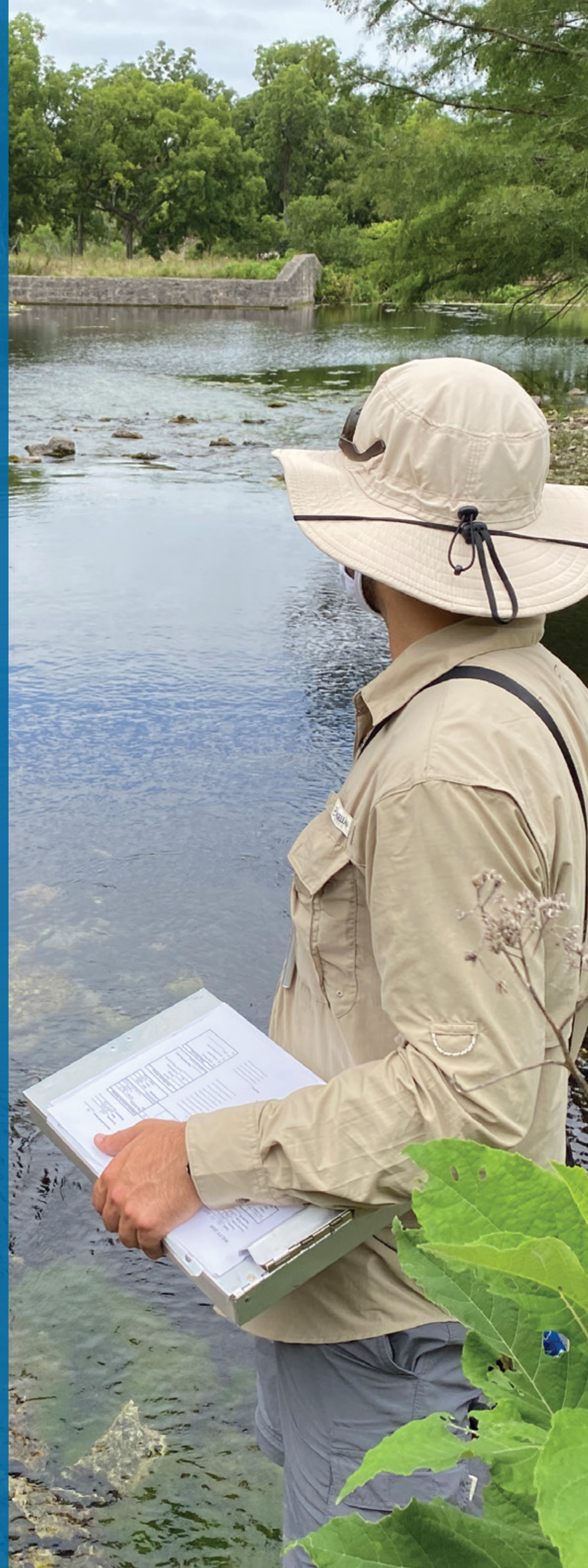
5

Water availability and existing supplies



QUICK FACTS

Total surface water availability is approximately 3 percent higher in both 2020 and 2070 than in the 2017 State Water Plan, primarily due to new systems operations and surface water availability model updates. However, total surface water availability declines by 3 percent over the planning horizon.

Total groundwater availability is approximately 1.9 million acre-feet, or 15 percent, higher in 2020 and 857,000 acre-feet, or 9 percent, higher in 2070 than in the 2017 State Water Plan, primarily due to changes in groundwater management policy. However, total groundwater availability declines by 25 percent over the planning horizon.

The existing water supplies—water already being provided in a drought from sources including surface water, groundwater, and reuse—are expected to decline approximately 18 percent between 2020 and 2070.

In 2020, more than one-third of irrigation and livestock water supplies is from the Ogallala/Edwards-Trinity (High Plains) Aquifer, while more than one-fifth of all non-agricultural-related water supply in Texas is from the Trinity River Basin.

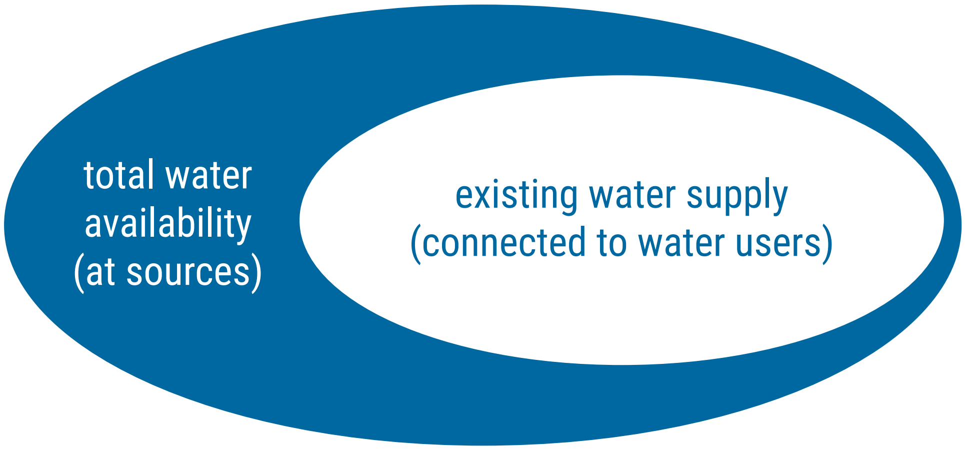
The state water plan is mandated to prepare for and respond to drought conditions. Essential to this process is estimating how much water Texans will have to meet their water demands during drought conditions, without over-allocating any water sources. To do that, the planning groups must determine how much total water is available and how much of that is already in use.

5.1 Evaluating water resources for planning

During development of the regional plans, each water planning group must identify all water sources within their planning area and their associated annual availability volumes. Water availability refers to the maximum volume of raw water that can be withdrawn annually from each source (such as a reservoir or aquifer) during a repeat of the drought of record. Availability does not account for whether the supply is connected to or legally authorized for use. Availability is analyzed from the perspective of the water source and answers the question: *How much water from this source could be delivered to water users during a repeat of the drought of record, as either existing water supply or as part of a future water management strategy?* Determining water availability is the first step in assessing potential water supply volumes (Figure 5-1).

Next, planning groups quantify the subset of that total water availability volume that is already connected to water user groups. This subset is defined as the existing supply. Existing water supplies are determined by legal access to the water as well as existing infrastructure (such as pipelines and treatment plant capacity) to treat and deliver the water to the "doorstep" of a water user group. Existing supply is analyzed from the perspective of water users and answers the question: *How much water supply could each water*

Figure 5-1. Water availability as relates to existing supply



user group already rely on should there be a repeat of the drought of record?

For example, the firm yield of a surface water reservoir may be 100,000 acre-feet per year. Of that available 100,000 acre-feet, the current pipeline to that source only conveys 60,000 acre-feet per year to users; 60,000 acre-feet is the existing supply. There remains an additional 40,000 acre-feet per year of available water that can serve as the basis for a future water management strategy.

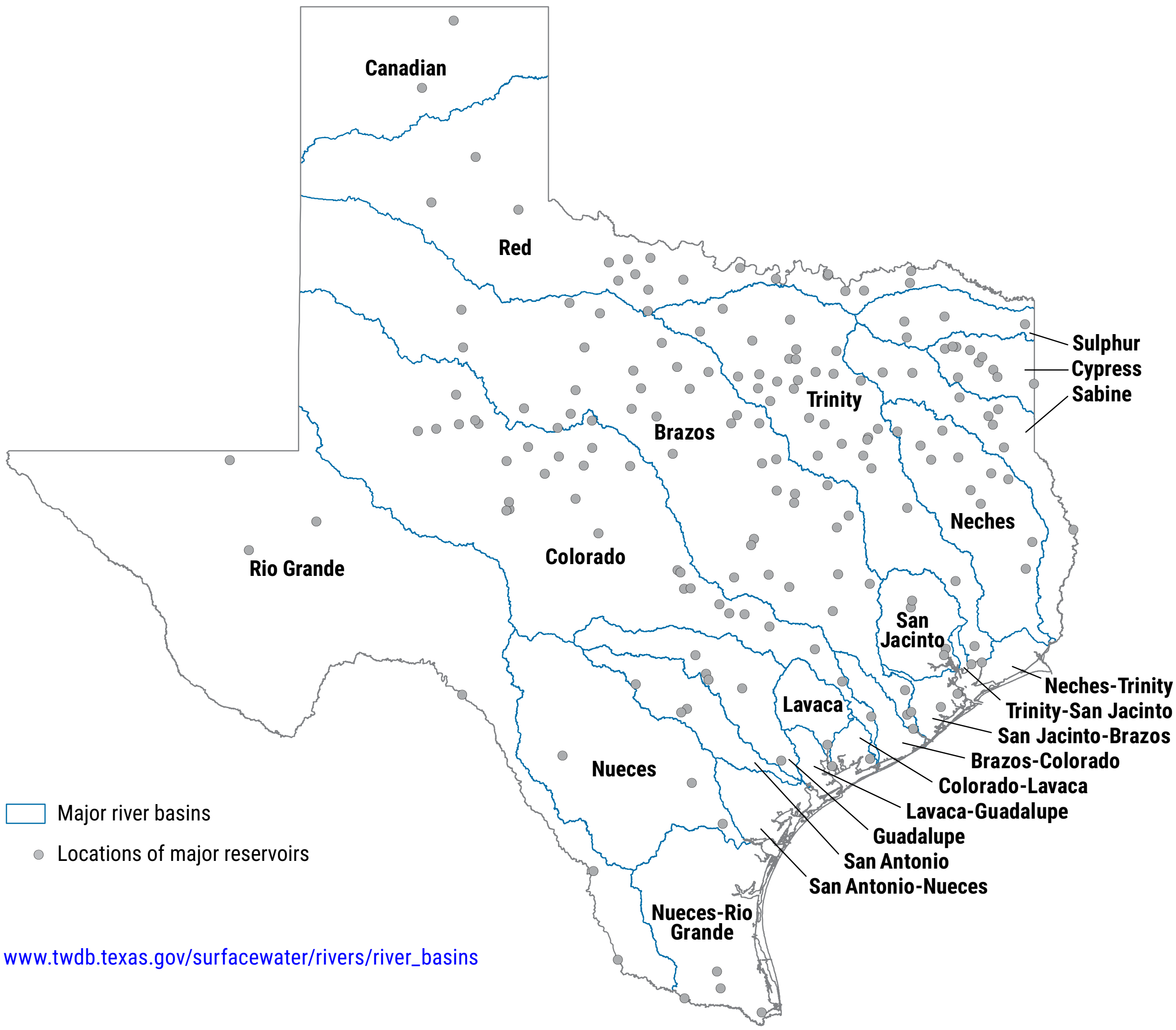
As another example, there may be within a county a modeled available groundwater volume of 50,000 acre-feet per year, but because current permits and pumping facilities are only able to pump 20,000 acre-feet per year for existing supplies, there remains 30,000 acre-feet per year in available groundwater that can support a future water management strategy.

