

TECHNICAL PAPER A-6
ASSUMPTIONS UNDERLYING THE WATER AVAILABILITY MODEL
USED TO SUPPORT DEVELOPMENT OF THE
LCRA WATER MANAGEMENT PLAN REVISION
January 2026

This paper summarizes the basic assumptions included in the Water Availability Model (WAM) supporting the revision of the Water Management Plan (WMP) (“the “WMP WAM”). The WMP WAM incorporates estimated 2032 conditions for firm demands for LCRA’s municipal, industrial and other firm water customers, reservoir storage capacity for lakes Buchanan and Travis, and irrigation demands for LCRA’s lower basin customers.

1. GENERAL

- 1.1. The TCEQ’s Water Availability Model of the Colorado River basin (Run 3) forms the basic structure for the WMP WAM, and this model is assumed to appropriately reflect water rights and hydrologic conditions in the basin to provide for meaningful and accurate simulations of water availability. The July 2018 version of the Texas A&M University “Water Rights Analysis Package” (WRAP)¹ is the program code used for all WAM simulations.
- 1.2. To support the revision of the WMP, TCEQ’s WAM was adapted to better represent an operational model of LCRA’s water supply system, including the incorporation of specific rules to approximate the operation of lakes Buchanan and Travis and provide water to LCRA’s water customers.
- 1.3. The WMP WAM includes the “no-call” assumption with regard to all water rights located upstream of lakes Buchanan and Travis (“cutoff model”).² This assumption, in effect, makes all water rights upstream of lakes Buchanan and Travis senior in priority to lakes Buchanan and Travis and other downstream water rights.
- 1.4. The 1940-2016 monthly naturalized flows and net evaporation rates included in the TCEQ’s Run 3 WAM for the Colorado River basin have been extended through calendar year 2023³, and this extended database was used to define the simulation period for the WMP WAM. These data are representative of actual variations in hydrologic conditions including through the previous drought of record in the 1950s and the current drought of record in the 2010s.
- 1.5. Water demands for all surface water rights in the Colorado River basin that are not partially or wholly supplied by LCRA’s water delivery system (lakes Buchanan and Travis and LCRA’s lower basin water rights) are conservatively assumed to be equal

¹ Wurbs, R. A., Water Rights Analysis Package (WRAP) Modeling System Reference Manual. Technical Report No. 255, Texas Water Resources Institute, College Station, TX. 12th Edition, July 2018

Wurbs, R. A., Water Rights Analysis Package (WRAP) Modeling System Users Manual. Technical Report No. 256, Texas Water Resources Institute, College Station, TX. 12th Edition, July 2018

² The “no-call” assumption in the WAM is an attempt to reflect the various agreements that LCRA has with upstream reservoir owners, i.e. Colorado River Municipal Water District, San Angelo Water Supply Corporation, and Brown County WID No. 1, and to better represent actual conditions with regard to the operation of existing water rights throughout the basin.

³ The naturalized flows for the 1999-2016 period were developed using the same methodology applied in developing the original WAM for the Colorado River basin.

to the maximum annual diversion amounts authorized by their individual water rights as reflected in TCEQ's Run 3 WAM.

2. LOWER BASIN RELIABLE RUN-OF-RIVER SUPPLIES

2.1. In the WMP WAM, the supply of run-of-river water originating downstream of Mansfield Dam made available for diversion was limited to the sum of flows historically reliable in the lower segments of the Colorado River and the return flows discharged from the City of Austin and City of Pflugerville wastewater treatment plants.⁴ This approach was taken to more accurately reflect the actual quantity of releases (inflow pass-throughs and stored water) from lakes Buchanan and Travis needed to meet LCRA's downstream demands in a manner consistent with historical operations.

2.2. The downstream reliable river flows (not including discharged return flows) were estimated by LCRA staff for specific reaches of the river using streamflows during low-flow periods in 1999 and 2005. These quantities are stipulated in the WMP WAM as follows:

Mansfield Dam to Austin gauge	2,600 acre-feet/month
Austin gauge to Bastrop gauge	0 acre-feet/month
Bastrop gauge to Columbus gauge	3,900 acre-feet/month
Columbus gauge to Wharton gauge	3,133 acre-feet/month
Wharton gauge to Bay City gauge	1,567 acre-feet/month

Hence, with regard to flows originating downstream of Mansfield Dam, there is a maximum of 11,200 acre-feet of downstream flow plus Austin and Pflugerville return flows in any given month assumed to be reliably available for supplying LCRA's downstream irrigation demands and certain other water supply customers, as discussed in section 2.3. The effective available flow simulated at any location is the lesser of the remaining reliable downstream river flow (including discharged return flows) and the unrestricted modeled available flow.

2.3. Demands downstream of Lake Travis that are met with run-of-river rights are subject to the availability of the reliable downstream river flows plus return flows. These demands include the four irrigation operations (Lakeside, Garwood, Pierce Ranch and Gulf Coast), Austin's run-of-river diversions at the Fayette Power Project (FPP), LCRA customers using the LCRA Garwood amendment (14-5434F), LCRA's Gulf Coast industrial customers, and the City of Corpus Christi using its water right. This method provides for a more realistic simulation of operations under the revised WMP, including the pass-through of run-of-river water originating upstream of Mansfield Dam and the releases of stored water from lakes Travis and Buchanan. In actual operations, LCRA does not intend to limit the ability of a downstream water

⁴ This limitation on available flows in the lower Colorado River is considered to be appropriate based on LCRA's historical operational experience attempting to provide pass-through flow and stored water from lakes Buchanan and Travis to downstream water users on a daily basis while also taking into consideration the actual river flows in the lower basin below Mansfield Dam that can be effectively diverted on a daily basis by the lower basin water users.

right holder to divert any run-of-river water that may be legally available under its water right.

