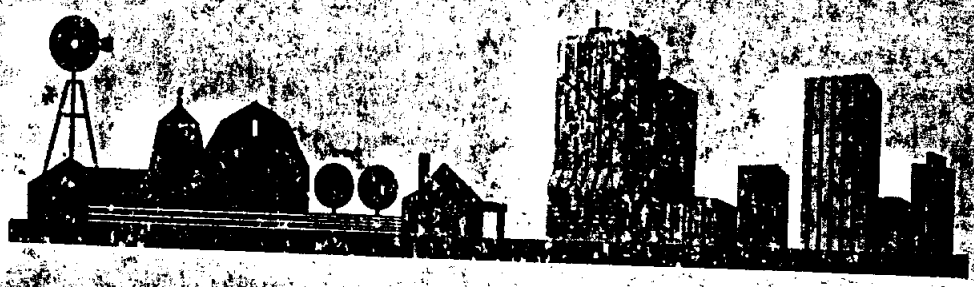
OGALLALA REGIONAL WATER MANAGEMENT PLAN

EXECUTIVE SUMMARY



INTRODUCTION

A grant proposal entitled "Regional Water Planning Needs in Texas," authored by Dr. Lloyd Urban and Mr. A. Wayne Wyatt was submitted near the end of August 1995. The grant signed in May 1996 provided one to one matching funding for work associated with the development of the Ogallala Regional Management Plan. Funds requested totaled $600,000. The planning area includes 47 counties of which any portion overlies the Ogallala Aquifer in the High Plains of Texas. Grant applicants are the political entities within the area with water planning authority: the major cities (Amarillo, Lubbock, Plainview) Dallam County Underground Water Conservation District, High Plains Underground Water Conservation District, Mesa Underground Water Conservation District, North Plains Groundwater Conservation District, Panhandle Ground Water Conservation District, Permian Basin Underground Water Conservation District, Sandy Land Underground Water Conservation District, South Plains Underground Water Conservation District, Brazos River Authority, Canadian River Municipal Water Authority, Colorado River Municipal Authority, Red River Authority of Texas, Mackenzie Municipal Water Authority, Palo Duro River Authority and White River Municipal Water District. The High Plains Underground Water Conservation District was listed as the primary contractor and that interlocal agreements will be negotiated as various entities request financial help to develop their portions of the plan.

The Project Tasks outlined in the grant application are 1) Organize/Initiate Planning Effort; 2) Mission Statement/Planning Issues; 3) Public Participation

Procedures; 4) Baseline Information/Projections; 5) Demand/Supply Management Options; 6) Environmental Concerns; 7) Rank Options/Alternatives; 8) Select Best Plan Components; and 9) Plan Implementation.

During a drought people are more receptive to future water planning and implementation of conservation measures than they are when precipitation is plentiful. A water management plan could be developed that would give the High Plains of Texas assurance that water would be available for all needs, while warding off any take-over of the water resources of the area by state or federal agencies. Development of such a plan would necessarily examine any alternatives for better, more efficient water use, such as the use of LEPA center pivot sprinkler systems, surge valves, underground pipeline, development of plants bred for higher water-use efficiency, and research of new water-use techniques such as high-frequency low volume irrigation.

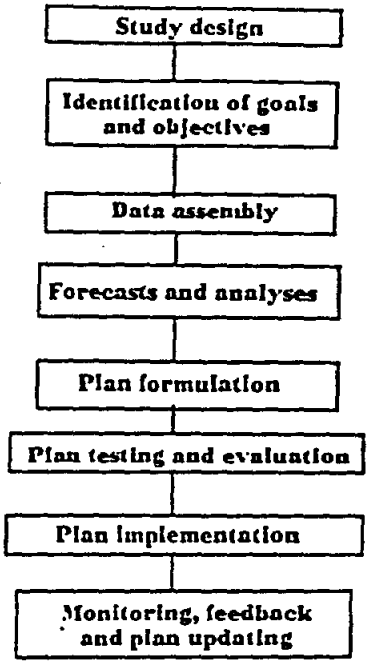
A proposed structure of the Water Management Plan was developed and designed to be flexible to allow changes as the plan developed. The adopted Mission Statement is as follows: Develop, promote, and implement water conservation, augmentation, and management strategies to provide adequate water supplies for the Ogallala region of the High Plains of Texas and to stabilize or improve the economic and social viability and longevity of the region through these activities.

The Water Management Plan will cover all or parts of 47 High Plains counties, an area of 34,450 square miles or 22,048,000 acres. According to Texas Water Development Board's Report 341, *The High Plains Aquifer System of Texas, 1980 to 1990, Overview and Projection, September 1993*, as of 1990, the Ogallala

Aquifer in the study area contained about 453 million acre-feet of water. The same report provides depletion projections by decade period. They project an annual net depletion rate for the area of 3.16 million acre-feet between 1990 and 2000.

Water Resources Center

Water Resources Planning Process



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Some Issues in Water Resources Planning

1. Availability of water
2. Uses and users
3. Deficits and/or surpluses
4. Constraints on development and/or management
5. Prevailing and projected legal, social and population patterns
6. Economic conditions
7. Water quality and environmental concerns
8. Opportunities (eg. conservation)

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Data Assembly

1. Population, economic data, land use, etc.
2. Hydrologic investigations
3. Field investigations
4. Water requirements
5. Current/projected management
6. Conservation programs
   a. Homeowners
   b. Municipalities
   c. Industry
   d. Agriculture

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Some Considerations in Water Resources Planning

Plan Objectives

- Supply/Demand management
- Environmental and other objectives

Planning Horizons

- Short term
- Long term

Alternative Futures

- Bracket "best to worst" situations
- Alternative approaches
- Growth, no-growth, and declining growth patterns

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Texas-Ogallala Aquifer Regional Water Management Plan

(Proposed Outline)

1. Introduction
2. Planning Principles
3. Regional Description - Baseline and Projections
4. Water Resources Issues and Needs
5. Water Resources Opportunities
6. Plan Alternative Scenario Development
7. Recommended Plan(s)
8. Plan Implementation

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Plan Evaluation

1. Economic
2. Regional
3. Social
4. Public Acceptance
5. Environmental
6. Implementation Opportunity

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Plan Implementation

1. Plan useless unless put into effect.
2. Do not make plan a "wish list."
3. Necessary attributes of a successful plan:
   a. Highly visible
   b. Competent
   c. Backed by factual data
   d. Clear priorities
   e. Consequences of not implementing
   f. Good information and strong arguements
   g. Public support

