Attachment F

NO. 115,414-A-1

IN RE: THE EXCEPTIONS OF THE LOWER COLORADO RIVER AUTHORITY AND THE CITY OF AUSTIN TO THE ADJUDICATION OF WATER RIGHTS IN THE LOWER COLORADO RIVER SEGMENT OF THE COLORADO RIVER BASIN	§ § § § § § §	IN THE DISTRICT COURT OF BELL COUNTY, TEXAS 264TH JUDICIAL DISTRICT

FINAL JUDGMENT AND DECREE

BE IT REMEMBERED that on the 20 day of April, 1988 came on to be heard the Joint Motion to Enter Final Judgment and Decree of the Texas Water Commission (the "Commission"), the Lower Colorado River Authority ("LCRA"), and the City of Austin (the "City"), and the Court being of the opinion that said motion should be granted, it is therefore,

ORDERED, ADJUDGED AND DECREED as follows:

I.

The City's water rights are defined by the findings of fact and conclusions of law found on pages 21-23 of the Final Determination entered by the Commission on July 29, 1985 in this matter (the "Final Determination"). These findings and conclusions are hereby modified in their entirety to read as set forth in Attachment No. 1 hereto.

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II.

LCRA's water rights with respect to the Highland Lakes are defined by the findings and conclusions found on pages 89-96 of the Final Determination. The findings and conclusions found on pages 90-91 relating to the Highland Lakes generally are hereby deleted in their entirety, and the remaining findings and conclusions relating to each of the Highland Lakes specifically are hereby modified in their entirety to read as set forth in Attachment No. 2 hereto.

III.

LCRA's water rights with respect to its Lakeside Water Division are defined by the findings and conclusions found on pages 76-77 of the Final Determination. These findings and conclusions are hereby modified in their entirety to read as set forth in Attachment No. 3 hereto.

IV.

LCRA's water rights with respect to its Gulf Coast Water Division are defined by the findings and conclusions found on pages 82-84 of the Final Determination. These findings and conclusions are hereby modified in their entirety to read as set forth in Attachment No. 4 hereto.

V.

All other portions of the Final Determination which define water rights of the City and LCRA are hereby affirmed.

VI.

This Final Judgment and Decree is final and conclusive as to all water rights and claims to water rights of the City and LCRA in the Lower Colorado River Segment, Colorado River Basin, as adjudicated herein. This Judgment is without prejudice to any further permits or amendments to the water rights of the City and LCRA issued by the Texas Water Commission after January 1, 1983. Such amendments shall be treated as if issued under § 11.336 of the Texas Water Code. All claims of water rights of the City and LCRA as of January 1, 1983 which were made under § 11.303 or § 11.307 of the Texas Water Code and which are not recognized herein or in other orders of the Court are hereby denied.

VI.

The Texas Water Commission is directed to take such action as is required by the Texas Water Rights Adjudication Act, §§ 11.301 et seq., Texas Water Code, to implement this Final Judgment and Decree.

SIGNED this 20 day of April, 1988.

/s/ J. F. Clawson

JUDGE PRESIDING

MODIFIED FINDINGS AND CONCLUSIONS DEFINING LCRA'S WATER RIGHTS WITH RESPECT TO THE HIGHLAND LAKES

WATER RIGHT CLAIMS

OF THE

LOWER COLORADO RIVER AUTHORITY (LCRA)

IN

THE HIGHLAND LAKES

LOWER COLORADO RIVER

SEGMENT ADJUDICATION

ATTACHMENT NO. 2 TO JUDGMENT
IN CAUSE NO. 115,414-A-1

DIVERSION POINTS NOS. (MCRS): 2280 and 2290 (Lake Buchanan)
TRACT NO: None

OWNERSHIP: Lower Colorado River Authority (LCRA)

IR. (MCRS): 250-252
APP. (MCRS): 25-26
XII/II SF 1-1128
(MCRS) II Contest SF 95-138
(LCRS) Contest SF Vols. III, IV, V and VII

SECTION 11.307 CLAIM: Under Permits Nos. 954 and 1259 and Section 11.303 Claim No. 5550 to maintain a dam and 992,475 acre-foot capacity reservoir on the Colorado River (Lake Buchanan) and to impound, divert and use therefrom 1,391,530 acre-feet of water per year at a maximum diversion rate of 3630 cfs for "hydroelectric, municipal, domestic, industrial, etc." purposes, with a priority date of June 29, 1913 and prior. (Exh. J8)

FINDINGS:

1. The LCRA is the owner of Permit No. 1259, which authorized the construction and maintenance of a dam and approximately 1,000,000-acre-foot capacity reservoir on the Colorado River in Llano and Burnet Counties and the impoundment, diversion and use therefrom of 1,391,530 acre-feet of the ordinary and storm and flood flows of the Colorado River for domestic, municipal, (industrial), irrigation, mining and hydroelectric power purposes. (Exh. 10a)

2. A special condition in Permit No. 1259 authorizes the LCRA to use the bed and banks of the Colorado River for the purpose of conveying the impounded water to diversion points downstream for the uses authorized. (Exh. J10a)

3. Another special condition in the permit concerns Permit No. 954:

   > The dam for which this permit is granted has been constructed by virtue and under the terms of Permit No. 954, heretofore granted by the Board to the Syndicate Power Company of Dallas, Texas, and the alterations and modifications thereof heretofore set out by declarations filed with the Board, as prescribed by Statute, and this permit shall be cumulative of and in addition to said Permit No. 954, and of the rights covered by said permit; provided that the total quantity of water to be impounded, diverted and appropriated shall not exceed the quantity set out in paragraph four of this permit.

   (Exh. J10a)

4. Paragraph four of Permit No. 1259 recites that of the 1,391,530 acre-feet authorized to be appropriated by the permit, ". . . 1,225,700 acre-feet per annum have heretofore been granted under Permit

No. 954, the total amount to be appropriated under both permits not to exceed. . .1,391,530 acre-feet per annum." (Exh. J10a)

5. Application No. 1345 for Permit No. 1259 was filed with the Board of Water Engineers on March 7, 1938, and the permit was issued on May 25, 1938. (Exh. J10a)

6. The LCRA is the owner of Permit No. 954, which authorized the construction and maintenance of a dam and 831,020 acre-foot capacity reservoir on the Colorado River in Llano and Burnet Counties and the impoundment, diversion and use therefrom of 1,225,700 acre-feet of water per year for "power development" (hydroelectric) purposes. (Exh. J13a)

7. Application No. 1024 for Permit No. 954 was filed with the Board of Water Engineers on March 29, 1926, and the permit was issued on May 15, 1926. (Exh. J13a)

8. Lake Buchanan is located on the Colorado River in Burnet and Llano Counties. Buchanan Dam is located at diversion point D-2280 on the Colorado River in Survey No. 32, Burnet County, and Survey No. 12, Llano County, at the site authorized by Permit No. 1259 and approximately 4.5 miles upstream of the site authorized by Permit No. 954. (Exhs. 7 at p. 26, J10a, J13a; SF 105-106, 110-111)

9. Construction was commenced on Buchanan Dam about April, 1931, and was completed in 1938 with the first deliberate impoundment of water on May 20, 1937. The first hydropower generating unit was placed in operation in January, 1938. (Exhs. J13d-e, J90; SF 361, 379-381)

10. The impounding capacity of Lake Buchanan, as constructed, was approximately 992,000 acre-feet. (Exhs. J87, J90, 1231; SF 106-114, 293-294; Contest SF 105-106)

11. Permit No. 1259 authorized a dam 160 feet high and 11,000 long. Permit No. 954 authorized a dam 165 feet high and 2,500 feet long. (Exhs. J10a, J13a)

12. Buchanan Dam is 145.5 to 150.5 feet high and approximately 11,200 feet long. (Exhs. J90, J120; SF 106)

13. A "Statement of Proposed Alteration of Plans under Permits to Appropriate Public Waters of the State of Texas," dated April 25, 1931, was filed with the Board of Water Engineers by the Emery, Peck and Rockwood Development Company, transferee of several permits, including Permit No. 954, from the Syndicate Power Company. The statement purported to be filed under TEX. REV. CIV. STAT. ANN. article 7495, repealed, Tex. Laws 1971, ch. 58 at 658. The statement proposed to construct the dam authorized under Permit No. 954 at a location on the Colorado River different from

that specified by the permit. The dam was proposed to be built at a height of 137 feet and length of 9,000 feet and having a storage capacity of 1,000,000 acre-feet. The statement further proposed to construct another dam approximately 70 feet high at the location specified by Permit No. 954. The statement recited that construction had begun on the larger dam; that a plan of the construction had been filed with the statement; and that additional detailed plans would be filed with the Board showing the size, location and character of the two additional dams to be constructed under Permits Nos. 954 and 955. (Exh. J13d)

14. On some date subsequent to November 3, 1936, the LCRA filed a request for extension of time for commencing or completing work under Permits Nos. 951, 952, 953, 954, 955 and 998. In this request, it was stated that construction of Buchanan Dam had begun about the month of April, 1931, and was nearing completion. It was further declared that Buchanan Dam had been built to a height of approximately 160 feet and a length of approximately 11,000 feet and would impound approximately 1,000,000 acre-feet of water. The location of the dam was shown on an attached plat. The request stated that complete plans and specifications of Buchanan Dam were on file with the Board of Water Engineers and that construction was nearing completion of a dam at the original site authorized by Permit No. 954, which was being called Inks Dam. (Exh. J13e)

15. Lake Buchanan is a variable level lake which was constructed primarily for hydropower generation and water supply, rather than flood control. There are three hydropower turbines located at Buchanan Dam with a discharge capacity of 1210 cfs each and a maximum hydropower generation capability of 36 megawatts. Due to the limited capacity of the Inks Dam turbines, normal operation is the generation of 24 megawatts with a 2420 cfs discharge rate through the turbines. (SF 323-328, 356, 375, 776-778, 785, 852)

16. There is a pump-back unit installed at diversion point D-2290 on Inks Lake just downstream from Buchanan Dam. The purpose of this unit is to pump water from Inks Lake back into Lake Buchanan to be reused for hydroelectric purposes. There are no interjacent appropriators between Buchanan Dam and D-2290. LCRA is authorized to use water at Buchanan and Inks Dams for hydroelectric generation and to use the bed and banks of the Colorado River to convey water for that purpose, among others. (Exhs. 7 at 25, J10a, J11, J13a, J13d-e; SF 110-111, 828-829)

17. The maximum amount of water used for hydropower purposes at Buchanan Dam was 1,679,300 acre-feet in 1958. (Exhs. J51a-jj, J136)

18. Permit 1259B, granted April 25, 1985, is a contractual amendment to Permit 1259 authorized under

the Texas Water Commission's Rules. Permit 1259B authorizes the Colorado River Municipal Water District (CRMWD) to divert at Stacy Reservoir water to which LCRA would otherwise be entitled under Permit 1259. Permit 1259B authorizes the diversion of 88,000 acre-feet per year for domestic and municipal use, and 25,000 acre-feet per year for industrial purposes. Permit 1259B was issued pursuant to a Settlement Agreement dated February 26, 1985 between CRMWD and LCRA, and the authorization to divert water at Stacy Reservoir shall remain effective only so long as the Settlement Agreement remains in effect. Permit 1259B contains the following language (paragraph 1(b)).

> Under Permit No. 1259 and this amendment, the maximum combined diversions of LCRA at or below Lake Buchanan for domestic, municipal, industrial, irrigation, mining and hydroelectric generation purposes and that of CRMWD at Stacy Reservoir for domestic, municipal and industrial purposes shall not exceed 1,391,530 acre-feet of water per annum, or such amount as may be finally determined in the proceedings of adjudication of all claims of water rights in the Lower Colorado River Segment.

Permit No. 1259, as amended by Permit No. 1259B, is hereinafter referred to as "Permit No. 1259."

19. The Highland Lakes and the Colorado River above and below the Highland Lakes should be managed together as a single system for water supply purposes. Major goals in the management of the system include maximizing the beneficial use of water derived from inflows below the Highland Lakes, and stretching and conserving the water stored in the Highland Lakes. In order to achieve these goals, the system should be managed in accordance with the following general guidelines:

a. To the extent allowed by law, all demands for water from the Colorado River downstream of the Highland Lakes should be satisfied first pursuant to water rights to the run-of-river flow of the Colorado River.

b. Inflows should be passed through the Highland Lakes to honor downstream senior water rights only to the extent that demands under those rights cannot be satisfied by the inflows below the Highland Lakes.

c. Water should be released from conservation storage in Lakes Travis and Buchanan to satisfy downstream demands for authorized purposes (municipal, industrial, irrigation and mining) only to the extent that such demands cannot be satisfied pursuant to independent run-of-river water rights.

d. Firm, uninterruptible commitments of water from conservation storage in Lakes Travis and

Buchanan should not exceed the Combined Firm Yield of such lakes (hereinafter defined).

e. Water from conservation storage in Lakes Travis and Buchanan may be available for supply on an interruptible basis at any time that the actual demand for stored water under firm, uninterruptible commitments is less than the Combined Firm Yield. To the extent that a demand for water may exist on a non-firm, interruptible basis, such stored water should be made available.

f. The supply of stored water pursuant to non-firm, interruptible commitments should be interrupted or curtailed to the extent necessary to allow LCRA to satisfy all existing and projected demands for stored water pursuant to all firm, uninterruptible commitments.

g. Water should not be released through any dam solely for hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for stored water from Lakes Travis and Buchanan pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

20. Water is supplied from conservation storage in Lakes Travis and Buchanan by the direct diversion of stored water from such lakes, the release of stored water from such lakes for downstream delivery, and the impoundment, diversion or use of the flows of the Colorado River and its tributaries upstream of such lakes pursuant to subordination and other agreements. Under the basic system management plan outlined above, the demand for stored water from Lakes Travis and Buchanan will be erratic. The demand for such water will vary greatly from year to year, depending upon the climatic conditions and the locations, amounts and distributions of demands during each year. It is currently estimated that the peak annual demand for stored water in the reasonably foreseeable future will not exceed 1,500,000 acre-feet in any year. Such a demand may occur during years in which the inflows below the Highland Lakes are very low. Such a demand may also occur in other years, if a large demand for water on a non-firm, interruptible basis should develop.

21. The amount of water that the Highland Lakes/Colorado River system can supply each year on a firm basis through a repeat of the drought of record will vary greatly from time to time in the future, depending upon factors such as the locations of points of diversion and the demand for water at each diversion point. Generally, in order to provide a firm supply of water for a given annual demand, less stored water is needed to firm up the run-of-river supply as the point of diversion is

moved farther downstream. Assuming that large municipal, industrial and irrigation demands will continue to exist downstream of the Highland Lakes, the firm yield of the entire system will exceed the Combined Firm Yield of Lakes Travis and Buchanan.

22. The Combined Firm Yield is less than the Combined Theoretical Yield. The "Combined Theoretical Yield" is the amount of water that could be supplied from conservation storage in Lakes Travis and Buchanan during each year of a simulated repeat of the drought of record, as calculated pursuant to studies that assume the following:

    a. Inflows to Lakes Travis and Buchanan are those flows that would occur in the Colorado River at the site of Mansfield Dam if the Highland Lakes did not exist and there were no other impoundment, diversion or use of the flows of the Colorado River and its tributaries upstream of that point.

    b. No portion of the inflows will be passed through Mansfield Dam to honor downstream senior water rights.

    c. Lakes Travis and Buchanan will be operated together as a system so as to maximize the yield of that system.

    The "Combined Firm Yield" is that portion of the Combined Theoretical Yield remaining after it is assumed that inflows will be reduced by honoring upstream senior water rights and/or passed through Mansfield Dam to honor downstream senior water rights, in accordance with the relative priorities of such rights, except to the extent that the holder of any such right may agree otherwise. In determining the Combined Firm Yield, it is assumed that each senior water right will be exercised to the full extent authorized, except to the extent that the holder of such right may agree otherwise, or unless the Commission otherwise approves. The Combined Firm Yield may be expressed as a constant amount of water annually, or as an average annual amount of water over a defined period of years. The Combined Firm Yield cannot be determined until after the Adjudication is final, and such yield may change from time to time in the future. However, at the present time it is estimated that the Combined Firm Yield is not less than 500,000 acre-feet of water per year. As discussed above, this amount may also be expressed as an average of 500,000 acre-feet per year over any five consecutive calendar-year period, or a total of 2,500,000 acre-feet over any such period. The Commission will determine the Combined Firm Yield, and whether such yield is expressed as an average annual amount of water over a defined period of years, in its adoption of a Management Plan (hereinafter defined).

23. Subordination of hydroelectric rights will greatly increase the amount of water that LCRA has

available to supply from Lakes Travis and Buchanan for other purposes of use. LCRA in the past has subordinated its own hydroelectric rights to its rights to store and use water for other purposes. The City of Austin's early-priority hydroelectric right at Tom Miller Dam under C.F. 330 is the only hydroelectric right in the basin that is senior to Permit Nos. 1260 and 1259 for Lakes Travis and Buchanan, other than those held by LCRA. The City leased such right to LCRA pursuant to the 1938 and 1966 Agreements between the City and LCRA. LCRA in the past has also subordinated the C.F. 330 hydroelectric right that it leased from the City to LCRA's rights to store and use water for other purposes.

24. The extent to which additional stored water will be available in any year, after satisfying all existing and projected demands for stored water pursuant to all firm, uninterruptible commitments, can be defined at the beginning of that year pursuant to a rule curve or other analysis based on conditions that exist at that time. The availability of such additional stored water can be confirmed or redefined at other times during that year by one or more additional analyses at other times during that year based on conditions that exist at such times.

25. LCRA's right to use water from Lakes Travis and Buchanan for purposes other than hydroelectric generation, and the initial conditions for the commitment and supply of such water, should be defined as follows:

LCRA is recognized a right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan for municipal, industrial, irrigation and mining purposes, with a priority date of March 7, 1938. LCRA may diligently develop such right to a maximum aggregate diversion and use of water for such purposes from Lakes Travis and Buchanan of not to exceed 1,500,000 acre-feet in peak-use years, with a priority date of March 7, 1938, subject to the following conditions:

(a) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation plan which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as defined in Finding 22, above) and demonstrate LCRA's compliance with, and its ability to comply with, these special conditions (the "Management Plan"). In making its decision on the adoption of an Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(1) recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with § 11.147 of the Texas Water Code;

(2) protection of fish and wildlife habitats consistent with § 11.147 of the Texas Water Code;

(3) consideration of the effects, if any, on existing instream uses and water quality consistent with § 11.147 of the Texas Water Code;

(4) mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(5) mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with § 11.152 of the Texas Water Code; and

(6) recognition of the Commission's statutory authority to require water conservation under § 11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an application for a permit governed by Section 11.147 of the Texas Water Code. The Commission shall name as other parties persons that establish a justiciable interest in the proceeding. In making a final decision on the adoption of a Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(b) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these special conditions during the previous year. Such report shall be in a form approved by the Executive Director.

(c) Except as provided in Special Condition (i), below, LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(d) LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(e) Each commitment by LCRA to supply water under Permits Nos. 1260 or 1259 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment."

(f) LCRA shall not commit to supply water under Permits Nos. 1260 and 1259 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under Permits Nos. 1260 or 1259 on a firm, uninterruptible basis, unless:

(1) the aggregate of all firm, uninterruptible commitments of water under Permits Nos. 1260 or 1259, including the commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet over any five consecutive calendar-year period; or

(2) the commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per year; or

(3) such contract or resolution is specifically approved by either the Executive Director or the Commission pursuant to this special condition (f).

(g) LCRA shall interrupt or curtail the supply of water under Permits Nos. 1260 and 1259 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such permits pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro-rata basis or in accordance with a system of priorities, as may be set forth in the various contracts and resolutions that define such commitments.

(h) LCRA shall not impose its priority under Permits Nos. 1260 and 1259 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(1) LCRA would have the right to impose such priority against such water right if LCRA's right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(2) the holder of such water right has agreed, or in the future agrees, otherwise.

(i) LCRA shall supply water under Permits Nos. 1260 and 1259 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per year, to the extent that:

(1) the holder of such water right applies to the Commission for release of such water; and

(2) the Commission finds that, but for the exercise of priority claims under Certified Filings Nos. 44, 107, 330 and 376:

[a] water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an

authorized point of diversion under such water right; and

[b] applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this Special Condition (i); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this special condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(j) LCRA may from time to time apply to the Commission for amendment of the above special conditions pursuant to Commission rules.

Additionally, LCRA's rights to use water for hydroelectric generation should include conditions that generally subordinate such rights to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, irrigation or industrial purposes. Such conditions should specifically prohibit the release of water through its dams solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

CONCLUSIONS:

1. The alterations in the location and specifications of Buchanan Dam and Lake Buchanan from those originally authorized by Permit No. 954 were authorized by the substantial compliance with TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658.

2. LCRA is recognized a right under Permits Nos. 954 and 1259 to maintain an existing dam (Buchanan Dam) at diversion point D-2280 on the Colorado River in Survey No. 32, Burnet County, and Survey No. 12, Llano County, creating a reservoir (Lake Buchanan) with an impounding capacity of 992,475 acre-feet and to use the impounded water for recreation purposes without right of diversion, with a priority date of March 29, 1926.

3. LCRA is recognized a right under Permits Nos. 954 and 1259 to divert and use water through Buchanan

Dam at a maximum rate of 3630 cfs for the purpose of hydroelectric generation, with a priority date of March 29, 1926, subject to the following conditions:

(a) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

(b) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

(1) LCRA shall not release water through Buchanan Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

(2) To the extent that water is released through Buchanan Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

4. LCRA is recognized a right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan for municipal, industrial, irrigation and mining purposes, with a priority date of March 7, 1938. LCRA may diligently develop such right to a maximum aggregate diversion and use of water for such purposes from Lakes Travis and Buchanan of not to exceed 1,500,000 acre-feet in peak-use years, with a priority date of March 7, 1938, subject to the following conditions:

(a) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation plan which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as defined in Finding 22, above) and demonstrate LCRA's compliance with, and its ability to comply with, these special conditions (the

"Management Plan"). In making its decision on the adoption of an Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(1) recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with § 11.147 of the Texas Water Code;

(2) protection of fish and wildlife habitats consistent with § 11.147 of the Texas Water Code;

(3) consideration of the effects, if any, on existing instream uses and water quality consistent with § 11.147 of the Texas Water Code;

(4) mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(5) mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with § 11.152 of the Texas Water Code; and

(6) recognition of the Commission's statutory authority to require water conservation under § 11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an application for a permit governed by Section 11.147 of the Texas Water Code. The Commission shall name as other parties persons that establish a justiciable interest in the proceeding. In making a final decision on the adoption of a

Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(b) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these special conditions during the previous year. Such report shall be in a form approved by the Executive Director.

(c) Except as provided in Special Condition (i), below, LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(d) LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(e) Each commitment by LCRA to supply water under Permits Nos. 1260 or 1259 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment."

(f) LCRA shall not commit to supply water under Permits Nos. 1260 and 1259 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under Permits Nos. 1260 or 1259 on a firm, uninterruptible basis, unless:

(1) the aggregate of all firm, uninterruptible commitments of water under Permits Nos. 1260 or 1259, including the commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet over

any five consecutive calendar-year period; or

(2) the commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per year; or

(3) such contract or resolution is specifically approved by either the Executive Director or the Commission pursuant to this special condition (f).

(g) LCRA shall interrupt or curtail the supply of water under Permits Nos. 1260 and 1259 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such permits pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro-rata basis or in accordance with a system of priorities, as may be set forth in the various contracts and resolutions that define such commitments.

(h) LCRA shall not impose its priority under Permits Nos. 1260 and 1259 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(1) LCRA would have the right to impose such priority against such water right if LCRA's right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(2) the holder of such water right has agreed, or in the future agrees, otherwise.

(i) LCRA shall supply water under Permits Nos. 1260 and 1259 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per year, to the extent that:

(1) the holder of such water right applies to the Commission for release of such water; and

(2) the Commission finds that, but for the exercise of priority claims under Certified Filings Nos. 44, 107, 330 and 376:

[a] water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an authorized point of diversion under such water right; and

[b] applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this Special Condition (i); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this special condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(j) LCRA may from time to time apply to the Commission for amendment of the above special conditions pursuant to Commission rules.

The rights recognized in this Conclusion 4 are duplicative of, and are not in addition to, those rights recognized in Conclusion 6 relating to LCRA's rights in Lake Travis, below.

5. LCRA is recognized a right to use the bed and banks of the Colorado River to convey water released from Lake Buchanan for use by LCRA or others entitled to use such water in the amounts and for the purposes recognized herein.

6. LCRA is recognized a right to maintain and operate its existing pump-back unit at diversion point D-2290, as an aid in utilizing the water authorized in Permits Nos. 954 and 1259 for hydroelectric purposes.

DIVERSION POINTS NOS. (MCRS): 2290 and 2380 (Inks Lake)
TRACT NO: None

OWNERSHIP: Lower Colorado River Authority (LCRA)

IR. (MCRS): 260-261
APP. (MCRS): 25-26
XII/II SF 1-1128
(MCRS) II Contest SF 95-138
(LCRS) Contest SF Vols. III, IV, V and VII

SECTION 11.307 CLAIM: Under Permit No. 1259A and Section 11.303 Claim No. 5549 to maintain a dam and a 17,545 acre-foot capacity reservoir on the Colorado River and to impound, divert and use therefrom 1,391,530 acre-feet of water per year at a maximum diversion rate of 2600 cfs for hydroelectric purposes at an unspecified diversion rate, with a priority date of June 29, 1913 and prior. (Exh. J8)

FINDINGS:

1. The LCRA is the owner of Permit No. 1259A, which authorized the construction and maintenance of a 16,400 acre-foot capacity reservoir on the Colorado River in Llano and Burnet Counties and the impoundment, diversion and use therefrom of 1,391,530 acre-feet of water per year for hydroelectric power purposes.

2. A special condition in the permit concerns Permit No. 954:

   > The dam for which this permit is granted has been constructed by virtue and under the terms of Permit No. 954, heretofore granted by the Board to the Syndicate Power Company of Dallas, Texas, and the alterations and modifications thereof heretofore set out by declarations filed with this Board, as prescribed by Statute, and this permit shall be cumulative of and in addition to said Permit No. 954, and of the rights covered by said permit; provided that the total quantity of water to be impounded, diverted and appropriated shall not exceed the quantity set out in paragraph four hereof.

   (Exh. J11)

3. Paragraph four of Permit No. 1259A declares that of the 1,391,530 acre-feet authorized to be appropriated, ". . . 1,225,700 acre-feet of water per annum have heretofore been granted under Permit No. 954, the total amount to be appropriated under both such permits not to exceed . . . 1,391,530 acre-feet per annum." (Exh. J11)

4. Application No. 1345 for Permit No. 1259A was filed with the Board of Water Engineers on March 7, 1938, and the permit was issued on May 25, 1938. (Exh. J11)

5. The LCRA is the owner of Permit No. 954, which authorized the construction and maintenance of a dam and 831,020 acre-foot capacity reservoir on the Colorado River in Llano and Burnet Counties and the impoundment, diversion and use therefrom of 1,225,700 acre-feet of water per year for "power development" (hydropower) purposes. (Exh. J13a)

6. Application No. 1024 for the permit was filed with the Board of Water Engineers on March 29, 1926, and Permit No. 954 was issued on May 15, 1926. (Exh. J13a)

7. Inks Lake is located on the Colorado River in Llano and Burnet Counties. Inks Dam is located at diversion point D-2380 on the Colorado River in Survey No. 531, Burnet County, and Survey No. 8, Llano County, at the site authorized by Permit No. 1259A and approximately 1.5 miles upstream of the site authorized by Permit No. 954. (Exhs. 7, p. 26, J11, J13a; SF 114-117)

8. Construction of Inks Dam began in 1936 and was completed in 1938 with the first deliberate impoundment of water in 1938. Hydropower generation began in June, 1938. (Exh. J90; SF 361-362)

9. The impounding capacity of Inks Lake is approximately 17,545 acre-feet. (Exh. J90, SF 114-117)

10. Permit No. 1259A authorized a dam 102 feet high and 1500 feet long. Permit No. 954 authorized a dam 165 feet high and 2500 feet long. (Exhs. J11, J13a)

11. Inks Dam is 98.5 feet to 100 feet high and 1550 feet long. (Exh. J90; SF 115-116)

12. A "Statement of Proposed Alteration of Plans under Permits to Appropriate Public Waters of the State of Texas" dated April 25, 1931, was filed with the Board of Water Engineers by the Emery, Peck and Rockwood Development Company, transferee of several permits including Permit No. 954, from the Syndicate Power Company. The statement purported to be filed under TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658. The statement proposed to construct the dam authorized under Permit No. 954 at another location upstream (Buchanan Dam) and to construct another dam at the location authorized by Permit No. 954. This dam would be approximately 70 feet in height. The statement further proposed to reduce the capacity of a reservoir authorized under Permit No. 955 (cancelled on February 7, 1967) so as not to result in an increased appropriation of water. The statement further declared that additional detailed plans would be filed with the Board showing the size, location and character of the two additional dams to be constructed under Permits Nos. 954 and 955. (Exh. J13d)

13. On some date subsequent to November 3, 1936, the LCRA filed a request for extension of time for

commencing or completing work under Permits Nos. 951, 952, 953, 954, 955 and 998. In this request, it was stated that construction had begun by the LCRA on Inks Dam at the site described in Permit No. 954. It was stated that the dam would be built to a height of approximately 102 feet and a length of approximately 1500 feet, creating a reservoir with a surface area of approximately 830 acres and storage capacity of approximately 16,400 acre-feet. The request stated that complete plans and specifications of Inks Dam were on file with the Board of Water Engineers. (Exh. J13e)

14. There are two turbines located at Inks Dam with a discharge capacity of 1300 cfs each and a maximum hydropower generation capability of 24 megawatts. Normal operation is a generation of 24 megawatts with a 2600 cfs discharge rate through the turbines. Operation at Inks Dam is coordinated closely with operation at Buchanan Dam, with Inks functioning primarily as a pass-through of flows released from Buchanan Dam and is essentially a limiting factor on releases from Buchanan Dam. Excess flows are routed through a gravity section in the dam. (SF 776-782, 852)

15. The maximum amount of water used for hydropower purposes at Inks Dam was 1,015,400 acre-feet in 1946. (Exhs. J52a-jj, J136)

16. LCRA's rights to use water for hydroelectric generation should include conditions that generally subordinate such rights to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, irrigation or industrial purposes. Such conditions should specifically prohibit the release of water through its dams solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

CONCLUSIONS:

1. The alterations in the location and specifications of Inks Dam and Inks Lake from those authorized by Permit No. 954 were authorized by the substantial compliance with TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658.

2. LCRA is recognized a right under Permits Nos. 954 and 1259A to maintain an existing dam (Inks Dam) at diversion point D-2380 on the Colorado River in Survey No. 531, Burnet County, and Survey No. 8, Llano County, creating a reservoir (Inks Lake) with an impounding capacity of 17,545 acre-feet of water and to use the impounded water for nonconsumptive recreation with no right of diversion or release for this purpose, with a priority date of March 29, 1926.

3. LCRA is recognized a right under Permits Nos. 954 and 1259A to divert and use water through Inks Dam at a maximum rate of 2600 cfs for the purpose of hydroelectric generation, with a priority date of March 29, 1926, subject to the following conditions:

(a) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

(b) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

(1) LCRA shall not release water through Inks Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

(2) To the extent that water is released through Inks Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

DIVERSION POINT NO. (MCRS): 2650 (Lake Lyndon B. Johnson)
TRACT NO: None

OWNERSHIP: Lower Colorado River Authority (LCRA)

IR. (MCRS): 301-302
APP. (MCRS): 26
XII/II SF 1-1128
(MCRS) II Contest SF 95-138
(LCRS) Contest SF Vols. III, IV, V and VII

SECTION 11.307 CLAIM: Under Permits Nos. 953 and 953A and Section 11.303 Claim No. 5547 to maintain a 138,460 acre-foot capacity reservoir on the Colorado River and to impound, divert and use therefrom 1,305,000 acre-feet of water per year for hydroelectric purposes at a maximum diversion rate of 9,000 cfs and to divert 68,400 acre-feet and consume 15,700 acre-feet of water per year for industrial purposes at a maximum diversion rate of 5270 cfs. Claimed priority date is June 29, 1913 and prior. (Exh. J8)

FINDINGS:

1. The LCRA is the owner of Permit No. 953, which authorizes the construction and maintenance of a dam and 28,750 acre-foot capacity reservoir on the Colorado River in Llano and Burnet Counties and the impoundment, diversion and use therefrom of 1,305,000 acre-feet of water per year for power development (hydroelectric) purposes. The permit authorized the construction of the dam at about the southwest corner of Survey No. 509, Burnet County, at a height of 40 feet. (Exh. J19a)

2. The maximum rate of flow set out in Permit No. 953 for water through the turbines for generation of hydroelectric power is 1810 cfs (814,500 gpm). (Exh. J19a)

3. Application No. 1023 for Permit No. 953 was filed with the Board of Water Engineers on March 29, 1926, and the permit was issued on May 15, 1926. (Exh. J19a)

4. The LCRA is the owner of Permit No. 953A, which amends Permit No. 953 to authorize a point of diversion on Lake Lyndon B. Johnson and the diversion of an unspecified amount of water at this diversion point at a maximum diversion rate of 5270 cfs (2,370,000 gpm) for the circulation and recirculation of cooling water in the operation of a thermal-electric power plant. (Exh. J23a)

5. Application No. 1023A for Permit No. 953A was filed with the Commission on August 24, 1970, and the permit amendment was issued on September 22, 1970. (Exh. J23a)

6. Lake Lyndon B. Johnson is located on the Colorado River in Llano and Burnet Counties. Wirtz Dam is located at diversion point D-2650 on the Colorado River in Surveys Nos. 18 and 4, Burnet County, approximately 6.5 miles downstream of the site

authorized by Permit No. 953. (Exhs. 7 at p. 26, J19a; SF 117-122)

7. Construction began on Wirtz Dam and Lake Lyndon B. Johnson in September, 1948 and was completed in 1951, with the first impoundment of water in May, 1951. Hydroelectric generation commenced on June 25, 1951. (Exh. J90; SF 362)

8. The impounding capacity of Lake Lyndon B. Johnson, as-built, was approximately 138,500 acre-feet. (Exh. J90; SF 122)

9. Permit No. 953 authorized a dam 40 feet high and 1200 feet long. (Exh. J19a)

10. Wirtz Dam is 100 to 127.5 feet high, and its length consists of 1,146 feet of concrete plus 3,670 feet of rolled earth and rock with a concrete core. (Exh. J90; SF 118)

11. By order dated December 11, 1970, the Texas Water Rights Commission approved modifications in Wirtz Dam pertaining to (1) alteration of the spillway gates to provide for the installation of stop logs, and (2) construction of a new gated overflow section in the south abutment of the dam. The order did not mention the location, size or impounding capacity of the dam. (Exh. 1230)

12. There are two hydroelectric turbines located at Wirtz Dam with a total discharge capacity of 9000 cfs and a maximum hydropower generation capability of 52 megawatts. When operating proportionally with flows released from Inks Dam, 20 megawatts are generated. Excess flows are routed through floodgates in the dam. (SF 781-784)

13. The maximum amount of water used for hydropower purposes at Wirtz Dam was 1,533,300 acre-feet in 1957. (Exhs. J53a-jj, J136)

14. The thermal-electric plant, known as the Ferguson Plant, on Lake Lyndon B. Johnson went into operation in 1974. There are three circulating water pumps in the plant which pump 92,000 gpm each of condenser water. There are three half-capacity cooling water pumps for plant cooling water which pump 3500 gpm each, with two being operated at any one time. Each year approximately 68,400 acre-feet of water is diverted out of Lake Lyndon B. Johnson at a maximum diversion rate of 630 cfs (283,000 gpm), with 15,000 to 15,700 acre-feet of water being consumed in this process by forced evaporation. (Exhs. J8, J23d, J55jj; SF 119, 1004-1007)

15. LCRA's rights to use water for hydroelectric generation should include conditions that generally subordinate such rights to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, irrigation or industrial purposes. Such conditions should specifically prohibit the

release of water through its dams solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

CONCLUSIONS:

1. The alterations in the location and impounding capacity of Wirtz Dam and Lake Lyndon B. Johnson, as-built, from the location and impounding capacity set out in Permit No. 953 are substantial and required approval by the Board of Water Engineers pursuant to TEX. REV. CIV. STAT. ANN. art. 7492, repealed, Tex. Laws 1971, ch. 58 at 658. (Supp. 1984-1985)

2. By issuing Permit 953A and its subsequent order dated December 11, 1970, the Texas Water Rights Commission approved the alterations in the location and impounding capacity of Wirtz Dam and Lake Lyndon B. Johnson as they presently exist.

3. LCRA is recognized a right under Permits Nos. 953 and 953A to maintain the existing Wirtz Dam and Lake Lyndon B. Johnson on the colorado River, with a capacity of 138,500 acre-feet, and to use the impounded water for recreation purposes with no right of diversion or release for this purpose, with a priority date of March 29, 1926.

4. LCRA is recognized a right under Permit No. 953 to divert and use water through Wirtz Dam at a maximum rate of 9000 cfs for the purpose of hydroelectric generation, with a priority date of March 29, 1926, subject to the following conditions:

   (a) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

   (b) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

      (1) LCRA shall not release water through Wirtz Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

(2) To the extent that water is released through Wirtz Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

5. LCRA is recognized the right under Permit No. 953A to divert, circulate and recirculate water for industrial (power plant cooling) purposes from Lake Lyndon B. Johnson at its Ferguson Power Plant at a maximum diversion rate of 5270 cfs, and to consumptively use not to exceed 15,700 acre-feet of such water per annum in forced evaporation, with a priority date of August 24, 1970.

DIVERSION POINT NO. (MCRS): 3060 (Lake Marble Falls)
TRACT NO: None

OWNERSHIP: Lower Colorado River Authority (LCRA)

IR. (MCRS): 315-316
APP. (MCRS): 28
XII/II SF 1-1128
(MCRS) II Contest SF 95-138
(LCRS) Contest SF Vols. III, IV, V and VII

SECTION 11.307 CLAIM: Under Permit No. 998 and Section 11.303 Claim No. 5546 to maintain a dam and 8,760 acre-foot capacity reservoir on the Colorado River and to impound, divert and use therefrom 1,305,000 acre-feet of water per year at a maximum diversion rate of 9600 cfs for hydroelectric purposes with a priority date of June 29, 1913 and prior. (Exh. J8)

FINDINGS:

1. The LCRA is the owner of Permit No. 998 which authorizes the construction and maintenance of a dam and 23,640 acre-foot capacity reservoir and a 6723 acre-foot capacity reservoir on the Colorado River in Burnet County and the impoundment, diversion and use therefrom of 1,305,000 acre-feet per year of the ordinary and storm and flood flow of the Colorado River for power development (hydroelectric) purposes. (Exh. J26a)

2. The maximum rate of flow set out in Permit No. 998 for water through the turbines for hydropower purposes is 1800 cfs (810,000 gpm). (Exh. J26a)

3. Application No. 1022 for Permit No. 998 was filed with the Board of Water Engineers on March 29, 1926 and the permit was issued on November 4, 1927. (Exh. J26a)

4. Lake Marble Falls is located on the Colorado River in Burnet County. Starcke Dam is located at diversion point D-3060 on the Colorado River in Surveys Nos. 606 and 15, Burnet County, at the site authorized by Permit No. 998. (Exhs. 7 at p. 26, J26a; SF 126-127)

5. Construction began on Starcke Dam and Lake Marble Falls in November, 1949, and was completed in October, 1951. Deliberate impoundment of water began in July, 1951, and power generation commenced on September 25, 1951. (Exh. J90; SF 362)

6. The impounding capacity of Lake Marble Falls as built was approximately 8760 acre-feet. (Exh. J90; SF 127-128)

7. Permit No. 998 authorized a dam 70 feet high and 748 feet long. (Exh. J26a)

8. Starcke Dam is 98 to 100 feet high and 860 feet long. (Exh. J90; SF 127)

9. The record does not reflect that any statement and plans of the alterations in the specifications of Starcke Dam and Lake Marble Falls from those specified in Permit No. 998 were ever filed with the Board of Water Engineers or its successor agencies. (Exhs. J124, J125)

10. The alterations of Starcke Dam and Lake Marble Falls from the specifications authorized by Permit No. 998 resulted in a smaller storage capacity of the reservoir from that authorized in the permit.

11. There are two hydropower generating turbines located at Starcke Dam with a total discharge capacity of 8120 cfs and a maximum generating capacity of 32 megawatts. When operating proportionally with flows released from Inks Dam, the turbines generate approximately 10 megawatts. The power generation at Starcke Dam is coordinated closely with that at Wirtz Dam and the additional flows of the Llano River through Wirtz Dam are released through the turbines at Starcke Dam. Excess flows are routed through floodgates in the dam. (Exh. J90; SF 781-785)

12. The maximum amount of water used for hydropower purposes at Starcke Dam was 1,409,700 acre-feet in 1957. (Exh. J55a-jj, J136)

13. LCRA's rights to use water for hydroelectric generation should include conditions that generally subordinate such rights to all present and future upstream rights to use the waters of the

Colorado River and its tributaries for municipal, domestic, irrigation or industrial purposes. Such conditions should specifically prohibit the release of water through its dams solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

CONCLUSIONS:

1. The alterations of Starcke Dam and Lake Marble Falls from the specifications authorized by Permit No. 998 were insubstantial and did not result in an increased appropriation of State water.

2. Starcke Dam and Lake Marble Falls were constructed in substantial compliance with Permit No. 998.

3. LCRA is recognized a right under Permit No. 998 to maintain an existing dam (Starcke Dam) at diversion point D-3060 on the Colorado River in Surveys Nos. 606 and 15, Burnet County, creating a reservoir (Lake Marble Falls) with an impounding capacity of 8760 acre-feet of water and to use the impounded water for nonconsumptive recreation with no right of diversion or release for this purpose, with a priority date of March 29, 1926.

4. LCRA is recognized a right under Permit No. 998 to divert and use water through Starcke Dam at a maximum rate of 8120 cfs for the purpose of hydroelectric generation, with a priority date of March 29, 1926, subject to the following conditions:

   (a) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

   (b) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

      (1) LCRA shall not release water through Starcke Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

      (2) To the extent that water is released through Starcke Dam solely for the

> purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

DIVERSION POINTS NOS. (MCRS): 9999 (Lake Travis)
TRACT NO: None

OWNERSHIP: Lower Colorado River Authority (LCRA)

IR. (MCRS): 341-344
APP. (MCRS): 34-35
XII/II SF 1-1128
II Contest SF 95-138

SECTION 11.307 CLAIM: Under Permits Nos. 951, 952 and 1260 and Section 11.303 Claim No. 5551 to maintain a dam and 1,170,752 acre-foot capacity reservoir on the Colorado River (Lake Travis) and to impound, divert and use therefrom 1,500,000 acre-feet of water per year at a maximum diversion rate of 5529 cfs for "hydroelectric, municipal, domestic, industrial, etc." purposes, with a priority date of June 29, 1913 and prior. (Exh. J8)

FINDINGS:

1. The LCRA is the owner of Permit No. 1260, which authorizes the construction and maintenance of a dam and 600,000 acre-foot capacity reservoir on the Colorado River in Travis County and the impoundment, diversion and use therefrom of 1,500,000 acre-feet per year of the ordinary and storm and flood flows of the Colorado River for domestic, municipal, (industrial), irrigation, mining and hydroelectric power purposes. (Exh. J41a)

2. A special condition in Permit No. 1260 authorizes the LCRA to use the bed and banks of the Colorado River for the purpose of conveying impounded water to diversion points downstream for the uses authorized. (Exh. J41a)

3. Another special condition in the permit concerns Permits Nos. 951 and 952:

   > The dam for which this permit is granted is being constructed by virtue and under the terms of Permits Nos. 951 and 952,

> heretofore granted by this Board to the Syndicate Power Company of Dallas, Texas, and the alterations and modifications thereof heretofore set out by declarations filed with this Board, as prescribed by Statute, and this permit shall be cumulative of and in addition to Permits Nos. 951 and 952 and of the rights covered by said permits; provided, that the total quantity of water to be impounded, diverted and appropriated shall not exceed the quantity set out in paragraph four of this permit.

(Exh. J41a)

4. Paragraph four of Permit No. 1260 recites that of the 1,500,000 acre-feet authorized by the permit to be appropriated, ". . . 1,391,530 acre-feet have heretofore been granted under Permits Nos. 951 and 952, the total amount to be appropriated under all such permits not to exceed . . . 1,500,000 acre-feet per annum." (Exh. J41A)

5. Application No. 1346 for the permit was filed with the Board of Water Engineers on March 7, 1938, and Permit No. 1260 was issued on May 25, 1938. (Exh. J41a)

6. The LCRA is the owner of Permit No. 951 which authorized the construction and maintenance of a dam and 196,708 acre-foot capacity reservoir on the Colorado River and the impoundment, diversion and use therefrom of 1,391,530 acre-feet of water per year for "power development" (hydropower) purposes. (Exh. J36a)

7. Application No. 1020 for the permit was filed with the Board of Water Engineers on March 29, 1926, and Permit No. 951 was issued on May 15, 1926. (Exh. J36a)

8. The LCRA is the owner of Permit No. 952, which authorized the construction and maintenance of a dam and 718,429 acre-foot capacity reservoir on the Colorado River and the impoundment, diversion and use therefrom of 1,391,530 acre-feet of water per year for power development (hydropower) purposes. (Exh. J31a)

9. Application No. 1021 for the permit was filed with the Board of Water Engineers on March 29, 1926, and Permit No. 952 was issued on May 15, 1926.

10. Lake Travis is located on the Colorado River in Travis and Burnet Counties, Texas. Mansfield Dam is located at diversion point D-9999 on the Colorado River in Surveys Nos. 461 and 192, Travis County, at the site authorized by Permit No. 1260 and approximately one mile downstream of the site authorized by Permit No. 952. (Exhs. 7 at p. 34-35, J41a, J36a, J31a; SF 135-136)

11. Construction began on Mansfield Dam in March, 1937. The first stages of the dam were completed

in July, 1939. After the flood of 1938, the LCRA decided to extend the dam to its present height to provide additional flood control capacity. The present structure was completed May 17, 1942. Deliberate impoundment of water began on September 9, 1940 and the first hydroelectric generation unit was placed in operation on July 27, 1941. (Exh. J90a; SF 357-360, 382)

12. The impounding capacity of Lake Travis as constructed was approximately 1,170,752 acre-feet at normal maximum operating level (681 feet above m.s.l.). (Exh. J90; SF 136-137)

13. Permit No. 1260 authorized a dam 180 feet high and 2,325 feet long. Permit No. 951 authorized a dam 75 feet high and 1,102 feet long. Permit No. 952 authorized a dam 125 feet high and 3,200 feet long. (Exhs. J41a, J36a, J31a)

14. Mansfield Dam is 239.5 to 278 feet high and 2,423 feet long. (Exh. J90; SF 136)

15. On some date subsequent to November 3, 1936, the LCRA filed a request for an extension of time to commence or complete the construction of works authorized by Permits Nos. 951-955 and 998, including a request to extend the time for completion of Mansfield Dam. The request declared that construction had begun on the dam. The location and specifications of the dam and reservoir were the same as those which were later set out in Permit No. 1260. (Exhs. J13e, J41a)

16. By letter dated October 2, 1941, the LCRA sent to the Board of Water Engineers several construction plans. One plan clearly depicted Mansfield Dam at the height at which it was later constructed. (Exh. 1232, J122; Contest SF 112-113)

17. The LCRA secured federal funding to construct Mansfield Dam to its present height. In a March 13, 1941 contract, the Secretary of the Interior designated the LCRA as his agent to operate and maintain the dam upon its completion, solely for the purposes of regulating the flow of the Colorado River below the dam and controlling the floods of the river. The agreement further required that when there was no flood in progress in the river system above the dam, the storage capacity in the reservoir above elevation 681 feet m.s.l. would be available primarily for flood control and stream regulation and such capacity below this elevation would be primarily for power production; provided that the water surface elevation in the reservoir must never, under ordinary conditions when no flood is in progress, exceed elevation 691 feet m.s.l. The LCRA was further obligated by this agreement to release water impounded in the reservoir in anticipation of floods originating in the watershed above the dam and to be responsible for the time and manner of releasing stored waters in anticipation of floods, giving due regard to channel capacities of the river below the dam in making such releases.

Other agreements were later made between the parties concerning construction costs. (Exhs. J62a-c; SF 357-359)

18. Federal regulation of the flood control function of Mansfield Dam eventually passed to the U.S. Army Corps of Engineers. In regulations effective from May 15, 1951 to April 1, 1976, when the surface water elevation of Lake Travis was below 681 feet m.s.l., the LCRA was not permitted to make releases which would result in a flow at Columbus, Texas in excess of 50,000 cfs, provided that no curtailment of normal hydropower releases were required. During periods when the surface water elevation in Lake Travis was above elevation 681 feet m.s.l., a minimum release of 5,000 cfs was required. Above elevation 691 feet m.s.l., releases were required at the maximum possible discharge rate without exceeding a flow of 50,000 cfs at Columbus, provided that no curtailment of normal hydropower operation would result thereby. Above elevation 722 feet m.s.l., the LCRA was authorized to discharge water at the rate necessary to protect the dam and appurtenances from major damage. (Exh. J131; SF 359)

19. At the time of the adjudication hearing, the LCRA was operating Mansfield Dam pursuant to interim regulations adopted by the Corps of Engineers on April 1, 1976. These regulations were similar to the 1951 regulations except that the minimum release rate of water from Lake Travis between surface water elevation 681 and 683 feet m.s.l. was reduced to 3,000 cfs. (Exh. J130; SF 359-360, 377, 786-787, 816-822, 1091-1096)

20. Mansfield Dam is the only significant flood control structure in the Highland Lakes. There are 40 floodgates in the dam with a gravity section at elevation 714 feet m.s.l. The maximum surface water elevation of Lake Travis to date is 707 feet m.s.l., which occurred July, 1963. The capacity of the flood pool between elevation 681 feet and 691 feet m.s.l. is approximately 780,000 acre-feet. All discharges from Mansfield Dam are through the hydropower turbines unless the turbines are not capable of routing the excess flows. (Exh. J90; SF 786-787, 816-822)

21. There are three hydropower generating turbines located at Mansfield Dam with a total discharge capacity of 5530 cfs and a maximum generating capability of 84 megawatts. When operating proportionally with flows released through the other Highland Lakes, the turbines generate approximately 20 megawatts. The variable lake level of Lake Travis permits 24-hour-a-day operation of the turbines. (Exh. J90; SF 783, 785-786)

22. The maximum amount of water used for hydropower purposes at Mansfield Dam was 2,063,185 acre-feet in 1968. (Exhs. J55a-jj, J136)

23. Permit No. 4007, which was issued to the City of Cedar Park, Texas on August 23, 1983, authorizes

the City of Cedar Park to transfer from the Colorado River Basin not to exceed 7000 acre-feet per annum from the perimeter of Lake Travis on the Colorado River at a maximum diversion rate of 21,700 gpm (48.4 cfs) to the environs of the City of Cedar Park for municipal purposes, pursuant to the water supply contract dated May 24, 1983 between LCRA and the City of Cedar Park. (Exh. No. 1406)

24. Special Conditions in Permit No. 4007 provide that (1) water diverted to the City under the authority of Permit No. 4007, but not consumed, shall be returned at a designated point on Brushy Creek in the Brazos River Basin; and (2) that the authorization for the transbasin diversion is contingent upon the existence of a valid permit between LCRA and the City of Cedar Park. (Exh. No. 1406)

25. The City of Cedar Park will require all water authorized under Permit No. 4007 to meet future water demands, based on projected growth in the city over the next thirty years. (III Contest 21-27)

26. The Highland Lakes and the Colorado River above and below the Highland Lakes should be managed together as a single system for water supply purposes. Major goals in the management of the system include maximizing the beneficial use of water derived from inflows below the Highland Lakes, and stretching and conserving the water stored in the Highland Lakes. In order to achieve these goals, the system should be managed in accordance with the following general guidelines:

    a. To the extent allowed by law, all demands for water from the Colorado River downstream of the Highland Lakes should be satisfied first pursuant to water rights to the run-of-river flow of the Colorado River.

    b. Inflows should be passed through the Highland Lakes to honor downstream senior water rights only to the extent that demands under those rights cannot be satisfied by the inflows below the Highland Lakes.

    c. Water should be released from conservation storage in Lakes Travis and Buchanan to satisfy downstream demands for authorized purposes (municipal, industrial, irrigation and mining) only to the extent that such demands cannot be satisfied pursuant to independent run-of-river water rights.

    d. Firm, uninterruptible commitments of water from conservation storage in Lakes Travis and Buchanan should not exceed the Combined Firm Yield of such lakes (hereinafter defined).

    e. Water from conservation storage in Lakes Travis and Buchanan may be available for supply on an interruptible basis at any time that the actual demand for stored water under firm, uninterruptible commitments is less than the Combined Firm Yield. To the extent that a demand for water may exist on a non-firm, interruptible basis, such stored water should be made available.

f. The supply of stored water pursuant to non-firm, interruptible commitments should be interrupted or curtailed to the extent necessary to allow LCRA to satisfy all existing and projected demands for stored water pursuant to all firm, uninterruptible commitments.

g. Water should not be released through any dam solely for hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for stored water from Lakes Travis and Buchanan pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

27. Water is supplied from conservation storage in Lakes Travis and Buchanan by the direct diversion of stored water from such lakes, the release of stored water from such lakes for downstream delivery, and the impoundment, diversion or use of the flows of the Colorado River and its tributaries upstream of such lakes pursuant to subordination and other agreements. Under the basic system management plan outlined above, the demand for stored water from Lakes Travis and Buchanan will be erratic. The demand for such water will vary greatly from year to year, depending upon the climatic conditions and the locations, amounts and distributions of demands during each year. It is currently estimated that the peak annual demand for stored water in the reasonably foreseeable future will not exceed 1,500,000 acre-feet in any year. Such a demand may occur during years in which the inflows below the Highland Lakes are very low. Such a demand may also occur in other years, if a large demand for water on a non-firm, interruptible basis should develop.

28. The amount of water that the Highland Lakes/Colorado River system can supply each year on a firm basis through a repeat of the drought of record will vary greatly from time to time in the future, depending upon factors such as the locations of points of diversion and the demand for water at each diversion point. Generally, in order to provide a firm supply of water for a given annual demand, less stored water is needed to firm up the run-of-river supply as the point of diversion is moved farther downstream. Assuming that large municipal, industrial and irrigation demands will continue to exist downstream of the Highland Lakes, the firm yield of the entire system will exceed the Combined Firm Yield of Lakes Travis and Buchanan.

29. The Combined Firm Yield is less than the Combined Theoretical Yield. The "Combined Theoretical Yield" is the amount of water that could be supplied from conservation storage in Lakes Travis and Buchanan during each year of a simulated repeat of the drought of record, as calculated pursuant to studies that assume the following:

a. Inflows to Lakes Travis and Buchanan are those flows that would occur in the Colorado River at the site of Mansfield Dam if the Highland Lakes did not exist and there were no other impoundment, diversion or use of the flows of the Colorado River and its tributaries upstream of that point.

b. No portion of the inflows will be passed through Mansfield Dam to honor downstream senior water rights.

c. Lakes Travis and Buchanan will be operated together as a system so as to maximize the yield of that system.

The "Combined Firm Yield" is that portion of the Combined Theoretical Yield remaining after it is assumed that inflows will be reduced by honoring upstream senior water rights and/or passed through Mansfield Dam to honor downstream senior water rights, in accordance with the relative priorities of such rights, except to the extent that the holder of any such right may agree otherwise. In determining the Combined Firm Yield, it is assumed that each senior water right will be exercised to the full extent authorized, except to the extent that the holder of such right may agree otherwise, or unless the Commission otherwise approves. The Combined Firm Yield may be expressed as a constant amount of water annually, or as an average annual amount of water over a defined period of years. The Combined Firm Yield cannot be determined until after the Adjudication is final, and such yield may change from time to time in the future. However, at the present time it is estimated that the Combined Firm Yield is not less than 500,000 acre-feet of water per year. As discussed above, this amount may also be expressed as an average of 500,000 acre-feet per year over any five consecutive calendar-year period, or a total of 2,500,000 acre-feet over any such period. The Commission will determine the Combined Firm Yield, and whether such yield is expressed as an average annual amount of water over a defined period of years, in its adoption of a Management Plan (hereinafter defined).

30. Subordination of hydroelectric rights will greatly increase the amount of water that LCRA has available to supply from Lakes Travis and Buchanan for other purposes of use. LCRA in the past has subordinated its own hydroelectric rights to its rights to store and use water for other purposes. The City of Austin's early-priority hydroelectric right at Tom Miller Dam under C.F. 330 is the only hydroelectric right in the basin that is senior to

Permit Nos. 1260 and 1259 for Lakes Travis and Buchanan, other than those held by LCRA. The City leased such right to LCRA pursuant to the 1938 and 1966 Agreements between the City and LCRA. LCRA in the past has also subordinated the C.F. 330 hydroelectric right that it leased from the City to LCRA's rights to store and use water for other purposes.

31. The extent to which additional stored water will be available in any year, after satisfying all existing and projected demands for stored water pursuant to all firm, uninterruptible commitments, can be defined at the beginning of that year pursuant to a rule curve or other analysis based on conditions that exist at that time. The availability of such additional stored water can be confirmed or redefined at other times during that year by one or more additional analyses at other times during that year based on conditions that exist at such times.

32. LCRA's right to use water from Lakes Travis and Buchanan for purposes other than hydroelectric generation, and the initial conditions for the commitment and supply of such water, should be defined as follows:

LCRA is recognized a right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan for municipal, industrial, irrigation and mining purposes, with a priority date of March 7, 1938. LCRA may diligently develop such right to a maximum aggregate diversion and use of water for such purposes from Lakes Travis and Buchanan of not to exceed 1,500,000 acre-feet in peak-use years, with a priority date of March 7, 1938, subject to the following conditions:

(a) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation plan which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as defined in Finding 29, above) and demonstrate LCRA's compliance with, and its ability to comply with, these special conditions (the "Management Plan"). In making its decision on the adoption of an Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(1) recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with § 11.147 of the Texas Water Code;

(2) protection of fish and wildlife habitats consistent with § 11.147 of the Texas Water Code;

(3) consideration of the effects, if any, on existing instream uses and water quality consistent with § 11.147 of the Texas Water Code;

(4) mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(5) mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with § 11.152 of the Texas Water Code; and

(6) recognition of the Commission's statutory authority to require water conservation under § 11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an application for a permit governed by Section 11.147 of the Texas Water Code. The Commission shall name as other parties persons that establish a justiciable interest in the proceeding. In making a final decision on the adoption of a Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(b) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these special conditions during the previous year. Such report shall be in a form approved by the Executive Director.

(c) Except as provided in Special Condition (i), below, LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(d) LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(e) Each commitment by LCRA to supply water under Permits Nos. 1260 or 1259 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment."

(f) LCRA shall not commit to supply water under Permits Nos. 1260 and 1259 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under Permits Nos. 1260 or 1259 on a firm, uninterruptible basis, unless:

(1) the aggregate of all firm, uninterruptible commitments of water under Permits Nos. 1260 or 1259, including the commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet over any five consecutive calendar-year period; or

(2) the commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per year; or

(3) such contract or resolution is specifically approved by either the Executive Director or the

Commission pursuant to this special condition (f).

(g) LCRA shall interrupt or curtail the supply of water under Permits Nos. 1260 and 1259 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such permits pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro-rata basis or in accordance with a system of priorities, as may be set forth in the various contracts and resolutions that define such commitments.

(h) LCRA shall not impose its priority under Permits Nos. 1260 and 1259 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(1) LCRA would have the right to impose such priority against such water right if LCRA's right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(2) the holder of such water right has agreed, or in the future agrees, otherwise.

(i) LCRA shall supply water under Permits Nos. 1260 and 1259 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per year, to the extent that:

(1) the holder of such water right applies to the Commission for release of such water; and

(2) the Commission finds that, but for the exercise of priority claims under Certified Filings Nos. 44, 107, 330 and 376:

[a] water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an authorized point of diversion under such water right; and

[b] applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this Special Condition (i); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this special condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(j) LCRA may from time to time apply to the Commission for amendment of the above special conditions pursuant to Commission rules.

Additionally, LCRA's rights to use water for hydroelectric generation should include conditions that generally subordinate such rights to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, irrigation or industrial purposes. Such conditions should specifically prohibit the release of water through its dams solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments.

CONCLUSIONS:

1. The alterations in the location and specifications of Mansfield Dam and Lake Travis as set out in Permit No. 1260 from those authorized by Permits Nos. 951 and 952 were authorized by the substantial compliance with TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658.

2. A plan of alterations of Mansfield Dam from the specifications set out in Permit No. 1260 was filed with the Board of Water Engineers in substantial compliance with TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658.

3. The construction of Mansfield Dam to its present height and impounding capacity was authorized by the substantial compliance with TEX. REV. CIV. STAT. ANN. art. 7495, repealed, Tex. Laws 1971, ch. 58 at 658.

4. LCRA is recognized a right under Permits Nos. 951, 952 and 1260 to maintain a dam (Mansfield Dam) at Diversion Point No. 9999 on the Colorado River in Surveys Nos. 461 and 192, Travis County, creating a reservoir (Lake Travis) with an impounding capacity of 1,170,752 acre-feet and to use the impounded water for recreation purposes without right of diversion, with a priority date of March 29, 1926.

5. LCRA is recognized a right under Permits Nos. 951, 952 and 1260 to divert and use water through Mansfield Dam at a maximum rate of 5,530 cfs for the purpose of hydroelectric generation, with a priority date of March 29, 1926, subject to the following conditions:

   (a) Such right is subordinated to the extent set forth in TEX. REV. CIV. STAT. ANN. art. 8280-107, as amended, Tex. Laws 1975, ch. 74 at 179, as such act may be amended from time to time (the "LCRA Act").

   (b) Such right is further subordinated, to the extent that it may not be subordinated pursuant to the LCRA Act, as follows:

      (1) LCRA shall not release water through Mansfield Dam solely for the purpose of hydroelectric generation, except during emergency shortages of electricity, and during other times to the extent that such releases will not impair LCRA's ability to satisfy all existing and projected demands for water from Lakes Travis and Buchanan under Permits Nos. 1260 and 1259 pursuant to all firm, uninterruptible commitments and all non-firm, interruptible commitments; and

      (2) To the extent that water is released through Mansfield Dam solely for the purpose of hydroelectric generation, such right is specifically subordinated, as to priority, to all present and future upstream rights to use the waters of the Colorado River and its tributaries for municipal, domestic, industrial, irrigation and/or mining purposes, except during emergency shortages of electricity, and during other times to the extent that the holder of any such upstream right has agreed, or in the future agrees, otherwise.