Because existing supplies are a subset of the availability of water sources, existing supplies cannot exceed availability without the risk of running short of water in a drought of record. If existing supplies exceed availability it is an over-allocation. To ensure that planning groups do not assign more water supply to a water source than the source can provide in a drought, the TWDB performs a detailed, statewide accounting of all assigned existing water supply volumes and notifies planning groups of over-allocations. Planning groups then adjust their plans accordingly.

5.2 Surface water availability within river basins

Surface water supplies in Texas come from Texas' 15 major river basins and 8 coastal basins via 187 major reservoirs and numerous river diversions, known as run-of-river supplies (Figure 5-2). Surface water availability is determined using the Texas Commission on Environmental Quality's surface water availability models (WAMs), which estimate the monthly and annual water volumes that can be diverted each year in drought of record conditions, all of which assume a repeat of the historic hydrologic record. The default model for planning purposes, known as WAM Run 3, conservatively assumes that all existing water rights are fully used without returning any flows to the river, unless a permit requires such returns, and is adjusted to consider the impacts due to sedimentation on reservoir yields. The state's WAM models are based on historic data, including inflows, that was available as of their last updates. WAMs reflect historic changes to hydrology, including inflows, but do not attempt to make predictions about the future changes to inflows or other parameters. However, planning groups are allowed and encouraged to modify

Figure 5-2. Major river and coastal basins and major surface water supply reservoir locations

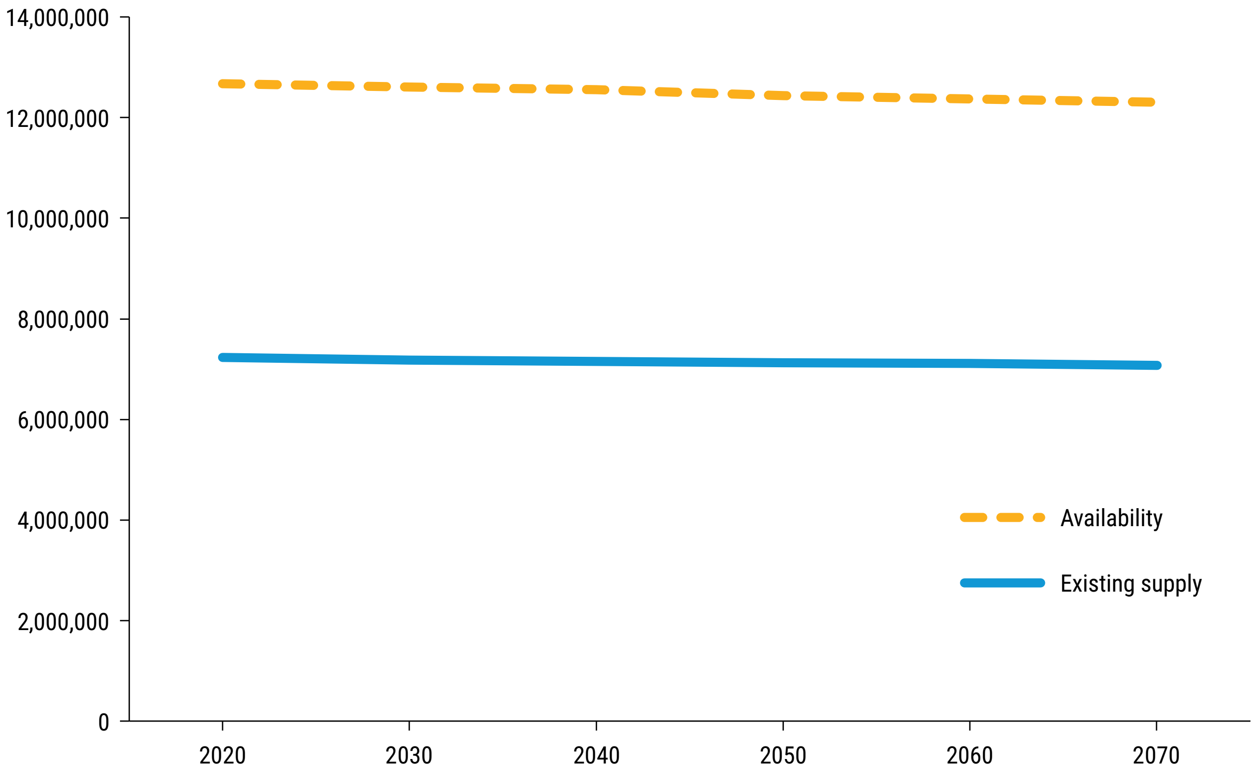


the default model to reflect appropriate conditions not included in WAM Run 3 when evaluating *existing* water supplies for planning purposes.

Justifiable modifications to the water availability models, which are expected to better reflect conditions encountered during a drought, include correcting known model errors; reflecting increased sedimentation or current river system operations; updating reservoir inflows to reflect recent drought conditions, including return flows; or utilizing a reservoir safe yield instead of firm yield. Safe yield is a reduced annual water volume that continues to be available from a reservoir for periods longer than a drought of record, which may provide a buffer against uncertainty for water supply purposes.

All regional water planning groups requested and received approval to modify their surface water availability analysis for the purpose of evaluating existing water supplies. Select modifications utilized in the development of the surface water availability models are summarized in Appendix B and available at www.twdb.texas.gov/waterplanning/rwp/planningdocu/2021/hydroassumptions.asp. Of note is that House Bill 723, enacted by the 86th Texas Legislature (2019),

Figure 5-3. Texas' annual surface water availability and existing surface water supply (acre-feet)



directed the Texas Commission on Environmental Quality to update the Brazos, Neches, Red, and Rio Grande water availability models by December 1, 2022. These updated models will be available and utilized in the next state water plan.

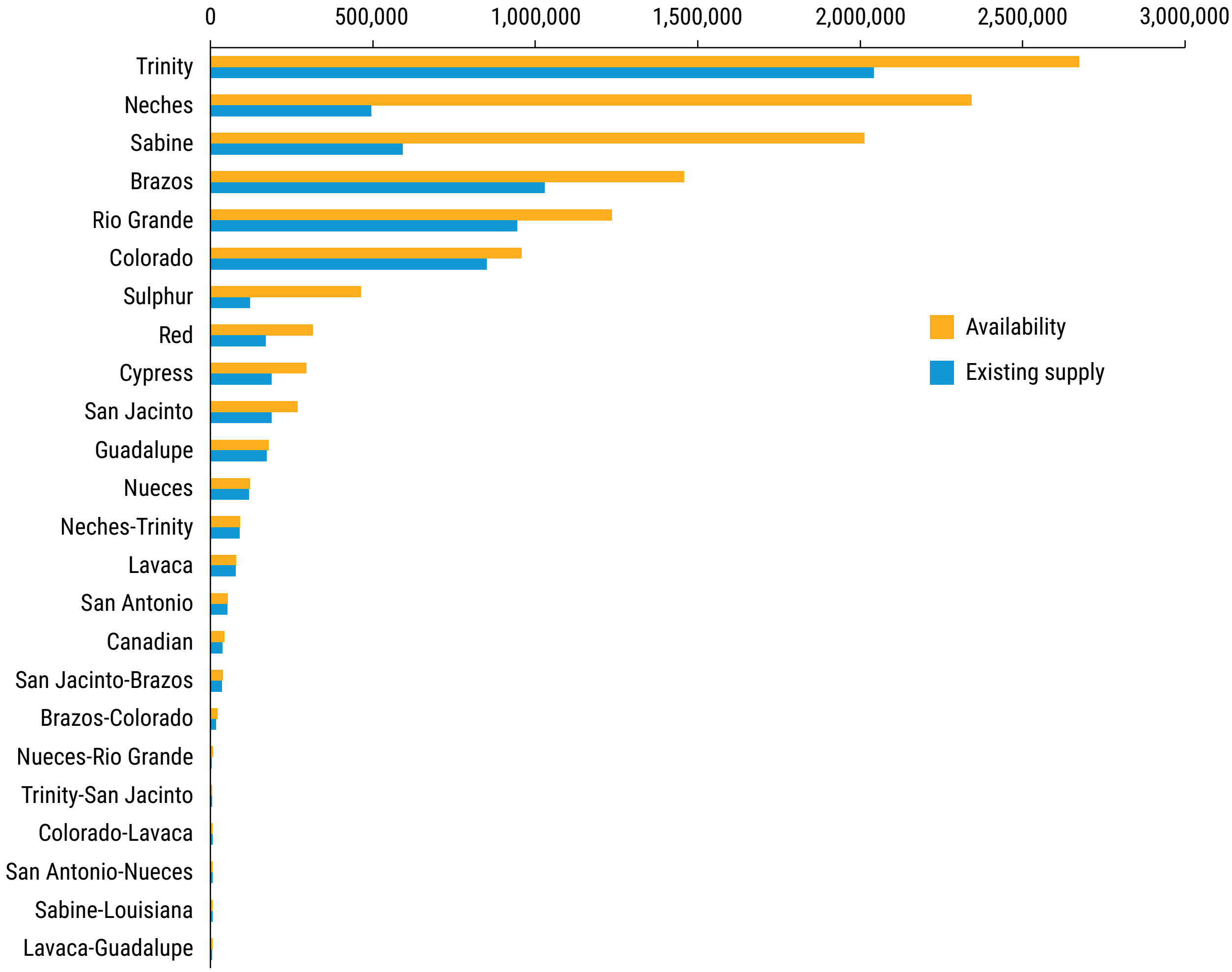
Surface water availability for *future* water management strategies (Chapter 7) was evaluated using WAM Run 3 unless an alternative model produced more conservative yields or the water management strategy itself was based on departing from the default model parameters. For example, if a senior water right is to be "subordinated" to a junior water right to increase the reliability of the junior water right, the alternative model would be used.