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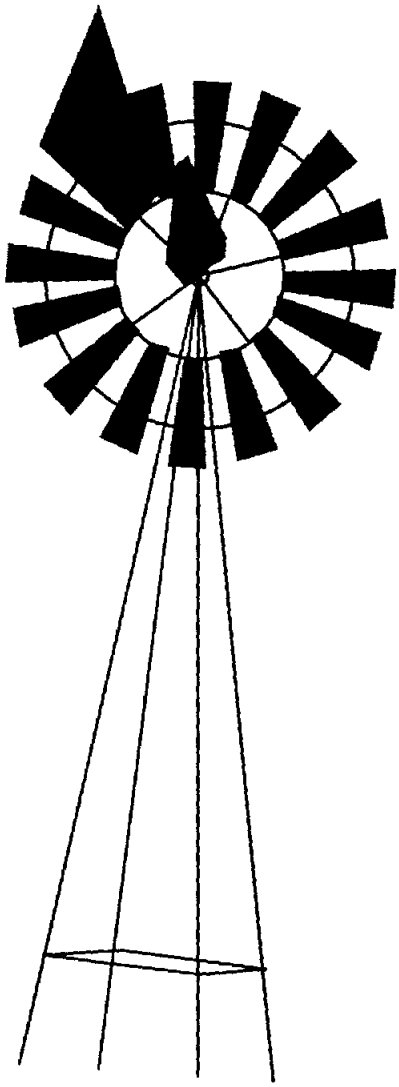
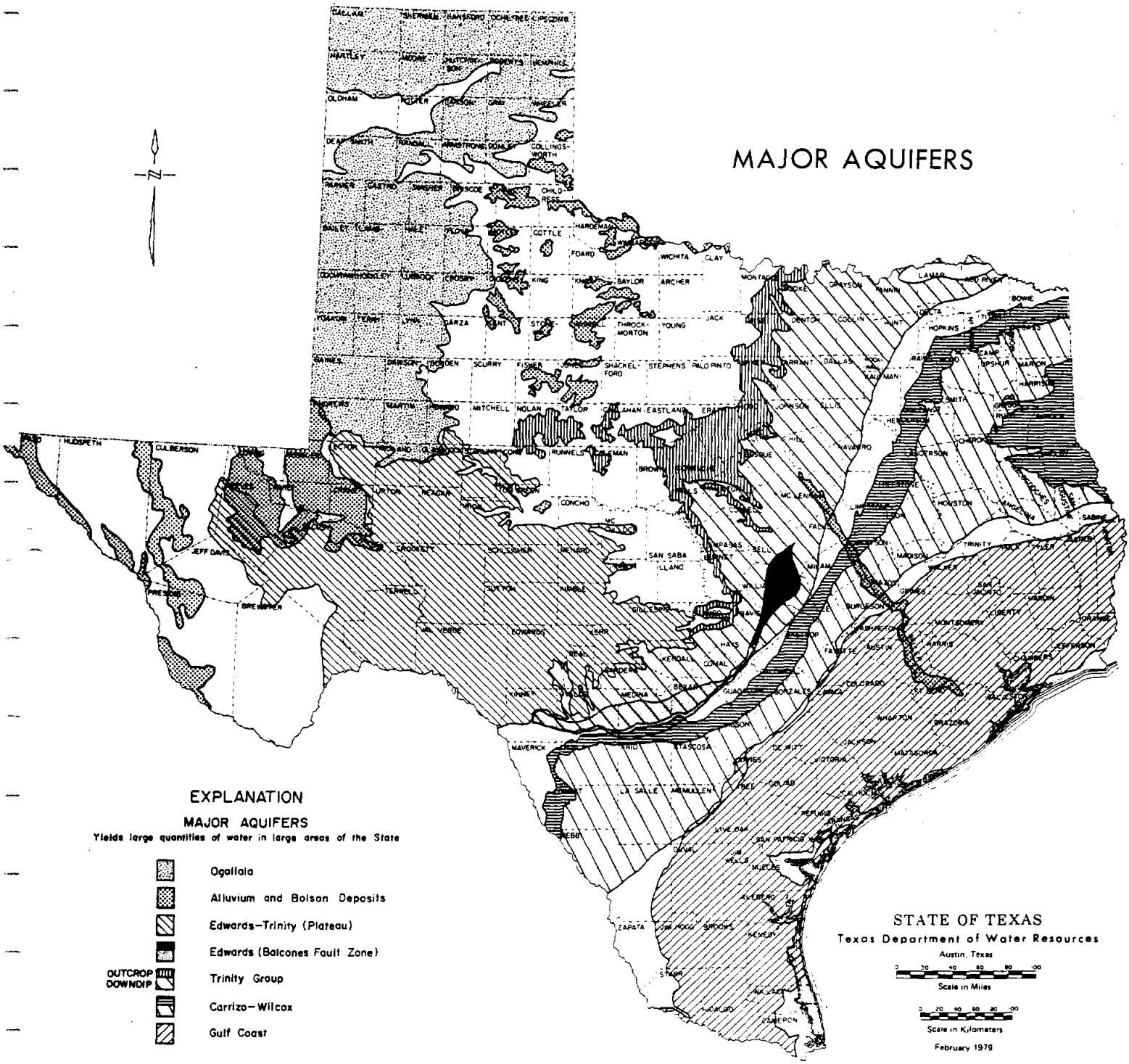
Management Team

Name	Representing
John Abernathy	Research
Lee Arrington	Single Co. Water Districts (South)
John Ashworth	TWDB
Patricia Bruno	Public Interest
Chester Carthel	Intermediate Municipalities
Ken Carver	Agricultural Water Use
Kathy Christensen	Ag. Industry Water Use
Ron Freeman	Large Municipalities
Gale Henslee	Industrial Water Use
Donald Johnson	Cotton Producers
Greg Ingham	Small Municipalities
Carl King	Corn Producers
Carmon McCain	Home Water Use
Bill Nelson	Wheat Producers
Leon New	Ag. Water Conservation
Ken Rainwater	Aquifer Modeling
James D. Ray	Wildlife (State)
Dean Robbins	Water Quality Protection
Y.F. Snodgrass	Grain Sorghum Producers
Jim Steiert	Wildlife (Public Sector)
Lloyd V. Urban	University
C.E. Williams	Medium Water Districts (North)
John Williams	Surface Water Providers
Ross Wilson	Livestock Industry
A. Wayne Wyatt	Large Water Districts (Middle)