6. LCRA is recognized a right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan for municipal, industrial, irrigation and mining purposes, with a priority date of March 7, 1938. LCRA may diligently develop such right to a maximum aggregate diversion and use of water for such purposes from Lakes Travis and Buchanan of not to exceed 1,500,000 acre-feet in peak-use years, with a priority date of March 7, 1938, subject to the following conditions:

(a) LCRA shall prepare and submit to the Commission, on or before December 31, 1988, a proposed reservoir operation plan which shall include such studies and other information as may be required by the Commission to determine the Combined Firm Yield of Lakes Travis and Buchanan (as defined in Finding 29, above) and demonstrate LCRA's compliance with, and its ability to comply with, these special conditions (the "Management Plan"). In making its decision on the adoption of an Management Plan, the Commission shall consider all relevant public policies including, without limitation, the following:

(1) recognition of the necessity of beneficial inflows from the Colorado River into the Lavaca-Tres Palacios Estuary consistent with § 11.147 of the Texas Water Code;

(2) protection of fish and wildlife habitats consistent with § 11.147 of the Texas Water Code;

(3) consideration of the effects, if any, on existing instream uses and water quality consistent with § 11.147 of the Texas Water Code;

(4) mitigation of adverse impacts, if any, on wildlife habitats inundated by new reservoir construction;

(5) mitigation of adverse environmental impacts, if any, caused by new projects taking, storing or diverting in excess of 5,000 acre-feet per year consistent with § 11.152 of the Texas Water Code; and

(6) recognition of the Commission's statutory authority to require water conservation under § 11.134(b)(4).

The Commission shall consider LCRA's proposal prior to adopting the initial Management Plan. The Management Plan may be amended from time to time upon the request of LCRA or on the Commission's own motion. The initial proceeding to consider the adoption of the Management Plan, and any major amendment thereof, shall be pursuant to contested case procedures. Any proceeding to consider the adoption or major amendment of the Management Plan shall be preceded by notice and opportunity to request a hearing in accordance with the Commission's regulations applicable to water rights permitting proceedings. The Texas Parks and Wildlife Department, at its option, may be a party in any such proceeding, in the same manner as it would be a party to a proceeding before the Commission incident to an application for a permit governed by Section 11.147 of the Texas Water Code. The Commission shall name as other parties persons that establish a justiciable interest in the proceeding. In making a final decision on the adoption of a Management Plan and any amendment thereof, the Commission, in addition to other information, evidence, and testimony presented, shall consider all information, evidence, and testimony presented by the Texas Parks and Wildlife Department, including, without limitation, any memorandum of understanding between LCRA and Texas Parks and Wildlife Department relating to the management of the Highland Lakes.

(b) LCRA shall prepare and submit to the Commission, on or before March 1 of each year beginning with March 1, 1990, a report which documents compliance with the Management Plan and these special conditions during the previous year. Such report shall be in a form approved by the Executive Director.

(c) Except as provided in Special Condition (i), below, LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to any other party except pursuant to a written contract between LCRA and such party that defines such commitment.

(d) LCRA shall not supply or commit to supply any water under Permits Nos. 1260 or 1259 to itself for use by itself or other parties except pursuant to resolution adopted by LCRA's Board of Directors that defines such commitment.

(e) Each commitment by LCRA to supply water under Permits Nos. 1260 or 1259 shall be considered to be on a firm, uninterruptible basis unless the contract, resolution or special condition defining such commitment specifically provides that such commitment "is subject to interruption or curtailment."

(f) LCRA shall not commit to supply water under Permits Nos. 1260 and 1259 on a firm, uninterruptible basis in excess of the Combined Firm Yield of Lakes Travis and Buchanan. During the period beginning as of January 1, 1988 until such time as the Management Plan is submitted and approved by the Commission, LCRA shall not enter into any contract or adopt any resolution by which it commits to supply any water under Permits

Nos. 1260 or 1259 on a firm, uninterruptible basis, unless:

(1) the aggregate of all firm, uninterruptible commitments of water under Permits Nos. 1260 or 1259, including the commitment made pursuant to such contract or resolution, does not exceed 2,500,000 acre-feet over any five consecutive calendar-year period; or

(2) the commitment made pursuant to such contract or resolution is for municipal use, and such commitment does not exceed 10,000 acre-feet of water per year; or

(3) such contract or resolution is specifically approved by either the Executive Director or the Commission pursuant to this special condition (f).

(g) LCRA shall interrupt or curtail the supply of water under Permits Nos. 1260 and 1259 pursuant to commitments that are specifically subject to interruption or curtailment, to the extent necessary to allow LCRA to satisfy all demands for water under such permits pursuant to all firm, uninterruptible commitments. Commitments to supply water on a non-firm, interruptible basis may be interrupted or curtailed as necessary either on a pro-rata basis or in accordance with a system of priorities, as may be set forth in the various contracts and resolutions that define such commitments.

(h) LCRA shall not impose its priority under Permits Nos. 1260 and 1259 against any junior permanent water right with a priority date senior to November 1, 1987, except to the extent that:

(1) LCRA would have the right to impose such priority against such water right if LCRA's right under Permits Nos. 1260 and 1259 to divert and use water from Lakes Travis and Buchanan were limited to the Combined Firm Yield of such lakes; or

(2) the holder of such water right has agreed, or in the future agrees, otherwise.

(i) LCRA shall supply water under Permits Nos. 1260 and 1259 to or for the benefit of any downstream water right with a priority date junior to December 1, 1900 and senior to November 1, 1987 that authorizes the diversion of not more than 3000 acre-feet of water per year, to the extent that:

(1) the holder of such water right applies to the Commission for release of such water; and

(2) the Commission finds that, but for the exercise of priority claims under Certified Filings Nos. 44, 107, 330 and 376:

[a] water would be available for diversion from the natural flow of the Colorado River or tributary thereof at an authorized point of diversion under such water right; and

[b] applicant's water right would entitle him to divert such water;

provided, however, that LCRA shall not be obligated to supply more than 20,000 acre-feet of water in any year pursuant to this Special Condition (i); that this commitment is subject to interruption or curtailment pro rata with other long-term interruptible commitments of LCRA; and that LCRA shall not be obligated to supply water under this special condition to or for the benefit of a temporary or term permit beyond the initial term thereof.

(j) LCRA may from time to time apply to the Commission for amendment of the above special conditions pursuant to Commission rules.

The rights recognized in this Conclusion 6 are duplicative of, and are not in addition to, those rights recognized in Conclusion 4 relating to LCRA's rights in Lake Buchanan, above.

7. LCRA is recognized a right to use the bed and banks of the Colorado River to convey water released from Lake Travis for use by LCRA or others entitled to use such water in the amounts and for the purposes recognized herein.

Attachment G

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8.10 Implementation of Water Conservation Plan, Drought Contingency Plan and Demand Schedule.
Purchaser shall adopt and implement the approved Water Conservation Plan and Drought Contingency Plan for the duration of the water contract. In addition, Purchaser must periodically report on progress made in implementation of its water conservation plan according to LCRA's Water Conservation Plan Rules. At least once every five (5) years, a Purchaser must submit an updated Drought Contingency Plan to LCRA, provided than any amended Drought Contingency Plan shall not be effective until reviewed and approved in writing by LCRA. At least once every five (5) years, a Purchaser must submit an updated Demand Schedule to LCRA.

ARTICLE 9. AGRICULTURAL INTERRUPTIBLE WATER SERVICE CONTRACTS

9.1 Applicability.
Notwithstanding any other provision of these Rules, this Article 9 controls requests for contracts for Agricultural Interruptible Water Service.

9.2 Deadline for Applications and Contracts.
LCRA shall not enter in a contract if the request for a contract is received after March 1 in any year except where:

(a) a curtailment of interruptible supply has not been declared by the LCRA Board;
(b) provision of water under the requested contract would not appreciably increase LCRA's operation costs nor unreasonably interfere with LCRA operations;
(c) provision of water under the requested contract would not impair LCRA's ability to deliver water to other customers who made request for contracts on or before March 1; and,
(d) the request for a contract is caused by a failure of the customer's other water supply (i.e. groundwater pump failure) or other emergency need for water.

9.3 Unpaid Account Balances.
LCRA shall not execute a Agricultural Interruptible Water Service Contract with a prospective customer if that customer has an unpaid account balance under a prior Agricultural Interruptible Water Service Contract.

ARTICLE 10. VARIANCES

Where special conditions or compelling circumstances exist, the LCRA Board of Directors may consider and approve requests for variances from the requirements of these rules on a case-by-base basis upon recommendation by LCRA staff.

ARTICLE 11. PRO RATA CURTAILMENT OF WATER USE BY FIRM WATER CUSTOMERS

11.1 Purpose and Overview

(a) The purpose of this chapter is to define the process and requirements under which LCRA will make water available to firm water customers during a pro rata curtailment in accordance with Texas Water Code §11.039 when, consistent with LCRA's Water Management Plan, the LCRA Board of Directors has declared a drought worse than the Drought of Record or other water emergency that drastically reduces the available firm supply.
(b) **Process Overview**
The following steps outline the process for preparing for, and implementing pro rata curtailment of firm customers:

1) consistent with the Water Management Plan, when projections indicate the potential for reaching the trigger for initiation of pro rata curtailment of firm water customers within six (6) months, LCRA will provide each customer with its Current Demand information and request that Customer prepare a Curtailment Plan;
2) Customer may request adjustments to its Baseline Amount, from which pro rata curtailment would be applied, or a variance to the Annual Allotment;
3) Customer updates its Drought Contingency Plan, if necessary;
4) Customer develops a Curtailment Plan to achieve the Percentage Curtailment(s), including the monthly pattern of use, and the measures to achieve the necessary reduction(s);
5) after the trigger for pro rata curtailment of firm customers is reached, LCRA issues a resolution directing customers to implement their Curtailment Plans;
6) LCRA may also direct customers to update their Curtailment Plans to include measures for possible higher levels of pro rata curtailment, and may subsequently take action directing customers to implement Curtailment Plans for higher or lower levels of curtailment; and
7) consistent with the Water Management Plan and the Board action implementing pro rata curtailment, when water supply conditions improve sufficiently, LCRA will issue a resolution ending the firm customer curtailment.

11.2 Definitions

In addition to the definitions provided in Article 3, the following definitions shall apply to terms when used in this Article. To the extent that there is any conflict with the definitions contained in Article 3 of the Water Contract Rules, the definitions contained in this section shall apply in this Article.

(a) Annual Allotment – the amount of water from LCRA supplies that would be made available to Customer in a 12-month billing period based upon Customer's Baseline Amount and the Percentage Curtailment currently in effect.

(b) Baseline Amount – Customer's projected reasonable demand which will be subject to pro rata curtailment. The calculation of Baseline Amount is provided in Section 11.5(a) below.

(c) Current Demand – Customer's diversion and beneficial use of LCRA water supplies as determined by LCRA staff from its billings for the Reference Year, unless modified to reflect conveyance losses, or as otherwise provided in a contract with LCRA.

(d) Curtailment Plan – a plan developed by Customer which includes the water use reduction measures that Customer will employ in order to achieve one or more percentage reductions in use. The Curtailment Plan may consist of drought response stages already found in Customer's Drought Contingency Plan plus supplemental information necessary for implementation of pro rata curtailment. LCRA's receipt of a Curtailment Plan (or any comments regarding water use reduction measures) does not affect the requirement that Customer achieve the Percentage Curtailment or be subject to higher rates or restrictions on the supply of water as described in this Article.

(e) Drought Coordinator - A person designated by Customer who is responsible for implementing Customer's Drought Contingency Plan and Pro Rata Curtailment Plan and coordinating with LCRA.

(f) General Manager – the General Manager of the Lower Colorado River Authority, or his designee.

(g) Monthly Distribution – the distribution of Customer's Annual Allotment into individual months.

(h) Percentage Curtailment – the percentage reduction(s) by which each customer is required to reduce its Baseline Amount.

(i) Reference Year – the most recent dry year for which there is a full and accurate record of water use as determined by the General Manager. In the event that the most recent dry year included voluntary watering restrictions that impacted water use, the General Manager may choose another recent dry year as the Reference Year.

(j) Quarterly Allotment – the amount of water that would be made available to Customer in any 3-month calendar billing period based upon Customer's Annual Allotment, and Customer's Monthly Distribution. The specific 3-month periods may start in any particular month based upon when the LCRA Board determines that Pro Rata Curtailment shall be implemented.

11.3 Time Periods and Billing Cycles

(a) Computation of Days. Unless stated otherwise, all time periods are in calendar days, not billing days. In the event that a time period ends on a weekend or LCRA holiday, the time period shall extend to the following business day.

(b) Billing Periods. "Billing periods" or "billing months" do not necessarily correspond to calendar months and are based upon the month in which the billing cycle ends. For example, the March billing period could be from February 15 to March 15.

11.4 LCRA Transmittal of Current Demand and Request for Curtailment Plan

Prior to Board action calling for the implementation of pro rata curtailment, the General Manager shall provide each customer, by certified mail, with:

(a) its Current Demand, which will be the default Baseline Amount;

(b) Customer's monthly billing data for the Reference Year;

(c) the potential Percentage Curtailment(s), the proposed Annual Allotment, and Customer's monthly use percentages from the billing data for the Reference Year;

(d) the date by which any request to modify the Baseline Amount or Annual Allotment shall be submitted; and

(e) the date by which Customer's initial Curtailment Plan shall be submitted to LCRA.

11.5 Determination of Customer's Baseline Amount and Annual Allotment

(a) The Baseline Amount shall be determined by the General Manager and shall be equal to Customer's Current Demand unless Customer demonstrates and the General Manager agrees that the Current Demand was not reflective of Customer's current reasonable demand because:

1) the implementation of water conservation and/or drought management measures by Customer in the Reference Year resulted in a reduction of Customer's water demand;

2) the water demand in the Reference Year does not reflect new growth and a corresponding increase in Customer's reasonable water demands;

3) Customer experienced a plant outage or other incident in the Reference Year that reduced the water demand for that year;

4) Customer's demand in the Reference Year does not represent its reasonable demand because Customer is a new customer and did not receive LCRA supplied water for the entire year; or

5) any other affirmative action or program by Customer that resulted in a reduction of water demand in the Reference Year.

(b) The Annual Allotment shall be determined by the General Manager and shall be equal to the Baseline Amount minus the Percentage Curtailment. In the event that Customer takes action which reduces delivery losses, or Customer's contract contains special provisions related to the delivery of water, the General Manager may adjust the Annual Allotment to reflect actual water saved.

(c) If Customer seeks to request a modification of the Baseline Amount or Annual Allotment, Customer shall submit a request to the General Manager for such modification within thirty (30) days of receipt of Customer's Baseline Amount and proposed Annual Allotment. Customer shall submit with the request all supporting documentation including, but not limited to:

1) for water savings as a result of water conservation and/or drought management measures, Customer must be able to demonstrate that real, not expected, savings have occurred. Such savings shall be normalized for weather and other factors, e.g. growth or type of use, and show comparison of use between recent or similar years of diversion;
2) for new customers (regardless of use type), any available use data for recent full or partial years, extrapolated to other months based on an appropriate seasonal distribution;
3) for municipal customers, data such as the current number of Living Unit Equivalents (LUEs) versus the number of LUEs in a previous year; and
4) any other appropriate information that may be presented by Customer or requested by the General Manager that demonstrates that the Baseline Amount or Annual Allotment should be adjusted.

(d) Neither the Baseline Amount nor the Annual Allotment shall exceed Customer's contractual quantity (maximum annual quantity). For a customer that has a new contract or has amended its contract in the most recent calendar year to a reduced maximum annual quantity (MAQ), the Baseline Amount shall be determined as if it was a new customer, or using the Current Demand from the Reference Year data, whichever is higher, subject to the foregoing limitation.

(e) If Customer has requested modification of its Baseline Amount or Annual Allotment, the General Manager will review the request and make a final determination with thirty (30) days of such request.

11.6 Development and Implementation of Customer Curtailment Plans

(a) Each customer shall provide the General Manager with its Curtailment Plan(s) as requested not later than ninety (90) days after Customer's receipt of its Current Demand and proposed Baseline Amount, or, in the event that Customer has requested a modification to its Baseline Amount, not later than thirty (30) days after the final determination of Customer's Baseline Amount. The plan shall:

1) identify Customer's Drought Coordinator and the coordinator's contact information (phone number, email, fax number and mailing address), as well as the contact information for any other person to whom LCRA shall provide materials and information during the period in which a curtailment is in effect;
2) include the specific measures which will be implemented by Customer to achieve the Percentage Curtailment(s) as identified by LCRA; and
3) include a Monthly Distribution of the proposed Annual Allotment. In the event that the Curtailment Plan addresses more than one level of Percentage Curtailment, Customer may have separate Monthly Distributions for each Percentage Curtailment.

(b) The General Manager will not accept a Curtailment Plan that does not include a reasonable Monthly Distribution of Customer's Annual Allotment, with such reasonableness to be determined by the General Manager. In determining whether the Monthly Distribution is reasonable, the General Manager will consider: the monthly diversion and use distribution from the Reference Year; a typical distribution based upon Customer's purpose of use; other sources of supply available to Customer; and any other relevant information.

(c) Within thirty (30) days of receipt of Customer's Curtailment Plan, the General Manager will review the plan and notify Customer as to whether Customer's Curtailment Plan is accepted or not.

(d) If Customer's Curtailment Plan is not accepted, Customer shall have twenty (20) days from receipt of the General Manager's notice of deficiency to remedy the elements of Customer's Curtailment Plan that are not acceptable.

(e) In the event that Customer has not submitted a plan or the General Manager has not accepted a Curtailment Plan for Customer prior to initiation of a Curtailment, Customer's Baseline Amount shall be based upon the Current Demand from the Reference Year, Customer's Annual Allotment shall be Customer's Baseline Amount less the Percentage Curtailment, and Customer's Monthly Distribution shall be 1/12 of the Annual Allotment per month.

(f) Customer may alter its Monthly Distribution for subsequent years in a Curtailment by submitting a revised Monthly Distribution by November 1, with the revised Monthly Distribution becoming effective beginning in the January billing period following such submission.

(g) The implementation and cancellation of a pro rata curtailment will coincide with Customer's billing months rather than specified days. If pro rata curtailment commences after the beginning of a year, the curtailment shall apply only to the remaining months of the year, and the Annual Allotment shall be pro-rated for the applicable portion of the year. If the pro rata curtailment is cancelled prior to the end of the year, Customer shall be responsible for meeting the Annual Allotment as pro-rated for the applicable portion of the year.

11.7 Updates to Customer Drought Contingency Plans

(a) Prior to submittal of its Curtailment Plan, Customer shall update its Drought Contingency Plan (including, where appropriate, obtaining approval of its governing body) as necessary, to ensure that the appropriate measures can be implemented and enforced consistent with rules of the Texas Commission on Environmental Quality contained in Chapter 288 of Title 30, Texas Administrative Code. A copy of the updated Drought Contingency Plan shall be provided to LCRA and, where required, the Texas Commission on Environmental Quality.

11.8 Board Action Implementing Pro Rata Curtailment

(a) If the LCRA Board of Directors issues a resolution calling for the implementation of pro rata curtailment of water use by firm water customers, the resolution will:

1) provide for the cessation of interruptible water supply prior to pro rata curtailment of water use by firm water customers;
2) establish the Percentage Curtailment applicable to LCRA firm water customers and applied to LCRA's commitment of firm water for environmental flow needs and the time period for which the Percentage Curtailment and Annual Allotment will initially apply; the initial curtailment will start no earlier than 120 days from the date customers are provided the information in section 11.4;
3) define any additional level(s) of Percentage Curtailment for which customers shall prepare amended Curtailment Plans for implementation in the event that water supply conditions worsen, as determined by LCRA;
4) direct all firm water customers to implement their Curtailment Plans and achieve the pro rata reduction of water use;

5) establish criteria for the cancellation of pro rata curtailment. Such criteria may be based upon the combined storage in lakes Buchanan and Travis reaching a specified amount, or any other criteria the Board deems appropriate; and

6) authorize LCRA staff to take any and all other necessary action for the implementation and enforcement of the pro rata curtailment and these rules.

(b) In addition, the Board may:

1) reevaluate the rates to be assessed against a customer for diverting water in excess of the amount allotted during the pro rata curtailment;

i) In establishing a graduated set of rates, the Board may consider the number of times that a customer exceeds its Quarterly Distribution under its Curtailment Plan and the degree to which the customer exceeds such distribution.

2) establish any incentives the Board deems appropriate that would apply to any customer that would result in the use of less water than the customer's Annual Allotment;

(c) In the event water supply conditions worsen, the LCRA Board may issue subsequent resolutions to implement amended Curtailment Plans and direct customers to develop subsequent Curtailment Plan(s) for higher level(s) of Percentage Curtailment. In the event that water supply conditions improve, but LCRA determines that pro rata curtailment should not be ceased entirely, the LCRA Board may issue subsequent resolutions to implement amended Curtailment Plans and direct customers to develop subsequent Curtailment Plan(s) for lower level(s) of Percentage Curtailment.

11.9 Monitoring, Reporting and Water Rates

(a) LCRA staff will monitor Customer's use of water on a monthly basis and will send to Drought Coordinator each month information including:

1) the Customer's actual use;

2) the Monthly Distribution and Quarterly Distribution amounts (based upon the then-current Percentage Curtailment) that will be used for purposes of determining applicable water use exceedance and/or credits;

3) the current Board adopted rates and available incentives; and

4) the current accrued amount of exceedance or credit; and any other applicable pro rata related information.

(b) At the end of each quarterly billing period, LCRA staff will aggregate the monthly amounts made available to Customer into a quarterly use total. LCRA staff will compare the quarterly use total to the Quarterly Distribution for the corresponding quarterly period.

(c) Except as otherwise provided by the Board in its resolution implementing pro rata curtailment, exceedances and credits will accrue beginning with the first full quarter following issuance of the Board's resolution.

(d) In the event that the amount of water used within a quarter is less than the Quarterly Distribution, a credit will be recorded for that quarter in units of acre-feet. The credit can be carried forward into subsequent quarters within the same calendar year, but cannot be used in a subsequent calendar year.

(e) Within a calendar year, if there is a quarter in which the amount diverted exceeds the Quarterly Distribution, an available credit from a prior quarter could apply.

(f) In the event that the amount used in a quarter is greater than the Quarterly Distribution in Customer's Curtailment Plan (and no "credits" are available from a prior quarter), an exceedance will be accrued.

(g) Credits and exceedances will be pro-rated for a billing quarter in which pro rata curtailment is ceased.

(h) Each customer's exceedances will be determined on a quarterly basis, unless the curtailment began or ended mid-quarter.

(i) For water made available or used in amounts in excess of Customer's Annual Allotment or portion thereof, the following rates apply:

1) For water made available or diverted in an amount up to 5.0 percent greater than the Annual Allotment or portion thereof, the rate shall be two-times the then-current base firm water rate;
2) For water made available or diverted in an amount from 5.01 percent to 10.0 percent greater than the Annual Allotment or portion thereof, the rate shall be four-times the then-current base firm water rate;
3) For water made available or diverted in an amount more than 10.0 percent greater than the Annual Allotment or portion thereof, the rate shall be six-times the then-current base firm water rate; however if Customer has exceeded its Annual Allotment by greater than 10.0 percent in a prior year, the rate shall be ten-times the then-current base firm water rate.

(j) On a monthly basis, the amount due will be limited to one-times the base firm water rate, with the remainder due consistent with the year-end invoice.

(k) Notwithstanding any rates applicable to the use of water in amounts greater than the Annual Allotment, LCRA reserves the right to cut off delivery of water in amounts that would exceed Customer's Annual Allotment.

11.10 Incentives

The LCRA Board of Directors in its resolution implementing pro rata curtailment, may establish incentives that would apply to any customer that uses less water than its Annual Allotment.

11.11 Trading

(a) A customer may transfer all or part of its Annual Allotment to another customer during all or part of a calendar year.

(b) The following customers may not transfer all or part of their Annual Allotments:

1) a customer with a contract quantity based upon its firm yield impact rather than actual diversions; and
2) a customer that received an adjustment to its Baseline Amount to a value that is higher than its Current Demand.

(c) Transfer agreements must be received by October 1 to be effective for a year in which pro rata curtailment is in effect. In the event that pro rata curtailment is lifted, transfer agreements received after curtailment is lifted will not be considered.

(d) For any agreement to be recognized by LCRA for purposes of compliance with the pro rata curtailment, the transfer must be accepted by the General Manager prior to its implementation and shall:

1) identify the amount of the Annual Allotment that would transfer to the purchaser for each Percentage Curtailment addressed in Customer's Curtailment Plan;
2) specify the time period(s) in which the transfer would apply, however the transfer cannot apply to a prior year;
3) identify the party responsible for payment of water use and/or reservation charges associated with the transferred amount;
4) identify the party responsible for payment of the reservation charges for the remainder of a year in the event that curtailment ends in the middle of a calendar year; and
5) be consistent with the overall pro rata curtailment and applicable contracts.

(e) A copy of the executed agreement shall be filed with the LCRA. The copy shall be submitted to: LCRA; Attn: Manager of River Services; RBC-325; P. O. Box 220; Austin, TX 78767.

(f) Each of the affected customer's Annual Allotments will be adjusted based upon LCRA's understanding of the parties' transfer agreement. Such adjustments may be pro-rated in the event that a curtailment is initiated or ends in the middle of a calendar year.

(g) Any rates or incentives affecting the seller or purchaser would be based upon their adjusted Annual Allotments.

(h) In the event that pro rata curtailment is lifted, the purchaser of a customer's Annual Allotment shall identify for LCRA and the seller the amount of water used under the agreement so that the remaining amount available for the seller to use in the remainder of the calendar year is known.

11.12 Enforcement

(a) LCRA staff will monitor Customer's compliance with its Curtailment Plan and the General Manager shall take enforcement action as necessary in the event that Customer is noncompliant.

(b) LCRA's enforcement actions may include:

1) increasing rate structures;
2) assessments of surcharges;
3) any other remedy available at law.

(c) Implementation of the measures contained in Customer's pro rata Curtailment Plan shall not excuse Customer's failure to achieve the Percentage Curtailment ordered by the Board.

(d) Monitoring and enforcement of water use restrictions at the end-user level will generally be Customer's responsibility.

11.13 Cessation of Pro Rata Curtailment

(a) During pro rata curtailment, LCRA staff will continue to monitor water supply conditions and provide updates to the LCRA Board of Directors, LCRA customers, and to the public.

(b) Prior to cancellation of pro rata curtailment, the Board will re-evaluate the criteria for cancellation identified in the Board resolution implementing the curtailment to determine if a different criteria should be used in canceling pro rata curtailment.

(c) In the event that the Board determines that pro rata curtailment shall be lifted, the Board shall issue a resolution specifying the date at which pro rata curtailment shall end.

11.14 Variance to the Pro Rata Curtailment

(a) A customer may request a temporary variance from the Annual Allotment prior to or with the submission of its Curtailment Plan, including a subsequent Curtailment Plan to address a higher level of Percentage Curtailment.

(b) The LCRA General Manager may grant a temporary variance to the Annual Allotment under Customer's Curtailment Plan if it is determined that:

1) failure to grant such a variance would cause an emergency condition adversely affecting the public health, welfare or safety; or
2) compliance with the plan cannot be technically accomplished during the duration of the water supply shortage or other condition for which the ordered curtailment plan is in effect.

(c) A Request for Variance shall include the following:

1) name and address of the customer seeking the variance;
2) detailed statement with supporting data and information as to how the Annual Allotment of water under the policies and procedures established by the LCRA's Firm Water Curtailment Procedures would cause the impacts as described in 11.14(b).

3) description of the relief Customer is requesting;
4) period of time for which the variance is sought; and
5) other pertinent information as provided by Customer or requested by the General Manager.

(d) Variances granted by the LCRA General Manager shall be subject to the following conditions:
1) variances shall include a timetable for compliance; and
2) variances granted shall expire when pro rata reduction requirements are no longer in effect; however, any outstanding obligations of Customer related to the granting of the variance must be fulfilled.

(e) No variance shall be retroactive or otherwise justify a violation of the LCRA drought contingency rules or requirements occurring prior to the issuance of the variance(s).

(f) The General Manager shall issue a written decision to Customer on the requested variance within 20 days of receipt of a Request for Variance.

11.15 Appeal of General Manager's Decision on a Request for a Variance from the Pro Rata Curtailment

(a) Only a decision by the General Manager denying a Request for Variance to the Annual Allotment may be appealed to the LCRA Board of Directors.

(b) Only the customer seeking the variance may appeal the decision by the General Manager.

(c) A customer eligible to file an appeal and who wishes to appeal must file the appeal within fifteen (15) days after the date of the General Manager's written decision. The appeal shall be filed with the LCRA General Counsel in accordance with the procedures outlined in this section.

(d) The LCRA General Counsel shall send written notice of receipt of any appeal to the Board, General Manager, LCRA staff, and Customer within five (5) business days after expiration of the date for filing appeals. Such notice shall generally describe and summarize the issues raised by an appeal, and advise Customer of the prohibition against unlawful ex parte contacts. In addition, the LCRA General Counsel may advise the Board of the receipt of an appeal at any time prior to the expiration of the date for filing appeals as necessary to prevent unlawful ex parte contacts.

(e) An appeal must be in writing, timely filed, submitted as an original and two (2) copies, and shall not exceed fifteen (15) pages in length including exhibits or attachments. The appeal shall include the following information:
1) the name and address of the customer filing the request for appeal;
2) a concise statement of how the customer requesting the appeal is affected by the granting or denial of the variance.

(f) Within ten (10) business days from receipt of an appeal, the General Counsel shall determine the validity or invalidity of the Request for Appeal. For an appeal to be valid, the Request for Appeal must: 1) be filed in accordance with this section; and 2) only raise issues that were presented in Customer's Request for Variance to the General Manager. The General Counsel's determination of the invalidity or validity shall be final. Upon a determination that an appeal is invalid, the General Manager's variance decision shall become final.

(g) The General Counsel shall immediately provide written notice of his decision regarding the validity of the appeal to staff and send such notice by first class mail to Customer.

(h) Within ten (10) business days after the receipt of the written notice of the validity of an appeal, staff shall prepare a written response to the appeal. The response shall not exceed fifteen (15) pages in length including exhibits and attachments, and shall be submitted to the LCRA General Counsel and mailed by certified mail, return-receipt requested to Customer.

(i) Upon expiration of the deadline for staff to submit a response, the LCRA General Counsel shall forward to the Chair of the Water Operations Committee a copy of Customer's request for variance, the General Manager's variance decision, Customer's appeal, and the staff response.

(j) Water Operations Committee Consideration of a Valid Appeal

1) Taking into consideration the complexity of the issues, and the need to develop an adequate evidentiary record, the Committee Chair shall determine the most appropriate forum for consideration of an appeal. The Committee Chair may:
   i) Consider all of the written information forwarded by the LCRA General Counsel and direct staff to issue the variance;
   ii) forward the appeal to the Committee with a recommendation that the Committee consider all of the written information submitted and allow Customer and staff a period of time to present oral argument;
   iii) Forward the appeal to the Committee with a recommendation that the Committee consider all of the written information submitted, and allow each party to the proceeding to submit additional evidence and present oral argument; or
   iv) Forward the appeal to the Committee with a recommendation that it consider the appeal using another method agreed to by all of the parties.

2) Upon the direction of the Committee Chair, as specified in this subsection, a hearing before the Committee may be held to consider a valid appeal. Such hearing shall be scheduled by the Committee Chair no later than forty-five (45) calendar days after receipt of the valid appeal from the General Counsel.

3) The hearing shall be open to the public.

4) Only Customer, LCRA staff, or any of their representatives, shall be entitled to participate in the hearing.

5) The Committee shall deliberate in open session taking into consideration the presentations of staff and the parties, if any, and all written materials submitted to the Committee as a valid part of the appeal process. Notwithstanding the foregoing, the Committee may confer with the LCRA General Counsel in executive session for the purpose of receiving legal advice concerning the appeal.

6) The appeal shall be decided from the written information provided to the Committee prior to the hearing, documents contained in Customer's file, and any other evidence or information submitted at the hearing, if recommended by the Committee Chair to be considered by the Committee. The Committee may:
   i) direct staff to issue the variance;
   ii) recommend modification of the variance as requested; or
   iii) recommend denial of the variance as requested.

   Any materials provided to the Committee for purposes of deciding the appeal, including documents in Customer's file, shall be provided to Customer prior to the hearing.

7) The Committee may alter the procedures set forth in this section, if necessary to develop an adequate record, to afford full opportunity for public participation or comment by Customer, appellants, or staff, or if in the public interest.

8) Any decision by the Committee Chair or the Committee that directs staff to grant a variance as requested by Customer is final and may not be appealed to the LCRA Board. If the Committee recommends that a variance be granted which is modified from Customer's request, Customer may accept the variance or appeal to the Board within ten (10) days by filing a request for Board consideration with the General Counsel.

(k) Board Consideration of a Variance Denial. If the Committee recommends denial of the Request for Variance, the Committee shall forward the decision to the full LCRA Board for consideration within forty-five days or at its next regularly scheduled meeting, whichever is later. The Board shall consider the Committee's recommendation and may allow, at its discretion, Customer and staff time to present oral argument in support their respective positions. The Board may take the following action:
   1) direct staff to issue the variance as requested;
   2) direct staff to issue the variance as modified by the Board; or
   3) deny the Request for Variance;

(l) Ex Parte Communications.
   1) Any communication by a customer requesting an appeal, LCRA staff member, or any other party in interest, or their representatives, with Committee or other member(s) of the LCRA Board on the merits of any pending appeal or decision affecting a variance request from the date Customer files a variance request with the General Manager until the date the appeal is decided, other than at a hearing or in a public meeting of the Committee, or the Board, is strictly prohibited, unless sufficient notice and opportunity to be present and to present evidence and/or oral argument is provided to all parties. Notwithstanding the foregoing, the LCRA General Counsel may consult with the Board or any of its Directors regarding any procedural or legal issues regarding the appeal.
   2) Any person who violates this provision may be subject to sanctions, which may include return of the variance request if the violation is from the customer seeking the variance or his/her representative.

ARTICLE 12. REQUIREMENTS FOR INTERBASIN WATER SALES TO WILLIAMSON COUNTY

12.1 Applicability.

This article sets forth additional requirements that apply to interbasin water sales to any person or entity within Williamson County that did not have a water sale contract with LCRA on or before May 1, 1997, consistent with the requirements of Section 8503.029, Texas Special District Local Laws Code. In the event of a conflict between a requirement set forth in this Article 12 and any other requirement in these rules, the requirements in this Article 12 control.

12.2 Definitions.

(a) **Adverse Effects of the Transfer:** The reduction in availability of sufficient Surface Water to meet the needs of LCRA's interruptible irrigation customers within Colorado, Wharton, and Matagorda counties resulting from water contracts entered into pursuant to Section 8503.029(a)(3)(B), Texas Special District Local Laws Code.

(b) **Average Annual Volume:** The arithmetical average volume of water over a contiguous 3-year period.

(c) **Conserved Water:** The Average Annual Volume of water made available under Section 8503.029(a)(3)(B), Texas Special District Local Laws Code from conservation projects and demand reduction projects within the water service areas of LCRA's irrigation operations within Colorado, Wharton, and Matagorda counties. Conserved Water can be classified as firm, interruptible or any combination thereof.

Attachment H

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

AN ORDER approving the Lower Colorado River Authority's Water Curtailment Plan for its Firm Water Customers; Docket No. 2011-2097-WR

On December 7, 2011, the Texas Commission on Environmental Quality ("TCEQ" or "Commission") considered the request for approval of its Water Curtailment Plan, filed on October 21, 2011. LCRA's firm Water Curtailment Plan is an amendment to LCRA's Raw Water Drought Contingency Plan, which is included in LCRA's Water Management Plan, Permit No 5838. LCRA's Water Management Plan, required by its Certificates of Adjudication Nos. 14-5478 and 14-5482, provides how LCRA makes water available from Lakes Buchanan and Travis to meet "firm" water customer needs, downstream interruptible irrigation demands, and environmental flow needs of Matagorda Bay and the lower Colorado River. It also provides how LCRA will manage and curtail supplies from the lakes during times of drought including through a repeat of the Drought of Record. LCRA's Water Management Plan additionally requires that this Water Curtailment Plan be prepared before the LCRA implements mandatory firm water customer curtailment under Tex. Water Code § 11.039, and that this plan be approved by the LCRA Board and the Commission.

The Commission finds that the plan meets the requirements of Texas Water Code § 11.039 and 30 Tex. Admin. Code Chapter 288.

THEREFORE, THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY ORDERS THAT:

Lower Colorado River Authority's Water Curtailment Plan filed October 21, 2001, is approved.

TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

Bryan W. Shaw

For the Commission

Issue Date: DEC 12 2011

THE STATE OF TEXAS
COUNTY OF TRAVIS
I hereby certify that this is a true and correct copy of a Texas Commission on Environmental Quality document, which is filed in the permanent records of the Commission.
Given under my hand and the seal of office on

Bridget C. Bohac DEC 14 2011

Bridget C. Bohac, Chief Clerk
Texas Commission on Environmental Quality

Attachment H
TCEQ Order Approving LCRA's Curtailment Plan

Attachment I

STATE OF TEXAS
OFFICE OF THE GOVERNOR

RICK PERRY
GOVERNOR

November 26, 2013

FILED IN THE OFFICE OF THE
SECRETARY OF STATE
2PM O'CLOCK
NOV 26 2013
Secretary of State

The Honorable John Steen
Secretary of State
State Capitol Room 1E.8
Austin, Texas 78701

Dear Mr. Secretary:

Pursuant to his powers as Governor of the State of Texas, Rick Perry has issued the following proclamation:

> A proclamation renewing the certification that exceptional drought conditions pose a threat of imminent disaster in a specified number of counties in the State of Texas.

The original proclamation is attached to this letter of transmittal.

Respectfully submitted,

Gregory S. Davidson
Executive Clerk to the Governor

GSD/gsd

Attachment

P. O. Box 12428 • Capitol Station • Austin, Texas 78711

Attachment I
Governor's Proclamation
(11-26-13)

PROCLAMATION

BY THE

Governor of the State of Texas

TO ALL TO WHOM THESE PRESENTS SHALL COME:

I, RICK PERRY, Governor of the State of Texas, issued an Emergency Disaster Proclamation on July 5, 2011, certifying that exceptional drought conditions posed a threat of imminent disaster in specified counties in Texas.

WHEREAS, record high temperatures, preceded by significantly low rainfall, have resulted in declining reservoir and aquifer levels, threatening water supplies and delivery systems in many parts of the state; and

WHEREAS, prolonged dry conditions continue to increase the threat of wildfire across many portions of the state; and

WHEREAS, these drought conditions have reached historic levels and continue to pose an imminent threat to public health, property and the economy; and

WHEREAS, this state of disaster includes the counties of Andrews, Archer, Bailey, Bandera, Baylor, Blanco, Briscoe, Brooks, Brown, Burnet, Cameron, Carson, Castro, Childress, Clay, Cochran, Coke, Coleman, Colorado, Comal, Concho, Cottle, Crosby, Dallam, Dallas, Dawson, Deaf Smith, Dickens, Dimmit, Ector, Edwards, Ellis, Fisher, Floyd, Foard, Frio, Gaines, Galveston, Garza, Gillespie, Hale, Hansford, Hardeman, Hartley, Haskell, Hidalgo, Hockley, Hood, Hudspeth, Hutchinson, Irion, Jack, Jim Hogg, Jim Wells, Johnson, Jones, Kendall, Kenedy, Kent, Kerr, Kimble, King, Kinney, Knox, La Salle, Lamar, Lamb, Lampasas, Llano, Lubbock, Lynn, Martin, Matagorda, McCulloch, McLennan, Medina, Midland, Mills, Mitchell, Moore, Motley, Nolan, Nueces, Ochiltree, Oldham, Palo Pinto, Parker, Parmer, Potter, Randall, Real, Runnels, San Patricio, San Saba, Scurry, Shackelford, Sherman, Somervell, Starr, Stephens, Sterling, Stonewall, Swisher, Tarrant, Terrell, Terry, Throckmorton, Tom Green, Travis, Uvalde, Val Verde, Walker, Webb, Wharton, Wichita, Wilbarger, Willacy, Williamson, Winkler, Yoakum, Young and Zavala.

THEREFORE, in accordance with the authority vested in me by Section 418.014 of the Texas Government Code, I do hereby renew the disaster proclamation and direct that all necessary measures, both public and private as authorized under Section 418.017 of the code, be implemented to meet that threat.

As provided in Section 418.016 of the code, all rules and regulations that may inhibit or prevent prompt response to this threat are suspended for the duration of the state of disaster.

In accordance with the statutory requirements, copies of this proclamation shall be filed with the applicable authorities.

IN TESTIMONY WHEREOF, I have hereunto signed my name and have officially caused the Seal of State to be affixed at my office in the City of Austin, Texas, this the 26th day of November, 2013.

Rick Perry
RICK PERRY
Governor of Texas

ATTESTED BY:

John Steen
JOHN STEEN
Secretary of State

Attachment J

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF RON ANDERSON

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, personally appeared Ron Anderson, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct. The tabs attached to this affidavit and referred to herein are incorporated by reference.

3. I, Ron Anderson, am an individual residing in Austin, Texas.

4. I have a Bachelor of Science in Engineering and a Master of Business Administration from the University of Texas at Austin. I am a Registered Professional Engineer in the State of Texas with specialization in Civil and Software Engineering. I am recognized as a Diplomate in Water Resources Engineering by the American Academy of Water Resource Engineers. A true and correct copy of resume, detailing my prior work history and education, is included as Tab 1.

5. I have worked for the Lower Colorado River Authority (LCRA) for twelve years where I have worked on water supply planning issues for Central Texas. My current title is Chief Engineer.

6. As part of my duties at the LCRA, I track current issues affecting water supply, manage studies and modeling projects related to water supply quality and availability, enhance water supply forecasting capabilities, and evaluate water management procedures.

7. My opinions stated herein are based on my familiarity with LCRA's water supply operations and my evaluation of potential future inflows to the Highland Lakes. I have also relied upon a variety of information provided to me by LCRA staff, which

is of a nature typically relied upon in my profession, as described below and for which true and correct copies are either attached or referenced to other portions of LCRA's emergency request and incorporated by reference herein:

a. Affidavit of Bob Rose, including attachments;

b. Affidavit of Ryan Rowney, including attachments;

c. Affidavit of David Wheelock, including attachments;

d. Affidavit of Nora Mullarkey, including attachments.

8. The 2010 Water Management Plan includes three criteria, all of which must be met at the same time for the LCRA Board to make a declaration of Drought Worse than Drought of Record. (*See* 2010 WMP at p.4-34.) These criteria are indicators that can be evaluated in real-time. The three criteria are:

   i. Duration of drought is more than 24 months, which is determined by counting the number of consecutive months since both lakes Buchanan and Travis were last full (i.e. "duration" criterion);

   ii. Inflows to the lakes are less than inflows during the Drought of Record (i.e. "intensity" criterion); and

   iii. Lakes Buchanan and Travis combined storage is less than 600,000 acre-feet of water.

9. One of the three criteria for the LCRA Board to make a declaration of Drought Worse than Drought of Record is the drought intensity as compared to the Drought of Record. Specifically, the inflow deficit must be at least five percent worse than the average inflow deficit over a similar period of time during the Drought of Record for at least six months. As part of my job responsibilities at LCRA, I track this criterion, which is depicted in the graphic under Tab 2. Based on this analysis, the current inflow deficit has exceeded the inflow deficit of the Drought of Record by at least five percent for more than six months. In fact, at times during the current drought, the inflow deficit has been as much as 90 percent more than the standard from the Drought of Record. (*See* Tab 2.)

10. As shown in the affidavit of Ryan Rowney, additional inflow statistics demonstrate the severity of the ongoing drought over the past six years as compared to any period of up to six years in the Drought of Record. (*See* Affidavit of Ryan Rowney.)

11. The inflow deficit and the inflow statistics for the past six years reveal a hydrologic condition that, for the past six years, is more severe than any hydrologic condition evaluated as part of the 2010 WMP.

12. The 2010 WMP includes a "curtailment curve" that determines the amount of interruptible stored water to be made available as a function of the combined storage

in lakes Buchanan and Travis on January 1 of any year. (*See* 2010 WMP at p.4-24 through 4-26.) However, under the 2010 WMP, interruptible stored water can be cut off completely during the irrigation season if the criteria for declaration of Drought Worse than Drought of Record, including combined storage in said lakes dropping to 600,000 acre-feet, are met. The 2010 WMP also allows for curtailment of firm water customers if a declaration of Drought Worse than the Drought of Record is made.

13. I have evaluated the likelihoods of lake contents dropping to 600,000 acre-feet and the drought intensity criteria continuing to qualify for a declaration of Drought Worse than Drought of Record using multiple hydrologic scenarios representing potential future inflows. (*See* Tab 3 for a description of the modeling tool.) Modeling methods are generally consistent within +/- 2 percent.

14. Based on my analysis and the foregoing review, it is my expert opinion that:

a. As of December 1, 2013, under conditions ranging from persistently dry to normal, the combined storage on January 1, 2014 would range from about 690,000 to 850,000 acre-feet. Wet conditions could result in higher storage. (*See* Tab 4, Figure 1.)

b. As of December 1, 2013, if severe drought conditions continue and LCRA were to supply water in 2014 based on the curtailment curve in the 2010 WMP, the criteria for a declaration of Drought Worse than Drought of Record (including combined storage in lakes Buchanan and Travis falling below 600,000 acre-feet) may be met as early as April 2014. (*See* Tab 4, Figure 1.)

c. As of December 1, 2013, if LCRA were to supply water in 2014 based upon the curtailment curve in the 2010 WMP, there is a one in 4 chance (or 26 percent chance) of triggering a declaration of Drought Worse than Drought of Record by the end of August 2014. (*See* Tab 4, Figure 2.)

d. As of December 1, 2013, if LCRA were to supply water in 2014 based upon the proposed relief, there is a less than one in 10 chance (or 8 percent chance) of triggering a declaration of Drought Worse than Drought of Record by the end of August 2014. (*See* Tab 4, Figure 3.)

e. If combined storage is at 1.1 million acre-feet on March 1, 2014 and LCRA supplies interruptible stored water based on the proposed relief:

   i. The risk of triggering a declaration of Drought Worse than Drought of Record by the end of August 2014 is eliminated. (*See* Tab 4, Figure 4.)

   ii. There is about a 99 percent chance that the criteria for triggering a declaration of Drought Worse than Drought of Record would not be met through at least April 2015, assuming similar triggers for supplying interruptible stored water stay in place through 2015. (*See* Tab 4, Figure 4.)

f. If on March 1, 2014 the combined storage was 850,000 acre-feet and LCRA were to supply 100,000 acre-feet of stored water for diversion by the Gulf Coast and Lakeside divisions and Pierce Ranch (plus 25,000 acre-feet of stored water for the Garwood division), the criteria for a declaration of Drought Worse than Drought of Record (including combined storage in lakes Buchanan and Travis falling below 600,000 acre-feet) may be met as early as June 2014. (*See* Tab 4, Figure 5.)

g. Three alternatives to the proposed relief would maintain the earliest possible date of triggering a declaration of Drought Worse than Drought of Record while providing a lesser amount of water at storage levels below 1.1 million acre-feet on March 1, 2014:

   i. As an alternative to the proposed relief, if on March 1, 2014 the combined storage is 1,070,000 acre-feet and LCRA was to supply a total of 75,000 acre-feet of interruptible stored water for the Gulf Coast and Lakeside divisions and Pierce Ranch, there is about a 99 percent chance that the criteria for triggering a declaration of Drought Worse than Drought of Record would not be met through at least April 2015, assuming similar triggers for supplying interruptible stored water stay in place through 2015. (*See* Tab 4, Figure 6.)

   ii. As an alternative to the proposed relief, if on March 1, 2014 the combined storage is 1,025,000 acre-feet and LCRA was to supply a total of 50,000 acre-feet of interruptible stored water for the Gulf Coast and Lakeside divisions and Pierce Ranch, there is about a 99 percent chance that the criteria for triggering a declaration of Drought Worse than Drought of Record would not be met through at least April 2015, assuming similar triggers for supplying interruptible stored water stay in place through 2015. (*See* Tab 4, Figure 7.)

   iii. As an alternative to the proposed relief, if on March 1, 2014 the combined storage is 1,000,000 acre-feet and LCRA was to supply a total of 25,000 acre-feet of interruptible stored water for the Gulf Coast and Lakeside divisions and Pierce Ranch, there is about a 99 percent chance that the criteria for triggering a declaration of Drought Worse than Drought of Record would not be met through at least April 2015, assuming similar triggers for supplying interruptible stored water stay in place through 2015. (*See* Tab 4, Figure 8.)

h. Two alternatives to the proposed relief would accelerate the earliest possible date for declaring a Drought Worse than Drought of Record as compared to the proposed relief:

   i. As an alternative to the proposed relief, if on March 1, 2014 the combined storage is 850,000 acre-feet and LCRA was to supply a total of 70,000 acre-feet of interruptible stored water for the Gulf Coast, Lakeside and Garwood divisions and Pierce Ranch, the criteria for a declaration of Drought Worse than Drought of Record may be met as early as August 2014. (*See* Tab 4, Figure 9.)

ii. As an alternative to the proposed relief, if on March 1, 2014 the combined storage is 950,000 acre-feet and LCRA was to supply a total of 130,000 acre-feet of interruptible stored water for the Gulf Coast, Lakeside and Garwood divisions and Pierce Ranch, the criteria for a declaration of Drought Worse than Drought of Record may be met as early as September 2014. (*See* Tab 4, Figure 10.)

Further affiant sayeth not.

Ron Anderson
RON ANDERSON, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 10th day of December, 2013.

Tabitha A Kottke
Notary Public in and for the State of Texas

My Commission Expires: 1-11-2014

Ronald E. Anderson, PE, MBA, D.WRE

LCRA, P.O. Box 220, MS L210 phone: (512) 578-3572
Austin, Texas 78767-0220 e-mail: ron.anderson@lcra.org

EXPERIENCE
2001-present

Lower Colorado River Authority
Chief Engineer/Water Resources Managment

Water Supply Forecasting
- Develops stochastic model to forecast water supply availability.
- Communicates water supply forecasts online through custom reports.
- Collaborates with academic researchers to enhance forecast methods.

Lower Basin Reservoir Project, Project Sponsor
- Maintain project direction and benefits of developing 90,000 AF/yr of new supply
- Communicate project needs and obtain timely decisions to maintain schedule
- Communicate project benefits
- Support the Project Manager and the project team.

New Supply Development, Modeling Lead
- Overseeing consultant evaluation of lower basin balancing reservoirs reliability.
- Developing models to optimally size off channel storage reservoirs in irrigation divisions.
- Providing technical expertise in facility planning, siting and preliminary design for balancing reservoir projects.

2010-2013 Drought Response
- Developed scenario responses for drought response consideration.
- Provided stakeholders with updated reservoir level projections and risk assessment.
- Communicate with stakeholders about potential impacts.

Highland Lakes Water Management Plan Update. Technical Lead
- Procured and managed professionals to review drought of record monitoring methods
- Procured and managed professionals to develop simulation models
- Developed quality assurance procedures for project team
- Review water supply simulations and provide technical documentation.

Emerging Issues
- Responsible for scanning the political and scientific developments that might impact the future operations of the Colorado River and development of power generation.

Water Supply Model Development Project. Project Manager
- Coordinated development of the new innovative water rights solver feature to support daily river operations and allocation simulation.
- Chartered and developed project controls for the $1 million water supply planning mode development using the RiverWare platform.
- Procured engineering professionals to conduct the work.
- Conducted workshops for internal and external training.

Water Supply Reliability Team Lead

- Lead a team of internal and external professionals to review and evaluate existing and proposed plans for water supply management.
- Developed a stochastic forecasting model of the water supply for medium range planning of response to drought conditions.
- Evaluated procedures for management and operations under a drought conditions worse than the drought of record.

LCRA-SAWS Water Project

- Project Manager during pre-planning period. Responsible for project costs estimation, project controls, project consultant procurement, and project communications coordination.
- Project Controls Manager during project planning period. Responsible for setting up project financial, document, and communication controls for over $1 million in planning activities.
- Project Engineer and Technical Studies Coordinator for project study period. Responsible for quality assurance of key study scopes and products. Responsible for coordination and integration of related LCRA Projects with technical studies as well as assisting with public, stakeholder, and agency communications.
- Responsible for review and evaluation of technical studies' consultant performance.
- Studies activities include: surface water modeling, groundwater modeling, agricultural conservation, facilities engineering, environmental assessment, water quality assessment, bay health, socio-economic, waterfowl, climate change, uncertainty, and permitting.

Brazos River Authority

1998-2001 *Senior Planning Manager*
1997-1998 *Senior Water Resources Planner*

HDR Engineering, Inc.

1995-1997 *Project Manager*
1986-1995 *Engineer/Computer Modeler*

EDUCATION

Master of Business Administration, University of Texas at Austin, 1993
Post Graduate Studies, Free Surface Flow, 1987, Operations Research, 1988, University of Texas
Bachelor of Science in Engineering, University of Texas at Austin, 1986

PROFESSIONAL CREDENTIALS & ASSOCIATIONS

- Registered Software Engineer, State of Texas
- Registered Civil Engineer, State of Texas
- Member, American Society of Civil Engineers, Environmental and Water Resources Institute
- Diplomate, American Academy of Water Resources Engineers

SELECTED PUBLICATIONS & PRESENTATIONS

Anderson, R.E. and Rose, B. *Searching for Predictive Climate Signals for River Flows in the Lower Colorado River Basin,* USCID Water Resources World Congress 2012.

Anderson, R.E. and Gooch, T. *Review of Drought Worse Than Drought of Record Monitoring Methods for the Lower Colorado River in Texas,* ASCE/EWRI Water Resources World Congress 2011.

Anderson, R.E. and Walker, D. *Use of Stochastic Modeling during the 2008 and 2009 Drought on the Lower Colorado River in Texas,* ASCE/EWRI Water Resources World Congress 2011.

Water Resource Implications of Climate Change in Central Texas, Austin Climate Protection Conference & Expo 2010

Beyond the Drought of Record: Supply Forecasting for Difficult Times, Texas Water Conservation Association Fall Meeting, 2009.

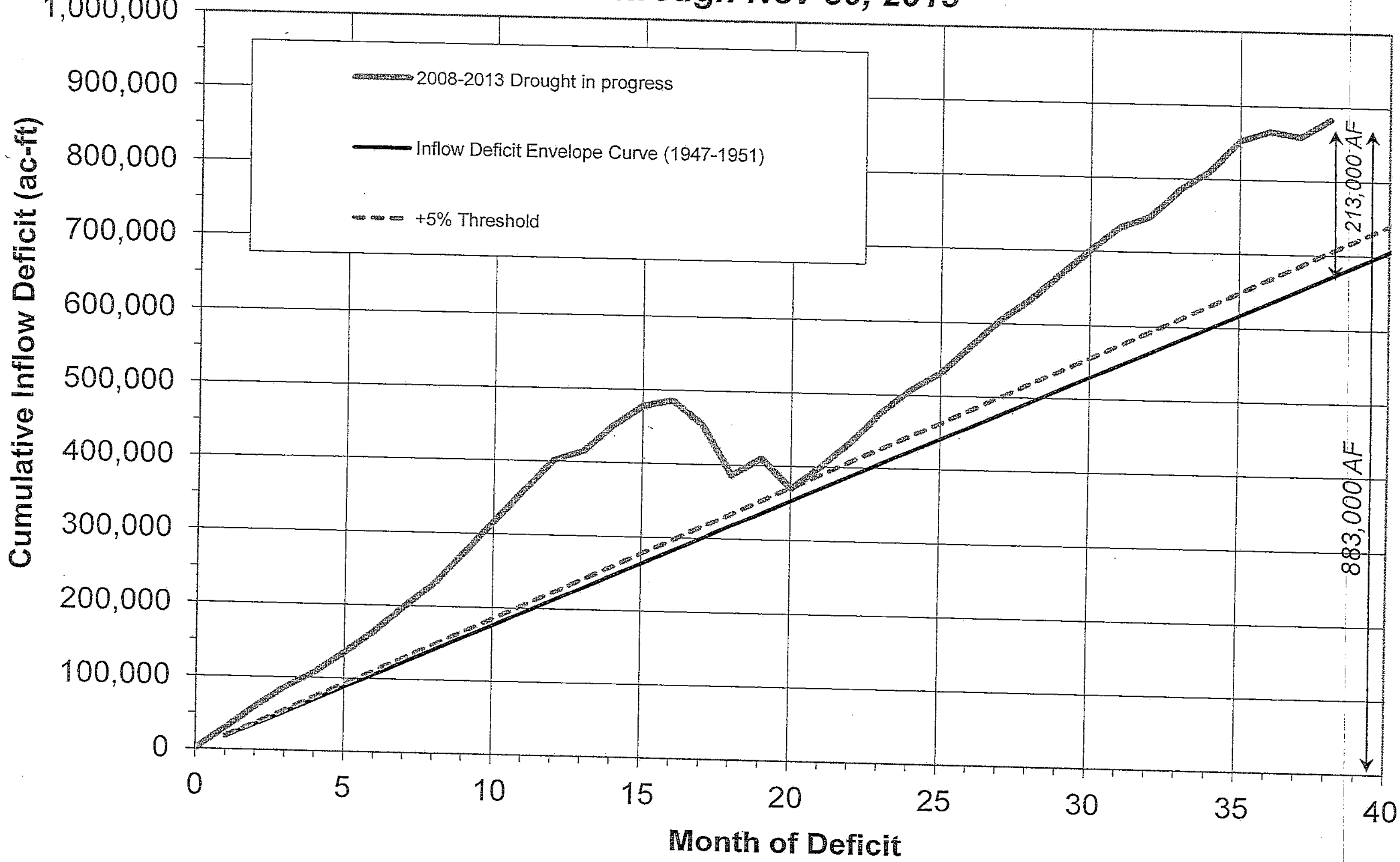
Anderson, R.E. and Walker, D. *Stochastic Forecasting of Conservation Storage on the Lower Colorado River in Texas,* Texas Water 2009.

Co-Author, *Assessing Potential Implications of Climate Change for Long-Term Water Resources Planning in the Colorado River Basin, Texas*, American Geophysical Union Annual Conference Poster, 2008.

Current and Future Drought Assessment Activities, Drought Benchmarking Conference, 2007.

Co-Author, *Matagorda Bay Freshwater Inflow Needs Study*, LCRA, TCEQ, TPWD, and TWDB, August 2006.

Comparison of Present Drought to the Inflow Deficit Envelope Curve
Through Nov 30, 2013



12/3/2013
Subject to Revsion

LCRA's Use of Stochastic Modeling to Forecast Future Combined Storage
December 2, 2013

Introduction

No one can predict the future, but decision makers in all walks of life have to make judgments based on their best analysis of likely future conditions. This can be particularly difficult in situations where multiple factors and their interplay can influence the outcome of important events.

Because of the complications involved in this type of decision making, many industries rely on computer models called stochastic models to evaluate the likelihood of future conditions. This type of model is able to take a number of factors and data into account to generate a large number of potential future outcomes. Each individual outcome is as statistically likely as any other. Therefore, when all outcomes are plotted on a graph, areas where potential outcomes are denser depict a range of future results that is more likely. Conversely, areas on the graph where potential outcomes are less dense depict a range of future results that is less likely. The number of outcomes in a range can be expressed as a statistical probability for the future.

The insurance and financial industries are among those that use this type of computer model to help make their decisions. LCRA has been using and refining its stochastic modeling for six years to help make water management decisions. LCRA's model has been reviewed internally by staff and externally by Dr. John Carron of Hydros Consulting and Dr. David Watkins of the Michigan Technological University. The methods have also been peer reviewed and published at multiple professional conferences of the American Society of Civil Engineering, American Water Works Association, and U.S. Committee on Irrigation and Drainage.

LCRA uses the model to show possible future combined storage levels of lakes Travis and Buchanan. LCRA also uses the results of the model to calculate potential future lake elevations. During drought, this is a popular tool for many of our firm water customers with intakes on the lakes. These customers use future lake level probabilities in their decision making process when determining whether or not to extend or move their intake structures.

What goes into LCRA's model?

LCRA uses the following sets of data in its stochastic model:

Current conditions: Each month when the projections are updated, the current levels of lakes Travis and Buchanan serve as the starting point for the model.

Historical hydrology: LCRA currently uses the hydrological record from 1940 to October 2013. Upstream inflows, downstream run-of-river flows and evaporation records for every month of that period are incorporated into the model. This includes the 10-year drought of the 1950s known as the state's Drought of Record and the drought of 2011, which is the most severe single-year drought on record. This data set is updated as each year of data becomes available.

Drought year firm customer demands: LCRA uses drought-year firm customer demands in its model that are similar to demands experienced in 2008 and 2012 (no major new firm customers have entered into agreements since then). Drought-year demands are appropriate when evaluating the impacts of drought on the water supply because drought conditions increase the demand for stored water that would otherwise be met through rainfall.

Interruptible customer requests: LCRA uses the 2011 planted acreage in the four irrigation operations to determine how much water downstream interruptible customers would require if all agricultural irrigation demands are met. This acreage is used to determine demands under an open supply scenario as well as to evaluate the level of curtailment under conditions that do not allow open supply.

2010 Water Management Plan: When determining how much interruptible stored water will be provided to the downstream irrigation districts, LCRA uses the assumptions of the current Water Management Plan. If a new Water Management Plan is approved or TCEQ approves an amendment to the current plan such as emergency relief, LCRA would use the new management assumptions in the model.

A measurement of El Niño/Southern Oscillation index: The El Niño/Southern Oscillation is a cyclic warming and cooling of the sea surface temperatures in the Pacific Ocean near the equator that can affect the weather in Texas. If the Pacific warms enough, it can produce an El Niño weather pattern that increases the chances of wetter than normal weather in Central Texas, particularly during the fall and winter. If the Pacific is cool enough, it can produce a La Niña weather pattern that increases chances of dry weather in central Texas. The El Niño/Southern Oscillation index (ONI) is a measurement of this cycle. LCRA uses the measurement in its model to help predict whether future conditions should be weighted toward a wet, dry or neutral scenario. Predictions of the index are provided by the Climate Prediction Center and updated monthly.

Last two months of inflows: As explained above, LCRA's model uses historical inflow data for the last 74 years to help evaluate the likelihood of possible future conditions. The model specifically uses inflow data from the last two months to help determine one very important factor: the chances that the region's weather pattern could change significantly from one month to the next.

Historical data shows the tendency for the weather to stay the same from one month to the next in Texas, particularly during the winter months and to a lesser extent in May and October. If the weather is wet one month, it tends to stay wet the next month. Conversely, if it is dry one month, it tends to stay dry the next. This weather pattern is the norm, but of course, it does not always hold true. The weather does eventually change.

Through years of improving the model, LCRA staff has found that the best way to evaluate the likelihood of a significant change in the weather is to (1) use the most recent two months of inflows to determine if there is a wet, dry or neutral weather pattern and (2) look at the historical record to determine how often the weather pattern has changed from one month to the next. The model is able to use this data to determine the probability that the local weather will change significantly from one month to the next (from wet to dry, dry to wet, neutral to dry, etc.).

