Technical Appendix 17

Population and Land Use

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Acronyms and Abbreviations

Acronym or Abbreviation	Full Phrase
ADWR	Arizona Department of Water Resources
AMA	Active Management Area
AZ	Arizona
Basin	Colorado River Basin
CA	California
CAP	Central Arizona Project
CCS	Continued Current Strategies
DMDU	decision making under deep uncertainty
ICS	intentionally created surplus
kaf	thousand acre-feet
LB Priority	Lower Basin Priority
LB Pro Rata	Lower Basin Pro Rata
M&I	municipal and industrial
maf	million acre-feet
Mexico	United Mexican States
MWD	Metropolitan Water District of Southern California
NIA	non-Indian agriculture
NPS	National Park Service
NV	Nevada
PPR	present perfected right
SAM	Shortage Allocation Model
SNWA	Southern Nevada Water Authority
United States	U.S.
U.S.	United States
USDA	United States Department of Agriculture
USGS	United States Geological Survey
UT	Utah

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TA 17. Population and Land Use

This section explores the baseline conditions and potential impacts from proposed management on analysis area population dynamics and land use changes, with a focus on potential changes in developed lands and lands used for irrigated agriculture.

Baseline information is provided to characterize the existing setting and trends related to population, general landownership and management, and developed land patterns. Information is also provided for municipal water which supports developed land use. Data are provided related to historical agricultural land use to support the discussion of irrigated agriculture.

Due to the influence of municipal water availability on developed lands, the impacts analysis examines changes to water availability for municipal supply and the related impacts on population and land use changes. Due to the influence of irrigation water availability on agricultural land use, the impacts analysis examines changes to irrigation water availability and related impacts on acres of lands in agriculture.

TA 17.1 Affected Environment

The analysis area for the population and land use section is separated by state and is the same for both population and land use issues.

The Arizona analysis area consists of Apache, Coconino, Gila, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, and Yuma Counties. These include counties that are directly adjacent to Lake Powell, Lake Mead, or the Colorado River and counties in which shortages would likely occur.

The California analysis area consists of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties. These counties were selected because they are either directly adjacent to the lower Colorado River, or they are within the Metropolitan Water District of Southern California (MWD) service area. Although Ventura County is also in the MWD service area, it does not receive any water from the Colorado River; therefore, it is not included in the analysis area.

The Nevada analysis area consists of Clark County. The analysis area was limited to Clark County because it is adjacent to Lake Mead and encompasses the Southern Nevada Water Authority's (SNWA) service area and other individual water providers. Shortages in Nevada would be limited to the SNWA's service area.

The Utah analysis area consists of Kane, Garfield, and San Juan Counties. Although these counties are not in the Lower Colorado River Basin (Basin) and thus would not experience shortages, baseline information on population and land use is included to provide content for analysis of social and economic impacts from recreation associated with the Colorado river and Lake Powell and Lake Mead (see **TA 16**, Socioeconomics).

TA 17.1.1 Population

Population is a driver of demand for consumptive water use, particularly for municipal water. Communities throughout much of the western United States (U.S.) have followed trends of increasing populations over the past decade. In the analysis area, population growth rate has generally been positive or stable. County and state level population change are discussed in the section below (see **Table TA 17-1** through **Table TA 17-4**).

Arizona

All counties in the analysis area, except La Paz and Apache Counties that saw a decrease in population (of 18.8 percent and 6.1 percent, respectively), followed the trend of increasing population from 2010 to 2022, with the biggest increase in Pinal County (31.6 percent). **Table TA 17-1** provides an overview of populations by county in the analysis area. In terms of population forecast, Arizona's population is anticipated to continue to increase over the analysis period, with similar county level trends continuing. Drivers of population gains in Pinal County, Arizona, included low housing costs and workforce increases from new manufacturing, logistics and distribution facilities (Arizona Office of Economic Opportunity 2024).

Table TA 17-1
Arizona Population 2010–2040

Geographic Area	Population 2010[0]	Population 2022[1]	Percent Change 2010–2022	Estimated Population 2040[2]	Estimated Percent Change 2022-2040
Apache County	70,312	66,054	-6.1	64,449	-2.4
Coconino County	131,824	144,705	9.8	159,557	10.3
Gila County	53,272	53,419	0.3	55,866	4.6
Graham County	36,030	38,453	6.7	44,028	14.5
La Paz County	20,549	16,681	-18.8	16,897	1.3
Maricopa County	3,751,410	4,430,871	18.1	5,762,655	30.1
Mohave County	199,177	214,229	7.6	270,598	26.3
Navajo County	107,060	107,110	0.0	104,100	-2.8
Pima County	964,462	1,042,393	8.1	1,195,070	14.6
Pinal County	329,297	433,338	31.6	778,909	79.7
Yuma County	190,526	204,374	7.3	259,032	26.7
Yavapai County	209,260	237,830	13.7	301,937	27.0
Arizona	6,246,816	7,172,282	14.8	9,206,879	28.4

Source: U.S. Census Bureau 2012[0], U.S. Census Bureau 2023[1], Arizona Office of Economic Opportunity 2023[2].

California

In California, the population has increased by 7.4 percent from 2010 to 2022. With the exception of Los Angeles, the analysis area counties' growth all surpassed that of the state. The largest increase in population was in Riverside County (15.2 percent; see **Table TA 17-2**). Historical trends are expected to continue over the next 20 years, with the largest increases predicted for Imperial and Riverside counties; notably, a decrease in population of 2.2 percent is anticipated for Los Angeles County. Factors influencing population loss likely include cost of housing leading to out-migration, as well as other demographic factors such as population aging and low birth rate (Johnson et al. 2023)

Table TA 17-2
California Population 2010–2022

Geographic Area	Population 2010[0]	Population 2022[1]	Percent Change 2010–2022	Estimated Population 2040[2]	Estimated Percent Change 2022-2040
Imperial County	168,052	179,578	6.9	203,470	13.3
Los Angeles County	9,758,256	9,936,690	1.8	9,732,175	-2.1
Orange County	2,965,525	3,175,227	7.1	3,243,240	2.1
Riverside County	2,109,464	2,429,487	15.2	2,703,895	11.3
San Bernardino County	2,005,287	2,180,563	8.7	2,333,216	7.0
San Diego County	3,022,468	3,289,701	8.8	3,424,184	4.1
California	36,637,290	39,356,104	7.4	40,968,090	4.1

Source: U.S. Census Bureau 2012[0], U.S. Census Bureau 2023[1], California Department of Finance 2023[2]

Nevada

In terms of population increases, Nevada represented some of the largest in the analysis area. The population of Nevada grew by 17.9 percent from 2010 through 2022. Clark County's population change of 19.5 percent, was higher than that of the state overall at 17.9 percent. Trends are expected to continue with a change of 28.7 percent anticipated in Clark County by 2040 (see **Table TA 17-3**).

Table TA 17-3
Nevada Population 2010–2040

Geographic Area	Population 2010[0]	Population 2022[1]	Percent Change 2010–2022	Estimated Population 2040[2]	Estimated Percent Change 2022-2040
Clark County	1,895,521	2,265,926	19.5	2,916,000	28.7
Nevada	2,633,331	3,104,817	17.9	3,889,575	25.3

Source: U.S. Census Bureau 2012[0], U.S. Census Bureau 2023[1], Center for Business and Economic Research 2025, Wright 2025[2]

Utah

Population changes in Utah are moderate compared with other analysis area counties. While a 9.7 percent increase was seen in Kane County from 2010-2022, population decreased in Garfield County (1 percent) and San Juan County (1.5 percent) over the same time period. Over the next 20 years, population change is anticipated to accelerate, with a 25 percent increase in population predicted for Kane County, 11.4 percent for San Juan County, and 3.4 percent for Garfield County (see **Table TA 17-4**).

For Kane County, Utah, the main driver of population growth was net migration to the region of people 65 years and older, with quality-of-life indicators such as outdoor recreation being cited as main factors drawing people to the area (Utah Population Committee 2022).

Table TA 17-4
Utah Population 2010–2040

Geographic Area	Population 2010	Population 2022	Percent Change 2010–2022	Population 2040	Percent Change 2022-2040
Garfield County, Utah	5,172	5,121	-1.0	5,294	3.4
Kane County, Utah	7,125	7,814	9.7	9,769	25.0
San Juan County, Utah	14,746	14,524	-1.5	16,186	11.4
Utah	**2,763,885**	**3,283,809**	**18.8**	**4,440,560**	**35.2**

Source: U.S. Census Bureau 2023, Kem C. Gardner Policy Institute 2023

TA 17.1.2 Industrial and Municipal (Domestic) Water Uses

This section provides a brief overview of municipal water supply, demand, and use trends within the U.S. and the Lower Basin. This section also provides information on the municipalities within Arizona, California, and Nevada with the potential to be affected by changes in domestic water availability.

Domestic water use includes the use of water for "household, stock, municipal, mining, milling, industrial, and other like purposes." 1922 Colorado River Compact, section II(h). More granularly, this includes indoor and outdoor uses at residences, and includes uses such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets, watering lawns and gardens, and maintaining pools. Domestic water use includes potable and non-potable water provided to households by a public water supplier (domestic deliveries) and self-supplied water use.

Domestic Water Supply, Demand, and Use Trends

Urbanization has increased the percentage of the U.S. population served by municipal water supplies from 70 percent in 1960 to 83 percent in 2021 (Liu et al. 2025). Per capita domestic water use in southwestern states varies regionally: residents in Arizona and Nevada use approximately 126–150 gallons per day, while California residents use 76–100 gallons per day (Chinnasamy et al. 2021; USGS 2025).

Although existing and ongoing municipal water management strategies do not change domestic water entitlement amounts, they illustrate how municipal systems have adapted—and may continue to adapt—to evolving water supply and demand conditions. This context is important for understanding how communities in the region respond to variability in water availability under different future conditions. Municipal water systems in these regions face growing pressures from population growth, climate trends, and uncertainties in future water availability, demand, and technological or policy adoption (Liu et al 2025). Communities throughout the region have long implemented a range of water management strategies—including conservation programs, demand-side measures, operational changes, and infrastructure investments—to maintain municipal reliability under these evolving conditions. Structural approaches such as dams, diversions, reservoirs, wastewater treatment facilities, and hydropower systems have historically played a critical role in supporting municipal water supply, while some more recent approaches involve building on existing infrastructure while emphasizing demand-side management through institutional, technological and behavioral changes (Larson et al. 2016). Strategies can range from implementation of water-use efficiencies, changes to system operations, and demand reduction through water conservation programs. Implementation of water conservation programs have significantly decreased per capita water use (Chinnasamy et al. 2021; DeOreo et al. 2016; Finley & Basu 2020; Price et al. 2014). Between the 2000s and 2010s, water conservation programs in urban areas of the southwestern U.S., including Arizona, California, and New Mexico, reduced per capita residential water use through targeted demand-side measures. Programs implementing high-efficiency appliances, leak detection, landscape irrigation restrictions, and tiered pricing reduced per capita demand by roughly 10–15 percent in some cities (Chinnasamy et al. 2021; DeOreo et al. 2016; Finley & Basu 2020; Price et al. 2014).

The availability of and access to domestic water can influence both population dynamics and land use and development. Population growth can increase the demand for water for domestic, agricultural, and industrial use and increase pressure on existing water sources. Studies have shown that population growth can be a dominant driver of long-term municipal water demand (Liu et al. 2025). Insufficient water supply can constrain population growth and development by limiting an area's capacity to support residents.

Peer-reviewed studies have documented the relationships between population growth, land use patterns, and domestic water delivery. Urban sprawl, characterized by low-density development and increased impervious surfaces, has been shown to elevate per capita water demand through higher outdoor water use (Heidari et al. 2021). In contrast, high-density development often reduces per capita water use and can lessen the frequency and severity of water shortages. Rapid urbanization and population growth can also increase pressure on existing water infrastructure, creating challenges in maintaining consistent domestic water delivery.

Water supply has influenced land use and development within the analysis area. Arizona Department of Water Resources' (ADWR) Assured and Adequate Water Supply programs provide a concrete example of how water availability can constrain development. While not directly related to Colorado River water, these programs require developers within Active Management Areas (AMAs) demonstrate assured or adequate water groundwater supplies before recording plats or selling parcels. The Assured Water Supply Program requires meeting seven criteria including physical, continuous, and legal availability of water, water quality, financial capability, consistency with AMA management plans and goals. The Adequate Water Supply program requires demonstration of all criteria, excluding consistency with AMA management plan(s) and goal(s). The Arizona Department of Real Estate will not issue the public report needed to market lots, without such determinations (ADWR 2025). Arizona's ADWR programs illustrate the role of water supply in constraining development, requiring developers to demonstrate reliable water before proceeding (ADWR 2025).

This context helps frame how communities might respond to changes in water availability under future conditions.

In models of projected water yield and demand in the western U.S. to 2070, data indicate that demands for municipal water are increasing across the socioeconomic analysis area, while projected water availability is decreasing (see, for example, Warziniack and Brown 2019). While this trend is seen throughout the western U.S., the Colorado River region has the largest percentage increases in projected domestic water use and the greatest percentage decreases in projected water yield from all sources, including Colorado River water (Warziniack and Brown 2019).

TA 17.1.3 Study Area Municipalities

Arizona

Municipalities potentially affected by the alternatives include Arizona municipalities along the Colorado River that have Colorado River water delivery contracts, such as Lake Havasu City, Yuma, and Bullhead City, as well as Phoenix, Tucson, Scottsdale, and other Arizona municipalities and tribal communities within the Central Arizona Project (CAP) service area, which includes more than 80 percent of the state's population (Central Arizona Project 2024). In Arizona, land uses on the Colorado River include the major power facilities of Glen Canyon Dam in Coconino County, Hoover and Davis Dams on the Arizona-Nevada border in Mohave County (and Clark County, Nevada) and Parker Dam in La Paz County (and San Bernardino County, California).