Overall surface water availability in Texas, represented as the sum of all reservoir firm yields, approved safe yields, and run-of-river availabilities as determined by the planning groups, is anticipated to decline by approximately 3 percent from 2020 to 2070 (Figure 5-3). The decline is primarily due to sedimentation, which reduces reservoir storage. Other factors not presently accounted for in the methodology for assessing surface water availability, but which may impact it, include stream-aquifer interactions, changes over time to reservoir inflows, and evaporative loss from reservoirs. More than half of the annual statewide surface water availability of 12.7 million acre-feet in 2020 occurs within the Trinity, Neches, and Sabine river basins (Figure 5-4, Table B-2).

5.3 Future surface water availability

Surface water availability may actually be increased by implementing certain types of water management strategies. By capturing and storing streamflows, for example, the construction of a new reservoir can increase the reliable volume of permitted water available for annual diversion. However, future surface water availability may also be limited to address environmental needs, such as environmental flow standards placed on permits and reflected in water availability modeling.

Figure 5-4. Annual surface water availability and existing surface water supplies by river and coastal basin in 2020 (acre-feet)

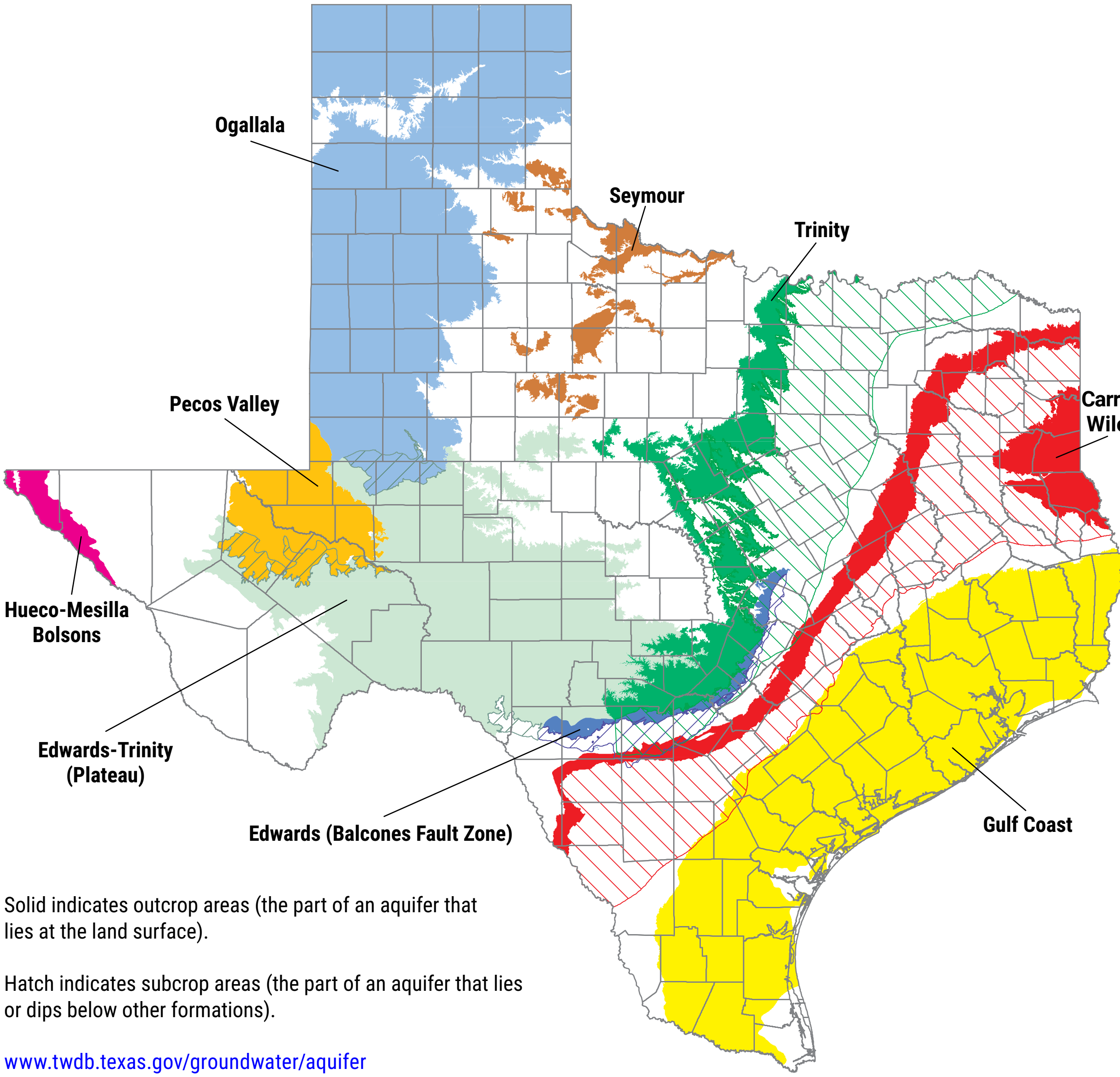


In cases where no environmental flow standards were adopted by the Texas Commission on Environmental Quality, planning groups were required to model diversions based on the Consensus Criteria for Environmental Flow Needs developed through a stakeholder process by the TWDB, the Texas Parks and Wildlife Department, and the Texas Commission on Environmental Quality. Alternatively, planning groups may utilize more detailed site-specific studies when available. Many recommended water management strategies remain subject to permitting requirements administered by the Texas Commission on Environmental Quality, regardless of the approach taken to estimate project yields or to consider environmental flow needs during the planning process.

5.4 Groundwater availability of aquifers

Groundwater supply in Texas comes from 9 major and 22 minor aquifers as well as other water-bearing geologic formations around the state. Major aquifers produce large amounts of water over large areas (Figure 5-5), whereas minor aquifers produce minor amounts of water over large areas or major amounts of water over small areas (Figure 5-6). Since the 2017 State Water Plan was adopted, the TWDB designated the Cross Timbers Aquifer as a minor aquifer. Groundwater availability is estimated through a combination of policy decisions made by groundwater conservation districts through joint groundwater planning and the ability of an aquifer to transmit water to wells.

Figure 5-5. Major aquifers of Texas



Solid indicates outcrop areas (the part of an aquifer that lies at the land surface).

