances the development of core internal capacity with flexible use of external resources so that it is right-sized for both surges and lulls. The Division must also be prepared under this scenario to be more proactive in times of reduced volatility while shifting to response mode as needed during intense increases in demand.

Southwestern Crossroads

- Ill-prepared to execute the USACE Mission in the region.
  - SWD faces increasing challenges to maintain level of service, manage tradeoffs for water use, and allocate resources. Infrastructure is increasingly vulnerable to extreme weather risks, and SWD is not positioned to adapt operations to changing trends or respond to rapid change.
- Despite limited investment in civil works capacity and few or no new starts, region continues to experience growth and increased demand for civil works.
- Continued need/demand for civil works projects and/or desirability of region presents opportunities to fund investments for increasing civil works capacity.

A Resilient Southwestern Region

- A prosperous region is supported by a robust SWD that provides maximum Value to the Nation
- SWD and regional stakeholders have increased civil works capacity to better adapt to changes in demand, extreme weather risks and economic volatility.
- Nimbleness to meet demand volatility: Capacity investments allow SWD to proactively and efficiently allocate resources, manage tradeoffs for water use, and align operations in response to rapid change.
- Potential feedback loop: In a volatile future with increased risk, a resilient southwest region helps to retain and attract investment, drive economic growth, and increase demand for civil works.



- Right sized for a period of reduced need
  - Drivers combined to reduce demand on civil works and current capacity is maintained with limited flexibility and adaptability
- Stuck in response mode: risk of being unable to adequately and efficiently meet surges in demand or shifts in need. SWD is acutely vulnerable to rapid change and has limited options for responding.
- Declining populations, reduced revenues and major shifts in energy alter the regional economic landscape and reduce funding and demand for civil works
- Potential feedback loop: Already limited investment in civil works capacity is perpetuated by less available funding, and capacity may start to decline as a result.

Tumbleweeds

- Potential to be overbuilt in time of reduced need
  - Drivers combined to reduce demand on civil works, but capacity is expanded and adaptability improved
- Able to nimbly redirect capacity and resources to needs within and beyond the region
- Proactive mode: investment enables broader range of future responses to potential surges in demand
  - SWD analyzes trends and drivers and uses that information to prepare for changes in demand
- Potential feedback loop: SWD is a center of expertise that supports IWRM at the National level

Controlled Release

Figure 17 - Detailed Future Scenarios for 2035

3.4.5 - Overarching Scenarios: Strategic Implications

Nimbleness and adaptability will be key to SWD's future success in continuing to provide value to the Nation. This overarching set of scenarios highlights some of the risks of overly focusing on right-sizing capacity to demand, without also investing in adaptive capacity and dynamic preparedness. SWD is planning not only for an uncertain future, but also potentially volatile demand for Civil Works over the coming decades. The Division needs to be ready to accommodate surges and able to redirect resources during times of less need. Maintaining capacity in core capabilities that exceeds local demand during times when that demands wanes is not inherently negative if managed correctly. This capacity can become a strong asset to partners within the region if resources and expertise can be nimbly redirected to where they are needed most. Maintaining adaptable capabilities in core strengths supporting SWD Mission Areas also positions the Division to serve as a leading resource on Integrated Water Resource Management for the Nation.

SWD will focus on building up key competencies the Division and its Districts can utilize to provide the necessary additional capacity for demand surges within the USACE Mission, while also building adaptability to redirect these core capabilities in times of waning demand. For capacity identified as necessary during surges in demand that are outside of key competency areas, SWD will leverage partner relationships within and beyond USACE to help fill those gaps in resources and expertise.

This final set of scenarios further highlights the important role IWRM will play for SWD in the future, enabling the Division to comprehensively and efficiently manage resources while considering tradeoffs across Mission Areas. The need for this holistic approach is especially high when surges in demand create further strain on limited water resources. Further putting IWRM into practice and increasing SWD's adaptability and nimbleness will require holistic implementation across all levels of operations, including changes to projects, processes, and approaches to partnerships. It will require a cultural shift and an operational shift, both of which will enabled through comprehensive implementation planning.

EXAMPLE GAPS & ENABLERS

Implementation of this Strategic Plan will require a granular identification of the potential roadblocks that may hinder action (gaps) and the potential catalysts or tools to propel action (enablers). Below are example gaps and enablers that have been identified through this scenario planning exercise. This is intended to be illustrative. A more comprehensive approach to identifying gaps and enablers will be taken during implementation planning.

Policies

- **Gap:** policies that enhance the flexibility and nimbleness of USACE, such as increased delegation of authority to the District and Division level
- **Enabler:** more flexibility in developing contingency plans during the budgeting process that allow SWD to be prepared for effective action across potential funding levels and priorities

Processes

- **Gap:** consistency in maintaining experienced staff at all levels of planning and implementation, particularly during surges in demand
- **Enabler:** identification of core competencies and capacity that SWD will develop and maintain in-house, vs. capacity that can is drawn as needed from other sources in or outside of USACE

Projects

- **Gap:** lack of sufficient funding and data to quantitatively prioritize infrastructure repair and enhancement based on current condition and value, despite policies being in place to support comprehensive asset management
- **Enabler:** increased flexibility and associated funding to implement adaptive management from the ground up in planning and implementing projects

Partnerships

- **Enabler:** coordination of key partners to support comprehensive and holistic approaches to IWRM within the region, including leveraging of varied authorities and funding streams

3.4.6 - Application of Scenario Planning in Practice

The future scenario planning exercises synthesized above enable SWD to plan within the context of an uncertain and rapidly changing future. The strategic implications identified for each set of scenarios serve as a basis for the strategies for action outlined in the next chapter—the Vision, Goals, and Objectives that set the framework for how SWD will respond over the next 15 years.

The future scenarios are also intended to serve as an ongoing and living reference for SWD throughout implementation of the Strategic Plan. The Division and its Districts will continue to use the scenarios to identify specific gaps and enablers to outline detailed actions and critical pathways. The scenarios will also support the benchmarking of success in achieving the Strategic Plan over time. Specific tactics, projects, and partnerships can be tracked against how they help to enable a more positive future, either moving SWD and the region in a more positive direction along an axis within the set of scenarios and/or supporting a more positive outcome within a given scenario. This more dynamic approach to benchmarking measures success as advancing positive outcomes for the region, while adapting to changes over time. This can be paired with a more USACE-focused benchmarking of progress towards implementation of identified strategies and actions.

4

A Framework for Action

Meeting the increasing challenges of today and planning for an uncertain future requires a paradigm shift in how the Southwestern Division approaches its work. The following Vision, cross-cutting Goals, and strategic Objectives lay a framework for how SWD will continue to meet the USACE Civil Works Mission and provide value to the Nation over the next decades (see Figure 22).

This strategy map builds on the action opportunities identified in the scenario planning exercises to address the key drivers of future risk and demand for Civil Works in the region, as well as the inherent uncertainties within them. The Goals and Objectives were developed by pairing the analysis on future trends with strengths, weaknesses, opportunities, and threats identified through a series of interviews with USACE staff and leadership at SWD, SWG, SWF, SWT, and SWL as well as meetings with local partners and stakeholders at each District

Central to this vision and framework for action is a focus on Integrated Water Resources Management (IWRM). IWRM is a holistic, coordinated, and cross-sectoral approach to the development and management of water, land, and related resources to maximize economic benefits, ecosystem quality, and health and public safety. Operationalizing IWRM requires an integrated approach to project development, organizational processes and procedures, and partnership building.

To advance the SWD Civil Works Vision, the Goals outlined here are intentionally cross-cutting across Mission Areas and Business Lines. Each Goal includes specific strategic Objectives towards achieving that Goal (see Figure 23, Figure 24, Figure 25, and Figure 26, respectively). These Objectives are organized by those relating to projects, processes, and partnerships, providing a framework for future implementation plans that align with these three areas.

SWD Civil Works Vision

*SWD works towards a **safe, reliable, sustainable, and resilient water future** for the communities we serve and the value they provide to the Nation, meeting the increasing challenges and demands on the region's water resources through an **integrated approach** to their management.*

GOAL 1:
Enable innovative solutions to complex challenges.