- 2.4. Prior to any diversions being made, the total quantity of reliable downstream river flow at any location along the lower Colorado River is equal to the sum of Austin and Pflugerville return flows and the sum of the incremental reliable downstream river flows that originate in each of the upstream reaches of the river. The effective available flow at any location is the lessor of the remaining reliable downstream river flow and the unrestricted modeled available flow.
- 2.5. The total quantity of reliable downstream river flow at any location along the lower Colorado River is reduced as diversions are made upstream in priority order by the individual irrigation operations, industrial diversions made under the Gulf Coast water right, Austin at FPP, LCRA customers using the Garwood amendment, and the City of Corpus Christi using its water right at their respective diversion points.

3. MUNICIPAL, INDUSTRIAL, POWER GENERATION AND OTHER FIRM DEMANDS AND SUPPLIES

- 3.1. For the WMP WAM, municipal, industrial, power generation and other firm water demands partially or wholly supplied by LCRA represent projected 2032 conditions. The weather-varied method and development of a data set for 2032 demands is discussed in Technical Papers A1 and A2. All of the municipal, industrial, power generation and other firm water demands supplied from LCRA are satisfied either from run-of-river diversions or backed up with stored water from lakes Buchanan and Travis or from Arbuckle Reservoir. Before providing stored water supplies from lakes Buchanan and Travis, demands at Lake Austin to Fayette Power Plant are provided run-of-river supplies under the Garwood water right (14-5434G) as described in Section 10. Demands with a diversion point authorized by the Gulf Coast water right (14-5476) are first supplied using run-of-river diversions, then from stored water in Arbuckle Reservoir before using lakes Buchanan and Travis stored water as described in Section 11.
- 3.2. The City of Austin owns several water rights that are used to meet Austin's demands before using stored water from lakes Travis and Buchanan.
 - 3.2.1. Austin's municipal and industrial (M&I) demands are met first from the city's Certificate of Adjudication 14-5471, as amended, with stored water backup from lakes Buchanan and Travis. 3,413 acre-feet/year of Austin's M&I demand is met with direct reuse from Austin's treated wastewater effluent. Direct reuse demands are supplied in a given month from the effluent generated the previous month from Austin municipal demands.
 - 3.2.2. An additional demand of 2,883 acre-feet/year, which is satisfied from direct reuse of effluent, has also been included in the WMP WAM for Austin. This demand is considered a historic direct reuse demand that is not included in the 2032 Austin M&I demand projections.
 - 3.2.3. Demands for Austin's Sand Hill power plant have been set as 1,250 acre-feet/year which is met from direct reuse from Austin effluent.

- 3.2.4. In the 2020 WMP update, the Decker Creek Power Station was included as a weather-varied demand. In this update, Decker Creek Power Station has been removed as a firm demand for steam electric because the two steam units were decommissioned in 2022. Lake Walter E. Long, the reservoir that previously functioned for cooling water supply for steam electric generation, is now modeled as a recreational reservoir with only natural evaporation as a demand. The reservoir is filled using the City of Austin Colorado River water right 14-5489, and backup water is provided if needed from lakes Buchanan and Travis to maintain a minimum storage of about 25,950 acre-feet in Lake Water E. Long.
- 3.2.5. Demands for Austin at FPP are weather-varied and are set as the demand expected from the Colorado River. These demands are satisfied first using Austin’s Certificate of Adjudication 14-5471, as amended, and are subject to available reliable downstream river flows, per Sections 2.2 and 2.3 above, then backed up with water from lakes Buchanan and Travis consistent with LCRA’s separate contract with Austin for FPP.
- 3.2.6. The Lady Bird Lake portion of Austin’s Certificate of Adjudication 14-5471, as amended, (subject to available reliable downstream river flows per Sections 2.2 and 2.3 above) is used first to satisfy demands for Austin at FPP limited to 24,000 acre-feet/year.
- 3.2.7. A portion of Austin’s municipal demand occurs at Lake Travis at its Berl Handcox Sr. Water Treatment Plant (previously known as Water Treatment Plant No. 4). This demand is supplied from Lake Travis under LCRA’s Lake Travis water right.

4. EFFLUENT AND RETURN FLOWS

4.1. Effluent from the City of Austin’s wastewater treatment plants is determined using factors that correspond with high-demand (dry) years and another set of factors for normal-demand (average) years:

- At the end of each monthly time step during a WAM simulation, the total amount of municipal water use by the City of Austin (inclusive of City of Austin reuse and the City’s wholesale customers) is recorded.
- The total quantity of treated wastewater effluent associated with Austin’s total municipal water use is then calculated by applying the corresponding monthly factors from the following table to Austin’s total water use. The dry-year factors were derived based on Austin’s actual municipal water use (inclusive of reuse) and effluent (return flows and direct reuse) reported for the years 2022-2023. The normal-year factors were derived based on Austin’s actual river diversions and effluent (return flows and direct reuse) reported for the years 2018-2021.

• Dry-Year Effluent Factors:

Jan	Feb	Mar	Apr	May	Jun
0.74299	0.86725	0.75280	0.71457	0.64950	0.56443
Jul	Aug	Sep	Oct	Nov	Dec
0.47401	0.45315	0.52464	0.61962	0.71533	0.76893

- Average-Year Effluent Factors:

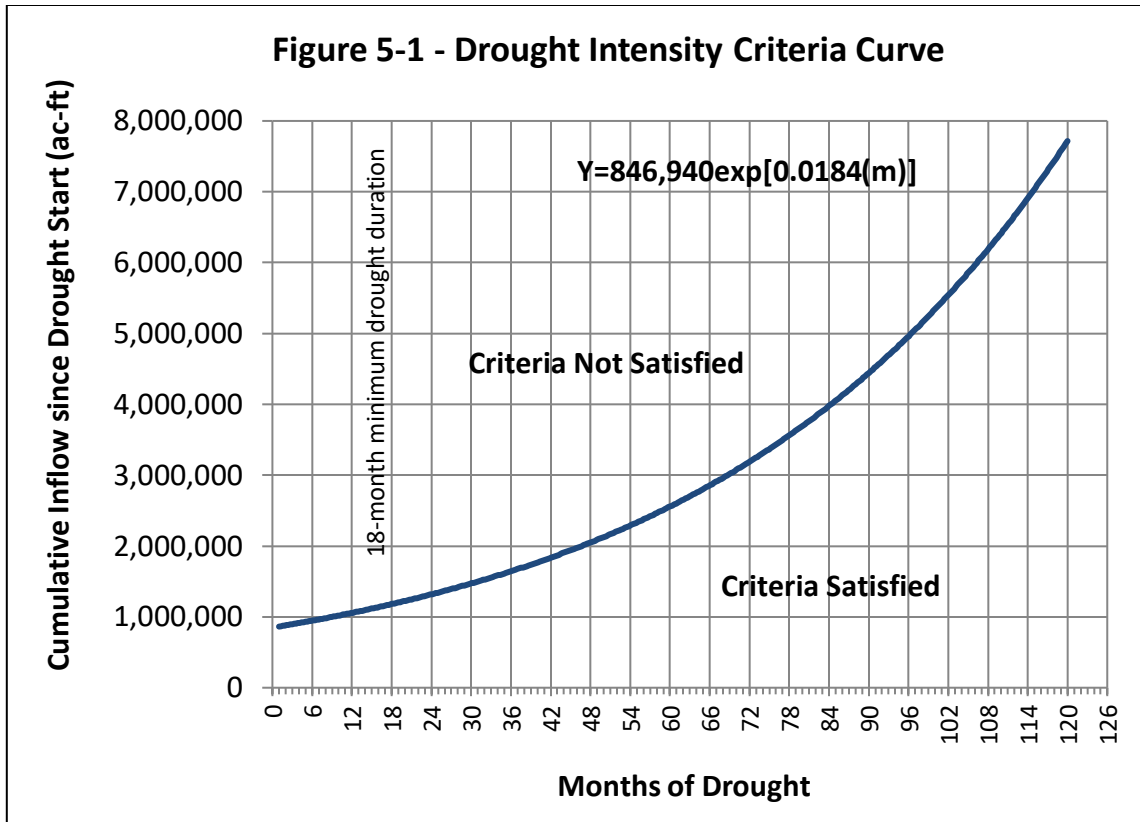
Jan	Feb	Mar	Apr	May	Jun
0.87779	0.86038	0.85156	0.75958	0.76923	0.65943
Jul	Aug	Sep	Oct	Nov	Dec
0.53273	0.47532	0.56600	0.68037	0.71308	0.79858

- At the beginning of the following time step, the calculated amount of Austin’s effluent from the previous time step is reduced by the amount of Austin’s M&I demand expected to be satisfied by direct reuse, and the direct reuse for the Sand Hill power plant.
- The remaining effluent represents the total amount of return flow discharged to the Colorado River at the beginning of the current time step.

- 4.2. For the WMP WAM, no indirect reuse of Austin’s return flows is included.
- 4.3. Return Flows for the City of Pflugerville were calculated based on an annual return flow factor of 0.59, which was the lowest annual return flow factor of the last 10 years and occurred in 2022. The annual return flow factor of 0.59 is distributed to monthly return flow factors using the 10-year average proportion of return flows per month. The monthly factors are used to distribute the annual return flow (59% of the diversion volume) to volumes for each month, and the return flows are applied in the model as constant inflows.

5. WATER SUPPLY CONDITION DETERMINATION

- 5.1. A three-tier water supply condition framework has been established for the WMP WAM, consisting of Extraordinary Drought, Less Severe Drought and Normal conditions. The water supply condition is defined by lakes Buchanan and Travis combined storage on March 1 and July 1 and inflow quantities over specified periods of time leading up to those dates. For each water supply condition, the model applies different provisions for the curtailment of interruptible stored water. (See Section 6, below.) The model also considers the water supply condition for certain provisions regarding support levels for both instream flows and freshwater inflows to Matagorda Bay and determines the amount of water to be provided for those purposes under various conditions.
- 5.2. Extraordinary Drought
 - 5.2.1. For droughts at least 14 months in duration: The model engages Extraordinary Drought provisions when combined storage in lakes Buchanan and Travis is below 1.45 million acre-feet on March 1 or July 1 AND it has been at least 14 months since the combined storage was 98 percent full or greater (combined drawdown less than 40,000 acre-feet) AND the cumulative inflows are equal to or less than the cumulative inflows over the same number of months on the curve representing cumulative inflows during the 1950s drought. This curve is shown in Figure 5-1.



5.2.2. For large drops in storage: The model engages Extraordinary Drought provisions when combined storage in lakes Buchanan and Travis is below 1.45 million acre-feet on July 1 AND combined storage dropped by more than 300,000 acre-feet during the period from March 1 to July 1.

5.2.3. Exit: The model lifts Extraordinary Drought provisions on the March 1 or July 1 evaluation date when combined storage in lakes Buchanan and Travis has been at or above 1.45 million acre-feet at any time during the previous season. (For the purpose of water supply condition evaluation, for the March 1 evaluation date, the “previous season” is the period from July to February; for the July 1 evaluation date, the “previous season” is the period from March to June.) However, the three drought trackers (drought duration, cumulative inflow and Extraordinary Drought inflow test) do not reset until the combined drawdown at the beginning of any month is less than 40,000 acre-feet. Consequently, absent a reset of the drought trackers, the Extraordinary Drought provisions will re-engage if the combined storage in lakes Buchanan and Travis is below 1.45 million acre-feet and the cumulative inflows are equal to or less than the cumulative inflows (described above) on a subsequent March 1 or July 1. If the criteria for lifting Extraordinary Drought provisions are met, the Less Severe Drought provisions automatically engage unless criteria for lifting Less Severe Drought also are met.