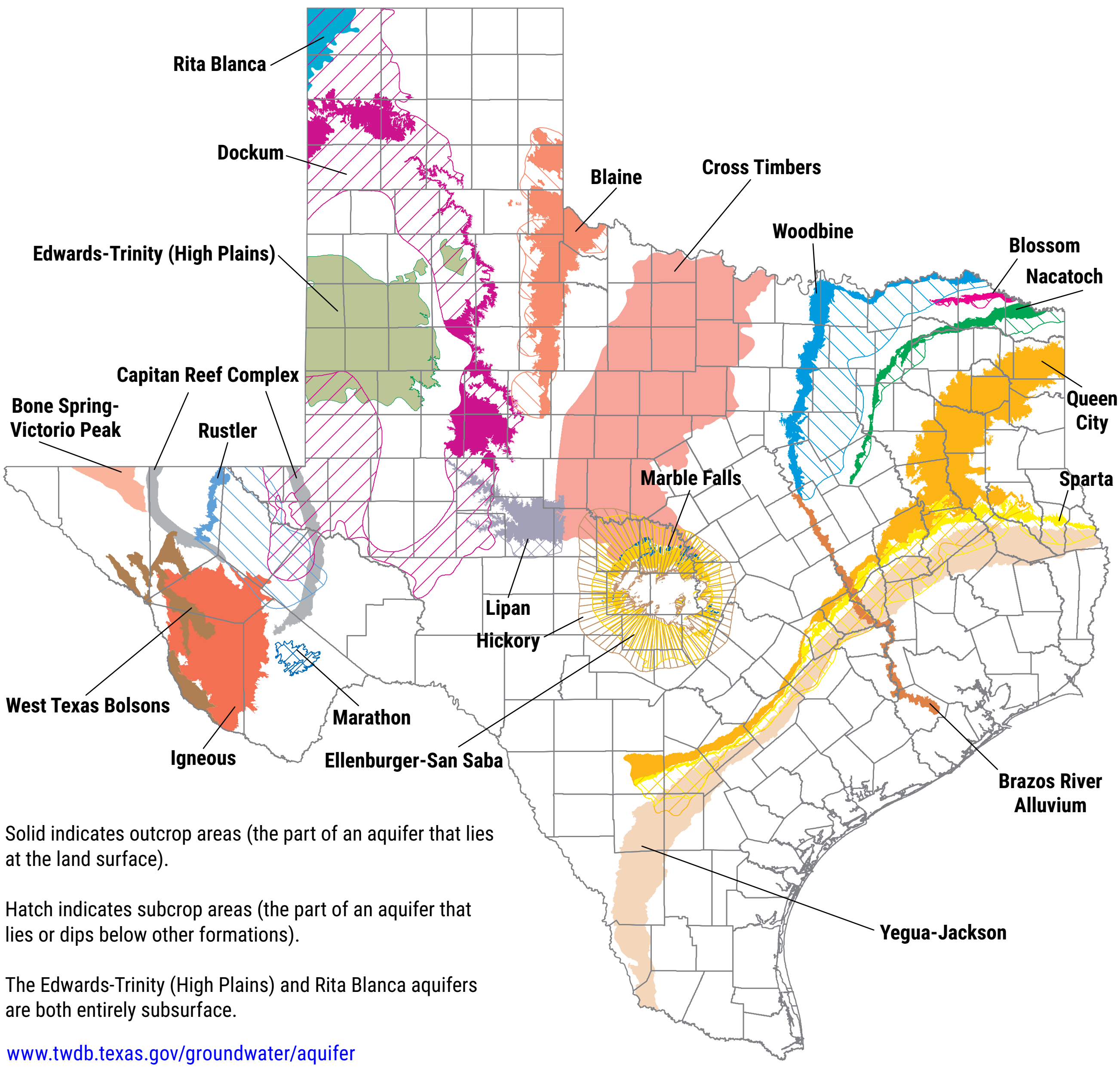
Hatch indicates subcrop areas (the part of an aquifer that lies or dips below other formations).

www.twdb.texas.gov/groundwater/aquifer

Groundwater is governed by the rule of capture, which may be modified where groundwater conservation districts and subsidence districts exist (Figure 5-7). Districts may issue permits that regulate pumping of groundwater and spacing of wells within their jurisdictions. Groundwater conservation districts within the state's groundwater management areas work together to determine groundwater management policies (desired future conditions of relevant aquifers) within that area. These policies inform the groundwater availability utilized in the state's water planning process.

Desired future conditions are the desired, quantified conditions of groundwater resources (such as water levels, water quality, spring flows, or storage volumes) at one or more specified future times. The desired future conditions are defined by participating groundwater conservation districts within a groundwater management area as part of the joint planning process. The TWDB uses desired future conditions to determine a modeled available groundwater value for an aquifer or part of an aquifer in the groundwater management area. A modeled available

Figure 5-6. Minor aquifers of Texas



Solid indicates outcrop areas (the part of an aquifer that lies at the land surface).

Hatch indicates subcrop areas (the part of an aquifer that lies or dips below other formations).

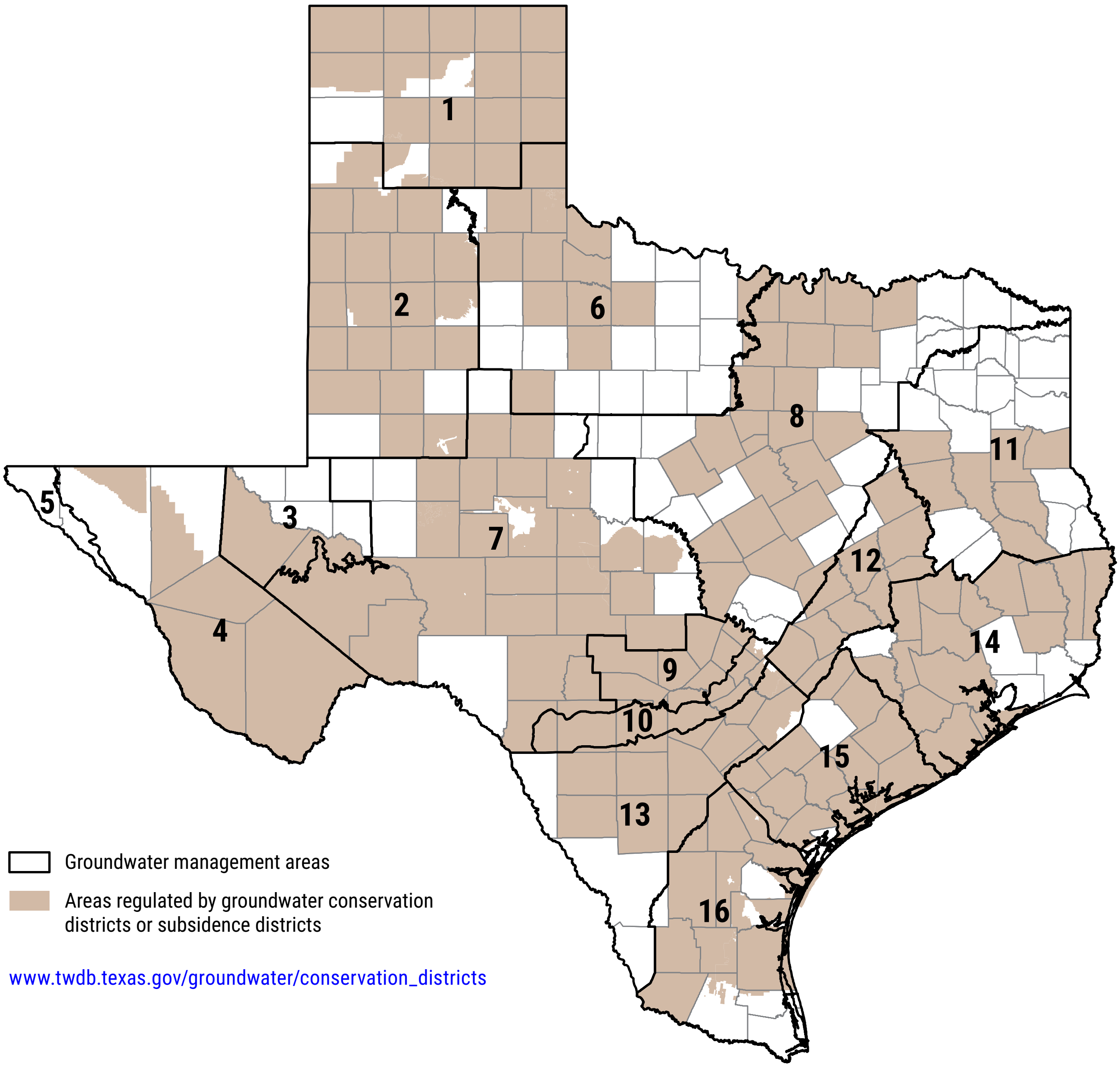
The Edwards-Trinity (High Plains) and Rita Blanca aquifers are both entirely subsurface.

www.twdb.texas.gov/groundwater/aquifer

groundwater value is the volume of groundwater production, on an average annual basis, that will achieve a desired future condition. These values are independent of existing pumping permits and may, depending on the aquifer characteristics and how the desired future conditions are defined, include a variety of water quality types, including brackish groundwater. Depending on the aquifer and location, the amount of brackish groundwater in modeled available groundwater values may require local and regional supply evaluations.

Modeled available groundwater volumes account for most of the groundwater availability considered in this plan. In response to concerns that most of these volumes were developed using groundwater availability models calibrated for long-term average conditions rather than drought of record, the TWDB revised its planning rules after the 2017 State Water Plan to allow for use of a *modeled available groundwater peak factor*.

Figure 5-7. Locations of groundwater conservation districts or subsidence districts and 16 groundwater management areas



A peak factor allows regional water planning groups to develop plans, where appropriate, that reflect more realistic groundwater availability in drought conditions. The modeled available groundwater peak factor accommodates short-term pumping above the modeled available groundwater value as long as it can be shown that the desired future conditions will still be met. It can accommodate anticipated fluctuations in pumping between wet and dry periods or account for other shifts in the timing of pumping while remaining consistent with desired future conditions. This approach reflects additional potential groundwater that could be available for pumping over limited periods of time in drought and is utilized for regional water planning purposes only—not permitting. The peak factor is not intended as a limit to permits or as guaranteed approval or pre-approval of any future permit application.

Subject to many variables, some examples of when the modeled available groundwater peak factor might be considered, while still achieving the desired future conditions, are the following:

- Actual pumping in wetter years is expected to fall below the modeled available groundwater, thereby allowing intermittent pumping of volumes greater than the modeled available groundwater during drought.
- Groundwater pumping in early decades is expected to consistently remain well below the modeled available groundwater, thereby accommodating pumping volumes somewhat higher than the modeled available groundwater in later decades.

The use of modeled available groundwater peak factors requires review and approval by relevant groundwater conservation districts, groundwater management areas, regional water planning groups, and the TWDB executive administrator. The peak factor is optional for planning groups, and two planning groups (Regions G and H) utilized the approach in this round of planning.

For aquifers and portions of aquifers that did not have modeled available groundwater values, planning groups determined availability in consultation with the TWDB. An exception to this is Texas Water Code Section 16.053(e)(2-a) that allows a regional water planning group to define all groundwater availability within its region as long as there are no groundwater conservation districts within the regional water planning area. This was added through Senate Bill 1101 from the 84th Legislative Session, and this is the first state water plan in which this provision applies. It is only applicable to the Northeast Texas Regional Planning Group, or Region D. The groundwater availability values estimated by Region D were reviewed by the TWDB to ensure physical compatibility with desired future conditions in groundwater conservation districts within co-located groundwater management areas.