California

Municipalities potentially affected by the alternatives include 7 cities in Imperial County, 88 cities in Los Angeles County, 34 cities in Orange County, 28 cities in Riverside County, 24 cities in San Bernardino County, and 18 cities in San Diego County as well as many more rural communities around the analysis area that are served by entities that use the Colorado River for water supply (California State Association of Counties 2024). These entities in California that use the Colorado River for water supply include the Metropolitan Water District of Southern California, Imperial Irrigation District, Desert Water Agency, Coachella Valley Water District, Palo Verde Irrigation District, as well as tribal reservations (Metropolitan Water District of Southern California 2024).

Nevada

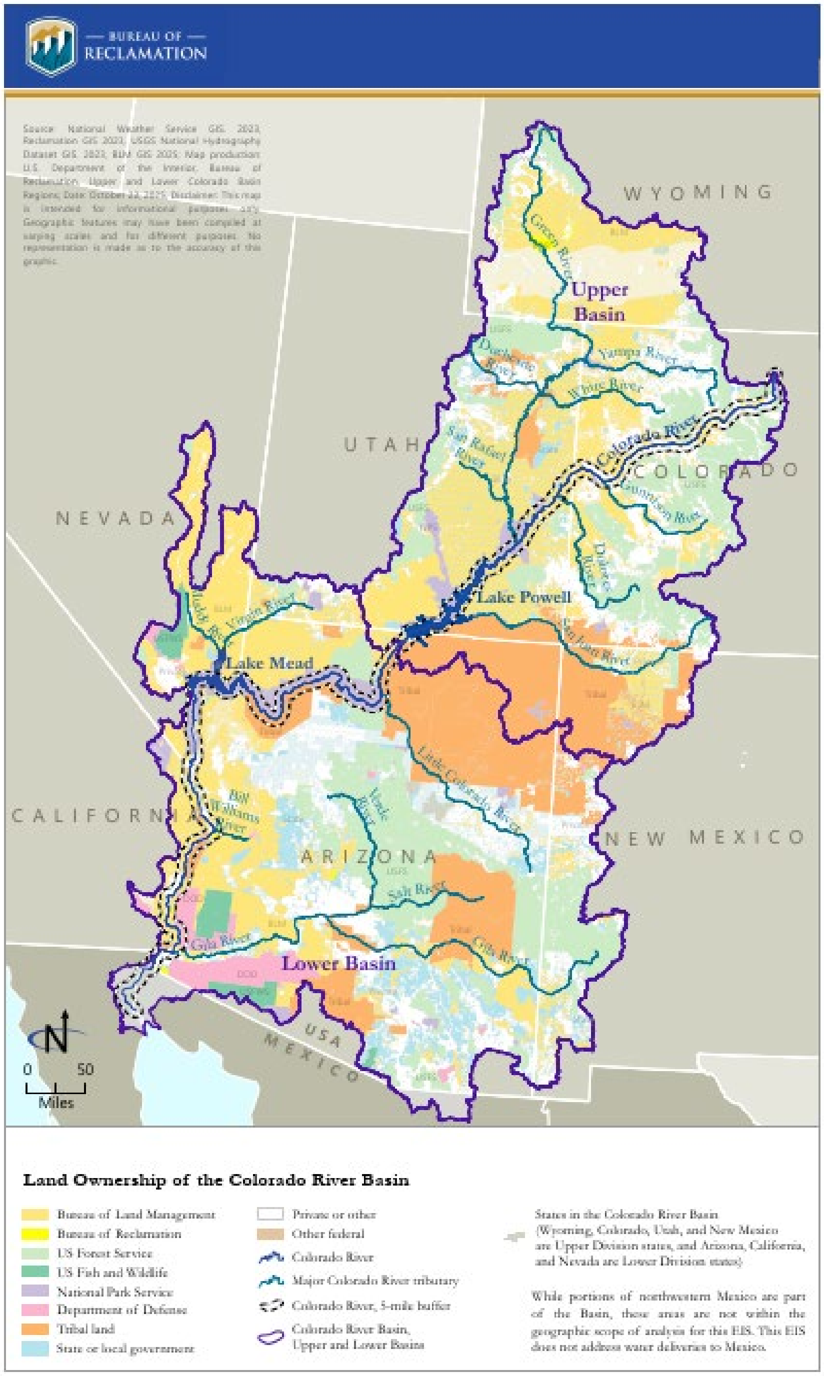
Municipalities potentially affected by the alternatives include Boulder City, Henderson, Las Vegas, Laughlin, and North Las Vegas due to their reliance on Colorado River water supplied by SNWA, which serves more than 2 million people in Clark County, Nevada (Southern Nevada Water Authority 2024).

TA 17.1.4 Land Use

Introduction and Scope

This section describes existing land use conditions along the mainstream Colorado River from Glen Canyon Dam to the U.S.– United Mexican States (Mexico) border. Land use includes recreation, agriculture, tribal land use, conservation and habitat management, residential and urban development, and utility and infrastructure corridors. Land use ownership is shown in **Figure TA 17-1**.

Figure TA 17-1
Landownership of the Colorado River Basin



Landownership and Management

Landownership along the Colorado River is highly variable and includes federal (National Park Service [NPS], Bureau of Land Management, U.S. Fish and Wildlife Service, and Bureau of Reclamation), tribal, state, and private lands. Federal agencies manage much of the land in the upper and middle portions of the river corridor, particularly in areas surrounding Glen Canyon National Recreation Area, Grand Canyon National Park, Lake Mead National Recreation Area, and multiple National Wildlife Refuges. Tribal lands are prominent in both Arizona and California. State and private lands are more common in the Lower Basin, especially in urban areas like Bullhead City and Yuma, and along agricultural corridors in California and Arizona.

Developed Land Use

Land development has continued across the analysis area over the past two decades. **Table TA 17-5** summarizes the number of acres classified as developed in 2001 and 2023 for each county in the analysis area, along with the percentage change during this period. The data are based on U.S. Geological Service (USGS) land cover classifications and provide a snapshot of how developed land has expanded over time. The table shows that most counties experienced growth in developed acreage, though the magnitude of change varies. State and local level details are provided in state sub-sections below. This information establishes a baseline for understanding patterns of land use change within the analysis area and provides context for evaluating potential interactions between land development and Colorado River operations.

Table TA 17-5
Acres of Development from 2001 to 2023 in Arizona Analysis Area

County, State	Acres Developed[1] in 2001	Acres Developed in 2023	Percent Change
Apache County, AZ	45,500	67,400	48
Coconino County, AZ	81,000	104,300	29
Gila County, AZ	25,100	33,300	33
Maricopa County, AZ	544,800	727,400	34
Mohave County, AZ	106,100	137,600	30
Navajo County, AZ	47,300	65,700	39
Pima County, AZ	168,500	227,500	35
Pinal County, AZ	129,300	147,800	14
Yuma County, AZ	55,100	67,100	22
La Paz County, AZ	32,200	35,100	9

Sources: USGS 2023
[1] Acreages classified as "Developed" include Low-, Medium-, and High-Intensity, or Roads. Low intensity development can include mixed forest, herbaceous, and shrubland cover.
Note: Arizona (AZ)

Arizona

Counties in the Arizona analysis area all saw an increase in developed land use in the last twenty years. The largest increase was seen in Apache (48 percent) and Navajo Counties (39 percent), while

Maricopa, Pima, Gila, and Mohave Counties also saw 30 percent or more of growth. The smallest increase was seen in Pinal County (14 percent) and La Paz County (9 percent; **Table TA 17-5**).

California

A few counties in the California analysis area, including Los Angeles, San Diego, and Orange County, showed slight declines in developed acreage between 2001 and 2023. These decreases may reflect land reclassification or changes in land use patterns rather than large-scale removal of development. San Bernardino County saw the largest increase in the California analysis area, with 14 percent growth from 2001 to 2023 (**Table TA 17-6**).

Table TA 17-6
Acres of Development from 2001 to 2023 in California Analysis Area.

County, State	Acres Developed[1] in 2001	Acres Developed in 2023	Percent Change
Imperial County, CA	83,100	86,100	4
Los Angeles County, CA	861,800	833,100	-3
Orange County, CA	305,800	293,400	-4
Riverside County, CA	407,700	425,600	4
San Bernardino County, CA	424,200	483,000	14
San Diego County, CA	479,400	469,600	-2

Sources: USGS 2023
[1] Acreages classified as "Developed" include Low-, Medium-, and High-Intensity, or Roads. Low intensity development can include mixed forest, herbaceous, and shrubland cover.
Note: California (CA)

Nevada

Compared with other counties in the region, Clark County, Nevada had robust growth in the past 20 years. At 37 percent, this increase was met or exceeded only by one county in Utah and one in Arizona (see **Table TA 17-7**).

Table TA 17-7
Acres of Development in Nevada Analysis Area from 2001 to 2023

County, State	Acres Developed[1] in 2001	Acres Developed in 2023	Percent Change
Clark County, NV	214,800	294,000	37

Sources: USGS 2023
[1] Acreages classified as "Developed" include Low-, Medium-, and High-Intensity, or Roads. Low intensity development can include mixed forest, herbaceous, and shrubland cover.
Note: Nevada (NV)

Utah

Development in some portions of the Utah analysis area, notably Garfield County (37 percent) and Kane County (18 percent) were higher than regional averages from 2001-2023. San Juan County, in contrast, saw only a 10 percent increase in developed acres (**Table TA 17-8**).

Table TA 17-8
Acres of Development in the Utah Analysis Area from 2001 to 2023

County, State	Acres Developed[1] in 2001	Acres Developed in 2023	Percent Change
Garfield County, UT	28,900	39,700	37
Kane County, UT	17,300	20,400	18
San Juan County, UT	31,000	34,200	10

Sources: USGS 2023
[1] Acreages classified as "Developed" include Low-, Medium-, and High-Intensity, or Roads. Low intensity development can include mixed forest, herbaceous, and shrubland cover.
Note: Utah (UT)

TA 17.1.5 Agricultural Land Use

Arizona

In the western US, agriculture represents a relatively small share of overall land use but requires large amounts of irrigation water. The most water-intensive crops include crops for food, feed, and fiber production. In Arizona, in 2015, irrigated agriculture accounted for about 74 percent of the state's water use; more than 50 percent of this is from surface waters (Dieter et al. 2018). Implementation of certain recent strategies and techniques in the western U.S., have resulted in a reduction in agriculture's share of water consumption. These methods include improvements in irrigation technology, voluntary fallowing programs that compensate farmers who reduce water consumption, and utilization of more effective irrigation strategies, such as changes to irrigation timing and using cover crops to protect the soil (Presson and Eden 2023). However, conservation methods do not reduce the legal water entitlement held by agricultural users.

Agricultural lands receiving water for irrigation from the CAP are generally within Pinal, Maricopa, and Pima Counties. The three counties account for approximately 50 percent of statewide irrigated, harvested cropland (USDA NASS 2024). Agricultural resources in western Arizona are primarily along the Colorado River in Mohave, La Paz, and Yuma Counties and along the Gila River Valley in Yuma County. These western counties account for approximately 32 percent of irrigated agricultural land in Arizona. **Table TA 17-9** provides a summary of county-wide irrigated agricultural lands within the Arizona analysis area.

Table TA 17-9
Irrigated Acres of Harvested Cropland in the Arizona Analysis Area (2022)

Area	Irrigated Harvested Cropland (Acres)	Total Harvested Cropland (Acres)	Percent Irrigated Harvested Cropland to Total Harvested Cropland	Percent of Statewide Irrigated Harvested Cropland
Maricopa County	202,086	202,092	100	23
Pima County	27,512	27,516	100	3
Pinal County	202,429	202,430	100	23
Total within CAP Counties	**432,027**	**432,038**	**100**	**50**
Apache County	5,339	5,369	99	1
Coconino County	511	520	98	0
Gila County	615	618	100	0
La Paz County	80,176	80,176	100	9
Mohave County	(D)	(D)	(D)	(D)
Navajo County	2,876	2,911	99	0
Yuma County	178,842	178,843	100	21
Total Arizona Analysis Area[1]	**700,386**	**700,475**	**100**	**80**
Total Arizona[1]	**871,746**	**871,863**	**100**	**—**

Source: USDA NASS 2024
(D) = data determined too sensitive to disclose by the U.S. Department of Agriculture (USDA).
— = not applicable
[1] The totals for the Arizona analysis area did not include data for Mohave County due to the USDA determining that the data was too sensitive to disclose; however, the totals for Arizona did include data for Mohave County.

Table TA 17-10 shows changes between 2017 and 2022 in acres of irrigated harvested cropland as well as in acres of total harvested cropland in each county in Arizona. In all counties where data was disclosed, except Maricopa County, there was a decrease in the acres of harvested cropland. In Pima, Pinal, and Gila Counties this decrease in acreage of harvested cropland corresponded with a similar percent decrease in irrigated harvested cropland. In Navajo and Yuma Counties, the reduction in harvested cropland was largely made up of non-irrigated cropland. In Apache County, the reduction in harvested cropland was fully made up of non-irrigated cropland, and irrigated harvested cropland saw an increase from 2017 to 2022. In Maricopa County, where there was an increase in total harvested cropland, the increase corresponded to an increase in irrigated cropland (USDA NASS 2024).