PARTNERSHIP OBJECTIVES

1.1 Coordinate to identify and develop solutions at **regional watershed and landscape scales**

PROCESS OBJECTIVES

1.2 Coordinate Business Lines and project timelines around key **nexus opportunities and tradeoffs**

1.3 Optimize workflows and processes to be more **agile, flexible, faster, and less risk averse** while maintaining safety and reliability

1.4 Enable and encourage **interdisciplinary and creative** approaches to problem solving

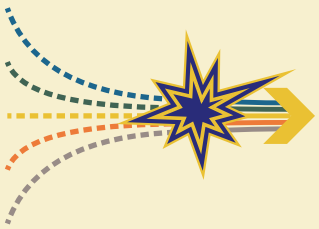
PROJECT OBJECTIVES

1.5 Encourage and prioritize **multi-use and multi-benefit** projects

1.6 Reevaluate **cost and benefit considerations** in decision making to be more inclusive

1.7 Consider **structural and non-structural approaches** in safe and reliable flood risk management that can be implemented by USACE or with partners.

GOAL 2:
Shift towards a proactive response mode.



PARTNERSHIP OBJECTIVES

2.1 Engage with academia to **build the workforce needed for the future**

PROCESS OBJECTIVES

2.2 Develop tools and processes to regularly **project future demands for civil works**

2.3 Update **technology** to meet **industry standards**

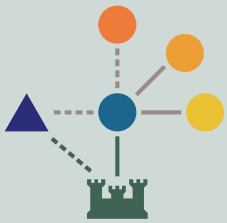
PROJECT OBJECTIVES

2.4 Invest in **pre-disaster** planning and **resilience** improvements

2.5 Incorporate **future trends** in population, land use, weather, and the economy into **planning and project design**

Figure 22 - Strategic Goals and Objectives

GOAL 3:
Re-envision role as a collaborative partner.



PARTNERSHIP OBJECTIVES

3.1 Raise awareness of the USACE Mission at the local, state, and national level through **targeted outreach**

3.2 Develop a strategy for working with and benefitting **underserved communities**

3.3 Take a leadership role in **coordinating federal decisionmakers and stakeholders**

3.4 Expand participation in **interagency water resource management** teams and working groups

PROCESS OBJECTIVES

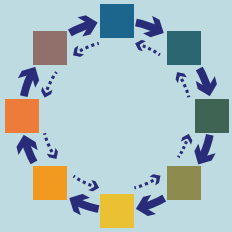
3.5 Ensure **consistent messaging and communication** from leadership through project teams

PROJECT OBJECTIVES

3.6 Identify action strategies for **studies that result in recommended approaches outside of USACE authority**

3.7 Support the **leadership of state and local agencies** in regional water resources strategic planning initiatives

GOAL 4:
Adaptively manage full lifecycle of water resources infrastructure.



PARTNERSHIP OBJECTIVES

4.1 Consider **public-private partnership options** and delegation of authority in developing, rehabilitating, and improving water resource infrastructure

PROCESS OBJECTIVES

4.2 Integrate project monitoring and metrics as part of an **adaptive management approach**

4.3 Develop a **Division-wide operations and prioritization plan** for Civil Works funding.

PROJECT OBJECTIVES

4.4 Design **new projects** with a **plan for long-term operations and maintenance**

4.5 Consider the benefits of **natural and nature-based features** (NNBF) and other approaches in improving and extending project performance over time

4.6 Evaluate the most efficient and cost-effective ways to meet current needs, including **opportunities to revamp existing projects**

4.1 - Goal 1: Enable Innovative Solutions to Complex Challenges

Figure 23 - Goal 1 Paradigm Shift

SWD and the region it serves are facing increasingly complex challenges in water resources management. Siloed approaches to problem solving, where discreet solutions are developed to address discreet challenges within individual Business Lines, are increasingly inadequate to manage the interconnected challenges posed by natural hazards, changing populations, and evolving economies. SWD will shift towards an integrated systems-based approach, working across Mission Areas, disciplines, jurisdictions, and agencies, to deliver comprehensive water resource solutions for the region. This approach promotes the efficient use of limited resources to address multiple challenges in a coordinated way that better meet the needs and interests of local communities and stakeholders. Moreover, this approach will position SWD to effectively navigate the increasingly complex tradeoffs in water resources management for its various Missions and be nimble in adjusting capacity to meet demand under a variety of future scenarios.

4.1.1 - Goal 1 Objectives

Partnerships

Objective 1.1
Coordinate to identify and develop solutions at regional watershed and landscape scales.

The external drivers of future risks for the region, such as extreme weather events and land use change, often have impacts far broader than traditional project scales. At the same time, other entities at the federal, state, and local scale are working to identify their own solutions to these challenges in ways that may also impact execution of the USACE Mission. Within USACE, projects in one AOR may impact other Districts and Divisions that are, for example, downstream in the same watershed. SWD will work towards addressing problems at the regional and landscape scales, building more coordination mechanisms across Districts and facilitating partnerships across multiple jurisdictions of government.

Processes

Objective 1.2
Coordinate Business Lines and project timelines around key nexus opportunities and tradeoffs.

As the challenges of the future become increasingly complex and interconnected, there are several key areas where external drivers and multiple USACE Mission Areas consistently intersect and require coordinated planning to navigate tradeoffs or maximize benefits. SWD will develop strategies, processes, and procedures to coordinate and integrate Mission Areas and Business Line planning around key nexus issues. For example, identifying ways to evaluate and meet increasing demands for Water Supply in the face of a growing population and extreme weather threats without compromising primary Missions such as Flood Risk Management, Navigation, and Hydropower.

Objective 1.3
Optimize workflows and processes to be more agile, flexible, faster, and less risk averse while maintaining safety and reliability.

Pressure from external drivers, such as increasing population at risk from flooding during extreme storms, drives an urgent need for rapid mitigating action that is felt keenly by stakeholders and potential non-federal sponsors. Streamlining processes to reduce project planning and implementation times will engender confidence in SWD and encourage other entities to continue forward with federal co-sponsored projects that make full use of USACE knowledge and capabilities.

Objective 1.4
Enable and encourage interdisciplinary and creative approaches to problem solving.

Identifying integrated solutions to complex problems and understanding the broad positive and negative consequences those solutions may have on communities, infrastructure, and the environment, requires teams with diverse backgrounds and multidisciplinary expertise. SWD and its Districts will identify opportunities to increase and operationalize interdisciplinary teamwork and cross-training, leveraging internal and external expertise across multiple fields to identify and develop innovative solutions to integrated water resources challenges.

Projects

Objective 1.5
Encourage and prioritize multi-use and multi-benefit projects.

SWD will prioritize the design and renovation of projects that serve more than one purpose and address multiple water resources goals, such as providing water supply, flood risk management, and recreation opportunities. This strategy will encompass new projects that provide multiple benefits; co-timed projects that allow efficient use of resources, such as beneficial use of dredge material; holistic scoping of planning studies; and identification of opportunities for project renovations that incorporate multiple uses and benefits. To enable this, SWD will work with project sponsors and HQUSACE to advocate to OMB and Congress to allow for study authorizations to incorporate more than one authority for project studies and project authorizations.

Objective 1.6
Reevaluate cost and benefit considerations in decision making to be more inclusive.

USACE is working nationally to update and modernize the agency's framework for evaluating and selecting major water projects to better account for a wider range of social, economic, and environmental benefits. Specifically, the Principles, Requirements and Guidelines (PR&G), a framework for evaluating and selecting major water projects, was updated in 2014 and now prescribes that projects to identify, analyze, and consider all benefits across the four accounts of National Economic Development (NED), Environmental Quality (EQ), Regional Economic Development (RED), and Other Social Effects (OSE). Historically, feasibility studies have undercounted RED and OSE benefits, including project impacts to life safety and local and regional economies. In addition to providing input to shape that framework to align with needs within the region, SWD and its Districts will continually advance the practical use of this guidance to more comprehensively and equitably evaluate project benefits and costs.