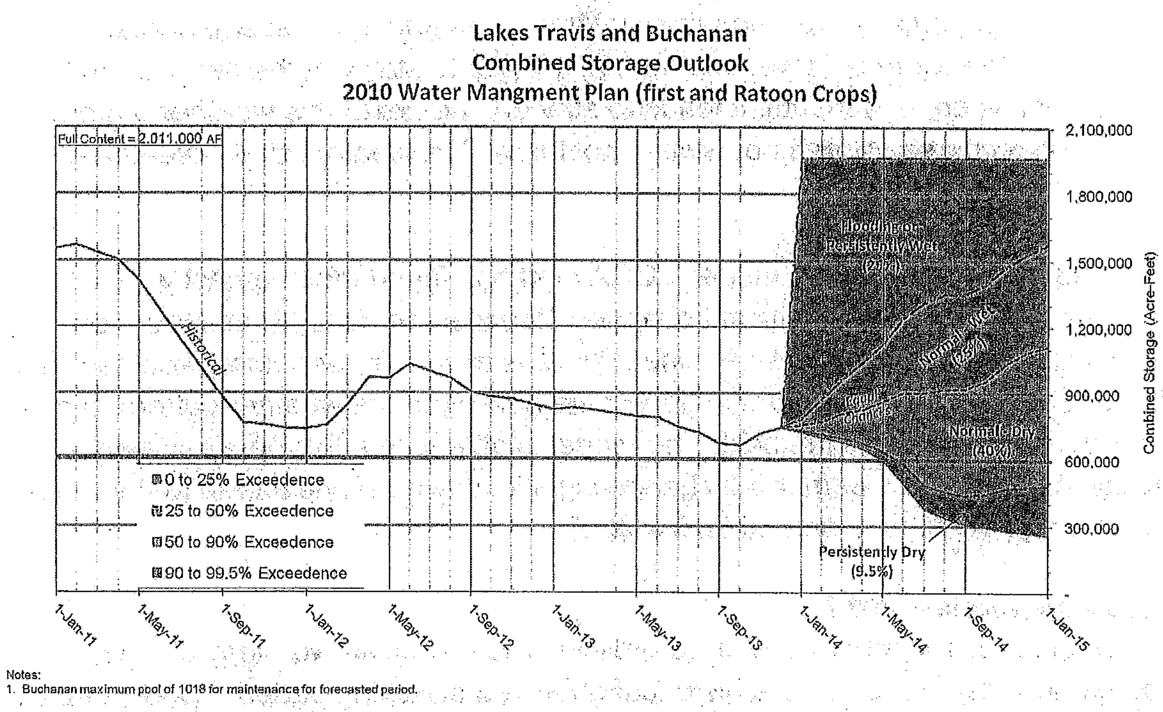
How does the model work?

The model proceeds month by month re-ordering the historical hydrology according to a rational method that preserves the historical observed switching patterns (wet, neutral, dry) and preserves the cumulative historical frequency of inflows to the highland lakes. That is the stochastic part of the model. Then it simulations operations of the system to meet demands and determines the monthly lake storage. That is the accounting part of the model. The model does this 2000 times. These multiple scenarios are then summarized into graphical products.

What comes out of the model?

As discussed above, LCRA's stochastic model uses the factors described above to calculate a large number (2,000) of possible future scenarios for the combined storage of lakes Travis and Buchanan. By plotting those 2,000 points on a graph, we are able to determine ranges that are more likely and less likely. The development of 2,000 equally likely scenarios does not include all possible outcomes but rather a very large data set. Using Monte Carlo methods requires some randomization of scenario selection and slightly different scenarios will be developed from simulation to simulation. However, the data set of 2,000 scenarios is large enough that computed results are generally consistent within +/- 2 percent likelihood observance for any given content. LCRA uses that information to produce a graph that shows future combined storage ranges under different inflow conditions and management actions.

Consider the following graphic produced from the results of our model:



This graphic depicts potential future combined storage scenarios. It is divided into four ranges associated with the general weather conditions that would lead to the ranges of combined storage. We have titled them: Flooding or Persistently Wet; Normal-Wet; Normal-Dry; and Persistently Dry.

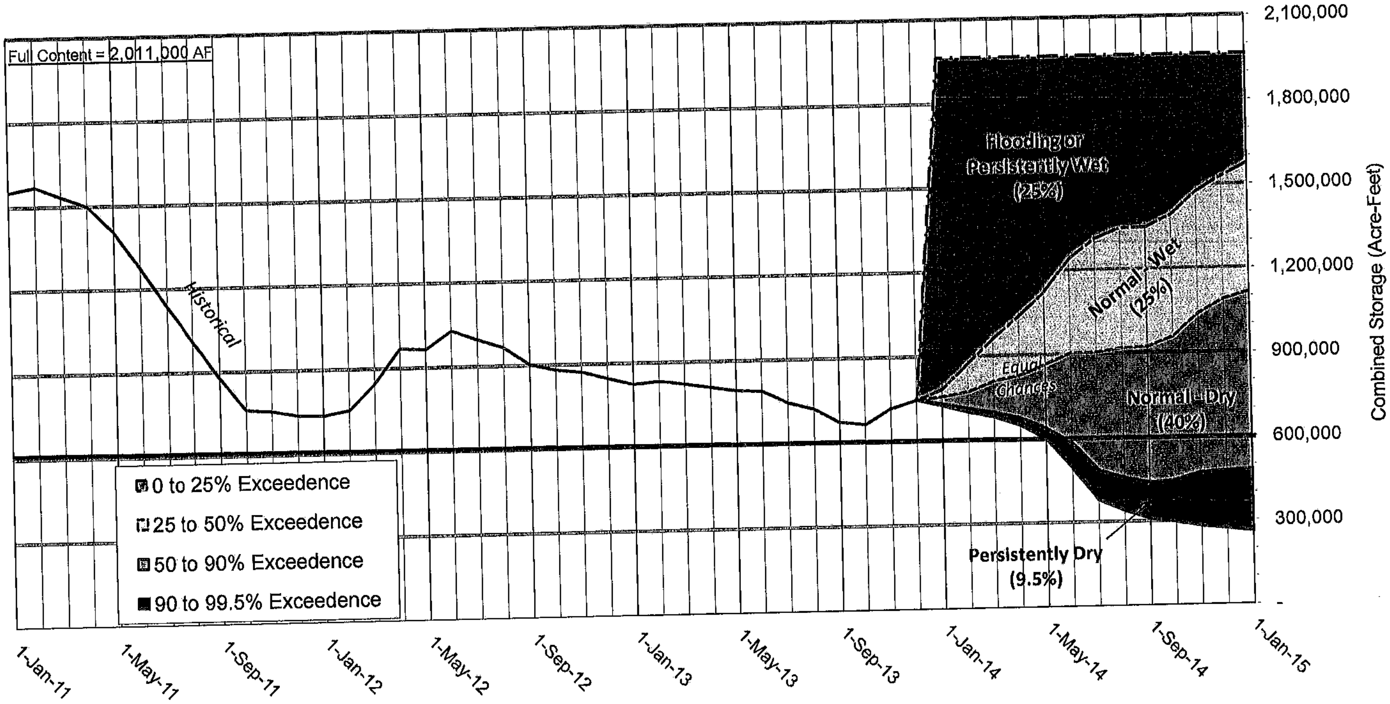
The legend with the graphic contains a percentage range associated with each category. This range corresponds with the percentage of the 2,000 future scenarios that falls into each category. Here's what it tells us:

- The Flooding or Persistently Wet range contains 25 percent, or 500, of the potential outcomes;
- The Normal-Wet range contains 25 percent, or 500, of the potential outcomes;
- The Normal-Dry range contains 40 percent, or 800, of the potential outcomes;
- The Persistently Dry range contains 9.5 percent, or 190, of the potential outcomes; and
- The Equal Chances line means that 50 percent of the potential outcomes, or 1,000, are above the line and 50 percent are below.

- A small number of outliers, 0.5 percent or 10 of the potential outcomes, are not depicted on the graphic.

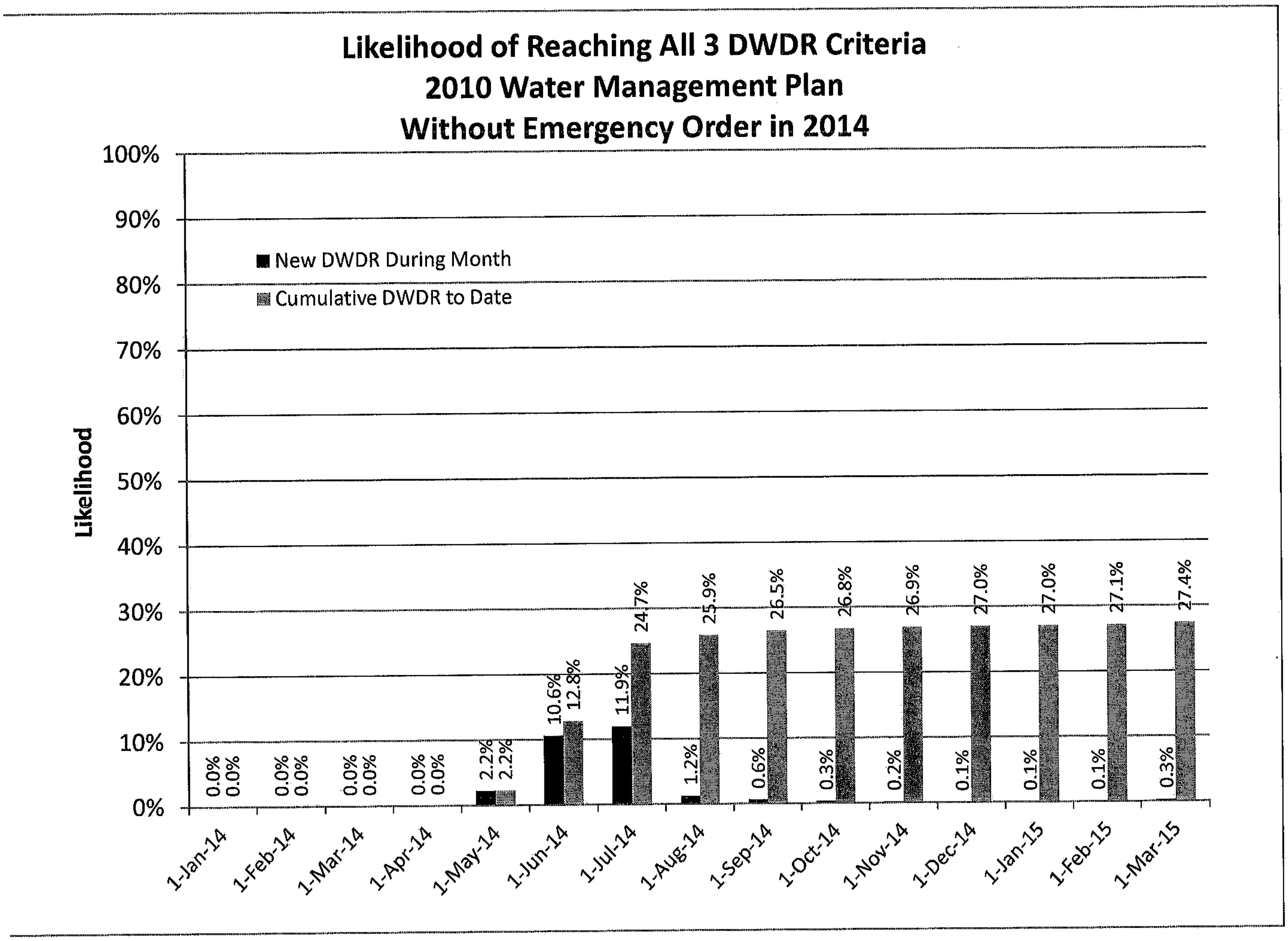
As the graphic shows, the model cannot predict the future. What it does show is how likely a range of combined storage is in the future based on the historical hydrological record and other information contained in the model. This information is intended to help LCRA staff, Board members, and stakeholders make informed water management decisions.

Lakes Travis and Buchanan Combined Storage Outlook 2010 Water Mangment Plan (first and Ratoon Crops)



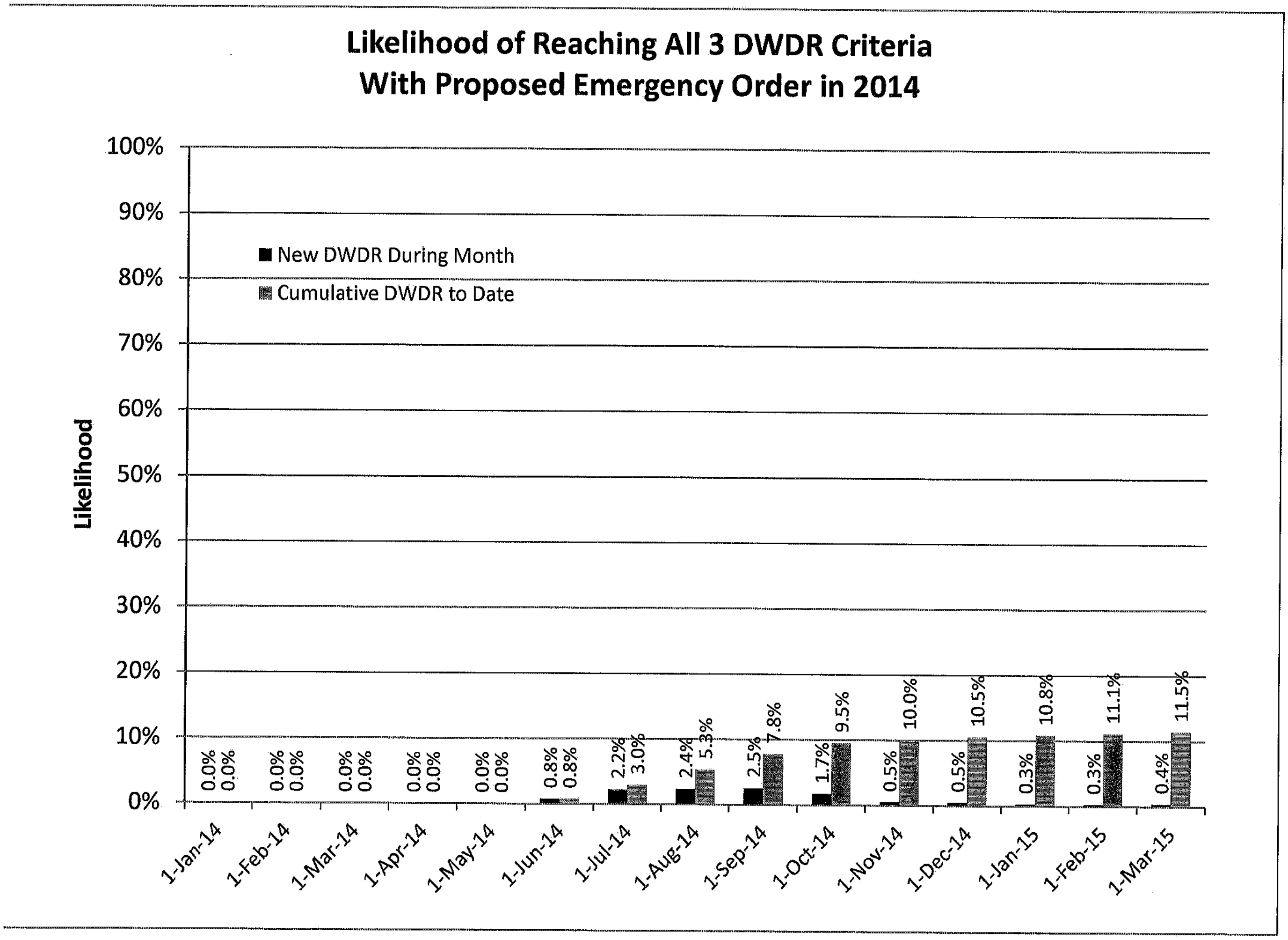
Notes:
1. Buchanan maximum pool of 1018 for maintenance for forecasted period.

Figure 2



12/3/2013

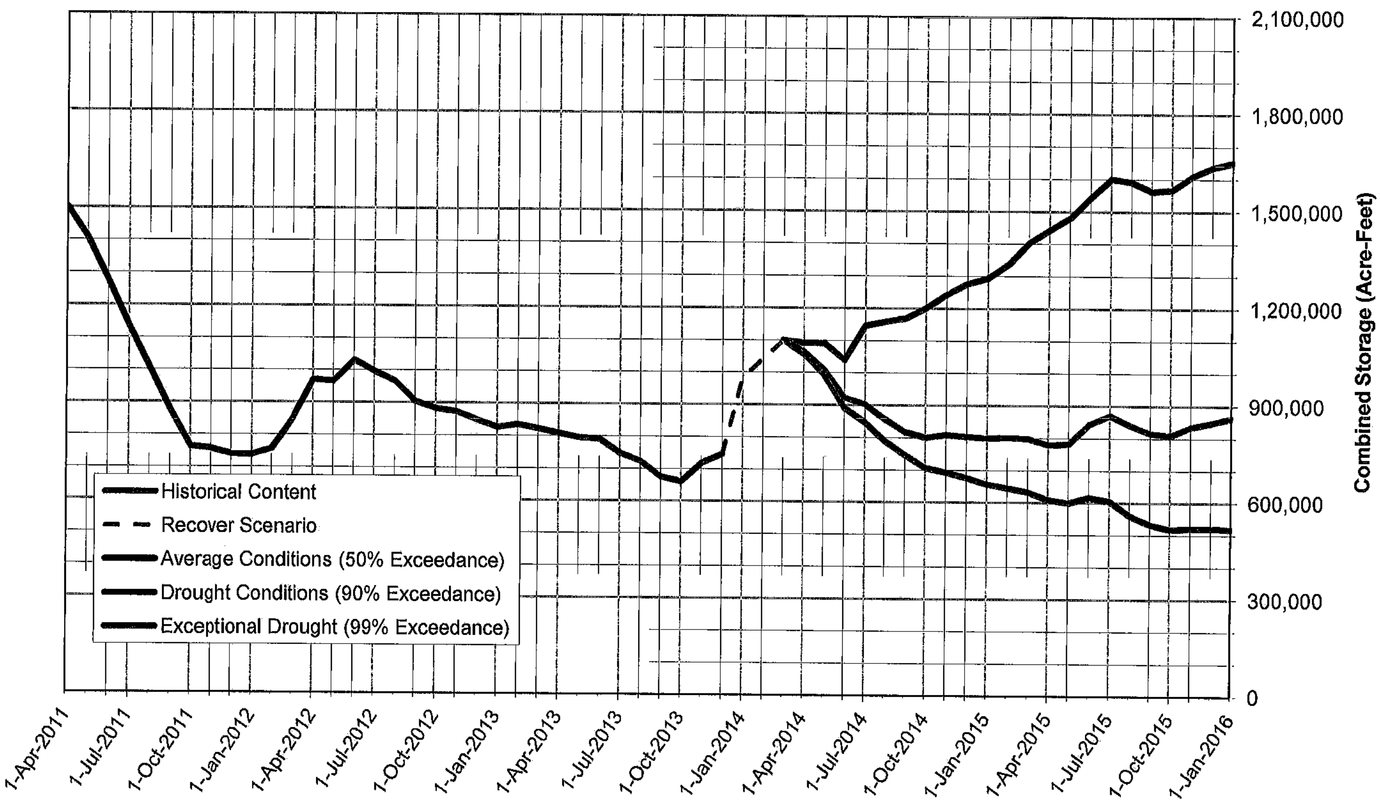
Figure 3



12/3/2013

Figure 4

Proposed2014 Emergency Relief from the Water Management Plan
Recover to 1,100,000 ac-ft with 100,000 ac-ft Interruptible Diversion plus Garwood



Assumptions:

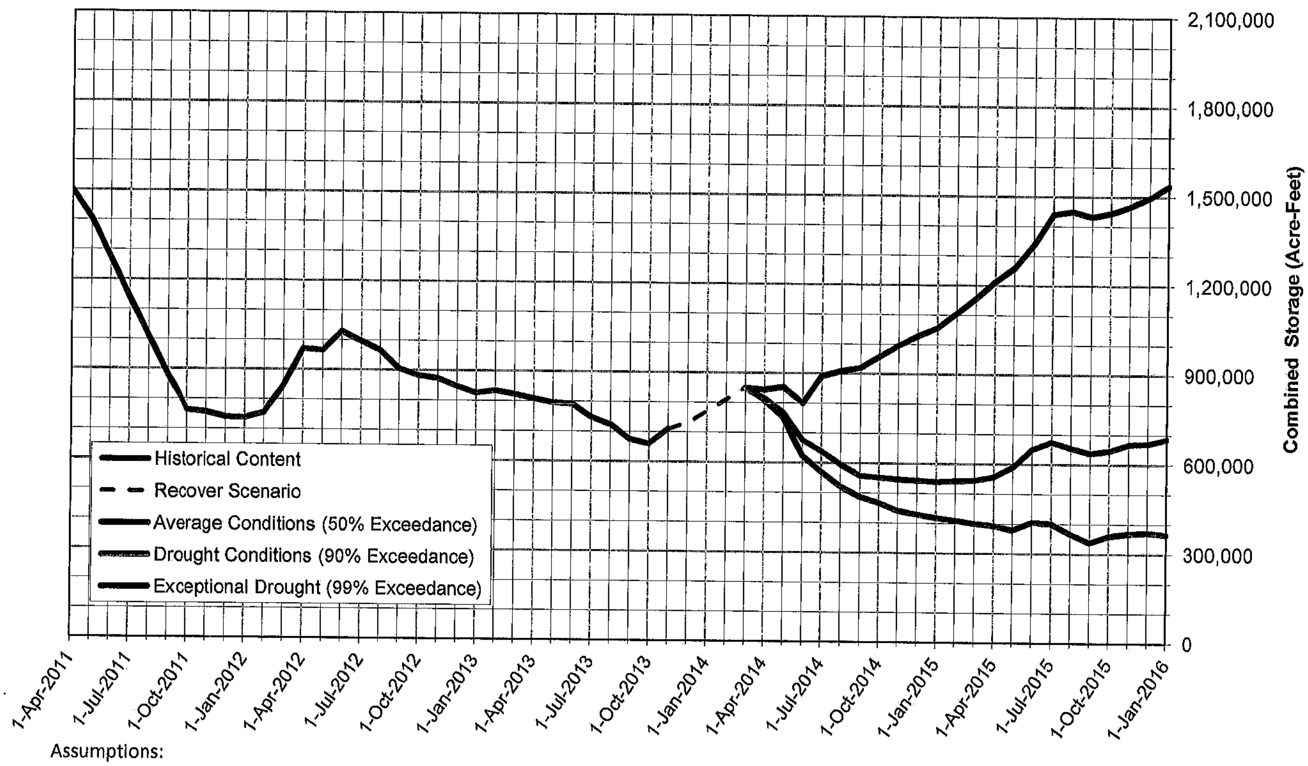
1. Maintain 10% M&I conservation from baseline when curtailing
2. 2015 interruptible supply also limited

12/4/2013

REA

Figure 5

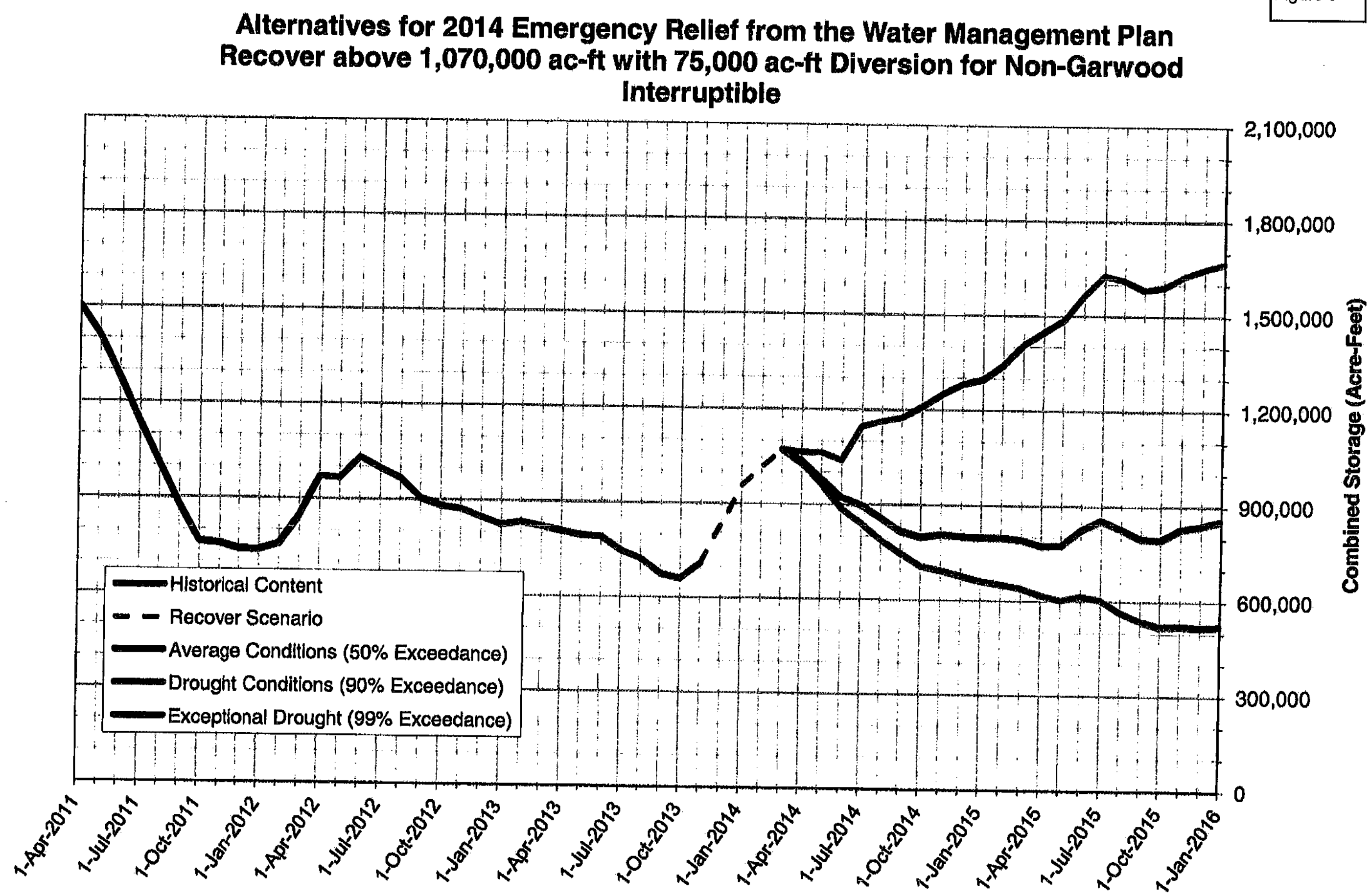
Alternatives for Emergency Relief from the Water Management Plan
Recover above 850,000 ac-ft with 125,000 ac-ft Diversion for Interruptible Supply



Assumptions:

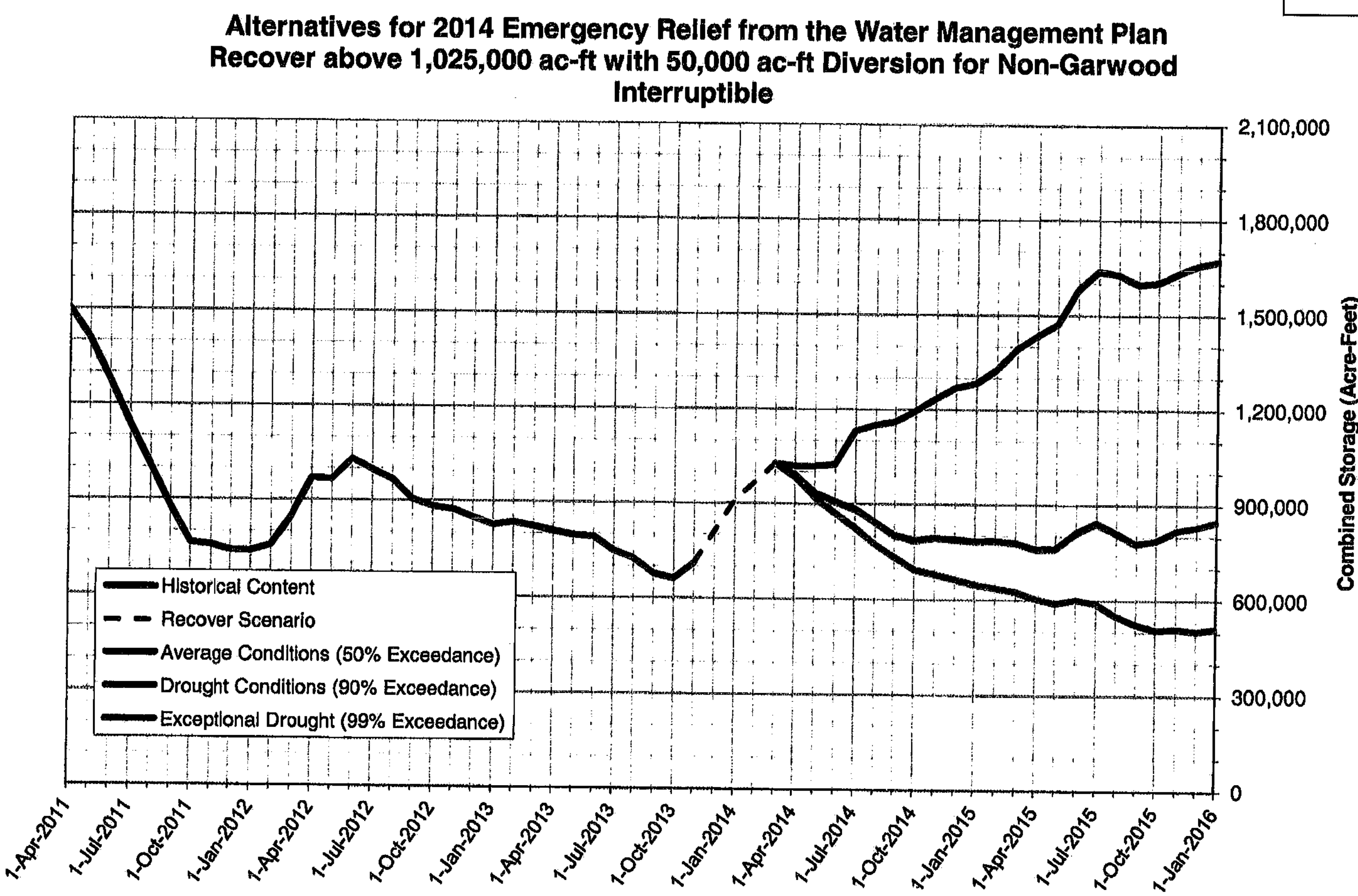
1. Maintain 10% M&I conservation from baseline
2. 2015 interruptible supply also limited to 125,000 ac-ft diversion unless DWDR

Figure 6



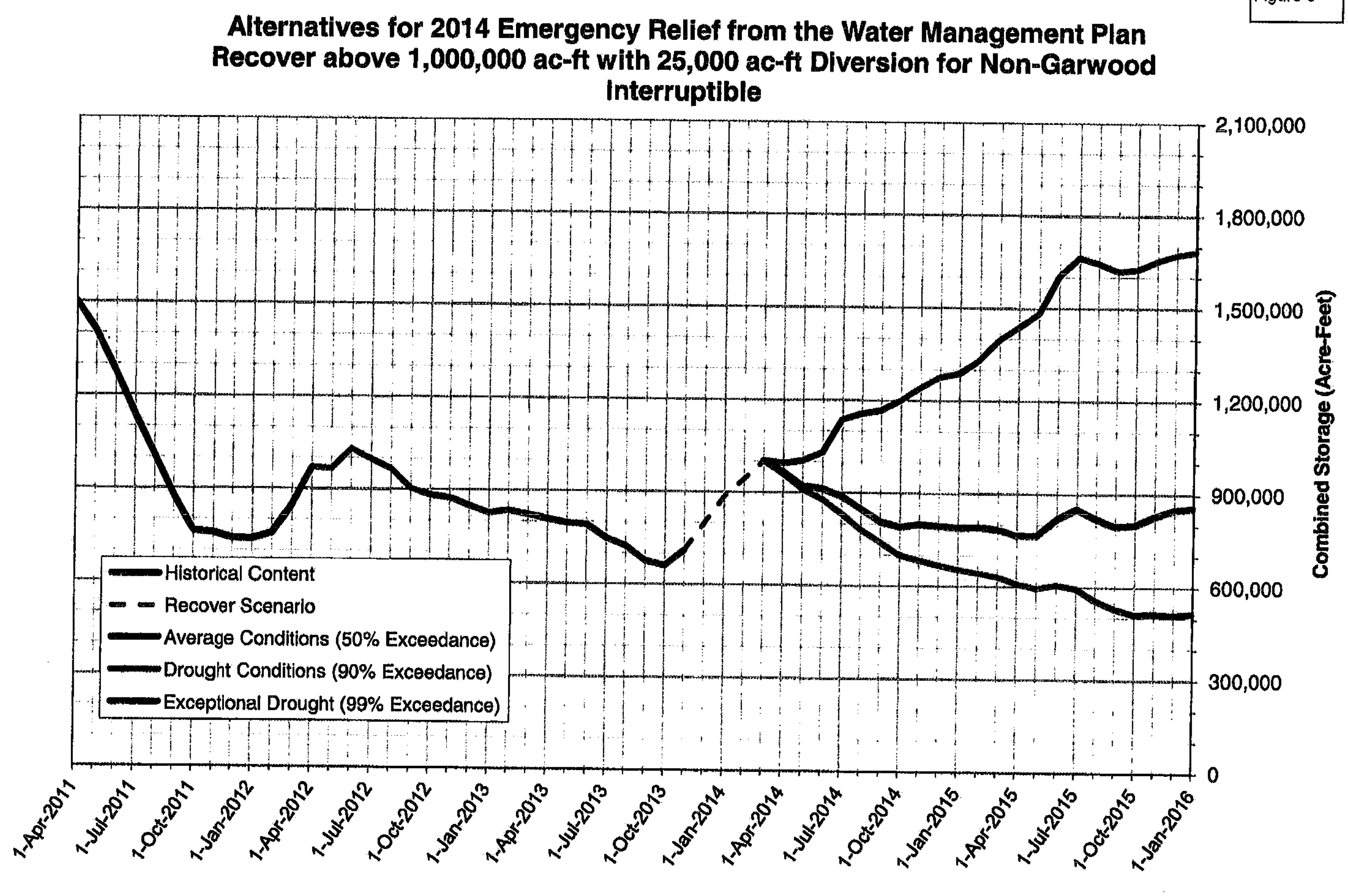
Alternatives for 2014 Emergency Relief from the Water Management Plan
Recover above 1,070,000 ac-ft with 75,000 ac-ft Diversion for Non-Garwood Interruptible
Historical Content
Recover Scenario
Average Conditions (50% Exceedance)
Drought Conditions (90% Exceedance)
Exceptional Drought (99% Exceedance)
2,100,000
1,800,000
1,500,000
1,200,000
900,000
600,000
300,000
0
Combined Storage (Acre-Feet)
1-Apr-2011
1-Jul-2011
1-Oct-2011
1-Jan-2012
1-Apr-2012
1-Jul-2012
1-Oct-2012
1-Jan-2013
1-Apr-2013
1-Jul-2013
1-Oct-2013
1-Jan-2014
1-Apr-2014
1-Jul-2014
1-Oct-2014
1-Jan-2015
1-Apr-2015
1-Jul-2015
1-Oct-2015
1-Jan-2016

Figure 7



Alternatives for 2014 Emergency Relief from the Water Management Plan
Recover above 1,025,000 ac-ft with 50,000 ac-ft Diversion for Non-Garwood Interruptible
Historical Content
Recover Scenario
Average Conditions (50% Exceedance)
Drought Conditions (90% Exceedance)
Exceptional Drought (99% Exceedance)
Combined Storage (Acre-Feet)
2,100,000
1,800,000
1,500,000
1,200,000
900,000
600,000
300,000
0
1-Apr-2011
1-Jul-2011
1-Oct-2011
1-Jan-2012
1-Apr-2012
1-Jul-2012
1-Oct-2012
1-Jan-2013
1-Apr-2013
1-Jul-2013
1-Oct-2013
1-Jan-2014
1-Apr-2014
1-Jul-2014
1-Oct-2014
1-Jan-2015
1-Apr-2015
1-Jul-2015
1-Oct-2015
1-Jan-2016

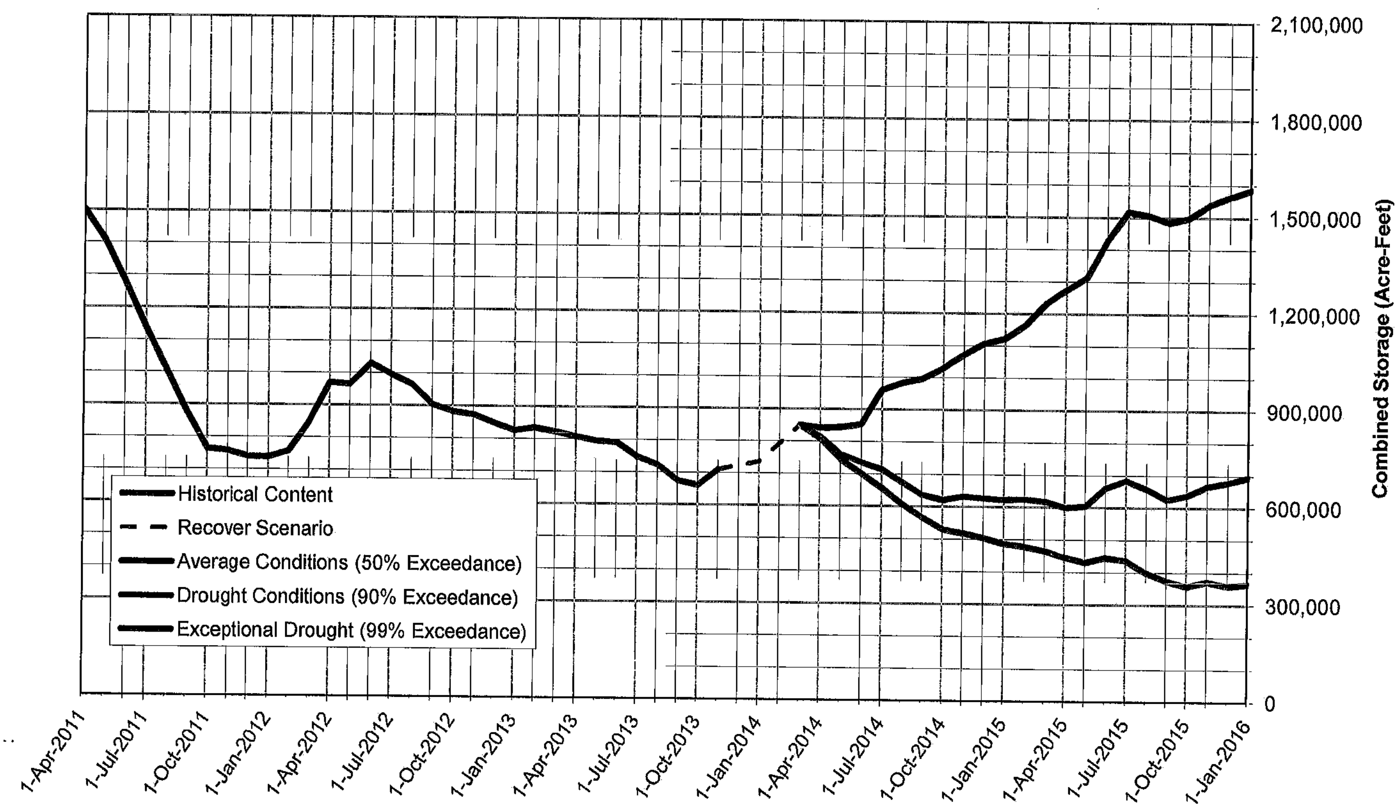
Figure 8



Alternatives for 2014 Emergency Relief from the Water Management Plan
Recover above 1,000,000 ac-ft with 25,000 ac-ft Diversion for Non-Garwood Interruptible
Historical Content
Recover Scenario
Average Conditions (50% Exceedance)
Drought Conditions (90% Exceedance)
Exceptional Drought (99% Exceedance)
2,100,000
1,800,000
1,500,000
1,200,000
900,000
600,000
300,000
0
Combined Storage (Acre-Feet)
1-Apr-2011
1-Jul-2011
1-Oct-2011
1-Jan-2012
1-Apr-2012
1-Jul-2012
1-Oct-2012
1-Jan-2013
1-Apr-2013
1-Jul-2013
1-Oct-2013
1-Jan-2014
1-Apr-2014
1-Jul-2014
1-Oct-2014
1-Jan-2015
1-Apr-2015
1-Jul-2015
1-Oct-2015
1-Jan-2016

Figure 9

Alternatives for 2014 Emergency Relief from the Water Management Plan
Recover above 850,000 ac-ft with 70,000 ac-ft Interruptible Diversion

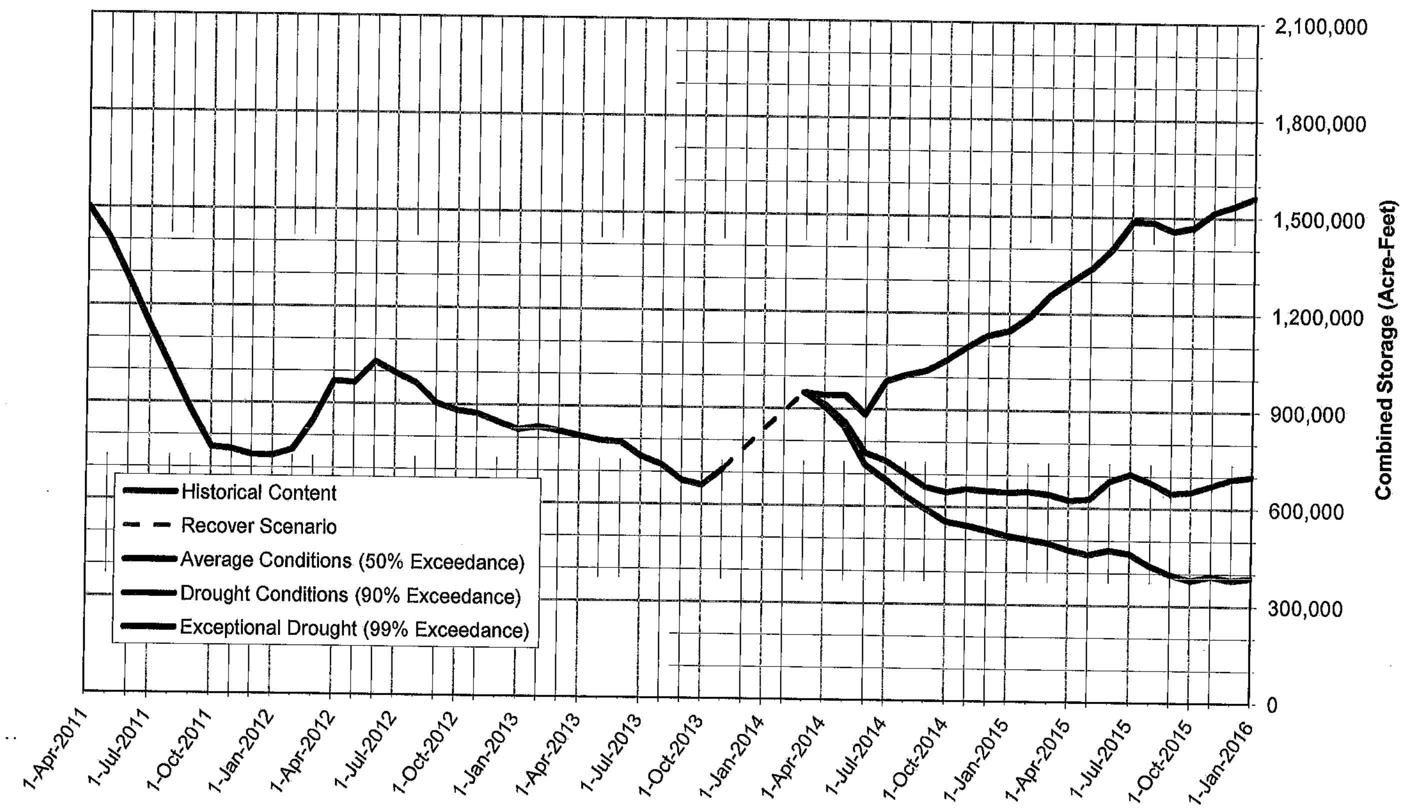


Assumptions:

1. Maintain 10% M&I conservation from baseline
2. 2015 interruptible supply also limited to 70,000 acft

Figure 10

Alternatives for 2014 Emergency Relief from the Water Management Plan
Recover above 950,000 ac-ft with 130,000 ac-ft Interruptible Diversion



Assumptions:

1. Maintain 10% M&I conservation from baseline
2. 2015 interruptible supply also limited to 130,000 acft

Attachment K

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF RYAN B. ROWNEY

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, personally appeared Ryan B. Rowney, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Ryan B. Rowney, am an individual residing in Burnet, Texas.

4. A true and correct copy of my resume, detailing my prior work history, is attached hereto under Tab 1.

5. I have worked for LCRA for 30 years. For the last 30 years, I have worked in LCRA's Water Operations. My current title is Executive Manager, Water.

6. As part of my duties at LCRA, my department provides planning services for the water utility and I am responsible for all operations within Water Operations including operations of the dams forming the Highland Lakes and operations of LCRA's Gulf Coast, Lakeside, and Garwood irrigation divisions. In addition, staff under my supervision is responsible for ensuring compliance with LCRA's instream flow and freshwater inflow obligations under the Water Management Plan.

7. My opinions stated herein are based on my familiarity with LCRA's operations, as well as my understanding of LCRA's contractual obligations to the farmers within LCRA's Garwood division and to Pierce Ranch, a wholesale interruptible irrigation customer. I also have a general familiarity with LCRA's firm customers' operations. I have also relied upon a variety of information provided to me by LCRA staff, which is of a nature typically relied upon in my profession, as described below and for which true and correct copies are either attached or referenced to other portions of LCRA's emergency request and incorporated by reference herein:

a. Affidavit of Ron Anderson, including attachments

b. Affidavit of Bob Rose, including attachments

c. Affidavit of David Wheelock, including attachments

d. Affidavit of Nora Mullarkey Miller, including attachments

8. IMPACTS OF DROUGHT ON IRRIGATION OPERATIONS.

a. Over the past two years, LCRA has significantly cut back the water supply available to downstream irrigation customers who rely on interruptible water supplies. In 2012 and 2013, consistent with emergency relief granted by TCEQ, LCRA did not supply any water from the Highland Lakes to the Gulf Coast and Lakeside irrigation divisions. These actions preserved a significant amount of supply in lakes Buchanan and Travis. For example, if LCRA had followed the 2010 WMP in 2013, LCRA would have made available for diversion about 165,000 acre-feet of additional stored water from lakes Buchanan and Travis for the downstream irrigation operations at diversion points from the river. With an estimated 20 percent delivery loss, the additional amount released would have been about 198,000 acre-feet.

b. Each of LCRA's irrigation divisions (Gulf Coast, Lakeside, and Garwood) and Pierce Ranch need to know the amount of water that will be made available to determine the amount of acreage that can be supported and to make crop choices.

c. To the best of my knowledge, our irrigation customers have very few, if any, alternative sources of water readily available. Though some irrigation customers have drilled groundwater wells in recent years, this is not a feasible option for all of the customers due to various factors, such as costs, water quality, or permitting issues.

d. Management and operation of a canal system used for irrigated agriculture depends heavily on a reliable, continuous supply of water, particularly for rice which is the primary crop grown on the LCRA canal systems. These systems cannot be operated based on a sporadic supply of water, such as that which is available based only on run-of-river supplies. For LCRA's operations, LCRA needs to be able to operate at least one pump at each pumping facility at all times to ensure a dependable supply. Moreover, without a continuous flow of water, LCRA cannot maintain canal levels, the accuracy of water measurement would be adversely affected, and some of our customers' crops would be in jeopardy.

e. If releases of interruptible stored water are suspended in the middle of the growing season, the farmers will likely sustain losses to their crops.

f. To efficiently provide water to all canal segments within the Gulf Coast, Lakeside and Pierce Ranch operations, a minimum of 100,000 acre-feet of total supply must be available for diversion. At lower amounts, LCRA cannot efficiently operate all of the canal segments: canal losses would increase significantly if LCRA were to try to maintain canal levels and push a releatively small amount of water throughout hundreds of miles of canals. Additionally, if lesser amounts of water were available, the amount that LCRA could make available to individual customers would be have to be reduced substantially relative to the acreage grown in normal years, which might make the farmer's operation infeasible.

g. The run-of-river water rights historically associated with the Gulf Coast and Lakeside operations cannot be relied upon in any significant manner during severe droughts because they are junior to Garwood and the City of Austin's municipal rights. I believe that 100,000 acre-feet of interruptible stored water will be required to feasibly operate the Gulf Coast, Lakeside and Pierce Ranch irrigation operations.

h. If less than a total of about 100,000 acre-feet of interruptible stored water is available for diversion at the Gulf Coast, Lakeside and Pierce Ranch operations, it is my opinion that LCRA should not operate either the Gulf Coast or Lakeside irrigation divisions. Alternatives that would provide less than a total of 100,000 acre-feet of interruptible stored water to the three operations are not reasonable or practicable. As noted in subparagraph f, above, losses from operating miles and miles of canal segment would be significant, and to maintain canal levels requires a steady supply of water. If such a reduced amount of water is available, in order to limit losses and maintain canal levels sufficiently to deliver water to any customers, LCRA would need to reduce the service area of the irrigation operations so that only a small portion of the canal systems was operated. LCRA would also need to develop an allocation system to divide this lesser amount of water among multiple irrigation operations and between multiple landowners/landlords-tenant farmers, which is impractical and unworkable in the short timeframe prior to obtaining emergency relief.

i. Based on my experience with the irrigation operations, including under emergency orders in 2012 and 2013, it is my opinion that it is appropriate for LCRA to wait to establish the amount of interruptible stored water supply based on the March 1 combined storage in lakes Buchanan and Travis for the 2014 crop year because:

(1) LCRA has determined that it can wait until as late as March 1 to determine the amount of interruptible stored water to be made available and still provide irrigators sufficient time to make planting decisions.

(2) Under the proposal in LCRA's application, if interruptible stored water is availabile for diversion to the Gulf Coast, Lakeside and Pierce Ranch operations, LCRA will allocate the available interruptible stored water to the irrigation operations and work with its customers to allocate the available interruptible stored water within each irrigation operation on a pro rata basis consistent with the procedures set forth in the 2010 Water Management Plan. Because of the current drought conditions, I believe it is appropriate to delay the determination of whether any water can be made available for the second half of the growing season, which generally runs from early August through October 15th. At, at a later date, LCRA may seek additional relief from the 2010 WMP to address the amount interruptible stored water available for second crop, if any.

j. To conserve water and create efficiencies to maximize the amount of acreage that can be served given the limited amount of water available, LCRA has already made and intends to change some of its contracting processes, as follows:

(1) If interruptible stored water is available, each irrigation division will be limited to a 145 day period for the first crop irrigation season. This fixed period will reduce the potential for canal and delivery losses.

(2) Deliveries of interruptible stored water to customers within a given irrigation operation will cease the earlier of: (A) 145 days from the start of deliveries within that customer's irrigation operation; (B) diversion of interruptible stored water to the customer's irrigation operation reaches that operation's allocation of interruptible stored water; (C) deliveries of water to the customer are in an amount that exceeds the acre-foot per acre duty limit specified in customer's contract; or (D) combined storage reaches 600,000 acre-feet. Rice fields requiring a longer growing season or more water will be subject to cut-off and are planted at the producers' own risk.

(3) During the contracting period, if interruptible stored water is available LCRA will initially only commit to providing water for first crop. If interruptible stored water becomes available for second crop, LCRA will enter into separate contracts or contract amendments for second crop.

(4) LCRA has established in its contracts a surcharge structure based upon the water use amount or duty (acre-feet per acre) to grow first crop. High water use will be subject to higher rates.

(5) LCRA requires that all privately-owned laterals be cleaned to LCRA's specifications or water service will not be delivered down those laterals.

k. If combined storage on Jan. 1, 2014 is between 690,000 acre-feet and 850,000 acre-feet, the 2010 WMP requires that LCRA make available about 175,000 to 182,000 acre-feet for the downstream irrigation operations at diversion points from the river. To make such water available, an additional 20 percent would need to be released to account for losses in delivering water from Lake Travis to the irrigation operations. Thus for the storage levels above, the 2010 WMP could result in the need to release up to about 220,000 acre-feet of water.

9. IMPACTS OF DROUGHT ON FIRM WATER CUSTOMERS.

a. Ensuring adequate supply for LCRA's firm customers is critical. The maximum historical annual amount of reported water use to meet firm customer demands from the firm supplies of lakes Buchanan and Travis during 2000 through 2012 was approximately 247,000 acre-feet in 2011. In addition, about 33,000 acre-feet of firm water was supplied to help meet environmental flow needs in 2011. The maximum amount of interruptible water released from lakes Buchanan and Travis during this same period occurred in 2011 and totaled about 433,000 acre-feet. The maximum total amount released or used from the Highland Lakes, about 714,000 acre-feet, occurred in 2011. In 2012, firm water use from lakes Buchanan and Travis by LCRA customers was about 148,000 acre-feet; about 31,000 acre-feet was supplied to help meet environmental flow needs; and about 9,000 acre-feet of interruptible water was supplied to farmers in the Garwood irrigation division. Total use of water from lakes Buchanan and Travis in 2012 was about 188,000 acre-feet. Based upon a review of water use through November 2013, total water use from lakes Buchanan and Travis for 2013 is expected to be similar to 2012.

b. LCRA owns four water treatment plants whose raw water supply is Lake Travis or Lake Buchanan as noted in Table 1

Table 1. LCRA Water Treatment Plants Supplied from Lakes Buchanan or Travis

System Name	Intake Location	Estimated Population Served	Service Area
Paradise Point Water System	Lake Buchanan	350	Paradise Point
Lake Buchanan Water System	Lake Buchanan	1,410	Service area around the south and west sides of Lake Buchanan
Smithwick Mills Water System	Lake Travis	160	Smithwick Mills
Ridge Harbor Water System	Lake Travis	400	Ridge Harbor

c. LCRA also owns the Spicewood Beach Water System. This groundwater-based system is influenced by the water levels in Lake Travis. As a result of the low lake levels, the production of the groundwater wells has diminished significantly. Water has been trucked to Spicewood Beach on a daily basis. The costs to date have exceeded $800,000.

d. Based on my knowledge of the treatment systems in and around lakes Buchanan and Travis, LCRA's water systems are representative of the types of potable water systems that obtain raw water from the lakes.

e. The table attached under Tab 2 shows the lowest elevations that LCRA's raw water intakes can currently draw from Lake Buchanan or Lake Travis. The table also shows the approximate amounts spent over the past few years to make adjustments to reach those elevations. In addition, the table provides information regarding the lowest intake elevation planned to date and the estimated costs for achieving those elevations. In some cases, lower elevations might be achieved at significantly greater costs, or LCRA may resort to hauling water for essential drinking and sanitation purposes for the smaller systems.

f. LCRA has 15 customers that currently take raw water for municipal purposes from Lake Travis that are not a part of LCRA's water utility systems. I reviewed information maintained by LCRA that identifies what LCRA believes to be the elevations of our customers' intake structures. The depth of those intakes ranges from 545 feet mean sea level (msl) to 645 feet msl on Lake Travis.

g. If the levels in Lake Travis or Lake Buchanan drop below the current lowest pumping elevations as indicated in the chart attached under Tab 2, LCRA must take actions to either lower the pumping elevation, or find alternative supplies for the LCRA water utility systems described in this affidavit. For smaller systems such as Paradise Point, Smithwick Mills, or Ridge Harbor, the alternative is likely to be to haul water from a water utility with a viable source. Temporary measures would likely need to be taken by LCRA's raw water customers that have their own intake facilities to extend the facilities to reach water at lower elevations. It is my understanding that firm customers are actively spending or planning to spend funds to allow their intakes to operate at lower elevations. At least one customer has looked into hauling water should Lake Travis levels drop below the lows of September 2013.

h. Based on this information, it is my opinion that the current drought presents an imminent threat to public health and safety for the LCRA water systems if the lake levels or releases drop more quickly than arrangements for alternative intakes or supplies can be implemented. This is also likely the case for several of LCRA's raw water customers on Lake Travis.

i. In addition to the water systems described above that draw surface water from lakes Buchanan or Travis, LCRA also owns one retail system that draws supply water from one of the pass-through lakes between Lake Buchanan and Lady

Bird Lake. That system, Sandy Harbor Water System, is supplied from Lake LBJ via the City of Horseshoe Bay treatment plant facilities and serves a population of approximately 245.

10. IMPACT OF DROUGHT ON HIGHLAND LAKES INFLOWS.

a. Inflows to the Highland Lakes over the past several years, including the first eleven months of 2013, are among the lowest on record.

b. Shown in Table 2 is a comparison of the lowest ten years of inflows into lakes Buchanan and Travis with the 2013 year-to-date inflows through November and the average annual inflows since 1942. Inflows for 2011 into the lakes were the lowest annual inflows on record, about 10% of average inflows. Calendar years 2008, 2009, 2011 and 2012 are all among the lowest 10 years of inflows to the Highland Lakes and 2013 is on track to be among the five lowest. Inflows from just one year from the historic Drought of Record (1950) fall within the 10 years of lowest inflows.

Table 2. Annual Inflows into the Highland Lakes (acre-feet)

Year	Amount
2011	127,802
Jan-Nov 2013	198,466
2008	284,462
2006	285,229
1963	392,589
2012	393,163
1983	433,312
1999	448,162
2009	499,732
1950	501,926
1967	503,572
Average (1942-2012)	1.24 million

c. Monthly inflows have been below average in 42 of the past 43 months as shown in Table 3.

Table 3. Monthly Inflows to Lakes Buchanan and Travis from May 2010 to August 2013

Month	Inflows (acre-feet)	Percent of Monthly Average	Month	Inflows (acre-feet)	Percent of Monthly Average
May 2010	95,821	46.2%	Mar 2012	112,517	121.6%
June 2010	33,517	20.1%	Apr 2012	19,477	18.3%
July 2010	59,905	69.1%	May 2012	83,699	40.4%
Aug 2010	10,783	16.6%	June 2012	12,599	7.5%
Sept 2010	86,952	83.9%	July 2012	8,712	10.0%
Oct 2010	14,385	11.7%	Aug 2012	2,041	3.1%
Nov 2010	13,899	19.6%	Sept 2012	12,006	11.6%
Dec 2010	16,845	24.4%	Oct 2012	19,338	15.7%
Jan 2011	21,158	32.3%	Nov 2012	6,042	8.5%
Feb 2011	16,306	18.8%	Dec 2012	6,854	9.9%
Mar 2011	13,811	14.9%	Jan 2013	15,086	23.0%
Apr 2011	9,175	8.6%	Feb 2013	8,665	10.1%
May 2011	11,182	5.4%	Mar 2013	10,549	11.5%
June 2011	1,340	0.8%	Apr 2013	10,898	10.4%
July 2011	734	0.8%	May 2013	28,953	14.1%
Aug 2011	403	0.6%	June 2013	5,471	3.3%
Sept 2011	922	0.9%	July 2013	17,378	20.3%
Oct 2011	29,927	24.3%	Aug 2013	1,593	2.5%
Nov 2011	6,874	9.7%	Sept 2013	30,413	29.6%
Dec 2011	15,969	23.1%	Oct 2013	50,163	41.0%
Jan 2012	35,178	53.6%	Nov 2013	19,297	27.5%
Feb 2012	74,699	86.0%			

d. Additionally, the inflows in the current drought over periods ranging from 12 months to 72 months are lower than lowest such periods within the historical Drought of Record as shown in Table 4.

Table 4. Comparison of inflows in current drought to Drought of Record

	Lowest inflows for time period in ongoing drought		Lowest inflows for time period in 1950s Drought of Record	
Time Period	Period ending	inflows	Period ending	inflows
12 months	September 2011	120,160	April 1951	408,784
24 months	March 2013	503,989	March 1952	1,006,681
36 months	September 2013	695,099	August 1952	1,636,088
48 months	November 2013	1,738,868	August 1952	3,035,846
60 months	August 2013	2,147,157	August 1952	4,128,806
72 months	November 2013	2,524,942	April 1955	5,193,016

e. As a result of extremely low inflows into the lakes, record high temperatures, high evaporation rates, and higher than anticipated interruptible demands, the combined storage in the lakes dropped significantly in 2011, and in a very short timeframe. In 2012 and through November 2013, even with interruptible stored water cut off from the Gulf Coast, Lakeside and Pierce Ranch irrigation divisions, the lake levels have not recovered. (*See* Tab 3.) The combined storage in lakes Buchanan and Travis fell to the lowest level in the current drought, 637,123 acre-feet or 31.7 percent capacity on Sept. 19, 2013. For the 12-month period from Sept. 1, 2012 to Sept. 1, 2013, combined storage had dropped by about 229,000 acre-feet; and from June 1 to Sept. 1, 2013, combined storage dropped by about 118,000 acre-feet. As of Dec. 1, 2013, combined storage was about 746,000 acre-feet or 37 percent capacity. On Nov. 18, 2013, combined storage was about 36 percent capacity. The last time both lakes Buchanan and Travis were simultaneously at their maximum allowable conservation storage was February 13, 2005.

f. Heavy, widespread rainfall in the Llano River and San Saba River watersheds above the Highland Lakes on Sept. 19 and 20, 2013 averaged two to three inches, with some rain gages reporting totals as high as six or seven inches. However, this rain event has only yielded approximately 24,000 acre-feet of inflow to the lakes. This low inflow total is symptomatic of the drought's severity which included dry soils that absorb most of the rainfall that does occur. By comparison, an event in March 2007 with about 40 percent *less* rainfall yielded almost 100,000 acre-feet of inflows to lakes Buchanan and Travis. A later event in March 2007 with about 15 percent more rainfall produced about 275,000 acre-feet of inflows to the lakes.

g. Two large rain events occurred in the lower Colorado River Basin watershed in October 2013. However the majority of rainfall and runoff occurred below the watersheds of lakes Buchanan and Travis. Gauged inflows to lakes Buchanan and Travis for October and November totaled about 69,000 acre-feet, as compared to flow that originated downstream and went past Bay City, totaling 355,000 acre-feet for those two months.

11. EFFICIENCY IMPROVEMENTS. In 2012, LCRA implemented process improvements that have improved the efficiency of releases from the Highland Lakes for downstream water needs. These include: 1) a smaller increment of instantaneous releases from Tom Miller Dam, which allows for more precisely meeting instream flow requirements as well as other demands; and 2) improvements to models and procedures for determining the downstream demand and the estimated amount of flows originating downstream.

Further affiant sayeth not.

Ryan B. Rowney

RYAN B. ROWNEY, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 10th day of December, 2013.

Tabitha A. Parke

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2014

Ryan B. Rowney
P.O. Box 220
Austin, TX 78767
(512)469-6874

EXPERIENCE

LOWER COLORADO RIVER AUTHORITY, Austin, TX — **October 1983 to Present**

Executive Manager, Water (Sept. 2011 to Present)
Responsible for all areas of Water Operations including Hydro Operations, Irrigation Operations, River Operations and Water and Wastewater Operations.

Provides safety oversight for Water Operations and reports directly to the Chief Operating Officer.

Responsible for the operations and maintenance of LCRA's six dam and 13 hydroelectric (hydro) generation units, 1,100 miles of irrigation canals, nine irrigation pump stations, LCRA's system of rain and stream gauges, and LCRA water and wastewater systems.

Responsible for the development and reporting of drought and lake conditions to the General Manager and the LCRA Board of Directors on a monthly basis.

Manager of Dam & Hydroelectric Operations (Mar. 2004 to Sept. 2011)
Operate and maintain LCRA's network of dam and hydro generating assets while providing leadership and direction to staff. Manage flood operations. Develop strategic and operating goals and objectives in line with LCRA's overall goals and objectives. Ensure adherence to safety procedures and policies. Provide leadership and direction to dam and hydro related utility maintenance activities.