Table TA 17-10
Irrigation Trend for Harvested Cropland in the Arizona Analysis Area (2017–2022)

Area	Percent Change in Irrigated Harvested Cropland	Percent Change in Total Harvested Cropland
Maricopa County	13.5	7.8
Pima County	-5.6	-5.7
Pinal County	-12.4	-13.9
Total within CAP Counties	**-1.4**	**-4.4**
Apache County	23.9	-7.4
Coconino County	(D)	(D)
Gila County	-36.6	-36.5
La Paz County	(D)	(D)
Mohave County	(D)	(D)
Navajo County	-30.2	-50.0
Yuma County	-1.3	-7.7
Total Arizona Analysis Area[1]	**-1.5**	**-5.8**
Total Arizona[1]	**-0.5**	**-4.8**

Source: USDA NASS 2024
(D) = data was determined as too sensitive to disclose by the USDA.
[1] The totals for the Arizona analysis area did not include data for Coconino, Mohave, and La Paz Counties due to the USDA determining that the data was too sensitive to disclose; however, the totals for Arizona included data for all counties in the state.

Table TA 17-11 shows the proportion of irrigation water that came from all surface water resources in each county, in 2015. In Apache County and Maricopa County, where there were increases in irrigated harvested cropland from 2017 to 2022, approximately 94 percent and 21 percent of the irrigated water comes from surface waters, respectively. In Gila County and Navajo County, which saw the largest percentage decrease in irrigated harvested cropland from 2017 to 2022, approximately 30 percent and 54 percent of the irrigation water comes from surface waters, respectively (see **Table TA 17-10** and **Table TA 17-11**).

Table TA 17-11
Percent Irrigated Water from Surface Water Sources (2015)[1]

Area	Percent of Irrigated Water Withdrawal for Crops from Surface Waters
Maricopa County	21
Pima County	38
Pinal County	62
Total within CAP Counties	**39**
Apache County	94
Coconino County	0
Gila County	30
La Paz County	87
Mohave County	56
Navajo County	54
Yuma County	90
Total within Arizona Analysis Area	**61**
Total Arizona	**57**

Source: Dieter et al. 2018
Note: CAP values are aggregated values of Maricopa, Pima, and Pinal Counties. Surface water sources include all sources; they are not exclusive to the Colorado River.
[1] The 2015 USGS water use (for specific purposes, such as irrigation) data by source (surface water or groundwater, etc.) are the most recent available county-level data.

California

About 96 percent of harvested cropland in the California analysis area is irrigated, which is the same as the percentage of irrigated harvested cropland for the state of California. However, the percentage varies across the counties in the analysis area, ranging from a low of 68 percent in Los Angeles County to a high of 99 percent in San Bernardino County. The proportion of irrigated croplands within the California analysis area represents approximately 11 percent of total irrigated croplands in the state. **Table TA 17-12** shows acres of irrigated harvested and total harvested cropland within the California analysis area.

Table TA 17-13 shows changes between 2017 and 2022 in acres of irrigated harvested cropland as well as in acres of total harvested cropland in each county. In Imperial, Los Angeles, and Riverside Counties, there was an increase in the number of acres of harvested cropland as well as irrigated harvested cropland. Whereas, in Orange, San Bernardino, and San Diego Counties, there was a decrease in the number of acres of harvested cropland that corresponded to a similar decrease in the number of irrigated harvested cropland acres (USDA NASS 2024).

Table TA 17-12
Irrigated Acres of Harvested Cropland in the California Analysis Area (2022)

Area	Irrigated Harvested Cropland (Acres)	Total Harvested Cropland (Acres)	Percent Irrigated Harvested Cropland to Total Harvested Cropland	Percent of Statewide Irrigated Harvested Cropland
Imperial County	623,098	634,602	98	8
Los Angeles County	13,876	20,422	68	0
Orange County[1]	3,241	3,299	98	0
Riverside County	166,297	183,926	90	2
San Bernardino County	15,039	15,210	99	0
San Diego County	35,535	37,953	94	0
Total California Analysis Area	**857,086**	**895,412**	**96**	**11**
California	**7,739,236**	**8,081,181**	**96**	**—**

Source: USDA NASS 2024
— = not applicable
[1] The number of irrigated harvested cropland acres was not disclosed for Orange County to avoid publishing confidential information, so the total number of irrigated acres (including harvested cropland) was used as a proxy.

Table TA 17-13
Irrigation Trend for Harvested Cropland in the California Analysis Area (2017–2022)

Area	Percent Change in Irrigated Harvested Cropland	Percent Change in Total Harvested Cropland
Imperial County	36.7	35.8
Los Angeles County	1.7	59.5
Orange County[1]	-23.1	-43.2
Riverside County	32.7	28.1
San Bernardino County	-30.0	-31.3
San Diego County	-14.6	-22.7
Total California Analysis Area	**29.5**	**27.8**
Total California	**5.3**	**2.8**

Source: USDA NASS 2024
[1] The number of irrigated harvested cropland acres was not disclosed for Orange County to avoid publishing confidential information, so the total number of irrigated acres (including harvested cropland) was used as a proxy.

In California, in 2015, irrigated agriculture accounted for about 74 percent of the state's water use; approximately 27 percent of this is from surface waters (Dieter et al. 2018). **Table TA 17-14** shows the proportion of irrigation water that came from all surface water resources in each county, in 2015. In all counties in the analysis area, approximately 30 percent of the irrigated water comes from surface waters, which is consistent with the state.

Table TA 17-14
Percent Irrigated Water from Surface Water Sources (2015 data)[1]

Area	Percent of Irrigated Water Withdrawal for Crops from Surface Waters
Imperial County	30
Los Angeles County	30
Orange County	30
Riverside County	30
San Bernardino County	30
San Diego County	30
Total within California Analysis Area	**30**
Total California	**27**

Source: Dieter et al. 2018
Note: Surface water sources include all sources; they are not exclusive to the Colorado River.
[1] The 2015 USGS water use (for specific purposes, such as irrigation) data by source (surface water or groundwater, etc.) are the most recent available county-level data.

Nevada

Agriculture in the Nevada analysis area, Clark County, is relatively small, with only 2,322 total acres for harvested cropland (USDA NASS 2024). Of the total harvested agricultural lands in Clark County, 100 percent were irrigated cropland, which is similar to the percentage of irrigated cropland in Nevada (99.8 percent; see **Table TA 17-15**). In Nevada, in 2015, irrigated agriculture accounted for about 71 percent of the state's water use; approximately 53 percent of this is from surface waters (Dieter et al. 2018). Approximately 35 percent of the irrigated water in Clark County comes from surface waters (see **Table TA 17-16**).

Table TA 17-15
Irrigated Acres of Harvested Agriculture in the Nevada Analysis Area (2022)

Area	Irrigated Harvested Cropland (Acres)	Total Harvested Cropland (Acres)	Percent Irrigated Harvested Cropland to Total Harvested Cropland
Clark County	2,322	2,322	100.0
Total Nevada	**486,100**	**486,935**	**99.8**

Source: USDA NASS 2024

Table TA 17-16
Percent Irrigated Water from Surface Water Sources (2015)[1]

Area	Percent of Irrigated Water Withdrawal for Crops from Surface Waters
Clark County	35
Total Nevada	**53**

Source: Dieter et al. 2018
Note: Surface water sources include all sources; they are not exclusive to the Colorado River.
[1] The 2015 USGS water use (for specific purposes, such as irrigation) data by source (surface water or groundwater, etc.) are the most recent available county-level data.

TA 17.1.6 Land Use and Management by Reach

Upper Reach (Glen Canyon Dam to Lees Ferry)

This reach is dominated by federal lands managed by the NPS as part of Glen Canyon National Recreation Area. Land use is primarily recreational, with boating, fishing, and sightseeing being the dominant uses. Infrastructure in this reach includes the Glen Canyon Dam and associated access roads. These facilities are sensitive to reservoir elevation changes, and declining water levels may result in reduced functionality, relocation needs, or closure.

Grand Canyon Reach (Lees Ferry to Lake Mead)

Most of the land in this reach is managed by the NPS as part of Grand Canyon National Park. Land use is regulated to preserve natural and cultural resources and provide for controlled public recreation. Access is limited, and development is minimal. This reach includes tribal lands, which are used for tourism and cultural purposes.

Lower Basin Reach (Hoover Dam to U.S.–Mexico border)

- Land use in this reach is more varied. It includes:
    - Urban development near Las Vegas, Bullhead City, Lake Havasu City, and Yuma.
    - Extensive irrigated agriculture in areas such as Palo Verde and Imperial Valleys.
        - Recreation and habitat management within National Wildlife Refuges (Cibola, Havasu, Imperial).
        - Transportation and utility corridors, including transmission lines and canals.
    - Landownership in this reach includes a greater proportion of state and private land, and land use is more intensive compared with upstream reaches.
    - Fluctuating water levels can affect the usability of these facilities, requiring adaptive management such as ramp extensions, marina relocations, or temporary closures. These infrastructure elements are vital to supporting recreation and tourism in the region and may be affected under the alternatives that result in lower Lake Mead elevations.
    - Water delivery constraints may influence future land use decisions in this reach. Some counties could experience changes in agricultural viability and development patterns due to reduced water reliability (see **TA 4**, Water Deliveries).

TA 17.2 Environmental Consequences

TA 17.2.1 Methodology

The analysis of population and land use impacts evaluates how operational changes and changes to domestic water delivery could affect overall population and land use patterns including developed lands for residential and commercial uses, and lands used for irrigated agriculture.

To analyze how operational changes may affect population and land use patterns, decision making under deep uncertainty (DMDU) was applied to modeled shortage to domestic users provided by the Shortage Allocation Models (SAMs) and Alternative Distribution Models. There are three unique

SAMs and five Alternative Distribution Models to capture the nuances of the alternatives and sensitivity analyses; these are further explained in **Appendix C**, Shortage Allocation Model and Alternative Distribution Model Documentation. The application of DMDU to analyze domestic water impacts involved multiple steps. First, to capture variation in modeled shortage by priority across the SAMs, the following priority groupings were established: Arizona CAP non-Indian agriculture (NIA)-A and NIA-B (Group 1), Arizona CAP municipal and industrial (M&I) and Priority 4(i) (Group 2), Arizona Priorities 2 and 3 (Group 4), Arizona present perfected right (PPR) (Group 5), California Priority 4 (Group 6), California PPR (Group 7), Nevada Priority 8 (Group 8), Nevada Priorities 1-7 (Group 9). Second, the domestic modeled shortage was analyzed for each of these priority groups, to identify at which shortage level, the average percentage shortage across a given priority group equal approximately 20, 40, 60, 70, 80, or 100 percent of the priority group's total entitlement. DMDU was then applied to generate **Figure TA 17-2** through **Figure TA 17-9**. These figures are the result of applying SAM-based, volumetric thresholds of Lower Basin shortage to annual shortage volumes computed from Colorado River Simulation System. The figures display the percentage of modeled futures in which annual domestic water delivery to a given priority group is always the specified percent of "normal delivery", across the alternatives. For purpose of this analysis, "normal delivery" is defined as a full Colorado River or CAP entitlement supply. The figures provide a comparison of impacts on domestic water by priority group across the action alternatives.

To analyze how operational changes may affect agricultural land use, this analysis relied on modeled shortages to irrigation users at the state level, produced by the SAMs. For more detailed information on the SAMs and consumptive impacts on irrigation users, see **Appendix C**, Shortage Allocation Model and Alternative Distribution Model Documentation**.** For more information on water deliveries and shortage impacts, including those for irrigation, refer to **TA 4**, Water Deliveries.

Impact Analysis Areas

The analysis area for the population and land use section is separated by state and is the same for both population and land use issues. The impact analysis area is defined by those counties that may be affected by management direction that could result in water shortages to domestic and irrigation users. As described above, both issue statements rely on the SAMs. As a result, the analysis area is informed by the SAMs and includes the counties represented in the SAMs. The Arizona analysis area consists of Apache, Coconino, Gila, La Paz, Maricopa, Mohave, Navajo, Pima, Pinal, and Yuma Counties. These include counties that are directly adjacent to Lake Powell, Lake Mead, or the Colorado River and counties in which shortages would likely occur. The California analysis area consists of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and San Diego Counties. The Nevada analysis area consists of Clark County. The Nevada analysis area was limited to Clark County because Clark County is adjacent to Lake Mead and encompasses SNWA's service area and other individual water providers. Shortages in Nevada would be limited to SNWA's service area.

Assumptions

- Colorado River operations do not directly control population change but they may indirectly influence migration patterns.
- Local socioeconomic conditions and demographic trends may also be influenced by factors outside river operations, such as housing costs, infrastructure investment, local attitudes towards water conservation, and regional employment patterns.

Impact Indicators

- Shortage to domestic water users
- Acres of developed land within the analysis area and potential for changes based on municipal water availability
- Acres of irrigated agricultural land within the analysis area and the potential for changes based on agricultural water availability

TA 17.2.2 Issue 1: How would operational changes affect population and developed land use patterns?

This issue examines how different operational strategies may influence population dynamics and developed land use patterns in communities that rely on Colorado River water for municipal water uses. While Colorado River operations do not directly determine population movement or developed land use patterns, long-term changes in water availability and recreational access may influence migration patterns and developed land patterns. This issue statement is analyzed by first presenting the DMDU figures and a detailed analysis for domestic water delivery and then by assessing how domestic water delivery impacts would impact population and developed land use patterns.

Domestic water delivery impacts are discussed in the context of a DMDU analysis framework. Additional details about the DMDU approach are included in **TA 4**, Water Deliveries.