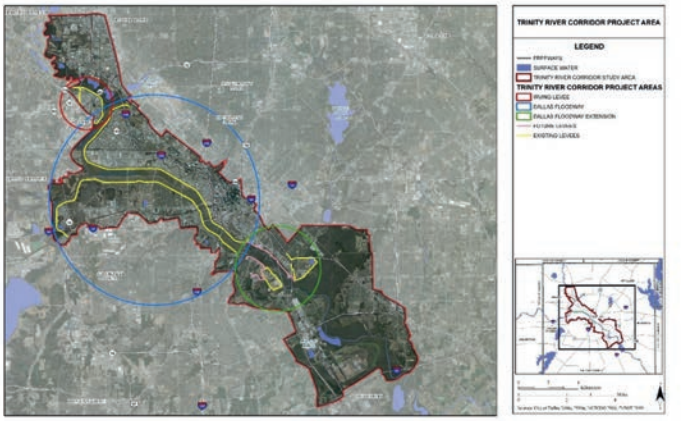
Objective 1.7
Consider structural and non-structural approaches in safe and reliable flood risk management that can be implemented by USACE or with partners.

A comprehensive approach to coastal and inland flood risk reduction and water resources management requires a range of structural measures (such as levees, floodwalls, storm surge barriers, and pump stations), natural and nature-based features (such as living shorelines, wetlands, barrier islands, reefs, beaches and dunes, riparian restoration, and green stormwater infrastructure), and non-structural measures (such as building codes and retrofits, acquisition and relocation, land use planning, and enhanced flood warning and evacuation planning). SWD and its Districts will promote and implement comprehensive risk reduction and adaption solutions across its regulatory, planning, and operations roles.

GOALS IN ACTION

Tulsa-West Tulsa Levees

Tulsa Levee in 2019 Flood



Dallas Floodway Project Map

Tulsa-West Tulsa Levee Feasibility Study: Use of Life Safety

Feasibility studies most often use a National Economic Development (NED) approach to account for project benefits. For the Tulsa-West Tulsa Feasibility study, which focused on potential alternatives to upgrade the levee system in the area, the Tulsa District approached the project from the standpoint of the benefits the levee would provide in reducing risk to human life. A Chief's Report for the Final Feasibility Report and Integrated Environmental Assessment for the Tulsa-West Tulsa Levees Feasibility Study was signed on 23 April 2020. The Chief's Report identified, evaluated, and disclosed all associated impacts that would result from the construction and operation of the recommended plan to improve life safety during flood events within the levee protected areas; the selected plan met the study objectives for reducing flood risk to the public. This effort was innovative in multiple ways, including being: 1) the first Planning Feasibility Study in the Nation to be formulated based on a "life safety" justification rather than NED; 2) the first Assistant Secretary of the Army for Civil Works (ASA(CW)) approval of a NED exemption memorandum for a planning feasibility study; 3) the first investigation study in the Nation to be completed under the authority of the Bipartisan Budget Act of 2018; and 4) the first planning study to be completed significantly ahead of schedule (18 vs. 36 months) and under budget ($2.2M vs. $3M). Completion of this study resulted in execution of a precedent setting initiative that has and will continue to inform national USACE policy for years to come. Including consideration of life safety vs. NED is a tactical advancement of **Objective 1.3: Optimize workflows and processes to be more agile, flexible, faster, and less risk adverse.**

Dallas Floodway Feasibility Project

Feasibility studies within USACE did not historically include a risk assessment to determine, for example, the potential risk an existing levee infrastructure project might have to the community if it were to fail. The Dallas Floodway Feasibility project, conducted by the Fort Worth District in 2009-2014, was the first feasibility study to utilize a risk assessment to inform project formulation. At the time of the study, the Dallas Floodway project included more than 22 miles of levees to protect regions of Dallas from flooding of the Elm Fork, West Fork, and Trinity River. The Risk Management Center (RMC) conducted this Levee Risk Assessment pilot project to evaluate potential failure modes of the levee system under current conditions and future-without-action, along with the consequences of those failures in terms of loss of life and impact to structures. The study determined that internal erosion would likely lead to levee failure without action and recommended a slurry cut-off wall through the center of the levee system. The subsequent formulation considering the Levee Risk Assessment recommended a small amount of levee toe cut-off wall and a minimal levee raise to reduce the risk of overtopping of the system at an estimated cost of $14M. The use of risk assessments in project formulation is an example of advancing **Objective 1.3: Optimize workflows and processes to be more agile, flexible, faster, and less risk averse while maintaining safety and reliability.**

4.2 - Goal 2: Shift Towards a Proactive Response Mode

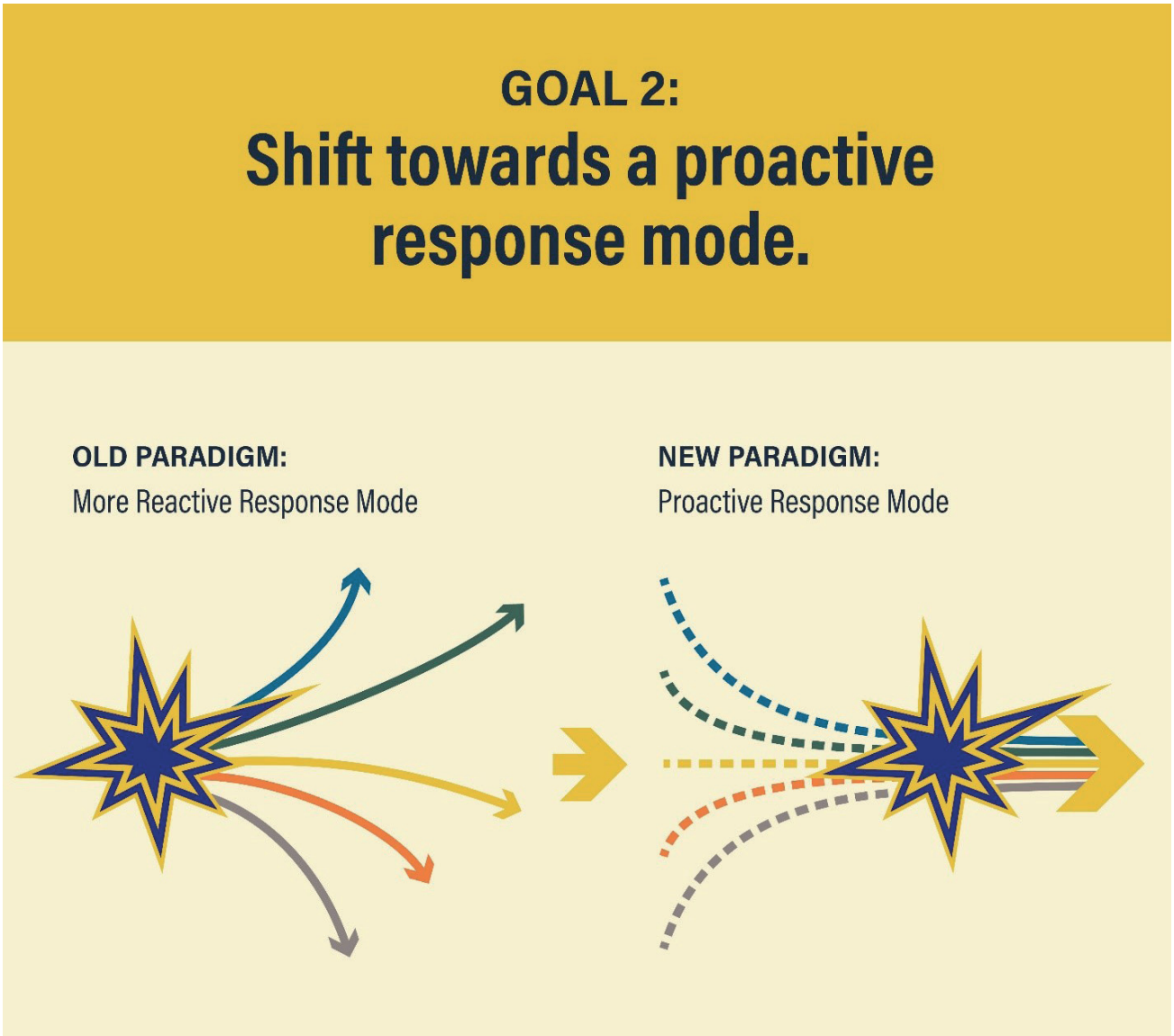


Figure 24 - Goal 2 Paradigm Shift

Meeting the demands of the future requires action today. SWD will shift away from a reactive response mode and towards more advance planning. In doing so, the Division can reduce overall costs and increase confidence in USACE by, for example, minimizing the potential devastating impacts of drought and extreme storms before they occur. Because planning for the future requires robust predictions of future demands, the Division and its Districts will incorporate trends and projection data into operations and project planning and use the best available tools and expertise to advance creative solutions. This includes proactively directing and/or nimbly redirecting resources where they are needed depending on which future scenario(s) are realized.