Superintendent of Dam & Hydroelectric Operations (May 2001 to Mar. 2004)
Supervise, coordinate and direct activities of dam and hydro staff. Act as liaison with the LCRA River Operations Center (ROC), LCRA Generation Desk (GenDesk) and LCRA System Operations Control Center (SOCC) to ensure the most efficient use of Hydro unit operations and flood management. Supervise the overall maintenance of the six Highland Lakes dams, the Lometa reservoir and pump station, thirteen hydroelectric turbine generators and all WWW treatment plants and associated water lines. Supervise the overall maintenance of all LCRA floodgates and related equipment.

Area Supervisor, Wirtz and Starcke Dams (Feb. 1997 to May 2001)
Supervise, coordinate and direct overall activities of staff responsible for monitoring and operating all LCRA dams and hydro generators. Lead and ensure communication and coordination of work activities with LCRA's Generation Desk (GenDesk) and the River Operations Center (ROC) to meet generation demand load requirements. Lead and ensure communication and coordination with the ROC to manage the lake levels of the six Highland Lakes, during normal, emergency and flood conditions.

Planner / Scheduler, Dam & Hydroelectric Operations (Aug. 1994 to Feb. 1997)

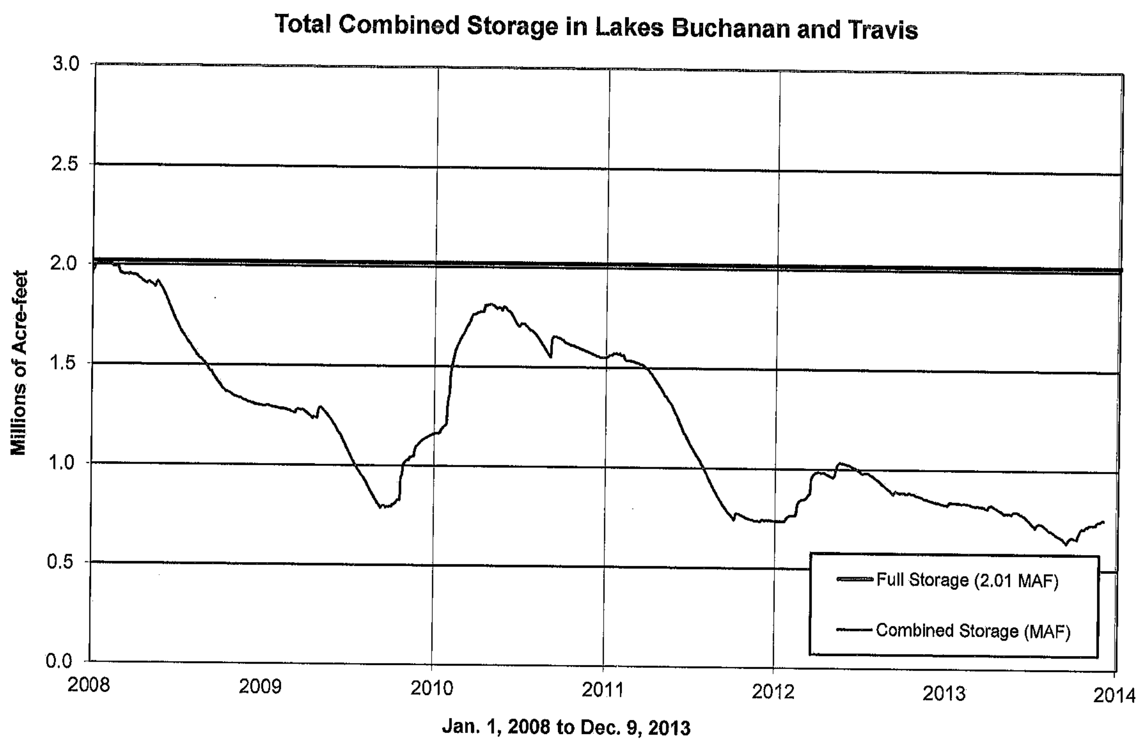
Develop and maintain departmental work plan and project schedules, time and cost estimates, work orders, work authorizations, requisitions, bid evaluations, pertinent records and logs, including ProCard documentation.

Electrician, Dam & Hydroelectric Operations (Oct. 1983 to Aug. 1994)

Responsible for repair, installation, replacement and testing electrical circuits, equipment and appliances in a facilities or other non-energy services environment. Isolate defects in wiring, switches, motors and other electrical equipment using testing instrument. Replace faulty switches, sockets and other elements of electrical systems. Dismantle electrical machinery and replaces defective electrical or mechanical parts such as gears, brushes and armatures. Mount motors, transformers and lighting fixtures into position and completes circuits according to diagram specifications.

LCRA Water Utility Intake Drought Response Summary

System Name	Intake Location	Current Lowest Pumping Elevation	Next Planned Lowest Pumping Elevation	Approximate Cost to Further Move Intakes/New Source	Additional Comments
Paradise Point Water System	Upstream third of Lake Buchanan	985 ft msl	975 ft msl	≈ $50,000	A new intake will need to be constructed when lake levels drop to about 985. The solution will likely include new submersible pumps enclosed in a screened intake pipe. Additional raw water piping and electrical work will be required.
Lake Buchanan Water System	Buchanan Dam	981 ft msl	940 ft msl	≈ $10,000	Spent approximately $60,000 in 2009 to add a new intake location. Treatment plant can be supplied provided there is water in the Buchanan Dam penstock. Additional costs will be incurred to add rails and pipe needed to lower the intake if Lake Buchanan drops below 981 ft msl.
Smithwick Mills Water System	Far upstream reach of Lake Travis	645 ft msl			Plant intake is located in a low spot that can continue to draw water as long as sufficient periodic releases are made from Starke Dam. Plan to truck water if necessary.
Spicewood Beach Regional Water System	Groundwater	Well Bottom elevation of 630 ft msl		≈$ 10,000 to $90,000 per month for water contract hauling; or $10,000 to $40,000 per month plus $80,000 to purchase tanker truck. Or $1.0MM for a new surface water plant.	Aquifer level is somewhat correlated to the level of Lake Travis adjacent to Spicewood. There has been decline in well production. Trucking water as necessary.
Ridge Harbor Water System	Upstream third of Lake Travis	625 to 627 ft msl	622 to 625 ft msl	≈$50,000	LCRA will need to construct a second intake when the lake levels drop to around 625 ft msl. The solution will likely include a new submersible pump with additional raw water piping and electrical work.


Total Combined Storage in Lakes Buchanan and Travis
3.0
2.5
2.0
1.5
1.0
0.5
0.0
Millions of Acre-feet
2008
2009
2010
2011
2012
2013
2014
Jan. 1, 2008 to Dec. 9, 2013
Full Storage (2.01 MAF)
Combined Storage (MAF)

Attachment L

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF BOB ROSE

THE STATE OF TEXAS	§
	§
COUNTY OF TRAVIS	§

Before me, the undersigned authority, personally appeared Robert H. Rosenzweig, also known as Bob Rose, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Bob Rose, am an individual residing in Austin, Texas.

4. I am the Chief Meteorologist for the Lower Colorado River Authority ("LCRA"). I have held this position since 1995. I have worked as a meteorologist in Texas for 30 years. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. As part of my duties at the LCRA, I regularly review and summarize short-term and long-term weather predictions and drought indices for the Central Texas region. My opinion is based on my experience in the field and a review of data and forecasts from the National Weather Service's Climate Prediction Center, National Oceanic and Atmospheric Administration's (NOAA's) Earth System Research Laboratory, Texas State Climatologist Dr. John Nielsen-Gammon and Research Scientist Gregory J. McCabe.

6. Extraordinary drought conditions have gripped much of Texas, including the Colorado River basin for more than three (3) years, dating back to October of 2010. The drought has been unprecedented relative to the long-term climate record in a number of ways: record low precipitation, extreme, record-setting summer heat and enormous wildfires. The drought conditions include both meteorological drought (taking into account rainfall and temperature) and hydrologic drought (taking into account streamflow and evaporation).

7. Rainfall. According to the Texas State Climatologist, Dr. John Nielsen-Gammon, on a statewide basis, rainfall during the 12 month period from Oct. 1, 2010 to Sep. 30, 2011 was the lowest ever recorded, dating back to 1895. (*See* Tab 2, available at http://climatexas.tamu.edu/files/2011_drought.pdf.) My review of the rainfall data indicates the following:

a) Total average rainfall across Texas during that period was 11.18 inches, just 38 percent of the long-term average. This is much lower than the previous record of 13.91 inches occurring between October 1955 and September 1956.

b) For the period from October 2011 through September 2012, rainfall was somewhat more plentiful. Statewide, rainfall averaged 28.94 inches, or 94 percent of the long-term average. (*See* Tab 3, Figure 1, available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=12&parameter=pcp&state=41&div=0&year=2012&month=9.)

c) However, rainfall during this period was very sporadic; often there were several weeks of dry weather between significant rainfall events. The sporadic nature of the rain precluded significant runoff. Inflows from January through October 2012 were less than 40% of average. (*See* Affidavit of Ryan Rowney.)

d) Statewide rainfall over the period between October 2010 and September 2012 totaled 40.21 inches, 15.73 inches below normal, or 73 percent of normal. This is the 5th driest such 24-month period on record dating back to 1895. (*See* Tab 3, Figure 2, available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=24&parameter=pcp&state=41&div=0&year=2012&month=9.)

e) Statewide rainfall so far in 2013 has been near normal. Between January 2013 and October 2013, statewide rainfall totaled 24.12 inches, 0.12 inches below normal. (*See* Tab 3, Figure 3, available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=10&parameter=pcp&state=41&div=0&year=2013&month=10.) The sporadic nature of rain events (over the past three years) has continued to produce well below average runoff. (*See* Affidavit of Ryan Rowney.)

f) Statewide rainfall for the three-year period of November 2010 to October 2013 was well below normal, totaling 65.51 inches. This total is 18.47 inches below normal or 78 percent of normal. This is the 7th driest such period on record dating back to 1895. (*See* Tab 3, Figure 4, available at http://www.ncdc.noaa.gov/temp-and-precip/ranks.php?periods%5B%5D=36&parameter=pcp&state=41&div=0&year=2013&month=10.)

g) Two heavy rain events occurred during October 2013, but both of these events occurred primarily downstream of the watershed to the Highland Lakes. The first event occurred on October 12 and 13, producing up to a foot of rain over southwest Austin and southwest Travis County. The second event occurred on October 30 and 31, producing widespread totals of 8 to 12 inches over parts of Travis, Hays and Comal Counties. The majority of the runoff from both rain events drained into the Colorado River below Austin.

8. According to the latest U.S. National Drought Monitor, a product of the National Weather Service, the U.S. Department of Agriculture, and the National Drought Mitigation Center, much of the Texas Hill Country was designated as being in "moderate drought," the first of four drought classifications. The Hill Country counties of Gillespie and Kerr were designated as being in "severe" to "extreme" drought, the second and third of four drought classifications. Much of Central Texas and the middle Texas coast were depicted as being abnormally dry, indicating drought conditions have improved considerably but some longterm drought impacts still remain in place. Generous rains in late September and October caused general drought improvement across the region. Soil moisture improved, stock ponds filled and vegetation greened up. However, the rains were not heavy enough to significantly improve the hydrologic drought. Note, the Drought Monitor does not specifically depict the state's hydrologic drought, which is considerably worse than depicted.

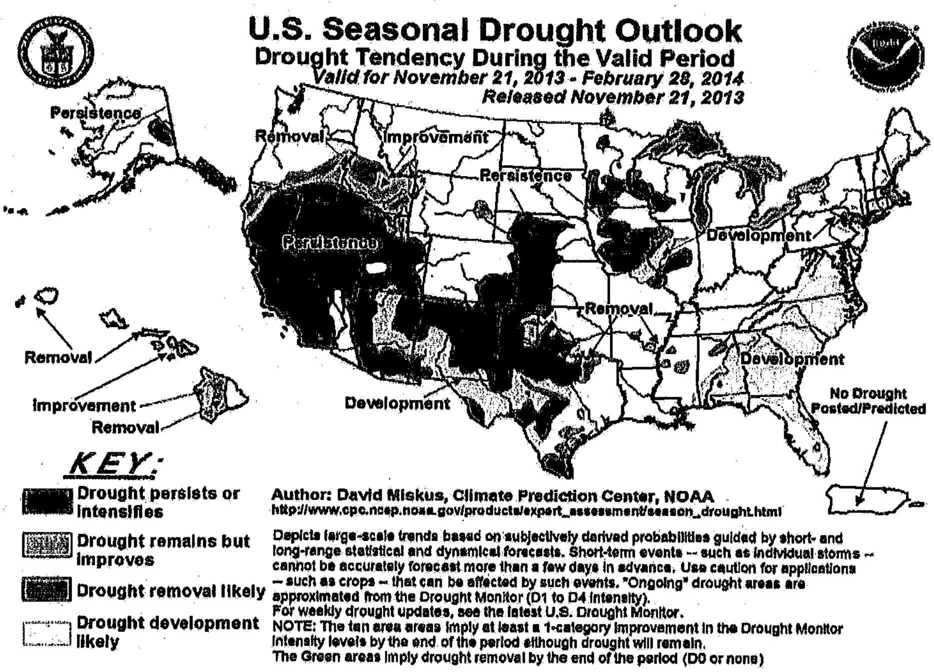
9. Heat. Another factor that has contributed to the severity of the ongoing drought has been the unprecedented heat. For Texas, the average temperature between June 1 and August 31 of 2011 was the hottest summer average temperature ever recorded in Texas and the second hottest summer average temperature for any state in the US dating back to 1895. Summer 2011 was also, by far, the hottest summer on record for Austin. Statewide, calendar year 2011 was the second hottest year ever recorded and the hottest year on record for Austin. The combination of well below normal rainfall and unprecedented heat created some of the most severe drought conditions ever recorded. (*See* http://www.ncdc.noaa.gov/sotc/drought/2011/9, last visited July 1, 2013 and http://www.srh.noaa.gov/images/ewx/wxevent/sum2011.pdf, last visited July 1, 2013.) These conditions even surpassed the drought conditions of the 1950s. The unprecedented hot temperatures combined with numerous sunny days to create much higher than normal losses from evaporation. Abnormally warm temperatures also continued in 2012. Statewide, the summer of 2012 was the 10th hottest summer on record. And it was the 11th hottest summer on record for Austin. Statewide, 2012 tied with 1921 for the warmest year ever recorded in Texas history. For Austin, summer temperatures in 2012 were the 9th warmest on record. Summer temperatures for Austin in 2013 were the 5th warmest on record.

10. Weather Forecast Sources. In developing my forecast, I have relied on various sources, including the National Weather Service's Climate Prediction Center,

NOAA's Earth Science Research Laboratory, Texas State Climatologist John Nielsen-Gammon and Gregory McCabe, Research Scientist.

a) The National Weather Service's Climate Prediction Center 3-Month Drought Outlook calls for the drought to persist across the Hill Country between the months of November through February. Limited to no drought is forecast for Central Texas and the middle Texas coast. *See* Figure 1.

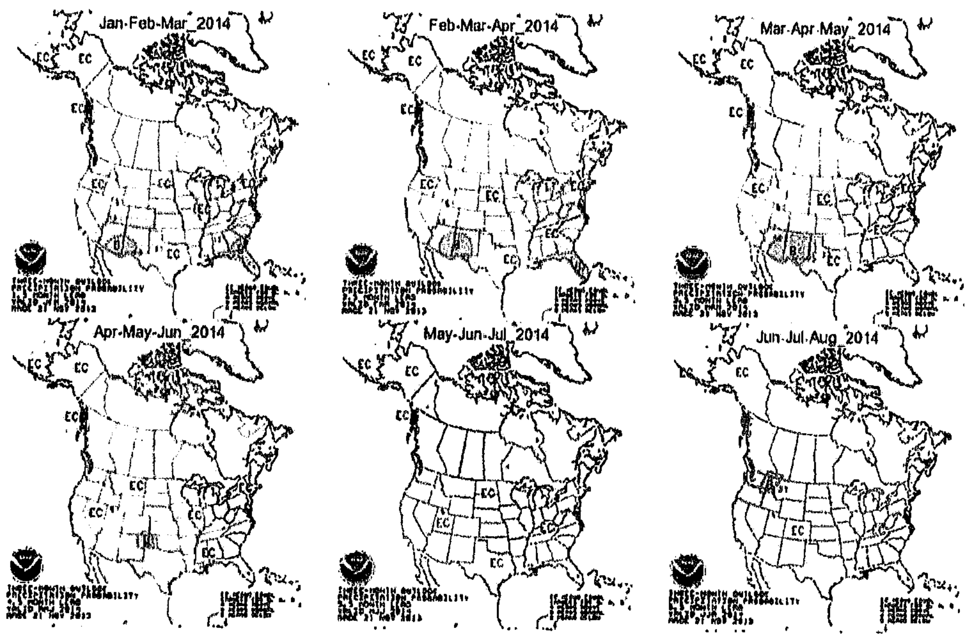
Figure 1.



According to CPC forecasters, this outlook is primarily based on the forecast for ENSO neutral conditions to continue in the tropical Pacific this winter. CPC forecasters state "the anticipated monthly and seasonal precipitation (outlooks) tilt toward abnormal dryness, plus 60- and 90-day (precipitation) shortages, supports development or persistence of drought (at least D1) in the Southwest (Texas) and the Southeast by the end of February 2014..." (*See* Tab 4, available at http://www.cpc.ncep.noaa.gov/products /expert_assessment/sdo_discussion.html.) Looking out longer-term, The International Research Institute, a partner of the National Weather Service's Climate Prediction Center, forecasts at least a 60 percent probability for ENSO neutral conditions to continue in the tropical Pacific through winter into early springlate fall and early winter. (*See* Tab 3, Figure 5, available at http://iri.columbia.edu/climate/ENSO/currentinfo/QuickLook.html.)

b) The latest National Weather Service precipitation outlook generally calls for equal chances for above, below, or near normal precipitation across Central and South Texas this winter, spring and early summer. *See* Figure 2. Climate Prediction Center forecasters state: "In areas without substantial and reliable climate signals, equal chances of below, near and above median seasonal precipitation amounts are forecast." (*See* Tab 5, available at http://www.cpc.ncep.noaa.gov/products/predictions/90day/fxus05.html.)

Figure 2. National Weather Service Precipitation Outlook

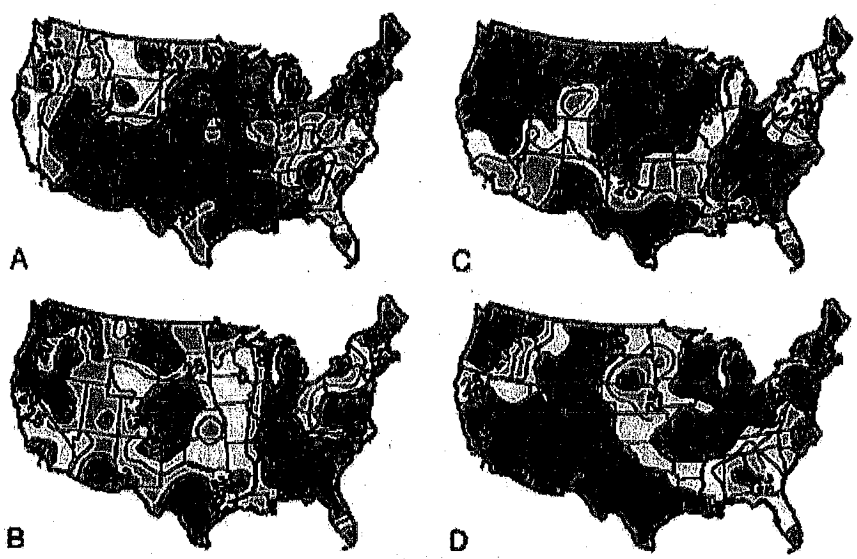


c) Sea surface temperatures in the tropical Pacific are currently neutral but these waters have been slowly warming over the past couple of months. Most all long-range climate forecast models indicate this warming trend will continue through the winter and spring months of 2014. Several of the models indicate the Pacific will reach the threshold for a weak El Niño sometime during the late spring or early summer. Should the El Niño develop, it is not expected to have a significant impact on Central Texas weather until the late summer or fall. But, the development of El Niño in 2014 is far from certain. Tropical Pacific waters reached the threshold for an El Niño in August of 2012 but sea surface temperatures unexpectedly cooled in September and October, and the El Niño failed to develop. By November of 2012, the Climate Prediction Center canceled the El Niño watch as Pacific waters continued to cool. In the current regime of a negative Pacific Decadal Oscillation (PDO), the development of an El Niño is far from certain as the overall oceanic pattern tends to fight the build up of unusually warm water in the tropical region.

d) In 2004, McCabe et. al. published a statistical study of drought frequency in the lower 48 states versus the PDO and Atlantic Multidecadal Oscillation

(AMO). (*See* Figure 3, below and Tab 6, available at http://www.pnas.org/content/101/12/4136.long.) Currently, the Pacific Ocean is in the midst of a negative phase of the PDO where waters on the eastern side of the Pacific are unusually cool. At the same time, waters in the North Atlantic Ocean are unusually warm, a result of the positive phase of the AMO. Oceanic conditions in both the Atlantic and Pacific Oceans seem to influence long-term drought conditions within the U.S. Scientists monitoring both oceans have been able to match the changing phases of multi-decadal oscillations within each ocean to the presence or absence of drought across the US. McCabe pointed out the difference between the dust bowl drought in the 1930s when the PDO and AMO were both positive and the multi-year drought of the 1950s over the south central and southwestern US when the PDO was cold and the AMO was warm.

Figure 3. Drought probability for the four classes of Pacific Decadal Oscillation and Atlantic Multidecadal Oscillation



A is Cold (-)AMO and Warm (+) PDO. B is Cold (-) AMO and Cold (-) PDO.
C is Warm (+) AMO and Warm (+) PDO. D is Warm (+) AMO and Cold (-) PDO.

The current conditions are indicative of classification D which indicates persistent drought for Texas and the southwestern United States. McCabe in 2004 wrote, "Should the current positive AMO (warm North Atlantic) conditions persist into the upcoming decade, we suggest two possible drought scenarios that resemble the continental-scale patterns of the 1930s (positive PDO) and 1950s (negative PDO) drought."

11. Weather Forecast. Based on my experience and a review of data and forecasts from the sources listed above, it is my opinion a general pattern of near normal

rainfall will be in place across Central and South Texas this winter into early spring. A neutral tropical Pacific Ocean in combination with a negative Pacific Decadal Oscillation is expected to produce a weather pattern where some storms move into Texas, but the primary storm track stays generally just north of Central Texas and the Hill Country. While this pattern will offer some opportunities for rain throughout the winter months, the rain is not expected to be heavy enough to cause significant drought improvement. With similar oceanic conditions in the Pacific and Atlantic to what was in place in the 1950s, it is quite possible that Texas is in the grip of a multi-year drought period, along the lines of what was observed in the drought years of the 1950s. Several long-range forecast models are 'showing a trend toward the development of a weak El Niño this spring into early summer. Should the El Niño develop as forecast, it could cause a wetter weather pattern by fall of 2014. In the mean time, I do not foresee a significant change in the rainfall pattern across Central and South Texas this winter into early spring.

Further affiant sayeth not.

Bob Rose

BOB ROSE, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 9th day of December, 2013.

TABETHA A. JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2014

Tabetha A. Jaske

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2014

BOB ROSE

P.O. Box 220
Austin, TX 78767-0220
bob.rose@lcra.org

EDUCATION

Texas A&M University, College Station, Texas
Bachelor of Science in Meteorology 1979.

PROFESSIONAL EMPLOYMENT

Jan 1995 to Present

Chief Meteorologist, **Lower Colorado River Authority, Austin, Texas**

- Responsible for the daily forecast of weather conditions and temperatures affecting the Lower Colorado River Authority's power generation, electrical transmission, flood control and water supply operations.
- Produce a daily weather blog about Central Texas weather: http://www.lcra.org/water/conditions/weather/weather_column.html
- Write daily operational weather briefs to keep all departments of LCRA apprised of expected weather conditions.
- Provide advance notice significant weather event e mails to emergency management officials, county judges along with city and state agencies.
- Present a bi-weekly video weather blog about Central Texas weather. Give numerous talks to various civic groups and organizations about the weather.
- Provide weather information to a number of newspapers and media outlets across Central Texas about regional weather.

Feb 1988 to Jan 1995

Meteorologist, **KVUE-TV (ABC), Austin, Texas**

- Responsible for the morning and midday newscasts for 4 years, weekend newscasts for 3 years.
- Prepared a weekly astronomical report called Skywatch, and did occasional science and environmental reporting.

Sep 1978 to Jan 1988

Weekend Meteorologist, **KBTX-TV, Bryan, Texas (ABC/CBS).**

- Responsible for the forecasting, preparation and presentation of the 10 PM weekend weathercasts.

PROFESSIONAL MEMBERSHIPS

Member, American Meteorological Society. TV Seal #501, AMS Certified Broadcast Meteorologist.
Member, Austin-San Antonio chapter, American Meteorological Society
Currently serving on the Board for Private Sector Meteorology with the American Meteorological Society

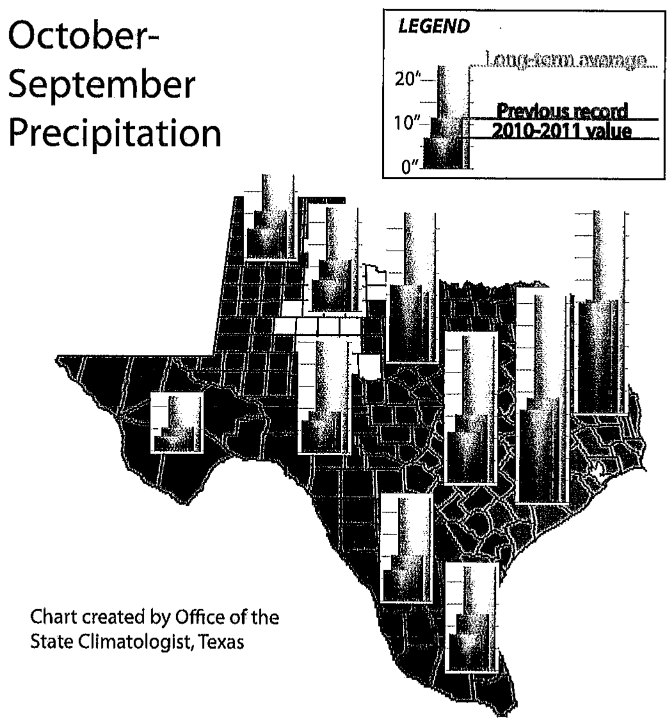
RELATED ACTIVITES:

A regular contributor to the National Drought Monitor.
Member of the Southern Climate Impacts Planning Program (SCIPP)
Travis and Williamson County Coordinator for CoCoRaHS

The 2011 Texas Drought

A Briefing Packet for the Texas Legislature
October 31, 2011

John W. Nielsen-Gammon
Professor of Atmospheric Sciences and Texas State Climatologist



The Office of the State Climatologist is housed in the College of Geosciences, Texas A&M University, College Station, Texas

Executive Summary

The 2011 drought in Texas has been unprecedented in its intensity. The year 2010 had been relatively wet across most of the state, except for extreme eastern Texas. Beginning in October 2010, most of Texas experienced a relatively dry fall and winter, but the record dry March 2011 brought widespread extreme drought conditions to the state. A record dry March through May was followed by a record dry June through August, and the 12-month rainfall total for October 2010 through September 2011 was far below the previous record set in 1956. Average temperatures for June through August were over 2 °F above the previous Texas record and were close to the warmest statewide summer temperatures ever recorded in the United States.

As the drought intensified, the previous year's relatively lush growth dried out, setting the stage for spring wildfires. Conditions were so dry during the spring planting season across much of the state that many crops never emerged from the ground. Continued dry weather through the summer led to increasing hardship for ranchers, who generally saw very little warm-season grass growth while stock tanks dried up. The record warm weather during the summer in Texas was primarily a consequence of the lack of rainfall, but the heat and resulting evaporation further depleted streamflow and reservoir levels. By early fall, trees in central and eastern Texas were showing widespread mortality and dry and windy conditions allowed forest fires to burn intensely and spread rapidly in Bastrop and elsewhere.

Twelve-month rainfall was driest on record across much of western, central, and southern Texas, and many stations received less than 25% of their normal 12-month precipitation. The area near, north, and east of Dallas was comparatively well off compared to the rest of the state, but still endured serious drought conditions and record heat.

This drought has been the most intense one-year drought in Texas since at least 1895 when statewide weather records begin, and though it is difficult to compare droughts of different durations, it probably already ranks among the five worst droughts overall. The statewide drought index value has surpassed all previous values, and it has been at least forty years since anything close to the severity of the present drought has been experienced across Texas.

Because of the return of La Niña conditions in the tropical Pacific, a second year of drought in Texas is likely, which will result in continued drawdown of water supplies. Whether the drought will end after two years or last three years or beyond is impossible to predict with any certainty, but what is known is that Texas is in a period of enhanced drought susceptibility due to global ocean temperature patterns and has been since at least the year 2000. The good news is that these global patterns tend to reverse themselves over time, probably leading to an extended period of wetter weather for Texas, though this may not happen for another three to fifteen years. Looking into the distant future, the safest bet is that global temperatures will continue to increase, causing Texas droughts to be warmer and more strongly affected by evaporation.

About the Texas State Climatologist

The Office of the State Climatologist, Texas, is housed in the Department of Atmospheric Sciences, College of Geosciences, Texas A&M University. The OSC has been designated an AASC-Recognized State Climate Office (ARSCO) by the American Association of State Climatologists. The mission of the OSC is to enable the State of Texas and its citizens make best possible use of climate data and outlooks, to monitor and document climate events and conditions across the state, to conduct climate research with direct benefit to Texans, and to serve as a local point person for NOAA and other federal agencies with regards to Texas climate. The OSC posts reports and real-time climate monitoring information on its web site (http://atmo.tamu.edu/osc, soon to be upgraded to http://climatexas.tamu.edu) and houses an archive of Texas climate-related publications.

The Texas State Climatologist is nominated by the President of Texas A&M University and appointed by the Governor of Texas. John Nielsen-Gammon has served as the Texas State Climatologist since the year 2000. He received his Ph.D. in Meteorology from the Massachusetts Institute of Technology in 1990 and joined the faculty of Texas A&M University in 1991. Nielsen-Gammon is a Fellow of the American Meteorological Society and Past President of the International Commission for Dynamical Meteorology. His climate-related research focuses on regional drought causes and regional drought and climate monitoring, and he has also played a key role in understanding the meteorological conditions contributing to high concentrations of ozone in the Houston area. The Houston Chronicle hosts his blog on weather and climate issues called Climate Abyss.

The Texas State Climatologist is a designated member of the Texas Drought Preparedness Council.

Table of Contents

1) Introduction

Drought is a condition of hardship due to lack of water caused by unusual meteorological conditions. Drought affects both society and the natural environment. Society attempts to use water to maximum benefit, and hardship results when insufficient water is available for the normal types and amounts of water uses. Natural ecosystems have adapted to the occasional occurrence of drought, though human interactions with the environment have sometimes reduced natural resilience.

The severity of a drought depends on its intensity and duration. Differences in drought duration make it difficult to compare various droughts. A short-term drought, one lasting less than six months or so, will have a large impact on the agricultural industry but cause relatively few water supply problems. In contrast, a long-lasting drought of low intensity may have relatively little agricultural impact but may cause major problems for water suppliers due to steadily declining reservoir and aquifer levels.

As shown in this report, the 2011 drought in Texas has been unprecedented in its intensity. While the current period of below-normal rainfall has only lasted slightly more than a year, the lack of rainfall has been so profound that many water supplies throughout the state have been seriously affected. With the drought very likely to continue for at least several more months, wintertime replenishment of water supplies will generally be below normal and additional worsening of water supply conditions is likely in 2012.

This report considers the Texas portion of the 2011 drought. As of this writing, drought conditions extend almost continuously across the southern United States from Arizona to North Carolina and from parts of the Northern Plains into central Mexico (source: North American Drought Monitor). However, the exceptional drought conditions have disproportionally affected Texas and Oklahoma along with neighboring parts of New Mexico, Colorado, Kansas, Arkansas, Louisiana, and the country of Mexico.

For designing policy to mitigate the impacts of this or future droughts, it is essential to understand the present drought in a historical context. A drought so rare as to be unlikely to recur in the next thousand years might require a one-time intervention, while a drought likely to repeat itself within our lifetimes may require a greater emphasis on permanent mitigation or adaptation measures.

A second area of policy concern is the potential continuation of the present drought beyond the immediate future. While most water systems are designed for the drought of record, most have never actually had their infrastructure and water plans tested by the drought of record. It is not too late to consider the possibility that this drought may turn out to be worse than the drought of record and to take steps to prepare for that possibility.

This report focuses on the meteorological aspects of the 2011 Texas drought. The second section of this report describes the conditions leading up to the onset of the 2011 Texas drought. Section three illustrates how dry conditions developed across the state during fall of 2010 and winter, spring, summer, and early fall of 2011. The fourth section considers the 2011 drought's place in the meteorological record books on a statewide, climate division, and local scale. Finally, section five considers the outlook for the present and future droughts over the next year, the next decade, and beyond.

2) Setting the Stage: Rainfall Patterns through September 2010

During the past fifteen years, Texas has experienced a succession of droughts interspersed by relatively wet years. This period of frequent drought followed the wettest ten to twenty years in the Texas climate record (Nielsen-Gammon, 2011). Note: unless otherwise stated, all weather records quoted in this report are with respect to a period of record extending from 1895 to the present.

The drought of 1995-1996 broke the string of wet years and partly influenced major water planning legislation enacted in many states, including Texas. A brief drought in 1998 was followed by the drought of 1999-2002, which reached its peak in most of Texas with record-setting temperatures in early September 2000 but which lingered in far West Texas two more years. The 2005-2006 drought was widespread across most of Texas but never really achieved historical proportions. The 2007-2009 drought, on the other hand, was relatively localized when it reached its peak intensity in 2009, but for some locations in south-central and south Texas it may well have been the worst drought on record up to that point (Nielsen-Gammon and McRoberts, 2009).

This section and the next will evaluate rainfall shortages using a drought index called the Standardized Precipitation Index, or SPI. The SPI has become one of the most popular drought indices, in part because of its simplicity and flexibility. The SPI takes a particular value of accumulated precipitation (such as precipitation over the past six months) at a given location and rescales it based on the historical record of precipitation variability at that location. The result is an index value that is negative when present conditions fall into the drier half of expectations based on historical values and positive when present conditions fall into the wetter half of expectations. The more negative the SPI value, the more unusually dry the weather conditions. The following table shows some sample values of SPI and their interpretation. Note that assessments of actual drought severity should not be based exclusively on a single measure.

SPI range	*Expected frequency*	*Designation*
0.5 to -0.5	About 40% of the time	Near Normal
-0.5 to -0.7	About 10% of the time	Abnormally dry
-0.8 to -1.2	About 10% of the time	Moderate drought
-1.3 to -1.5	About 5% of the time	Severe drought
-1.6 to -1.9	About 3% of the time	Extreme drought
-2.0 to -2.5	About 1.5% of the time	Exceptional drought
Below -2.5	About 0.5% of the time	Exceptional drought

Table 1: Interpretation of various ranges of values of the Standardized Precipitation Index (SPI). Source: modified after http://droughtmonitor.unl.edu/classify.htm (accessed October 30, 2011).

SPI values below -2.5 are unlikely to have occurred previously on a given date in the historical record. SPI values below -3.0 have an expected return period for a given date of once every 1000 years in an unchanging climate, though the historical record is too brief to allow such low probabilities to be calculated with much accuracy.

This report presents SPI maps from the online archives of the Office of the State Climatologist, Texas (OSC). The maps are accessible through http://atmo.tamu.edu/osc/drought and the method of map generation is described in McRoberts and Nielsen-Gammon (2011b). The input data is the 4 km daily precipitation analysis produced by the National Weather Service's River Forecast Centers, calibrated using long-record stations in the Cooperative Observer Network. These maps provide an excellent guide to the distribution of drought conditions across Texas in space and time, but the quality of the maps is occasionally hampered by uncorrected errors in the radar estimation of precipitation. The color gray designates areas with insufficient radar coverage for accurate precipitation estimation.

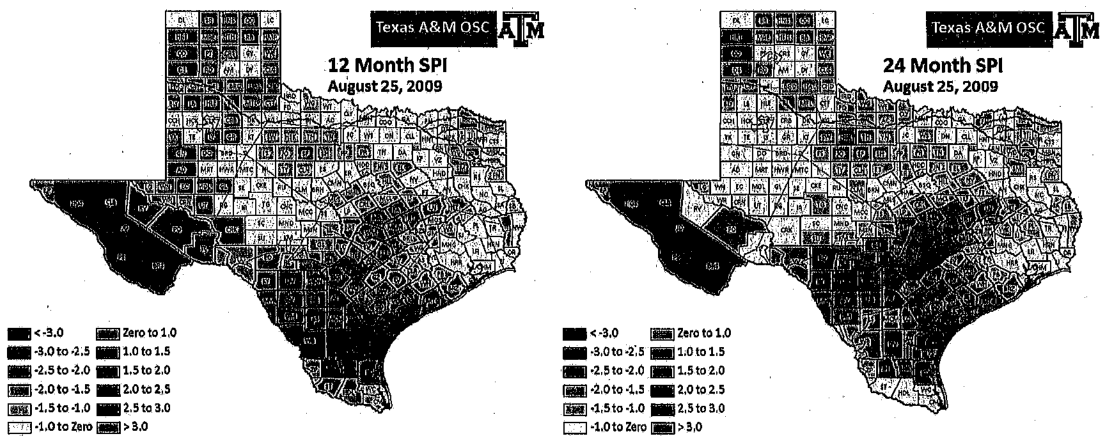


Figure 1: SPI values for accumulated precipitation over 12 months (left) and 24 months (right), at the height of severity of the 2007-2009 drought.

The 2007-2009 drought was most severe in south-central and south Texas (Fig. 1). The short-term dryness was most acute in the Coastal Bend area, where at least one county experienced a total failure of its cotton crop, while longer-term drought was most intense along and just southeast of the Balcones Escarpment in central and south-central Texas. Extreme drought conditions in the Lower Valley and east Texas were largely mitigated by the rainfall from hurricanes Dolly and Ike and tropical storm Edouard.

The distribution of drought in August 2009 is shown here for two reasons. First, it indicates which portions of the state were most seriously affected in 2007 and 2009 and which may not have recovered prior to the 2011 drought. Second, it provides a useful point of comparison by which to indicate the much greater severity of the 2011 drought.

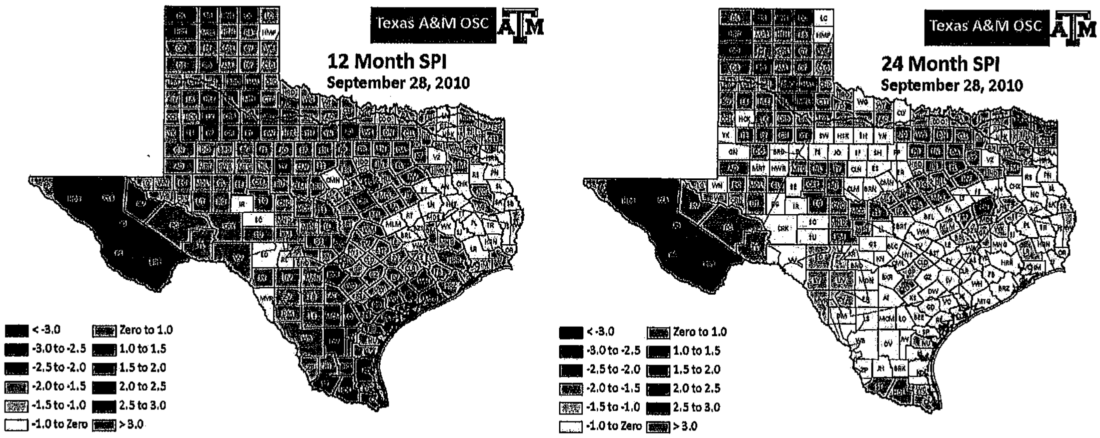


Figure 2: SPI values for accumulated precipitation over 12 months (left) and 24 months (right), just prior to the onset of the 2011 drought.

The date of onset of the 2011 drought can be stated with remarkable precision: September 27, 2011. On that date a storm system bringing widespread rain to Texas left the state. Though it could not be known at the time, twelve of the next thirteen months would bring below-normal precipitation to Texas.

The September 2010 conditions reflected a relatively wet winter, spring and summer, caused in part by an El Niño event in the tropical Pacific. Based on rainfall over the preceding 12 months, most of the state was above or near normal (Fig. 2), with the driest conditions found along the Louisiana border. When 2009 is factored in, the two-year accumulations averaged near-normal across the state, with the lowest two-year totals (compared to normal) found in scattered pockets in the southern and eastern portions of the state.

Parts of eastern Texas would rightfully take exception to the claim that the drought started at the end of September 2010. As Fig. 2 shows, moderate drought conditions already existed at both one-year and two-year time scales in Newton County, and other parts of eastern Texas had just finished a summer with below-normal rainfall and unusually little hay production. However, for the state as a whole, the end of September represents the "high water mark" prior to the onset of widespread drought conditions. In the U.S. Drought Monitor (http://droughtmonitor.unl.edu), only 2.4% of the state was classified as being in drought at the end of September.

3) Drier and Drier: Development of the 2011 Texas Drought

This section tells the story of the evolution of the 2011 Texas Drought to date using four separate SPI indices. The two-month SPI characterizes precipitation shortages (and excesses) for the two-month period ending on the date specified. This index is most useful for monitoring the month-to-month variations in rainfall and for characterizing short-term drought stress during the warmer parts of the year. The six-month SPI characterizes the rainfall amounts during the preceding half-year, and is most useful for characterizing shallow soil moisture available to agricultural crops and forage grasses. The twelve-month and 24-month SPI maps are most useful for characterizing precipitation on time scales relevant to the recharge of reservoirs and some aquifers, as well as deep soil moisture available to trees.

October 2010

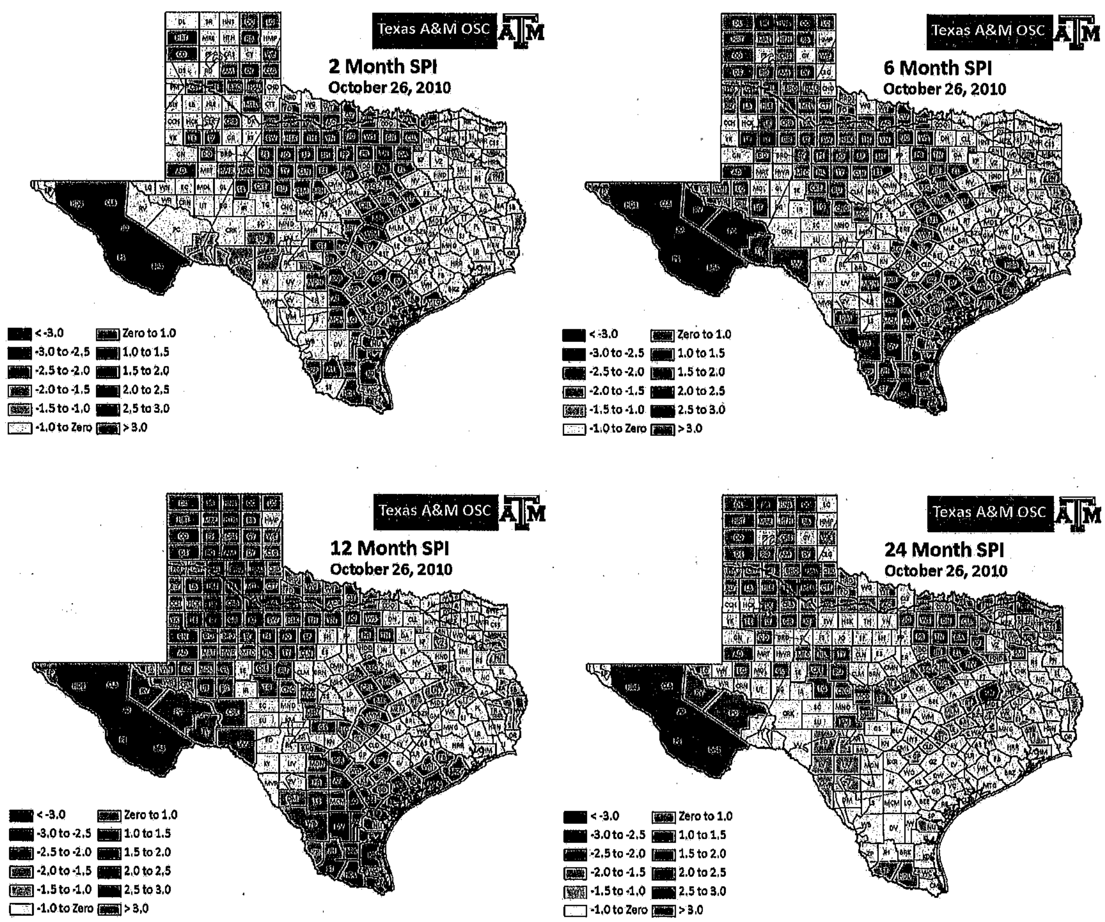


Figure 3: SPI drought index values as of October 26, 2010. The more negative values indicate more severe drought conditions.

Already by the end of October, the dry conditions in eastern Texas were becoming increasingly clear, as some rainfall events prior to the summer no longer contributed to the current SPI values. The two-month SPI reflected a combination of a wet September, with multiple tropical disturbances bringing rain to south Texas and the I-35 corridor, and an October that was eighth-driest on record for the state as a whole.

November 2010

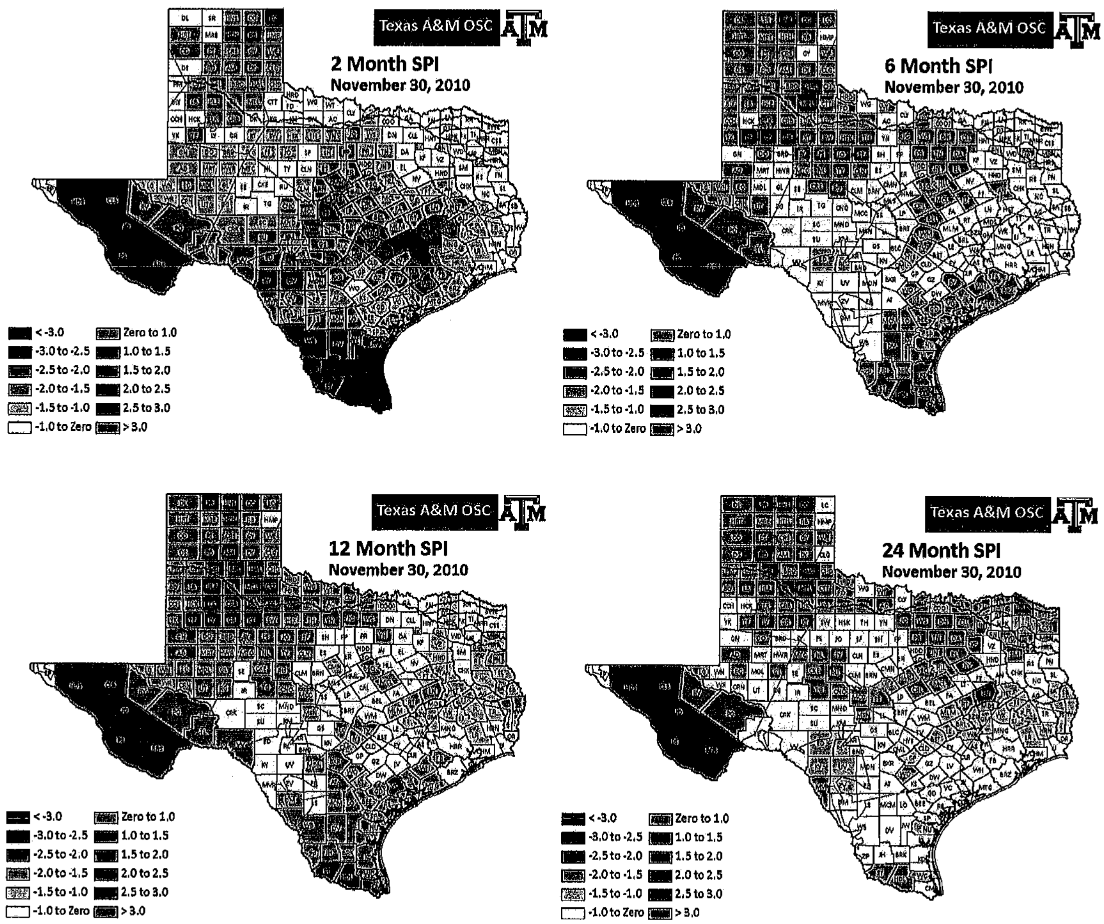


Figure 4: SPI drought index values as of November 30, 2010. The more negative values indicate more severe drought conditions.

At the end of November, the two-month SPI is based on two consecutive dry months, and Figure 4 shows that the fall dryness was exceptional in parts of central and south Texas. The Panhandle had actually received above-normal precipitation for the two-month period, due almost entirely to rain from a single storm system on the 11th and 12th of November.

December 2010

December was the third consecutive drier-than-normal month for Texas. The November 11-12 Panhandle rain event was all that kept the entire state from receiving below-normal precipitation for the November-December period. The three months of dry weather had thrown most of eastern Texas into drought conditions according to the six-month and 12-month SPI maps (Fig. 5). The year 2009 had been the 11th wettest on record for the East Texas climate division (#4), but the year 2010 was the 8th driest. The 12-month and 24-

month SPI maps in Fig. 5 indicates that 2010 was driest toward the Louisiana border, while 2009 was apparently wettest near the Oklahoma border. This left the southern half of the Louisiana border in drought conditions for all at all depicted time scales, based on the SPI.

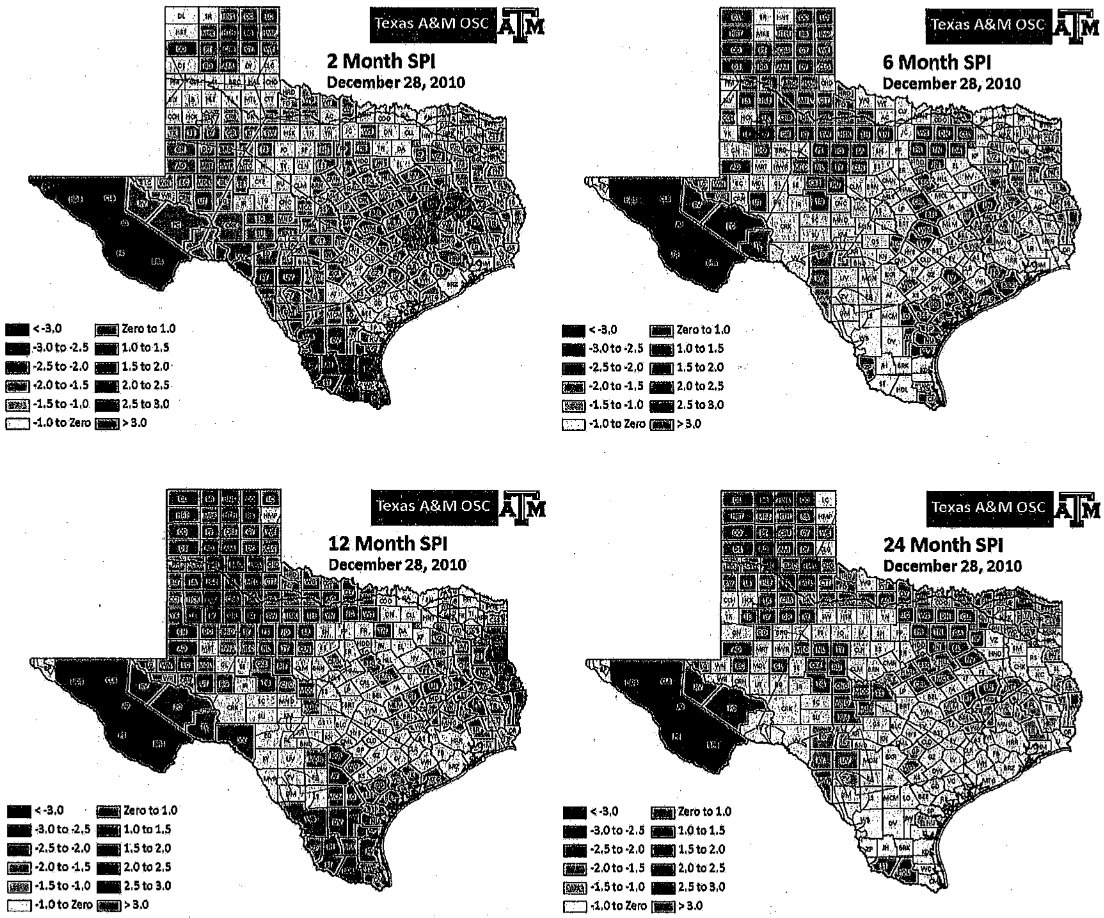


Figure 5: SPI drought index values as of December 28, 2010. The more negative values indicate more severe drought conditions.

Both short-term and long-term drought were also already present in east-central Texas, in an area centered on Bryan/College Station, and in the western Winter Garden area of southwestern Texas east of Del Rio. In the rest of the state, the wet summer was still substantially reducing the potential impact of the dry fall. However, the combination of a wet summer and dry fall provided substantial fuel for wild fires. Potential wildfire danger is indicated by those areas in which the two-month SPI is much drier than the six-month SPI.

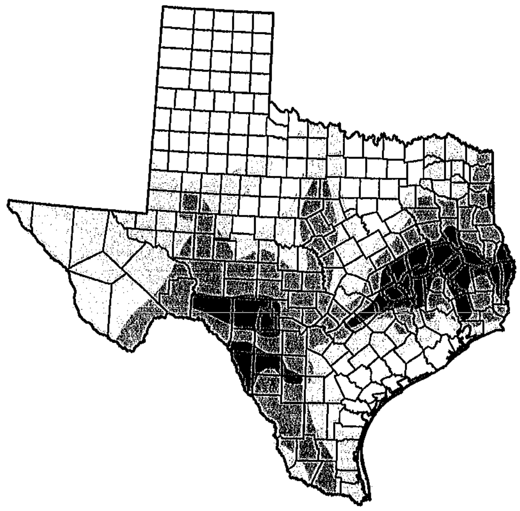
U.S. Drought Monitor

December 28, 2010
Valid 7 a.m. EST

Texas

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	7.89	92.11	69.43	37.46	9.59	0.00
Last Week (12/21/2010 map)	13.61	86.39	73.68	38.41	9.66	0.00
3 Months Ago (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
Start of Calendar Year (12/29/2009 map)	72.90	27.10	6.98	2.32	0.00	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (12/22/2009 map)	72.27	27.73	8.14	2.32	0.00	0.00



Intensity:

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

USDA National Drought Mitigation Center

Released Thursday, December 30, 2010
D. Miskus, CPC/NOAA

Figure 6: U.S. Drought Monitor for Texas for December 28, 2010. Available online at http://droughtmonitor.unl.edu.

Three months into what would become the 2011 drought, the U.S. Drought Monitor was indicating short-term drought across most of Texas (Figure 6). Already, 69.4% of the state was classified as being in at least moderate drought. However, exceptional drought had not yet made an appearance, and only 9.6% of the state was in extreme drought.

January 2011

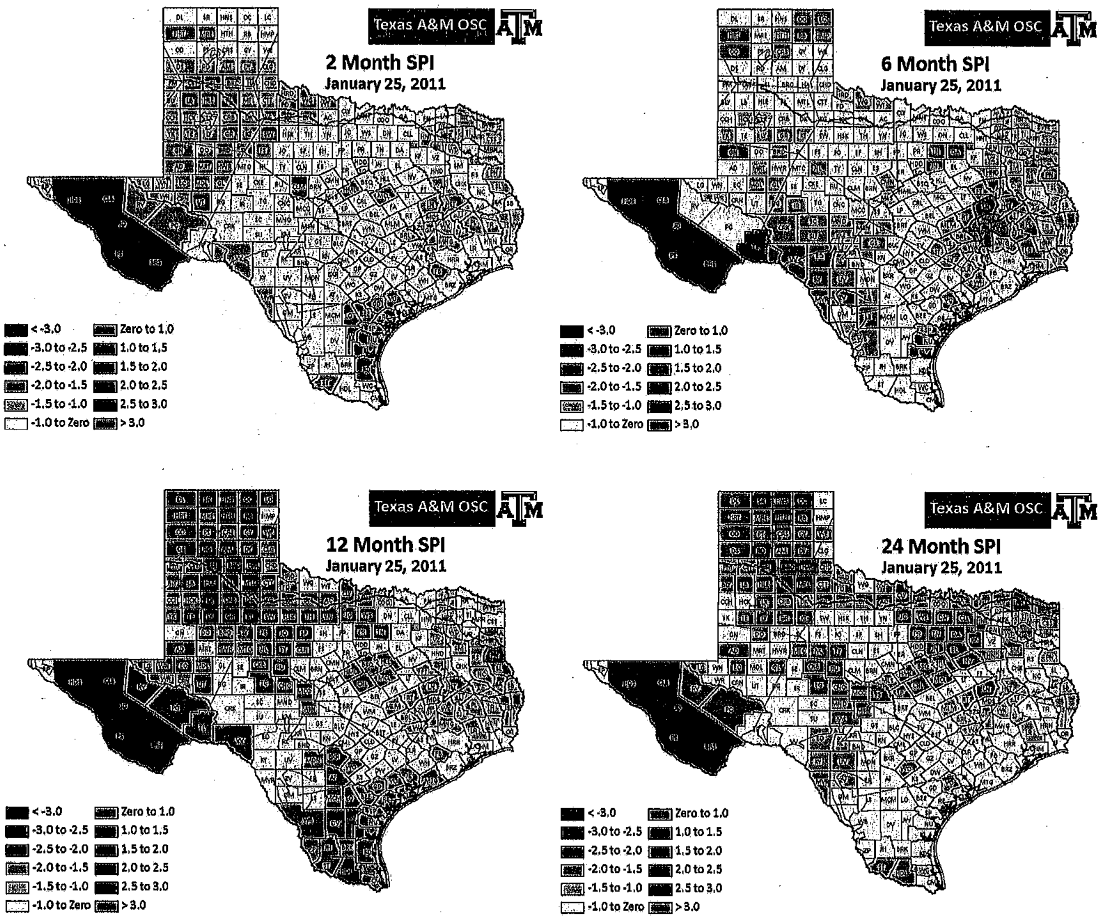


Figure 7: SPI drought index values as of January 25, 2011. The more negative values indicate more severe drought conditions.

January was the only month within the period in which statewide average rainfall (barely) exceeded its long-term average. The precipitation was sufficient to bring the two-month and six-month totals to above normal in the Coastal Bend area (Fig. 7); this rain was extremely beneficial for establishing suitable conditions for crop planting and seed germination. Most of the rest of the state also benefited temporarily from the rainfall (or, in northern Texas, snowfall). However, less than a tenth of an inch of precipitation was record in most of western Texas, and the lack of mid-season precipitation and snow cover would have serious implications for much of the winter wheat crop.

By the end of January, the area around Bryan/College Station had crossed into the exceptional drought threshold at the six-month accumulation period. However, environmental and societal water demands are minimal in that region during the wintertime, so the impacts of the drought were still far short of exceptional. Terrell County in southwest Texas had also crept into exceptional drought on the basis of six-month precipitation.

February 2011

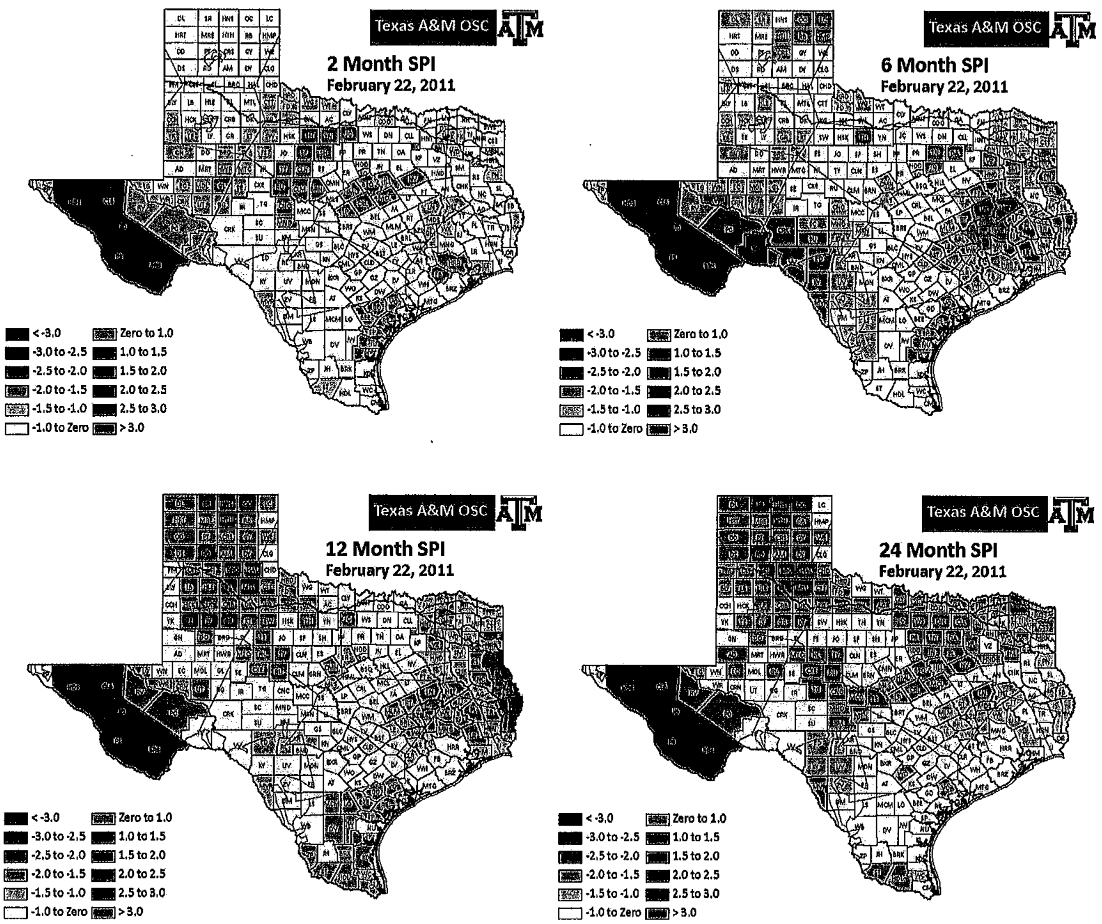


Figure 8: SPI drought index values as of February 22, 2011. The more negative values indicate more severe drought conditions.

February was again a dry month, but not exceptionally so. The SPI index maps (Fig. 8) showed little change from the end of January. At this point, six months into the drought, true drought conditions were present throughout east Texas, extending westward almost as far as Dallas, Austin, and Houston. Drought conditions also prevailed across southwestern Texas and parts of western and northern Texas as well. According to the U.S. Drought Monitor (not shown), the fraction of the state suffering under drought was about the same size as at the end of December.