In evaluating these outcomes, it is important to recognize that the DMDU framework highlights the potential for a wide range of plausible future conditions that cannot be predicted with confidence. Factors such as climate trends, hydrologic change, and evolving population or land use trends may interact in complex ways that influence domestic water delivery. Therefore, while robustness provides an indicator of how well an alternative performs across many possible futures, decision makers should consider these uncertainties when interpreting results and determining which management approaches are most adaptive and resilient under changing conditions.

Incorporating DMDU principles supports a transparent and adaptive evaluation by considering a range of plausible futures rather than a single forecast. This approach helps decision makers understand the trade-offs, vulnerabilities, and adaptive capacity of each alternative, enhancing the resilience of long-term management strategies.

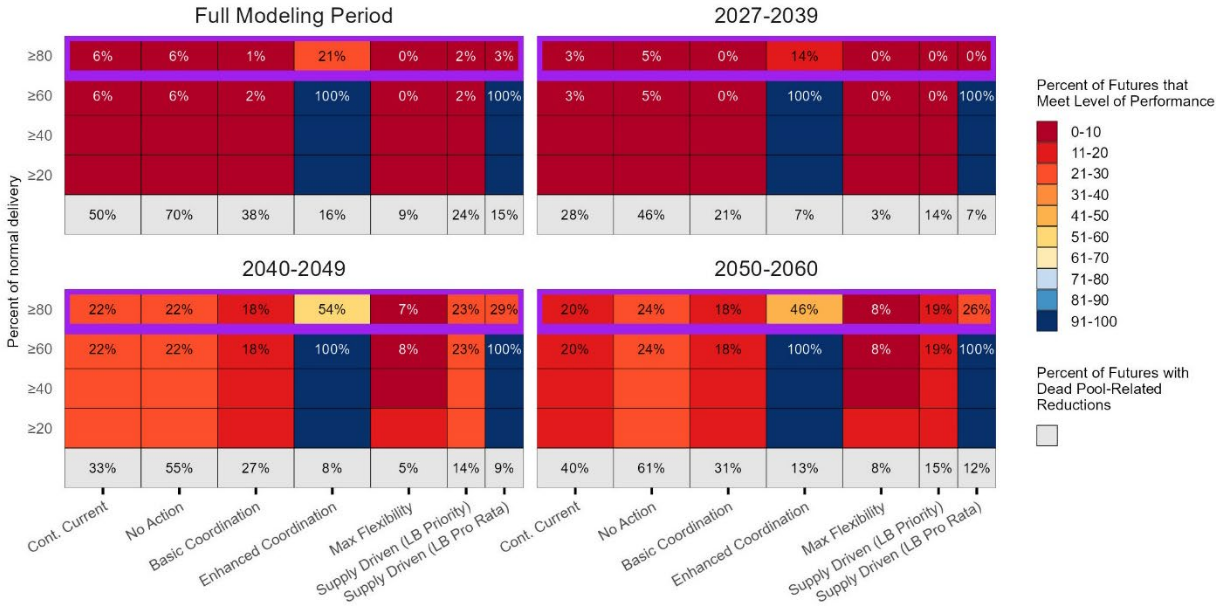
The alternatives with greater robustness would likely result in fewer potential indirect impacts on population growth and developed land. Greater robustness corresponds to a higher percentage of futures in which domestic water delivery remains consistent with normal conditions and shortages occur less frequently. In contrast, less robust alternatives are more susceptible to reductions in domestic water availability due to more shortages. These shortages could manifest as reduced water deliveries, delivery restrictions, or the need for additional conservation measures, which could in turn limit the capacity to meet domestic water demand. A more robust alternative would therefore help ensure that domestic water supplies remain reliable to support existing populations and accommodate anticipated future growth, thereby minimizing potential secondary impacts on development patterns and land use.

Figure TA 17-2 through **Figure TA 17-9** display potential impacts on domestic water deliveries by presenting the percentage of normal domestic water deliveries that can be achieved across a range of modeled futures. Specifically, each figure shows the percentage of normal domestic water deliveries that can be achieved in 90 percent of years, over a 34-year modeling period, across different percentages of potential futures for each priority group. The metric of ninety percent of years was selected for this analysis, rather than 100 percent of years, because it better displays variation between the alternatives. For all figures, the rows of the figure represent different percentages of normal domestic water delivery, where higher rows mean a higher volume of delivery which is harder to achieve. Lower rows represent higher, more frequent modeled shortages to domestic water delivery that are easier to achieve. For this analysis, greater than 80 percent of normal delivery in 90 percent of years was selected as the minimum level of performance. The row of greater than 80 percent delivery was highlighted because it represents the scenario closest to normal domestic water delivery of all percentages displayed in the figure and thereby the least amount of shortage to domestic water users.

Each figure also displays a row at the bottom for percent futures with dead pool–related reductions. As described in **TA 4**, Water Deliveries, dead pool–related reductions (or dead pool–related reductions) occur when there is not enough water in Lake Mead to fully meet downstream demands and/or when Hoover Dam infrastructure constraints result in releases below the demand volume. In some cases, this occurs because Lake Mead is approaching dead pool (elevation 895 feet) and in some cases it occurs earlier (up to elevation 950 feet). The approach to distributing reductions associated with dead pool is not addressed in this analysis. By providing the information on dead pool–related reductions in the domestic water, the DMDU figures provide additional context on the robustness of the alternatives. **Figure TA 17-2** through **Figure TA 17-9** are described in further detail below.

Figure TA 17-2 presents potential shortage impacts on domestic water deliveries to Arizona CAP NIA-A and NIA-B priorities.

Figure TA 17-2
Arizona CAP, NIA-A & NIA-B: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years

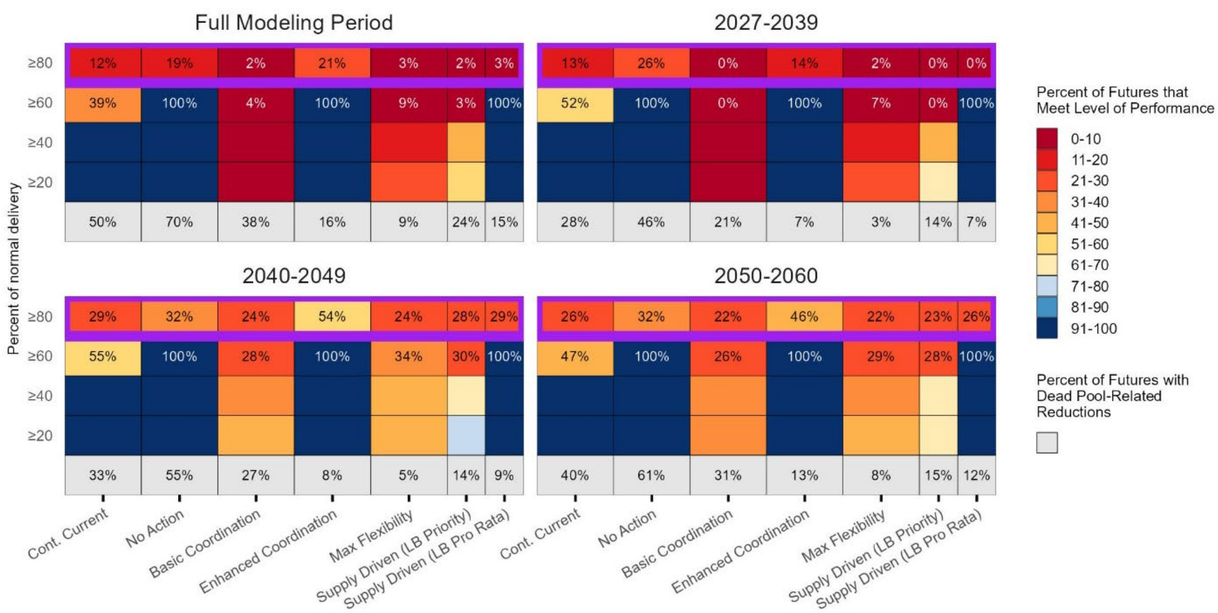


Over the full modeling period, there are no or minimal (<6 percent) potential futures in which any of the alternatives meet the preferred minimum performance (greater than 80 percent of normal domestic water is delivered in 90 percent of years) for the Arizona CAP NIA-A and NIA-B priorities. Over the full modeling period, greater than 80 percent of normal delivery would occur in less than 6 percent of potential futures under the Continued Current Strategies (CCS) Comparative Baseline and the No Action, Basic Coordination, Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (both Lower Basin (LB) Priority and LB Pro Rata approaches) Alternatives. Therefore, the CCS Comparative Baseline and No Action, Basic Coordination, Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (both LB Priority and LB Pro Rata approaches) alternatives would result in similar impacts on shortage for domestic deliveries to Arizona CAP NIA-A and NIA-B priorities.

The next level below the preferred minimum performance is greater than 60 percent of normal domestic water delivery to Arizona CAP NIA-A and NIA-B priorities. When considering this next level of performance, the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives are the most robust alternatives for CAP NIA-A and NIA-B priorities compared with all other alternatives, with greater than 60 percent of normal delivery in 90 percent of years occurring in 100 percent of potential futures across the full modeling period. The Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives perform well for CAP NIA-A and NIA-B priorities at lower volumes of delivery because they apply pro rata distribution of Lower Basin shortage (shortage is distributed evenly across entitlement holders). Note that with a priority-based distribution, water is distributed to those with more senior water entitlements first, with senior water entitlements facing less shortage. In contrast, with pro rata distribution, shortage is distributed proportionately across all entitlements, regardless of their seniority, with all users bearing some shortage. Therefore, it makes sense that these two alternatives would be the most robust alternative in terms of domestic water delivery to junior priority pools such as the Arizona CAP NIA-A and NIA-B, compared with the other alternatives. If you consider dead pool–related reductions, which may impact these users, the Enhanced Coordination Alternative remains the most robust alternative compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives).

Figure TA 17-3, below, presents potential shortage impacts on domestic water deliveries to Arizona CAP Indian, CAP M&I, and 4(i) priorities.

Figure TA 17-3
Arizona CAP Indian, CAP M&I and 4(i): Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years



Over the full modeling period, there are minimal (<2-3 percent) potential futures in which any of the alternatives, excluding the CCS Comparative Baseline, the No Action Alternative, and the Enhanced Coordination Alternative, meet the selected level of performance (greater than 80 percent of normal domestic water is delivered in 90 percent of years) for the Arizona CAP Indian, CAP M&I, and 4(i) priorities. As displayed in **Figure TA 17-3** above, greater than 80 percent of normal delivery occurs in 2-3 percent of potential futures under the Basic Coordination, Maximum Operational Flexibility, and the Supply Driven Alternative (both LB Priority and LB Pro Rata approaches). Under the CCS Comparative Baseline and the No Action Alternative, greater than 80 percent of normal delivery occurs in 12 percent and 19 percent of potential futures, respectively. Therefore, when compared with the CCS Comparative Baseline and the No Action Alternative, the

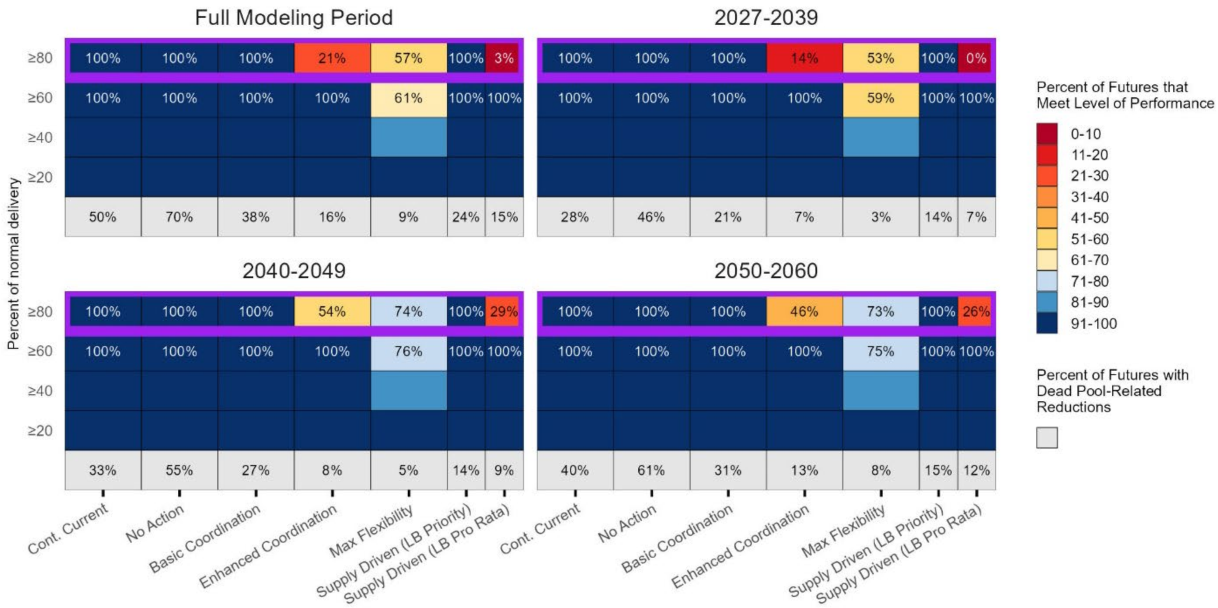
Basic Coordination, Maximum Operational Flexibility, and Supply Driven (both LB Priority and LB Pro Rata approaches) Alternatives are less robust. Under the Enhanced Coordination Alternative, greater than 80 percent of normal delivery would occur in 21 percent of potential futures.