The TWDB has been charged by the legislature to identify and designate brackish groundwater production zones in the state for certain aquifers by December 1, 2032. The TWDB's Brackish Resources Aquifer Characterization System, or BRACS, program has completed 12 studies and has four ongoing studies. As of publication of the 2022 State Water Plan, the TWDB has designated a total of 31 brackish groundwater production zones in the following aquifers: Carrizo-Wilcox, Gulf Coast, Rustler, Blossom, Nacatoch, and Northern Trinity aquifers. Since the last state water plan, there has been a net increase in the 2020 brackish groundwater availability of approximately 138,000 acre-feet per year and approximately 182,000 acre-feet per year in 2070. The BRACS program continues to study the aquifers of the state, which will enable the identification of additional possible brackish groundwater sources for planning purposes.

On a statewide basis, total groundwater availability is projected to decline by approximately 25 percent from 2020 to 2070 (Figure 5-8). This decrease is primarily due to reductions in groundwater availability in the Ogallala/Edwards-Trinity (High Plains), Ogallala/Rita Blanca, and Ogallala aquifers and revised desired future conditions since the 2017 State Water Plan (Appendix B).

Annual statewide groundwater availability in 2020 is estimated to be 14.2 million acre-feet. Just over half of that comes from the Ogallala/Edwards-Trinity (High Plains), Ogallala, and Gulf Coast aquifers (Figures 5-9 and 5-10, Table B-4).

5.5 Future groundwater availability

For planning purposes, future groundwater availability cannot be increased by implementing water management strategies other than aquifer recharge-type projects. These are different from aquifer storage and recovery projects, which generally provide underground storage of water from another source and are not a mechanism to actually increase an aquifer's groundwater availability. Changes in groundwater availability

Figure 5-8. Texas' annual groundwater availability and existing groundwater supplies (acre-feet)

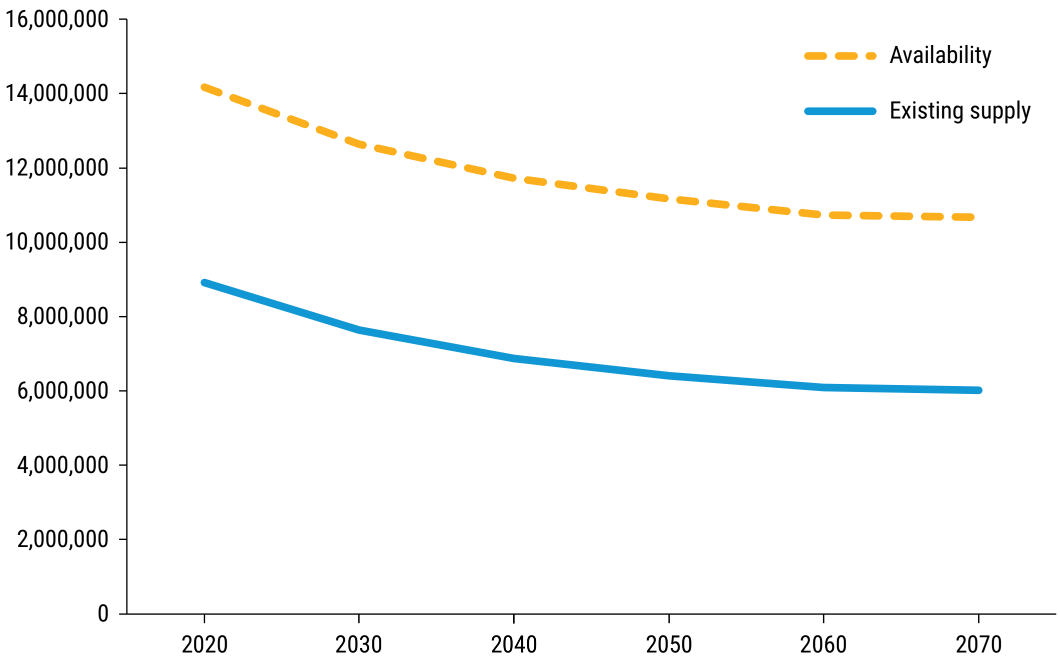
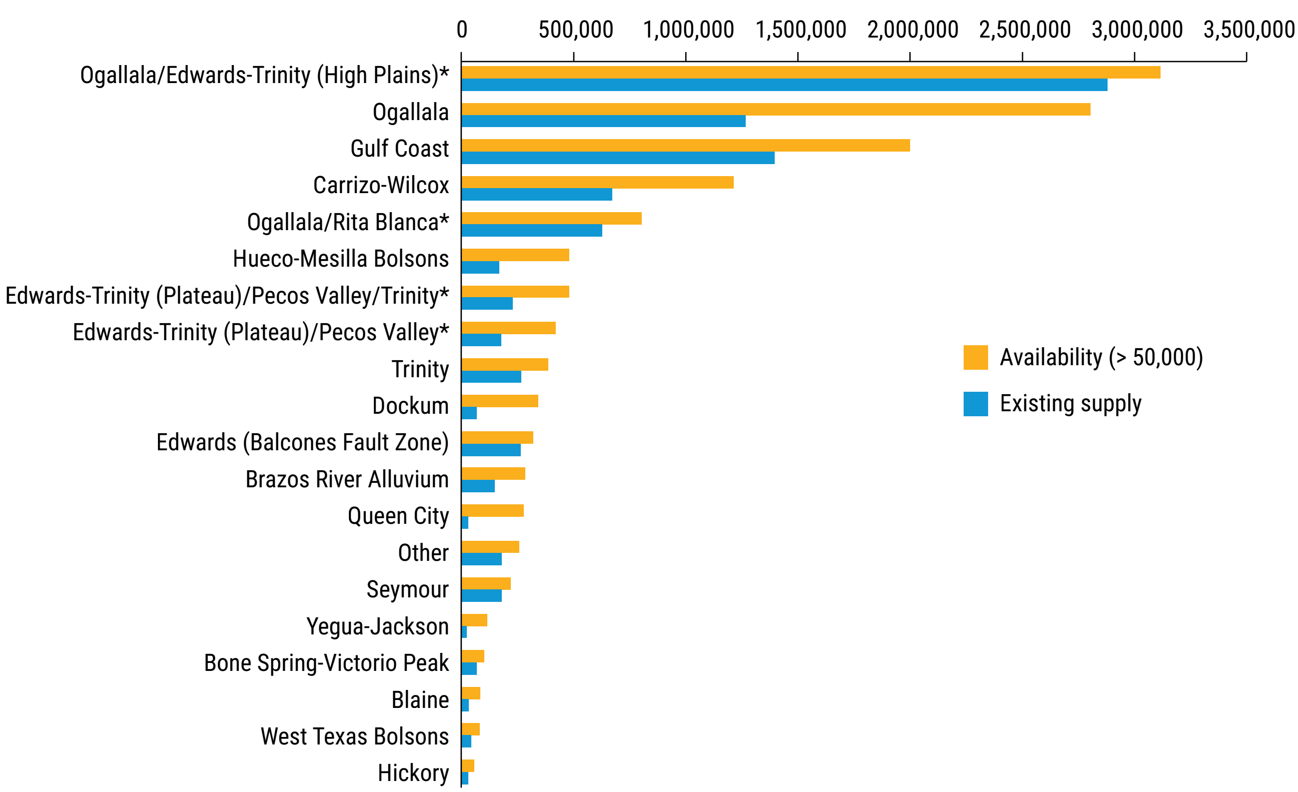
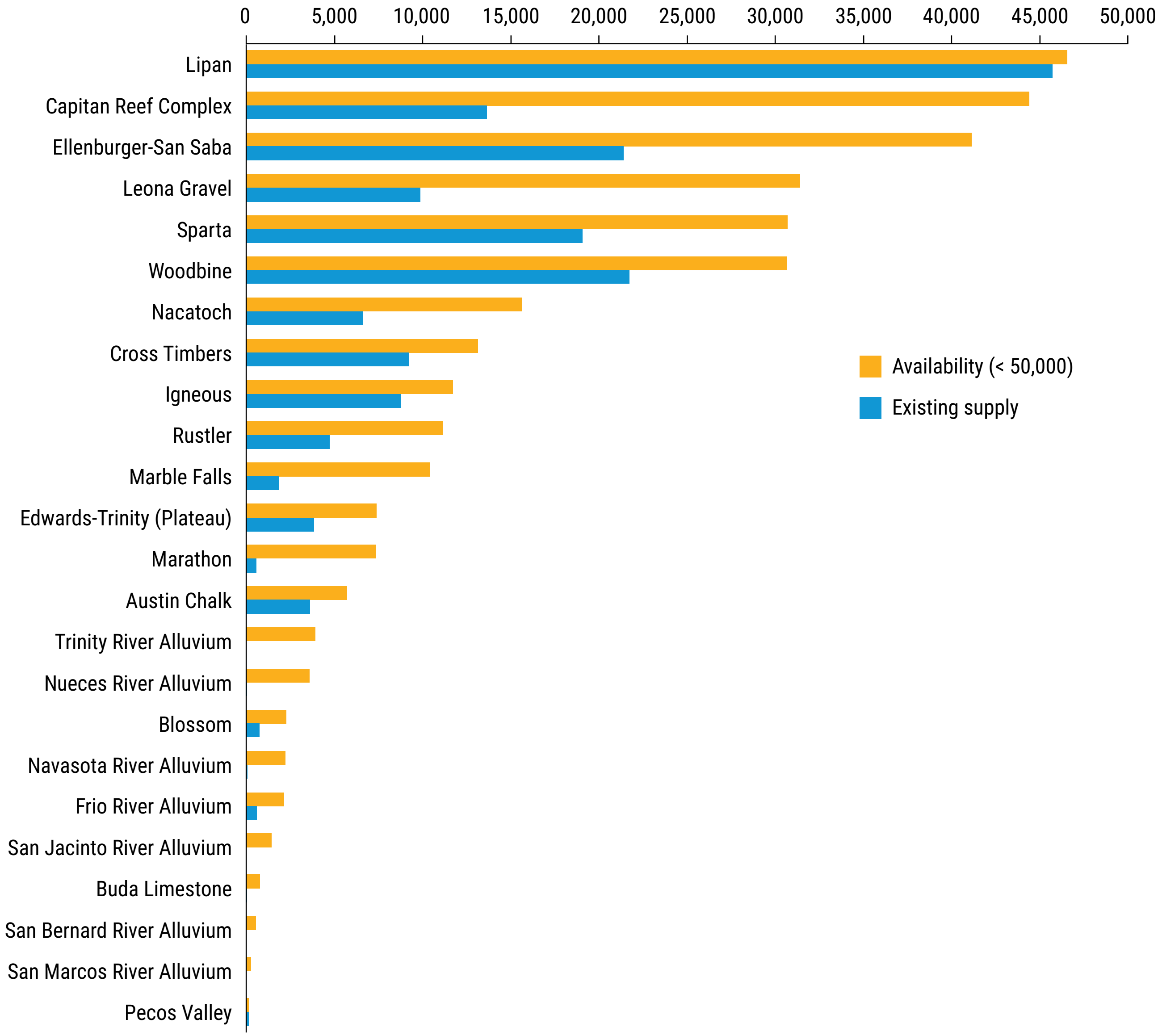