REGIONAL WATER RESOURCES




MAJOR AQUIFERS
N
EXPLANATION
MAJOR AQUIFERS
Yields large quantities of water in large areas of the State
Ogallala
Alluvium and Bolson Deposits
Edwards–Trinity (Plateau)
Edwards (Balcones Fault Zone)
OUTCROP
DOWNDIP
Trinity Group
Carrizo–Wilcox
Gulf Coast
STATE OF TEXAS
Texas Department of Water Resources
Austin, Texas
Scale in Miles
Scale in Kilometers
February 1979

TEXAS WATER DEVELOPMENT BOARD
PLANNING DIVISION

COUNTY SUMMARY HISTORICAL WATER USE
(Units: Acre-feet)

County		Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
REGION TOTALS									
1950		626777							
1960		897269							
1970		876907							
1974	Ground		85684	47647	14977	8227030	89389	34303	8499030
	Surface		85025	10587	4350	12541	1970	15710	130183
	Total	919830	170709	58234	19327	8239571	91359	50013	8629213
1977	Ground		94803	61889	8497	7372150	75334	41666	7654339
	Surface		86609	23332	1200	16915	3825	10869	142750
	Total	954821	181412	85221	9697	7389065	79159	52535	7797089
1980	Ground		102843	47144	8824	7028610	69360	41295	7298076
	Surface		97995	12703	6466	22101	2071	9784	151120
	Total	992403	200838	59847	15290	7050711	71431	51079	7449196
1984	Ground		114682	50187	11338	5173083	33816	55325	5438431
	Surface		97654	9228	4253	32338	52	23457	166982
	Total	1076015	212336	59415	15591	5205421	33868	78782	5605413
1985	Ground		109192	39407	12630	4570709	33945	63679	4829562
	Surface		96236	9838	5844	33786	668	25720	172092
	Total	1076265	205428	49245	18474	4604495	34613	89399	5001654
1986	Ground		101479	37570	11172	3966036	34774	55445	4206476
	Surface		94881	9044	2932	24144	768	29392	161161
	Total	1078400	196360	46614	14104	3990180	35542	84837	4367637
1987	Ground		97770	37038	11392	3431672	32678	59089	3669639
	Surface		90661	7313	2414	27418	685	23729	152220
	Total	1062200	188431	44351	13806	3459090	33363	82818	3821859
1988	Ground		100035	35626	12115	3513266	30949	36270	3728261
	Surface		93906	8473	3600	6791	681	21051	134502
	Total	1045900	193941	44099	15715	3520057	31630	57321	3862763
1989	Ground		107641	38042	13617	4690924	27212	36793	4914229
	Surface		97208	7689	2522	31478	533	21446	160876
	Total	1011076	204849	45731	16139	4722402	27745	58239	5075105
1990	Ground		107884	38846	15173	5518964	27212	40236	5748315
	Surface		100907	7638	3016	12118	533	22854	147066
	Total	1013915	208791	46484	18189	5531082	27745	63090	5895381
1991	Ground		104243	36912	12472	4739249	34164	41259	4968299
	Surface		101192	7717	0	11059	2937	23422	146327
	Total	1026092	205435	44629	12472	4750308	37101	64681	5114626
1992	Ground		93534	36051	12733	4433656	33642	66673	4676289
	Surface		100284	7814	0	61871	2744	35139	207852
	Total	1039462	193818	43865	12733	4495527	36386	101812	4884141

(1) Data is by county in which the water is used.
(2) Municipal use excludes reported industrial sales.
(3) Electric power cooling water is consumptive use.
(4) Irrigation surface water use for 1974, 1977 is on-farm use.
Surface water diversion loss estimates are included after 1977.
(5) 1989 mining data is substituted for 1990.
(6) 1991 and 1992 surface water for power is not available.