March 2011

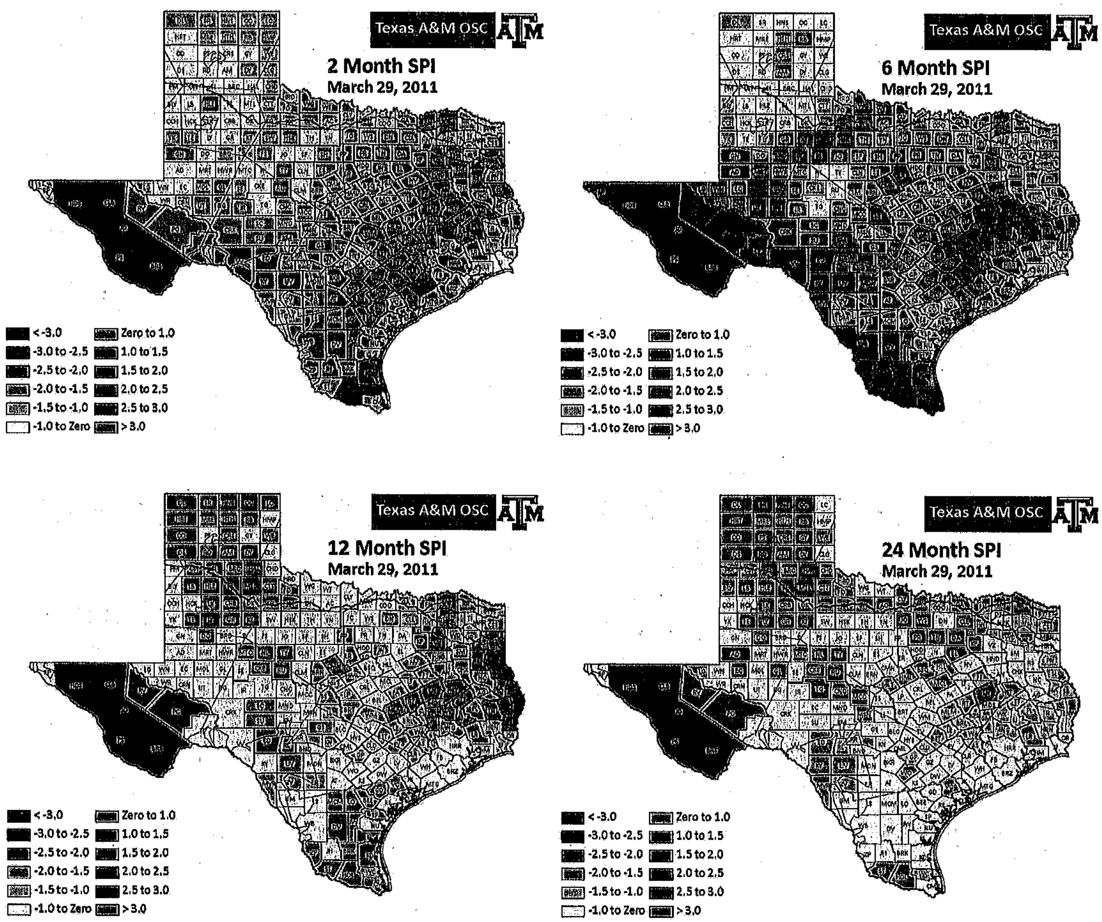


Figure 9: SPI drought index values as of March 29, 2011. The more negative values indicate more severe drought conditions.

While Texas was already in serious drought at the end of February 2011, the upcoming months were disastrous for farmers and ranchers. With ample rain beginning in March, the most serious drought impacts might have been limited to the winter wheat crop and excess winter feeding costs for ranchers.

Instead, the opposite happened. March 2011 was the driest March on record for the state of Texas as a whole. Below-normal precipitation for the February-March period occurred everywhere except parts of western Texas, where rainfall in February and March is normally light (Fig. 9).

The record dry March combined with the removal of September from the six-month precipitation accumulation period combined to allow the six-month SPI to depict terrible drought conditions across the state. Many counties in east-central, south, and west Texas had SPI values below -2.5, implying a lack of cool-season rainfall that was probably unprecedented in the historical record. The only portion of the state with positive SPI values at the six-month time scale were in the Panhandle, due to the storm back in November.

Aside from the Panhandle, the remarkable lack of rainfall combined with springtime warmth to dry out the previous year's growth of grasses. Because the previous growth season had been relatively wet, there was ample dry grass available to serve as fuel for wildfire, especially in central and western Texas where absolute precipitation amounts were smallest and winds tended to be stronger. By early April, wildfires were burning in many parts of western and west-central Texas.

U.S. Drought Monitor

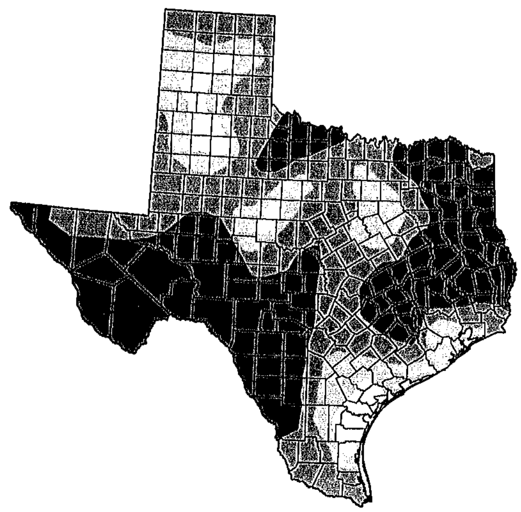
March 29, 2011
Valid 7 a.m. EST

Texas

Drought Conditions (Percent Area)	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	94.87	78.54	43.07	0.00
Last Week (03/22/2011 map)	1.70	98.30	92.05	64.06	28.98	0.00
3 Months Ago (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Calendar Year (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (03/23/2010 map)	96.51	3.49	0.00	0.00	0.00	0.00

Intensity:

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*



The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

Released Thursday, March 31, 2011
Eric Luebehusen, United States Department of Agriculture

Figure 10: U.S. Drought Monitor for Texas for March 29, 2011. Available online at http://droughtmonitor.unl.edu.

The U.S. Drought Monitor indicated dry conditions throughout Texas at the end of March 2011 (Fig. 10). More significantly, over 43% of the state was classified as D3, extreme drought, the second most severe drought category. The Drought Monitor began 2000, and in its existence only two weeks during August 2006 had a greater portion of Texas in extreme or exceptional drought. That record would be broken during the first week of April 2011. The record for the greatest percentage of Texas in severe or worse drought would be broken during the third week of April, as would the record for the greatest percentage of Texas in at least moderate drought when the entire state was so designated. The record for the greatest percentage of Texas in exceptional drought would be broken during the fourth week of April.

So according to the U.S. Drought Monitor, the 2011 Texas drought was already in April the most severe Texas drought in recent memory.

April 2011

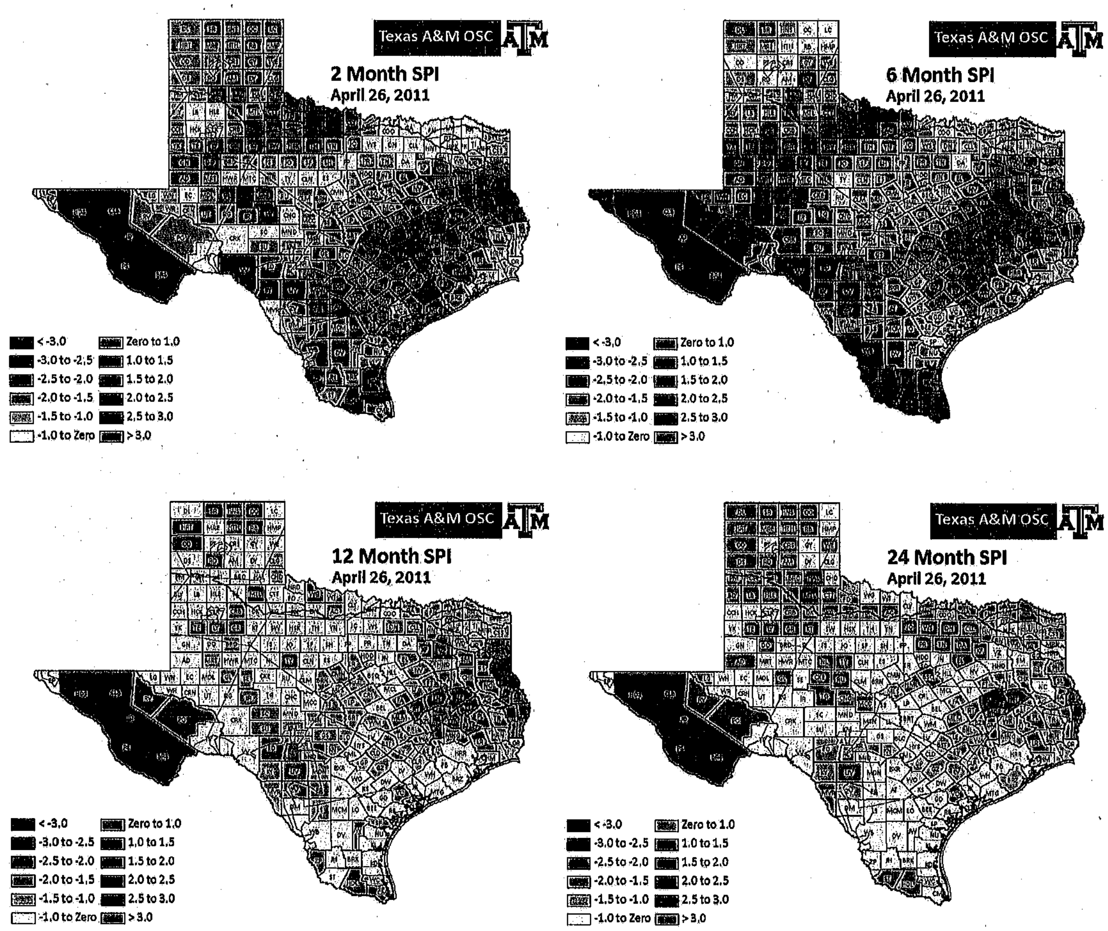


Figure 11: SPI drought index values as of April 26, 2011. The more negative values indicate more severe drought conditions.

The dry weather continued in April, and the SPI index values tracked with the U.S. Drought Monitor in showing worsening conditions (Fig. 11). The two-month SPI shows that only the very northeastern top of Texas received more precipitation than the historical norm. Elsewhere, precipitation was well-below normal, providing insufficient moisture for development of warm-season dryland crops and initiation of warm-season forage growth.

Besides east-central, south, and west Texas, a new area of especially dry conditions emerged in west-central Texas, extending from the Midland-Lubbock area to the Red River between Childress and Wichita Falls. In all but a handful of counties, the wet weather at the beginning of the preceding twelve-month period was overshadowed by the more recent dry weather.

May 2011

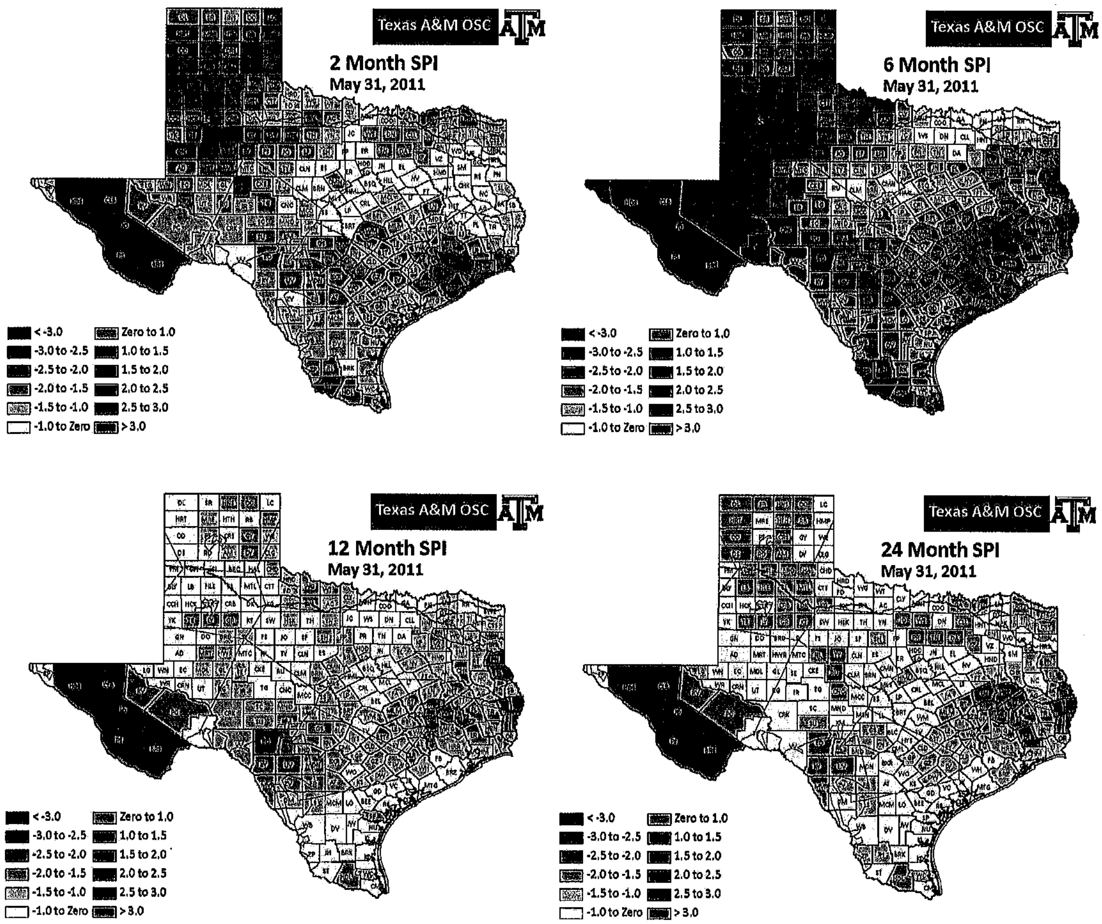


Figure 12: SPI drought index values as of May 31, 2011. The more negative values indicate more severe drought conditions.

Statewide, May averages more precipitation than any other month. May 2011 turned out to be the ninth-driest May on record, and the three-month period from March through May was the driest March-May on record. For all of the state except parts of north-central and northeast Texas, the dry March-May, on the heels of an already dry winter, guaranteed very low to nonexistent dryland crop yields for the 2011 growing season, irrespective of potential future rainfall. In the drier areas, warm-season forage had yet to emerge.

The wetter conditions in northeast Texas were on the edge of a region of flood-producing rainfall extending from eastern Oklahoma and Arkansas northeastward into the Ohio River Valley. In general, if one region of the country is unusually dry, another region will be unusually wet, so the floods can be thought of as being caused by the same set of circumstances that produced the 2011 Texas drought as of the end of April.

With the November Panhandle storm no longer part of the six-month accumulation period, the six-month SPI (Fig. 12) showed a remarkably broad area of -3.0 or worse drought across much of western Texas. This part of Texas is normally dry during the wintertime, but the rains become more plentiful during May as squall lines and severe thunderstorms typically form along the dryline. In 2010-2011, many areas had received less than 10% of even their meager normal rainfall and a large swath of the state west of Midland had not received any measurable precipitation whatsoever during December through May.

June 2011

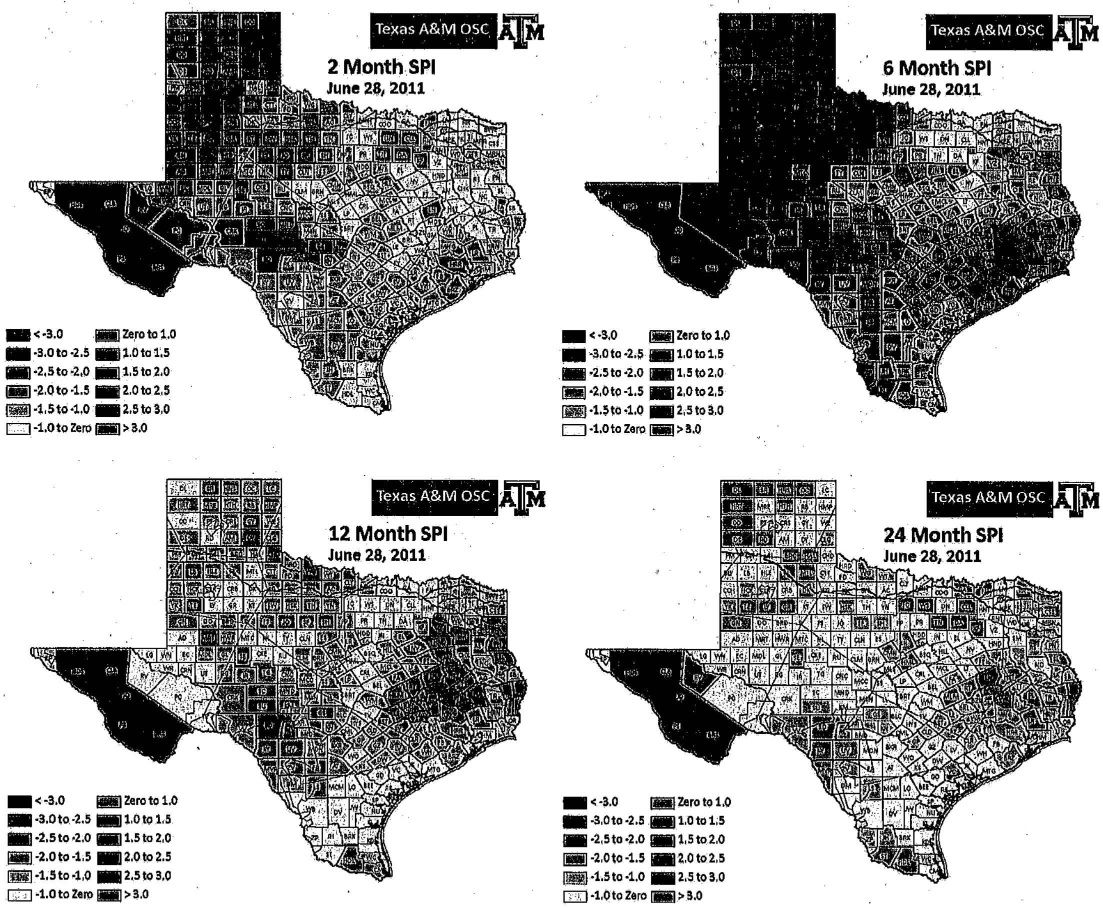


Figure 13: SPI drought index values as of June 28, 2011. The more negative values indicate more severe drought conditions.

The near-total absence of dryline thunderstorm activity continued through June (Fig. 13). Thus the Panhandle, which had benefited from a November storm that missed the rest of the state, now suffered through spring weather not merely much drier than normal, but much drier than any previous record. In the High Plains climate division (#1), May-June precipitation averaged 0.57", roughly 8% of the long-term average for those two months and less than half of the previous record set in 1999, and the 1.63" average for the first six months of the year was likewise less than half the previous record set in 1954. Most counties west of a San Angelo-Wichita Falls line had six-month SPI values below -3.0, indicating an agricultural drought far worse than anything previously experienced in the area.

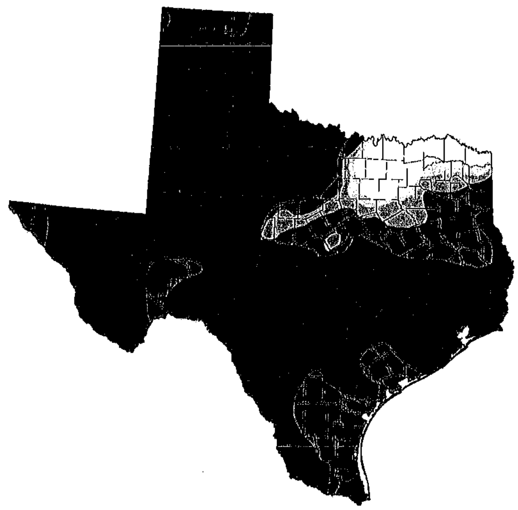
Despite the particular severity of the drought there, West Texas received little attention because the drought was extremely bad elsewhere too. Most of the area within 75 miles of Interstate 10, from the western border to the eastern border, had six-month SPI values below -2.0, and the timing seemed designed to produce maximum impact on ranchers. In most of the state, warm-season grasses were still very slow to develop, and stock tanks and stream flows were rapidly declining because of the lack of precipitation combined with the excessive heat.

U.S. Drought Monitor Texas

June 28, 2011
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	2.68	97.32	95.71	94.52	90.62	72.32
Last Week (06/21/2011 map)	3.33	96.67	95.71	94.52	91.31	70.61
3 Months Ago (03/29/2011 map)	0.00	100.00	94.87	78.54	43.07	0.00
Start of Calendar Year (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (06/22/2010 map)	51.78	48.22	13.00	0.00	0.00	0.00



Intensity:
- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://drought.unl.edu/dm

USDA

Released Thursday, June 30, 2011
Richard Heim/Liz Love-Brotak, NOAA/NESDIS/NCDC

Figure 14: U.S. Drought Monitor for Texas for June 28, 2011. Available online at http://droughtmonitor.unl.edu.

Because the more recent lack of rainfall had occurred at precisely the time of year when rain was most needed, the U.S. Drought Monitor showed that drought conditions had rapidly worsened during the three months ending June 2011 (Fig. 14). Three months before, 43% of the state had been in extreme drought; by the end of June, 72% of the state was depicted as being in exceptional drought. The only portion of the state not shown as abnormally dry was the region near and north of Dallas, where several counties had received adequate rain during May and June.

Amplifying the severity of the drought was the excessive heat that had developed across the state. June was the warmest June on record and the fourth warmest month on record up to that point. Unusually warm weather is common during summertime droughts in Texas, because the lack of available soil moisture causes almost all of the energy in the Sun's rays to go into heating up the ground and the adjoining air. The high temperatures in turn produce greater drought stress in most plants and accelerate evaporation from streams, reservoirs, and stock tanks.

July 2011

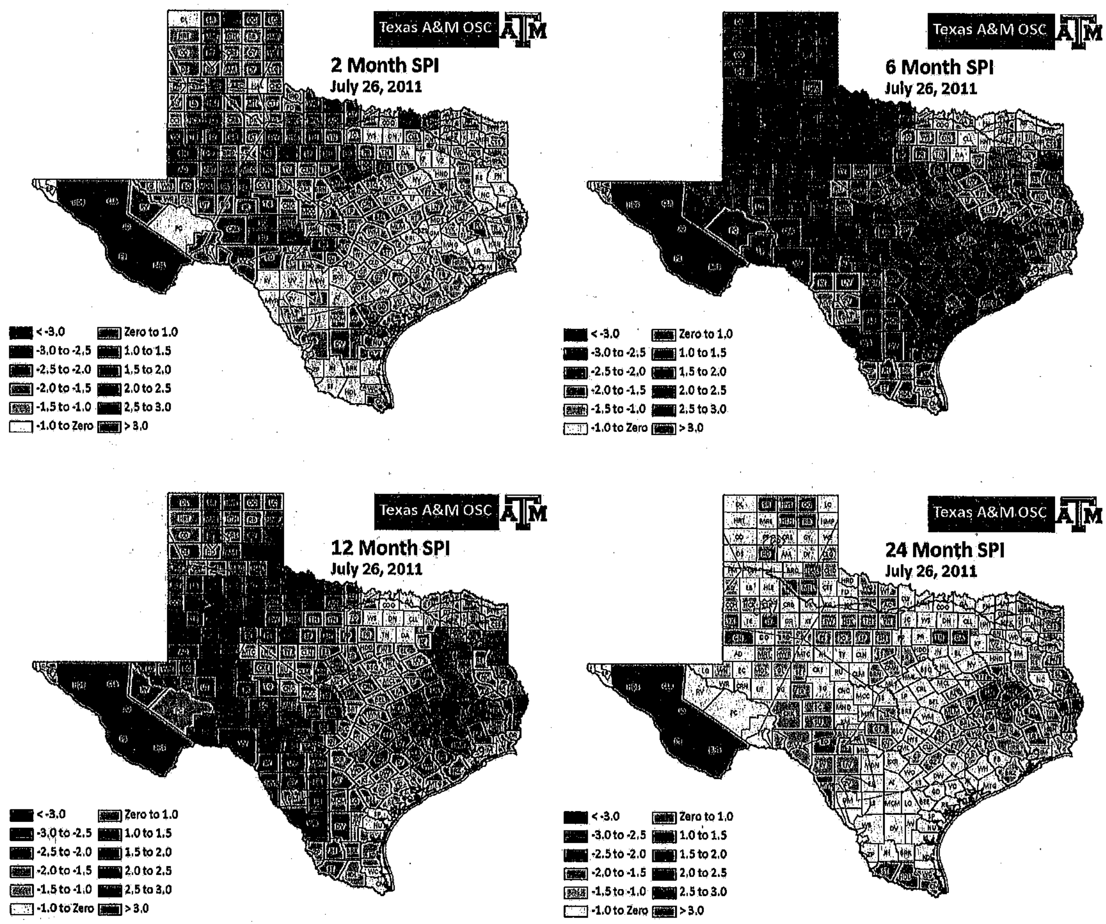


Figure 15: SPI drought index values as of July 26, 2011. The more negative values indicate more severe drought conditions.

The dry weather continued into July, which was the third driest July on record despite the occurrence of a landfalling tropical depression (Don). The six-month SPI (Fig. 15) showed that extremely severe drought conditions (SPI < -2.5) had spread from west Texas across the Edwards Plateau into central and south-central Texas. With rains during June and July 2010 now a distant memory, the twelve-month SPI had plummeted, with SPI values below -2.5 in many parts of the state.

At the same time, temperatures continued to set records. July was not just the warmest July on record for Texas but the warmest month ever in the state. Records for days with triple-digit temperatures began to be threatened.

The prolonged dry and hot weather had also begun to have a serious impact on trees. Normally, trees are able to tolerate short-term drought because their root systems penetrate deeper into the soil. By the end of July, twelve months of remarkably dry and hot weather across central and eastern Texas had caused even deep soil moisture to become seriously depleted.

August 2011

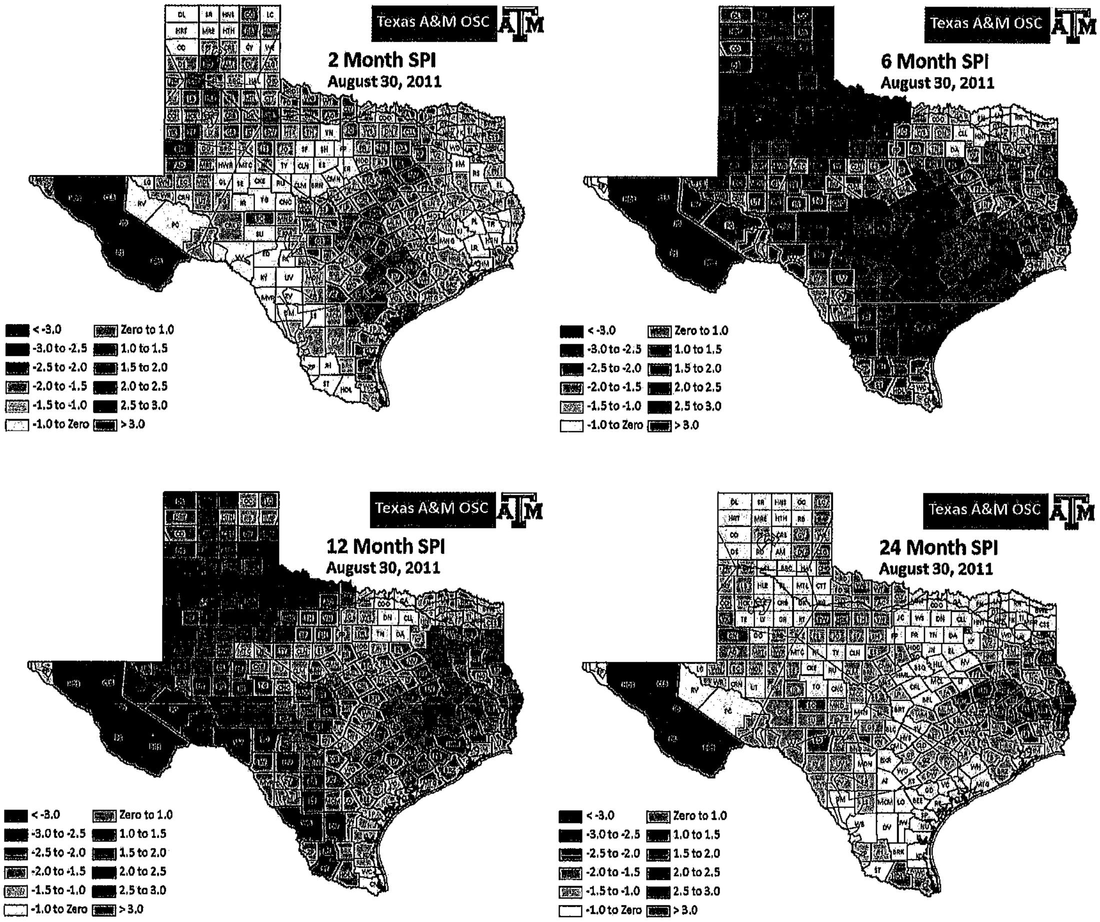


Figure 16: SPI drought index values as of August 30, 2011. The more negative values indicate more severe drought conditions.

In August, scattered rains in parts of west Texas had reduced the severity of drought conditions in some areas, but elsewhere conditions worsened (Fig. 16). The two-month SPI indicated that July and August had been especially dry almost precisely where the previous summer's rainfall had been most beneficial: along a line from Corpus Christi through Austin and nearly to Dallas. Over the six months from March through August, rainfall in that area was so small that the six-month SPI was below -3.0, and similar conditions were found near Houston, in much of the Hill Country, and almost the entire region north and west of Abilene.

The record for warmest month in Texas, set during July, was surpassed by more than one degree Fahrenheit in August. The combined June-August temperatures were in a statistical dead heat with those of Oklahoma, but both states shattered the previous record for warmest June-August, set by Oklahoma in 1934.

September 2011

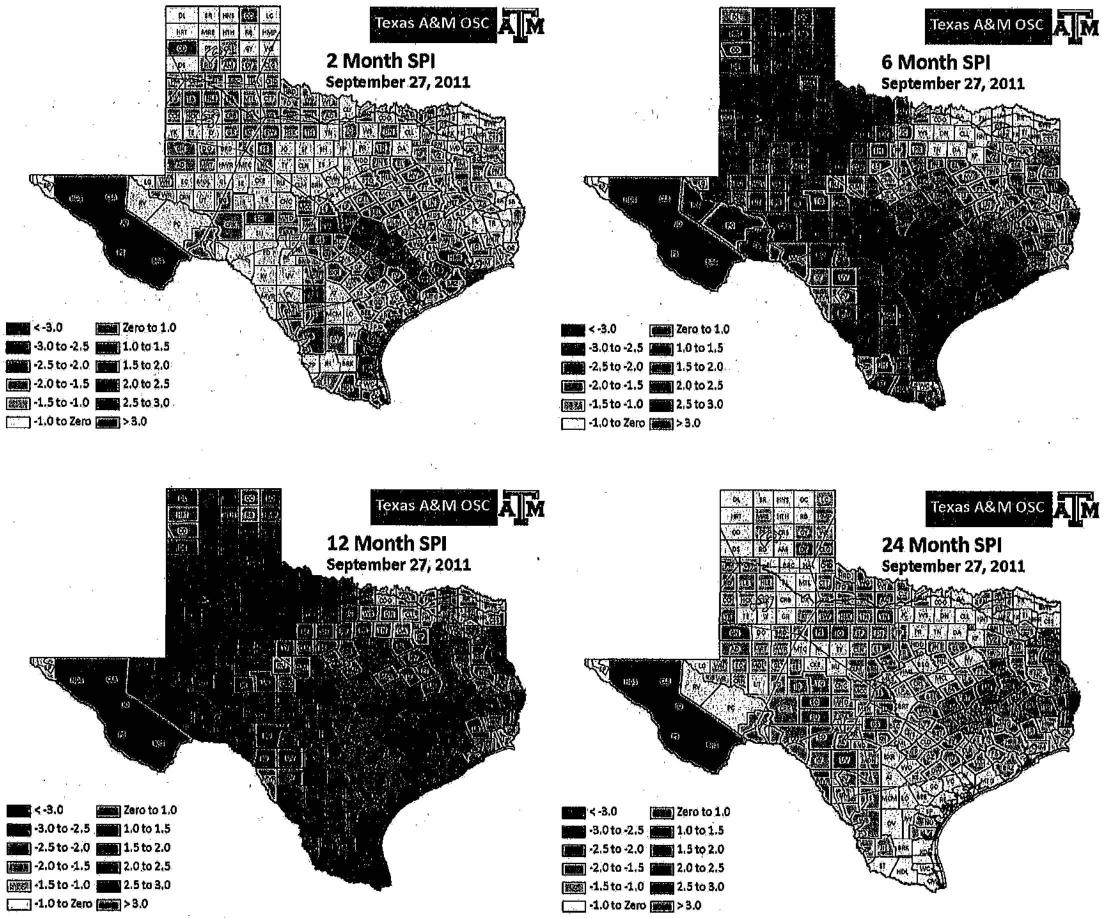


Figure 17: SPI drought index values as of September 27, 2011. The more negative values indicate more severe drought conditions.

The continued record warm and dry weather had caused most Texas forests to become extremely dry, and the near approach of Tropical Storm Lee, making landfall in Louisiana, provided the high winds necessary to produce a widespread outbreak of rapidly-growing forest fires. The most well-known of this group was the Bastrop Fire Complex, but other fires burned large areas of timber and some homes in northeast Texas and northwest of Houston.

By the end of September, the drought was one year old, and the twelve consecutive months of precipitation from October 2010 through September 2011 were the driest twelve consecutive months on record for the state. Texas averaged slightly more than 11" for the twelve months, much less than the 27" average value and roughly 2.5" less than the previous 12-month record set during the 1950s drought. The dry statewide conditions are reflected in the twelve-month SPI map (Fig. 17), which depicts most of the state at -2.5 or below and only a few corners of the state with SPI values better than -1.5.

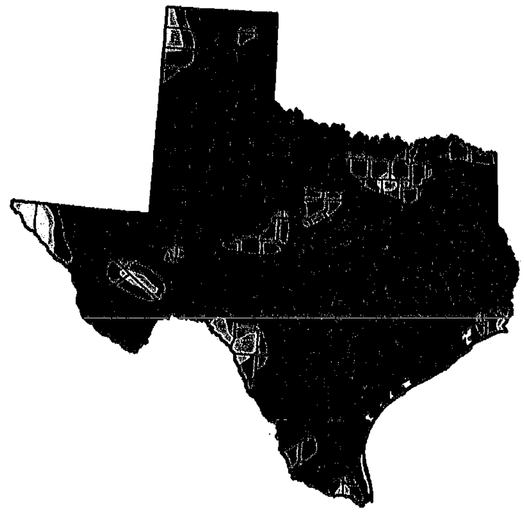
U.S. Drought Monitor

September 27, 2011
Valid 7 a.m. EST

Texas

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	99.16	96.65	85.75
Last Week (09/20/2011 map)	0.00	100.00	100.00	99.03	96.10	85.43
3 Months Ago (06/28/2011 map)	2.68	97.32	95.71	94.52	90.62	72.32
Start of Calendar Year (12/28/2010 map)	7.89	92.11	69.43	37.46	9.59	0.00
Start of Water Year (09/28/2010 map)	75.57	24.43	2.43	0.99	0.00	0.00
One Year Ago (09/21/2010 map)	77.29	22.71	3.34	0.97	0.00	0.00



Intensity:

- *D0 Abnormally Dry*
- *D1 Drought - Moderate*
- *D2 Drought - Severe*
- *D3 Drought - Extreme*
- *D4 Drought - Exceptional*

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

http://droughtmonitor.unl.edu

USDA

Released Thursday, September 29, 2011
Michael Brewer, National Climatic Data Center, NOAA

Figure 18: U.S. Drought Monitor for Texas for September 27, 2011. Available online at http://droughtmonitor.unl.edu.

The U.S. Drought Monitor map for October 4, 2011 (Fig. 18) depicts the most severe drought conditions yet experienced in Texas as of this writing. Only 3% of the state was not classified in at least extreme drought, and almost 88% of Texas was classified as exceptional drought. If the U.S. Drought Monitor depicted conditions corresponding to D5 or D6, they would probably be widespread across Texas.

October 2011

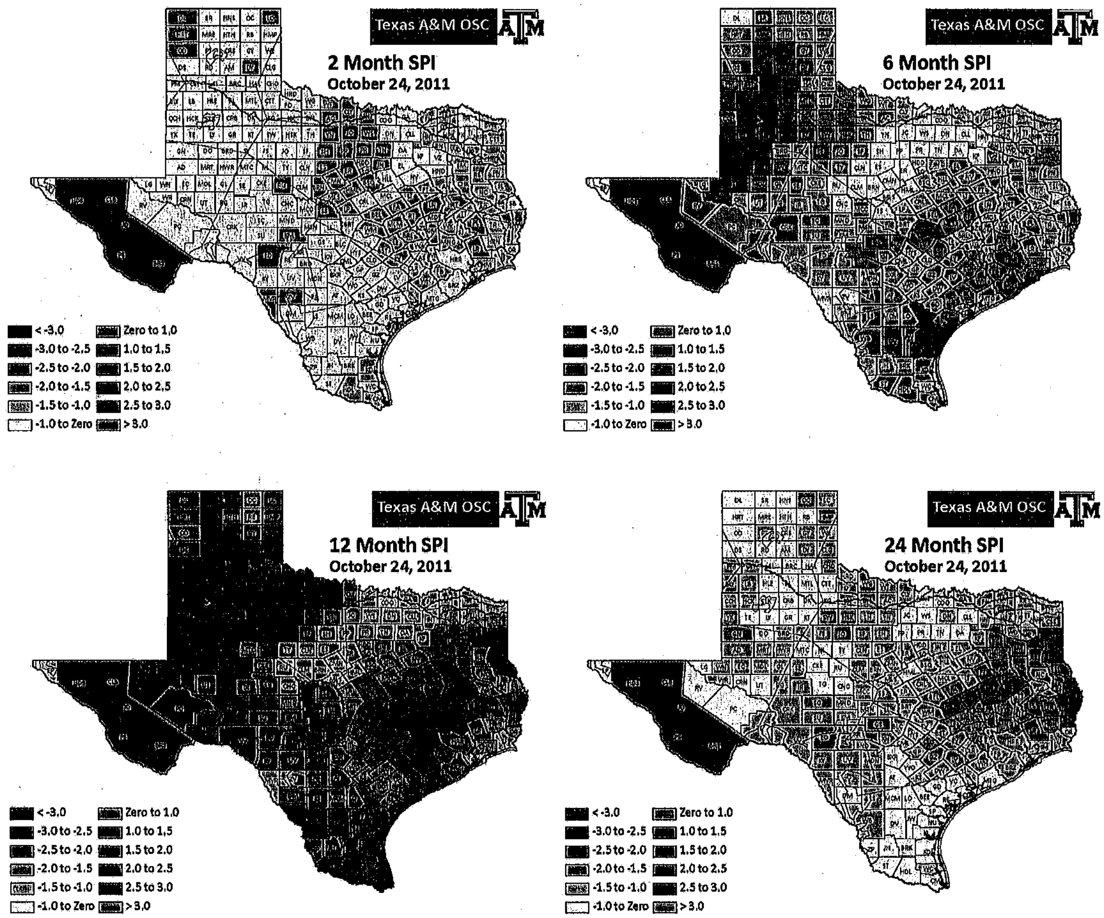


Figure 19: SPI drought index values as of September , 2011. The more negative values indicate more severe drought conditions.

It appears that October will yet again be another month with below-normal precipitation for Texas, despite an early October rain event that brought over 6" of rainfall to parts of the state. The rain alleviated much of the shorter-term dry conditions in central Texas, but twelve-month rainfall deficits continued to be daunting.

As the drought continues, longer-term rainfall shortages begin to emerge. Twelve counties in eastern Texas are below -2.5 on the 24-month SPI map (Fig. 19), including one county along the Louisiana border below -3.0. This implies long-term issues for streamflow and reservoir levels in eastern Texas. In west and central Texas where other reservoirs are at or near historic lows, the magnitude of the lack of rainfall during the past year is extreme, but two-year rainfall totals there generally fall within the -1.0 to -1.5 range, much less unusual than in eastern Texas where almost no values are between -1.0 to -1.5.

4) Historical Perspective

Temperatures

The June-August average temperature across Texas was roughly 2.5 °F warmer than any previous Texas summer and over 5 °F above the long-term average. The public's attention was captured by the unusually high number of days reaching or exceeding 100 °F.

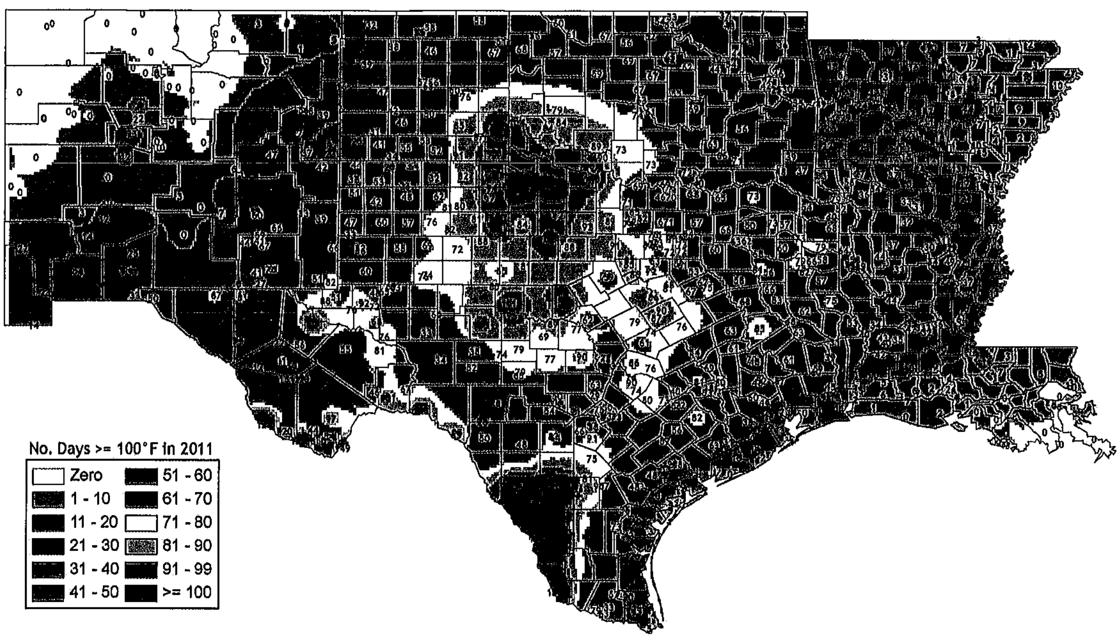


Figure 20: Number of days with maximum temperatures equaling or exceeding 100 °F in calendar year 2011 (through October 17, 2011). Graphic created by Brent McRoberts, Office of the State Climatologist, from Applied Climate Information System data.

Assuming no further 100 F days, the final tally for stations in the south-central United States is shown in Fig. 20. Note that the interpolation does not take into account topographic features, so the analysis will misrepresent the actual pattern in regions of large topographic relief such as far west Texas.

Many parts of the state achieved the "double-triple": at least 100 days of at least 100 degrees. Such areas include a large portion of south Texas surrounding Laredo, parts of north Texas near and west of Wichita Falls, and stations along the Rio Grande upstream at least as far as Big Bend. Much easier to count are the four stations that did not have a single day reach 100 F: two of them are along the Gulf Coast, while the other two are in far west Texas at altitudes exceeding 5000' above sea level.

According to my preliminary analysis, most of the excess summer heat was a direct consequence of the lack of rainfall prior to and during the summer. When there is little water available for evaporation, most of the energy from sunlight goes into heating the ground and the overlying atmosphere. Based on a statistical analysis of past summers, each inch of rainfall below normal in Texas is associated with summertime temperatures at least half a degree warmer.

Gauge-Based Precipitation

The SPI analysis in the preceding section is based on National Weather Service precipitation analyses that use radar estimates of precipitation as a starting point and a statistical analysis of regional precipitation records. A much more direct assessment of drought severity may be made by directly analyzing the long-term climate records from the United States Historical Climatology Network, Version 2 (USHCNv2).

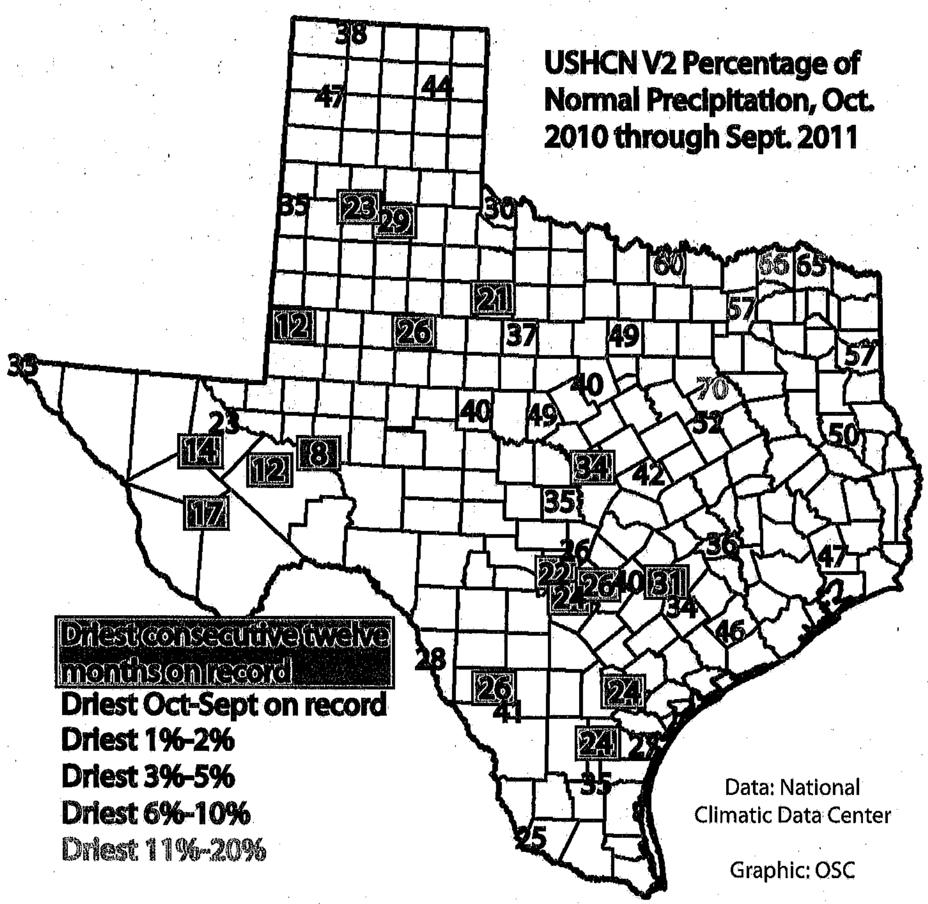


Figure 21: Percentage of normal precipitation for the 12-month period October 2010 through September 2011, as observed by the USHCNv2 station network. An additional station (Nacogdoches) has been added to fill a gap in the distribution of stations in eastern Texas. The colors indicate the ranking of the observed precipitation relative to previous October-September periods or, for exceptionally dry stations, all previous twelve consecutive month periods regardless of starting month.

Figure 21 shows that, across much of western and south-central Texas, the twelve-month period ending in September 2011 was the driest twelve consecutive months on record. About one-third of all Texas USHCNv2 stations set their all-time twelve-month record, and over half of the stations experienced their driest October-September on record. The lowest measurement was a remarkable 8% of normal at the McCamey USHCNv2 station. It was as though McCamey received one month of rainfall instead of one year of rainfall.

The twelve months were among the driest five percent throughout the state except for parts of Texas near, north, and east of Dallas. Though the lack of precipitation near Dallas was not as extreme as in the rest of the state, Dallas was forced to suffer through the exceptionally high temperatures caused by the dryness across the rest of the state, exacerbating evaporative stresses on plants and water supplies.

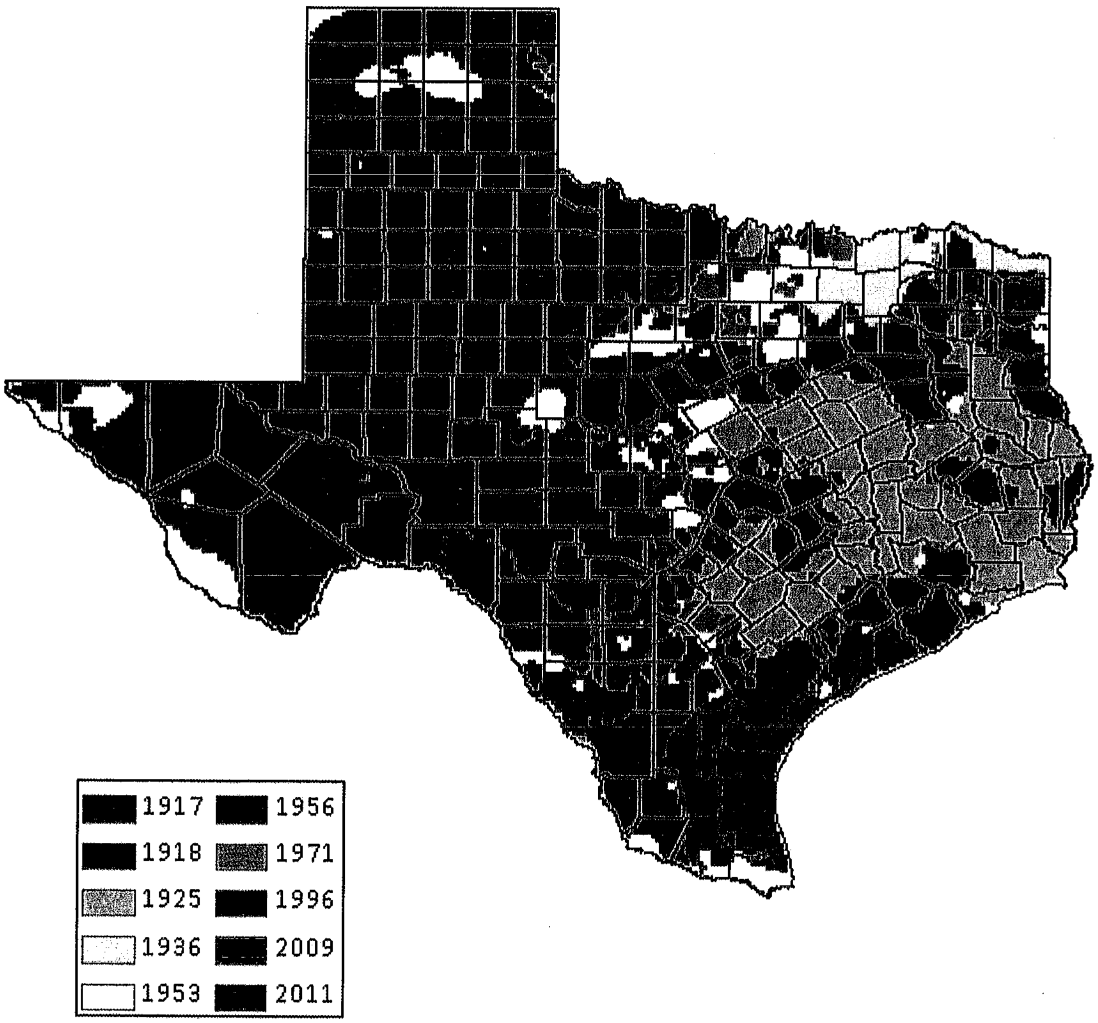


Figure 22: Year experiencing the lowest percentage of normal precipitation for the period prior to and during the growing season, defined here as the nine-month period ending June, July, or August, based on spatial analysis of Cooperative Observer Network data. Only the ten years having the greatest coverage are indicated. Only the 100 years since 1911 are analyzed.

Figure 22 provides another perspective on the drought in an historical context, by showing which year out of the past 100 experienced the smallest percentage of normal precipitation prior to and during the growing season. For most of the state, 2011 had the driest growing season conditions, as indicated by the pink shading. The year 2011 was worst for almost every location in the western half of Texas, as well as for many locations in central, south, southeast, and northeast Texas. In many parts of central and east Texas, the 1925 drought surpassed the 2011 drought in short-term intensity. Elsewhere, record-setting years were 2009 in the Coastal Bend area, 1917 in parts of south Texas, 1956 in many parts of central Texas, and 1918 in parts of central and eastern Texas. Various other years establish the driest observed conditions in north-central and northeast Texas, where the current 2011 drought is not as severe as elsewhere.

Except for the Coastal Bend and parts of north-central and northeast Texas, most of the state has not experienced an agricultural drought as severe as this one for fifty-five years, and more than half of the state has never experienced a growing season drought so severe.

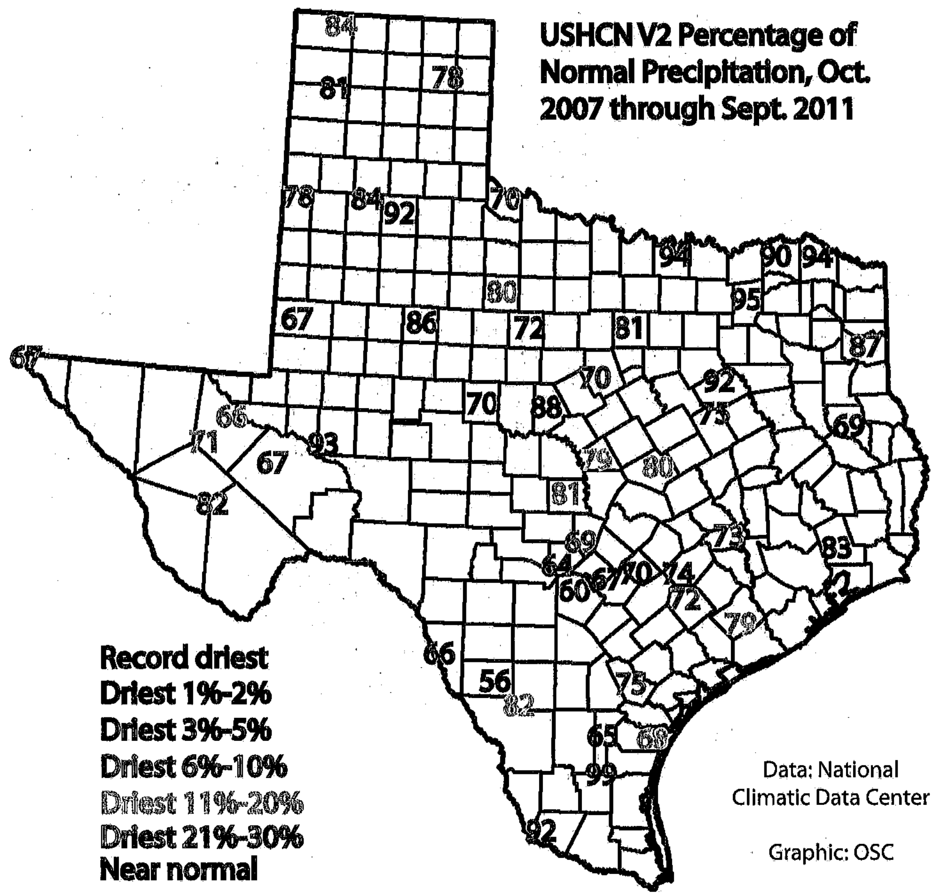


Figure 23: Percentage of normal precipitation for the 4-year period October 2007 through September 2011, as observed by the USHCNv2 station network. An additional station (Nacogdoches) has been added to fill a gap in the distribution of stations in eastern Texas. The colors indicate the ranking of the observed precipitation relative to previous October-September periods.

Though the drought has been most intense at time scales of one year or less, the lack of precipitation has been so extreme that the multi-year precipitation totals are also unusually dry. The four years since October 2007 includes a two-year drought (2008-2009) and a relatively wet year (2010) in addition to the current 2011 drought.

Figure 23 shows the four-year accumulated precipitation as a percentage of normal, color-coded as in Fig. 21. At a few stations in south and east Texas, the past four years has already been drier than any previous corresponding four-year period, including any such period during the drought of the 1950s. The current drought may well be considered to be worse than the 1950s drought in these areas.

Elsewhere, the long-term drought is least severe in northeast Texas, extreme south Texas, and parts of western Texas. In these locations, the lack of rain by itself doesn't imply a long-term water shortage, though the warm temperatures will have enhanced evaporation and made water available worse than the numbers in Fig. 23 would indicate.

Statewide Records

Because the drought was widespread throughout the state of Texas, its overall evolution and intensity is well represented by statewide average conditions. Table 2 shows the historical ranks of monthly statewide precipitation since the beginning of the drought. The statewide precipitation values represent area-weighted averages of values within each of the ten Texas climate divisions. Precipitation data are obtained from the National Climatic Data Center and are adjusted to correct for changes in network configuration (McRoberts and Nielsen-Gammon 2011a). The rankings indicate that a dry fall and winter was followed by an exceptionally dry spring and summer. October values are not yet in but will probably place the precipitation among the 40th to 50th driest Octobers. Note that precipitation values for August and September are preliminary and subject to change.

Month	*Ranking*
October 2010	8th driest
November 2010	29th driest
December 2010	14th driest
January 2011	47th wettest
February 2011	19th driest
March 2011	Record driest
April 2011	5th driest
May 2011	9th driest
June 2011	6th driest
July 2011	3rd driest
August 2011	6th driest
September 2011	7th driest

Table 2: Ranking of monthly precipitation among historical values, based on Texas statewide average precipitation.

When unusually dry months occur one after the other, multimonth precipitation records are likely to be broken. Tables 3-5 show records established for three-month, six-month, and nine-month periods.

Months	*Precipitation Amount (in.)*	*Ranking*
February-April 2011	1.80	Record driest
March-May 2011	2.66	Record driest
April-June 2011	3.39	2nd driest
May-July 2011	3.35	2nd driest
June-August 2011	2.48	Record driest
July-September 2011	2.54	2nd driest

Table 3: Ranking of three-month precipitation among historical values, based on Texas statewide average precipitation.

Months	*Precipitation Amount (in.)*	*Ranking*
November 2010-April 2011	5.20	2nd driest
February-July 2011	5.15	Record driest
March-August 2011	5.14	Record driest
April-September 2011	5.93	Record driest

Table 4: Ranking of six-month precipitation among historical values, based on Texas statewide average precipitation.

Months	*Precipitation Amount (in.)*	*Rank*
December 2010-August 2011	8.25	#1
November 2010-July 2011	8.55	#2
January-September 2011	8.59	#3
October 2010-June 2011	8.64	#4
June 1917-February 1918	9.36	#5

Table 5: All-time rankings of nine-month accumulated precipitation, based on Texas statewide average precipitation.

The records tend to become more extreme as the durations become longer. Note, in Table 3, that the driest March through May on record was immediately followed by the driest June through August on record. The nine-month precipitation totals in Table 5 are much lower than any other nine-month precipitation totals for any time of year.

Table 6 shows the overall ranking of non-overlapping 12-month precipitation totals. (Non-overlapping means that a particular month is not allowed to be part of more than one 12-month period.) The record driest 12-month period was the 12-month period from October 2010 to September 2011. While the recent numbers are still preliminary and subject to slight changes, the previous record (set in 1956) was broken by a comfortable 2.5 inches.

Months	*Precipitation Amount*	*Rank*
October 2010-September 2011	11.18	#1
October 1955-September 1956	13.69	#2
February 1917-January 1918	14.27	#3
July 1924-June 1925	15.50	#4
February 1910-January 1911	17.62	#5
January 1956-December 1956	17.85	#6
March 1901-February 1902	17.91	#7
October 1908-September 1909	18.24	#8
June 1970-May 1971	18.50	#9
November 1951-October 1952	18.69	#10
October 1950-September 1951	18.88	#11
May 1977-April 1978	19.35	#12
November 1962-October 1963	19.40	#13
September 2005-August 2006	19.66	#14

Table 6: All-time rankings of twelve-month accumulated precipitation, based on Texas statewide average precipitation. Periods are constrained to be non-overlapping.

Two other aspects of Table 6 deserve comment. First, the driest four periods are substantially drier than the remaining periods. For statewide one-year precipitation deficits, 2010-2011, 1955-1956, 1917-1918, and 1924-1925 are by far the most extreme events since records began in 1895. Second, it was necessary to continue the list to period number 14 to ensure that the list included another drought from the past 30 years. This means that while there have been several severe one-year droughts in the past, none of the recent Texas droughts measure up except for the current one. Though it would have been difficult to prepare for a drought of this magnitude, it had been many decades since Texas had experienced a one-year drought anywhere close to the present one in severity.

Palmer Drought Severity Index

The information presented so far has focused on the lack of rainfall, with some additional discussion of unusually high temperatures. The most common measure of drought intensity in the United States is the Palmer Drought Severity Index, or PDSI. The PDSI attempts to assess the relative amount of water available in the soil, based upon precipitation, an estimate of evaporation based on temperature, and information regarding soil type. Because it combines temperature and precipitation information, it is a more comprehensive measure of drought intensity than the SPI. Unlike the SPI, the PDSI has its own intrinsic time scale, so a single numerical value characterizes the overall drought intensity.

Drought is considered to be present when the PDSI value is below -2, and extreme drought is present when the PDSI value is below -4. The National Climatic Data Center calculates PDSI values for each climate division as well as a statewide PDSI value.

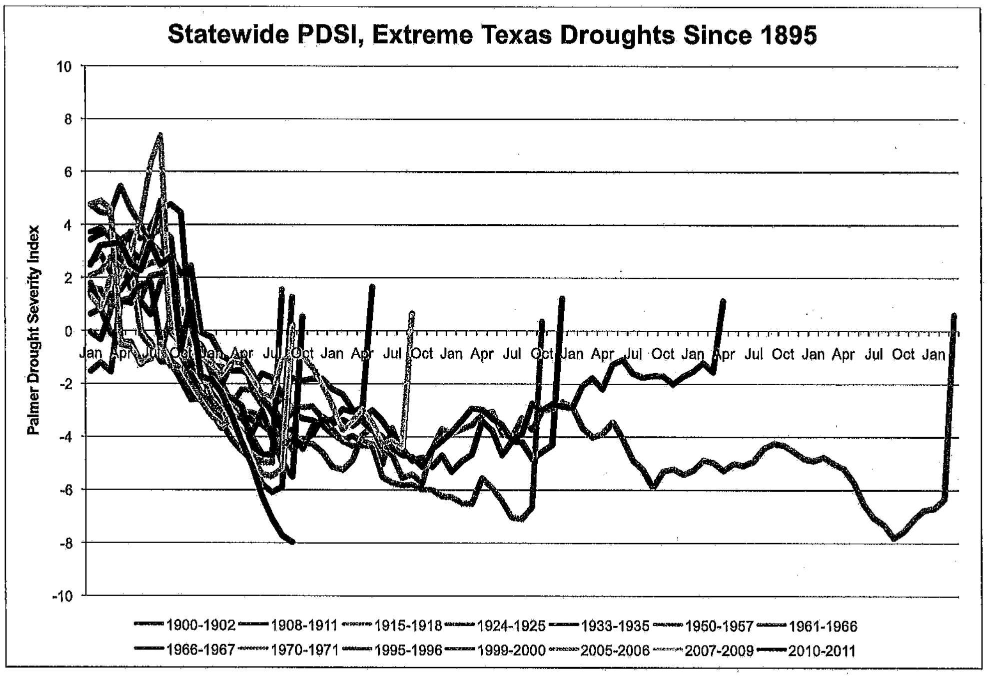


Figure 24: Texas statewide Palmer Drought Severity Index values for all previous droughts attaining a PDSI value of -4 or lower. Droughts are plotted on a common time scale, beginning in January of the year in which the run of negative PDSI values first appeared and ending when the PDSI value again became positive. Drought endings appear abrupt because the PDSI jumps suddenly from a characterization of dry conditions to a characterization of wet conditions. Thus the PDSI is ill-suited for monitoring recovery from drought.