Figure 5-9. Annual groundwater availability greater than 50,000 acre-feet and existing groundwater supplies by aquifer in 2020 (acre-feet)



** The Ogallala/Edwards-Trinity (High Plains); Ogallala/Rita Blanca; Edwards-Trinity (Plateau)/Pecos Valley/Trinity; and the Edwards-Trinity (Plateau)/Pecos Valley are aquifer combinations that reflect specific groundwater management policy decisions based on aquifer properties. In these cases, the modeled available groundwater and existing supply values have likewise been developed to honor these aquifer combinations.*

Figure 5-10. Annual groundwater availability less than 50,000 acre-feet and existing groundwater supplies by aquifer in 2020 (acre-feet)

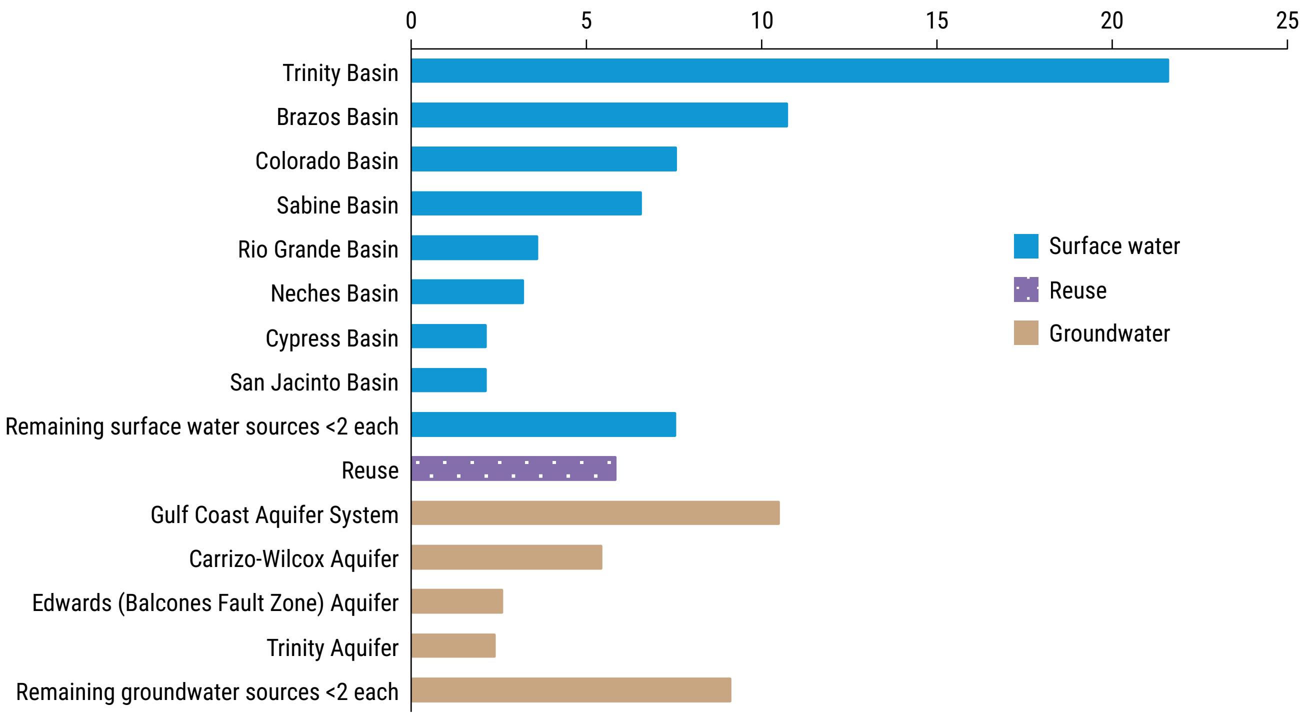


between state water plans is largely attributed to changes in groundwater management policies as revised through the state's groundwater joint planning process. Additionally, updates or revisions to groundwater availability models or newly developed local studies bring new data to the process and may result in different availability estimates from previous plans. More details on differences across the groundwater joint planning process cycles are included in Appendix B.

5.6 Availability of other sources

The vast majority of Texas' water supply comes from river basins and aquifers, but seawater and reclaimed wastewater for reuse represent other widely available sources of water. Seawater availability is generally limited only by the ability to legally access it along the coast. The availability of reclaimed wastewater for reuse, on the other hand, changes over time and is limited by the amount of wastewater generated by water users

Figure 5-11. Shares of total, statewide existing municipal, steam-electric, manufacturing, and mining supply by water source in 2020 (percent)



at any given time unless a water use permit or agreement states otherwise.

5.7 Existing supplies

The share of available surface and groundwater that can be legally produced and delivered to water user groups based on existing infrastructure—the existing supply—during a repeat of the drought of record is influenced by many factors. For example, a reservoir may have a large volume of available water, but existing water supplies that can be delivered to users may be limited by pipeline infrastructure, treatment plant capacity, or legal permits to divert water. Based on the volume of available water at each source, planning groups evaluated the share of supplies that can be relied upon to meet water demands in the event of drought. The planning group analyses considered both legal and physical limitations of the supplies for each water user group.

Relying on and combining water sources for each water user group varies greatly by group and location. Statewide, surface water makes up almost two-thirds of the total existing water supply (8.9 million acre-feet per year) for municipal, manufacturing, steam-electric, and mining users (Figure 5-11). However, irrigation and livestock users rely on groundwater for 80 percent of their total existing water supply (7.9 million acre-feet per year) (Figure 5-12). Overall, reuse contributes 4 percent to total existing supplies, primarily in the municipal, irrigation, and manufacturing sectors.

In 2020, Texas' existing water supply of approximately 16.8 million acre-feet consists roughly of half surface water and half groundwater, with reuse contributing 4 percent. By 2070, existing water supply is projected to decline 18 percent, to approximately 13.8 million acre-feet per year (Table 5-1, Figure 5-13), although changes in supply to water user groups vary significantly by location.

Figure 5-12. Shares of existing irrigation and livestock supply by water source in 2020 (percent)

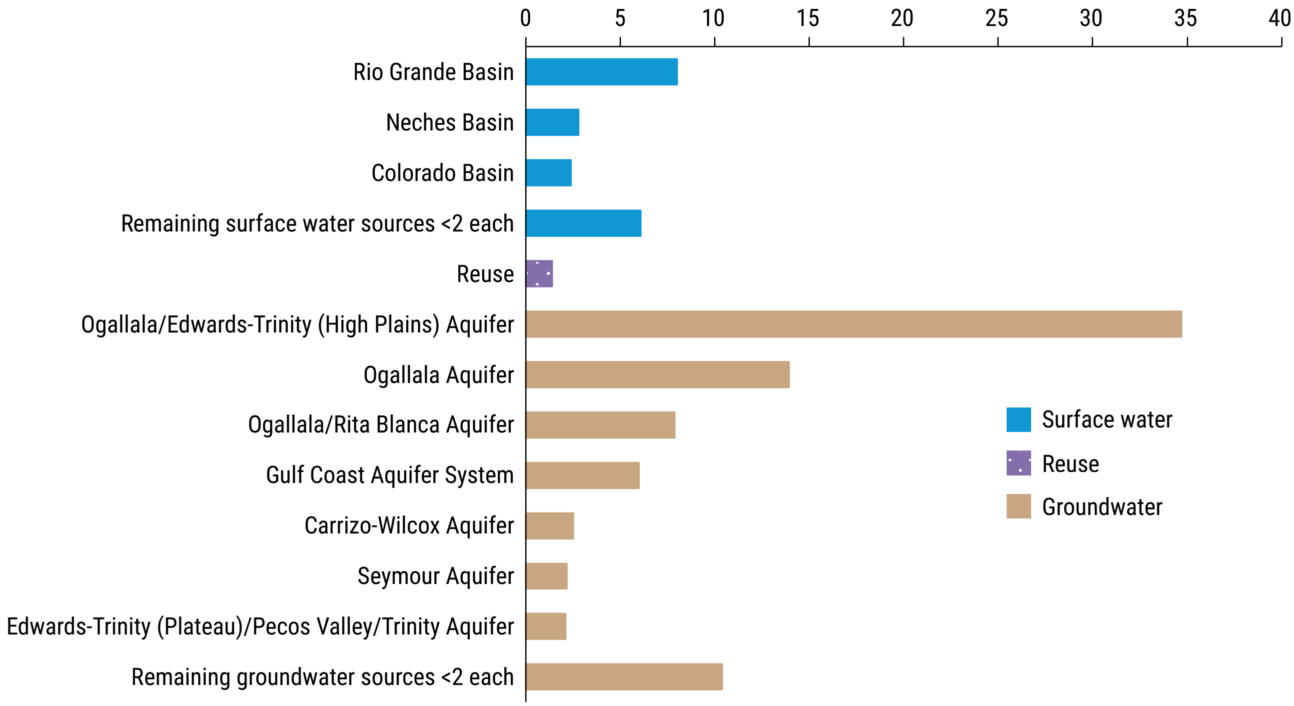


Table 5-1. Texas' annual existing water supply (acre-feet)