5.3. Less Severe Drought

5.3.1. Engagement: The model engages Less Severe Drought provisions from Normal conditions if either of two separate sets of criteria are met:

- 1) Combined storage in lakes Buchanan and Travis is below 1.7 million acre-feet on March 1 or July 1 AND over the previous three months, the cumulative inflows were less than 60,000 acre-feet.
- 2) Combined storage in lakes Buchanan and Travis is below 1.6 million acre-feet on March 1 or July 1 AND over the previous three months, the cumulative inflows were less than the 33rd percentile of inflows for that three-month period.

Additionally, the model engages Less Severe Drought provisions when lifting from Extraordinary Drought condition unless the criteria (below) for lifting Less Severe Drought also are met.

5.3.2. Exit: The model lifts Less Severe Drought provisions and returns to Normal conditions if either of two separate sets of criteria are met:

- 1) Combined storage in lakes Buchanan and Travis has been at or above 1.6 million acre-feet at any time during the previous season,
- 2) Combined storage in lakes Buchanan and Travis has been at or above 1.5 million acre-feet at any time during the previous season AND over the three months preceding March 1 or July 1, the cumulative inflows were greater than or equal to the median for the three-month period.

If neither of the above Less Severe Drought condition exit criteria are met, the Less Severe Drought condition is maintained for the upcoming season, unless the Extraordinary Drought criteria is met as described above. If the criteria for engaging Extraordinary Drought provisions are met on an evaluation date while in Less Severe Drought, the Extraordinary Drought provisions take effect.

5.4. Normal Conditions

5.4.1. Engagement: If not in Extraordinary Drought or Less Severe Drought in the previous season AND if the criteria for engagement of Extraordinary Drought or Less Severe Drought are not met on March 1 or July 1, then Normal conditions are in effect.

5.4.2. Exit: The model removes provisions for Normal Conditions if the criteria are met for engaging either Extraordinary Drought or Less Severe Drought on March 1 or July 1.

6. LCRA INTERRUPTIBLE AGRICULTURAL SUPPLY

6.1. Water demands associated with the four downstream irrigation operations (Garwood, Lakeside, Pierce Ranch and Gulf Coast) corresponding to year 2032 conditions have been projected as documented in Technical Paper A-3.

6.2. A generalized pattern of monthly use has been applied to the weather-varied demands to derive monthly demand estimates.

- 6.3. The model seeks to meet water demands associated with the four downstream irrigation operations first with available run-of-river supplies originating downstream of Mansfield Dam, then with the Arbuckle Reservoir for Gulf Coast Division only, then with available inflows passed through lakes Buchanan and Travis, and finally, with any available interruptible stored water from lakes Buchanan and Travis.
- 6.4. The supply of run-of-river water originating downstream of Mansfield Dam assumed to be available for diversion by the downstream irrigation operations is limited to the available supply of reliable river flows as described in Section 2.
- 6.5. The Garwood run-of-river water right is the most senior major water right in the Colorado River basin. As such, it has higher reliability and lower needs for interruptible stored water as a portion of total supply, compared to the non-Garwood irrigation operations. The Garwood irrigation operation’s stored water needs are met under a separate agreement from the non-Garwood irrigation operations. In the WMP WAM, the Garwood operation is not limited to a set quantity of interruptible stored water and stored water cutoff triggers are deactivated for the operation. This is included as a conservative assumption based upon the historically high reliability of the Garwood water right and correspondingly low demand for backup water under historic hydrologic conditions. In actual operations, the Garwood operation would be subject to curtailment or cutoff consistent with the purchase agreement for the Garwood water rights.
- 6.6. For the non-Garwood irrigation operations (Gulf Coast, Lakeside and Pierce Ranch), the amount of interruptible stored water made available for diversion is set according to which of the three water supply conditions is engaged and by the combined storage on March 1 for first irrigation season (generally first crop) and July 1 for second irrigation season (generally second crop). If the criteria for Extraordinary Drought are met, no stored water is made available for the non-Garwood irrigation operations. The model also includes an approach for simulating a “look-ahead” test whereby no stored water is made available for the non-Garwood irrigation operations if combined storage is below certain trigger levels on March 1 or July 1. The look-ahead provision is discussed in more detail in Section 6.7. In either of the above cases, for seasons where no stored water is made available for the non-Garwood irrigation operations, the entire demand is set to zero. The amounts of stored water available when Less Severe Drought and Normal Conditions are engaged are provided in the following tables:

6.6.1. First Season Non-Garwood Interruptible Stored Water Availability

Normal Conditions		Less Severe Drought Condition	
Combined storage on March 1 (million acre-feet)	Interruptible supply (acre-feet) *	Combined storage on March 1 (million acre-feet)	Interruptible supply (acre-feet) *
Above 1.6	125,000	Above or equal to-1.7	N/A **
1.3 to 1.6	100,000 to 125,000	1.3 to 1.699999	80,000 to 96,000
Below 1.3	0	Below 1.3	0

**Anytime Cutoff if storage drops to or below 1.1 million acre-feet*

***When combined storage is above 1.7 million acre-feet, Normal conditions apply*

6.6.2. Second Season Non-Garwood Interruptible Stored Water Availability

Normal Conditions		Less Severe Drought Condition	
Combined storage on July 1 (million acre-feet)	Interruptible supply (acre-feet) *	Combined storage on July 1 (million acre-feet)	Interruptible supply (acre-feet) *
Above 1.5	66,000	Above or equal to-1.6	N/A **
1.3 to 1.5	55,000 to 66,000	1.3 to 1.599999	47,000 to 66,000
Below 1.3	0	Below 1.3	0