COUNTY SUMMARY HISTORICAL WATER USE
OF GROUND WATER
DURING THE 1970's
Average per Years Given for Decade
(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	11,398.00	2,588.00	108.00	0.00	7,139.00	11,642.50	239.00	21,716.50
Armstrong	1,948.00	290.00	1.50	0.00	27,654.00	0.00	596.00	28,541.50
Bailey	8,368.60	1,588.00	22.50	0.00	375,437.00	1.50	586.00	377,635.00
Borden	877.00	80.00	0.00	0.00	655.00	4.00	86.50	825.50
Briscoe	2,713.33	317.50	1.00	0.00	100,134.50	1.00	333.00	100,787.00
Carson	6,471.67	935.50	1,223.50	0.00	187,177.00	900.00	850.00	191,086.00
Castro	10,453.00	1,796.50	1,538.00	0.00	518,080.00	0.00	2,803.50	524,218.00
Cochran	5,138.33	797.50	18.00	0.00	85,282.00	7,335.50	836.00	94,269.00
Collingsworth	4,715.00	660.00	1.00	0.00	12,189.00	0.00	165.00	13,015.00
Crosby	9,001.33	611.00	268.50	0.00	195,900.00	101.50	390.00	197,271.00
Dallam	6,198.67	1,388.00	433.00	0.00	271,760.00	1.00	1,221.50	274,803.50
Dawson	16,448.67	789.00	6.00	0.00	33,622.50	1,405.50	589.00	36,412.00
Deaf Smith	19,775.33	4,222.00	2,754.50	0.00	482,399.50	5.00	4,498.00	493,879.00
Dickens	3,663.33	218.50	0.00	0.00	12,760.50	7.00	140.50	13,126.50
Donley	3,796.00	236.00	0.00	0.00	21,510.00	1.50	139.50	21,887.00
Ector	100,041.67	9,194.50	3,172.00	0.00	3,169.00	2,937.50	138.00	18,611.00
Floyd	10,589.67	1,551.50	24.00	0.00	273,700.00	4.00	696.00	275,975.50
Gaines	12,149.00	2,589.50	289.00	0.00	286,913.00	15,330.00	397.50	305,519.00
Garza	5,305.67	161.00	16.50	0.00	13,833.50	498.50	86.50	14,596.00
Glasscock	1,208.00	178.00	0.00	0.00	50,051.50	30.50	316.50	50,576.50
Gray	26,741.33	994.50	4,303.00	0.00	42,859.50	2,177.00	776.00	51,110.00
e	35,378.67	4,475.00	2,510.00	0.00	728,088.50	1,729.50	1,586.00	738,389.00
Hansford	6,298.33	1,433.00	31.50	0.00	404,670.50	365.00	1,506.00	408,006.00
Hartley	3,190.67	713.50	17.00	0.00	206,486.00	1.00	2,242.50	209,460.00
Hemphill	3,807.00	1,132.00	56.00	0.00	5,222.00	22.50	345.00	6,777.50
Hockley	21,407.00	1,643.50	84.00	0.00	272,751.00	14,630.50	465.00	289,574.00
Howard	36,043.33	797.00	123.00	0.00	2,080.00	942.00	173.00	4,115.00
Hutchinson	25,115.00	2,214.50	21,504.00	434.50	90,654.00	1,677.50	122.00	116,606.50
Lamb	18,096.00	3,128.00	333.00	5,080.00	410,061.00	161.50	1,246.50	420,010.00
Lipscomb	3,586.67	585.00	2.00	0.00	26,162.00	15.50	174.50	26,939.00
Lubbock	190,755.33	9,121.50	955.50	919.00	228,204.50	65.00	1,390.50	240,656.00
Lynn	8,920.33	653.00	0.50	0.00	62,387.00	2.00	212.00	63,254.50
Martin	4,740.33	382.00	0.00	0.00	27,662.50	524.00	215.00	28,783.50
Midland	71,438.67	4,319.00	1,007.50	0.00	33,432.00	2,043.00	400.00	41,201.50
Moore	14,950.67	3,648.50	8,333.00	888.50	326,454.00	1,270.50	1,682.50	342,277.00
Motley	2,092.00	397.50	2.00	0.00	6,999.50	0.00	345.50	7,744.50
Ochiltree	9,661.00	1,726.50	37.00	0.00	185,042.50	1,315.50	1,245.50	189,367.00
Oldham	2,266.67	2,019.00	0.00	0.00	28,344.00	89.50	694.50	31,147.00
Parmer	10,700.67	2,136.50	1,310.00	0.00	644,026.00	1.50	2,445.50	649,919.50
Potter	93,437.67	8,612.50	3,776.00	3,106.00	21,538.50	325.50	57.50	37,416.00
Randall	61,122.00	7,109.50	56.50	0.00	97,403.50	57.50	1,212.00	105,839.00
Roberts	1,044.00	193.50	0.00	0.00	13,509.00	0.50	86.00	13,789.00
Sherman	3,474.33	761.00	19.50	0.00	315,096.50	2.50	1,649.00	317,528.50
Swisher	10,131.00	1,936.50	19.00	0.00	409,314.00	2.00	2,150.50	413,422.00
Terry	14,286.33	739.50	93.50	0.00	136,495.00	1,128.00	194.50	138,650.50
Wheeler	6,686.00	1,071.00	301.00	0.00	10,282.50	160.00	577.00	12,391.50
Yoakum	7,685.33	1,356.50	125.50	1,309.00	124,325.50	25,088.50	86.50	152,291.50
TOTAL	933,316.60	93,491.50	54,877.00	11,737.00	7,818,918.00	94,004.00	38,388.50	**8,111,416.00**