Source	2020	2030	2040	2050	2060	2070	Percent change
Surface water	7,232,000	7,184,000	7,153,000	7,126,000	7,107,000	7,080,000	-2
Groundwater	8,912,000	7,638,000	6,869,000	6,407,000	6,092,000	6,023,000	-32
Reuse	620,000	640,000	661,000	676,000	704,000	714,000	15
Texas[a]	**16,764,000**	**15,462,000**	**14,683,000**	**14,209,000**	**13,903,000**	**13,817,000**	**-18**

[a] *Does not reflect some portions of existing supplies that are associated with purely saline water sources such as untreated seawater.*

Surface water supply

Total annual existing surface water supply is anticipated to remain generally stable, declining approximately 2 percent from 2020 through 2070 (Figure 5-3, Table B-3). The decrease is primarily due to sedimentation decreasing the storage capacity of many reservoirs. However, factors not projected in the model results, including changes to inflow or evaporative loss, contribute uncertainty to the noted decline.

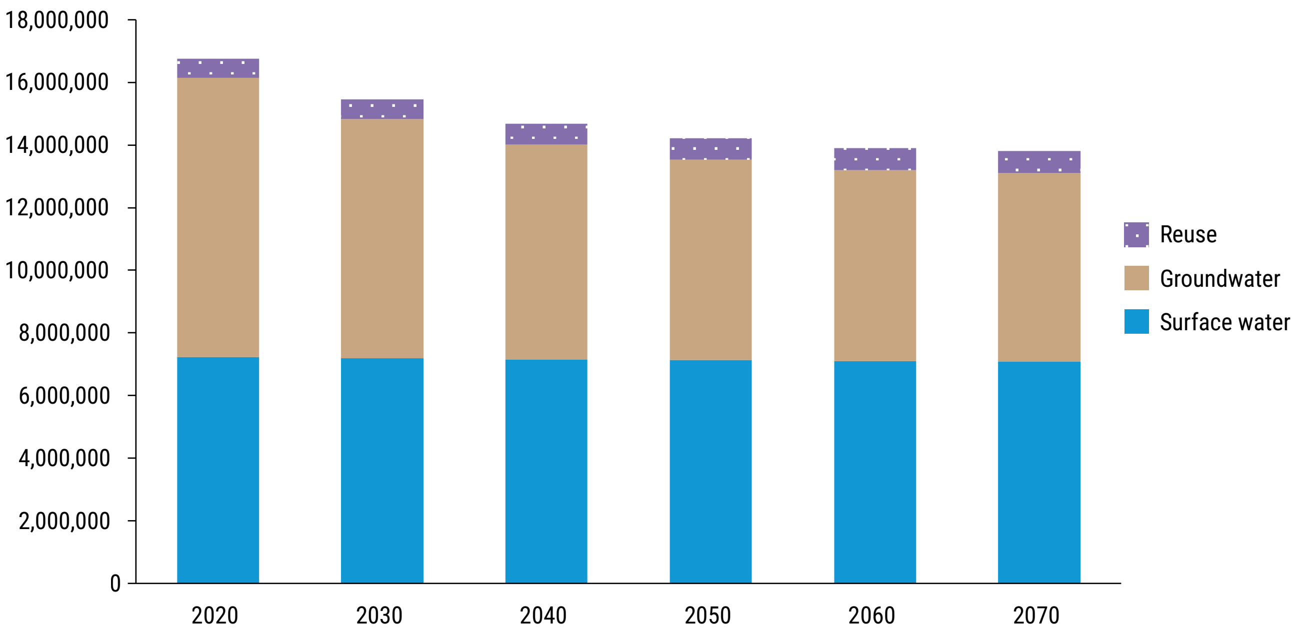
Groundwater supply

Total annual existing groundwater supply is anticipated to decline about 32 percent from 2020 to 2070 (Table B-5). The decline is due primarily to reduced availability from the Ogallala Aquifer, based on its managed depletion, and the Gulf Coast Aquifer, based on regulatory limits and management goals aimed at reducing groundwater pumping in the long-term to limit land surface subsidence (Figure 5-8). Of these groundwater supplies, the total annual supply from brackish sources remains relatively stable from 2020 to 2070.

Reuse supply

Total annual reuse supply makes up nearly 4 percent of total supplies in 2020, with approximately

*Figure 5-13. Texas' projected annual existing water supply (acre-feet)**



** Does not reflect some portions of existing supplies that are associated with purely saline water sources such as untreated seawater.*

half of this supply occurring in Region C. Reuse supplies are estimated to increase statewide about 15 percent from 2020 to 2070 (Table 5-1).

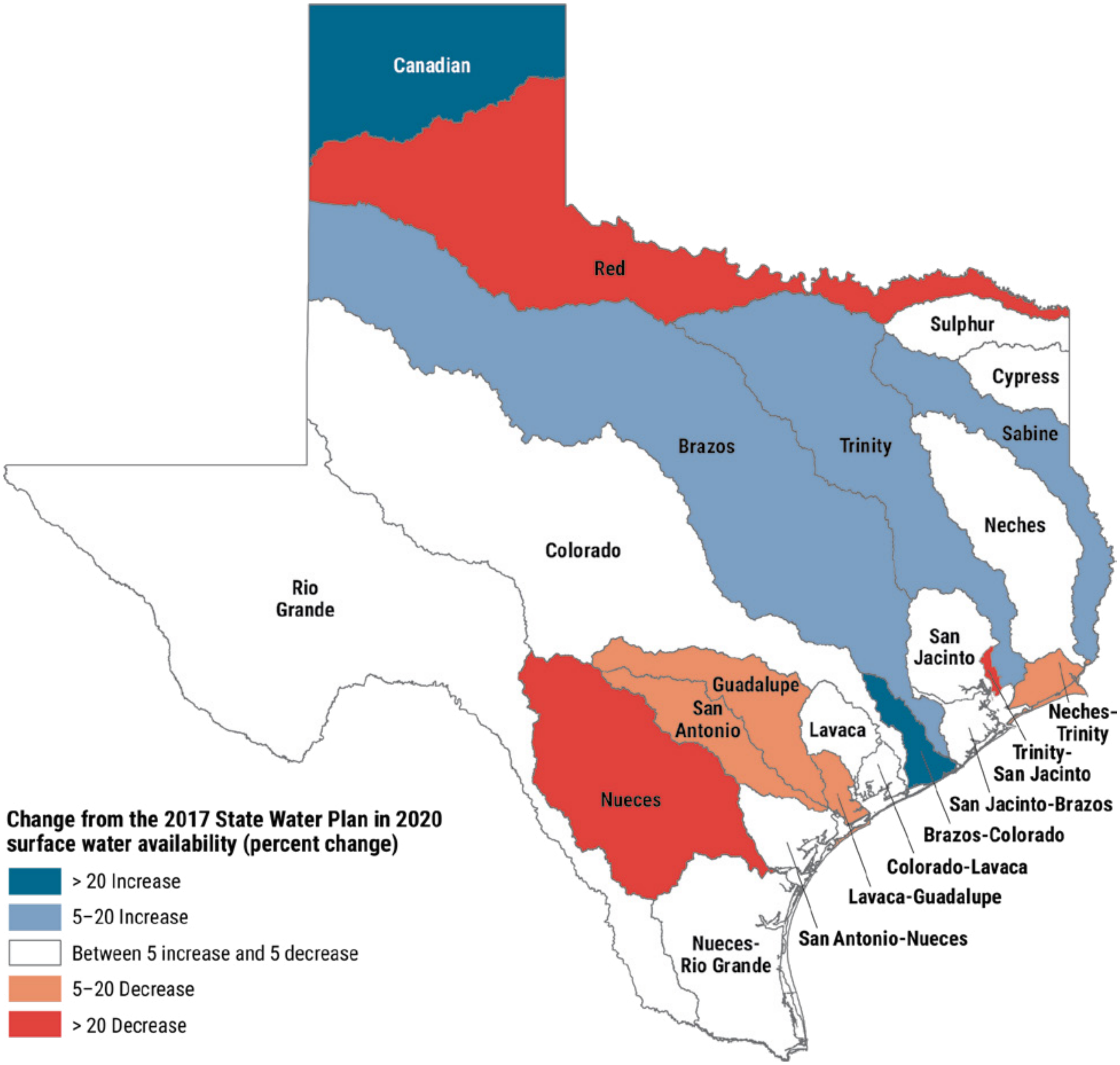
Source availability for future development

The share of available water that remains to be developed for water supply varies by water source. In the Trinity River Basin, three-fourths of the available water is committed as existing surface water supplies, but only about one-third of the Sabine and one-fifth of the Neches basins' availability are similarly connected as supply (Figure 5-4). In the Ogallala/Edwards-Trinity (High Plains), Edwards (Balcones Fault Zone), Seymour, and several other, smaller aquifers, more than 80 percent of the available water is connected as existing supply, whereas less than 20 percent of the Dockum and Queen City aquifers is connected as existing supply (Figure 5-9). Any remaining available water beyond that already connected as existing supply can, in concept, be the water source to support a recommended water management strategy, subject to many feasibility factors including its proximity to identified water needs and costs. However, there are factors unrelated to water source availability that can also reduce the existing supply of specific water users, including declines in groundwater levels relative to a well pump intake, reduced reservoir surface levels relative to an intake elevation, groundwater quality degradation, and expiring water supply contracts.