4.2.1 - Goal 2 Objectives

Partnerships

Objective 2.1
Engage with academia to build the workforce needed for the future.

USACE has a unique opportunity to build careers through the agency's work. SWD and its Districts will identify the full range of skill sets needed to meet new challenges and will strengthen relationships with local academic institutions to cultivate the right people to do the jobs needed over the timeframe of this plan.

Processes

Objective 2.2
Develop tools and processes to regularly project future demands for civil works.

Although existing data and tools will be leveraged in projecting future demands for Civil Works projects where available, in some cases the proper tools may not yet exist. SWD will regularly evaluate key gaps where more precise predictions of infrastructure demand and project performance would significantly improve the cost-effectiveness or efficiency of infrastructure development or maintenance. SWD will then close those priority gaps through internal development or engagement of external research and development programs.

Objective 2.3
Update technology to meet industry standards.

The past decades have brought a surge in technology in everything from project management software to models for real-time forecasting of flood risk to remote systems for infrastructure operation. Budget constraints and the challenges of updating technology in large-scale operations such as USACE have led to difficulties keeping software and hardware current with industry standards. SWD will identify key technology gaps where investing in improvements will ultimately lead to more cost-effective and efficient operations.

Projects

Objective 2.4
Invest in pre-disaster planning and resilience improvements.

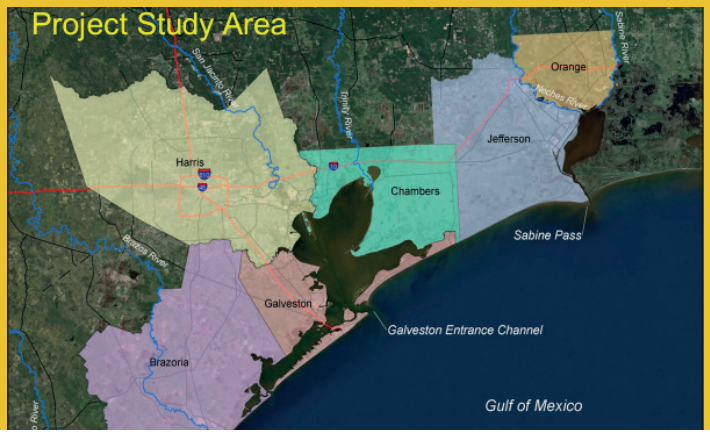
Investing in pre-disaster planning saves lives and protects homes, businesses, and critical and essential infrastructure. SWD will consider funding models that support projects to reduce the potential impacts of future storms, droughts, and other disasters.

Objective 2.5
Incorporate future trends in population, land use, weather, and the economy into planning and project design.

Projections such as population change and variability in weather patterns can directly inform future needs for infrastructure such as hydropower and freshwater demand, allowing capacity to be properly right-sized for need through the end of the project design lifespan. Current USACE planning guidance allows for incorporating some, but not all, future conditions into planning analysis. For example, USACE incorporates future sea level rise and storm event frequency curves into CSRM and FRM project studies, but it does not attempt to incorporate future land use patterns into CSRM and FRM future conditions analysis. SWD will use available data and model output to evaluate how a comprehensive set of trends in drivers may modulate infrastructure capacity needs and design, and create adaptable plans to meet conditions under various future scenarios.

GOALS IN ACTION

GIWW Aerial Photo



Sabine Pass Project Study Area

Gulf Intracoastal Waterway (GIWW) Coastal Resiliency Study (CRS)

The Gulf Intracoastal Waterway (GIWW) is an inland navigable channel stretching along the Gulf of Mexico coast more than 1,000 miles from Florida to Texas. The GIWW Coastal Resiliency Study (CRS) is being conducted to evaluate methods of making a portion of the GIWW within the SWD's AOR resilient to future storms and coastal processes. This is a proactive, pre-disaster planning approach to improve the system and reduce the need to expend funds to restore the GIWW after a disaster, instead of continually responding to repair damage caused by extreme weather and coastal change disasters that impact the GIWW. The overall, cumulative cost of this proactive approach is expected to be less than those incurred with a reactive paradigm. This study illustrates how innovative approaches can be used to advance **Objective 2.4: Invest in pre-disaster planning and resilience improvements.**

Pass to Galveston Bay Feasibility Study

Hurricane Harvey made landfall along the Texas Coast on August 25, 2017 and caused an estimated $150 billion in damages. This event exposed the vulnerabilities of the region to extreme storms and coastal flooding, which are likely to continue to be a threat moving into the future based on analysis of environmental trends. The Sabine Pass to Galveston Bay (S2G) Feasibility Study was designed to identify and recommend Coastal Storm Risk Management (CSRM) projects that could reduce the damage of future storms in the area. The Chief's Report for this study, produced in December 2017, recommended improvements to and construction of three CSRM projects along the Texas Coast. After Hurricane Harvey, Congress passed legislation PL115-123 that authorized $3.8 billion in full federal funding to support the S2G project. This funding has catalyzed execution of the S2G project and reduced the implementation time from ten years to six years, reducing the period for which the region must wait for these additional protections by four years. This project is an example of advancing **Objective 2.4: Invest in pre-disaster planning and resilience improvements, as well as Objective 2.5: Incorporate future trends in population, land use, weather, and the economy into planning and project design.**