**Anytime Cutoff if storage drops to or below 1.1 million acre-feet*

***When combined storage is above 1.7 million acre-feet, Normal conditions apply*

- 6.7. The WMP WAM includes a proxy for the look-ahead test based on analysis performed for prior water management plans. Under a look-ahead test, interruptible stored water (non-Garwood) would be cut off if the LCRA Board of Directors determines combined storage would fall below 600,000 acre-feet in the next 12 months or below 900,000 acre-feet during the upcoming crop season. Representing the look-ahead provision, if the combined storage is less than 1.22 million acre-feet on March 1, no stored water is made available for the non-Garwood irrigation operations for first crop. If the combined storage is less than 1.19 million acre-feet on July 1, no stored water is made available for the non-Garwood irrigation operations for second crop. Interruptible stored water for the Garwood irrigation operation is not subject to the look-ahead provision.
- 6.8. For the non-Garwood irrigation operations to simulate possible reductions in acreage due to limited stored water availability, first crop demands are reduced by multiplying by the ratio of the amount of stored water available for first crop according to the allocation table divided by the maximum stored water allocation. Second crop demands are reduced by multiplying by the minimum of the first crop ratio or the amount of stored water available for second crop according to the allocation table divided by the maximum stored water allocation.
- 6.9. If no interruptible stored water is available for the upcoming crop season, the model sets demands to zero for the non-Garwood irrigation operations.
- 6.10. If the allocated quantity of interruptible stored water for the non-Garwood irrigation operations is exhausted before the end of the season, a mid-crop cutoff occurs, and no additional stored water is made available for the remainder of the season. This WMP revision would allow all or part of a second crop allocation of water to be used to finish first crop if water would be available for second crop following a mid-crop cutoff of first crop due to the first crop allocation being exhausted. Note this shift of water use from second crop to first crop is not explicitly modeled.
- 6.11. If the interruptible stored water supply is exhausted prior to the end of the crop season and combined storage is below 1.3 million acre-feet, pass-through of run-of-river inflow to lakes Buchanan and Travis also is cutoff for the non-Garwood irrigation operations. If the interruptible stored water supply is exhausted prior to the end of the crop season and combined storage is at or above 1.3 million acre-feet, pass-through of run-of-river inflow to lakes Buchanan and Travis is provided, if available, to the extent needed to finish the crop.

- 6.12. If interruptible stored water is not available for first crop, it also is not available for second crop.
- 6.13. Return flows to the Colorado River from the downstream irrigation operations are discharged at the beginning of the next month after each crop season (August for first crop and November for second crop), with these return flows calculated based on the following percentages of the total water supply utilized by each irrigation operation during that season:

Garwood	3 percent	Lakeside	2 percent
Pierce Ranch	18 percent	Gulf Coast	10 percent

7. LAKES BUCHANAN AND TRAVIS STORAGE AND RELEASES

- 7.1. Based on the most recent sedimentation studies conducted by the Texas Water Development Board, the combined conservation storage capacity of lakes Buchanan and Travis is projected to decrease to 1,980,768 acre-feet in 2032 due to sedimentation.
- 7.2. The conservation storage capacity of Lake Buchanan at elevation 1,020 feet above mean sea level (feet msl) is projected to decrease to approximately 872,439 acre-feet in 2032.
- 7.3. The conservation storage capacity of Lake Travis at elevation 681 feet msl is projected to decrease to approximately 1,108,329 acre-feet in 2032. Lakes Buchanan and Travis are simulated to operate up to their conservation storage capacity year-round.
- 7.4. To be consistent with current LCRA operating procedures, the quantity referred to as “storable inflows” to lakes Buchanan and Travis is determined as the volume of available inflows capable of being stored in the reservoirs at the 1926 priority date immediately after inflows to the reservoirs have been passed downstream to satisfy the demands of senior water rights. The storable inflows quantity is the volume of inflows made available to satisfy environmental flow needs. Stored water also is made available to satisfy certain environmental flow needs as discussed further below.
- 7.5. A release of 20,000 acre-feet/year is made from lakes Buchanan and Travis to true-up the capability of the model with the real-world capability to deliver stored water to downstream customers and to meet environmental flow obligations. This release is associated with channel losses, temporary bank storage, and uncertainty caused by the attenuation of releases and timing of downstream flows. This release is not simulated as available for meeting instream flow obligations. This release, along with the reliable flow concept discussed in Section 2, firm delivery losses discussed in Section 7.6, and ordered-but-not-diverted concept discussed in Section 7.7, were included in the calibration model used in support of the 2015 WMP. This model demonstrated that the WAM model was capable of reasonably reproducing historical combined storage of lakes Buchanan and Travis. Releases from lakes Buchanan and Travis, made to true-up the model with the real-world capability of delivering water downstream, are made available only to help meet freshwater inflow needs and for meeting instream flow requirements of water rights not supplied by LCRA. Because this true-up release is used by the monthly WAM to better represent daily

operational uncertainties, it is not considered to be reliable for customers that order water or for meeting instream flow requirements. Thus, these releases are disregarded when determining the required releases from lakes Buchanan and Travis for such needs.

- 7.6. Requirements for releases from lakes Buchanan and Travis to satisfy the demands of LCRA’s downstream firm M&I water users below Travis County are increased by the following factors to account for delivery inefficiencies and losses along the Colorado River. These factors are in addition to the true-up release described in Section 7.5. In the WMP WAM, the additional water released described in this section becomes available for diversion and use by all downstream users once it passes the points of diversion associated with the release, with the exception of those demands whose run-of-river supplies are limited to the reliable downstream river flows as described in Section 2, i.e., the LCRA irrigation operations, Austin’s FPP demand, LCRA’s demand for the amended Garwood water right, LCRA’s industrial demands at the Gulf Coast division, and the Corpus Christi demand. Arbuckle Reservoir does not attempt to refill using the releases described in this section. The delivery factors below were calculated using a method developed by LCRA staff for estimating inefficiencies and losses associated with the conveyance of stored water.