The next row below the preferred minimum performance is greater than 60 percent of normal domestic water delivery to Arizona CAP Indian, CAP M&I, and 4(i) priorities. When considering this next level of performance, the No Action, Enhanced Coordination, and Supply Driven (LB Pro Rata approach) Alternatives are the most robust for these users compared with the other alternatives, with greater than 60 percent of normal domestic water delivery occurring in 100 percent of futures across the full modeling period. Under the CCS Comparative Baseline, greater than 60 percent of normal delivery occurs in 39 percent of potential futures. Generally, deeper shortages do not occur for the No Action and Basic Coordination Alternatives and the CCS Comparative Baseline. For the CCS Comparative Baseline and the No Action Alternative, this is because the shortages do not extend far into the apportionments of the Lower Division States. However, it is important to note that for the No Action Alternative and the CCS Comparative Baseline, the percent of futures with dead pool–related reductions are 50 percent and 70 percent, respectively. The No Action, Enhanced Coordination, and Supply Driven (LB Pro Rata approach) Alternatives would result in similar impacts on shortage for Arizona CAP M&I and Priority 4(i). However, if you consider dead pool–related reductions, which may impact these users, the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives are the most robust alternatives for these users compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives). These two alternatives perform well for domestic entitlement holders at lower volumes of delivery because they use pro rata distributions.

Figure TA 17-4, below, presents potential shortage impacts on domestic water deliveries to Arizona Priorities 2 and 3.

Over the full modeling period, greater than 80 percent of normal domestic water delivery to Arizona Priorities 2 and 3 would occur in 100 percent of potential futures under all the alternatives, excluding the Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (LB Pro Rata approach) Alternatives. Under the Maximum Operational Flexibility Alternative, greater than 80 percent of normal delivery occurs in 57 percent of potential futures. This is because the Maximum Operational Flexibility Alternative applies priority-based distribution with deeper shortages. Under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, greater than 80 percent of normal delivery to Arizona Priorities 2 and 3 occurs in 21 percent and 3 percent of potential futures, respectively. This is because the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives use a pro rata distribution, thus shortage is distributed evenly across entitlement holders regardless of the seniority of water entitlements. Overall, the Supply Driven Alternative (LB Pro Rata approach) is the least robust for these users, followed by the Enhanced Coordination Alternative compared with the other alternatives.

Figure TA 17-4
Arizona Priorities 2 and 3: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years



Over the full modeling period, under the No Action, Basic Coordination, and Supply Driven (LB Priority approach) Alternatives and the CCS Comparative Baseline, greater than 80 percent of normal domestic water is delivered to Arizona Priorities 2 and 3 in 100 percent of potential futures. There would be no impacts on shortage for Arizona Priorities 2 and 3, except under the Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (LB Pro Rata approach) Alternatives. Therefore, the No Action, Basic Coordination, and Supply Driven (LB Priority approach) Alternatives and the CCS Comparative Baseline would result in similar impacts on shortage for Arizona Priorities 2 and 3. However, if you consider dead pool–related reductions, which may impact these users, the Supply Driven Alternative (LB Priority approach) is the most robust alternative compared with the CCS Comparative Baseline and No Action Alternative (as well as all action alternatives).

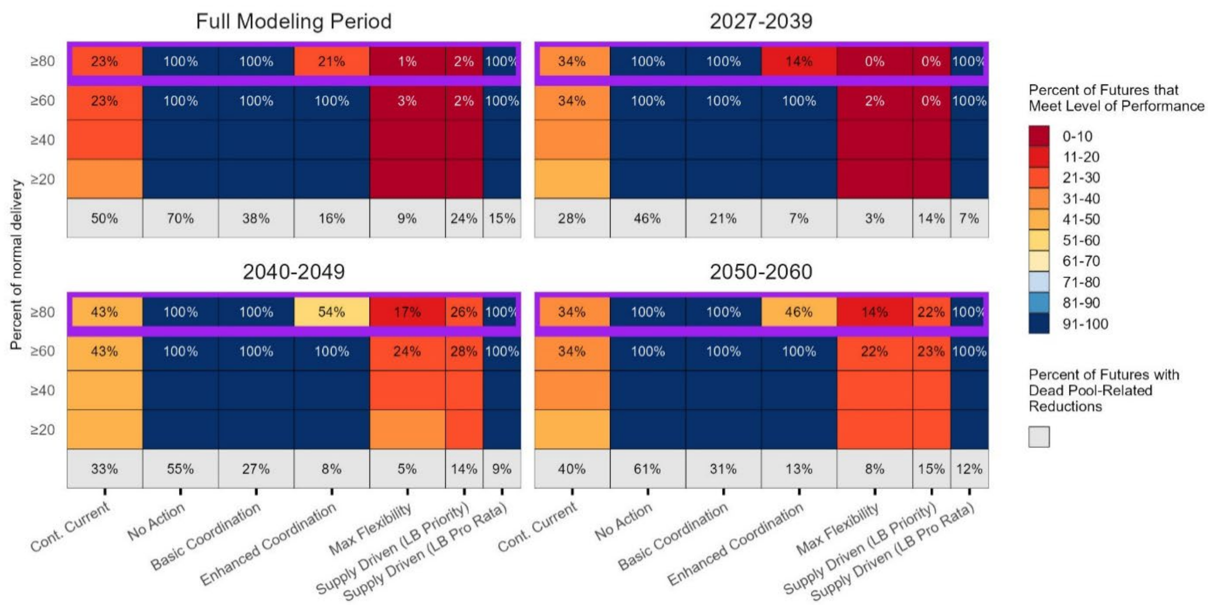
Figure TA 17-5, below, presents potential shortage impacts on domestic water deliveries to Arizona PPR.

Figure TA 17-5
Arizona Present Perfected Rights: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years

Over the full modeling period, greater than 80 percent of normal domestic water delivery to Arizona PPR occurs in 100 percent of potential futures under all alternatives, excluding the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives. Under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, greater than 80 percent delivery to Arizona PPR occurs in 21 percent and 3 percent of potential futures, respectively. However, greater than 60 percent of normal delivery occurs in 100 percent of potential futures under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives. This is because the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives apply a pro rata distribution, thus shortage is distributed evenly across entitlement holders regardless of the seniority of water entitlements. Under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives (the least robust alternatives for these users), shortages would be higher, and domestic deliveries would not be consistent with annual normal delivery. Under the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven Alternatives and the CCS Comparative Baseline, greater than 80 percent of normal delivery to Arizona PPR occurs in 100 percent of futures. There would be no impacts on shortage for Arizona PPR, except under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives. Therefore, the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives and the CCS Comparative Baseline would result in similar impacts on shortage for Arizona PPR. However, if you consider dead pool–related reductions, which may impact these users, the Maximum Operational Flexibility Alternative is the most robust compared with the CCS Comparative Baseline and the No Action Alternative (as well as all the action alternatives).

Figure TA 17-6, below, presents potential shortage impacts on domestic water deliveries to California Priority 4.

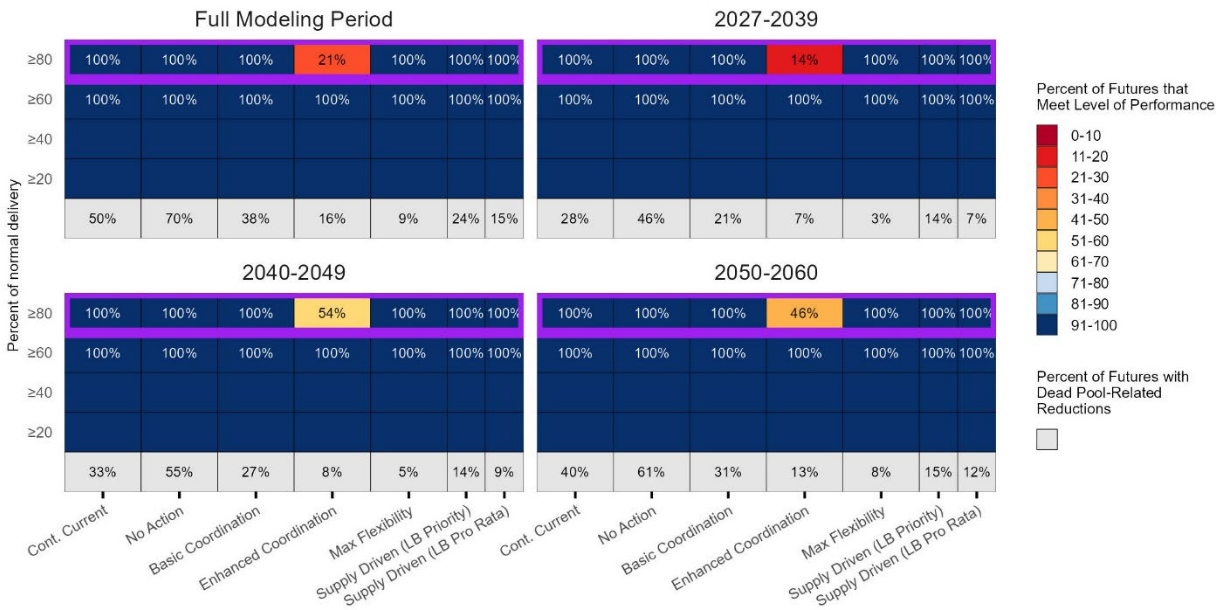
Figure TA 17-6
California Priority 4: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years



Over the full modeling period, greater than 80 percent of normal domestic water is delivered to California Priority 4 under the No Action, Basic Coordination, and Supply Driven (LB Pro Rata approach) Alternatives. Under the CCS Comparative Baseline and the Enhanced Coordination Alternative, greater than 80 percent delivery to California Priority 4 occurs in 23 percent and 21 percent of potential futures, respectively. Under the Maximum Operational Flexibility and Supply Driven (LB Priority approach) Alternatives, greater than 80 percent delivery to California Priority 4 occurs in 1 percent and 2 percent of potential futures, respectively. When compared with the No Action Alternative and the CCS Comparative Baseline, the Supply Driven (LB Pro Rata approach) and Basic Coordination Alternatives are the most robust action alternatives. However, additional alternatives are robust when looking at the next row of normal water delivery: greater than 60 percent of normal delivery. When considering this next level of performance, the No Action, Basic Coordination, Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives would result in similar impacts on shortage for California Priority 4, with greater than 60 percent of normal domestic water delivery occurring 100 percent of futures across the full modeling period. However, it is important to note that under the No Action Alternative, there are 70 percent of futures with dead pool–related reductions across the full modeling period. In contrast, there are 38 percent, 16 percent, and 15 percent of futures with dead pool–related reductions under the Basic Coordination, Enhanced Coordination, and Supply Driven (LB Pro Rata approach) Alternatives across the full modeling period. When considering dead pool–related reductions, which may impact these users, the Supply Driven Alternative (LB Pro Rata approach) is the most robust, followed by the Basic Coordination Alternative, compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives).

Figure TA 17-7, below, presents potential shortage impacts on domestic water deliveries to California PPR.

Figure TA 17-7
California Present Perfected Rights: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years



Over the full modeling period, greater than 80 percent of normal domestic water is delivered to California PPR in 100 percent of potential futures under all alternatives, excluding the Enhanced Coordination Alternative. While there are 21 percent of potential futures in which greater than 80 percent delivery to California PPR occurs under the Enhanced Coordination Alternative, greater than 60 percent delivery to California PPR occurs in 100 percent of potential futures under this alternative. Again, this is because the Enhanced Coordination Alternative uses a pro rata distribution, thus shortage is distributed evenly across entitlement holders regardless of the seniority of water entitlements. Because the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven Alternatives and the CCS Comparative Baseline meet the preferred minimum performance in 100 percent of futures, there is no shortage to California PPR, except under the Enhanced Coordination Alternative. While the No Action, Basic Coordination, Maximum Operational Flexibility and Supply Driven Alternatives and CCS Comparative Baseline would result in similar impacts on shortage, if you consider dead pool–related reductions, which may impact these users, the Maximum Operational Flexibility Alternative followed by the Supply Driven

Alternative (LB Priority approach), are the most robust alternatives compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives).

Figure TA 17-8, below, presents potential shortage impacts on domestic water deliveries to **Nevada Priorities 1-7**.

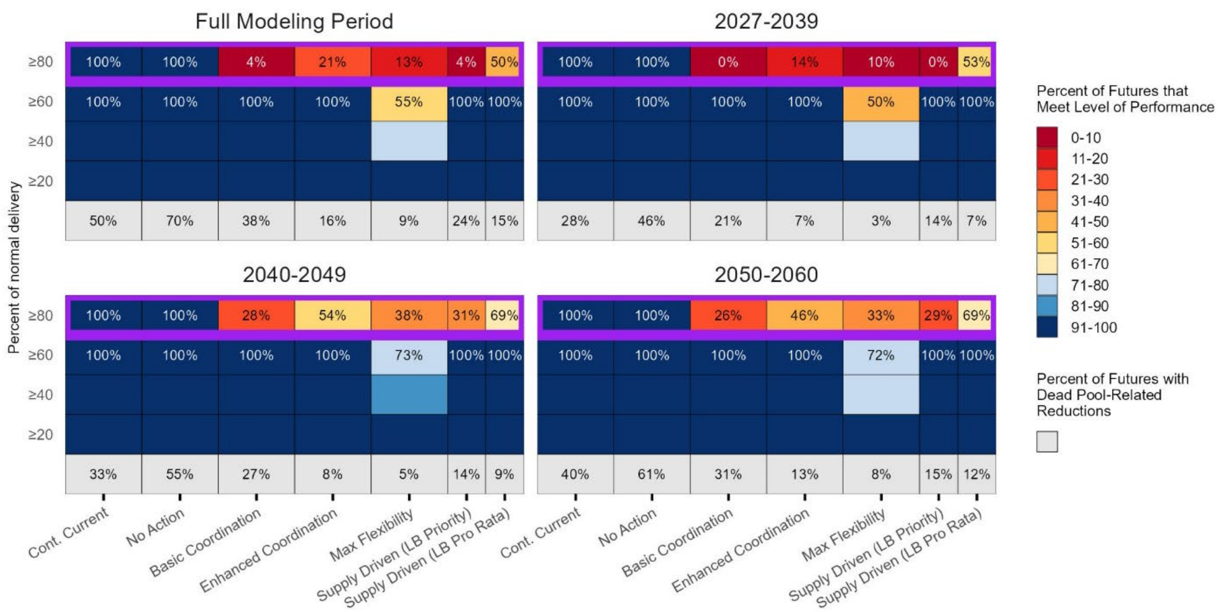
Figure TA 17-8
Nevada Priorities 1-7: Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years

Over the full modeling period, greater than 80 percent of normal delivery to Nevada Priorities 1-7 occurs in 100 percent of potential futures under all alternatives, excluding the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives. Under the Enhanced Coordination and Supply Driven (LB Priority approach) Alternatives, greater than 80 percent delivery to Nevada Priorities 1-7 occurs in 21 percent and 50 percent of potential futures, respectively. This makes sense because the Enhanced Coordination and Supply Driven (LB Priority approach) Alternatives apply a pro rata distribution, where shortage is distributed evenly across all entitlements regardless of the seniority of water entitlements. Under all alternatives, greater than 60 percent of normal delivery occurs in 100 percent of futures under the Enhanced Coordination Alternative.