5.8 Comparison to the 2017 State Water Plan

Many factors have affected estimates of water availability and existing water supplies since adopting the 2017 State Water Plan, including policy decisions, modeling assumptions, accumulated historical streamflow data, additional information regarding physical and legal constraints to supplies, and implementation of water supply projects during the intervening years. When comparing the planning decades of 2020 through 2070 statewide, changes range greatly by water source location and user.

Figure 5-14. Changes from the 2017 State Water Plan in annual surface water availability in 2020



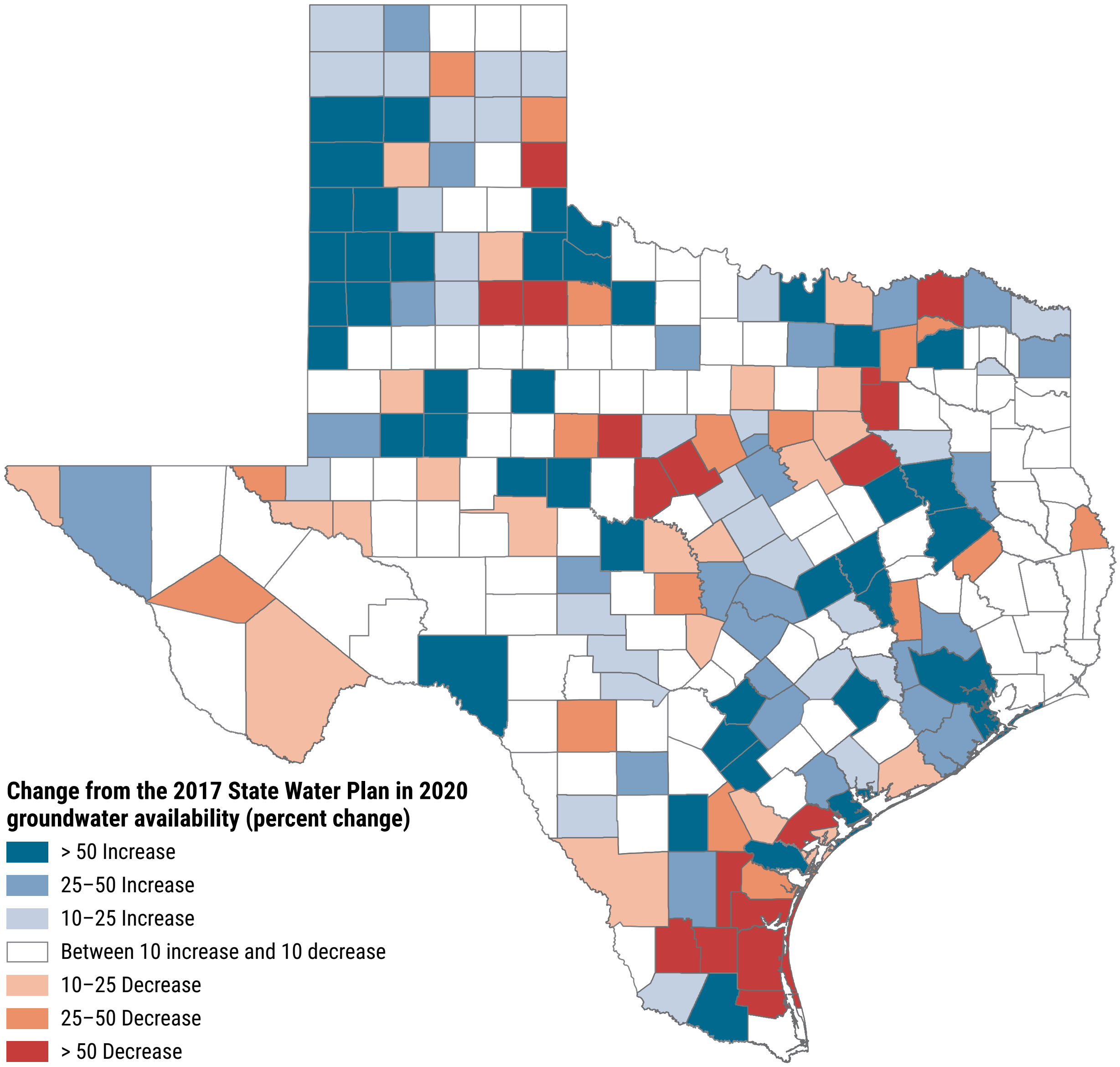
Surface water

Statewide, there is more surface water availability but less existing supply as compared to the last plan, although this varies significantly by location (Figure 5-14). The greatest relative change is an approximate 186 percent increase in existing surface water supplies in 2020 in the Canadian Basin due to revised modeling assumptions.

Groundwater

Both groundwater availability and supply increased as compared to the 2017 State Water Plan. Statewide, availability increased, though there was considerable variation by county, including relatively more decreases in western and southern counties (Figure 5-15). The greatest relative change in statewide availability occurred for the planning decade 2020, with an approximate 15 percent increase primarily due to policy decisions made as part of the groundwater management

*Figure 5-15. Changes from the 2017 State Water Plan in annual groundwater availability in 2020**



** In the 2022 State Water Plan, modeled available groundwater peak factors were used to determine groundwater availability for certain aquifers in the following counties: Austin, Brazoria, Brazos, Madison, Montgomery, Walker, and Waller. Availability increases shown in these counties reflect changes in groundwater availability reported for regional water planning purposes and do not necessarily reflect increases in resource availability since the 2017 State Water Plan.*

area joint planning process, although updated groundwater availability models may have contributed to noted differences. Additionally, groundwater availability reported for regional water planning purposes increased in several counties in Regions G and H where modeled available groundwater peak factors were utilized. Statewide, existing supply increased in all decades as compared to the 2017 State Water Plan.

Reuse

Existing reuse supply is slightly higher in the decades from 2020 to 2050 but decreases slightly in the 2060 and 2070 decades as compared to the 2017 State Water Plan. The greatest relative change was an approximate 10 percent increase in 2020, attributed to the implementation of direct and indirect reuse projects primarily in Regions B, C, and H.

5.9 Uncertainty of our future water supply

Because hydrology—the study of water in the natural environment—is highly complex, there will always be significant uncertainty over the future timing and quantity of available water resources. Precipitation, temperature, evaporation, wind, and soil moisture conditions all play roles in determining how much water moves in and through Texas' streams, reservoirs, and aquifers. Further, the interrelated nature of these variables makes it difficult to quantify and predict when, where, or to what degree hydrologic events will impact water supply. In some cases, snowfall in southern Colorado and rainfall in northern Mexico impact Texas' water availability. Additionally, non-climate-related variables, such as the introduction and spread of invasive species, can also impact the use of certain water sources.

Texas' water plans are based on benchmark drought of record conditions using historical hydrologic data. While the TWDB recognizes that the full sequence of historical hydrologic events will never be repeated exactly, the droughts have been of such severity that it is reasonable to use them for the purpose of planning. However, uncertainty about the likelihood or severity of worse future droughts limits the ability to predict future water availability. Some planning groups have begun to address drought uncertainty by utilizing conservative (safe) yields or a management supply factor, a pre-determined or other ratio to which existing and future supplies will exceed demands, to assess project needs. Some larger water providers across the state have conducted drought scenario planning that considers the possibility of worse droughts for their individual long-range plans, but smaller entities may not have the resources or technical expertise to develop similar analyses for managing their systems. These types of assessments are integral to identifying the likelihood and severity of potential future water supply shortages.

Quantifying surface water availability for state water planning purposes relies largely on deriving a single firm yield or safe yield value that has been generated based on the historical record that includes the drought of record, which serves as the benchmark condition for Texas' long-term water planning. This approach has provided a reasonable basis for long-term planning. The implicit assumption that any firm yield is 100 percent reliable is a weak assumption and an inherent uncertainty. A single, specific water supply firm yield estimated using a specific hydrologic time-series has a singular probability of occurring. Likewise, it has a risk (the inverse probability) of *not* occurring, which is not generally acknowledged or mitigated against in the current planning process. Similarly, quantifying groundwater availability involves inherent uncertainty related to the complexity of aquifer systems, the overlay of evolving state laws, and the dynamic nature of legal cases that may affect groundwater policy and management.

Regional and state water planning address uncertainties related to water supply and demand, including related to climate variability, in a primarily adaptive manner rather than in a speculative manner. There currently isn't much agreement among climate models (or scientists) about the nature of long-term changes to water resources in Texas and no forecasting tools capable of providing quantitative certainty about future water resources in Texas at the resolution needed for water planning. However, efforts to improve technical capabilities and address uncertainty are in progress. To provide the best available, actionable science, grounded in observed data and trends, the TWDB continues to collect data, provide technical services, improve water availability models, and support studies for consideration in developing the next state water plan. Further, the TWDB will continue to expand its understanding of the interactive relationship between the rivers and aquifers of Texas to improve planning and better inform future water management and policy decisions.