In Fig. 24, the evolution of statewide PDSI values for all fourteen previous extreme droughts are plotted on a common time scale. As Fig. 24 shows, the most recent PDSI value for the 2011 drought (shown in black) is a record low value for statewide PDSI, surpassing the previous record set in 1956 (orange). However, the 1950-1957 drought is generally regarded as a much worse drought overall because it lasted for so many years. The most intense year of that drought, in 1956, immediately followed five other consecutive drought years.

The 1915-1918 drought might also arguably be worse than the 2010-2011 drought overall. The 1915-1918 drought was third most intense, according to the PDSI, but it maintained values below -5 from June 1917 through September 1918. In contrast, the 2010-2011 drought has only had five or six months below -5.

Ultimately, all droughts are different, and it is not possible to say at what point a particular drought surpasses another in overall severity. At this point, the 2010-2011 drought is easily the most severe one-year drought on record and is clearly among the top five overall. Whether it lasts long enough and remains intense enough to surpass the 1908-1911, 1961-1966, 1915-1918, and 1950-1957 droughts (or whether it already has surpassed some of them) will depend on both future weather and the means by which one drought is compared against another.

Climate Division Perspective

The previous sections discussed the overall statewide intensity of the drought as well as the severity of the drought recorded at specific rain gauges. In this section, the historical ranking of the 2011 drought within the various climate division of Texas is considered.

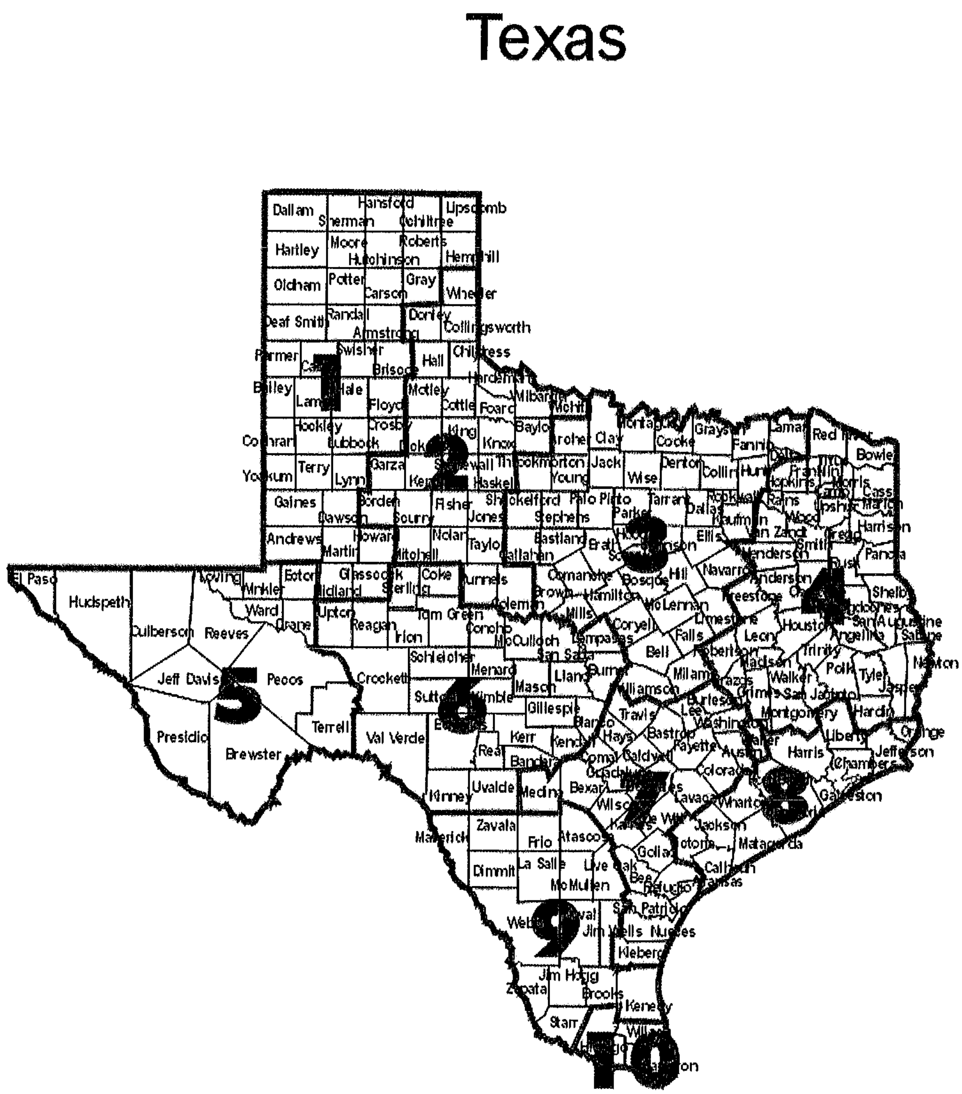


Figure 25: Boundaries of Texas climate divisions. Figure from NOAA's Climate Prediction Center.

Texas is divided into ten climate divisions (Fig. 25). Nine are approximately equally-sized, while climate division #10 separately reflects conditions within the farming region of the Lower Valley.

Table 7 shows the PDSI values and drought durations within each of the ten climate divisions during the major Texas droughts of the past and present. The table allows one to compare the intensity and duration of the present drought to past droughts in the same portion of the state.

	High Plains	Low Rolling Plains	North Central Texas	East Texas	Trans-Pecos	Edwards Plateau	South Central Texas	Upper Coast	South Texas	Lower Valley
	1	2	3	4	5	6	7	8	9	10
1908-1911	-5.31 11 26	-5.66 14 40	-4.29 1 30	13	-4.49 4 24	-4.23 3 33	-4.91 4 34	12	34	18
1915-1918	-4.04 1 19	-5.61 16 22	-6.03 15 27	-5.99 **10** 27	-4.33 4 20	-5.25 15 28	-6.16 20 33	**-5.72** **14** 34	-4.43 8 30	25
1924-1925	11	-4.81 4 13	-5.61 5 10	-5.99 7 13	9	-4.90 3 10	-5.19 3 10	-5.38 6 12	6	3
1933-1935	-5.01 10 32	-4.03 1 13	4	4	-5.23 9 29	-4.57 2 17	3		1	
1950-1957	-5.86 **24** **58**	-6.33 **25** **71**	**-6.92** **22** **71**	-4.54 8 **40**	-5.10 **16** **74**	**-6.08** **29** **66**	**-6.67** **36** **67**	-5.45 12 **55**	**-5.73** **20** **77**	**-4.89** **5** **79**
1961-1966	-4.19 1 24	11	-4.00 1 14	27	28	-4.54 4 25	-5.04 7 32	-4.14 2 34	35	; 0
1966-1967	8	8	-4.56 3 8	7	3	-4.33 3 8	-4.63 2 7	5	4	1
1970-1971	10	-4.67 2 9	-4.18 1 5	8	5	7	-4.84 2 7	6	5	5
1995-1996	5	4	-4.07 1 6	5	-4.06 1 23	-4.12 1 6	-4.31 1 6	2	10	7
1999-2002	5	7	9	10	-5.12 7 56	-5.06 6 13	-4.09 1 10	-4.69 6 13	8	-4.23 2 31
2005-2006	-4.38 2 7	-4.78 3 8	-4.47 3 14	-4.11 5 16	4	-4.04 1 11	-4.95 8 14	6	-4.42 3 11	-4.42 3 16
2007-2009		9	3		1	16	-6.51 3 16	8	-4.77 3 12	4
2010-2011	**-6.73** 4 6	**-7.08** 5 7	-5.37 3 7	**-6.47** 7 14	**-6.22** 5 10	-6.05 5 8	-5.79 4 7	-5.32 3 6	-4.98 1 6	-4.45 1 6

Table 7: Droughts surpassing -4 PDSI in three or more climate divisions. Shown are the minimum PDSI value, the number of months at or below -4 PDSI, and the number of months at or below -2 PDSI.

Only two droughts have reached extreme (PDSI below -4) status in all ten climate divisions: the 1950-1957 drought and the current drought. The PDSI attains its lowest value in the current drought within four climate divisions: 1, 2, 4, and 5. From a historical perspective, the current drought is worst in East Texas (climate division #4). The current drought far exceeds the 1950-1957 drought in intensity (though not in duration), has already surpassed the 1924-1925 drought by all measures, and is most strongly rivaled by the 1915-1918 drought. Based on the combination of precipitation and temperature incorporated into the PDSI, the present drought is already at least the third-worst drought on record in East Texas.

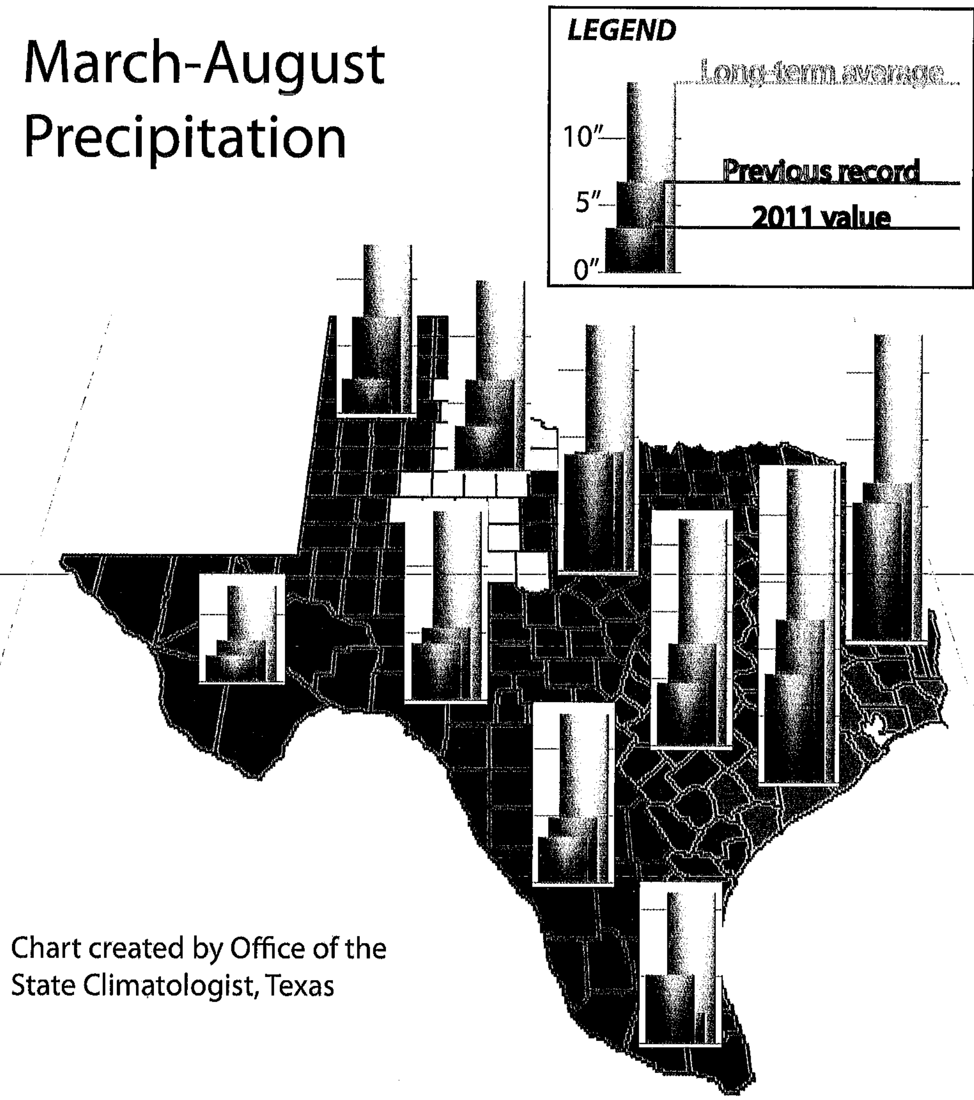


Figure 26: Climate division average precipitation for March-August 2011 (blue), compared to the long-term average for March-August (green) and the previous record for driest March-August (red). See legend for scale.

Figure 26 is a graphical depiction of the driest six-month period of the 2011 drought. The six-month rainfall was below the previous record in all but climate division 10 (see Fig. 25 for climate division identification). In climate divisions 1 and 2, the total rainfall was less than half the previous record and less than a quarter of normal precipitation. Even the "wettest" climate division received less rainfall than normally occurs everywhere but climate division 5.

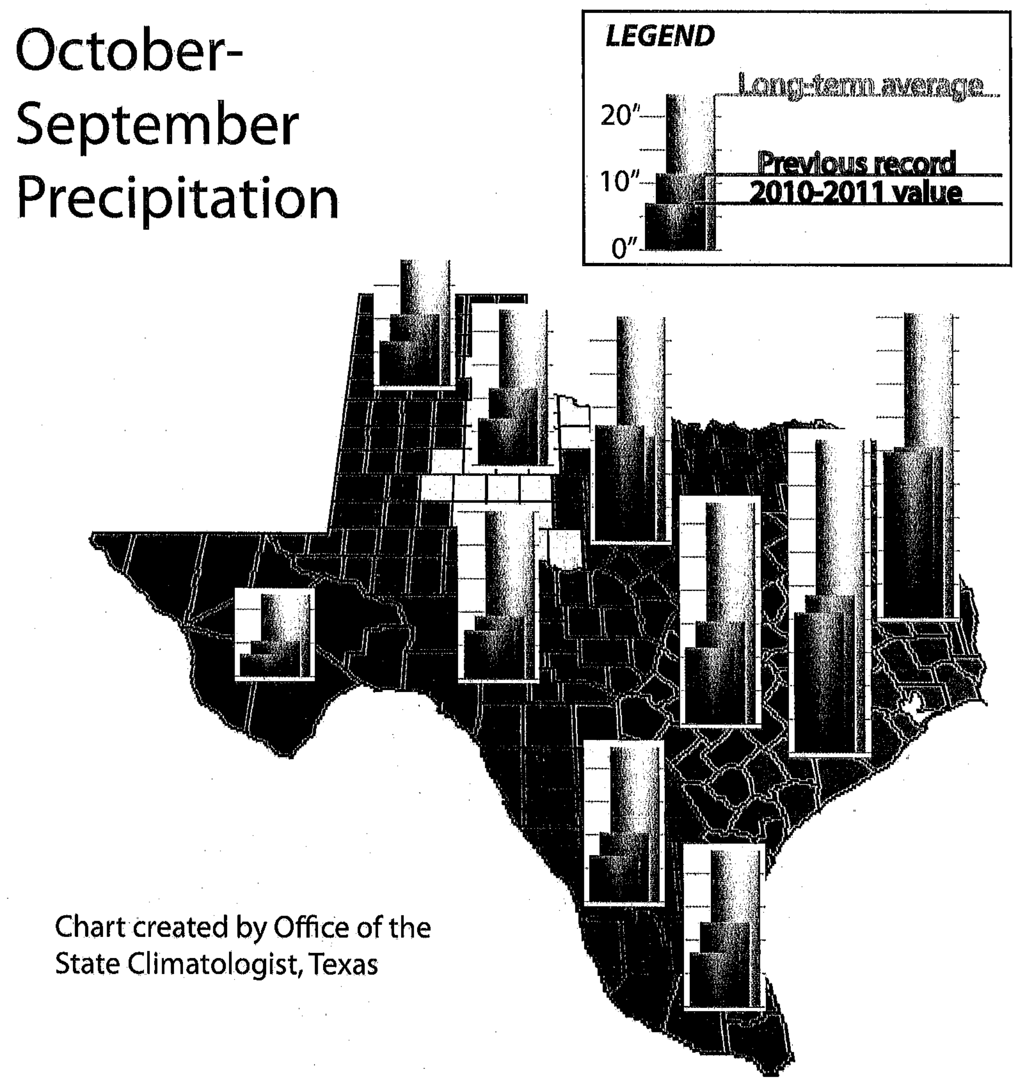


Figure 27: Climate division average precipitation for October 2010-September 2011 (blue), compared to the long-term average for 12 months (green) and the previous record for driest October-September (red). See legend for scale.

The twelve-month totals are no less staggering. East Texas received the normal rainfall of the Low Rolling Plains. South Central Texas received the normal rainfall of the Trans-Pecos. Only North Central Texas managed to receive more precipitation than its previous record. Most climate divisions received much less than half of their normal precipitation.

5) What's Next

The 2010-2011 drought has now lasted for a year in most of Texas, longer in many parts of east Texas. At this point it seems likely to continue for at least another year.

La Niña conditions have become established in the tropical Pacific Ocean, and most La Niña events induce changes in weather patterns that lead to dry late fall to early spring conditions for Texas and surrounding parts of the southern United States. Accordingly, NOAA's Climate Prediction Center is predicting that November through January precipitation in Texas has about a 50-55% chance of being below the normal range, a 33% chance of falling within the normal range, and a 12-17% chance of being above the normal range. The outlook for February through April is only slightly better: a 45% chance of being below the normal range, a 33% chance of falling within the normal range, and a 22% chance of being above the normal range. Thus, substantial improvement of drought conditions between now and the end of April 2012, while possible, is not likely.

Substantial rains are always possible from May through October, so many parts of the state may well get lucky and receive significant drought relief by this time next year. However, there is no reason at this point to expect the summertime precipitation to be above normal, and even near-normal conditions would allow a continuation of the present drought into fall 2012. It therefore seems likely that at least a large portion of Texas will need to endure a second summer of drought.

Though a second year of drought is expected, the lack of rainfall will almost certainly not be as extreme as it was during the first year. This expectation is based on little more than the fact that the 2010-2011 rainfall total was such an outlier that it is highly unlikely to recur in any given year. Also helping slightly is the fact that the 2011-2012 La Niña is not forecasted to be as intense as the 2010-2011 La Niña, though scientists disagree on whether the strength of La Niña is closely related to the strength of its effects on United States weather.

More rainfall in 2011-2012 would be good news for farmers and ranchers. The lack of deep soil moisture would make crops and forage particularly vulnerable to extended periods of dry weather, though, so the rainfall would have to come at the right time. However, a continuation of the drought would be bad for water supplies across the state. The effects of drought tend to be cumulative on surface water storage and aquifers: continued depletion without adequate recharge would lead to more water restrictions and priority calls.

Whether the drought will last beyond a second year is impossible to determine at this point. There have been rare occasions in the past when La Niña conditions were observed for three consecutive years. Conversely, an El Niño event would be likely to bring wetter than normal conditions to Texas. It is also possible that tropical Pacific conditions will return to a neutral state, with little resulting impact on Texas precipitation.

Historical records and atmospheric model simulations indicate that long-term precipitation variations in Texas are primarily controlled by a sea surface temperature pattern called the Pacific Decadal Oscillation, or PDO. Presently the PDO is in a configuration associated with relatively dry weather in Texas, and it has been in that configuration since about 1998. Some observational and model evidence suggests that a slowly-varying temperature pattern in the Atlantic Ocean, called the Atlantic Multidecadal Oscillation or AMO, also affects Texas precipitation, with dry conditions favored when the Northern Hemisphere Atlantic Ocean is relatively warm. Presently, the AMO is in its warm phase, and has been since about 1995. During the past decade or so, with both patterns in an unfavorable state, Texas has experienced multiple droughts, including drought in five of the last seven years.

The only other recent time both patterns were clearly in an unfavorable state was from the mid 1940s to the early 1960s. During that period, Texas experienced its drought of record (1950-1957) and a second prolonged drought (1961-1966). Tree ring evidence indicates that such multi-year droughts have also occurred in Texas prior to weather records.

The same conditions that seemed to enable the drought of the 1950s are in place today. Whether Texas will continue with its recent pattern of drought years interspersed with occasional wet years or whether the present drought will evolve into a prolonged one is impossible to determine at this point.

Also unknown is how long the unfavorable PDO and AMO conditions will last. Some recent research suggests that the AMO may change sign in the next few years and begin favoring rainfall in Texas. Based on past history, the present phase of drought susceptibility could last anywhere from three more years to fifteen more years.

Beyond the next few years, climate change must be taken into account. Projected changes in precipitation are relatively small compared to past natural precipitation variations (Nielsen-Gammon, 2011), so it seems unlikely that anthropogenic climate change will induce a substantial decrease in Texas precipitation by mid-century. Natural variations presently have Texas in a dry phase, so it seems relatively likely that as the PDO and AMO evolve over the next couple of decades Texas will pass into another relatively wet phase, albeit temporary. Scientists also do not know whether La Niña, which exerts such a strong influence on Texas weather from year to year, will become more or less frequent as the climate changes.

Projected temperature changes are much larger than past decade-scale temperature variations in Texas, and the projected warming is robust across models. While it is not known how much warmer temperatures will become, an increase of several degrees Fahrenheit by mid-century in Texas is well within the realm of possibility.

Whether such a large temperature increase comes to pass or not, it seems very likely that temperatures will become at least somewhat warmer than present, so that evaporation will have an increasingly large impact on water supplies throughout Texas. Future droughts will almost certainly be warmer than the Texas droughts of the past, and consequently will tend to be more severe even if precipitation is unchanged. It took rainfall only a third of normal to achieve summertime Texas temperatures five degrees warmer than their 20th century average; perhaps by mid-century a drought with two-thirds of normal precipitation will be sufficient to achieve similarly warm conditions.

In summary, a second year of drought in Texas is likely. Whether the drought will end after two years or last three years or beyond is impossible to predict with certainty, but what is known is that Texas is in a period of enhanced drought susceptibility due to global ocean temperature patterns and has been since at least 2000. The good news is that these global patterns tend to reverse themselves over time, probably leading to an extended period of wetter weather for Texas, though this may not happen for another three to fifteen years. Looking into the distant future, the safest bet is that global temperatures will continue to increase, causing Texas droughts to be warmer and more strongly affected by evaporation.

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Climatological Rankings

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Please note, **Degree Days** *are not available for Agricultural Belts*

Period(s) *(Hold "Ctrl" to select multiple)*:
1-month period
2-month period
3-month period
4-month period
5-month period
6-month period
7-month period
8-month period
9-month period

Select All

Parameter: Precipitation

State/Region/Ag Belt: Texas

Climate Division: All Divisions Year: 2012 Month: September

Check to display statistics as of month/year requested (leave unchecked for statistics relative to the entire period of record)

View

Texas Precipitation Rankings, September 2012

« August 2012 October 2012 »

Driest ≤1/10 ≤1/3 Normal ≥1/3 ≥1/10 Wettest

More information on Climatological Rankings

Period	Amount	20th Century Average	Departure	Rank (out of 119 years)	Record	Wettest/Driest Since
Oct 2011 - Sep 2012 12-month period	28.94" (735.08 mm)	27.87" (707.90 mm)	1.07" (27.18 mm)	67th Driest	2011	Driest since: 2011
				52nd Wettest	1941	Wettest since: 2010

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Climatological Rankings

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7-month period
8-month period
9-month period

Select All

Parameter: Precipitation

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Texas Precipitation Rankings, September 2012

« August 2012 October 2012 »

Driest ≤1/10 ≤1/3 Normal ≥1/3 ≥1/10 Wettest

More information on Climatological Rankings

Period	Amount	20th Century Average	Departure	Rank (out of 119 years)	Record	Wettest/Driest Since
Oct 2010 - Sep 2012 24-month period	40.21" (1,021.33 mm)	55.94" (1,420.88 mm)	-15.73" (-399.55 mm)	5th Driest	1918	Driest since: 1956
				113th Wettest	1920	Wettest since: 2011

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Please note, **Degree Days** *are not available for Agricultural Belts*

Period(s) *(Hold "Ctrl" to select multiple)*:
1-month period
2-month period
3-month period
4-month period
5-month period
6-month period
7-month period
8-month period
9-month period

Select All

Parameter: Precipitation

State/Region/Ag Belt: Texas

Climate Division: All Divisions Year: 2013 Month: October

Check to display statistics as of month/year requested (leave unchecked for statistics relative to the entire period of record)

View

Texas Precipitation Rankings, October 2013

« September 2013

Driest ≤1/10 ≤1/3 Normal ≥1/3 ≥1/10 Wettest

More information on Climatological Rankings

Period	Amount	20th Century Average	Departure	Rank (out of 119 years)	Record	Wettest/Driest Since
Jan - Oct 2013 10-month period	24.00" (609.60 mm)	24.12" (612.65 mm)	-0.12" (-3.05 mm)	59th Driest	2011	Driest since: 2012
				61st Wettest	1919	Wettest since: 2010

November US Release: 11 Dec 2013, 11:00 AM EST

Climatological Rankings

Look up monthly U.S., Statewide, Divisional, and Regional Temperature, Precipitation, Degree Days, and Palmer (Drought) rankings for 1-12, 18, 24, 36, 48, 60-month, and Year-to-Date time periods. Data and statistics are as of January 1895.

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4-month period
5-month period
6-month period
7-month period
8-month period
9-month period

Select All

Parameter: Precipitation

State/Region/Ag Belt: Texas

Climate Division: All Divisions Year: 2013 Month: October

Check to display statistics as of month/year requested (leave unchecked for statistics relative to the entire period of record)

View

Texas Precipitation Rankings, October 2013

« September 2013

Driest ≤1/10 ≤1/3 Normal ≥1/3 ≥1/10 Wettest

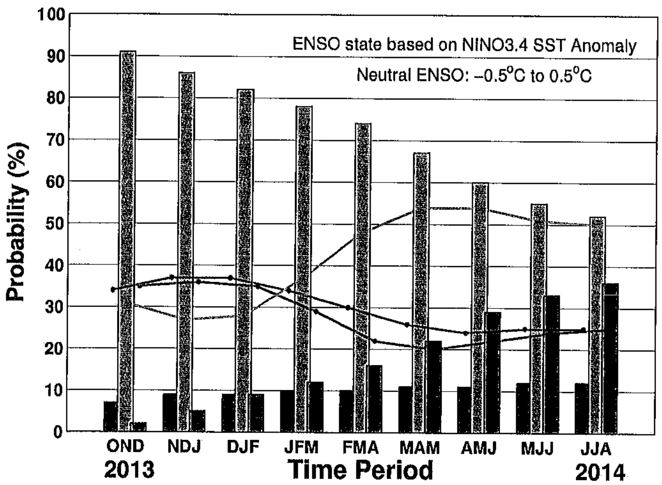
More information on Climatological Rankings

Period	Amount	20th Century Average	Departure	Rank (out of 119 years)	Record	Wettest/Driest Since
Nov 2010 - Oct 2013 36-month period	65.51" (1,663.95 mm)	83.98" (2,133.09 mm)	-18.47" (-469.14 mm)	7th Driest	1956	Driest since: 1956
				110th Wettest	1921	Wettest since: 2012

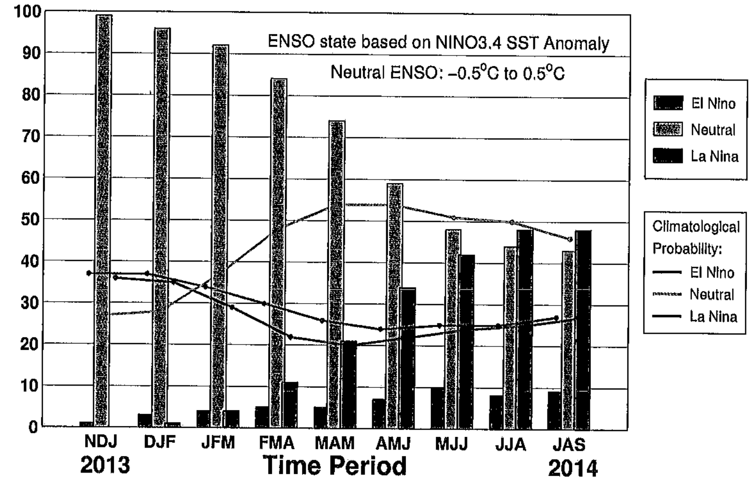
ENSO *QUICK LOOK* November 21, 2013 A monthly summary of the status of El Niño, La Niña and the Southern Oscillation, or "ENSO", based on NINO3.4 index (120-170W, 5S-5N)

During October through mid-November the observed ENSO conditions remained neutral. Most of the ENSO prediction models indicate a continuation of neutral ENSO into the first quarter of 2014. During northern spring and summer a warming tendency is seen in both dynamical and statistical models.

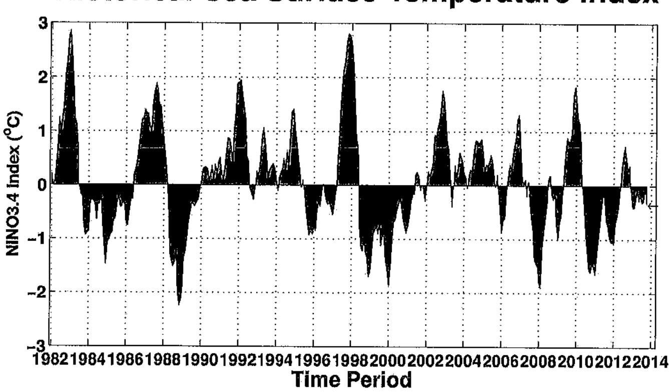
Early-Nov CPC/IRI Consensus Forecast[1]



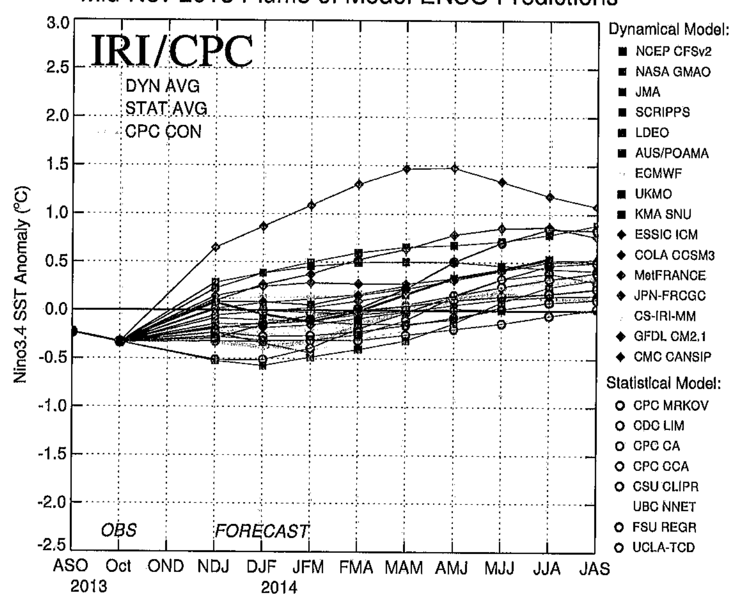
Mid-Nov IRI/CPC Plume-Based Forecast[2]



Historical Sea Surface Temperature Index



Mid-Nov 2013 Plume of Model ENSO Predictions



Historically Speaking

El Niño and La Niña events tend to develop during the period Apr-Jun and they:

- Tend to reach their maximum strength during Dec-Feb

- Typically persist for 9-12 months, though occasionally persisting for up to 2 years

- Typically recur every 2 to 7 years

---

[1]Based on a consensus of CPC and IRI forecasters, in association with the official CPC/IRI ENSO Diagnostic Discussion.

[2]Purely objective, based on regression, using equally weighted model predictions from the plume.

Discussion for the Seasonal Drought Outlook

Tools used in the U.S. Seasonal Drought Outlook (SDO) included the official CPC temperature and precipitation outlooks for December 2013, the long lead forecast for December 2013 - February 2014, various short- and medium-range forecasts and models such as the 5-day and 7-day precipitation totals from the Weather Prediction Center, 6-10 day and 8-14 day CPC forecasts, the NAEFS precipitation outlooks, the soil moisture tools based on the Constructed Analog on Soil (CAS) moisture, dynamical models (CFSv2, NMME, and IMME), the 384-hour total precipitation forecasts from several runs of the GFS, the four-month Palmer drought termination and amelioration probabilities, DJF climatology, and initial conditions. ENSO conditions continue to be and are forecast to remain neutral.

The 30-day ACIS-based precipitation was less than 50 percent of normal across the central Gulf and Atlantic Coast States (from Alabama northeastward into Maine, and southern Florida). Deficits of 4 to 8 inches have accumulated during the past 90-days, especially in the Southeast and lower New England. The current 28-day USGS averaged stream flow values have begun to drop into the below normal (<25th percentile) category in the Southeast, and are below to much below normal (<10th percentile) in central North Carolina/southern Virginia and from New Jersey into southern New Hampshire. As a result, the latest Drought Monitor has increased D0 across the region, and expanded D1 in New England. Impacts could have been worse except that the short-term dryness has been offset by longer-term (6-month) surpluses, lower temperatures, and the end of the growing season. Little or no precipitation is forecast for the upcoming 5-days, however, precipitation is expected to begin spreading northeastward from the western Gulf during days 6 and 7, with odds for above median precipitation in the 6-10 and 8-14 day outlooks. Further complicating the situation is that once the ground freezes in northern areas, moisture conditions generally remain locked in place until the spring thaw. Therefore, the next several weeks will be critical as to whether or not further deterioration or improvement will occur in New England – with the odds slightly favoring drier weather here. Farther south, with general troughing over the East during late November plus the normal end of the Atlantic hurricane season fast approaching (Nov. 30), the chances for significant moisture from any tropical system are unlikely over the southeastern U.S. Lastly, the CPC December outlook has slight chances for below median precipitation along the southern Atlantic Coast while the seasonal outlook (Dec-Feb) depicts probabilities above 40-percent for below-median precipitation. Therefore, drought development is possible from the central Gulf Coast northeastward into Virginia, in eastern Florida, and southern New England, where 90-day deficits are the highest, D0 already exists, and stream flows continue to slowly drop. *Forecast confidence for the **central Gulf and Atlantic Coast States** are low-moderate (Northeast) to moderate (Southeast).*

Above normal precipitation fell on most of the Midwest and Great Lakes region since Oct. 21, providing some drought relief. Unfortunately, some of the precipitation was accompanied by severe weather on Nov. 17, with Illinois especially hard-hit with numerous tornadoes. In contrast, under half of normal precipitation was observed over the northern Great Plains and upper Midwest (less than an inch); however, late autumn and winter are climatologically dry for the upper Mississippi Valley, so accumulated deficits were rather small. Similar to New England, the soils, streams, and lakes will eventually freeze as the winter progresses, so the amount of precipitation during the next several weeks will be influential toward impacting the drought. Therefore, in the absence of well above normal precipitation, it is difficult to realize significant drought improvements during this period. Additional light accumulations, generally under a half inch, are anticipated during the upcoming 7-days across most of the region, except for somewhat heavier totals (0.5-2 inches) in southern Missouri. The CPC 6-10 and 8-14 day outlooks indicate enhanced chances of below-median precipitation over the Midwest. The CPC monthly and seasonal outlooks both maintain equal chances for below, near, or above-median precipitation. But with similar conditions to surrounding D1 areas and expected minimal precipitation the next several weeks, development was added to northeastern Missouri and western Illinois. Elsewhere, based on the time of year climatology, persistence is forecasted for lingering drought areas in Missouri, Illinois, Minnesota, Iowa, and Wisconsin.
*Forecast confidence for the **upper and middle Mississippi Valley** is moderate.*

During the previous 30 days, surplus rains overspread eastern Texas and western Louisiana, but missed areas to the east. The moisture brought localized drought relief to parts of eastern Texas and western Louisiana, but increasing 90-day deficits expanded D0 across southern Arkansas, central Mississippi, and central Louisiana. During the next 7 days as a slow-moving upper-air disturbance tracks eastward out of the Southwest, it will tap Gulf moisture and drop significant rains (2-4 inches) on the western and central Gulf Coast states, and northward into southern Missouri. The CPC 6-10 and 8-14 outlooks tilt the odds towards above-median rainfall, indicating a continuation of the wet pattern during the remainder of November. The CPC official monthly and seasonal outlooks generally maintain equal chances for below, near, or above-median precipitation, although the December outlook hints at slight odds for below-median precipitation in western areas. Climatological rainfall slightly increases during the winter months across the lower Mississippi Valley as the mid-latitude storm track shifts southwards towards the Gulf Coast. Given the wet short-term forecast and climatology, drought improvement is anticipated over the lower Mississippi Valley.
*Forecast confidence for the **lower Mississippi Valley** is moderate-high.*

During the previous 30 days, surplus rains fell across eastern, southwestern, and extreme southern Texas, easing drought conditions. In contrast, the remainder of the state measured subnormal rainfall. Over the past 3-months, the largest deficits (3 to 6 inches) have accumulated in the Panhandle and in the Red River Valley, and drought persisted or intensified. Rainfall was spottier in Oklahoma, but southern and eastern Kansas recorded 2 to 6 inches, or 1.5 to 3 times above normal. Above normal precipitation also fell on eastern Nebraska. Late autumn and winter months are climatologically dry across the Plains, making significant reductions in drought less likely during this period. However, a slow-moving storm tracking across the southern tier of states during the next 7 days is expected to drop significant precipitation on eastern sections of Texas, Oklahoma, and Kansas, possibly easing drought along the

Plains eastern drought area. The CPC 6-10 and 8-14 day outlooks tilt the odds towards abnormal wetness across the southern two-thirds of Texas, with abnormal dryness more likely over the remainder of the southern and central Plains. The CPC monthly outlook for December indicates enhanced chances for below-median precipitation across the southern Plains, and the winter outlook indicates favorable odds for below-median precipitation and above-normal temperatures across western Texas, the Oklahoma Panhandle, and New Mexico. Based on the dry climatology and outlooks, therefore, drought persistence is forecast for the central and southern High Plains, with areas of development possible across southwestern Texas, western Oklahoma, and southern New Mexico. In contrast, the near term rainfall is forecast to continue improving drought conditions across parts of eastern Texas, particularly in areas that have shallower drought conditions due to recent rains and short-term surpluses.
*Forecast confidence for the **central and southern Plains** is moderate.*

After an early October storm brought widespread heavy precipitation to the northern Rockies and adjacent Plains, more tranquil conditions have occurred since then. Since Oct. 21, above normal precipitation was limited to northern Montana and western Wyoming. Fortunately, this early October precipitation eased drought conditions across Wyoming, with only lingering long-term D0 and a small D1 area left. Little or no precipitation is forecast during the upcoming 7-day period across Montana and the Dakotas, while Wyoming can expect light to moderate totals (0.5 to 1.5 inches). The CPC 6-10 day outlook favors dry weather, but the 8-14 day outlook indicates above-median precipitation for Montana and the Dakotas. Climatologically, the winter months are normally dry in the northern High Plains, but normal do increase as one travels west (northern Rockies). Additionally, the CPC monthly and seasonal outlooks tilt the odds towards above-median precipitation across the northern Rockies and northern Plains. Based on the wet guidance in the medium and long range, and additionally the fairly shallow drought conditions in Wyoming and parts of Idaho (surpluses at 60- and 90-days), drought improvement or removal is forecast.
*Forecast confidence for the **northern Rockies and northern High Plains** is moderate-high.*

Mostly dry weather dominated the southwestern U.S. as the monsoon season came to a close in mid-September. Portions of southern California, western Arizona, and southern Nevada received little or no rainfall the past 30 days, while subnormal precipitation was common across the region the past 60 days. The lone exception with surplus 2-month rainfall was northern New Mexico. As an upper-air low develops in the Southwest during the next 5 days, significant precipitation (1 to 2 inches, locally to 5 inches) is forecased for most of Arizona, southern California, southern Utah, southern Colorado, and western New Mexico. Then, during the 6-10 and 8-14 day periods, the probabilities call for near to above median precipitation. In contrast, the CPC seasonal outlook tilts the odds toward below-median precipitation across much of New Mexico and Arizona, while the December outlook calls for below-median values in eastern New Mexico (and equal chances elsewhere). Although the short-term forecast favors some improvement, the existing short term dryness, long-term hydrological drought impacts, and the monthly and seasonal outlooks skew the forecast toward persistence of existing drought areas, with additional development possible over parts of New Mexico and Arizona at the end of February 2014.
*Forecast confidence for the **Southwest** is moderate.*

California, Oregon, and Washington receive a significant percentage of their annual precipitation during the winter months due to Pacific winter storm activity. Therefore, precipitation anomalies during this period play a large role in the amelioration or development of drought. Light precipitation is forecast during the upcoming 7-days for the Pacific Coast, with some moderate amounts (an inch) possible in the Sierra Nevada and southeastern California. The CPC 6-10 and 8-14 day outlooks indicate enhanced odds for below-median precipitation during the remainder of November. Several climate models forecast abnormal dryness during December, but the seasonal signal becomes mixed, with some models suggesting above normal precipitation later in the winter period (e.g. January and February). The CPC monthly and seasonal outlooks both maintain equal chances for below, near, or above-median precipitation; therefore this outlook is based primarily on the impact of climatological rainfall, and the enhanced odds for above-median monthly and seasonal precipitation in the northern Rockies and Plains. Based upon this, some reduction in drought is possible across northwestern California and southern Oregon, and into the north-central Rockies. The improvement areas of the outlook were not extended into Sierra Nevada due to the possibility of a slow start to the winter wet season.
*Forecast confidence for the **Pacific Coast States** is moderate.*

Precipitation rates normally drop during the autumn months in interior Alaska as cold, dry Arctic air masses dominate, but to date the opposite conditions have prevailed. A very wet and mild October lingered into November, easing D1 conditions across central Alaska by mid-November. The easternmost D1 area remained as deficits were higher and recent precipitation was lower. As this region enters winter, the remaining D1 should persist as colder and drier air should envelop the interior. Therefore, drought persistence is forecast during the December through February period.
*Forecast confidence for **Alaska** is high.*

Precipitation rates increase during the winter months across Hawaii due to influence from mid-latitude winter storms. With recent rainfall increasing along the windward sides, some drought relief has occurred. The CPC winter outlook tilts the odds toward above-median rainfall. Precipitation amounts near or above normal across the islands would ease or erase existing drought conditions. Therefore, improvement or removal is indicated in this outlook.
*Forecast confidence for **Hawaii** is high.*

Forecaster: D. Miskus

Next Seasonal Drought Outlook issued: December 19, 2013 at 8:30 AM EDT

Official 90-day Outlooks are issued once each month near mid-month at 8:30am Eastern Time. Please consult the schedule of 30 & 90-day outlooks for exact release dates.

PROGNOSTIC DISCUSSION FOR LONG-LEAD SEASONAL OUTLOOKS
NWS CLIMATE PREDICTION CENTER COLLEGE PARK MD
830AM EST THURSDAY NOV 21 2013

SUMMARY OF THE OUTLOOK FOR NON-TECHNICAL USERS

THE MAIN FACTORS THAT USUALLY INFLUENCE THE SEASONAL CLIMATE OUTLOOK INCLUDE:
1) EL NINO AND LA NINA - WHICH TOGETHER COMPRISE EL NINO/SOUTHERN OSCILLATION OR ENSO. IMPACTS OF THESE EVENTS ARE SUMMARIZED BY SEPARATING 3-MONTH OBSERVATIONS FROM 3 OR MORE DECADES INTO EL NINO, NEUTRAL, AND LA NINA SETS, AVERAGING EACH SEPARATELY, AND THEN COMPUTING ANOMALIES. THESE ARE CALLED "ENSO COMPOSITES", WHICH ARE USED AT TIMES TO SUBJECTIVELY MODIFY THE FORECAST.
2) TRENDS - APPROXIMATED BY THE OCN TOOL AS THE DIFFERENCE BETWEEN THE MOST RECENT 10-YEAR MEAN OF TEMPERATURE OR 15-YEAR MEAN OF PRECIPITATION FOR A GIVEN LOCATION AND TIME OF YEAR AND THE 30-YEAR CLIMATOLOGY PERIOD (CURRENTLY 1981-2010).
3) THE TROPICAL 30-60 DAY OSCILLATION - SOMETIMES CALLED MADDEN JULIAN OSCILLATION (MJO) - AFFECTS CLIMATE VARIABILITY WITHIN SEASONS.
4) THE NORTH ATLANTIC OSCILLATION (NAO) AND THE PACIFIC NORTH AMERICAN (PNA) PATTERNS - WHICH AFFECT THE TEMPERATURE ANOMALY PATTERN ESPECIALLY DURING THE COLD SEASONS. THESE PHENOMENA ARE CONSIDERED LESS PREDICTABLE ON A SEASONAL TIMESCALE THAN ENSO.
5) THE PACIFIC DECADAL OSCILLATION (PDO) - AN ENSO-LIKE PATTERN OF CLIMATE VARIABILITY AFFECTING THE TROPICS AND THE NORTH PACIFIC AND NORTH AMERICAN REGIONS, BUT WHICH VARIES ON A MUCH LONGER TIME-SCALE THAN ENSO.
6) PERSISTENTLY DRY OR WET SOILS IN THE SPRING AND SUMMER AND SNOW AND ICE COVER ANOMALIES IN THE WINTER. THESE FACTORS TEND TO PERSIST FOR LONG PERIODS AND ACT AS A KIND OF MEMORY IN THE CLIMATE SYSTEM.
7) STATISTICAL FORECAST TOOLS - CANONICAL CORRELATION ANALYSIS (CCA), SCREENING MULTIPLE LINEAR REGRESSION (SMLR), CONSTRUCTED ANALOGUE (CA) AND ENSEMBLE CCA (ECCA).
8) DYNAMICAL FORECAST MODELS - INCLUDING THE NCEP CLIMATE FORECAST SYSTEM (CFS). AN EXPERIMENTAL MODEL FORECAST SYSTEM, THE NATIONAL MULTI-MODEL ENSEMBLE, COMPRISED OF SEVERAL MODELS AND DESIGNATED NMME, MAY ALSO BE USED EXPERIMENTALLY AND SUBJECTIVELY UNTIL IT IS INCLUDED INTO THE CONSOLIDATION. AN INTERNATIONAL MODEL ENSEMBLE DESIGNATED IMME IS ALSO AVAILABLE.
9) CONSOLIDATION (CON) - AN OBJECTIVE, SKILL WEIGHTED COMBINATION OF THE OCN, CCA, SMLR, ECCA, AND CFS FORECASTS IS USED AS A FIRST GUESS IN PREPARING THE FORECAST MAPS. THIS TECHNIQUE MAKES OPTIMUM USE OF THE KNOWN SKILL OF OUR FORECAST TOOLS.

RECENT ATMOSPHERIC AND OCEANIC OBSERVATIONS CONTINUE TO INDICATE ENSO NEUTRAL CONDITIONS. THE OFFICIAL ENSO OUTLOOK CALLS FOR A CONTINUATION OF THE ENSO NEUTRAL STATE INTO EARLY 2014.

THE TEMPERATURE OUTLOOK FOR DECEMBER-JANUARY-FEBRUARY (DJF) 2013-14 INDICATES ELEVATED CHANCES FOR ABOVE-NORMAL TEMPERATURES FOR PARTS OF THE SOUTHWEST, THE SOUTHERN ROCKIES, THE SOUTHERN GREAT PLAINS, TEXAS AND PARTS OF THE SOUTHEAST. ABOVE-NORMAL TEMPERATURES ARE ALSO FAVORED FOR MUCH OF NEW ENGLAND. THERE ARE INCREASED ODDS FOR ABOVE-NORMAL TEMPERATURES IN WESTERN ALASKA. ENHANCED CHANCES FOR BELOW-NORMAL TEMPERATURES ARE INDICATED FOR PARTS OF THE NORTHERN GREAT PLAINS, AS WELL AS IN THE ALASKAN PANHANDLE.

THE DJF 2013-14 PRECIPITATION OUTLOOK CALLS FOR ELEVATED ODDS OF ABOVE-MEDIAN PRECIPITATION IN THE NORTHERN ROCKIES. BELOW-MEDIAN PRECIPITATION AMOUNTS ARE FAVORED IN THE SOUTHWEST, SOUTHERN ROCKIES, AND WESTERN SECTIONS OF THE SOUTHERN GREAT PLAINS. THE CHANCES FOR BELOW-MEDIAN PRECIPITATION ARE ALSO ELEVATED IN PARTS OF THE SOUTHEAST. BELOW-MEDIAN PRECIPITATION AMOUNTS ARE FAVORED FOR MOST OF THE ALASKAN PANHANDLE. IN AREAS WHERE THE LIKELIHOODS OF SEASONAL MEAN TEMPERATURES AND SEASONAL ACCUMULATED PRECIPITATION AMOUNTS ARE SIMILAR TO CLIMATOLOGICAL PROBABILITIES, EQUAL CHANCES (EC) IS SHOWN.

BASIS AND SUMMARY OF THE CURRENT LONG-LEAD OUTLOOKS
NOTE: FOR GRAPHICAL DISPLAYS OF THE FORECAST TOOLS DISCUSSED BELOW SEE:
HTTP://WWW.CPC.NCEP.NOAA.GOV/PRODUCTS/PREDICTIONS/90DAY/TOOLS/BRIEFING

CURRENT ATMOSPHERIC AND OCEANIC CONDITIONS

EQUATORIAL SEA SURFACE TEMPERATURES (SSTS) REMAINED NEAR-AVERAGE IN MUCH OF THE CENTRAL PACIFIC OCEAN IN THE FIRST HALF OF NOVEMBER, WHILE ABOVE NORMAL SSTS OF BETWEEN +0.5 AND +1.0 DEGREE C PREVAIL TO THE WEST OF THE INTERNATIONAL DATE LINE. EQUATORIAL SSTS NEAR THE SOUTH AMERICAN COAST CONTINUE TO BE AROUND 0.5 DEGREES C. BELOW NORMAL. THE MEAN OCEANIC HEAT CONTENT IN THE EASTERN EQUATORIAL PACIFIC FROM THE SURFACE TO A DEPTH OF 300 METERS HAS RISEN FROM LATE OCTOBER TO MID-NOVEMBER AND IS NOW ABOUT 0.3 DEGREES C. ABOVE NORMAL.

ATMOSPHERIC CIRCULATION OVER THE TROPICAL PACIFIC OCEAN IN THE PAST MONTH SUGGESTS CONTINUED ENSO NEUTRAL CONDITIONS. WINDS AT BOTH UPPER AND LOWER LEVELS ARE NEAR LONG TERM AVERAGES. CONVECTION REMAINED ENHANCED OVER INDONESIA AND SUPPRESSED OVER THE CENTRAL PACIFIC IN THE LAST FEW WEEKS.

PROGNOSTIC DISCUSSION OF SST FORECASTS

THE MAJORITY OF STATISTICAL AND DYNAMICAL MODELS FOR SSTS PREDICT ANOMALIES NEAR ZERO THROUGH THE NORTHERN HEMISPHERE WINTER OF 2013-14 AND INTO SPRING 2014. MOST DYNAMICAL MODELS PREDICT THAT SST ANOMALIES IN THE NINO 3.4 REGION THROUGH THE EARLY PART OF 2014 WILL BE VERY SLIGHTLY ABOVE ZERO, WHILE STATISTICAL MODELS SUGGEST THAT ANOMALIES WILL REMAIN SLIGHTLY NEGATIVE. THE CPC CONSOLIDATION OF NINO3.4 SST FORECASTS PREDICTS ANOMALIES WITHIN A FEW TENTHS DEGREE C OF ZERO THROUGH LATE SPRING 2014, SUGGESTING CONTINUED ENSO NEUTRAL CONDITIONS. THERE IS A GROWING CONSENSUS AMONG BOTH STATISTICAL AND DYNAMICAL MODELS FOR A SLOW INCREASE IN NINO 3.4 SST ANOMALIES INTO AT LEAST THE LATE SPRING 2014, WITH ANOMALIES LIKELY BECOMING SLIGHTLY POSITIVE EARLY IN THE YEAR. THE RANGE OF SOLUTIONS AMONG MODELS, AND THE INDIVIDUAL MODEL ENSEMBLES SUGGEST THAT IT IS TOO EARLY TO MAKE A PREDICTION OF ENSO CONDITIONS BEYOND MID-2014, ALTHOUGH THE PROBABILISTIC PREDICTIONS FROM THE CPC CONSOLIDATION OF SST FORECASTS SHOW ENHANCED ODDS FOR EITHER NEUTRAL OR EL NINO CONDITIONS WITH NO CLEAR INDICATION OF WHICH CATEGORY TO FAVOR. THUS ENSO NEUTRAL CONDITIONS ARE STRONGLY FAVORED THROUGH THE END OF THE YEAR AND THE FIRST HALF OF 2014, WITH AN UNCERTAIN EVOLUTION THEREAFTER.

PROGNOSTIC TOOLS USED FOR U.S. TEMPERATURE AND PRECIPITATION OUTLOOKS

THE TEMPERATURE AND PRECIPITATION OUTLOOKS WERE MADE CONSIDERING ENSO NEUTRAL CONDITIONS TO BE MOST LIKELY THROUGH AT LEAST LATE SPRING 2014. THE FORECASTS FROM DJF 2013-14 THROUGH MAM 2014 WERE BASED ON A COMBINATION OF STATISTICAL TOOLS, INCLUDING ONE BASED ON THE CONSTRUCTED ANALOG SST FORECAST, AND DYNAMICAL MODEL GUIDANCE (CFS, AND MEMBERS THAT COMPRISE THE NMME AND IMME). THE CON AND DECADAL TRENDS FROM THE OCN WERE CONSIDERED FOR ALL LEADS WHILE DECADAL CLIMATE TRENDS WERE THE PRIMARY SOURCE OF PREDICTABILITY FOR THE FORECASTS AFTER MAM 2014.

PROGNOSTIC DISCUSSION OF OUTLOOKS - DJF 2013 TO DJF 2014

TEMPERATURE

THE DJF 2013-14 TEMPERATURE OUTLOOK INDICATES ELEVATED CHANCES FOR ABOVE-NORMAL SEASONAL MEAN TEMPERATURES FROM THE SOUTHWESTERN CONUS EASTWARD TO THE SOUTHEASTERN STATES. ABOVE-NORMAL TEMPERATURES ARE ALSO FAVORED FOR WESTERN ALASKA. THE CHANCES FOR BELOW-NORMAL TEMPERATURES ARE ELEVATED FOR PARTS OF THE NORTHERN GREAT PLAINS AND ALSO IN THE ALASKAN PANHANDLE. THESE SIGNALS ARE EVIDENT IN A CONSENSUS OF DYNAMICAL MODELS INDICATED BY THE NMME, WHICH SHOWS A PATTERN OF FAVORING GENERALLY ABOVE NORMAL TEMPERATURES IN THE SOUTHERN CONUS, AND BELOW NORMAL TEMPERATURES EXTENDING FROM THE ALASKAN PANHANDLE EASTWARD INTO WESTERN CANADA, WITH ITS SOUTHWARD EXTENT ENDING NEAR THE U.S.-CANADIAN BORDER. THE IMME SUGGESTS A WARMER SOLUTION THAN THE NMME FOR THE WESTERN CONUS, BUT LACKS SUPPORT FROM STATISTICAL TOOLS, SUGGESTING EQUAL CHANCES FOR ABOVE, NEAR, OR BELOW NORMAL TEMPERATURES FOR NORTHERN AND CENTRAL PORTIONS OF THE WEST. MODEL FORECAST DIFFER WIDELY IN THE EASTERN CONUS. A COMBINED FORECAST FROM CCA AND SMLR SUPPORTS INCREASED ODDS OF ABOVE-NORMAL TEMPERATURES NEAR NEW ENGLAND.

THE PATTERN PREDICTED BY THE NMME AND IMME FOR JFM THROUGH MAM 2014 REMAINS

SIMILAR THEIR RESPECTIVE FORECASTS FOR DJF. STATISTICAL TOOLS SHOW A GRADUAL EXPANSION AND EASTWARD SHIFT OF THE REGIONS FAVORING ABOVE-NORMAL TEMPERATURES IN THE SOUTHERN CONUS, AND A WESTWARD SHIFT OF THE AREA FAVORING BELOW-NORMAL TEMPERATURES NEAR THE CANADIAN BORDER. THE OUTLOOKS FOR AMJ 2014 AND BEYOND REFLECT MAINLY TRENDS AND STATISTICAL TOOLS AS INDICATED ON THE CON TOOL. THERE ARE ENHANCED ODDS FOR ABOVE-NORMAL TEMPERATURES ACROSS MUCH OF THE SOUTH AND PARTS OF THE EASTERN CONUS THROUGH JJA 2014, WITH THE HIGHEST PROBABILITIES INDICATED FOR THE SOUTHWEST. FROM JAS TO ASO 2014, THERE ARE ELEVATED ODDS OF ABOVE-NORMAL TEMPERATURES ACROSS MUCH OF THE WESTERN CONUS, THE NORTHEAST, AND FLORIDA. LONG TERM POSITIVE TEMPERATURE TRENDS, LIKELY FROM REDUCED ARCTIC OCEAN SEA ICE COVER AND ASSOCIATED IMPACTS FAVOR ABOVE-NORMAL TEMPERATURES FOR THE NORTH SLOPE OF ALASKA FROM AMJ 2014 THROUGH OND 2014.

IN AREAS WITHOUT SUBSTANTIAL AND RELIABLE CLIMATE SIGNALS, EQUAL CHANCES OF BELOW-, NEAR- AND ABOVE-NORMAL SEASONAL MEAN TEMPERATURES ARE INDICATED.

PRECIPITATION

THE DJF 2013-14 PRECIPITATION OUTLOOK INDICATES ENHANCED ODDS FOR ABOVE-MEDIAN SEASONAL TOTAL PRECIPITATION FOR PARTS OF THE NORTHERN ROCKIES, PRIMARILY BASED ON DYNAMICAL MODEL GUIDANCE FROM THE NMME. THE NMME FAVORS BELOW-MEDIAN SEASONAL PRECIPITATION TOTALS FOR THE ALASKAN PANHANDLE. THE CON, STATISTICAL FORECAST TOOLS AND DYNAMICAL MODEL GUIDANCE FROM MEMBERS OF THE NMME AND IMME SUPPORT ELEVATED CHANCES OF BELOW-MEDIAN PRECIPITATION FOR AREAS IN THE SOUTHEASTERN CONUS FROM DJF 2013-14 THROUGH FMA 2014. THERE IS A GENERAL CONSENSUS FROM BOTH DYNAMICAL AND STATISTICAL MODELS FOR BELOW-MEDIAN PRECIPITATION OVER THE SOUTHWEST, SOUTHERN ROCKIES AND PARTS OF THE SOUTHERN GREAT PLAINS FROM DJF 2013-14 THROUGH AMJ 2014.

SEASONAL PRECIPITATION SIGNALS ARE WEAK AND UNRELIABLE FOR MOST OF THE REMAINING SEASONS, EXCEPT FOR THE PACIFIC NORTHWEST IN JJA AND JAS 2014, WHERE RECENT TRENDS FAVOR BELOW-MEDIAN PRECIPITATION. TRENDS ALSO FAVOR DRY CONDITIONS FOR THE SOUTHEASTERN CONUS LEADING TO ELEVATED CHANCES FOR BELOW-MEDIAN PRECIPITATION AMOUNTS FROM NDJ THROUGH DJF 2014-2015, ALTHOUGH THE ACTUAL WINTERTIME PRECIPITATION IN THIS REGION IS LARGELY DEPENDENT ON THE ENSO STATE, WHICH CURRENTLY IS UNCERTAIN AT THESE LEADS.

IN AREAS WITHOUT SUBSTANTIAL AND RELIABLE CLIMATE SIGNALS, EQUAL CHANCES OF BELOW-, NEAR- AND ABOVE-MEDIAN SEASONAL TOTAL PRECIPITATION AMOUNTS ARE INDICATED.

FORECASTER: DAVID UNGER

THE CLIMATIC NORMALS ARE BASED ON CONDITIONS BETWEEN 1981 AND 2010, FOLLOWING THE WORLD METEROLOGICAL ORGANIZATION CONVENTION OF USING THE MOST RECENT 3 COMPLETE DECADES AS THE CLIMATIC REFERENCE PERIOD. THE PROBABILITY ANOMALIES FOR TEMPERATURE AND PRECIPITATION BASED ON THESE NEW NORMALS BETTER REPRESENT SHORTER TERM CLIMATIC ANOMALIES THAN THE FORECASTS BASED ON OLDER NORMALS.

FOR A DESCRIPTION OF OF THE STANDARD FORECAST TOOLS - THEIR SKILL- AND THE FORECAST FORMAT PLEASE SEE OUR WEB PAGE AT
HTTP:/WWW.CPC.NCEP.NOAA.GOV/PRODUCTS/PREDICTIONS/90DAY/DISC.HTML
(USE LOWER CASE LETTERS)
INFORMATION ON THE FORMATION OF SKILL OF THE CAS FORECASTS MAY BE FOUND AT:
HTTP://WWW.CPC.NCEP.NOAA.GOV/SOILMST/FORECASTS.HTML (USE LOWERCASE LETTERS)
NOTES - THESE CLIMATE OUTLOOKS ARE INTENDED FOR USE PRIOR TO THE START OF THEIR VALID PERIOD. WITHIN ANY GIVEN VALID PERIOD OBSERVATIONS AND SHORT AND MEDIUM RANGE FORECASTS SHOULD BE CONSULTED.

THIS SET OF OUTLOOKS WILL BE SUPERSEDED BY THE ISSUANCE OF THE NEW SET NEXT MONTH ON DEC 19 2013

1981-2010 BASE PERIOD MEANS WERE IMPLEMENTED EFFECTIVE WITH THE MAY 19, 2011 FORECAST RELEASE.
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NOAA/ National Weather Service
National Centers for Environmental Prediction
Climate Prediction Center
5200 Auth Road
Camp Springs, Maryland 20746

Climate Prediction Center Web Team
Page last modified: January 17, 2006

Pacific and Atlantic Ocean influences on multidecadal drought frequency in the United States

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Edited by Inez Y. Fung, University of California, Berkeley, CA, and approved January 12, 2004 (received for review October 17, 2003)

More than half (52%) of the spatial and temporal variance in multidecadal drought frequency over the conterminous United States is attributable to the Pacific Decadal Oscillation (PDO) and the Atlantic Multidecadal Oscillation (AMO). An additional 22% of the variance in drought frequency is related to a complex spatial pattern of positive and negative trends in drought occurrence possibly related to increasing Northern Hemisphere temperatures or some other unidirectional climate trend. Recent droughts with broad impacts over the conterminous U.S. (1996, 1999–2002) were associated with North Atlantic warming (positive AMO) and northeastern and tropical Pacific cooling (negative PDO). Much of the long-term predictability of drought frequency may reside in the multidecadal behavior of the North Atlantic Ocean. Should the current positive AMO (warm North Atlantic) conditions persist into the upcoming decade, we suggest two possible drought scenarios that resemble the continental-scale patterns of the 1930s (positive PDO) and 1950s (negative PDO) drought.

Although long considered implausible, there is growing promise for probabilistic climatic forecasts one or two decades into the future based on quasiperiodic variations in sea surface temperatures (SSTs), salinities, and dynamic ocean topographies. Such long-term forecasts could help water managers plan for persistent drought across the conterminous United States (1). The urgency for such planning became evident when much of the U.S. was gripped by drought in 1996 and again in 1999–2003, evoking images of the dry 1930s and 1950s.