4.3 - Goal 3: Re-Envision Role as a Collaborative Partner

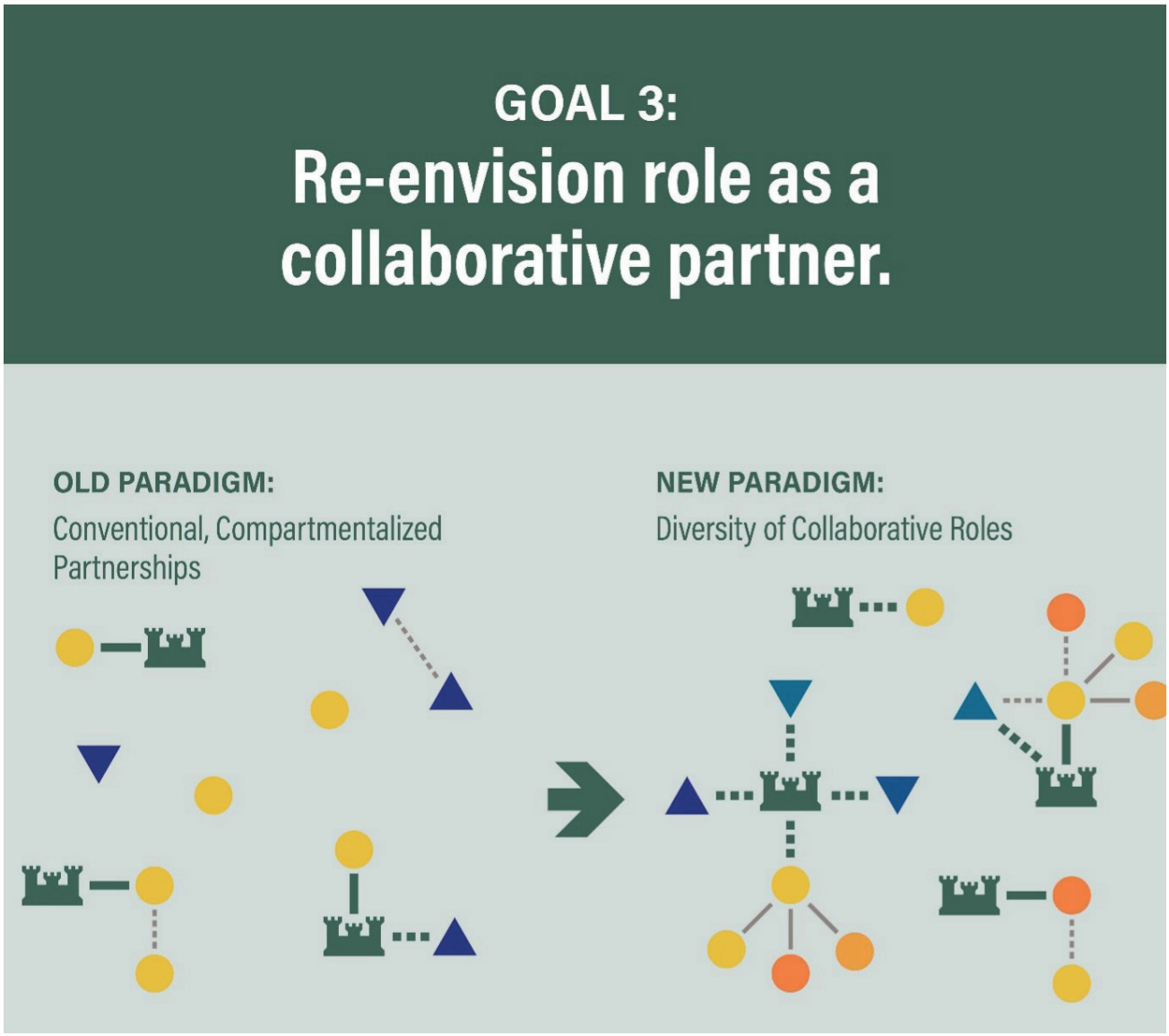


Figure 25 - Goal 3 Paradigm Shift

Addressing the increasing diversity of challenges and demands on SWD Civil Works requires more diverse partnerships with a wide range of local stakeholders and federal partners. Where needs intersect core USACE Mission Areas, such as maintenance of navigable waterways, USACE may further serve the region by leading and facilitating collaboration across federal, state, and local partners. Where USACE has technical expertise without a project execution role, such as municipal flood risk management, USACE may fill a supporting or advisory role under the leadership of other agencies. SWD will work towards deepening and expanding partnerships with local, state, and federal entities and flexibly approaching those partnerships to adapt the right USACE role appropriate to the context. SWD will also work to broaden the communities it serves, with a particular focus on equitably addressing the disproportionate risk faced by vulnerable and underserved populations, such as black, indigenous, and people of color; older adults and people with disabilities; rural communities; and communities with lower property values.

4.3.1 - Goal 3 Objectives

Partnerships

Objective 3.1
Raise awareness of the USACE Mission at the local, state, and national level through targeted outreach.

Because the role USACE plays in water resource management includes planning, regulation, development, and operation across a wide spectrum of issues, many local stakeholders may be unaware of opportunities to work with SWD Districts as a non-federal sponsor or to tap USACE expertise in project planning and development. Even at the state and national level, potential partner organizations and entities may have preconceived ideas of when and how to work with USACE that does not capture the organization's shift toward more holistic, integrated water resource management. SWD will work to close this gap through targeted local outreach and the development of communication strategies for raising awareness at the state and national level.

Objective 3.2
Develop a strategy for working with and benefitting underserved communities.

Communities traditionally underserved by water resources infrastructure—such as rural communities, lower-income communities, Indigenous, and people of color—are in many cases also at greatest risk of water resources challenges. SWD will develop targeted strategies to address common challenges in project funding in underserved communities, such as more comprehensive approaches to benefit-cost calculations and more diverse partnerships to meet cost-share requirements. SWD will also identify opportunities to provide additional engagement, and technical and planning support to underserved communities.

Objective 3.3
Take a leadership role in coordinating federal decision makers and stakeholders.

SWD Districts are significantly involved in water resource infrastructure development through their regulatory and planning roles, even in projects that are not ultimately built or maintained by the federal government. For this reason, USACE is well-positioned to take a leadership role in advancing IWRM across Mission Areas through coordination of local, state, and federal partners. SWD will identify and leverage these opportunities, such as by convening working groups focused on reducing regional flood risk through a combination of approaches.

Objective 3.4
Expand participation in interagency water resource management teams and working groups.

USACE has extensive experience in managing a wide range of water resource management issues; at the same time, other entities possess complimentary skills sets and have synergistic missions in, for example, floodplain management (FEMA). Sharing this expertise and working together to holistically address water resource management enables a broader range of solutions to be simultaneously considered and potentially executed. SWD will identify and expand opportunities for interagency engagement at the local, state, and federal level through participating in, for example, programs like the Silver Jackets.

Processes

Objective 3.5
Ensure consistent messaging and communication from leadership through project teams.

One challenge of an organization as large and complex as USACE is ensuring consistent communication to stakeholders and partners, which is vital for maintaining credibility and trust in the organization. For example, if on-the-ground improvements in reducing Navigation project construction time are not seen after USACE leadership indicates that they are a priority, stakeholders may begin to see these messages as empty promises, lose confidence in the Districts, and execute their projects with limited federal involvement. SWD will synchronize communication from project development teams up through management to ensure consistency and engender stakeholder trust.

Projects

Objective 3.6
Identify action strategies for studies that result in recommended approaches outside of USACE authority.

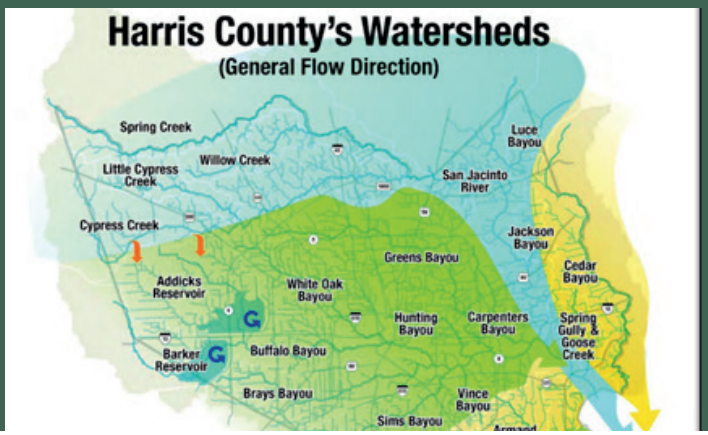
Planning studies can often result in a best-case course of action that is outside of USACE project construction authority. For example, reducing the amount of impervious surfaces in an urban area can reduce flooding if infrastructure project options have been exhausted to the limit that is feasible or are less cost-effective overall. SWD will expand mechanisms for transferring the analysis and results of these planning efforts to other management entities and provide support where possible in developing and executing non-USACE projects, such as through further leveraging of the Interagency Flood Risk Management program (https://webapps.usgs.gov/infrm/). SWD will also explore opportunities for supporting projects that serve multiple functions, including those that fall within USACE Mission and Authority, that may be implemented through a diversity of layered funding sources.

Objective 3.7
Support the leadership of state and local agencies in regional water resources strategic planning initiatives.

Decades of experience in water resources management have fostered extensive institutional knowledge within USACE addressing issues including flood risk management, dredging, and environmental restoration. This expertise can be invaluable in efforts led by partners in which the USACE Mission dictates SWD play a supporting rather than lead role. SWD will identify and expand opportunities to share this technical and planning expertise with other entities through use of, for example, the Planning Assistance to States (PAS) program.