Over the full modeling period, greater than 80 percent delivery occurs in 100 percent of potential futures under the CCS Comparative Baseline and the No Action, Basic Coordination, Maximum Operational Flexibility and Supply Driven (LB Priority approach) Alternatives. Therefore, there would be no shortage to Nevada Priorities 1-7, except under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives. While the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives would result in similar impacts on shortage, if you consider dead pool–related reductions, which may impact these users, the Maximum Operational Flexibility Alternative followed by the Supply Driven Alternative (LB Priority approach), are the most robust alternatives compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives).

Figure TA 17-9, below, presents potential shortage impacts on domestic water deliveries to **Nevada Priority 8**.

Figure TA 17-9
Nevada Priority 8 (Including Balance and Surplus): Robustness
Percent of futures in which annual delivery is the percent of normal domestic delivery specified in each row in at least 90% of years



Over the full modeling period, greater than 80 percent delivery to Nevada Priority 8 occurs in 100 percent of futures under the CCS Comparative Baseline and the No Action Alternative. For all other alternatives, the percentage of potential futures in which greater than 80 percent of normal delivery occurs varies. Under both the Basic Coordination and Supply Driven (LB Priority approach) Alternatives, greater than 80 percent of normal delivery occurs in 4 percent of potential futures. Under the Enhanced Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, greater than 80 percent delivery to Nevada Priority 8 occurs in 21 percent, 13 percent, and 50 percent of potential futures, respectively. Generally, deeper shortages do not occur for the CCS Comparative Baseline and the No Action and Basic Coordination Alternatives. For the CCS Comparative Baseline and the No Action Alternative, this is because the shortages do not extend far into Nevada's apportionment. However, it is important to note that for the CCS Comparative Baseline and the No Action Alternative, the percentage of futures with dead pool–related reductions are 50 percent and 70 percent, respectively.

The next level below the preferred minimum performance is greater than 60 percent of normal domestic water delivery to Nevada Priority 8. Over the full modeling period, greater than 60 percent of normal delivery occurs in 100 percent of futures for all alternatives except the Maximum Operational Flexibility Alternative. The Maximum Operational Flexibility Alternative is the least robust compared with the other alternatives, because Maximum Operational Flexibility uses a priority distribution with deeper shortage. When considering this next level (greater than 60 percent delivery), and considering dead pool–related reductions, the Basic Coordination, Enhanced Coordination, and Supply Driven Alternatives are the most robust compared with the other alternatives, with greater than 60 percent of normal domestic water delivery occurring in 100 percent of futures across the full modeling period. Additionally, when considering dead pool–related reductions, which may impact these users, dead pool–related reductions would be lowest under the Enhanced Coordination and Supply Driven Alternatives. Overall, the Enhanced Coordination, Basic Coordination, and Supply Driven Alternatives would result in similar impacts on shortage. However, if you consider dead pool–related reductions, which may impact these users, the Supply Driven Alternative (LB Pro Rata approach) followed by the Enhanced Coordination Alternative would be the most robust compared with the CCS Comparative Baseline and the No Action Alternative (as well as all action alternatives).

TA 17.2.3 DMDU Analysis Summary

The DMDU Analysis allows for comparison of the alternatives in terms of potential shortage impacts on domestic entitlements. When comparing the domestic water impacts, it is important to note that a more robust alternative results in a higher percentage of potential futures where domestic water delivery remains consistent with normal conditions and shortages occur less frequently. Conversely, a less robust alternative yields fewer futures with normal domestic water delivery and a higher frequency of shortages.

The SAMs used to inform the DMDU analysis do not incorporate water management measures such as conservation programs or demand-reduction strategies. These measures do not change entitlement amounts or shortages; however, as described in the affected environment section, conservation programs and other management strategies can influence domestic water demand and help mitigate the operational pressures associated with shortage, uncertain supply, and population growth. Therefore, while the model results presented here do not capture these measures, the potential impacts of shortages on domestic water supply for the Lower Basin would also depend in part on existing and future conservation and management actions implemented by states, local water providers, and individual users. Potential impacts would also depend on other external factors such as environmental and economic conditions.

Table TA 17-17, Summary of Potential Effects on Domestic Water by Alternative, below, provides an overview of impacts on domestic water by alternative based on the DMDU figures discussed in detail above. The table demonstrates how the different alternatives perform in terms of percentage of normal delivery in potential futures. **Table TA 17-17** includes two performance indicators: greater than 80 percent of normal delivery and greater than 60 percent of normal delivery in 90 percent of modeled futures, across the full modeling period. The table displays how each alternative performs for these two performance indicators, by priority group. The performance indicators illustrate how each alternative performs in maintaining domestic water deliveries under a wide range of uncertain future conditions. The alternatives that would achieve greater than 80 percent of normal delivery in 90 percent of years demonstrate strong robustness, indicating that domestic deliveries would remain near normal levels across most modeled futures. These alternatives would result in fewer and less severe shortages, which would provide greater reliability for domestic water users. This performance indicator is difficult to achieve under many alternatives. To show further variation across the alternatives, **Table TA 17-17** includes greater than 60 percent of normal delivery in 90 percent of years. The alternatives that only meet the greater-than-60-percent-of-normal-delivery-in-90-percent-of-years threshold demonstrate lower robustness. Under these conditions, more frequent domestic delivery reductions or shortages could occur in modeled futures, particularly for junior priority groups. Such outcomes could increase the likelihood of secondary socioeconomic impacts, including constraints on growth or secondary changes in land development patterns.

As shown in **Table TA 17-17**, for the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, which apply a priority-based distribution of shortage, under most modeled futures, water users with senior entitlements would likely continue to experience relatively consistent domestic water deliveries, as these entitlements are contractually prioritized during periods of reduced supply. However, junior entitlements could face greater reductions in water deliveries during Shortage Conditions. Consequently, while senior entitlement holders may maintain service levels closer to normal, junior entitlement holders could experience more frequent or severe delivery constraints.

As shown in **Table TA 17-17**, for the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, which apply pro rata distribution of shortage, under most modeled futures, would generally allow a larger number of priority groups to receive domestic water deliveries closer to normal conditions. While a pro rata approach would change the distribution of water across all users during shortages, this section solely focuses on the distribution of water to domestic users. This approach would deviate from the priority-based distribution, resulting in some modeled reductions to domestic deliveries for senior entitlement holders who would otherwise maintain normal domestic delivery under the existing priority system. In contrast, more domestic junior-priority water entitlement holders continue to receive some level of water supply under this approach. Essentially, the pro rata method would result in more existing users receiving moderate water deliveries during shortages through a redistribution of water from senior entitlements.

As described in **Section TA 17.1**, Affected Environment, peer-reviewed studies document that domestic water availability significantly influences population dynamics and land use. To provide a high-level overview of potential impacts on domestic water and the associated impacts on population and land use patterns, key summaries are also provided below for Arizona, Nevada, and California.

Table TA 17-17
Summary of Potential Effects on Domestic Water by Alternative

Impact Category	Performance Indicator	Impacts Summary					
		No Action Alternative	Basic Coordination Alternative	Enhanced Coordination Alternative	Maximum Operational Flexibility Alternative	Supply Driven Alternative (LB Priority)	Supply Driven Alternative (LB Pro Rata)
Priority Group: Arizona CAP NIA-A and NIA-B	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries[1].	**6%** of modeled futures meet the performance definition.	**1%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**0%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**6%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**0%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
Priority Group: Arizona CAP Indian, M&I, and 4(i)	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**19%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**4%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**9%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
Priority Group: Arizona Priorities 2 and 3	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**57%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**61%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.

[1] Normal delivery refers to a full supply of Colorado River water throughout this table.

Impact Category	Performance Indicator	Impacts Summary					
		No Action Alternative	Basic Coordination Alternative	Enhanced Coordination Alternative	Maximum Operational Flexibility Alternative	Supply Driven Alternative (LB Priority)	Supply Driven Alternative (LB Pro Rata)
Priority Group: Arizona PPR	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
Priority Group: California Priority 4	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**1%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**3%** of modeled futures meet the performance definition.	**2%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
Priority Group: California PPR	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
Priority Group: Nevada Priorities 1-7	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**50%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.

Impact Category	Performance Indicator	Impacts Summary					
		No Action Alternative	Basic Coordination Alternative	Enhanced Coordination Alternative	Maximum Operational Flexibility Alternative	Supply Driven Alternative (LB Priority)	Supply Driven Alternative (LB Pro Rata)
Priority Group: Nevada Priority 8	Percent of potential futures in which greater than 80% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the more robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**4%** of modeled futures meet the performance definition.	**21%** of modeled futures meet the performance definition.	**13%** of modeled futures meet the performance definition.	**4%** of modeled futures meet the performance definition.	**50%** of modeled futures meet the performance definition.
	Percent of potential futures in which greater than 60% of normal domestic delivery occurs 90% of the time, across the full modeling period. The higher the percentage, the robust an alternative is with respect to achieving normal domestic deliveries.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**55%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.	**100%** of modeled futures meet the performance definition.
What are the tradeoffs between alternatives?	Shortage to domestic water users across the full modeling period	N/A	**>80%** of normal delivery to some senior entitlements (AZ P2, P3, AZ PPR, California P4, CA PPR, NV P1-7) occurs in 100% of potential futures. In contrast, for junior entitlements there are **fewer potential futures** in which there is any percentage of normal delivery. **Minimal futures** (0-10) in which AZ CAP NIA-A and NIA-B receive >80% normal delivery.	While this alternative results in more priority groups receiving domestic delivery closer to normal conditions, it results in shortage impacts on senior entitlements that would otherwise receive deliveries consistent with normal conditions.	**>80%** of normal delivery to some senior entitlements (AZ PPR, CA PPR, NV P1-7) occurs in 100% of potential futures. In contrast, for junior entitlements (AZ CAP NIA-A, NIA-B, M&I, AZ 4(i), CA P4, NV P8) there are **fewer potential futures**, and in some cases **no potential futures**, in which there is any percentage of normal domestic water delivery.	**>80%** of normal delivery to senior entitlements (AZ P2, P3, AZ PPR, PPR, NV P1-7) occurs in 100% of potential futures. In contrast, for junior entitlements (AZ CAP NIA-A, NIA-B, M&I, AZ 4(i), CA P4, NV P8), there are **fewer potential futures**, and in some cases **no potential futures**, in which there is any percentage of normal domestic water delivery.	While this alternative results in more priority groups receiving domestic delivery closer to normal conditions, it results in shortage impacts on senior entitlements that would otherwise receive deliveries consistent with normal conditions.
How would operational changes affect irrigated agricultural land use patterns?	Acres of irrigated agricultural land within the corridor and potential for changes based on agricultural water availability	Frequent and severe shortages for junior-priority irrigation users likely lead to fallowing, crop switching, and long-term land retirement in Arizona CAP counties; Imperial Valley remains protected.	Capped shortages reduce extreme outcomes but concentrated impacts in Arizona still drive significant agricultural land use changes; California remains insulated.	Pro rata distribution mitigates concentrated impacts but introduces broader reductions, increasing risk of widespread crop switching and fallowing in both Arizona and California.	Large shortage volumes and reliance on conservation participation create high uncertainty; potential for extensive land retirement if participation is low.	Concentrates impacts on junior users, preserving senior districts but accelerating land use change in Arizona CAP counties.	Distributes shortages broadly, increasing exposure for California and potentially leading to widespread fallowing and crop switching across the Basin.