COUNTY SUMMARY HISTORICAL WATER USE
OF GROUND WATER
DURING THE 1980's
Average per Years Given for Decade
(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	15,443.14	3,077.29	43.14	0.00	4,971.86	4,870.29	224.86	13,187.43
Armstrong	2,030.70	311.40	0.00	0.00	8,710.57	18.86	516.14	9,556.97
Bailey	8,085.00	1,388.00	48.14	0.00	173,489.57	19.14	1,192.71	176,137.57
Borden	916.57	129.43	0.00	0.00	424.14	525.00	26.86	1,105.43
Briscoe	2,239.29	216.43	1.14	0.00	37,251.57	0.00	244.14	37,713.29
Carson	6,872.14	1,349.86	837.29	0.00	94,774.71	1,189.86	947.00	99,098.72
Castro	10,106.00	1,787.43	1,564.14	0.00	289,347.29	0.00	3,515.29	296,214.14
Cochran	4,583.57	800.57	64.00	0.00	61,294.14	1,698.00	667.14	64,523.86
Collingsworth	4,010.00	848.86	0.00	0.00	8,214.71	0.00	60.43	9,124.00
Crosby	8,184.14	534.57	5.86	0.00	80,381.71	317.71	261.00	81,500.86
Dallam	6,218.00	1,288.29	62.86	0.00	275,969.29	0.00	1,711.14	279,031.57
Dawson	15,795.71	651.29	71.71	0.00	28,415.86	775.86	86.29	30,001.00
Deaf Smith	20,233.86	4,177.29	1,144.14	0.00	260,763.00	0.00	8,698.00	274,782.43
Dickens	2,990.43	146.00	4.57	0.00	4,685.29	13.43	56.71	4,906.00
Donley	3,979.29	94.71	12.00	0.00	8,113.86	16.29	68.29	8,305.14
Ector	127,018.43	9,859.71	1,926.00	0.00	4,116.86	5,460.14	271.71	21,634.43
Floyd	8,916.43	539.29	7.14	0.00	141,565.86	59.00	839.43	143,010.71
Gaines	13,982.14	2,699.57	277.00	0.00	293,353.00	5,750.14	532.43	302,612.14
Garza	5,309.57	155.29	0.00	0.00	4,100.43	571.29	40.29	4,867.29
Glasscock	1,261.00	174.57	4.57	0.00	36,306.71	3.14	234.71	36,723.71
Gray	25,862.57	2,495.43	3,126.43	0.00	24,757.29	1,097.14	306.14	31,782.43
[illegible]le	36,871.57	4,349.43	1,551.57	0.00	425,365.86	297.00	1,147.29	432,711.14
Hansford	6,237.00	1,360.43	35.57	0.00	219,115.00	656.71	2,633.43	223,801.14
Hartley	3,710.43	770.43	0.00	0.00	167,403.43	0.00	2,384.86	170,558.72
Hemphill	4,796.14	1,013.43	71.43	0.00	4,907.14	0.14	337.14	6,329.28
Hockley	24,406.43	1,714.29	85.71	0.00	82,863.00	4,978.86	378.86	90,020.71
Howard	34,745.71	898.43	273.71	0.00	1,180.71	994.29	194.00	3,541.14
Hutchinson	26,796.86	3,418.00	15,976.86	98.57	57,635.71	956.71	67.14	78,153.00
Lamb	16,670.57	2,855.71	604.29	8,923.29	368,956.00	115.86	1,844.71	383,299.86
Lipscomb	3,655.57	745.57	111.00	0.00	15,017.43	6.71	81.43	15,962.14
Lubbock	222,922.57	8,837.29	505.14	110.14	115,916.86	159.14	1,620.43	127,149.00
Lynn	7,522.71	646.14	14.86	0.00	38,666.29	113.43	189.86	39,630.57
Martin	4,367.71	319.00	24.43	0.00	13,020.43	695.29	239.43	14,298.57
Midland	104,022.71	10,818.43	91.43	0.00	18,419.57	867.29	309.86	30,506.57
Moore	17,250.29	3,431.43	7,355.00	244.57	274,859.29	919.14	2,628.14	289,437.57
Motley	1,754.86	331.71	3.86	0.00	3,383.00	0.00	56.00	3,774.57
Ochiltree	10,115.57	2,149.57	0.00	0.00	106,289.00	202.86	797.57	109,439.00
Oldham	2,537.29	2,593.14	0.00	0.00	9,939.43	494.86	639.86	13,667.29
Parmer	10,669.14	1,977.43	1,456.14	0.00	279,256.86	0.00	4,801.43	287,491.86
Potter	103,531.57	12,160.14	3,008.71	1,925.29	12,151.00	531.43	60.57	29,837.14
Randall	87,147.43	10,837.14	283.00	0.00	40,143.14	113.86	2,484.14	53,861.29
Roberts	1,091.43	212.86	0.00	0.00	5,853.57	6.00	55.43	6,127.86
Sherman	3,048.29	694.71	0.00	0.00	237,988.14	21.29	2,258.43	240,962.57
Swisher	8,889.71	728.29	1.29	0.00	139,181.00	5.86	3,759.57	143,676.00
Terry	14,760.29	717.71	55.71	0.00	80,588.00	1,076.00	156.14	82,593.57
Wheeler	6,809.29	1,106.71	31.14	0.00	3,881.57	136.29	234.86	5,390.57
Yoakum	9,249.57	1,319.71	18.14	282.14	75,097.43	6,669.43	123.43	83,510.29
TOTAL	1,067,618.69	108,732.41	40,759.12	11,584.00	4,638,086.58	42,403.74	49,984.72	**4,891,550.54**

COUNTY SUMMARY HISTORICAL WATER USE OF GROUND WATER DURING THE 1990's

Average per Years Given for Decade

(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	14,569.00	3,163.60	21.20	0.00	10,775.00	4,078.80	250.80	18,289.40
Armstrong	2,073.20	337.80	0.00	0.00	12,889.80	18.80	699.00	13,945.40
Bailey	7,110.60	1,335.20	146.00	0.00	205,042.20	22.40	1,508.40	208,054.20
Borden	814.80	90.00	0.00	0.00	570.40	913.60	25.40	1,599.40
Briscoe	1,953.40	182.20	0.00	0.00	35,217.20	0.00	204.00	35,603.40
Carson	6,618.00	1,284.40	622.40	0.00	109,157.40	1,646.80	1,127.00	113,838.00
Castro	8,966.80	1,675.80	1,949.80	0.00	349,791.40	0.00	4,935.80	358,352.80
Cochran	4,393.40	857.20	0.00	0.00	46,305.20	747.40	588.40	48,498.20
Collingsworth	3,680.80	687.20	0.00	0.00	22,595.60	0.00	64.00	23,346.80
Crosby	7,355.00	431.00	6.40	0.00	111,341.00	490.00	233.00	112,501.40
Dallam	5,557.80	1,180.60	0.00	0.00	288,940.60	0.00	2,216.80	292,338.00
Dawson	14,960.60	684.40	31.20	0.00	47,944.80	490.80	105.60	49,256.80
Deaf Smith	19,209.40	3,951.80	917.40	0.00	266,586.60	0.00	11,298.60	282,754.40
Dickens	2,583.00	152.80	0.00	0.00	3,817.00	12.20	61.80	4,043.80
Donley	3,688.60	79.60	0.00	0.00	11,192.20	17.60	72.40	11,361.80
Ector	121,119.20	8,748.80	1,427.60	0.00	5,419.00	7,709.80	232.80	23,538.00
Floyd	8,358.60	295.00	10.80	0.00	194,751.20	63.80	1,024.60	196,145.40
Gaines	14,266.80	2,864.00	325.80	0.00	475,469.60	3,021.80	738.40	482,419.60
Garza	5,221.40	161.80	0.00	0.00	3,578.00	571.20	38.80	4,349.80
Glasscock	1,514.40	204.00	0.00	0.00	36,982.80	7.40	183.00	37,377.20
Gray	24,162.80	3,453.40	3,652.40	0.00	23,977.80	1,197.20	239.60	32,520.40
ale	35,212.40	4,723.60	1,730.20	0.00	371,233.20	122.00	1,250.60	379,059.60
Hansford	5,760.00	1,233.20	43.80	0.00	203,017.20	1,047.20	2,085.60	207,427.00
Hartley	3,646.40	803.00	0.00	0.00	179,958.20	0.00	2,300.40	183,061.60
Hemphill	3,674.60	693.60	2.00	0.00	2,228.80	0.00	670.40	3,594.80
Hockley	24,562.80	1,725.80	4.60	0.00	119,852.80	3,510.40	495.20	125,588.80
Howard	32,665.80	947.80	297.00	0.00	2,096.80	329.80	228.80	3,900.20
Hutchinson	25,952.40	2,713.00	17,886.80	0.20	59,473.60	475.00	79.40	80,628.00
Lamb	15,219.80	2,749.80	431.00	11,924.60	284,632.40	120.60	2,192.00	302,050.40
Lipscomb	3,172.00	748.40	95.00	0.00	15,281.60	6.00	90.20	16,221.20
Lubbock	227,786.20	10,957.60	508.40	0.00	180,958.00	288.60	1,866.00	194,578.60
Lynn	6,716.40	524.60	0.00	0.00	42,028.80	138.40	190.60	42,882.40
Martin	5,076.40	336.80	22.80	0.00	9,285.20	1,160.20	284.00	11,089.00
Midland	110,867.60	10,507.40	125.60	0.00	21,606.00	724.20	423.60	33,386.80
Moore	18,427.40	3,129.40	6,547.20	298.80	342,664.20	598.00	3,365.20	356,602.80
Motley	1,550.40	306.00	2.20	0.00	4,009.00	0.00	46.40	4,363.60
Ochiltree	9,052.80	2,049.80	1.00	0.00	105,132.20	188.00	156.60	107,527.60
Oldham	2,335.80	1,643.20	0.00	0.00	8,593.60	467.60	148.60	10,853.00
Parmer	10,011.20	2,002.20	1,429.00	0.00	352,864.20	0.00	6,520.20	362,815.60
Potter	100,499.40	12,015.80	2,124.00	1,491.00	13,194.40	705.20	74.20	29,604.60
Randall	92,796.00	11,647.40	260.80	411.40	39,752.80	10.20	3,090.40	55,173.00
Roberts	972.60	227.20	0.00	0.00	4,582.40	10.80	53.40	4,873.80
Sherman	2,901.00	630.40	0.00	0.00	260,291.60	22.80	2,732.40	263,677.20
Swisher	8,287.40	439.00	0.00	0.00	169,381.20	4.80	4,253.00	174,078.00
Terry	13,217.40	662.80	2.00	0.00	139,267.20	792.60	131.80	140,856.40
Wheeler	5,786.20	903.80	0.00	0.00	2,831.00	120.20	190.60	4,045.60
Yoakum	8,843.60	1,776.60	0.00	0.00	107,814.00	4,380.00	129.40	114,100.00
TOTAL	1,053,171.60	107,918.80	40,624.40	14,126.00	5,304,375.20	36,232.20	58,897.20	**5,562,173.80**