<u>Diverter</u>	<u>Delivery Factor</u>
FPP	6.5 percent
Matagorda County Industrial/Power Generation	10.9 percent
South Texas Project	11.5 percent

- 7.7. Requirements for releases from lakes Buchanan and Travis to satisfy the demands of the downstream irrigation operations (to the extent there are demands for a particular month) are increased by the following seasonal delivery factors. These factors are applied monthly to account for delivery losses along the lower Colorado River and for water ordered to meet requested demands but not diverted due to weather or other circumstances. These factors were developed using historical release and diversion data for each of the irrigation operations from 2001 to 2023. Separate seasonal factors were developed for wet, moderate and dry weather conditions. The weather condition for each season is read into the model, and the appropriate delivery factors are applied for the specific irrigation operation. First crop seasonal factors are applied in the months March to July and second crop seasonal factors are applied in the months August to October. Once such ordered water passes the associated points of diversion, it is available for meeting the bay inflow criteria or for diversion and use by downstream water rights whose run-of-river supplies are not limited to the reliable downstream river flows. As described in Section 11, Arbuckle Reservoir attempts to refill using ordered-not-diverted water subject to limitations.

Wet-Weather Factors:

Season	Garwood	Gulf Coast	Lakeside	Pierce Ranch
First Crop	61%	26%	100%	27%
Second Crop	36%	23%	78%	39%

Moderate-Weather Factors:

Season	Garwood	Gulf Coast	Lakeside	Pierce Ranch
First Crop	41%	21%	61%	45%
Second Crop	32%	18%	59%	53%

Dry-Weather Factors:

Season	Garwood	Gulf Coast	Lakeside	Pierce Ranch
First Crop	20%	12%	24%	35%
Second Crop	19%	16%	31%	36%

- 7.8. Releases of stored water from Lake Buchanan are made to maintain the intervening Highland Lakes (Inks Lake, Lake LBJ and Lake Marble Falls) within an established operating range at all times. In addition, releases of stored water from Lake Travis are made to maintain Lake Austin and Lady Bird Lake within historic operating ranges.
- 7.9. The allocation of releases from lakes Buchanan and Travis to meet downstream water demands (the percentage of release coming from lake Buchanan and percentage coming from lake Travis to meet a demand) is determined before each discrete release as stipulated in the Buchanan release table below corresponding to the relative storage zones each reservoir is in (see zone definitions table). The Travis release percentage is the remainder needed to be released to meet 100% of a release after consideration of the Buchanan release percentage. These allocations of releases from lakes Buchanan and Travis reflect LCRA current practice; however, LCRA may deviate from these specific allocations.

	Buchanan Allocation % of Buchanan and Travis Total Release				
	Zone 1	Zone 2	Zone 3	Zone 4	Zone 5
Travis Zone 1	0	0	0	0	0
Travis Zone 2	25	20	0	0	0
Travis Zone 3	60	60	50	0	0
Travis Zone 4	100	75	75	50	0
Travis Zone 5	100	100	75	50	50

	Zone Definitions	
	Buchanan Storage (acre-feet)	Travis Storage (acre-feet)
Zone 1	>= 701,220	>= 981,273
Zone 2	>= 567,146	>= 760,593
Zone 3	>= 439,567	>= 540,533
Zone 4	>= 168,376	>= 375,518
Zone 5	>= 0	>= 0

8. ENVIRONMENTAL INSTREAM FLOW CRITERIA

- 8.1. The Subsistence, Base Dry and Base Average instream flow criteria described in Lower Colorado River, Texas, Instream Flow Guidelines (2008)⁵ are in effect in the WMP WAM at the Austin, Bastrop, Columbus and Wharton gauges on the Colorado River.
- 8.2. The engagement of the Base Dry and the Base Average instream flow criteria is determined based on the combined storage in lakes Buchanan and Travis on March 1, July 1 and November 1 of any given year. If the combined storage is between 1.86 and 1.96 million acre-feet, then the Base Dry criteria are engaged; otherwise, they are disengaged. If the combined storage exceeds 1.96 million acre-feet, then the Base Average criteria are engaged; otherwise, they are disengaged.
- 8.3. Releases of storable inflows, or in the absence of sufficient storable inflows, stored water from lakes Buchanan and Travis, are made to help satisfy the Subsistence instream flow criteria all of the time for the Austin and Bastrop gauges. After storable inflows are fully utilized, releases of stored water from lakes Buchanan and Travis are made to help satisfy the Subsistence instream flow criteria at Columbus and Wharton when combined storage is equal to or greater than 1,300,000 acre-feet. When combined storage is less than 1,300,000 acre-feet, the criteria in Section 8.4 apply at the Columbus and Wharton gauges.
- 8.4. When combined storage is less than 1,300,000 acre-feet but above 900,000 acre-feet, storable inflows are provided to help satisfy subsistence flows at the Columbus and Wharton gauges. However, for the Wharton gauge, stored water is only released to meet the greater of 107 cubic feet per second (cfs) or 50 percent of the monthly Wharton Subsistence criteria. For the Columbus gauge, stored water is only released to meet 279 cfs for February, March, and May through July; or 190 cfs for January, April, and August through December. Additionally, when combined storage is less than 900,000 acre-feet the availability of storable inflows is limited to the same extent as the release of stored water when combined storage is below 1,300,000 acre-feet.

⁵ BIO-WEST, Inc. (2008); Lower Colorado River, Texas, Instream Flow Guidelines, Colorado River Flow Relationships to Aquatic Habitat and State Threatened Species: Blue Sucker; prepared for Lower Colorado River Authority and San Antonio Water System; Round Rock, Texas.

- 8.5. Only releases of storable inflows to lakes Buchanan and Travis, to the extent they are available, are made to help satisfy the Base Dry and Base Average instream flow criteria.
- 8.6. In determining the quantity of lakes Buchanan and Travis water required to be released or passed to offset a river flow deficit with regard to a particular instream flow criterion, only the currently available reliable river flows as defined in Section 2, plus any releases from lakes Buchanan and Travis for downstream users, environmental flows and delivery inefficiencies as defined in Sections 7.6 and 7.7 passing the subject environmental flow location, are considered.
- 8.7. The WAM is based on a monthly time step. Intra-daily or instantaneous flows were not simulated.