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Arizona: The No Action, Basic Coordination, and Supply Driven (LB Priority approach) Alternatives would result in similar impacts on shortage for more senior entitlements (Arizona Priorities 2 and 3 and Arizona PPR), with greater than 80 percent of normal delivery occurring in 100 percent of potential futures. Under the Maximum Operational Flexibility Alternative, greater than 80 percent of normal delivery to Arizona PPR and Arizona Priorities 2 and 3 occurs in 100 percent and 57 percent of potential futures, respectively. Compared with the No Action, Basic Coordination, and Supply Driven (LB Priority approach) Alternatives, the Maximum Operational Flexibility Alternative is less robust with respect to achieving normal domestic deliveries to Arizona Priorities 2 and 3. If you consider dead pool–related reductions, which may impact these users, the Supply Driven Alternative (LB Priority approach) is the most robust of the alternatives, followed by the Basic Coordination Alternative, with respect to achieving normal domestic deliveries to more senior entitlements (Arizona Priorities 2 and 3 and PPR). Under these alternatives, there is a higher percentage of potential futures where domestic water delivery to Arizona PPR, Priority 2, and Priority 3 remains consistent with normal conditions. A higher percentage of potential futures with greater than 80 percent of normal delivery could support future population growth, water demand, and development in areas serviced by these priority groups. Because the Basic Coordination and Supply Driven (LB Priority approach) Alternatives, have greater robustness for Arizona PPR, Priority 2, and Priority 3, there could be fewer potential indirect impacts on population growth and land development.

In contrast, the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives would result in similar impacts on shortage for more junior entitlements (Arizona CAP NIA-A, CAP NIA-B, CAP Indian, M&I, and 4(i)), with greater than 80 percent delivery occurring in less than 6 percent of potential futures. Under these alternatives, there is a higher frequency of shortage and few to no potential futures in which normal domestic delivery to these priorities occurs. Shortages could manifest as reduced water allocations, delivery restrictions, or the need for additional conservation measures, limiting the capacity to meet domestic water demand. A higher frequency of shortages and fewer potential futures with normal domestic delivery to these junior priorities could result in potential impacts on municipalities and communities that rely on domestic water delivery to these entitlements. Under the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, Arizona CAP NIA-A, CAP NIA-B, CAP Indian, M&I, and 4(i)) could experience less reliable water delivery for existing populations and future population growth, secondary impacts on land use and development patterns, and decreased capacity to respond to water demands. As described in **TA 4**, Water Deliveries, maximum shortage to junior entitlements is highest under the Maximum Operational Flexibility Alternative. Should shortages result in a reduction or elimination of legal access to municipal water, widespread impacts on social and economic conditions may also be possible. In some scenarios, municipalities may find the need to pursue alternative water sources, or hauled water if available, as an alternative to support continued services. In addition, indirect social costs may occur as a result of a reduction in ecosystem services, or benefits to people provided by the environment. For example, trees in urban areas have been shown to provide high levels of benefits to people in the form of shade (mitigating impacts of urban heat), local air quality improvements, and enhancement of the visual setting. Should a reduction in domestic water supply result in die-offs of urban and suburban area trees, this could represent a loss of value that would take decades to recapture, due to the growth time required for trees (see, for example, Bloome et al. 2016).

When considering all Arizona priority groups, the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives generally demonstrate the most robust performance for domestic water entitlements, based on maintaining greater than 60 percent of normal delivery in at least 90 percent of years across the full modeling period, for the greatest number of users. Compared with the CCS Comparative Baseline and the No Action Alternative, under the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, 60 percent or more of normal domestic water delivery occurs across the largest percentage of potential futures and for the greatest number of priority groups. While this approach maximizes delivery reliability for more users overall, it involves a trade-off: senior entitlements would experience delivery reductions that would not occur under a priority distribution, whereas more junior entitlements may continue to receive near-normal deliveries, across the modeled futures. This allocation reflects a balance between broad delivery coverage and the reallocation of shortage risk across the priority groups.

California: Under the No Action, Basic Coordination, and Supply Driven (LB Pro Rata approach) Alternatives, greater than 80 percent of normal delivery occurs in 100 percent of potential futures for California PPR and Priority 4. In other words, there would be no impacts on shortage for California PPR and Priority 4, under these alternatives. However, potential impacts do vary by the other action alternative for these two priority groups. Under all alternatives, excluding the Enhanced Coordination Alternative, 100 percent of normal delivery to California PPR occurs in 100 percent of potential futures. Under the Maximum Operational Flexibility and Supply Driven (LB Priority approach) Alternatives there would be no shortage to California PPR across modeled futures. When considering dead pool–related reductions, which may impact California PPR, the Maximum Operational Flexibility Alternative is the most robust compared with other alternatives, with the lowest percent of potential futures with dead pool–related reductions (9 percent across the full modeling period). Therefore, with the greatest frequency of normal domestic water delivery, this alternative would result in the least potential impacts on domestic water for California PPR. However, for California Priority 4, deliveries greater than 80 percent of normal occurs in only 0 percent and 2 percent of potential futures under the Maximum Operational Flexibility and Supply Driven (LB Priority approach) Alternatives, respectively.

When evaluating both California priority groups together, the Supply Driven Alternative (LB Pro Rata approach) is the most robust compared with the No Action Alternative and all other action alternatives. It provides 100 percent of normal delivery to California PPR and California Priority 4 in 90 percent of years across 100 percent of potential futures. Additionally, considering the dead pool–related reductions, which could affect these users, the Supply Driven Alternative (LB Pro Rata approach) has the lowest percentage of futures with constrained releases (7 percent), compared with all other alternatives. Reliable domestic water deliveries under the Supply Driven Alternative (LB Pro Rata approach) would support continued population growth and land development in areas served by California PPR and Priority 4. Maintaining near-normal deliveries across modeled futures supports the capacity for new development, housing availability, and municipal services that rely on water supply. In contrast, the alternatives with lower reliability or greater exposure to dead pool–related reductions could limit opportunities for residential and commercial growth, particularly areas experiencing high population growth, intensive development, or elevated municipal water demand, and could influence land use patterns or delay new construction. Ensuring robust water delivery across multiple futures is therefore an important factor supporting sustainable population growth and land use planning in California.

Nevada: Under all alternatives, except the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, 100 percent of normal delivery to Nevada Priorities 1–7 occurs in 90 percent of years across 100 percent of potential futures. Under the Enhanced Coordination Alternative, deliveries greater than 80 percent of normal to both priority groups occurs in only 21 percent of potential futures.

The No Action and Basic Coordination Alternatives result in similar outcomes for both Nevada priority groups—Priorities 1–7 and Priority 8—with 100 percent of normal delivery to each group occurring in 90 percent of years across 100 percent of potential futures.

For Nevada Priorities 1–7 specifically, the Maximum Operational Flexibility Alternative is the most robust, followed by the Supply Driven (LB Priority approach) and Basic Coordination Alternatives, compared with the No Action Alternative and the other action alternatives. In contrast, for Nevada Priority 8, these same alternatives are the least robust, with deliveries greater than 80 percent of normal occurring in only 4 percent of potential futures (Basic Coordination and Supply Driven [LB Priority approach] Alternatives) and 13 percent of potential futures (Maximum Operational Flexibility Alternative).

When considering both Nevada priority groups together, the Basic Coordination Alternative, followed by the Supply Driven Alternative (LB Pro Rata approach), provides the most robust performance. These alternatives deliver greater than 80 percent of normal domestic water across the largest percentage of potential futures and for the greatest number of priority groups. Robust domestic water deliveries are critical to supporting population growth and land development in Nevada. The alternatives that maintain reliable deliveries across modeled futures for both priority groups support the capacity for new housing, commercial development, and essential municipal services that depend on water supply. Conversely, the alternatives with lower reliability, particularly for Nevada Priority 8, could limit the capacity of communities to expand, influence land use patterns or delay new construction projects. By sustaining domestic water availability across a broad range of potential futures, the Basic Coordination and Supply Driven (LB Pro Rata approach) Alternatives help support stable population growth and more predictable land use planning across the state.

TA 17.2.4 Issue 2: How would operational changes affect irrigated agricultural land use patterns?

This issue examines how different operational strategies may influence land use patterns associated with irrigated agriculture, and the potential for long term changes to these land uses based on Colorado River water availability for this use.

Estimated water shortages for Lower Basin agricultural users are shown in **Table TA 17-18** by modeling approach and Environmental Impact Statement alternative. Additional details related to the shortage allocation model estimates are included in **Appendix C**, Shortage Allocation Model and Alternative Distribution Model Documentation. An overview of state levels shortages for all uses is included in **TA 4**, Water Deliveries.

The CCS Comparative Baseline reflects Colorado River operations from recent years, incorporating the 2007 Colorado River Interim Guidelines for Lower Basin Shortages and the Coordinated Operations for Lake Powell and Lake Mead, the 2019 Drought Contingency Plan, Minute 323 of the 1944 United States-Mexico Treaty on Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande, and related agreements. These strategies have supported a mix of voluntary conservation, intentionally created surplus (ICS) banking, and coordinated shortage responses that have helped buffer impacts on land use, particularly in urban and agricultural areas. While shortages still occur under the CCS Comparative Baseline, the framework provides more predictability and flexibility than the No Action Alternative, which reverts to pre-2007 operations. As a result, land use patterns, including irrigated agriculture and urban development, are more likely to remain stable under the CCS Comparative Baseline, especially in areas with access to ICS or conservation programs. However, long-term viability of water-dependent land uses may still be challenged by declining reservoir elevations and increasing demand pressures.

While the CCS Comparative Baseline framework offers structure and predictability, modeled results illustrate how these outcomes vary between states and across different shortage levels, reflecting the continued vulnerability of certain user groups. Irrigation users in Arizona experience greater reductions under alternatives with pro rata distribution approaches at lower to mid-level system shortage volumes because currently most irrigators hold higher priority entitlements, and allocating reductions proportionally results in larger volumetric impacts than the priority-based framework. Although existing conservation and management measures help moderate impacts, irrigation reductions are still expected and may influence land use decisions such as fallowing or crop switching. Existing literature supports these findings, showing that sustained irrigation reductions in Arizona, particularly among junior-priority users, have already led to reduced farm income and localized economic contraction (Arizona Extension 2024). In contrast, California's agricultural users experience relatively greater shortages only under higher system shortage volumes, consistent with the state's senior water rights structure that provides protection under moderate conditions but may require larger contributions during more severe shortages. Studies in California similarly indicate that even modest reductions in irrigation can result in shifts toward drought tolerant crops and eventual land retirement in more vulnerable areas (Prakash 2023). Overall, while the CCS Comparative Baseline provides greater predictability than the No Action Alternative, the long-term viability of irrigated agriculture in Arizona and California may still be challenged by persistent shortages and declining reservoir conditions.

Table TA 17-18
Agricultural Water Shortage by State by Alternative

	Irrigation Shortage Impacts		Total Shortage Volume (KAF)									
	Modeling Approach	**EIS Alternative**	**600**	**1000**	**1500**	**1800**	**2000**	**2100**	**2300**	**3000**	**3500**	**4000**
Arizona	Priority	No Action	6									
Arizona	Continuing Current Strategies[1]	Continued Current Strategies	8	13								
Arizona	Priority	Basic Coordination[2]	6	19	34							
Arizona	LB Priority	Supply-Driven Priority State-Specific	2	9	18	27	33	36				
Arizona	LB Priority	Maximum Operational Flexibility	2	9	18	27	33	36	43	161	286	411
Arizona	Pro-Rata	Enhanced Coordination	55	91	136	164	182	191	209	273		
Arizona	LB Pro-Rata	Supply Driven Pro Rata State-Specific	108	158	221	245	260	268				
California	Priority	No Action	0									
California	Continuing Current Strategies[1]	Continued Current Strategies	0	14								
California	Priority	Basic Coordination[2]	0	0	0							
California	LB Priority	Supply-Driven Priority State-Specific	0	0	52	52	52	52				
California	LB Priority	Maximum Operational Flexibility	0	0	52	52	52	52	52	348	574	799
California	Pro-Rata	Enhanced Coordination	261	435	653	783	870	914	1001	1305		
California	LB Pro-Rata	Supply Driven Pro Rata State-Specific	98	229	393	534	628	675				

Note: The highlighting shows the values from the smallest (in white or no highlighting) to the largest (in yellow highlighting). The cells with hash-marks represent the values above shortages; these values are outside of the scope of this analysis. See the Shortage Allocation and Alternative Distribution Models (**Appendix C**) for more information on the shortage values for each entitlement holder type above shortages.

[1] Due to its fixed shortage volumes for the CCS Comparative Baseline, shortages for 600 thousand acre-feet (kaf) and 1 million acre-feet (maf) are actually associated with 613 kaf and 1.013 maf in the CCS Comparative Baseline. Greater shortages are based on an extension of priority beyond the levels of shortage provided by the pertinent documents.

[2] The maximum shortage for the Basic Coordination Alternative is 1.48 maf, however, the table above shows the maximum shortage as 1.5 maf for ease of comparison across the alternatives.

Without conservation mechanisms or coordinated flexibility, agricultural users face more severe impacts. Conservation mechanisms can support water deliveries by increasing usable system supply and providing operational buffers, without altering the delivery priority hierarchy unless an alternative explicitly modifies it. Water banking and groundwater savings facilities allow participating entities to reduce immediate diversion, store conserved water in reservoir accounts, and recover water later when needed, helping to maintain deliveries during shortage periods. Under the No Action Alternative, no new conservation mechanisms are introduced, and shortages are distributed by priority. Agricultural users with junior entitlements, in western Arizona counties, would likely experience frequent and severe reductions in water deliveries because they rely heavily or entirely on surface water, may also face increased fallowing. The lack of flexibility in water management due to the absence of operational or conservation mechanisms, could exacerbate long-term declines in irrigated acreage, especially in counties already showing downward trends in harvested cropland (USDA 2025). Analysis of water productivity across the Colorado River Basin shows that Lower Basin counties, particularly in Arizona and California, generate higher crop revenue per acre-foot of water applied than Upper Basin regions. This suggests that reductions in agricultural water deliveries in these areas could have disproportionately high economic impacts, reinforcing the need for more adaptive water management strategies (Bickel et al. 2024). Under the No Action Alternative, Lake Mead is projected to fall below dead pool in 70 percent of modeled futures, which could constrain releases to downstream users. These constraints may result in reduced water availability for urban and agricultural land uses, potentially leading to fallowing, development delays, or infrastructure abandonment in affected counties (see **TA 4**, Water Deliveries). The No Action Alternative offers slight improvement in predictability due to capped shortages, but not necessarily meaningful change in agricultural water reliability or land use outcomes.