COUNTY SUMMARY HISTORICAL WATER USE
OF SURFACE WATER
Average per Years Given for Decade
(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
REGIONAL TOTAL								
1970s	933,299.00	83,926.00	12,559.50	9,066.00	14,971.50	2,897.50	14,076.00	**137,496.50**
1980s	1,068,347.29	95,514.98	9,183.98	4,004.43	25,494.70	779.72	22,656.42	**157,634.28**
1990s	1,053,171.60	101,640.40	7,625.60	603.20	27,833.60	3,445.20	31,603.20	**172,751.20**

(1) Data is by county in which the water is used, not necessarily the water source.
(2) Municipal use excludes reported industrial sales.
(3) Electric power cooling water is consumptive use.
(4) Irrigation surface water use for 1974, 1977 is on-farm use.
Surface water diversion loss estimates are included beginning in 1980 where applicable.
(5) 1989 minimg data is substituted for 1990 mining data.
(6) 1991 - 1994 surface water consumption for power is not available.

COUNTY SUMMARY HISTORICAL WATER USE
OF SURFACE WATER
DURING THE 1970's
Average per Years Given for Decade
(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	11,398.00	0.00	0.00	0.00	62.50	0.00	79.00	141.50
Armstrong	1,948.00	0.00	0.00	0.00	0.00	0.00	184.00	184.00
Bailey	8,368.60	0.00	0.00	0.00	0.00	0.00	129.00	129.00
Borden	877.00	19.00	13.00	0.00	7.50	0.00	466.00	505.50
Briscoe	2,713.33	0.00	1.50	0.00	888.00	0.00	317.00	1,206.50
Carson	6,471.67	0.00	0.00	0.00	0.00	91.50	204.00	295.50
Castro	10,453.00	0.00	0.00	0.00	0.00	0.00	353.50	353.50
Cochran	5,138.33	0.00	0.00	0.00	0.00	0.00	161.50	161.50
Collingsworth	4,715.00	0.00	0.00	0.00	181.00	0.00	707.50	888.50
Crosby	9,001.33	622.00	152.00	0.00	1,000.00	318.00	125.00	2,217.00
Dallam	6,198.67	0.00	0.00	0.00	0.00	0.00	338.00	338.00
Dawson	16,448.67	1,867.00	82.50	0.00	0.00	0.00	145.00	2,094.50
Deaf Smith	19,775.33	0.00	0.00	0.00	0.00	0.00	432.00	432.00
Dickens	3,663.33	355.50	4.00	0.00	258.50	0.00	609.00	1,227.00
Donley	3,796.00	494.50	3.00	0.00	0.00	0.00	751.50	1,249.00
Ector	100,041.67	8,179.50	986.50	0.00	284.50	0.00	25.00	9,475.50
Floyd	10,589.67	0.00	0.00	0.00	0.00	0.00	135.50	135.50
Gaines	12,149.00	0.00	0.00	0.00	0.00	0.00	117.50	117.50
Garza	5,305.67	457.50	283.00	0.00	0.00	321.00	374.00	1,435.50
Glasscock	1,208.00	0.00	0.00	0.00	0.00	0.00	33.50	33.50
Gray	26,741.33	3,519.00	1,038.00	0.00	0.00	447.50	451.00	5,455.50
e	35,378.67	1,826.00	42.50	0.00	90.00	0.00	240.50	2,199.00
Hansford	6,298.33	0.00	0.00	0.00	65.00	0.00	240.50	305.50
Hartley	3,190.67	0.00	0.00	0.00	0.00	0.00	308.50	308.50
Hemphill	3,807.00	0.00	0.00	0.00	68.00	0.00	548.00	616.00
Hockley	21,407.00	1,852.00	27.00	0.00	0.00	83.50	98.50	2,061.00
Howard	36,043.33	6,366.50	3,273.50	0.00	97.00	1,120.00	59.00	10,916.00
Hutchinson	25,115.00	0.00	1,891.00	6,291.00	0.00	109.50	561.50	8,853.00
Lamb	18,096.00	0.00	0.00	0.00	0.00	0.00	166.50	166.50
Lipscomb	3,586.67	0.00	0.00	0.00	12.50	0.00	779.50	792.00
Lubbock	190,755.33	27,890.50	2,294.50	2,725.00	7,250.00	0.00	179.50	40,339.50
Lynn	8,920.33	446.50	1.00	0.00	154.00	0.00	71.00	672.50
Martin	4,740.33	290.00	7.50	0.00	0.00	0.00	72.00	369.50
Midland	71,438.67	10,967.00	600.50	0.00	1,596.50	0.00	100.00	13,264.00
Moore	14,950.67	0.00	0.00	0.00	0.00	0.00	155.50	155.50
Motley	2,092.00	0.00	0.00	0.00	55.00	0.00	421.00	476.00
Ochiltree	9,661.00	0.00	0.00	0.00	77.50	0.00	231.50	309.00
Oldham	2,266.67	0.00	0.00	0.00	0.00	406.50	359.50	766.00
Parmer	10,700.67	0.00	0.00	0.00	222.50	0.00	294.00	516.50
Potter	93,437.67	11,083.50	1,822.50	50.00	1,350.00	0.00	284.50	14,590.50
Randall	61,122.00	6,205.50	33.00	0.00	913.00	0.00	702.50	7,854.00
Roberts	1,044.00	0.00	0.00	0.00	0.00	0.00	452.00	452.00
Sherman	3,474.33	0.00	0.00	0.00	92.00	0.00	272.00	364.00
Swisher	10,131.00	0.00	0.00	0.00	0.00	0.00	335.50	335.50
Terry	14,286.33	1,484.50	3.00	0.00	90.00	0.00	59.00	1,636.50
Wheeler	6,686.00	0.00	0.00	0.00	156.50	0.00	917.00	1,073.50
Yoakum	7,685.33	0.00	0.00	0.00	0.00	0.00	28.50	28.50
TOTAL	933,316.60	83,926.00	12,559.50	9,066.00	14,971.50	2,897.50	14,076.00	**137,496.50**