Analyses and forecasting of U.S. precipitation have focused primarily on the Pacific Ocean, and more specifically on oceanic indices such as those used to track the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO). Much of the long-term predictability in North American climate, however, may actually reside in both observed and modeled multidecadal (50–80 years) variations in North Atlantic SSTs (2–7). Modeling studies indicate that multidecadal variability in North Atlantic climate is dominated by a single mode of SST variability (7). An important characteristic of this mode of SST variability is that the SST anomalies have the same sign across the entire North Atlantic Ocean and resemble the Atlantic Multidecadal Oscillation (AMO). The AMO is an index of detrended SST anomalies averaged over the North Atlantic from 0–70°N and has been identified as an important mode of climate variability (8). Warm phases occurred during 1860–1880 and 1930–1960, and cold phases occurred during 1905–1925 and 1970–1990. Since 1995, the AMO has been positive, but it is uncertain whether this condition will persist long enough to be considered a new warm phase. These large swings in North Atlantic SST's are probably caused by natural internal variations in the strength of ocean thermohaline circulation and the associated meridional heat transport (6, 7).

Recent analysis has shown that the AMO has a strong influence on summer rainfall over the conterminous U.S., and may modulate the strength of the teleconnection between the El Niño Southern Oscillation (ENSO) and winter precipitation (8). Positive AMO conditions (warm North Atlantic SSTs) since 1995, and the cold PDO episode from 1998 to 2002, have together raised concerns among scientists about the potential for an emerging megadrought that could pose serious problems for water planners. Here, we decompose drought frequency in the conterminous U.S. into its primary modes of variability without *a priori* consideration of climate forcing factors. These modes are then related both spatially and temporally to the PDO and AMO to determine the relative influence of the SST patterns tracked by these indices on the probability of drought. Consideration of the potential role of the Northern Hemisphere (NH) temperature or some other unidirectional trend also proved necessary to understand the variance in drought frequency. Given the time scales and current conditions of the three climate indices, we explore two possible drought scenarios for the upcoming decade.

Materials and Methods

Drought frequency for 20-year moving periods was calculated for each of the 344 climate divisions in the conterminous U.S. for the period 1900–1999. This period of record was chosen for analysis because it is common to all of the data sets used in this study (i.e., climate division precipitation, annual PDO, annual AMO, and annual NH temperature).

The climate division precipitation data were obtained from the National Climatic Data Center in Asheville, North Carolina via the internet at (http://www1.ncdc.noaa.gov/pub/data/cirs). The climate division data represent monthly means of climate station observations from regions within states that are considered to be climatically homogeneous (9). In addition, the data for the climate divisions have been corrected for time-of-observation bias (10). Although extreme climatic variations can occur in areas of complex terrain, such as the mountainous areas of the western U.S., standardized departures of temperature and precipitation from normal are spatially consistent within a climate division (9).

The PDO data were obtained from the University of Washington at (ftp://ftp.atmos.washington.edu/mantua/pnw_impacts/INDICES/PDO.latest), and the AMO data were obtained by personal communication with David Enfield (National Oceanographic and Atmospheric Administration Atlantic Oceanographic and Meteorological Laboratory, Miami). Mean annual NH temperature data also were used for part of the study and these data were obtained from the Climate Research Unit, East Anglia, U.K. (www.cru.uea.ac.uk/cru/data/temperature).

Drought conditions were considered to exist in a climate division if annual precipitation was in the lowest quartile (25%) of the 100-year record. Other definitions of drought frequency also were examined, such as the number of years with precipitation in the lowest 33% or the lowest 20% of the distribution, or annual Palmer Drought Severity Index (PDSI) values below specified thresholds; all approaches produced similar temporal and spatial results. For 20-year moving windows, the number of

This paper was submitted directly (Track II) to the PNAS office.

Abbreviations: SST, sea surface temperature; PDO, Pacific Decadal Oscillation; AMO, Atlantic Multidecadal Oscillation; NH, Northern Hemisphere.

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www.pnas.org/cgi/doi/10.1073/pnas.0306738101

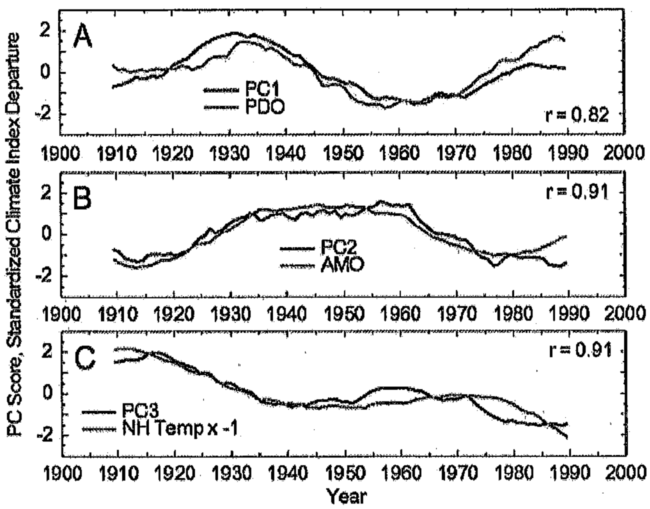

Fig. 1. Scores from the first three components (PC1, PC2, and PC3) of a rotated principal components analysis of 20-year moving drought frequency in the conterminous United States, compared to standardized departures of 20-year moving averages of the annual PDO, AMO, and NH temperature (NH Temp). The NH Temp values are multiplied by −1 for easy comparison with PC3 scores. All values are plotted at the centers of the window periods.

years with drought conditions was computed for each climate division and assigned to the center of the window period (10- and 30-year moving windows also were examined and produced results similar to those from the analysis of 20-year moving windows). The time series of 20-year moving drought frequencies (hereafter referred to as drought frequency) then were subjected to a rotated principal components analysis (RPCA) with varimax rotation to identify the primary modes of variability in the drought frequency data. The scores and loadings of the leading rotated principal components were subsequently examined and compared with 20-year moving averages of the PDO and AMO to better understand how these climate indices are related to the temporal and spatial variability of drought in the conterminous U.S.

Results and Discussion

The rotated principal components analysis (RPCA) of drought frequencies for the 344 climate divisions in the conterminous U.S. produced three leading components (PC1, PC2, and PC3) that explain 74% of the total variance in the drought frequency data; after varimax rotation, PC1 explains 24% of the total variance in drought frequency, PC2 explains 28%, and PC3 explains 22%. The score time series (Fig. 1) illustrate the temporal variability of the drought frequency components, and the loadings (Fig. 2*A*–*C*) illustrate the spatial pattern of drought frequency variability represented by each component.

The scores for PC1 (Fig. 1*A*) are positive for 20-year periods centered from around 1920 to the mid- to late 1940s, are negative from the late 1940s until the late 1970s, and are slightly positive after the 1970s. This decadal variability in drought frequency is similar to variability in the PDO (Fig. 1*A*). The correlation between PC1 scores and 20-year moving mean annual PDO is 0.82.

Because of the large autocorrelation inherent in smoothed time series, the degrees of freedom must be estimated to use standard statistical significance tests. Instead, an alternative approach was used to assess the significance of the correlations between the PC score and climate index time series. A Monte Carlo approach (11) was used that involves the shuffling of the raw climate index time series 1,000 times. Each shuffled time series was subsequently smoothed with a 20-year moving average and then correlations between the smoothed shuffled time series and the PC scores were computed. The 95th and 99th percentiles of the resulting correlations (0.69 and 0.83, respectively) then were compared with the correlations obtained between the PC scores and the observed 20-year moving average climate index time series. The results of this analysis indicated that the correlation ($r = 0.82$) between the time series shown in Fig. 1*A* is between the 98th and 99th percentile of correlations from the 1,000 trials, indicating a high level of statistical significance.

To further compare PC1 with PDO, the loadings of drought frequency for each climate division on PC1 (Fig. 2*A*) were compared with correlations between 20-year moving average annual PDO and drought frequency for each climate division (Fig. 2*D*). Comparison of these figures indicates that the patterns of the PC1 loadings and the PDO correlations are similar. Both indicate negative values for the southwestern U.S. that extend into the Rocky Mountain region and the south-central U.S. (Fig. 2 *A* and *D*). Negative values also are found in the northeastern U.S. Positive values are indicated in the northwestern U.S., the north-central plains, and most of the southeastern U.S. The correlation between these patterns is 0.92. The PDO has been shown previously to modulate winter precipitation in the U.S. (12–14), as well as summer drought and streamflow in the conterminous U.S. (15).

The strong correlation of the spatial patterns represented by the PC1 loadings and the PDO correlations (Fig. 2 *A* and *D*), when combined with the magnitude of the time series correlation, strongly supports the conclusion that the first mode of drought frequency identified in this study is a response to the multidecadal variability of the PDO. The annual response pattern is a combination of the winter and summer influences of PDO on precipitation. Although both seasons share a dipolar response in the northwest and southwest U.S., the response to the PDO in the Midwest is of a different sign in the summer and winter, weakening the annual response in that region.

The scores for PC2 increase from the early part of the record to the 20-year period centered around 1930. The score values remain relatively constant until after 1960, when they decline until the end of the period of record (Fig. 1*B*). This time series corresponds to the temporal variability of the AMO (Fig. 1*B*). The correlation between PC2 scores and 20-year moving average annual AMO is 0.91, which is significant at the 99th percentile.

Loadings for PC2 (Fig. 2*B*) and correlations between 20-year moving average annual AMO and drought frequency (Fig. 2*E*) are highly similar (the correlation between these patterns is 0.95). Maps of the PC2 loadings and the AMO correlations indicate positive values for most of the central two-thirds of the conterminous U.S. and suggest an almost nationwide covariance of drought frequency (Fig. 2 *B* and *E*). Previous research has shown that, during positive AMO conditions, the central U.S. receives below-average precipitation, particularly during summer (1, 8). The large positive correlations between smoothed AMO and drought frequency for the central U.S. (Fig. 2*E*) support this statement. This mode explains 28% of the variance in drought frequency, and covers a large geographical area with uniformly strong loadings. Correlations between smoothed AMO and similarly smoothed climate division precipitation (the inverse of drought frequency) produced a continental-scale pattern of negative correlations (8).

Scores for PC3 indicate a long-term negative trend (Fig. 1*C*). Areas with negative loadings had an increasing trend in drought frequency (Fig. 2*C*), whereas areas with positive loadings had a decreasing trend in drought frequency. Geographically, California, the northern Rocky Mountains, and the Ohio Valley (negative loadings) have experienced an increasing tendency for drought, whereas the Pacific Northwest, a band from New York

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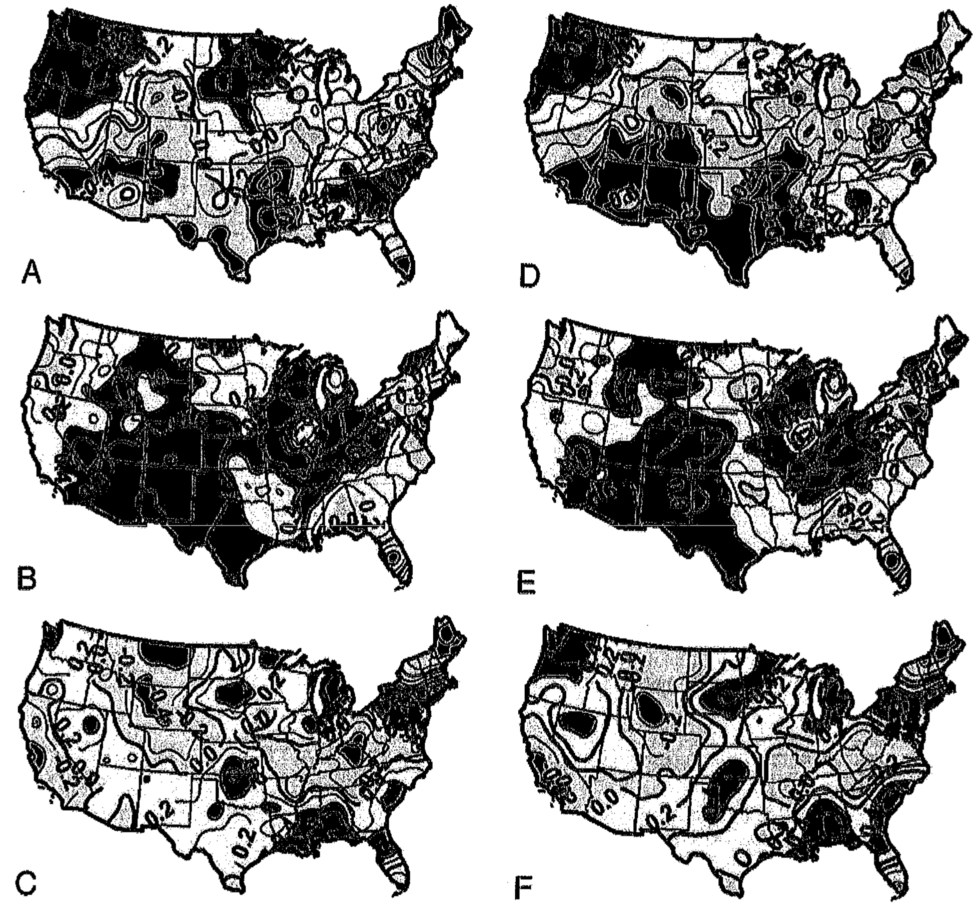

Fig. 2. (*A–C*) Loadings for the first three components of a rotated principal components analysis of 20-year moving drought frequency in the conterminous United States. (*D*) Correlations between 20-year moving drought frequencies and 20-year moving annual PDO. (*E*) Correlations between 20-year drought frequency and 20-year moving AMO. (*F*) Inverse of trends in 20-year drought frequency. The correlations in *F* were multiplied by −1 for easy comparison with other figures. Positive values are shaded red, and negative values are shaded blue. Darker shades indicate values >0.4 or <−0.4.

to the Upper Midwest, and the Gulf Coast (positive loadings) have had a decreasing tendency for drought.

The pattern of loadings for PC3 (Fig. 2*C*) is very similar to the spatial pattern of the inverse of trends in 20-year moving drought frequency (Fig. 2*F*) (correlation coefficient is 0.91). The trends in 20-year moving drought frequency were multiplied by −1 for direct comparison with the PC3 loadings and were computed as linear correlations with time.

The PC3 score time series does not appear to be related to known atmosphere–ocean modes of variability; instead, it matches well with both a trend line and the time series of mean annual NH temperature. In Fig. 1*C*, the NH temperatures were multiplied by −1 for direct visual comparison with the scores for PC3. Instrumental observations of NH temperatures indicate a generally increasing trend with some distinct inflections over the period of record used in this study (16); the inverse 20-year moving mean annual NH temperatures are significantly correlated with PC3 scores (correlation coefficient is 0.91, $P < 0.01$).

These results suggest that PC3 reflects a regional pattern of changes within the hydrologic cycle that may be related indirectly with increases in NH temperature, or may be trending in response to some other forcing that has not yet been identified. Climate modeling studies indicate that a substantial intensification of the global hydrologic cycle is likely in a warming world, although the regional patterns of temperature and precipitation responses are likely to be complex (16).

Because previous research showed relations between drought in the conterminous U.S. and El Niño/Southern Oscillation (ENSO) (17), we compared 20-year moving averages of annual NINO3.4 SSTs, representing ENSO conditions, with the PC scores of drought frequency examined in this study (NINO3.4 SSTs are averaged for the region from 5°N latitude to 5°S latitude and from 170°W longitude to 120°W longitude; these data were obtained via the internet from http://climexp.knmi.nl).

Correlations between the smoothed NINO3.4 time series and the PC scores were strongest for PC2 (−0.58). This correlation with PC2 scores is much weaker than the correlation between PC2 scores and the similarly smoothed AMO (0.91), and is not statistically significant.

To test the interpretation of the PCA analysis that PDO, AMO, and a trend such as that represented by NH temperature explain a large percent of the temporal and spatial variability in multidecadal drought frequency in the conterminous U.S., regressions were developed to estimate drought frequency for the 344 climate divisions of the conterminous U.S. The regressions were developed by using 20-year moving drought frequency as the dependent variable and 20-year moving average annual PDO, AMO, and NH temperature as the independent variables. The median coefficient of determination for the regressions for all 344 climate divisions was 0.72 (the mean was 0.68, the first quartile was 0.58, and the third quartile was 0.81), indicating that, on average, ≈70% of the temporal variability in drought fre-

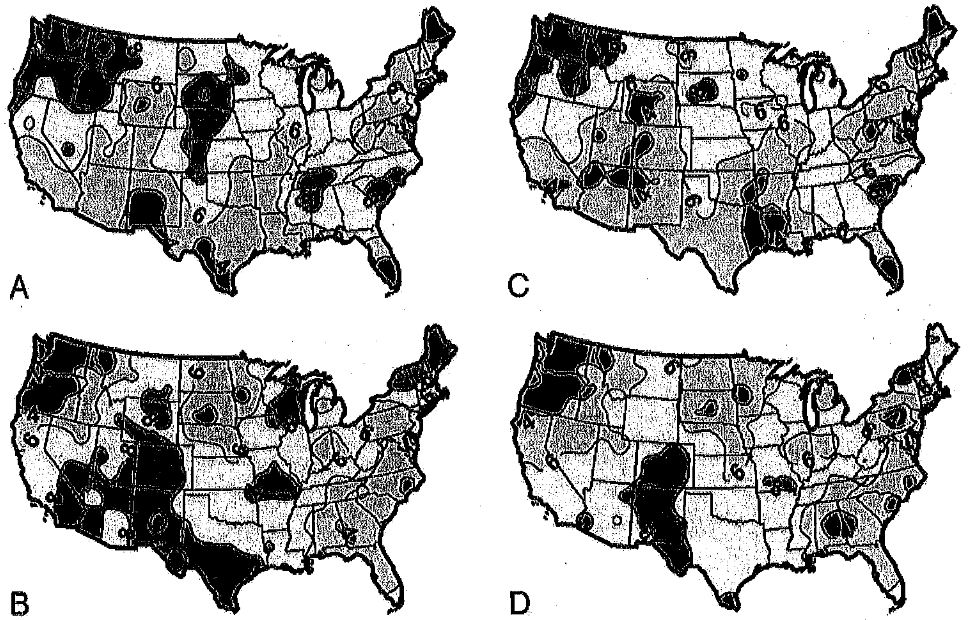

Fig. 3. Observed (*A* and *B*) and simulated (*C* and *D*) 20-year drought frequency (in years) for 1924–1943 (the 1930s drought) and 1947–1966 (the 1950s and 1960s droughts). Areas with drought frequencies of 6 years or more are indicated in red.

quency for the climate divisions is explained by the PDO, AMO, and NH temperature.

The reliability of the regressions to explain the spatial variability in drought frequency was evaluated by comparing observed and simulated drought frequency for specific periods (Fig. 3). Because 20-year moving periods were used to compute drought frequency, the period for 1924–1943 provided an example incorporating the 1930s drought, and the period 1947–1966 was chosen to encompass both the 1950s drought and the 1960s Northeast drought. Results indicate that the spatial distributions of drought frequency for these periods represented by the observed and simulated drought frequencies are highly similar. The correlation between the observed and simulated drought frequency values for the 1924–1943 period (Fig. 3 *A* and *C*) is 0.91 ($P < 0.01$), and for the 1947–1966 period (Fig. 3 *B* and *D*), the correlation is 0.92 ($P < 0.01$). The correlations between observed and simulated drought patterns for all 20-year periods examined in this study ranged from 0.70 to 0.95, with a median value of 0.88.

To validate the robustness of the regressions used to simulate the spatial patterns of drought for the 1924–1943 and the 1947–1966 periods, additional regressions were developed, excluding in each case the 20-year periods of interest. The correlations between the observed and simulated spatial patterns of drought using the new regressions were 0.83 ($P < 0.01$) for 1924–1943 and 0.86 ($P < 0.01$) for 1947–1966. These correlations, although somewhat smaller than those using all of the data, indicate that the regressions are robust.

These results indicate that, in addition to reliably explaining the temporal variability in drought frequency, the regression equations also reliably explain the spatial variability in drought frequency. Without inclusion of all three time series, the PDO, AMO, and NH temperature, the fidelity of the regression modeled drought frequency pattern with the observed pattern is substantially reduced.

So what are the prospects for drought under varying PDO and AMO regimes? Annual time series of PDO and AMO were used to identify periods of positive and negative PDO and AMO regimes (Fig. 4). Four periods were identified: (*i*) positive PDO and positive AMO (1926–1943), (*ii*) negative PDO and positive AMO (1944–1963), (*iii*) negative PDO and negative AMO (1964–1976), and (*iv*) positive PDO and negative AMO (1977–1994). Composite drought frequencies were computed for the four combinations of PDO and AMO regimes. The drought frequencies were determined by counting the number of years at each climate division with annual precipitation in the lowest quartile of the 1900–1999 record, and were expressed as a percent of the total number of years in each PDO/AMO regime category. Because the normal rate of occurrence of precipitation in the lowest quartile is 25% of the time, composite percentages >25% represent a greater than normal probability of drought, and values <25% characterize less than normal chances of drought.

Fig. 5 shows drought frequencies for the four general scenarios based on different combinations of the AMO and PDO. In the case of negative AMO, above normal drought frequency is restricted to a few regions, for example, to the Pacific Northwest and Maine during positive PDO (Fig. 5*A*) and southern California and the central High Plains during negative PDO (Fig. 5*B*). Irrespective of the PDO phase, positive AMO is associated with an above normal frequency of drought across large parts of the U.S. With positive AMO and positive PDO (Fig. 5*C*), the pattern is more reminiscent of the 1930s drought, sparing the Southwest but entraining the northern two-thirds of the U.S. With positive AMO and negative PDO (Fig. 5*D*), the pattern is that of the 1950s drought with the greatest impact in the Midwest, Southwest, and the Rocky Mountains/Great Basin area.

Because the AMO generally has greater multidecadal persistence than the PDO, North Atlantic warming that began in 1995 may continue. After a negative downturn in mid-1998, the PDO reversed sign in mid-2002. Given the current positive anomalies in North Atlantic SSTs (positive AMO), continuation of the present 1999–2003 drought is more likely than normal, and a decadal-scale drought may be emergent. The pattern of recent drought in the conterminous U.S. resembles a 1950s-like drought (positive AMO and negative PDO) (Figs. 3*B* and 5*D*). However, if the AMO continues to be positive and the PDO becomes

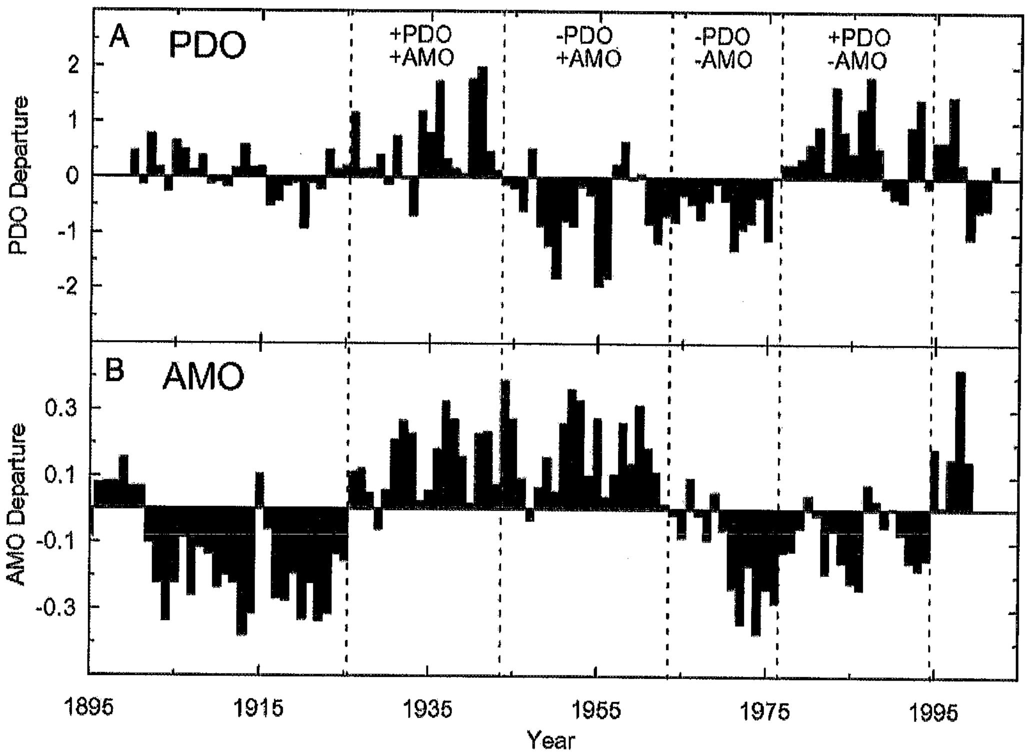

Fig. 4. Time series of the annual PDO and AMO. Shaded areas indicate combinations of positive (+) and negative (−) PDO and AMO periods.

positive, the drought pattern could shift to one more like the 1930s era (Figs. 3*A* and 5*C*). Although it is always prudent to be conservative about water resources, particularly in the semiarid West, it may be particularly necessary in the next decade.

Conclusions

Three rotated principal components explain 74% of the variance in 20-year moving frequencies of drought in the conterminous U.S. The first component is highly correlated with the PDO, and the second component is correlated with the AMO. These first two components explain nearly equal proportions of variance in the entire data set and, combined, explain 52% of the total variance. These results support previous research that has indicated the existence of a relation between these climate indices and drought variability in the U.S. The third component represents a complex pattern of positive and negative trends in U.S.

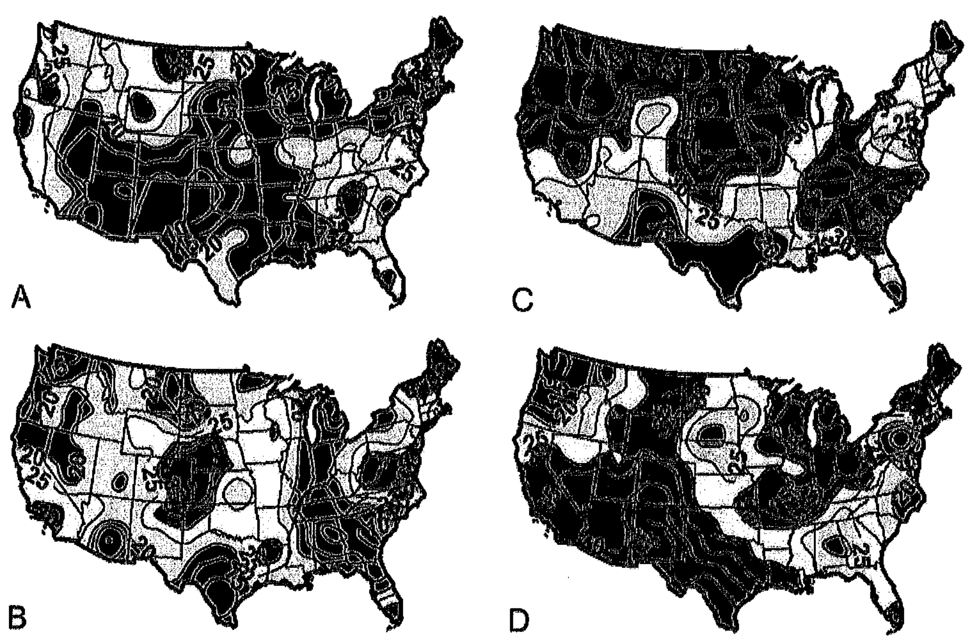

Fig. 5. Drought frequency (in percent of years) for positive and negative regimes of the PDO and AMO. (*A*) Positive PDO, negative AMO. (*B*) Negative PDO, negative AMO. (*C*) Positive PDO, positive AMO. (*D*) Negative PDO, positive AMO.

drought frequency over the 20th Century, and its score time series is highly correlated with both a trend line and the inverse NH temperature time series. The inclusion of all three time series, the PDO, AMO, and a trending geophysical indicator like NH temperature, appears to be crucial in generating multiple regression equations that can accurately simulate the historical 20-year patterns of drought frequency. This research indicates that persistence of the current positive AMO state may lead to continuing above normal frequencies of U.S. drought in the near future, with the pattern of drought modulated by the sign of the PDO.

This work was partially supported by National Oceanographic and Atmospheric Administration Cooperative Agreement NA67RJ0146.

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Attachment M

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF DAVID WHEELOCK

THE STATE OF TEXAS	§	
	§	
COUNTY OF TRAVIS	§	

Before me, the undersigned authority, personally appeared David Wheelock, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct. The tabs attached to this affidavit and referred to herein are incorporated by reference.

3. I, David Wheelock, am an individual residing in Travis County, Texas.

4. I have a Bachelor of Science in Civil Engineering from the University of Texas at Austin and a Master of Science in Civil Engineering with a water resources specialty from the University of Texas at Austin. I am a registered Professional Engineer in the State of Texas. A true and correct copy of my resume, detailing my prior work history and education, is attached hereto under Tab 1.

5. I have worked for the Lower Colorado River Authority ("LCRA") for more than three years. At LCRA, I have been responsible for the development and maintenance of various plans and permits directly affecting LCRA's water supply. I currently manage LCRA's water rights portfolio and active permit applications, Water Management Plan amendment process, groundwater development initiatives, and am the designated representative to the Region K Regional Water Planning Group. I am personally familiar with LCRA's raw water system, its water rights, and the TCEQ-approved LCRA Water Management Plan ("WMP"), which governs LCRA's operations of lakes Buchanan and Travis. In my position, I am responsible for understanding LCRA's raw water customer water needs now and in the future. In my position, I have also been involved in evaluating various alternative water supplies for LCRA's firm water customers.

6. My opinions stated herein are based on my over thirty years of experience in water supply development, water supply planning, and regulation of water rights in the state of Texas. I have also relied upon a variety of information provided to me by LCRA staff, which is of a nature typically relied upon in my profession, as described below and for which true and correct copies are attached and incorporated herein:

a. Map of LCRA Water Service Area, attached hereto under Tab 2;

b. Summary of Water Supply Alternatives, attached hereto under Tab 3, prepared by LCRA staff;

c. Excerpts of the 2010 LCRA Water Management Plan;

d. Affidavit of Ron Anderson, including attachments;

e. Affidavit of Ryan Rowney, including attachments;

f. Affidavit of Nora Mullarkey Miller, including attachments; and

g. Affidavit of Bob Rose, including attachments.

7. Based on the foregoing review and the reasons stated herein, my expert opinion on the following issues is set forth below:

a. <u>LCRA Firm Customer Demands</u>.

i. LCRA provides raw water from the firm water supply lakes Buchanan and Travis to over 60 retail and wholesale potable water suppliers that together serve over one million people. See Map of LCRA's Service Area, attached here under Tab 2. LCRA's municipal raw water customers include, but are not limited to, the Cities of Austin, Burnet, Cedar Park, Leander, Marble Falls, Pflugerville, Lakeway, Bee Cave, Horseshoe Bay, other Highland Lakes cities, water supply corporations, special districts (including LCRA's own water utility systems), and investor-owned utilities. In addition, LCRA provides water to several electric utilities—LCRA, Bastrop Energy Partners, Austin Energy, Gen-Tex Corporation, and South Texas Project Nuclear Operating Company—from the firm water supply of lakes Buchanan and Travis. These electric utilities provide power into the electrical grid in Texas operated by the Electric Reliability Council of Texas ("ERCOT") and provide electricity to customers in Texas. LCRA also provides firm raw water to several industries located downstream of the Highland Lakes, including Oxea Chemical and Underground Services Markham.

ii. The maximum historical annual amount of water use by firm water customers from lakes Buchanan and Travis during 2000 through 2011 was about 247,000 acre-feet in 2011. (*See* Affidavit of Ryan Rowney.)

b. Emergency Relief – Only Resonable Alternative to Protect Firm Supply

i. There are no reasonably available and feasible practicable alternative water supplies or water management or conservation strategies that could be obtained or implemented at this time that would replace the volume of water that LCRA might otherwise have to release from the lakes if the requested relief is not granted that LCRA is not already pursuing. As demonstrated by the summary of alternatives attached hereto under Tab 3, most of the supplies identified would produce insufficient or uncertain quantities of supply, are constrained by existing contractual commitments, would create other operational issues for customers, and/or are subject to a high level of regulatory uncertainty and lengthy permitting process if not obtained on an emergency basis. In most cases, these alternatives would take years to develop and transport to the area of use. In short, none of the additional strategies identified would allow LCRA to prevent the need for the relief requested in its application.

ii. For 2012 and 2013, LCRA has obtained temporary permits that allow LCRA to use its downstream water rights to meet some of the needs of firm water customers downstream of the Highland Lakes, to the extent that those supplies are not being used to meet agricultural needs in the four irrigation operations. LCRA is seeking similar authorization for 2014. However, the amount of demand that can be met using these downstream water rights is limited by the availability of run-of-river flows and subject to envirionmental flow requirements. In 2012, LCRA was able to divert about 4,000 acre-feet under the temporary authorizations. In addition, in 2011 LCRA obtained a permanent amendment to its Gulf Coast water right (14-5476) that allows use for industrial purposes. In 2012, about 9,000 acre-feet of industrial demands were met with that amended water right. These authorizations have the potential to conserve water in the Highland Lakes, but as demonstrated by the amounts used in 2012, the amounts are limited when compared to the amount of interruptible stored water that might be made available under the 2010 WMP.

iii. LCRA and its customers are taking action to bring on some additional supplies. LCRA has recently obtained groundwater production permits in Bastrop County and is currently installing wells which will meet a portion of the demand at the Lost Pines Power Park. In response to the drought, the City of Burnet has turned to its groundwater wells to meet a portion of the city's demand. These additional supplies, while important, are not of the scale to offset potential shortages under worsening drought conditions.

c. Adequacy of Emergency Relief. It is my opinion that strict adherence to the 2010 WMP presents too great of a risk that LCRA will have to make a Drought Worse than Drought of Record declaration in 2014. Even with emergency relief in place in 2012 and 2013, the combined storage in lakes Buchanan and Travis has not recovered. Limiting the supply of interruptible stored water for first crop in 2014 to the conditions and amounts specified in this application is a prudent drought response that would help maintain the overall supply of water available to all of LCRA's firm water customers.

Further affiant sayeth not.

DAVID WHEELOCK, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 10th day of December, 2013.

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2014

David C. Wheelock, PE
Manager, Water Supply and Conservation
Lower Colorado River Authority

David Wheelock is a key member of LCRA's water resources planning and management team.

He is an experienced water resources engineer and manager in water planning with river authorities and in consulting. He has been in responsible charge of managing wholesale raw water systems, contract administration, hydrologic modeling, water rights modeling, water supply planning, acquisition of water supplies, reservoir management, dam safety and hydroelectric generation development. Mr. Wheelock has participated in the development and implementation of strategic plans, setting direction and goals, advising senior management, and working with local entities, governments, and engineering firms to create solutions to water resource problems.

EXPERIENCE

Manager, Water Supply and Conservation, Lower Colorado River Authority — Austin, TX, 2010-2013

From 2010-2011, supervised the Water Resources Planning and Management Department and the Water Conservation Department. As such, he was responsible for the development and maintenance of various plans and permits directly affecting LCRA's wholesale water supply. He obtained a number of important water right amendments, including changes to senior water rights to better manage the resource.

Currently, Mr. Wheelock is managing LCRA's water rights portfolio and active permit applications, Water Management Plan amendment process, groundwater development initiatives, and is the designated representative to the Region K Regional Water Planning Group.

Water Services Manager, Brazos River Authority — Waco, TX, 2004 - 2010

Supervised the Water Services Department in the day-to-day management of eleven water supply reservoirs to meet contractual commitments and permit requirements. Was responsible for the administration of water supply contracts, compliance with state water right permits, controlling releases for water supply and during flood events, support for water rights applications (i.e. System Operations Permit application), and water supply planning.

Principal Engineer, Brazos River Authority — Waco, TX, 2002 - 2004

In-house consultant to the General Manager, Regional Managers, and the Planning & Development Department in performing and implementing the goals of the Authority, as well as support for on-going operations. Provided leadership for planning, permitting, and design functions throughout the Authority's area of operations; communicating technical aspects of the vision and goals of the Authority; working closely with Authority technical staff; reviewing plans/specifications for new work and rehabilitation of existing projects; and, carrying out duties in accordance with the Authority's Strategic Plan.

Vice President, HDR Engineering, Inc. — Austin, TX, 1993-2002

Project management, marketing, and leadership responsibilities for major water resource planning efforts of river authorities and state government, including: Brazos G Regional Water Planning Area (Texas Water Development Board SB 1 and SB 2 initiatives); Trans-Texas Water Program, including Austin, San Antonio, and Williamson County study areas (LCRA, BRA, SARA, SAWS); Williamson County Water Supply Facilities Plan (BRA); Western Canyon Regional

Water System (GBRA); and, Tarrant County Water Management Plan (TRWD). Other projects include planning and conceptual engineering for the Corpus Christi area (NRA, City of Corpus Christi); project management for rehabilitation of DeCordova Bend Dam flood control gates (Lake Granbury - BRA), rehabilitation of critical components of the flood control gates Morris Sheppard Dam (Possum Kingdom Reservoir - BRA), hydroelectric evaluation and assessment at Morris Sheppard Dam, and resident engineer for outlet works replacement at Red Bluff Dam on the Pecos River (Red Bluff Water District).

Self-Employed Consulting Engineer — Annapolis, MD, 1992-1993

Self-employed consulting engineer providing services to construction and government clients. Services included construction management, scheduling, structural design, and estimating for dam rehabilitation and water resource projects.

Chief Engineer, Synergics, Inc. — Annapolis, MD, 1990-1992

In responsible charge of technical and management duties for design and construction of dam rehabilitation and hydroelectric projects.

Vice President, Gebhard Engineers — Austin, TX, 1984-1990

Project manager and engineer for a number of water resource projects, including two hydroelectric plants in New Hampshire; waterline projects; feasibility assessment of numerous hydroelectric sites; major wastewater interceptor and tunnel; hydrology studies in New Mexico and Arizona; and, general civil and water resource projects.

Project Manager, Meyer-Lytton-Allen, Inc. — Austin, TX, 1983-1984

Responsible for the engineering and construction of a number of land development and commercial development projects in Central Texas, including water and wastewater pumping stations, water pipelines, and stormwater drainage facilities.

Project Engineer, Turner Collie & Braden, Inc. — Austin, TX, 1979-1983

Responsible for the design and construction of a variety of municipal water and wastewater treatment projects, including floating water intakes; water transmission pipelines; wastewater treatment plant rehabilitations; well systems; sludge handling and digestion facilities; and regional treated water system; resident project engineer for construction of water and wastewater treatment plants.

EDUCATION and REGISTRATIONS

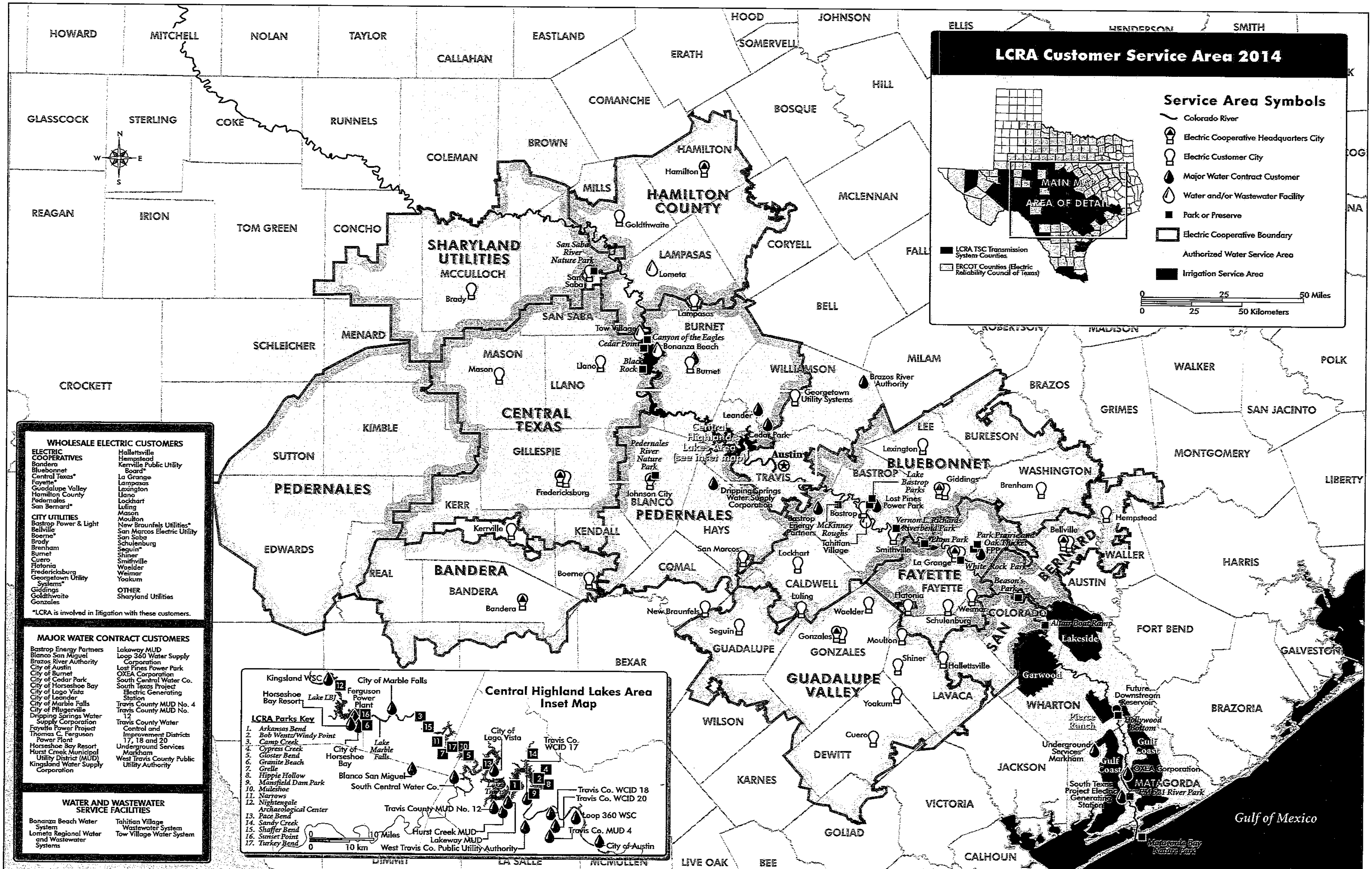
BSCE, University of Texas at Austin, 1979.
MSCE – Water Resources, University of Texas at Austin, 1986.

Registered Professional Engineer: Texas (#54303); inactive registrations: Arizona; Arkansas; Maryland; New Hampshire; Pennsylvania; Virginia.

PROFESSIONAL ASSOCIATIONS

American Water Works Association – past Chair of Standards Committee on Slide Gates.
American Society of Civil Engineers – past Director – Texas Section.

Member, SB 1094 State-wide Water Conservation Implementation Task Force.


LCRA Customer Service Area 2014
Service Area Symbols
Colorado River
Electric Cooperative Headquarters City
Electric Customer City
Major Water Contract Customer
Water and/or Wastewater Facility
Park or Preserve
Electric Cooperative Boundary
Authorized Water Service Area
Irrigation Service Area
0 25 50 Miles
0 25 50 Kilometers
MAIN MAP AREA OF DETAIL
LCRA TSC Transmission System Counties
ERCOT Counties (Electric Reliability Council of Texas)
WHOLESALE ELECTRIC CUSTOMERS
ELECTRIC COOPERATIVES
Bandera
Bluebonnet
Central Texas*
Fayette*
Guadalupe Valley
Hamilton County
Pedernales
San Bernard*
CITY UTILITIES
Bastrop Power & Light
Bellville
Boerne*
Brady
Brenham
Burnet
Cuero
Flatonia
Fredericksburg
Georgetown Utility Systems*
Giddings
Goldthwaite
Gonzales
Hallettsville
Hempstead
Kerrville Public Utility Board*
La Grange
Lampasas
Lexington
Llano
Lockhart
Luling
Mason
Moulton
New Braunfels Utilities*
San Marcos Electric Utility
San Saba
Schulenburg
Seguin*
Shiner
Smithville
Waelder
Weimar
Yoakum
OTHER
Sharyland Utilities
*LCRA is involved in litigation with these customers.
MAJOR WATER CONTRACT CUSTOMERS
Bastrop Energy Partners
Blanco San Miguel
Brazos River Authority
City of Austin
City of Burnet
City of Cedar Park
City of Horseshoe Bay
City of Lago Vista
City of Leander
City of Marble Falls
City of Pflugerville
Dripping Springs Water Supply Corporation
Fayette Power Project
Thomas C. Ferguson Power Plant
Horseshoe Bay Resort
Hurst Creek Municipal Utility District (MUD)
Kingsland Water Supply Corporation
Lakeway MUD
Loop 360 Water Supply Corporation
Lost Pines Power Park
OXEA Corporation
South Central Water Co.
South Texas Project Electric Generating Station
Travis County MUD No. 4
Travis County MUD No. 12
Travis County Water Control and Improvement Districts 17, 18 and 20
Underground Services Markham
West Travis County Public Utility Authority
WATER AND WASTEWATER SERVICE FACILITIES
Bonanza Beach Water System
Lometa Regional Water and Wastewater Systems
Tahitian Village Wastewater System
Tow Village Water System
Central Highland Lakes Area Inset Map
LCRA Parks Key
1. Arkansas Bend
2. Bob Wentz/Windy Point
3. Camp Creek
4. Cypress Creek
5. Gloster Bend
6. Granite Beach
7. Grelle
8. Hippie Hollow
9. Mansfield Dam Park
10. Muleshoe
11. Narrows
12. Nightengale Archaeological Center
13. Pace Bend
14. Sandy Creek
15. Shaffer Bend
16. Sunset Point
17. Turkey Bend
Kingsland WSC
Horseshoe Bay Resort
Lake LBJ
Ferguson Power Plant
City of Marble Falls
City of Horseshoe Bay
Lake Marble Falls
Blanco San Miguel
South Central Water Co.
City of Lago Vista
Travis Co. WCID 17
Travis Co. WCID 18
Travis Co. WCID 20
Loop 360 WSC
Travis Co. MUD 4
City of Austin
Travis County MUD No. 12
Hurst Creek MUD
Lakeway MUD
West Travis Co. Public Utility Authority
0 10 Miles
0 10 km
SHARYLAND UTILITIES
HAMILTON COUNTY
CENTRAL TEXAS
PEDERNALES
BANDERA
BLUEBONNET
FAYETTE
GUADALUPE VALLEY
SAN BERNARD
Central Highland Lakes Area (see inset map)
Gulf of Mexico
HOWARD
MITCHELL
NOLAN
TAYLOR
CALLAHAN
EASTLAND
ERATH
HOOD
SOMERVELL
JOHNSON
ELLIS
SMITH
GLASSCOCK
STERLING
COKE
RUNNELS
COLEMAN
BROWN
COMANCHE
HAMILTON
BOSQUE
HILL
MCLENNAN
CORYELL
MILLS
REAGAN
IRION
TOM GREEN
CONCHO
MCCULLOCH
SAN SABA
LAMPASAS
BELL
BURNET
WILLIAMSON
MILAM
SCHLEICHER
MENARD
MASON
LLANO
CROCKETT
SUTTON
KIMBLE
GILLESPIE
BLANCO
TRAVIS
BASTROP
LEE
BURLESON
BRAZOS
GRIMES
WALKER
POLK
SAN JACINTO
MONTGOMERY
LIBERTY
WASHINGTON
WALLER
HARRIS
AUSTIN
FORT BEND
GALVESTON
BRAZORIA
EDWARDS
REAL
KERR
KENDALL
HAYS
COMAL
CALDWELL
GUADALUPE
GONZALES
FAYETTE
COLORADO
WHARTON
MATAGORDA
LAVACA
JACKSON
BEXAR
WILSON
KARNES
DEWITT
VICTORIA
GOLIAD
CALHOUN
LIVE OAK
BEE
REFUGIO
LA SALLE
MCMULLEN
Brady
Mason
Goldthwaite
Hamilton
Lometa
Lampasas
San Saba River Nature Park
San Saba
Tow Village
Canyon of the Eagles
Cedar Point
Bonanza Beach
Black Rock
Llano
Burnet
Fredericksburg
Kerrville
Bandera
Boerne
Pedernales River Nature Park
Johnson City
Leander
Cedar Park
Georgetown Utility Systems
Brazos River Authority
Austin
Dripping Springs Water Supply Corporation
San Marcos
New Braunfels
Seguin
Lockhart
Luling
Bastrop Energy Partners
McKinney Roughs
Tahitian Village
Bastrop
Lost Pines Power Park
Lake Bastrop Parks
Lexington
Giddings
Brenham
Smithville
Vernon L. Richards Riverbend Park
Plum Park
La Grange
Park Prairie and Oak Thicket
FPP
White Rock Park
Bellville
Hempstead
Beason's Park
Flatonia
Schulenburg
Weimar
Waelder
Gonzales
Moulton
Shiner
Hallettsville
Yoakum
Cuero
Altair Boat Ramp
Lakeside
Garwood
Pierce Ranch
Underground Services Markham
Future Downstream Reservoir
Hollywood Bottom
Gulf Coast
OXEA Corporation
FM 521 River Park
South Texas Project Electric Generating Station
Matagorda Bay Nature Park

Potential Alternatives to the Emergency Relief Requested by LCRA's Emergency Applications

LCRA has explored several alternative water supplies that might be available to alleviate strain on LCRA's water supply reservoirs, lakes Buchanan and Travis, caused by the persistent drought conditions. These alternatives are generally described below.

None of these alternatives could be obtained in sufficient supply or on a schedule that could serve to eliminate the need for immediate relief that LCRA seeks in its applications.

Moreover, it is important to note that LCRA lacks readily available funding to acquire or implement many of these alternatives, which means that rate increases for firm customers would be required to pay for these supplies at the same time LCRA may be significantly curtailing their access to water from lakes Buchanan and Travis.

1. **Utilize water from LCRA's Lakes Inks, LBJ, and Marble Falls.** These lakes are not currently authorized for municipal use, so amendments may be required to make full use of these supplies on a more permanent basis – a process that could take several years. If LCRA were to simply stop exercising its right to refill these lakes, but still allow the lakes to be maintained at levels that would not have significant impacts to cities and industries around them, it estimates that perhaps a one-time supply of about 34,000 acre-feet (AF) could be made available. Reduction in storage could also have significant impacts on hydroelectric generation capabilities.

2. **Conservation incentives and customer buyouts of nonessential uses (irrigation, recreation firm contracts).** LCRA has approximately 11,000 AFY under contract for firm irrigation and recreational use. LCRA may consider providing further financial incentives to these customers to reduce water use, but given the nominal amount of supply that might be made available, such alternatives would not be sufficient to alleviate the need for emergency relief.

3. **Aggressive municipal conservation.** This would include identifying and addressing water loss areas (i.e., toilets, shower heads, leaking pipes, etc.). In LCRA's experience, this requires solid partnerships with customers, a good method for calculating water savings (which is elusive) and a strong education and enforcement program (which is costly to the customers and requires time to become effective). Benchmarking and experience tells us that to achieve meaningful water savings, it often takes 1-2 years or more. While LCRA will continue to encourage water conservation, this alternative does not eliminate the need for emergency relief requested to avert the very near-term prospect of reducing storage levels beyond a protective level. The estimated cost of this long term program to achieve a 20% demand reduction is $220,000,000.

4. **Groundwater.** Many areas within LCRA's water service area have local groundwater conservation districts that regulate the use and permitting of groundwater supplies. Although groundwater appears to be available in many areas, the uncertainty associated with the long-term availability of such groundwater supplies in light of an unsettled regulatory environment renders any significant reliance on groundwater as an alternative supply a relatively high risk option. Within Matagorda County, which is governed by the Coastal Plains Groundwater Conservation District, LCRA estimates that it might be able to obtain agreements to lease up to 10,000 AFY of groundwater from existing wells or drill new wells to serve existing industrial customers in Matagorda County. Further, it might be able to do the same in and around Fayette County for purposes of securing supplies to meet some or all of the existing power plant water demands in that area. Groundwater development in Fayette County is regulated by the Fayette County Groundwater Conservation District. Similarly, LCRA has explored options for obtaining groundwater from the Carrizo-Wilcox aquifer to the east of Austin. Both the Lost Pines and Post Oak Savannah Groundwater Conservation districts have jurisdiction over large parts of the aquifer close to LCRA's service area. LCRA has recently obtained a groundwater permit in the Lost Pines Groundwater Conservation District for up to 10,000 AFY to use at LCRA's power facilities in Bastrop County. However, LCRA must still install a number of groundwater wells in order to produce the water.

   It takes approximately 9-12 months to secure written agreements with landowners and often takes several years to obtain new groundwater permits or permit amendments from local groundwater conservation districts, the need for emergency relief is not diminished. Further, to secure and develop any such supplies would take several years and thus would not avert the need for emergency relief.

   LCRA has recently learned that some limited supplies of groundwater are currently being delivered to Manor, a small city east of Austin, and that there may be some small amount of additional supply available for use at that point. It is estimated that 6-18 months, minimum, would be required to implement this alternative – not soon enough to eliminate the need for emergency relief.

5. **Off-Channel Reservoir.** Engineering work is underway on a new reservoir to be built in the lower Colorado River basin. LCRA is moving forward with plans to build the new reservoir to replace some supplies currently met from the Highland Lakes, improve agricultural water reliability and efficiency, and increase LCRA's overall water supply.

   The new reservoir in Wharton County will capture water downstream and hold it for beneficial use by downstream industrial and agricultural customers. This is the first project that will allow LCRA to capture and store significant amounts of water downstream that can be used by multiple customers.

The reservoir will be able to hold about 40,000 acre-feet, but could be filled and used multiple times over the course of a year, making it capable of adding 90,000 acre-feet of firm water to the region's supply. The preliminary cost estimate for the reservoir is $206 million, and it currently scheduled to be on-line in 2017 – which may not be early enough to help with the current drought, and definitely not early enough to help lake levels in 2014.

6. **Wastewater reuse program in the Highland Lakes.** Enhanced direct reuse of wastewater around the Highland Lakes could reduce demand by about 5,000 AFY over the next 1-2 years. This amount of savings is not sufficient over the near term to alleviate the need for emergency relief. The estimated cost for an enhanced direct wastewater reuse pilot project for 1,120 acre-feet of supply is $5,700,000.

7. **Line or pipe high loss canals utilized by industry.** Determining high loss areas of canals can be a challenge and estimating the amount of water savings difficult. Although LCRA has some very general information about its canal systems, it could not immediately implement a canal lining project that would serve to reduce water usage in such quantities as to avert the need for emergency relief.

8. **Interbasin transfers or water trucking/rail transport.** Interbasin transfers of water or transport of water by truck or rail from areas with a more plentiful supply is an option that poses no realistic likelihood of alleviating the need for the emergency relief requested. Moreover, there are very few options close to the lower Colorado River basin with much supply to spare. Even if such supply exists, the interbasin transfer permitting process and construction of the necessary infrastructure would significantly limit the ability to bring such supplies on line in a timely manner. The logistics of locating sufficient transporting equipment to meet the levels of demand would be very difficult if not impossible.

9. **Ocean or Brackish Groundwater Desalination.** Although ample supply is likely available, the time required to permit and construct such facilities is estimated to be 5-10 years. This alternative thus does not eliminate the need for emergency relief. The estimated cost of this alternative is $177,000,000 for 22,400 acre-feet of supply.

Attachment N

APPLICATION OF THE LOWER COLORADO RIVER AUTHORITY FOR EMERGENCY AUTHORIZATION	§ § § §	**BEFORE THE TEXAS COMMISSION ON ENVIRONMENTAL QUALITY**

AFFIDAVIT OF NORA MULLARKEY MILLER

THE STATE OF TEXAS §
§
COUNTY OF TRAVIS §

Before me, the undersigned authority, personally appeared Nora Mullarkey Miller, a person known by me to be competent and qualified in all respects to make this affidavit, who being by me first duly sworn, deposed as follows:

1. I am over 21 years of age, of sound mind, and have never been convicted of a felony or crime of moral turpitude. I am fully competent and qualified in all respects to make this affidavit.

2. The facts stated in this affidavit are within my personal knowledge and are true and correct.

3. I, Nora Mullarkey Miller, am an individual residing in Austin, Texas.

4. I have a Bachelor of Arts degree in Sociology from the University of Texas at Austin and a Master of Public Health degree from the University of Texas Health Science Center in Houston.

5. I have worked for the Lower Colorado River Authority (LCRA) for over 26 years. My current title is Water Conservation Supervisor. My experience is further detailed in the attached resume, attached under Tab 1.

6. As part of my duties at the LCRA, I am responsible for helping to prepare and implement LCRA water conservation plans and drought contingency plans.

7. I have had experience implementing mandatory water restrictions for the City of Austin, as well as for the LCRA water utilities.

8. The Drought Contingency Plan (DCP) for LCRA's firm water customers establishes what measures the LCRA will take during times of drought. (The DCP is included in Chapter 4 of LCRA's Water Management Plan. *See* 2010 Water Management Plan at 4-32.) Those measures are as follows: 1) when combined storage in lakes Travis and Buchanan is at or below 1.4 million acre-feet, LCRA encourages all of its customers to implement voluntary water conservation measures; 2) when combined storage in lakes Travis and Buchanan is at or below 900,000 acre-feet of water, LCRA asks its firm water customers to implement mandatory water restrictions, with a goal of decreasing water use by 10-20%; and 3) when

combined storage in lakes Travis and Buchanan reach 600,000 acre-feet of water, and upon a declaration of a Drought Worse than Drought of Record (DWDR) by the LCRA Board of Directors, LCRA will implement pro rata curtailment of its firm customers' water use, with a goal of reducing water use by 20% initially. If combined storage continues to drop below 600,000 acre-feet, the Board may implement further mandatory reductions. LCRA's rules provide for a temporary variance from these requirements only in the limited circumstance where a customer can demonstrate that the public health, welfare or safety is threatened. (*See* LCRA Water Contract Rules, Article 11, rule 11.14 available at: http://www.lcra.org/library/media/public/docs/water/supply/water_Water_Sale_Contract_Administrative.pdf.)

9. Further, in November 2013, the LCRA Board of Directors temporarily amended the firm customer Drought Contingency Plan to require that firm customers limit outdoor landscape irrigation to no more than once per week if on March 1, 2014 the combined storage in lakes Buchanan and Travis is below 1.1 million acre-feet and if interruptible stored water supply to customers in LCRA's Gulf Coast and Lakeside divisions and Pierce Ranch is cut off. This drought response measure will not require that customers achieve a specific percentage savings. It is my opinion that this is a reasonable measure in light of the extended drought affecting LCRA water supplies.

10. To conserve water, LCRA has engaged in extensive water conservation efforts since 1989. Attached under Tab 2 is LCRA's Ongoing Water Conservation Initiatives and Drought Response Efforts Report, which provides more details about LCRA's water conservation and drought contingency planning and response efforts. Additional information can also be found in the 2009 LCRA Raw Water Conservation Plan, which is available electronically on LCRA's website at: http://www.lcra.org/library/media/public/docs/savewater/2009_LCRA_Water_Conservation.pdf.

11. All of LCRA's firm customers that currently divert and purchase water from LCRA are required to have a drought contingency plan. As of December 2013, 100% of those customers (other than those with "temporary" contracts of up to three years and up to 10 acre-feet per year) have plans on file. LCRA has implemented a separate drought contingency plan for its domestic use and irrigation customers which fall under the temporary contract category. (*See* http://www.lcra.org/library/media/public/docs/water/supply/DCP_Domestic_and_Temp_Contracts_Final_9_23_13.pdf.) Further, LCRA has a drought contingency plan that applies to its irrigation operations. (*See* 2010 WMP pp. 4-23 to 4-31.)

12. On August 23, 2011, combined storage in lakes Travis and Buchanan dropped below 900,000 acre-feet. LCRA has asked firm customers to implement their mandatory drought measures with a goal of reducing water use by 10-20%, as required by LCRA's DCP. The response of these customers is summarized under Tab 2, attached to my affidavit.

13. In the summer of 2008, the City of Austin, the LCRA West Travis County System, and Travis County Water Control and Improvement District No. 17 began requiring their retail customers to limit outdoor watering to twice a week. The City of Austin moved to require limits on landscape watering to once per week during the fall of 2009, when LCRA asked

customers to implement mandatory water restrictions as a result of reaching the 900,000 acre-feet combined storage trigger. Once the 2009 drought eased, the City of Austin decided to move back to the required twice weekly limit on landscape irrigation, but continued this on a year-round basis. In September of 2011, the City of Austin once again implemented the limitation on landscape irrigation to once per week for its retail customers due to hitting the 900,000 acre-feet combined storage trigger. Except for about a six week period in the summer of 2012, City of Austin customers have stayed in once a week restrictions for the past two years. Other major municipal customers are also currently in once per week watering restrictions. Together with the City of Austin, these customers represent nearly 95% of the population that receive raw water from the LCRA.

14. If a Drought Worse than Drought of Record is declared, LCRA's 2010 Water Management Plan provides that the firm customers' supply be curtailed on a pro rata basis, consistent with state law. In December 2010, LCRA obtained approval from the Texas Commission of Environmental Quality of its Water Curtailment Plan for Firm Customers. As of September 5, 2013, LCRA has pending or final pro rata plans for all of its firm water customers who are actively diverting water. LCRA is continuing to work with some of these customers to finalize the plans.

15. In evaluating potential water savings from drought response measures, I have reviewed a 2009 study by the Texas Water Development Board, "Drought Management in the Texas Regoinal and State Water Process." (*See* Tab 3, available at http://www.twdb.state.tx.us/publications/reports/contracted_reports/doc/0804830819_DroughtMgmt.pdf.) The report estimates that implementation of the drought of record stage in the drought contingency plans of all municipal providers across Texas would reduce annual water demands by between 15 and 20 percent (based on information in the drought plans). According to the TWDB study, the measures required to achieve this level of savings would have some onerous effects on customers and would affect customers' quality of life and local economic conditions. The study team stated that some of the goals listed in the water suppliers' drought contingency plans were unrealistic and most were untested. For most providers in Texas who have implemented their drought contingency plans, there is limited or no data available regarding actual water savings during drought conditions.

16. In 2011 and 2013, LCRA conducted benchmarking research throughout the United States as well as Australia, to assess the effectiveness of drought response measures. The water providers interviewed stated that water savings between 15 to 40 percent were realized from implementation of mandatory drought restrictions. The timeframe for savings varied from six months to three years for wholesale providers and less for smaller, mainly retail providers. For some water suppliers such as the City of Atlanta, East Bay Municipal Utility District, and North Texas Municipal Water District water savings were below 15 percent for the first year of implementation. Atlanta had an initial reduction of 10 percent during the first year of drought restrictions but was able to receive an additional 14 percent when the state of Georgia declared a statewide drought emergency. A 40 percent savings was achieved in Australia after an extended period and included a ban on outdoor watering. Information obtained during the benchmarking effort can be found under Tab 4 and Tab 5.

17. Some LCRA customers have reported their estimated savings from drought restrictions imposed over the past two years. Those customers implementing the once per week limit on landscape irrigation are estimating savings of 15% or greater on an annual basis. This savings estimate is consistent with calculations performed by LCRA using 2007-08 winter water use compared with 2008 summer water use to develop a proxy of how much water might be used outdoors. Many municipal customers DCPs eliminate all outdoor spray irrigation under pro rata curtailment. Assuming winter use represents only indoor use for municipal customers, eliminating all outdoor water use might save somewhere between 15% to 25% on an annual basis. Completely eliminating outdoor water use is expected to create significant financial hardship for the landscape and irrigation community.