These modeled outcomes are further supported by additional analyses that examine how physical and policy-based delivery constraints under deteriorating hydrologic conditions would exacerbate agricultural vulnerabilities. Under the No Action Alternative, modeled capacity constraints occur frequently enough that irrigation users in Arizona and California would face reductions that exceed existing policy-level shortage mechanisms. Without continuation of current shortage-sharing and conservation mechanisms, this alternative exposes Arizona and California to heightened risks of physical delivery constraints as reservoir elevations decline. Literature from USGS, 2019 and Prakash, 2023 indicates that when water availability is constrained by infrastructure or operational limits, agricultural users often experience abrupt and severe reductions in supply, leading to land retirement, fallowing, and associated economic disruption. In Arizona, such outcomes could accelerate land use changes in western Arizona counties, while in California, even senior-priority districts may be affected if physical shortages become the limiting factor in water supply. These findings highlight the increased vulnerability of irrigated agriculture under conditions of limited operational flexibility and deteriorating hydrologic reliability.

The Basic Coordination Alternative introduces a capped shortage mechanism, offering modest improvements in predictability but few new tools for agricultural resilience. This alternative retains the priority-based shortage distribution of the No Action Alternative but introduces a capped shortage volume of 1.48 maf. While this cap is intended to ensure that an assumed minimum flow is available for infrastructure protection and delivery for municipal use by CAP users and other Fourth Priority mainstem entitlement holders in Arizona when mainstream shortage is distributed by priority, it does not establish new agricultural conservation mechanisms to offset reductions through stored or deferred diversions. As a result, agricultural users in Arizona and California, especially those with junior entitlements, continue to face significant reductions in water deliveries.

The increase in capped volume may reduce the frequency of extreme shortages compared with the No Action Alternative, but the absence of conservation pools means agricultural land use remains highly vulnerable. In Arizona, La Paz, Mohave, and Yuma Counties may see increased fallowing and economic stress in farming communities. California's Imperial Valley would not experience shortages, but other regions could experience similar pressures. The capped shortage volume provides marginal improvement in predictability, but agricultural water reliability and land use outcomes remain largely unchanged from the No Action Alternative.

Detailed modeling results reinforce this outcome, showing that although the capped shortage slightly moderates total reductions, its benefits remain distributed by priority across states and users. The Basic Coordination Alternative irrigation shortages follow a pattern similar to the No Action Alternative but are capped at a system-wide reduction up to the policy-level cap of 1.48 maf. Within this range, Arizona bears all modeled irrigation shortages, while California experiences none, consistent with the continuation of existing priority structures. Because this alternative maintains the current priority framework and does not change delivery priorities, shortages follow existing priority rules. As a result, junior-priority users, including both irrigation and domestic users within Arizona Priority 4, continue to bear the largest reductions. The resulting reductions increase the likelihood of fallowing, crop switching, and economic stress in affected agricultural communities, potentially leading to long-term land use changes such as farmland retirement (Presson and Eden 2023).

By comparison, the Enhanced Coordination Alternative incorporates conservation pools and reductions that distribute shortages across more users and increase operational flexibility. This alternative introduces coordinated reservoir operations and conservation pools in Lake Powell (2 maf) and Lake Mead (5 maf), with shortages distributed pro rata across Lower Basin water users. This represents a departure from the No Action Alternative's priority-based approach.

Agricultural users in Arizona benefit from a broader distribution of shortages, reducing the likelihood of concentrated fallowing impacts among junior users. Western Arizona counties (Yuma, Mohave, and La Paz) and California's Imperial Valley see enhanced stability relative to the No Action Alternative due to conservation pool access. The pro rata distribution method ensures that agricultural users across states share reductions more evenly, mitigating the concentrated impacts seen under the No Action Alternative for juniors.

This alternative supports the continuation of some irrigated agriculture across the Basin, with the potential to sustain a measure of productivity across all priorities. Compared with the No Action Alternative, it provides a more resilient framework for some level of irrigated agriculture under a range of hydrologic conditions. Studies suggest that pro rata reductions tend to spread fallowing and crop-switching more broadly, whereas priority-based approaches protect senior-rights districts but concentrate impacts on lower-priority users (Singletary et al. 2020; Prakash 2023; USDA ERS 2021).

The quantitative results under the Enhanced Coordination Alternative mirror these operational changes, demonstrating how pro rata allocation redistributes impacts across states. Irrigation shortages in Arizona are generally larger than those under the No Action and Basic Coordination Alternatives when total shortage volumes are low. However, when total shortage volumes are above 3.5 maf, irrigation shortages are smaller than under those alternatives because of the coordinated, pro rata shortage allocation across Lower Basin water users. This approach reduces the concentration of impacts on Arizona's junior-priority irrigation users but results in a broader distribution of shortages across states, meaning California's agricultural users, typically protected under priority-based operations, would experience increased reductions. Literature suggests that such shared reductions may lessen localized land use impacts but increase regional exposure. Prakash (2023) found that more equitable shortage sharing often encourages widespread adoption of efficient irrigation practices and crop switching, particularly in regions such as the Imperial Valley and Yuma County. While these adjustments may enhance long-term resilience, the higher overall shortage volumes modeled under this alternative could still contribute to land retirement and economic stress in water-dependent regions (USGS 2019; Arizona Extension 2024).

While enhanced coordination emphasizes shared reductions, the Maximum Operational Flexibility Alternative expands management tools even further, allowing for the largest potential shortages (up to 4 maf) and includes a Conservation Reserve (up to 8 maf) shared across basins. While this introduces flexibility not included in the No Action Alternative, it also increases exposure to extreme shortage scenarios. Agricultural users in western Arizona counties may face high risk of fallowing unless conservation participation is robust. The Conservation Reserve allows users to store water in either Lake Powell or Lake Mead and convert it to system water when needed, offering a buffer against extreme shortages. California's agricultural regions benefit from similar flexibility, though effectiveness depends on participation and reservoir conditions. Compared with the No Action Alternative, this alternative introduces tools for adaptation and resilience, but agricultural outcomes depend heavily on conservation engagement and interbasin cooperation.

Modeling results under this framework underscore the same theme: flexibility can help smooth impacts under moderate conditions but cannot fully offset risks to agricultural viability under prolonged shortages. The Maximum Operational Flexibility Alternative modeled irrigation shortages in Arizona are similar to those under the Supply Driven Alternative (LB Priority approach). This alternative incorporates operational flexibility based on hydrologic conditions and system storage, which helps moderate shortages during less severe periods. California experiences smaller but more consistent irrigation reductions through the middle range of system shortages, though less than under the alternatives using pro rata distribution. Overall, this approach maintains a priority-based structure while introducing adaptive mechanisms that influence the timing and distribution of irrigation impacts across the Basin. Literature indicates that the flexibility introduced under this alternative may help buffer irrigation impacts during less severe hydrologic periods, though its effectiveness depends on conservation participation. Conservation programs have helped stabilize water availability, but long-term reductions still pose risks. USDA ERS (2021) notes that irrigated agriculture increasingly relies on adaptive strategies such as deficit irrigation and crop switching to maintain productivity. In both Arizona and California, these adjustments may lead to shifts in land use toward fallowing or land retirement and may reduce the economic viability of certain crops.

The Supply Driven Alternative decouples Lake Powell and Lake Mead operations and analyzes both priority-based and pro rata shortage distribution schemes. This dual-path approach allows for more nuanced control than the No Action Alternative, which relies solely on priority-based allocation.

Under priority-based allocation, agricultural users with junior entitlements, particularly in Arizona, would face impacts similar to those under the No Action Alternative. However, under pro rata distribution, impacts are more evenly spread, reducing impacts on western Arizona counties and increasing impacts on senior priorities. The conservation pools in Lake Mead (8 maf) and Lake Powell (3 maf) offer conservation mechanisms, and the phased conversion of existing ICS may add further flexibility.

Compared with the No Action Alternative, the Supply Driven Alternative has the potential to improve agricultural outcomes, particularly under the Supply Driven Alternative (LB Pro Rata approach). However, its effectiveness depends on implementation details, stakeholder agreements, and conservation participation. It offers a more tailored approach that distributes shortages across a broader set of users, changing how agricultural water deliveries are managed compared with the other alternatives.

Further detail from the two modeled approaches of the Supply Driven Alternative clarifies how different allocation schemes affect the scale and distribution of irrigation shortages, revealing important tradeoffs between distribution of reductions, magnitude of reductions, and overall agricultural outcomes. Under the Supply Driven Alternative (both LS priority and LB Pro Rata approaches), modeled irrigation shortages reach the policy-level cap at 2.1 maf. Under the Supply Driven Alternative (LB Priority approach), Arizona and California are modeled as splitting the irrigation reductions unevenly. In contrast, under the Supply Driven Alternative (LB Pro Rata approach), the reductions would be distributed more evenly and more heavily on California as the modeled shortage increases. While this approach reduces concentrated impacts in Arizona, it introduces greater irrigation reductions for California's agricultural users than under the other alternatives. Overall, the Supply Driven Alternatives reflect a trade-off between distribution and magnitude of impact, with broader distribution of shortages but higher total volumes of shortage to irrigators. Literature indicates that pro rata reductions are more likely to result in widespread fallowing and crop switching, while priority-based approaches preserve senior-rights districts but concentrate impacts (Singletary et al. 2020; Prakash 2023; USDA ERS 2021). In both cases, sustained irrigation reductions are expected to influence land use decisions and economic outcomes across the Basin., 2023; USDA ERS, 2021).

TA 17.2.5 Summary Comparison of Alternatives

Population and Developed Land Use – The alternatives vary in how they distribute domestic shortages and, in their potential, to impact domestic water deliveries and in turn indirectly impact population dynamics and land use within the analysis area.

As shown in **Table TA 17-17**, for the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, which apply a priority-based distribution of shortage, under most modeled futures, water users with senior entitlements would likely continue to experience relatively consistent domestic water deliveries. This is because these entitlements are contractually prioritized during periods of reduced supply. However, junior entitlements could face greater reductions in water deliveries during Shortage Conditions. Consequently, while senior entitlement holders may maintain service levels closer to normal, junior entitlement holders could experience more frequent or severe delivery constraints.

Under the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, greater than 80 percent of normal domestic delivery to most senior entitlements occurs in all potential futures. The specific Arizona, California, and Nevada senior entitlements vary by alternative (See **Table TA 17-17**). Because these alternatives have greater robustness for senior priority groups there could be fewer potential indirect impacts on population growth and land development. A higher percentage of potential futures with greater than 80 percent of normal delivery could support future population growth, water demand, and development in areas serviced by these priority groups.

Under the No Action, Basic Coordination, Maximum Operational Flexibility, and Supply Driven (LB Priority approach) Alternatives, for junior entitlements there are fewer potential futures in which there is any percentage of normal delivery. Domestic shortages could manifest as reduced water allocations, delivery restrictions, or the need for additional conservation measures, which could in turn limit the capacity to meet domestic water demand. Should shortages result in a reduction or elimination of legal access to municipal water, widespread impacts on social and economic conditions could also be possible. In some scenarios, municipalities could find the need to pursue alternative water sources, or hauled water if available, as an alternative to support continued services. In addition, indirect social costs could occur as a result of a reduction in ecosystem services; also, indirect social costs could occur from reduction of benefits to people provided by the environment. For example, trees in urban areas have been shown to provide high levels of benefits to people in the form of shade (mitigating urban heat impacts), local air quality improvements, and enhancement of the visual setting. Should a reduction in domestic water supply result in die-offs of urban and suburban area trees, this could represent a loss of value that would take decades to recapture, due to the growth time required for trees (see, for example, Bloome et al. 2016).

As shown in **Table TA 17-17**, for the Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives, which apply pro rata distribution of shortage, under most modeled futures, would generally allow a larger number of priority groups to receive domestic water deliveries closer to normal conditions. While a pro rata approach would change the distribution of water across all users during shortages, this approach would deviate from the priority-based distribution, resulting in some modeled reductions to domestic deliveries for senior entitlement holders who would otherwise maintain normal domestic delivery under the existing priority system. In contrast, more domestic junior-priority water entitlement holders would continue to receive some level of water supply under this approach. Essentially, the pro rata method would result in more users receiving moderate water deliveries during shortages through a redistribution of water from senior entitlements.

Agricultural Land Use: The alternatives vary in how they distribute irrigation shortages and therefore in their potential to influence long-term land use patterns. The No Action and Basic Coordination Alternatives rely on priority-based distribution and result in concentrated impacts on junior-priority users in Arizona, particularly in western Arizona counties, with limited mitigation tools. These conditions increase the likelihood of fallowing, crop switching, and economic stress in affected communities. The CCS Comparative Baseline offers more predictability and flexibility, helping buffer some impacts, though shortages still occur. The Enhanced Coordination and Supply Driven (LB Pro Rata approach) Alternatives distribute shortages more broadly across the states and users, reducing concentrated impacts on junior priority holders but introducing greater reductions in California, which could lead to more widespread land use changes. The Maximum Operational Flexibility and Supply Driven (LB Priority approach) Alternatives incorporate adaptive tools and conservation reserves, offering potential buffers against extreme shortages; however, their effectiveness depends on stakeholder participation and hydrologic conditions.

TA 17.3 References

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