GOALS IN ACTION

Logo of the Silver Jackets Program



Flow Direction in Harris County's Watersheds

Silver Jackets Program

Mitigating the risk of flooding is a challenging problem in part because numerous federal, state, and local agencies have varying focus and authority related to the issue. The Silver Jackets Program brings together state and federal partners to facilitate a coordinated approach to flood risk management in each state. In Texas, participating agencies include USACE SWF and SWG, Federal Emergency Management Agency (FEMA) Region VI, the U.S. Geological Survey (USGS), and the National Weather Service (NWS), in addition to several Texas state agencies. This multi-agency partnership has been identifying tools and strategies to support local communities in advancing Texas' Hazard Mitigation Plan, including a proposed Texas Floodplain Prioritization Tool and strategies for procuring undeveloped land within the floodplain. The work being advanced by the Texas Silver Jackets partnership seeks to engage stakeholders within priority watersheds in Texas to better understand flood risk management needs at a regional scale. USACE can leverage this partnership and ongoing work to help identify opportunities to advance both **Objective 2.4: Invest in pre-disaster planning and resilience improvements and Objective 3.3: Take a leadership role in coordinating federal decision makers and stakeholders.**

Houston Regional Watershed Assessment, Stakeholder Engagement

The Metropolitan Houston Regional Watershed Assessment is an in-progress, comprehensive evaluation of the region's 22 watersheds and the various institutional levers being used to implement flood risk reduction efforts. The Assessment will characterize successes and identify gaps of ongoing efforts and recommend actions that can improve the effectiveness of FRM efforts and expenditures. The recommendations will include coordination efforts, technical assistance, policy changes, funding priorities, and alternative consideration of risks when evaluating structural and non-structural flood risk management measures. Those recommendations include efforts that can be undertaken by residents, communities, USACE, and local stakeholders to reduce flood risk in the Houston Metropolitan Area now and into the future. The process has involved regular coordination between USACE, various stakeholders, and other federal agencies. In developing a watershed plan that leverages USACE and sponsor authority, USACE can further **Objective 3.3: Take a leadership role in coordinating federal decision-makers and stakeholders.**

4.4 - Goal 4: Adaptively Manage Full Lifecycle of Water Resources Infrastructure

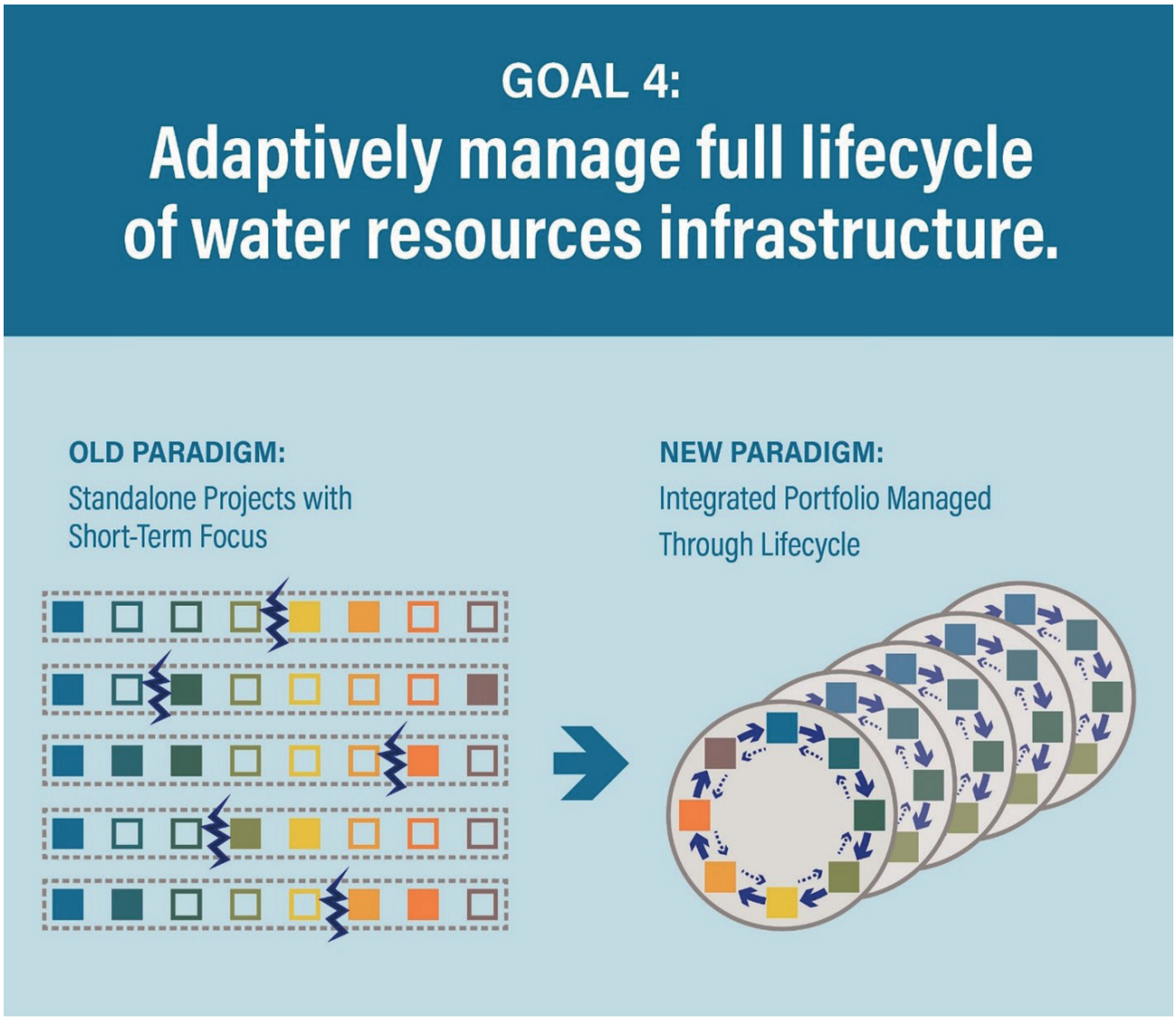


Figure 26 - Goal 4 Paradigm Shift

The combination of aging water resources infrastructure and increased infrastructure capacity demands driven by population growth, development, and extreme weather requires a more coordinated and adaptive approach to asset management. Use of this approach will facilitate resolving existing backlogs of infrastructure maintenance as well as reduce the cost of operations moving into the future. SWD will manage the full lifecycle of its water resources assets, taking a holistic approach to the design, construction, operations, and maintenance of its projects over their planning life. SWD and its Districts will monitor the full portfolio of water resources infrastructure using an adaptive management framework, promoting flexible and iterative decisions about new starts, renovations of existing infrastructure, and long-term operations and maintenance plans.

4.1.1 - Goal 4 Objectives

Partnerships

Objective 4.1
Consider public-private partnership options and delegation of authority in developing, rehabilitating, maintaining, and improving water resource infrastructure.

Public-private partnerships (P3) are a mechanism for increasing the involvement of the private sector in the development of projects that may have historically been developed through more traditional USACE funding models. P3s can reduce the time it takes to get projects on the ground by providing new funding streams and leveraging greater involvement of local entities, while also allowing for increased risk-sharing in project execution. SWD Districts will evaluate the potential for use of P3s and other non-traditional approaches such as delegation of authority in developing, managing, and maintaining the full portfolio of water resource management infrastructure.

Processes

Objective 4.2
Integrate project monitoring and metrics as part of an adaptive management approach.

Developing clear project objectives and articulating metrics that can be used to benchmark success in achieving those objectives requires upfront investment in project development, but the payout can be immense. Doing so allows early warning signs to be identified if a project has or begins to fail to meet its objectives, allowing early intervention ahead of more catastrophic failure. Evaluation of quantitative metrics also enables future projects to leverage strategies and approaches that have been proven to be the most effective in the past. SWD Districts will incorporate the development and use of success metrics throughout project development, as well as in operations and maintenance. Implementation of this objective also requires evaluating policies and project funding mechanisms to increase opportunities for practical implementation of adaptive management approaches.

Objective 4.3
Develop a Division-wide operations and prioritization plan for Civil Works funding.

The network of CW infrastructure that SWD Districts maintain on the landscape has grown considerably over the decades, which has resulted in a backlog of maintenance and necessary improvements as that infrastructure has aged and the capacity needs have increased. At the same time, new projects are needed to address added stressors and partner needs in, for example, Flood Risk Management and Navigation. SWD will develop a Division-wide plan for prioritizing projects that defines and prioritizes the most pressing needs in both O&M and new starts, while also comprehensively addressing the full portfolio of needs in the longer term.

Projects

Objective 4.4
Design new projects with a plan for long-term operations and maintenance.

Pressure points such as flooding and inadequate water supply result in the development of new water resources infrastructure as short-term priority. Because the lifespan of these projects spans from years to decades, the long-term costs of operation must be considered to ensure the full project portfolio can be managed in future years. SWD Districts will consider the long-term cost of operation and maintenance in project development, including identifying ways to reduce that burden through project design.