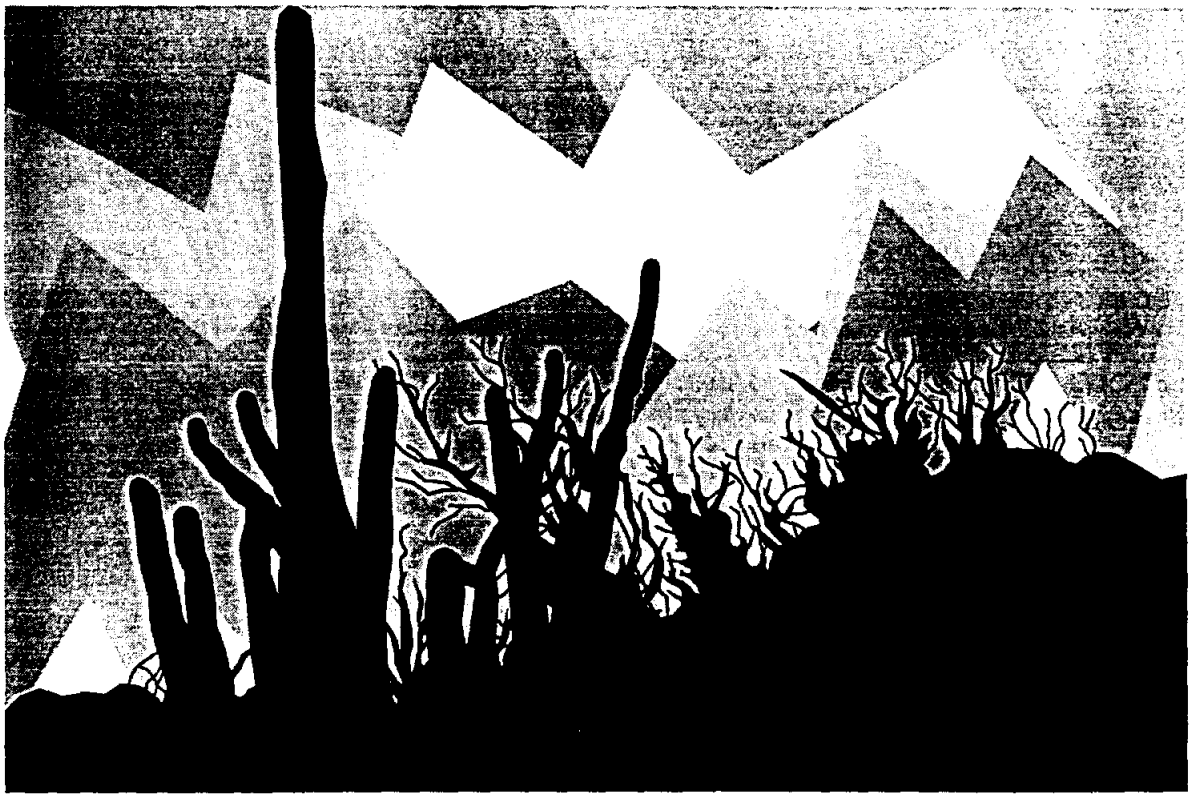
COUNTY SUMMARY HISTORICAL WATER USE
OF SURFACE WATER
DURING THE 1980's
Average per Years Given for Decade
(Units: Acre Feet)