9. ENVIRONMENTAL BAY & ESTUARY FRESHWATER INFLOW CRITERIA

- 9.1. The requirements for passing Colorado River flows to Matagorda Bay are based on the recommendations of the Matagorda Bay Health Evaluation (MBHE) study⁶, and have been operationalized for use in the WMP. The environmental requirements in the WMP WAM are based on two-month volumes of inflows with subsequent adjustments if the three-month seasonal bay inflow recommendations of the MBHE study have already been satisfied.
- 9.2. The two-month bay inflow need as included in the WMP WAM vary by season according to the amount of combined storage in lakes Buchanan and Travis as of March 1 for the spring season (March-June), July 1 for the fall season (July-October), and Nov. 1 for the intervening period (November-February). For example, for March, for the MBHE Operational Inflow Level 1 criteria of 76,000 acre-feet to be satisfied, the total inflows for the months of February and March must equal or exceed 76,000 acre-feet. This two-month target is repeated in the months of April, May and June, such that for the criteria to be satisfied, the total of the current month and preceding month must equal or exceed 76,000 acre-feet. The different two-month bay inflow needs are listed in the following table by season or period.

MBHE Operational Inflow Level	Two-Month Bay Inflow Need (acre-feet)		Associated Buchanan-Travis Combined Storage (million acre-feet)
	Spring Season (March-June)	Fall Season (July-October)	
Level 1	76,000	54,000	1.1 - 1.3
Level 2	112,000	80,000	1.3 - 1.5
Level 3	164,000	117,000	1.5 - 1.95
Level 4	289,000	205,000	1.95 - Full

⁶ Lower Colorado River Authority and San Antonio Water System (2008); Final Report, Matagorda Bay Inflow Criteria (Colorado River), Matagorda Bay Health Evaluation; Austin, Texas.

MBHE Operational Inflow Level	Two-Month Bay Inflow Need (acre-feet)	
	Intervening Period (November-February)	Associated Buchanan-Travis Combined Storage (million acre-feet)
Level 1	35,000	1.1 - 1.3
Level 2	52,000	1.3 - 1.5
Level 3	76,000	1.5 - 1.95
Level 4	133,000	1.95 - Full

- 9.3. For engaging the operational criteria, the March 1 combined storage in lakes Buchanan and Travis is used to establish the two-month bay inflow needs at the end of the subsequent months of March, April, May and June. Similarly, the July 1 combined storage in lakes Buchanan and Travis is used to establish the two-month bay inflow needs at the end of the subsequent months of July through October, and the Nov. 1 combined storage in lakes Buchanan and Travis is used to establish the two-month bay inflow needs at the end of the subsequent months of November through February. At the end of each of these months during the WAM simulations, the volume of additional bay inflow beyond the available river inflow that is required to fully satisfy the two-month bay inflow need is released from the available storable inflows to lakes Buchanan and Travis. An exception to this procedure is noted in Section 9.4.
- 9.4. For May and June during the spring season and September and October during the fall season, an additional check is made to determine if the three-month cumulative inflow to the bay has satisfied the corresponding MBHE three-month bay inflow need. If it has, then the effective two-month bay inflow need for the particular month is set equal to the two-month intervening bay inflow need for the corresponding MBHE Operational Inflow Level. The relevant MBHE three-month bay inflow needs, after rounding, corresponding to the four different MBHE inflow levels (and their associated Buchanan-Travis combined storage) for the three-month periods ending in May and June and September and October are listed in the following table. It should be noted this check against the MBHE bay inflow needs in the WMP WAM is made for only the complete three-month consecutive periods that fall within the MBHE Operational seasons as defined above.

MBHE Inflow ID	MBHE 3-Month Bay Inflow Need (acre-feet)	
	Spring Season	Fall Season
MBHE-1	114,000	81,000
MBHE-2	169,000	120,000
MBHE-3	246,000	175,000
MBHE-4	433,000	308,000

- 9.5. On a monthly basis, only releases of storable inflows to lakes Buchanan and Travis, to the extent they are available, are made to help satisfy bay inflow needs. Previously stored water was not released to meet bay inflow targets, with the exception of the Threshold need, which may call for the release of a limited amount of storable inflows from the preceding month as described in Section 9.8.

9.6. In the WMP WAM, after the amount of water needed for bay inflow criteria is calculated, limitations on the amount of storable inflow provided are engaged based on the provisions described below:

9.6.2. If combined storage on the evaluation date is less than 1.4 million acre-feet and interruptible stored water for agricultural operations in Gulf Coast, Lakeside and Pierce Ranch is cut off for the season, Threshold is the only freshwater inflow criteria in effect until the next evaluation date. (For the November to February period, if interruptible stored water for agricultural operations in Gulf Coast, Lakeside and Pierce Ranch was cutoff for the second season then Threshold is the only freshwater inflow criteria in effect.)

9.6.3. Anytime combined storage falls below 1.1 million acre-feet, the only bay criteria in effect is Threshold for that month.

9.6.4. The maximum release of storable inflows in the current month to meet freshwater inflow criteria based on combined storage at the end of the previous month is limited to the following amounts:

Combined storage (million acre-feet)	Maximum release of storable inflow to meet bay criteria (acre-feet)
Less than 1.4	20,000
1.4 to 1.599	40,000
Greater than 1.6	60,000

9.6.5. Releases of storable inflows to meet bay criteria that exceed 10,000 acre-feet in a month are limited to the following percentages of storable inflows after the release of water for instream flow needs and the release of 10,000 acre-feet for bay needs:

Combined storage (million acre-feet)	Release will be no more than listed percentage of storable inflow for the month
Less than 1.6	40 %
1.6 million or greater	50 %

9.7. Under the operational methodology, a minimum Threshold bay inflow criteria of 15,000 acre-feet per month also is in effect every month, including those months when the combined storage in lakes Buchanan and Travis is less than the minimum storage for Level 1. To the extent available river inflows entering the river below Longhorn Dam are not adequate to meet this requirement, storable inflows to lakes Buchanan and Travis are passed through the reservoirs downstream to the bay to help satisfy the Threshold requirement, regardless of the combined storage of lakes Buchanan and Travis or the season of the year. In most cases, previously stored water is not released to meet Threshold freshwater inflow targets. An exception to this provision is provided below.