Objective 4.5
Consider the benefits of natural and nature-based features (NNBF) and other approaches in improving and extending project performance over time.

Hard infrastructure such as levees and dams incur annual maintenance and operation costs and will degrade over time, eventually needing to be replaced or reengineered. Innovative approaches including natural and nature-based features may present an ultimately more cost-efficient solution in some cases if both the up-front and maintenance costs are considered in tradeoff analysis. SWD will expand consideration of innovative approaches such as NNBF in cases where they may ultimately be more cost effective over project lifetime.

Objective 4.6
Evaluate the most efficient and cost-effective ways to meet current needs, including opportunities to revamp existing projects.

The extensive role SWD Districts have played over the last decades has led to an expansive portfolio of levees, reservoirs, and other water resource infrastructure that are currently maintained by USACE. In some cases, this infrastructure is approaching the end of its design life and/or is approaching or exceeding design capacity. SWD will evaluate the complete spectrum of potential approaches to meeting the needs of the region, including renovating existing projects, decommissioning projects no longer necessary, and building new infrastructure.

GOALS IN ACTION

Maintenance and Operations of the MKARNS

Cooper Dam and Jim Chapman Lake

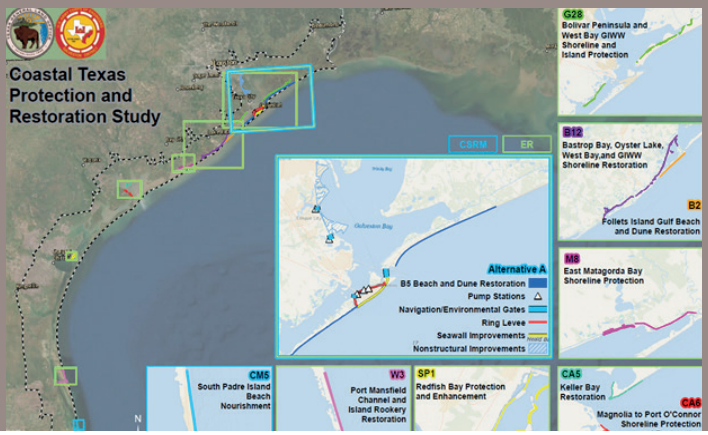
McClellan-Kerr Arkansas River Navigation System (MKARNS)

As the MKARNS infrastructure turns 50 years old, the need for maintenance or rehabilitation is increasing, especially as growing extreme weather variability and other key drivers exert additional pressures on the aging system. With these challenges in mind, SWD and its affected Districts are collaborating with key stakeholders to identify the MKARNS' most critical needs now and for the future. For example, a pilot investment tool has been developed to assist in justifying and validating the priorities of the system to manage and budget for efficiency and cost effectiveness. The use of this tool assists and facilitates the implementation of **Objective 4.3: Develop a Division wide operations and prioritization plan for Civil Works funding; and Objective 4.6: Evaluate the most efficient and cost-effective ways to meet current needs, including opportunities to revamp existing projects.**

Water Supply Study

Providing water supply storage and conducting studies to assist states and local interests with future needs are the main functions of the Water Supply Business Line, and SWD serves as the center for water supply studies across the nation. Sustainably managing population-driven increased demands for water supply without compromising other Division Missions may become increasingly difficult in the future, as populations and other threats such as extreme weather variability continue to grow. Water supply studies are an important tool for preparing for future needs and changing conditions. Increased collaboration is critical to analyzing future water supply needs and includes USACE partnering with local stakeholders to develop water supply plans to find the most efficient, cost-effective, and environmentally sustainable methods of providing water to customers throughout the Division's AOR. Often the most cost-effective way involves continued examination of USACE storage to meet those needs, and in turn, the local stakeholder provides funds to maintain infrastructure. Conducting water supply studies in this sustainable and cost-effective manner can further **Objective 4.1 Consider public-private partnership options and delegation of authority in developing, rehabilitating, maintaining, and improving water resource infrastructure; and Objective 4.6: Evaluate the most efficient and cost-effective ways to meet current needs, including opportunities to revamp existing projects.**

GOALS IN ACTION



Selection of Coastal Management Projects along the Texas Coast

Coastal Texas Protection and Restoration Feasibility Study (Coastal Texas Study)

The Coastal Texas Study is authorized to "develop a comprehensive plan to determine the feasibility of carrying out projects for flood damage reduction, hurricane and storm damage reduction, and ecosystem restoration in the coastal areas of the State of Texas." The Coastal Texas study was initiated in 2014 to evaluate large-scale coastal storm risk management (CSRM) and ecosystem restoration (ER) alternatives aimed at providing the coastal communities of Texas with a comprehensive plan of multiple lines of defense. These projects are designed to function as a system to reduce the risk of coastal storm damages using natural and built infrastructure along the Texas Coast and provide resiliency and redundancy to those areas. The ER features are designed to restore degraded coastal ecosystems, increase resiliency along the coast, and to provide future adaptations to sea level change. Texas has been a staunch supporter of this effort and plans to use the draft feasibility report in working with the Texas legislature to support the non-Federal responsibilities of the study.

Formulation included pre-disaster planning to enhance the resiliency, redundancy, and robustness of the proposed systems. Measures were created to:

- Form Multiple Lines of Defense: By combining various lines of defense (e.g. barrier islands, living shorelines, coastal marshes, etc.), redundant levels of protection and restoration are provided for both humans and coastal ecosystems. Multi-use and multiple benefit features such as beach and dune systems not only provide primary CSRM benefits to Bolivar and Galveston reaches, but also incidental ER benefits for various habitats.
- Be Comprehensive: The CSRM alternatives were assembled using a systems approach to work in concert with other measures considered, connect to existing systems, and be adaptable over time to address sea level change. The system includes structural, natural, and nature-based features.

Cost and benefits assessments for the effort looked beyond traditional National Economic Development (NED) metrics and took into consideration to include a non-standard benefit category for the assessment of the NED benefit for the recommended plan. These benefits are calculated with the Regional Economics Model, Inc (REMI model), which quantifies the non-physical impacts or direct losses to petroleum refinery outputs and the corresponding national impacts from a storm event.

This study is an example of a comprehensive approach to advancing multiple objectives of the CWSP, including **Objectives 1.5, Encourage and prioritize multi-use and multi-benefit projects; 1.6, Reevaluate cost and benefit considerations in decision making to be more inclusive; 1.7, Consider structural and non-structural approaches in flood risk management that can be implemented by USACE or with partners; 2.4 Invest in pre-disaster planning and resilience improvements; 2.5, Incorporate future trends in population, land use, weather, and the economy into planning and project design; 3.7, Support the leadership of state and local agencies in regional water resources strategic planning initiatives; 4.4, Design new projects with a plan for long-term operations and maintenance; and 4.5, Consider the benefits of natural and nature-based features (NNBF) and other approaches in improving and extending project performance over time.**

5

Towards Implementation

This CWSP was intentionally developed with a strong focus on being quickly and easily transitioned into implementation, with the CWSP sections designed to facilitate action plan development and the advancement of IWRM principles throughout the Division and beyond. Too often, well-intentioned strategic planning processes result in plans that lack actionability, especially as conditions change over time. On the opposite end of the spectrum, strategic plans may also be overly focused on quantitative metrics of output that are readily measured and tracked, without necessarily cross-linking those metrics back to positive outcomes overall holistic achievement of Goals and Objectives. For this reason, SWD set forth on a deliberate approach to enable implementation planning steps that will result in a CWSP that achieves implementation through action, is adaptable to future uncertainties, promotes accountability, and is focused on maximizing the probability of positive outcomes for the Division, its Districts, and those it serves.

To help in achieving these results, a new approach to implementation planning is needed—one that is outcome-driven, focuses on truly holistic and coordinated approaches to IWRM across Division Missions and Business Lines, and addresses the complex and sometimes competing interests and priorities involved with managing these resources and helping to meet the needs of partners and stakeholders throughout SWD. This approach to implementation requires thinking and acting outside of a traditional linear format—revisiting Goals and Objectives as conditions change or additional gaps and enablers are identified. This non-linear approach is more complex to manage and assess but is more responsive to changing conditions (see Figure 27).