18. LCRA's TCEQ-approved Water Curtailment Plan for Firm Customers considers the extent to which customers have already implemented conservation and drought contingency measures in determining their effective required pro rata curtailment. Many of LCRA's customers sought and obtained modifications to their required curtailment based on a variety of factors, including conservation savings. In addition, some of the customers, including the City of Austin, have already implemented drought response measures that may bring them close to meeting the initial required reduction. However if water supplies continue to decline, the LCRA Board could adopt more stringent water reductions, thus requiring customers to implement additional measures.

19. LCRA staff has proposed for consideration by the LCRA Board at its December 2013 meeting changes to the LCRA rules for pro rata curtailment and drought contingency plans. These changes would clarify how pro rata curtailment would be implemented and the circumstances in which customers would face surcharges. The proposed rule changes include minimum drought response measures that, if implemented, could help customers avoid surcharges.

20. LCRA continues to work with its firm customers in preparation for the possible implementation of pro rata curtailment.

Further affiant sayeth not.

Nora Mullarkey Miller

NORA MULLARKEY MILLER, AFFIANT

SWORN TO AND SUBSCRIBED before me on the 10 day of December, 2013.

TABETHA A. JASKE
Notary Public, State of Texas
My Commission Expires
January 11, 2014

Tabetha A. Jaske

Notary Public in and for the State of Texas

My Commission Expires: 1-11-2014

Tab 1

Nora Mullarkey Resume

Nora Mullarkey has nearly 30 years of experience in water conservation. She began her work as a conservation coordinator at the City of Austin, where she oversaw water conservation plumbing retrofit programs and evaluated programs for water savings and cost effectiveness. For the past 26 years, Nora has been with the Lower Colorado River Authority (LCRA), and currently manages its water conservation program. In this capacity, Nora oversees the planning and implementation of conservation programs for LCRA firm and interruptible raw water customers, and provides planning and policy oversight on conservation issues affecting the LCRA and its customers. During this historic drought, Nora has managed the pro rata curtailment process for firm water in anticipation of reaching a drought worse than the drought of record.

While at the LCRA, Nora has also been responsible for environmental education programs and special community events such as volunteer water quality monitoring, household hazardous waste collections and river and lake cleanups. Before joining the LCRA, Nora worked as a water conservation specialist for the City of Austin and as a socioeconomic and land use specialist for Espey, Huston and Associates.

Nora is or has been involved in the following local, state and national water conservation professional activities:

- TCEQ Irrigation Advisory Council member
- TWDB Water Conservation Advisory Council, alternate
- Texas AWWA Water Conservation and Reuse Division Past Chair
- Texas Legislative Task Force on Rainwater Harvesting member
- American Rainwater Catchment Systems Association Board member
- City of Austin Citizen's Water Conservation Advisory Committee

Nora received a Bachelor of Arts degree in Sociology and a Master of Public Health degree- both from the University of Texas.

Tab 2
Lower Colorado River Authority
On-going Water Conservation Initiatives and Drought Response Efforts Report

LCRA Water Conservation Overview

LCRA believes that water conservation will benefit its customers and is necessary for the long-term quality and sustainability of the lower Colorado River basin's water supply. LCRA has coordinated, and will continue to coordinate, with its customers and the public to implement innovative, effective and cost-efficient water conservation practices. LCRA has focused its conservation efforts on reducing the water used for irrigated agriculture, providing public awareness through outreach and education, and providing technical assistance and incentives to wholesale customers.

Municipal customers in the lower Colorado River basin also have been leaders in water conservation. As LCRA's largest municipal customer serving more than 80 percent of the population in the basin, the City of Austin has maintained one of the most comprehensive water conservation programs in the state for more than two decades. Austin's conservation efforts combine incentive programs with customer education, conservation ordinances and rules. In recent years, additional municipal customers in the LCRA basin such as Travis County Water Control and Improvement District (WCID) No. 17 have implemented irrigation evaluation programs and other water conservation efforts to effectively lower water use in their service areas.

Ongoing LCRA Water Conservation Efforts

Agricultural water conservation strategies

As the largest user of water from the lower Colorado River system, irrigated agriculture has provided one the best opportunities for LCRA to reduce the overall water demand through conservation programs. Beginning in 1986, LCRA initiated a major program to increase irrigation water use efficiency in rice irrigation systems. Between 1989 and 1997, the introduction of volumetric pricing and canal rehabilitation are estimated to have saved approximately 13 percent or about 41,500 acre-feet annually, of the projected water use that would have occurred without conservation practices in place.

House Bill 1437, passed by the Texas Legislature in 1999, authorizes LCRA to provide funds for the development of water resources or other water-use strategies to replace or offset up to 25,000 acre-feet per year of surface water transferrable to Williamson County. Guided by the HB 1437 implementation plan, a grant program was initiated in 2006 to help finance agricultural water conservation strategies both for structural improvements within LCRA irrigation divisions and for grants to agriculture producers. One of the main priorities on the list of conservation strategies to implement has been precision laser land leveling. Over the past five years, LCRA has provided up to 30 percent of the costs to the farmers for the implementation of this conservation measure on nearly 27,500 acres of land, with an estimated water savings of 7,760 acre-ft/yr.

In 2009, LCRA completed a short-term strategy report update, which recommended two major capital projects in the irrigation divisions in addition to continuation of the precision land leveling program. These projects are: 1) implementing volumetric measurement in the Garwood Irrigation Division, and 2) retrofitting and automating in-canal gate structures in the LCRA Irrigation Divisions. In late 2009, LCRA began implementation of a $1 million Garwood volumetric measurement project. Through this project, over 400 standardized water delivery and flow management structures were installed in the Garwood canal system, and 85 miles of canal laterals have been cleaned or rehabilitated. In addition, 139 miles of existing canals formerly managed by land owners are now managed by LCRA. Installation of 36 walk bridges and measurement piers at every delivery structure allow staff to collect accurate daily water measurements. Volumetric pricing was implemented for the first time in the 2012 irrigation season after two test seasons of daily water measurement throughout the Garwood canal system. A $100,000 grant was secured from TWDB in 2009 to assist with the Garwood measurement project.

In 2010, LCRA received a nationally competitive grant from the U.S. Bureau of Reclamation (USBR) to fund $257,000 or almost half of the Gulf Coast Gate Rehabilitation and Control project. This project replaced and automated eleven canal check structure sites (22 gates) within the eastern canal system of the Gulf Coast Irrigation Division. The grant funds allowed LCRA to pursue the installation of a supervisory control and data acquisition (SCADA) system to remotely monitor and control canal water levels at the gates. Three spill monitoring sites will also be monitored to quantify water loss from the canal system. The project construction, SCADA software interface, and radio communications testing have been completed and the new gates are ready to be fully utilized in the next irrigation season. In June 2013, TWDB awarded LCRA $101,700 to assist with additional gate structures in the Gulf Coast Irrigation Division. Combined, these measures are projected to meeting LCRA's 2009 water conservation plan goal to save an estimated 10,000 acre feet per year by 2014.

Municipal and Industrial Water Conservation Strategies

As a major water rights holder, the Lower Colorado River Authority (LCRA) is required to develop and implement a water conservation plan. In 1989, prior to the Texas Administrative Code, Chapter 288 rules, LCRA developed Rules for Water Conservation and Drought Contingency and required all new firm water customers applying for a new or modified water supply contract to develop plans in accordance with these rules. As a wholesale provider of water, LCRA must work through its wholesale customers to save water at the end-user level. LCRA offers a variety of strategies to save water such as incentive programs through which LCRA partners with its customers to offer water-saving fixtures such as high-efficiency toilets or other technologies; requirements that new or updated contracts include conservation best management practices; and an expansion of LCRA's education outreach efforts to provide useful information to consumers.

LCRA is currently ending its fourth fiscal year of implementing its current 2009 water conservation plan. In the fall of 2009, LCRA modified its water conservation rules to require all customers have water conservation coordinators and provide annual plan implementation reports to LCRA. A Conservation Coordinator Committee now works in concert with LCRA to implement programs.

In 2010, LCRA began a residential indoor plumbing fixture replacement program where it provides free toilet vouchers and showerheads. LCRA wholesale customers are responsible for administering the program on a local level. Eleven wholesale customers have distributed 4,100 toilets and 2,290 showerheads since 2010.

Also in 2010, LCRA began offering water efficiency audits to commercial, institutional and industrial (CII) water users that directly or indirectly receive water from LCRA. Since then, 32 business and school water audits have been completed within the service area of six retail customers. In 2012, LCRA began a CII rebate program to offer incentives to replace commercial equipment up to a fixed dollar amount or cost per acre-foot saved, based on recommendations from water audits. Nine schools have participated in the rebate program, saving an estimated 24 acre-feet of water annually.

LCRA also began providing irrigation evaluation training to the staff of LCRA's wholesale customers. As a result, nine of LCRA's wholesale customers completed approximately 550 residential and 40 commercial irrigation evaluations between 2010 and 2012. In the summer of 2012, LCRA began offering evaluations directly to domestic users who have contracts with LCRA to use water from the Highland Lakes. Beginning this fiscal year, irrigation technology rebates are also available to wholesale customer end-users and domestic users if recommended as part of an irrigation evaluation. The rebates can be used for soil moisture sensors, rain sensors, pressure-regulating spray heads and other water saving irrigation technology. LCRA began offering the rebates in the summer of 2012, and three wholesale customers plan to offer them to their customers this year.

LCRA began a wholesale customer cost-share program in the spring of 2012. LCRA will pay up to $151 per acre-foot saved, assuming a 10-year project life, or 50 percent of the cost, whichever is less. So far, two customers have received cost-share funding; one for a project to replace a potable water line with a reclaimed water line to irrigate a park, and another to decrease utility water loss. The combined savings for these two projects is estimated at 67 acre-feet annually.

LCRA power plants have been implementing water conservation measures as well, as outlined in LCRA's 2009 Raw Water Conservation Plan. At the Fayette Power Plant, stormwater from the coal pile runoff pond is now being reused as cooling water instead of being discharged, and a project to convert from a wet to a dry ash handling system resulted in the closure of a 32- acre ash storage pond. Leak repair work is being completed with more efficiency, outdoor irrigation is done only as needed, and old plumbing fixtures have been upgraded at the Ferguson Power Plant. Combined, these measures have resulted in an estimated 270 acre-feet per year of water savings.

Finally, LCRA has been educating customers in its service area about water conservation through its public awareness efforts. Monthly conservation articles with supporting how-to videos are made available through LCRA WaterSmart Web site. In addition, the LCRA conservation team regularly staffs events and gives presentations with water conservation tips and other information throughout LCRA's service area.

Since 2009, these water conservation programs have conserved an estimated 1,380 acre-feet of water per year (450 million gallons per year). The savings is a combination of customer programs implemented directly with LCRA and programs customers implemented on their own, such as implementing TCEQ landscape irrigation standards, adopting mandatory water use restrictions, and LCRA power plant reuse and conservation projects.

LCRA administers an annual progress report survey to its customers and uses the Alliance for Water Efficiency water savings tracking tool to determine the progress of the conservation programs.

Drought Response Efforts

As a wholesale water supplier, LCRA requires all of its firm municipal, industrial and irrigation water customers to prepare and submit drought contingency plans. The drought contingency plans are designed to reduce water demands through supply and demand management measures as a result of water supply conditions. Since it began requiring drought plans as part of its contract rules, LCRA has provided technical assistance and other relevant information to its wholesale customers during the planning process. In November 2010, LCRA staff began actively working with customers to update their drought contingency plans to be consistent with the LCRA drought plan. As of December 2013, 100 percent of customers who are actively diverting water have plans on file with LCRA.

Some measures thought of as drought response measures have the potential to become permanent water demand management measures. Three wholesale customers – Travis County WCID #17, Lakeway Municipal Utility District and the West Travis County Public Utility Authority – have adopted permanent landscape water restrictions from May through September each year. Their end users must follow a mandatory water schedule that limits outdoor landscape irrigation to no more than twice weekly and are prohibited from irrigating between the hours of 10 a.m. and 7 p.m. except with a hand-held hose. The City of Austin implemented a mandatory schedule in 2008 that corresponds to the same landscape restrictions, but is in effect year-round.

LCRA Drought Response—Customer Communications and Support

LCRA strives to maintain open lines of communication with all of its water customers. During the 2009 drought, LCRA hosted several work sessions with its firm water customers, particularly in the fall and winter of 2009 and in January 2010. The goals of the work sessions were for customers to share information on their mandatory drought response efforts and learn from each others' experiences and challenges, and for LCRA staff to introduce pro rata curtailment. Customers provided feedback on proposed pro rata curtailment rules, some of which were incorporated into the final pro rata contract rules.

As drought conditions worsened in 2011, LCRA focused on providing up-to-date, clear information to its customers and assistance with drought restriction implementation through sharing of resources and technical information. LCRA has held four customer meetings with its customers since July of 2011 to keep them updated regarding drought conditions.

July 2011 meeting
This meeting between LCRA and water customers focused on the seriousness of drought conditions, importance of water conservation, and timeframe for potential mandatory water restrictions. LCRA staff met with more than 60 people who represent many of LCRA's municipal and industrial raw water customers. Presentations included updates on the ongoing drought conditions throughout the lower Colorado River watershed, water storage projections, water conservation, and measures that LCRA has taken and will take under its state-approved plan if drought conditions worsen. LCRA informed its customers of what actions will occur when water storage levels fall below set triggers, including reducing releases for environmental needs, cutting back water for agricultural customers, and working with its wholesale municipal and industrial customers to implement mandatory water-use restrictions.

October 2011 meeting
The primary purpose of this meeting was to prepare customers for the possibility of pro rata curtailment in 2012. LCRA shared information on the current drought and water supply, explained the history and reasons for pro rata curtailment, and reviewed the process and procedures for implementing pro rata curtailment, and. Customers had the opportunity to express their challenges and issues with implementing pro rata curtailment.

January 2012 meeting
Almost 90 customers attended this customer meeting and were updated on a number of issues, including the drought, the weather outlook, the Water Management Plan and a new conservation incentive program. Those that attended also took part in a roundtable discussion on topics including: 1) the need to coordinate drought messages; 2) the importance of conservation education; 3) the challenges of enforcing drought measures; and 4) the benefits and challenges of having a uniform watering schedule throughout the region.

August 2012 meeting
The drought was again on the agenda for this customer meeting. LCRA staff provided an update on the current drought and water supply situation, gave an update on the pro rata curtailment plan review process, and gathered customer feedback on the pro rata curtailment process. Over sixty customers attended this meeting.

Meetings in 2013
LCRA has held firm customer meetings on May 2, June 28, August 29 and November 15 of this year. The May meeting focused on customer curtailment plans and the possibility of mandatory pro rata curtailment later this year. At the June meeting, LCRA and its customers shared and discussed lessons learned from drought response benchmarking, approaches taken by various LCRA customers to implement drought response measures, and the additional steps that may be taken if pro rata is triggered and conditions continue to worsen. The August meeting continued the discussion of pro rata curtailment, including clarification that customers could modify current pro rata plans on file to add demand growth in 2012. Finally, at the November meeting, the 2014 emergency relief proposal as well as proposed changes to LCRA drought contingency plan rules for customers were discussed.

Other communication efforts
Combined storage of lakes Travis and Buchanan, two reservoirs constructed to store water supply, reached the milestone storage volume trigger of 900,000 acre-feet on August 24, 2011 under LCRA's Water Management Plan. As a result, the following day LCRA called on its wholesale firm water customers to implement mandatory water use restrictions under their individual drought contingency plans to reduce their water use by 10 to 20 percent. Information was sent out via a direct e-mail newsletter to customers, and certified letters. LCRA created a section titled "Water Use Restrictions" on the LCRA Web site that provides links to individual customers' water restrictions, including restrictions for LCRA water utility customers.

LCRA sent out a notice to customers on April 26, 2012 stating that while the combined storage levels had risen to over 1.0 million acre-feet, LCRA was requesting that customers continue implementing mandatory water restrictions until the combined storage increased to at least 1.1 million acre feet. When the combined storage dropped once more to less than 900,000 acre-feet on September 3, 2012, LCRA sent out a reminder to customers to implement mandatory restrictions. LCRA continues to update the Water Use Restrictions page on the LCRA web site. The page shows which customers are in various stages of restrictions.

Customer drought response efforts

In September of 2011, 21 LCRA municipal customers and LCRA's retail water utilities began implementing mandatory water restrictions. Currently, all major municipal water customers are in mandatory restrictions, and customers representing nearly 95% of the total population served by the LCRA limit outdoor water use with a hose-end sprinkler or automatic system, not including drip irrigation, to no more than once per week. Other non-essential uses have also been curtailed. Major customers in once per week watering drought restrictions include Austin, Cedar Park, Pflugerville, Travis County WCID 17, Lakeway MUD and the West Travis County Public Utility Authority. Except for about a six week period in 2012, the City of Austin has been under once per week water restrictions since the fall of 2011. Most of the other municipal customers have been under mandatory restrictions of at least no more than twice per week watering since that time as well.

Many irrigation and recreation customers also informed LCRA of the water reduction measures they implemented to cut back their water use by 10 to 20 percent. Most golf courses reduced their overall water budget, while others scaled back on ornamental beds, area of irrigated roughs (areas not essential to the playability of a course), or other high water using areas.

LCRA industrial customers, who consist of power plants and a few large industries along the Gulf Coast, cut back on non-essential water uses, such as outdoor watering. However, these cutbacks likely have resulted in a very minimal savings. Any further cutbacks for industrial customers could result in a decrease in production.

Pro rata curtailment preparation

The LCRA Water Management Plan requires LCRA to begin working with customers to develop pro rata curtailment plans once the 900,000 acre-feet combined storage trigger has been reached. As stated earlier, a customer meeting was held in October 2011 to begin this process and provide the customers with an opportunity to ask questions.

Customers were sent letters with their proposed water allotment, assuming a 20% curtailment, and given a deadline of February 15, 2012 to submit their plans. Those that did not submit plans by that time were automatically assigned a 20% pro rata allotment.

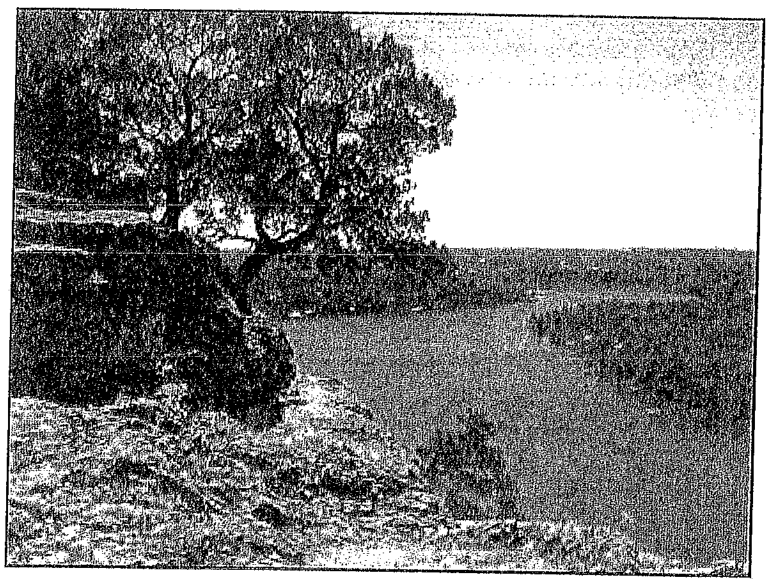
LCRA water conservation staff met with customers in person as well over the phone, and also responded to hundreds of emails to answer questions and assist customers in the development of their plans. Eighty-four customers submitted plans and 54 of those customers requested modifications. Customers were allowed to modify their water demand baseline for conservation, reuse, growth, outage, and alternative water supply. The last of the customer plans was accepted in July, 2012. As a result of modifications to the reference year baseline water use, the effective savings under pro rata curtailment would be 8%, with a range from 0% to 20%, depending on the customer. However if water supplies continue to decline, the LCRA Board could adopt more stringent water reductions.

LCRA met with its firm water customers in May, June, August and November of 2013 in further preparation for the possibility of the implementation of pro rata curtailment as discussed above.

Final Report

Drought Management in the Texas Regional and State Water Planning Process

Texas Water Development Board



Final Report

May 31, 2009

Drought Management in the Texas Regional and State Water Planning Process

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Drought Management in the Texas Regional and State Water Planning Process

May 31, 2009

SECTION ES.
Executive Summary

In June 2008, the Texas Water Development Board retained a consulting team led by BBC Research & Consulting (BBC) to evaluate the role of drought management measures in the regional and statewide water planning process. This study examined the potential benefits and drawbacks of including drought management as a regional water management strategy.

Study Approach

The study team conducted a series of research tasks regarding the role of drought management measures in regional and state planning, including:

- Review of planning documents prepared for the 2007 State Water Plan;
- Review of planning processes used in other western states;
- Interviews with chairpersons of the 16 regional water planning groups;
- Interviews with 90 regional water planning group members and other stakeholders; and
- Analysis of a sample of more than 100 drought contingency plans from across Texas.

Key Results

The study team investigated four key questions during this study. Below is a brief discussion of study team findings for each of these questions. Section VI provides a more detailed discussion of the conclusions.

Question #1, part A— Is it possible to use drought management measures as water management strategies in the regional plans? There are substantial analytical challenges in evaluating drought management as a water management strategy. The main difficulties involve estimating water savings achieved through drought measures and comparing the "costs" of drought management measures with traditional water supplies. Additionally, the current modeling framework (calculating water needs by comparing supplies and demands during drought of record conditions) makes it difficult to fully assess effects from incorporating drought management as a strategy.

These issues could be resolved. Recent draft studies by Regions L and H provide a starting point for calculating the costs and savings of drought management and comparing drought management with other water management strategies. The regional planning approach to analyzing future needs could be modified to consider other climatological and hydrologic conditions. Water planning continues to become more sophisticated, and approaches such as probabilistic modeling of future supplies, demands and costs are being implemented by some providers.

Question #1, part B — Is it appropriate to use drought management measures as water management strategies in the regional plans? There are well reasoned arguments for and against including drought management measures as a water management strategy. The most common reasons for opposing the use of drought management measures as a water management strategy were the removal of the safety factor provided by drought management plans, potential economic impacts and the unwillingness of water providers and the public to accept a planning approach that includes future shortages and demand reduction measures. Proponents, on the other hand, argue that during periods of drought most providers would implement drought measures, and not including effects from these measures in the planning process could lead to unnecessary water projects. Most proponents also noted that occasional reliance on drought management measures can be cost effective. Arguments on both sides suggest the need for refinements in the process for analyzing future needs in order to make the inherent safety factor provided by drought planning more explicit and determine which water management strategies might be used only during drought conditions.

Question #2 — Why haven't Regional Water Planning Groups (RWPGs) recommended drought management as a water management strategy? There are five major reasons why RWPGs have not recommended drought management measures as a water management strategy:

- The difficulty of quantifying the costs and yields of drought management measures;
- Lack of information on water supplies and demands under varied hydrologic conditions leads to uncertainty that promotes a cautious approach to water supply planning;
- In many regions, relatively affordable new supply alternatives remain;
- Concerns about regional competition for state assistance and inter-regional equity; and
- The makeup of the RWPGs likely favors the perspective of those opposed to including drought management as a water management strategy.

Question #3 — What are the ranges of savings, statewide, if drought management was included as a water management strategy? The study team estimates a reduction in demand of 15 to 20 percent if all municipal providers implemented measures identified in the drought of record stage of their drought plans. These measures would, in many cases, at least temporarily reduce customer quality of life and could adversely affect the local economy. Less onerous drought measures might reduce demand by 5 percent or less. It is important to note that there is considerable uncertainty in these estimates as the study team used projections reported by providers with drought plans and there are limited data on actual savings achieved using drought measures in Texas.

Question #4 — What would have to change for RWPGs to recommend drought management as a water management strategy? The study team identified four key changes required for RWPGs to recommend drought management as a water management strategy:

- Reliable estimates of water savings and costs for drought management measures;
- More sophisticated supply, demand and "need" analysis in the water planning process;
- Increases in the cost and difficulty of pursuing water supply alternatives; and
- More incentives for including drought management as a water management strategy.

Additional Findings

The study team identified a number of other insights and questions from this research. These issues are discussed in detail at the end of Section VI.

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Benchmarking Research on Drought Restrictions implemented in other Communities (Compiled in 2011)

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Timeframe drought response measures implemented	2006-2009	9/1/2007 -2009	2002-2003	2002-2003	1984-1986, 1996, 2001	2005 -2006	1977, Late 1990s, Summer 2008-2009
Water Savings							
Percent Reduction Goal (overall)	10%	10%	Undefined ("as much as possible")	30% by Stage 3 (10%-20% previous stages)	Current goals (1%-5%-10%-15%) 1996 plan (10-5-10%) for stages 1-3	5%	15% Overall (Mandatory savings goals varied depending on customer class)
Percent Reduction Achieved (overall)	14-24% (water use remains at 17% below pre-drought)	~10%	32%	29%	30% (off of peak summer usage in 1980s) 11% savings in 1996 (although the goal at that time was 25%)	10-15%	12%
Tracking Water Savings	Monthly comparison to pre-drought for savings	Reports required of water providers	Monthly comparison to pre-drought for savings	Annual comparison to pre-drought for savings	Monthly	Monthly tracking of water use & reduction goal was emailed out to all member cities	Savings triggers were based off of expected production for that timeframe
Drought Response Measures							
Mandatory Watering Schedule	No Outdoor Watering (with exceptions)	No Outdoor Watering (with exceptions)	Twice weekly, no more than 15 minutes per zone	Twice weekly	Once every 5-day or 14-day schedule (depending on stage)	Varied depending on Member City	Recommended Schedule (no more than 3 days/week)
New Landscapes	Allowed if installed by professional & green industry certification received	Allowed (green industry represents significant jobs and impact on the economy)	Not allowed	Allowed (soil restrictions added)	Allowed, landscape plan must be submitted in advance	Member Cities Allowed	Allowed (New connections limited sod & required efficient irrigation systems)
Restrictions on Golf Courses	Tees and Greens exempt	Stage 4 – greens only (95% curtailment)	No more than twice weekly watering allowed	Difficulty with compliance	Time of day and day of the week restrictions	Tees and Greens exempt	30% Reduction Goal

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Restrictions on Industrial Customers	10% reduction goal included industrial (large success from customers such as Delta Airlines, Georgia Aquarium)	10% reduction goal included industrial	Outdoor water use restrictions (Surcharges likely prompted conservation)	Surcharges & aggressive attempts to get reductions (plus rebates) led to process improvements for customers including Pepsi & Frito Lay	Surcharges for industrial customers if use is in excess of baseline minus a pre-defined percentage reduction goal	Only on outdoor water use	Industrial 5% Reduction Goal
Enforcement							
Enforcement Actions (for violations)	Fines (surcharges) on water bills	NA	Fines (surcharges) on water bills	Fines (surcharges) on water bills and flow restrictors	Citations	NA	EBMUD investigates customers who have not saved and installed flow restrictors
Surcharges as a Result of Excess Use	No	NA	Surcharges were added to bills (30% reduction applied to outdoor historical use)	Surcharges were added to bills for Denver retail (flat gallon amount applied)	Surcharges added to bills (for residential, commercial, industrial customers)	Some member cities added surcharges to bills	Drought rate structure took effect in 2008
Additional Staff Needed	5 inspectors plus hotline staff added	NA	Aurora: 8 hotline and 15 patrol staff added	Denver added ~10 staff for enforcement	Staff were pulled from other areas and deputized by the court	Many member cities added staff for enforcement	Staff shifted responsibilities to add enforcement
Public Information							
Marketing Campaign	Relied heavily on free media and state-wide campaign	Georgia "Water Smart Campaign: Save Water, Save Time, Save Money"	"Use Only What You Need" Regional Campaign	"It's a Drought…Do Something!" Campaign	"Have You Saved Water Today?" and "If We All Save a Little, We Save A Lot"	"Water IQ: Know Your Water Campaign"	"Save Water. Beat the Drought. This is a job for everyone: be a water saving hero" (Bay Area Water Savings Partnership)
Stakeholder meetings	Yes	Yes	Yes	Golf Course associations, etc.	Yes	Water IQ helped facilitate & organize	Yes

	Atlanta, Georgia	Georgia (state-wide)	Aurora Water, Colorado	Denver Water, Colorado	Corpus Christi, Texas	North Texas Municipal Water District, Texas	East Bay MUD, California
Customer Council/ Advisory Group	Yes	No response	12-person Customer Advisory formed during drought (appointments by City Council)	Customer Advisory Council in place since 1970s	Water Use Allocation Committee formed (of Council/ Mayoral appointees) to assist with industrial reduction	NTMWD held monthly meetings with member cities to provide drought updates and exchange of information	
Technical Presentations given to End-use Customers	Top 50 Customer Workshop held to help encourage water use reduction for these high water use customers	Throughout the state, particularly with industrial customers	Yes	Yes	Yes	NTMWD gave presentations throughout member cities' service areas	Speakers Bureau available

Benchmarking Conclusions

Drought conditions and the implementation of mandatory, rather than voluntary, drought response measures can result in water savings. The water providers interviewed stated that water savings between 10 to 30 percent were realized once mandatory drought restrictions were put in place. All programs were supported by large-scale public awareness efforts, and most water suppliers implemented a surcharge system in addition to outdoor restrictions to help achieve water savings.

Aurora Water Supply, Denver Water Supply, East Bay Municipal Utility District (EBMUD), Corpus Christi and a number of member cities served by North Texas Municipal Water District (NTMWD)implemented a water use allocation system that charged customers for additional water use above and beyond a specified amount. EBMUD allocated a monthly water use amount based on historical use minus the percent reduction goal; for residential, the goal was 19 percent. Residential customers using less than 100 gallons per capita per day were not penalized for their low-water use habits and were exempt from the drought charges.

All water providers interviewed stated that water savings had a significant impact on revenue in the short term. In addition to water savings achieved during the time of drought restrictions, a "drought-shadow" effect also occurred for nearly all of the water providers, where water use remained low after restrictions were lifted. Nearly all the water providers interviewed stated that some level of water use reduction remained after the drought as a result of changed behaviors, new programs implemented, and greater public awareness. For EBMUD, water use restrictions were lifted in late 1977 after a multi-year drought; however, water use levels by the mid-1980s had not returned to pre-drought levels despite a steadily growing population.

A number of the water suppliers interviewed provided water directly to industrial customers. For these large industrial customers, limitations on outdoor water use alone could not achieve the water savings goals set by the water suppliers. In addition, the possibility of surcharges forced some industrial customers to threaten relocation. By offering technical expertise and significant rebates for water saving initiatives, Denver and Atlanta were able to partner with their industrial customers such as Pepsi, Frito Lay, Xcel Energy, the Georgia Aquarium, and others to evaluate the way they used water and help the customers put in place process changes that often resulted in substantial water savings with no negative impact to production.

Individual Water Providers' Drought Response Overview

Corpus Christi, Texas

Corpus Christi implemented drought response measures in 1984-1986, in 1996, and again in 2001. In 1986, as a result of the multi-year drought where the City was faced with less than a one-year water supply, the water supplier developed its first drought contingency plan. The plan currently includes four stages that correspond to the percentage of combined reservoir levels. The following triggers and drought response measures are included in the latest version of the drought plan:

- 50% capacity triggers City-wide voluntary water conservation (1% reduction goal)
  - ✓ Municipal operations on mandatory conservation
- 40% capacity triggers community-wide mandatory conservation (5% reduction goal)
  - ✓ No lawn or vegetation watering between 10 am to 6 pm
  - ✓ Large parcels of land must obtain approval for watering plan
  - ✓ Commercial nurseries must use hand-held, drip or sprinkler system to irrigate stock
  - ✓ Use of wastewater effluent permitted; sign must be posted on property
- 30% capacity triggers the five-day outdoor watering schedule (10% reduction goal)
  - ✓ Irrigation of golf courses permitted at a minimum rate
  - ✓ Suspend targeted inflows when reservoir below 30% of capacity
  - ✓ Violations punishable by $500 per day
- 20% capacity triggers the monthly residential household water allocation (15% reduction goal)
  - ✓ Each household is allotted 6,000 gallons/month (unless a customer can verify that she or he has more than 2 people living there). Water use in excess of this amount is charged at an aggressive increasing rate per 1,000 gallons (with additional use being charged $5-$8-$13-$40 per each 1,000 gallons above the customers' water use allotment).

In Corpus Christi, a multi-stage conservation program was imposed during the 1984 drought to extend dwindling supplies. Water use restrictions were first implemented during the summer of 1984 and remained in effect through the rest of 1984 and into 1985. During this time, three separate stages, or conditions, of water use restrictions were implemented: (1) condition 1 called for voluntary limitations on outdoor water use; (2) condition 2 restrictions put mandatory limits on allowable watering hours and limited watering to a designated day, once every ten days; and, (3) condition 3 restrictions implemented water rationing on a monthly basis; also, during 1984, under condition 3 a total ban on outdoor water use was implemented.

Corpus Christi Drought Trigger	Date Initiated	Effect on Water Use
Voluntary Conservation (Stage 1)	May 17, 1984	Little to no effect
Mandatory Conservation (Stage 2)	July 1, 1984	28.6 MGD daily reduction
Mandatory Water Rationing (Stage 3)	August 25, 1984	25.4 MGD daily reduction
Some Condition 3 Restrictions Lifted	October 30, 1984	----
Mandatory Water Rationing Lifted	September 24, 1984	----
Return to Condition 2 Restrictions	January 22, 1985	----

When mandatory drought restrictions were implemented in 1984 and 1985, the restrictions reduced water use in Corpus by approximately 30 percent of peak summer usage, according to a study by David Maidment and D.T. Shaw. The study's analysis also showed there to be an average reduction of 27.2 MGD during the period of July through November 1984. Lastly, the analysis showed that the voluntary restrictions, implemented during the early stages of the drought, had little effect in the city.

More than 40 percent of the annual water use in the City of Corpus Christi is for industrial purposes. City staff has worked closely in the past with the large industrial customers to help them determine ways to reduce their water use and a number of industrial representatives are included on the City's Water Resources Advisory Committee. Industrial customers have made significant strides in reducing their water use—with some refineries averaging 50 gallons of water use per barrel of crude oil refined compared to refineries in California who use from 90-100 gallons of water per barrel on average.

During times of serious drought, the City creates a Water Use Allocation and Review Committee, comprised of mayoral and city council appointees who are charged with the task of granting variances and evaluating industrial, commercial, and institutional (ICI) water needs, among other tasks. Similar to residential customers, the ICI customers are limited to water use allocations when the combined reservoir storage drops to 20 percent or below. The committee helps to determine those allocations and reviews variances to the allocation amounts. New services are also prohibited during this stage, unless approved by the Allocation and Review Committee.

Lastly, to help set an example during drought times, the City developed a water diverter to be used in the field during line flushing to divert water to landscaped areas rather than run it down the storm drains.

City of Atlanta, Georgia

The City of Atlanta implemented drought response measures in 2006. The state of Georgia implemented its drought response plan, finally declaring a Stage IV Drought Emergency in September 2007. The City of Atlanta restrictions mirrored the state restrictions, with the greatest emphasis on outdoor water use reduction.

Stage IV of the Georgia Drought Emergency Plan called for a ban on most outdoor watering with a few exceptions. According to City of Atlanta staff, there was some reluctance on the part of the state to declare a Stage IV Drought Emergency until absolutely and completely necessary, due to the projected impact on the landscaping industry, which is estimated to employ more than 75,000 Georgians.

Stage IV set a statewide goal of 10 percent reduction in overall water use by water providers. Savings amounts varied between regions, with nearly 15 percent monthly savings for northern Georgia. For the City of Atlanta, although the drought restrictions were officially lifted in January 2009, the current water use remains below 17 percent of 2006 use—which savings are thought to be a result of awareness, an increase in alternative water use, conservation initiatives, and the downturn in the economy.

The City of Atlanta brought together its top 100 largest customers, a group that included hotels, hospitals, office complexes, a federal prison, Pepsi bottling company, airline corporate headquarters and others, for a workshop on the potential impact of the drought measures and ways to reduce water use. Nearly 90 percent of the customers attended the meeting where case studies and other information were presented. The state also offered support by performing audits on large Industrial Commercial and Institutional (ICI) customers. According to the City of Atlanta, all of its high water use customers saved water.

New landscape installations were allowed under the restrictions; however, a partnership was formed with the Metro Atlanta Lawn and Turf Association (MALTA) to help increase water use efficiency for new landscape installations. In order to be issued the variance by the City of Atlanta to water outdoors, a landscaper had to first take a course on proper watering and design administered by MALTA.

Denver Water, Colorado

Denver's Drought Response Plan called for percentage reductions based on reservoir levels; however, it quickly found itself in a drought worse than the drought of record in 2002 after significant snowfall reductions. Denver Water's Board of Directors changed Denver's Drought Response Plan regularly as the drought became more severe—as a planning document, it had never been implemented and so much of what came up, according to staff, was unexpected and unplanned.

The public awareness campaign, "It's a Drought. Do Something!" used humor to help increase awareness of the drought. Advertisements included sayings like "no need to wash your clothes, just don't wear any" or "don't wash your dishes, just get a dog." Denver Water staff stated that while funny and entertaining, there might not have been enough of an emphasis on the importance of saving water and other messages that needed to be communicated during the drought.

A lot of the challenges faced by Denver Water included managing public expectations. Significant backlash was received from the public concerning what was perceived to be a lack of planning on Denver Water's part that resulted in the implementation of restrictions. Some neighboring communities who relied on groundwater supplies were not as heavily impacted during the 2002-2003 drought, adding to the lack of public understanding about water resource planning and availability. Other challenges included budget reductions as a result of the drought having an impact on CIP funding.

Aurora Water Supply, Colorado

Aurora Water Supply provides water to a primarily residential community. With the first in time, first in right priority water right system in Colorado, Aurora's water supply reservoirs were nearly 26 percent full as a result of severely reduced snowfall from 2002-

2004. Mandatory restrictions were put in place with a no more than twice weekly watering schedule and limits on the times that individual irrigation zones could run (no more than 15 minutes per zone). The installation of new landscaping was not allowed, which resulted in significant push-back from home builders and the landscaping industry. Other drought restriction requirements included restrictions on car washes that mandated recycling or ceasing operation, prohibiting the use of all fountains (unless supporting aquatic habitat), and limiting golf courses and parks to the mandatory watering schedule. While some of these measures were not thought to achieve significant water savings, the issue of public perception was linked to the individual measures and provided as the reason for implementation.

As a result of the drought, long-term changes to outdoor landscape codes for new development were put in place such as minimum soil requirements, limitations on turf grass, and an efficient irrigation system design requirement.

East Bay Municipal Utility District

Rebates, incentives, and regulations have been a part of East Bay Municipal Utility District's (EBMUD) conservation program for years to help encourage efficient water use practices. EBMUD has put in place mandatory drought response measures a number of times since the 1970s. In August 2008, EBMUD declared a severe water shortage emergency as a result of consecutive dry years. The District implemented drought response measures designed to achieve an overall water savings goal of 15 percent.

A number of water efficiency measures were required of customers during this time including a provision on prohibiting water waste (allowing water to run off a property), and requiring shut-off nozzles on all hoses. The main focus of the drought response measures in 2008, however, was a water use customer allocation. Baseline water use for customers was calculated using monthly billing information from the previous three years. Customer allocations were then calculated according to the percentage reduction goals included in Table 2. Surcharges for water use in excess of the allocated amounts were charged at an increasing rate for single family residential customers and a flat rate for all others. Customers using less than 100 GPCD were not penalized for their low-water use habits and were exempt from the drought charges.

EBMUD Customers' Water Use Reduction Goals

Customer Group	**Water Use Reduction Goal**
Single Family Residential	19%
Multi-family Residential	11%
Irrigation	30%
Commercial	12%
Institutional	9%
Industrial	5%
Overall Goal	**15%**

In addition to the surcharges, flow restrictors were used for customers who were found to be wasting water. A regional public awareness campaign also complimented these measures. The implementation of drought response and conservation measures were estimated to reduce water use by 12 percent or nearly 26,000 acre-feet of water.

North Texas Municipal Water District

The North Texas Municipal Water District (NTMWD) implemented drought restrictions in 2005. Stage 1 voluntary restrictions began in October 2005 and the stages implemented increased in severity until mandatory restrictions were lifted in 2007. Stage 3, the first stage that required mandatory measures, set a 5 percent overall reduction goal for its member cities. Savings numbers were tracked on a monthly basis—with NTMWD setting the 5% goal off of previous water use prior to the drought. Water use by the member cities was e-mailed to the cities every month along with information on what was being saved and whether or not the savings exceeded or fell short of the 5 percent savings goal.

Member cities implemented various drought contingency measures, including mandatory watering schedules with time of day and day of the week water restrictions, limitations on ornamental fountains, prohibiting car washes without shut-off nozzles, and adding surcharges to water bills if water use exceeded a pre-determined amount. The watering schedule varied between the member cities depending on their specific system needs—for instance, the City of Frisco implemented a restriction on outdoor water use between 5am and 8am due to capacity and pumping issues when indoor use was at its highest, while others promoted a schedule that allowed watering on your trash day to make it easy for customers to remember. Nearly all the member cities' schedules did not allow outdoor watering to occur between the hours of 10 am and 6 pm, which consistency aided regional messaging efforts.

A representative from NTMWD stated that the system was able to shave off approximately 200 MGD during the summer when drought restrictions were in place. Overall, water savings were an average of 10-15 percent. Moreover, some level of water savings has continued despite restrictions being lifted. The NTMWD representative said this is thought to be in part due to increased awareness in addition to member cities implementing conservation incentive programs and keeping the watering schedule in place on a permanent basis.

NTMWD played an active role in helping its customers with their drought response efforts. Staff served as a technical resource, and they made themselves available to give presentations and other talks throughout the member cities' service areas. In addition, NTMWD brought together its member cities on a monthly basis to give them an update on the drought situation, Water IQ efforts, the likelihood of advancing to the next drought emergency stage, and to provide a forum for members to voice questions and concerns. Member cities were made aware of the change in drought stages (from Stage I to Stage II to Stage III) 30 days in advance of it being declared.

Stakeholder meetings were held with the help of Enviromedia, who assisted in advanced outreach to stakeholder groups, securing locations, and coordinating the meetings for groups of irrigators, landscapers, pool maintenance specialists and others. Member cities were always informed in advance of any presentation, speaking event, or stakeholder meeting if it was to be held in their service area.

After the drought ended, NTMWD revised its model drought contingency plan to reduce the number of voluntary stages to one rather than two and to add a restriction on cool season rye grass.

Tab 5

Benchmarking Research on Mandatory Drought Restrictions implemented in other Communities (Compiled in 2013)

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Timeframe drought response measures implemented	2011-2012	2012-2013	Nov 2002-Feb 2005 and Sept 2006- Nov 2012	2005-2009	July 2009- June 2010	2009	2002-2003, 8 of last 11 years dry
Type of Water Use Provider	Wholesale and Retail	Mostly retail, some wholesale ~1.6 million end users	Wholesale to 3 large municipal retailers ~4 million end-users	Wholesale- State Govt owned entity responsible for managing regional water supply	Wholesale only, 26 member cities/districts, 19 million end-users	Wholesale only to 9 retail cities/districts 600,000 end-users	Wholesale only to 7 member cities/districts ~2 million end-users
Water Savings							
Percent Reduction Goal (overall)	20% - 6 months 30% - 4 months	26-36% (varies based on aquifer level)	18% Stage 4 (outdoor water bans) 25% over ~10 years by 2015	Targets in per capita use instead of % reduction	15% wholesale 10% retail	25%	Mandatory 10% first year
Percent Reduction Achieved (overall)	10-38% monthly	25% off permitted volume, required reduction 22%, normal year use 80-85% of permit	44% since 1997	41-43% achieved by 2009	15%	25%	16% first year, 34% by 2011
Baseline used to cut back from	Permitted volume	Permitted volume	None specified- recent use, changed over time	2004-2005 (pre-restriction average rainfall year)	Past three years of pre-drought water sales (2004-2006)	2004 baseline (state mandate)	N/A
Driver of Water Use Reduction Efforts	Edwards Aquifer Authority mandated reduction permitted volume	Edwards Aquifer Authority mandated reduction permitted volume	Yearly supply available, State regulatory entity required specific mandatory retail restrictions	State Govt required mandatory specific water use restriction measures	Yearly April 1st Board declaration of available water supply/need for allocation	State regulatory entity mandated cutback of 25%	Supply allocation capped at 300,000 acft
Timeframe reduction goal achieved	2 months for 20% 1 months for 30%	Ongoing, met target aquifer levels	Target 155 goal lcd (41 gpcd) achieved in 1 yr (7% decrease)	3 years	One year	6 months	One year

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Tracking Water Savings	Monthly tracking of goals, high level management meetings if goal exceeded	Weekly meetings/internal projection updates	Responsibility on retail side, yearly outlook issued forecasting supply capacity zone and action plan	Weekly, retail customers supplied water use weekly,	Monthly reports given to each member agency during allocation, Local ordinance database compiled	Collected reports from retailers bi-weekly, Monthly tracking of water use & reduction goal	No formal process
Modification credits	N/A	N/A	Time/volume offsets w/ water use plan for some large community use like sports fields, one/one w/ industries	N/A	Conservation (only equipment change outs), Reuse, Growth, Local supply	No	N/A
Before/after per capita use, residual effect of drought		N/A- complicated by merger with Bexar Met	423 lcd in 1990s (112 gpcd) to 240 lcd (63 gpcd) in 2010	475 lcd in 2004 (126 gpcd), 225 lcd (59 gpcd) in 2008	1990- 205 gpcd 2008-185 gpcd	2007- 139 avg gpcd 2012- 119 avg gpcd (high 160 gpcd)	2002- 314 gpcd 2013- 219 gpcd
Drought Response Measures							
Mandatory Watering Schedule	20% 5 day schedule 7pm-10am 30%- hand-hold only irrigation	Once every other week in Stage 3 (640 msl), Stage 2 once weekly w/ restricted hours (650 msl)	Critical (Stage 4) bans outdoor water use except for food gardens w/ water use plan	Stage 4- outdoor bucket watering only, 4 hrs, 3x/wk, Stage 5, gardens only, Stage 6, gardens, 3 hrs, 1x/week	None mandated at wholesale level, request 1 day/wk reduction	Varied depending on Member City	Recommended Schedule (no more than 3 days/week)
New Landscapes	30%- all outdoor use except with hand held hose banned	Max 10,000 sq ft irrigated area, 4 in soil, Variance permitted Stage 2- for 5 wks Stage 3- less than 50% turf	Not allowed	Stages 4-6- hand held only 1 hr/day for 2 wks	No restrictions at wholesale level	Member Cities decide	New homes turf not allowed in front yards

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Restrictions on Commercial Outdoor Irrigation		Golf courses- Stage 2- 20% less than ET rates or <= 1.6x base usage, Stage 3, 30% less than ET rates or <=1.4x base usage	Same as residential, exemptions for public gardens or sports fields at discretion of retail provider	25% reduction in water use from baseline, potable water not allowed for parks in later restriction levels	No restrictions at wholesale level	50% reduction required on all commercial irrigation by 2014	Water budgets imposed for golf courses- 10% reduction goal 1st year
Enforcement							
Enforcement Actions (for violations)	$250-$500/day, 2x during critical stage (30%), board order/hearing, ultimately law suit	Strict, consistent enforcement, off-duty police officer patrol all hours, 75-200 citations per month year round	Retail only: Fines, daily penalties, disconnection, imprisonment	$150K wholesale non-compliance, Retail level fines ranged from $90-$200	Fines (surcharges) <10% over – 2-3x base rate >10% over – 4-5x base rate	Enforced by state water resources control board	Fines for commercial users for exceeding budget, individual retail agency fine structures
Allotment	20%- max use/mo 12,000 gal/conn 30%- max use/mo 9,000 gal/conn		N/A		Level 2 of 10 levels Regional shortage 10%, wholesale <=15%		No formal allotment process at wholesale level
Surcharges as a Result of Excess Use	Has not been needed, high level meetings effective deterrent	In the plan, not implemented since 1996	N/A	Surcharges added to bills	Surcharges added to bills	Member cities discretion	No formal surcharge process at wholesale level
Additional Staff Needed	No additional staff, enforcement mostly rests on retailers to achieve reduction	NA	Not at wholesale level	Not substantial, but some at wholesale level due to formation of new regulatory entity	No, staff resources reallocated to drought activities	Member cities discretion	N/A

	Barton Springs Edwards Aquifer Authority	San Antonio Water System	Melbourne Water, Australia	Seqwater, Queensland, Australia	Metropolitan Water District, CA	Sonoma County Water Authority, CA	Southern Nevada Water Authority, NV
Public Information							
Public Awareness outreach	Supplied retailers with flags, road signs (and require use in DCP), car magnets, bill inserts, relatively small service area	Media partnership critical (weather people, local news), scorecard for media	Weekly reports to mass media, Newspaper, radio, TV, billboards etc, public forum & surveys, phone hotline, social media, website		Bill boards, radio, local news spots, partnership campaigns w/ member agencies	High profile regional water awareness campaign	Contact public information division for more info
Communication efforts/ challenges	Streamlined messaging, repeatable messaging	Messaging confusion w/ Edwards Aquifer Authority, Ongoing, high level of awareness		Consistent messaging over a broad area initially a challenge	Participation in rebate programs increased to 3x more than budgeted	Working through state mandated commercial use reduction	
Lessons Learned	Ask for evidence of letters sent to violators, ask for list of top users		Rapid Climate Shift created uncharted territory. Need flexibility of stages within state mandated DCP	Critical need for consistency, community must be engaged & understand severity of situation to achieve targets	Have a robust appeals process that is defined well, plan ahead for refinement process after drought ends	Effectively engaged landscape community through landscaper training, landscape water advisory group	Avoid outright bans that affect economic interests- can still achieve target water savings. Public perception about small volume but highly visible water uses matters.

2013 Benchmarking Conclusions

Drought conditions and the implementation of mandatory drought response measures during severe droughts can result in substantial water savings. The water providers interviewed stated that water savings between 15 to 40 percent were realized from implementation of mandatory drought restrictions. The timeframe for savings varied from six months to three years for wholesale providers and less for smaller, mainly retail providers. However, several wholesale water providers did not have the actual percent reduction achieved, just that the goals were met. The driving force behind the mandated water use reductions was either imposed by a regulatory authority or self-driven due to a water shortage or system constraint. The baseline water use varied from a permitted annual water volume, to a recent period of use where weather conditions were average and mandatory restrictions were not in place.

Most programs required a specific percent reduction goal and gave retail providers the latitude to determine specific drought response measures. The exception was in Australia, where template retail drought plans were mandated by the state, in some cases with minimal options. A few wholesale providers had different goals by customer class, with a per capita use goal for the municipal sector.

All wholesale programs included three key components: large-scale public awareness efforts, significant effort to partner with customers; and supported the compilation and sharing of information regionally. Regional awareness campaigns were a cornerstone of successful plan implementation for most water providers surveyed, and for all with service over a large geographic area. Those campaigns helped achieve water savings faster as drought conditions worsened, provided consistent messaging, and drove increased participation in conservation programs. Most water suppliers implemented a surcharge system in addition to outdoor restrictions to help achieve water savings.

Lessons learned from the implementation of mandatory drought response measures to achieve significant water use reduction included having consistent regional messaging, using a variety of approaches to achieve desired water use reductions, using outright bans on specific types of water use as a last resort, partnering closely with retail customers, and assisting with information sharing among customers. Most wholesale water providers interviewed did not significantly increase staff but reallocated staff time and other resources to fund awareness campaigns.

In addition to water savings achieved during the time of drought restrictions, a "drought-shadow" effect also occurred for nearly all of the water providers, where water use remained low after restrictions were lifted. Nearly all the water providers interviewed stated that some level of water use reduction remained after the drought as a result of changed behaviors, new programs implemented, and greater public awareness.

Allocation systems were not utilized by many of the wholesale providers interviewed, although Metropolitan Water District of Southern California (MWD) required its wholesale customers to cut back purchases from a growth-adjusted pre-drought baseline. Metropolitan's Water Supply Allocation Plan formula, which accounted for local alternative supplies and included credits for conservation and reuse. MWD went through an extensive revision process of its allocation plan after the first time it was fully implemented in 2009-2010. One of the changes was to allow for a minimum per capital threshold of 100 total gpcd and 55 indoor gpcd to address significant variation in per capita use among its customers.

Attachment O

LCRA BOARD POLICY

102 - AUTHORITY AND RESPONSIBILITIES

December 14, 2011

102.10 PURPOSE

This policy defines the relationship between the Board of Directors and the management of LCRA through the description of responsibilities and expectations and through the establishment of guidelines for the delegation of certain powers and duties.

102.20 POLICY

102.201 Responsibilities of the Board of Directors. The Board of Directors (Board) will establish the overall goals and objectives of LCRA, review them on an ongoing basis and adopt Board policies setting forth desired direction of management actions to attain such goals and objectives. The Board will approve an annual business plan that provides funding for the realization of those goals and objectives.

The Board will consider and establish policies in the public interest. The Board will faithfully discharge its public trust by conducting its affairs in a highly moral, ethical and sound business manner. Board members, collectively and severally, will not direct the policies and actions of LCRA from perspectives of private gain or personal advantage.

102.202 Delegations to the General Manager. The Board of Directors delegates to the general manager all general powers and duties in the LCRA enabling legislation, other applicable law, LCRA Bylaws and Board Policies necessary to accomplish LCRA's purpose, plans and objectives as approved by the Board, except for those specifically reserved for the Board by provisions of the LCRA enabling legislation, Bylaws, Bond Resolutions and other Board policies. Notable exceptions include:

A. Authorization to borrow money or approve bond resolutions.

B. Approval of agreements related to joint ownership of generating facilities.

C. Setting rates charged for water, power and other services.

D. Approval of sale of any real property.

E. Approval of contracts and purchase orders for consultant services in accordance with related Board policies.

F. Approval of contracts and purchase orders for the acquisition of materials, supplies, equipment, and related services, in accordance with related Board policies (except that the general manager is delegated the authority to approve contracts for capacity and/or energy purchases to replace capacity, for emergency conditions, and for economic advantage related to LCRA electric system operations, provided that any such off-system purchase must be for a term of less than one year).

G. Regardless of delegated authority in this or any other LCRA Board policy, Board approval is required for all decisions where Board policy or direction has not been clearly established.

The Board will articulate clear and coherent goals and statements of its expectations through its policies and plans.

102.203 Responsibilities of the General Manager. The general manager, as the chief executive officer of LCRA, is responsible for carrying out the business and activities of LCRA according to state law, the LCRA Bylaws, and Board policy.

The general manager may delegate in writing any general powers, duties and related authorities, as deemed appropriate, to officers and management staff members.

The general manager is responsible for bringing policy matters to the attention of the Board when its current policies give inadequate direction to LCRA operations or leave LCRA at a disadvantage because of changing conditions. The general manager will provide thorough, well-organized information to the Board in a timely manner. Communications to the Board will be made forthrightly and with candor in the evaluation of the conduct of business and operations of LCRA.

102.30 PROCEDURES

102.301 Goals and Priorities. As provided in the bylaws, the general manager each year will present to the Board objectives, goals and priorities for its consideration. These goals will clearly establish the Board's direction in key areas of LCRA affairs.

102.302 Annual Budget. The general manager will present to the Board an annual Business Plan that will include operating and capital budgets to carry out the Board's goals and priorities. The Business Plan will include projections of LCRA's overall financial performance and capital financing plans, and describe the projects, programs and the associated revenues and expenditures for the next fiscal year.

Adoption of the Business Plan authorizes the general manager to complete work plans and make associated expenditures within budgets as provided for in accordance with Board policies. The general manager will provide quarterly updates that include indicators of performance toward key goals, actual revenues and expenditures compared to budget, future financial performance projections and status of major capital projects. The resolution adopting the budget will establish the amount that may not be exceeded without Board approval and the guidelines for approving amendments, reallocations or adjustments to the capital and operating budgets.

102.303 Sunset Review of Regulatory Programs. The general manager will review the effectiveness of, and need for, each major regulatory program of LCRA at least once every six years. These programs shall include, but not be limited to, the Highland Lakes Watershed Ordinance, the Highland Lakes Marina Ordinance, the On-Site Sewerage Facilities Rules, the Litter and Illegal Dumping Abatement Ordinance, and the LCRA Land and Water Use Regulations. The general manager shall recommend to the Board whether to abolish, continue or modify each such program.

102.40 AUTHORITY

LCRA enabling legislation, Chapter 8503, Special District Local Laws Code
LCRA Bylaws, Sections 3.02, 6.01, 6.02

EFFECTIVE: December 1984. Amended Dec. 14, 1989; Oct. 25, 1991; Sept. 22, 1994; Dec. 15, 1999; March 22, 2000; July 1, 2002; Nov 19, 2003; and Dec. 14, 2011.

LCRA EMPLOYEE POLICY MANUAL: 100 GENERAL AND ADMINISTRATIVE

Policy 106: Delegation of Authority

Approval Date	November 2010	Owner	General Manager
Effective Date	July 1, 2011	Policy Owner Review	Annual
Revision Dates	November 18, 2011	Next Executive Team or Designee Review	2014

Purpose
This policy ensures compliance with matters specifically reserved by the Board of Directors and identifies matters either reserved to or delegated by the general manager.

Policy
No employee of LCRA is authorized to take any action reserved to the Board of Directors under Board Policy 102. All other general powers and duties in the LCRA Enabling Act, bylaws, Board policies, and other applicable law necessary to accomplish LCRA's purpose, plans, and objectives are the responsibility of the general manager and those persons to whom the general manager specifically delegates such authority.

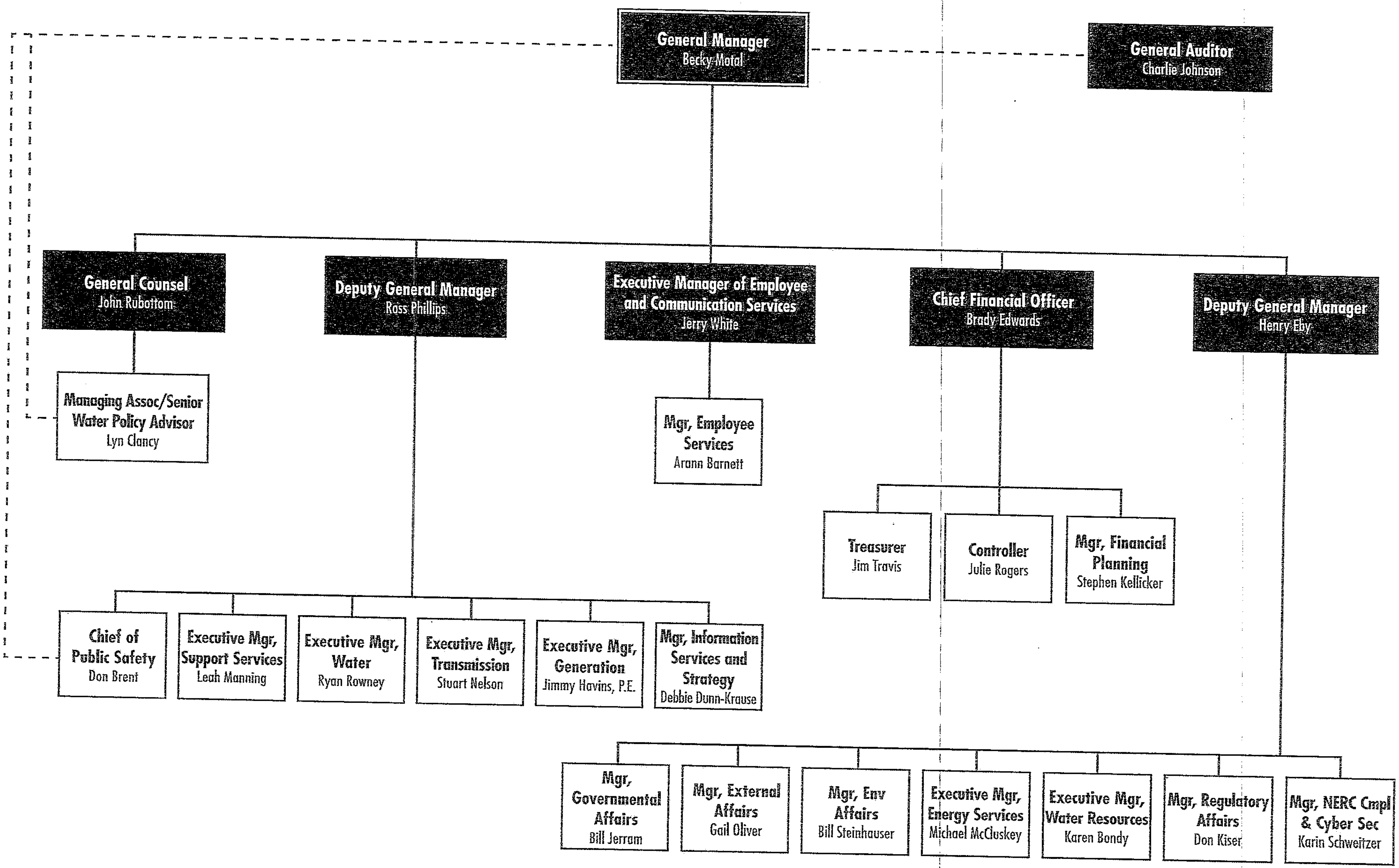
106.1 Authority Reserved to General Manager
Authority for the following matters is reserved to the general manager unless specifically delegated to an executive manager/officer or other LCRA employee by separate documented authorization from the general manager:
- Taking a position on matters that significantly affect relations with public or private entities outside of LCRA
- Employing outside legal counsel, in consultation with the general counsel
- Filing, dismissing, or settling a lawsuit, in consultation with the general counsel
- Taking a formal position in the name of LCRA with regard to federal, state, or local legislation consistent with Board Policy 104
- Filing non-routine pleadings before any state or federal administrative agency
- Acquiring interests in real property. However, documents of conveyance or acquisition may be executed by managers or their designees after the transaction or project involving acquisition has been approved by the Board of Directors.

106.2 General Delegation of Authority by General Manager
The general manager delegates to the executive managers/officers any and all powers and duties necessary to manage their respective departments and service areas, except for those matters reserved to the Board of Directors or general manager as specified in this policy and Board Policy 102. Executive managers/officers are further authorized to delegate authority to their respective department managers and staff. Except in cases of unanticipated short-term absences and emergencies, all delegations must be authorized by another policy, or be documented and consistent with this and other policies, including but not limited to policies related to employment, contract administration, and supply management.

106.3 Exception for Unanticipated Short-Term Absence or Emergency
Temporary delegations by the general manager or executive managers/officers, or re-delegations necessitated by short-term absence in the event of an emergency, should be in writing when possible but may be made verbally. For purposes of this exception, an emergency is a condition or circumstance that poses an imminent threat to power generation, transmission, or distribution; environmental quality; flood control; water operations; employee or public safety; or that could result in an immediate, significant financial, or operational loss or damage to property.

See also:
EPM Policy 107: Contract Management
EPM Policy 108: Supply Management
Board Policy 104 - LCRA Board Position on Legislation

LCRA Executive Team



Enterprise Risk Mgmt Team — Sept. 19, 2013

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