9.8. If combined storage at the beginning of a month is greater than 1 million acre-feet, and all of the prior month's storable inflows were not released, up to 5,000 acre-feet

of the prior month's remaining storable inflows is carried forward and made available for release to the extent needed to help meet the Threshold bay inflow criteria.

- 9.9. In determining the quantity of storable inflows to lakes Buchanan and Travis required to be released to offset a bay inflow deficit with regard to a particular bay inflow need, the total inflow to Matagorda Bay is considered (and not solely the reliable flows discussed in Section 2).
- 9.10. Arbuckle Reservoir is used to help meet Bay demands that would otherwise be met from storable inflows from lakes Buchanan and Travis. Arbuckle Reservoir operations are described in Section 11.

10. UPSTREAM DIVERSIONS UNDER GARWOOD WATER RIGHT (Certificate 14-5434E)

- 10.1. LCRA firm demands (non-City of Austin demands) at FPP and upstream to Lake Austin are supplied using 14-5434G as a run-of-river supply, before providing stored water from lakes Buchanan and Travis.
- 10.2. Diversions under 14-5434G are subject to the environmental instream flow criteria specified in the water right.
- 10.3. Firm diversions under 14-5434G are limited to 33,000 acre-feet per year and are limited in the model to not exceed about 9,000 acre-feet per month (i.e., the monthly equivalent of 150 cfs diversion rate).

11. ARBUCKLE RESERVOIR OPERATIONS

- 11.1. Arbuckle Reservoir serves any demand that would otherwise be served from lakes Buchanan and Travis at any of the authorized Gulf Coast diversion points (Gulf Coast Irrigation Division, Gulf Coast area industrial, South Texas Project and water provided to supplement freshwater inflows to Matagorda Bay). The maximum monthly release simulated from Arbuckle Reservoir is about 27,600 acre-feet, based on a release rate of up to 450 cubic feet per second.
- 11.2. The model seeks to meet demands first using available run-of-river flows originating downstream of Mansfield Dam, then with water stored in Arbuckle Reservoir, then with run-of-river flows originating upstream of Mansfield Dam, and finally with stored water from lakes Buchanan and Travis.
- 11.3. In the WMP WAM, Arbuckle Reservoir is used to help meet the Bay Threshold criteria, even if there is no obligation based on storable inflows into lakes Buchanan and Travis. Up to 50 percent of the water in Arbuckle Reservoir, in excess of 20,000 acre-feet of conservation storage in the reservoir, is released to help meet the monthly Bay Threshold criteria.
- 11.4. Arbuckle Reservoir is filled using run-of-river flows not needed for other demands and ordered-but-not-diverted releases from lakes Buchanan and Travis. Available run-of-river flows are diverted under the Gulf Coast water right at its priority date.
 - 11.4.2. Arbuckle Reservoir is not filled from any source unless at least 15,000 acre-feet has flowed into the bay in the current month.

- 11.4.3. Arbuckle Reservoir does not call on run-of-river flows originating above Lake Travis.
- 11.4.4. Interruptible stored water from lakes Buchanan and Travis that is ordered but not diverted by the irrigation operations becomes available for diversion to Arbuckle Reservoir, subject to a simulated 15,000 acre-feet bypass to help meet the Bay Threshold criteria

12. SOUTH TEXAS PROJECT

- 12.1. The consumptive demand for South Texas Project is met from the main cooling reservoir (MCR). The MCR is refilled from Certificate of Adjudication 14-5437 and backup water from LCRA.
- 12.2. The current Water Delivery Plan (WDP) for providing backup water to the South Texas Project, which was adopted as part of the 2006 Settlement Agreement between LCRA and STP Nuclear Operating Company (STPNOC) (Jan. 1, 2006), is implemented in the WMP WAM. As structured, this WDP stipulates that LCRA shall initiate staged deliveries of water to STPNOC from LCRA's available sources upstream of the Bay City Dam when the water surface elevation of STPNOC's MCR falls below 35 feet msl. Under the WDP, deliveries continue to be made to maintain the level of the MCR above a minimum elevation of 27 feet msl.
- 12.3. The WDP does not specifically state how the water deliveries are to be staged with regard to either timing or the quantities to be delivered; it only requires that they commence when the level of the MCR falls below elevation 35 feet msl. For modeling purposes, the operating procedures for delivery of water are assumed to be consistent with the previous Water Delivery Plan.
- 12.4. In the WMP WAM, the total supply for STPNOC from run-of-river diversions is limited to the 102,000 acre-feet/year stipulated in Certificate of Adjudication 14-5437, as amended, and the backup supply from lakes Buchanan and Travis is limited to a rolling five-year average of 20,000 acre-feet/year (Supply under Certificate of Adjudication 14-5437 is not limited to the reliable flows discussed in Section 2).
- 12.5. The WMP WAM assumes STPNOC will divert under Certificate of Adjudication 14-5437 whenever the streamflow exceeds the parameters in the certificate without regard to any operational preferences related to salinity or conductivity.

13. MISCELLANEOUS

- 13.1. Diversions from the Colorado River authorized under the City of Corpus Christi's Garwood water right are set to the full authorized diversion amount of 35,000 acre-feet/year. A uniform monthly demand pattern is assumed for these.