Defining Successful Outcomes. The process of implementation planning in SWD will begin with a broad focus—envisioning and defining what success looks like for USACE and the region under multiple future scenarios, and what positive outcomes may indicate that implementation of the CWSP has been successful and continues to be successful. This process will build on existing partnership engagement activities SWD has undertaken to understand the needs and priorities of the Region and its stakeholders. The scenarios will be used to identify what “success” means for the region and for SWD, regardless of how uncertain drivers shape the future.

Identifying Critical Pathways. The Goals and Objectives of the CWSP will then be used to identify critical success factors, transformational policies, and organizational changes that are within USACE control to implement and that would facilitate the desired outcomes under the range of possible futures. In addition, gaps and enablers will be identified as the key impediments to implementation of the CWSP and the primary catalysts for change, respectively.

Developing Tactical Action Plans. These components will be synthesized and used to develop a prioritized set of tactical actions that outline specific steps to advance the Goals and Objectives of the CWSP. Action Plans will be developed at the Division and District levels and may include recommended actions at the USACE HQ level. Action Plans may be broadly categorized into Operations Plans, Project Development Plans, and Partnership Plans to address distinct aspects of the CW Program that will: facilitate execution of the CW Mission and advance the strategic goals and objectives; identify high-priority projects that span Mission Areas; and identify strategic engagement opportunities with external stakeholders at the local, regional, and national levels. Specific timelines, action leads, and partners will be identified to provide a framework for accountability.

Ongoing Regional Coordination. Successful implementation of the CWSP will require an integrated approach across every aspect of the CW Program—at the project, Mission Area, District, and Division-wide scales. The Division will foster and facilitate regular forums for engagement and collaboration across Districts, Mission Areas, and Business Lines to support the holistic development and implementation of Action Plans across policies, processes, projects, and partnerships.

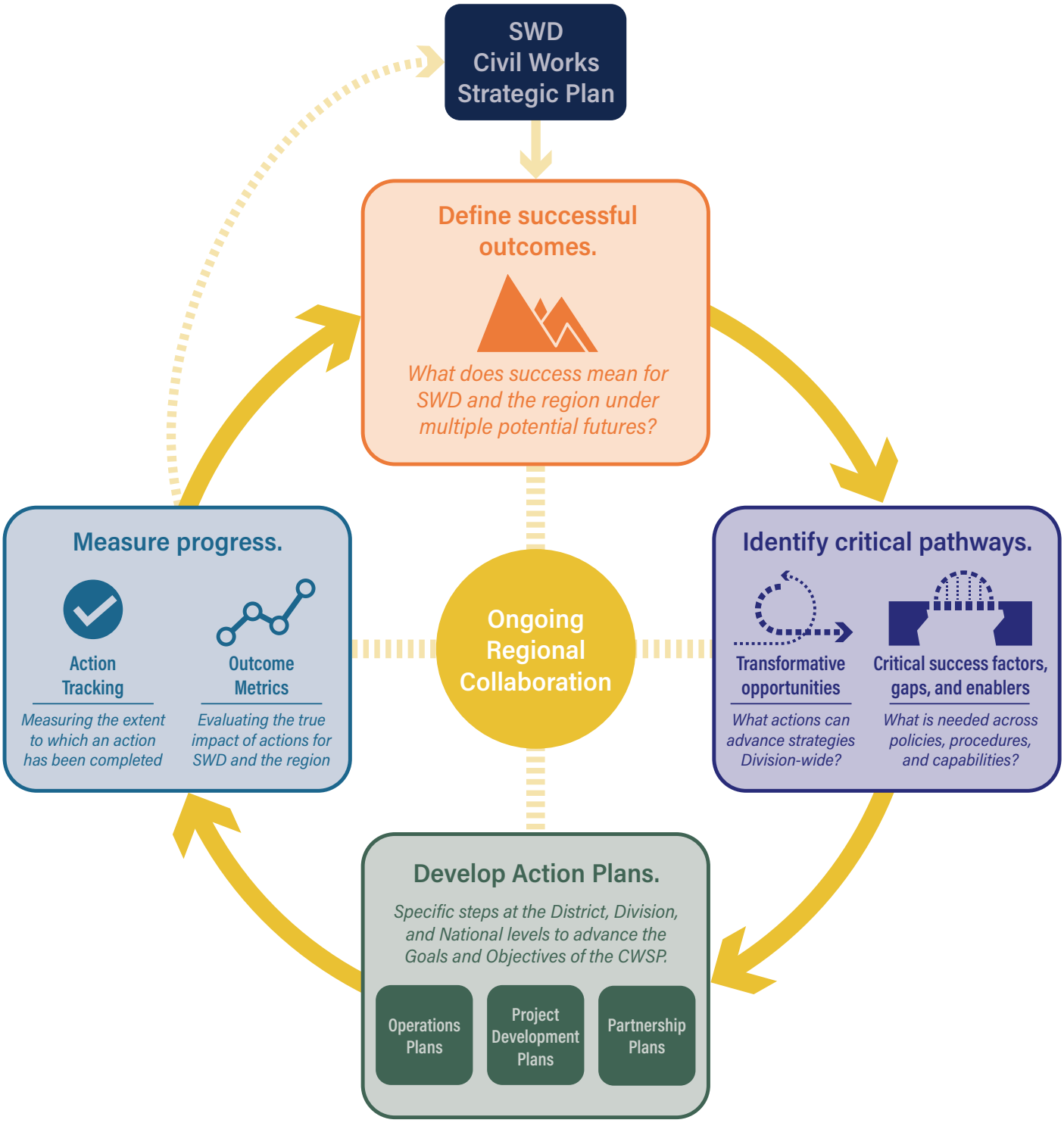


Figure 27 - SWD CWSP Non-Linear Approach to Implementation Planning

Measuring Progress. Tracking progress in implementing the CWSP is critical to maintaining SWD credibility and maximizing support for the CW program from the public, external partners, and across USACE. In addition, tracking progress enables SWD to adaptively manage the implementation of the CWSP itself, refining and advancing response plans as needed based on their effectiveness in advancing Goals and Objectives of the CWSP. A common pitfall of implementation planning is focusing purely on metrics that effectively tabulate the actions or efforts tracked in implementing the CWSP, but do not necessarily measure the ultimate value or impact of the actions. In contrast, outcome metrics that measure the level of performance or consequence that occurred because of the actions tracked are a more appropriate indicator of success and evaluate progress in ways that are more meaningful and valuable to stakeholders. Ultimately, outcomes tell a story about the difference made by the outputs. For example, the number of flood risk reduction projects built (metric) is most valuable if it is linked to benchmarks such as overall reduction in flood risk and flood-related damages over time within the AOR or a region within it (outcome).

Effectively communicating the outcomes by which to gauge successful CWSP implementation to stakeholders as well as internally throughout SWD is critical. This transparency and clarity of benchmarks provides opportunities to assess and realign efforts as needed to help ensure SWD remains on track to achieve its goals, while also enabling timely adjustments to be made if actions are not producing their intended results. Engaging stakeholders further engenders confidence and trust in SWD, while simultaneously providing an outside perspective on the level of progress SWD is making in achieving its goals. Capitalizing on this input requires that implementation planning be a dynamic process with critical path decision points incorporated for reevaluating tactical actions. Progress on achieving outcomes can be regularly revisited to assess if the actions taken are moving SWD and the AOR in the desired direction or if metrics of success are not accurately capturing what successful implementation should like for the region. Similarly, the CWSP is intentionally a “living document” that will be regularly revisited with the Goals, Objectives, and future scenarios evaluated to ensure they remain relevant and effective in maximizing the support SWD provides to the AOR and the Nation.

The CWSP is designed as a foundation for implementable steps to drive future action that will be taken in the form of changes in policy, procedures, projects, and relationships with partners, in addition to changing how SWD operates across these areas as it navigates an uncertain future. In doing so, the SWD and its Districts will continually move toward implementation of actions that help support the CWSP Goals and Objectives, including mainstreaming IWRM in its operations. The ultimate result of this transparent, integrated, and adaptive approach to implementation planning will be helping to ensure that the Division is positioned to provide the maximum value to the Nation now and for decades to come, regardless of what future scenario becomes reality.

Report Footnotes

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