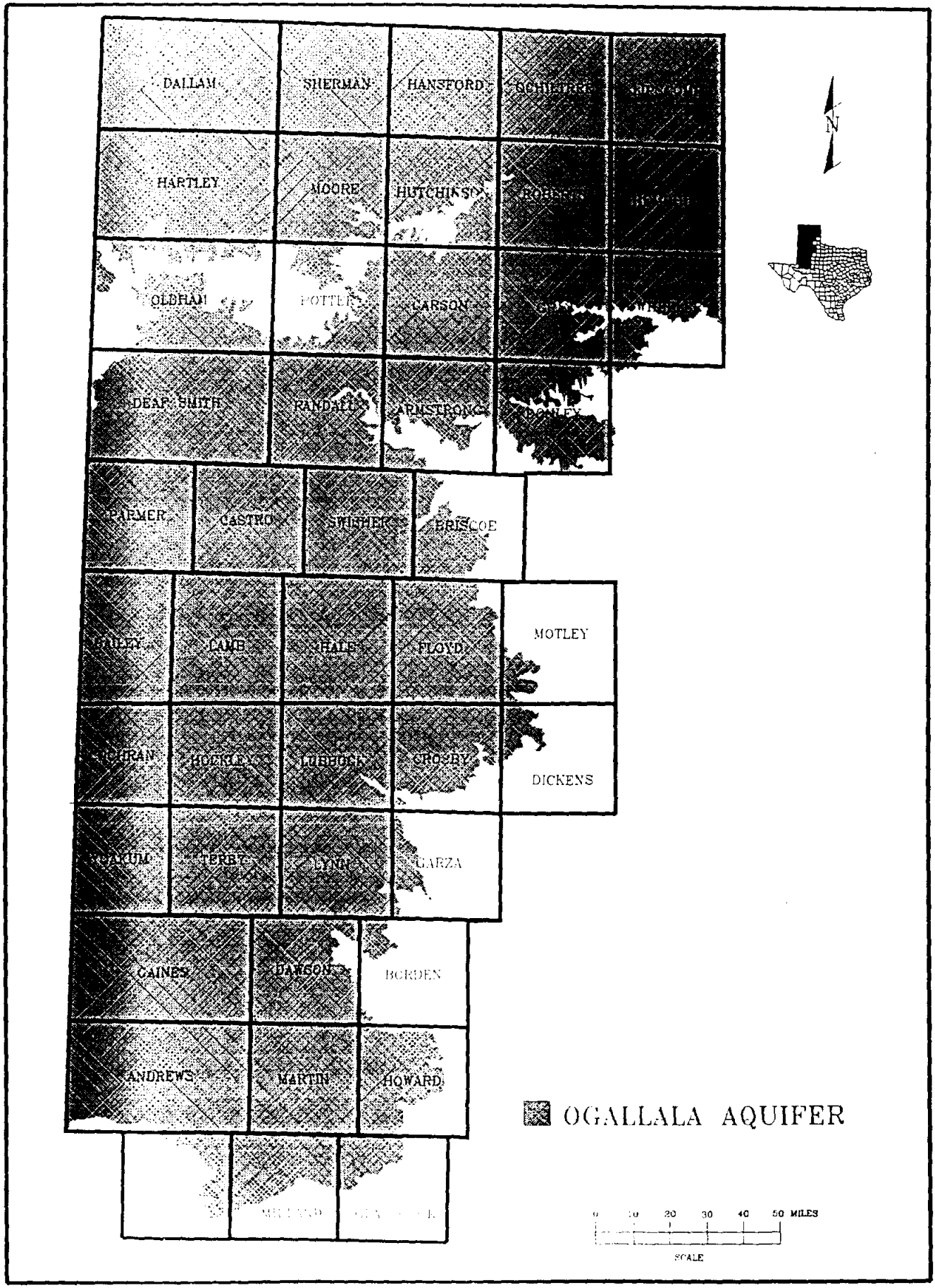
County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	15,443.14	0.00	0.00	0.00	32.71	0.00	59.43	92.14
Armstrong	2,030.70	0.00	0.00	0.00	0.00	0.00	127.00	127.00
Bailey	8,085.00	0.00	0.00	0.00	0.00	0.00	283.14	283.14
Borden	916.57	8.14	75.71	0.00	8.00	0.00	250.29	342.14
Briscoe	2,239.29	108.43	0.00	0.00	128.71	0.00	60.57	297.71
Carson	6,872.14	0.00	0.00	0.00	0.00	129.43	225.57	355.00
Castro	10,106.00	0.00	0.00	0.00	0.00	0.00	802.71	802.71
Cochran	4,583.57	0.00	0.00	0.00	0.00	0.00	153.71	153.71
Collingsworth	4,010.00	9.14	0.00	0.00	25.43	0.00	514.29	548.86
Crosby	8,184.14	723.57	0.00	0.00	1,498.71	143.57	64.29	2,430.14
Dallam	6,218.00	0.00	0.00	0.00	0.00	0.00	419.29	419.29
Dawson	15,795.71	1,901.86	6.71	0.00	0.00	0.00	19.86	1,928.43
Deaf Smith	20,233.86	0.00	0.00	0.00	0.00	0.00	2,002.29	2,002.29
Dickens	2,990.43	273.57	0.00	0.00	395.14	0.00	501.43	1,170.14
Donley	3,979.29	615.57	0.00	0.00	0.00	0.00	614.86	1,230.43
Ector	127,018.43	13,101.29	1,090.57	0.00	1,491.14	0.00	13.00	15,696.00
Floyd	8,916.43	637.57	2.14	0.00	1,421.71	0.00	194.86	2,256.29
Gaines	13,982.14	0.00	0.00	0.00	0.00	0.00	124.14	124.14
Garza	5,309.57	853.14	44.29	0.00	6.43	104.00	346.14	1,354.00
Glasscock	1,261.00	0.00	0.00	0.00	0.00	0.00	58.29	58.29
Gray	25,862.57	2,567.00	17.14	0.00	0.00	236.29	1,599.71	4,420.14
e	36,871.57	2,108.57	29.71	0.00	806.43	0.00	254.86	3,199.57
Hansford	6,237.00	0.00	0.00	0.00	23.00	0.00	1,499.71	1,522.71
Hartley	3,710.43	0.00	0.00	0.00	0.00	0.00	1,044.57	1,044.57
Hemphill	4,796.14	0.00	0.00	0.00	31.00	0.00	985.71	1,016.71
Hockley	24,406.43	1,855.14	17.43	0.00	141.29	0.00	84.14	2,098.00
Howard	34,745.71	7,155.00	1,906.57	0.00	268.57	134.14	48.14	9,512.43
Hutchinson	26,796.86	890.71	2,061.14	0.00	0.00	0.00	509.43	3,461.29
Lamb	16,670.57	0.00	0.00	0.00	0.00	0.00	431.29	431.29
Lipscomb	3,655.57	0.00	7.71	0.00	51.43	0.00	724.43	783.57
Lubbock	222,922.57	30,580.57	1,120.71	2,465.57	5,327.57	0.00	372.43	39,866.86
nn	7,522.71	454.29	0.00	0.00	2,723.43	0.00	46.00	3,223.71
Martin	4,367.71	330.14	0.00	0.00	0.00	0.00	59.14	389.29
Midland	104,022.71	12,997.00	73.29	0.00	3,286.14	0.00	76.71	16,433.14
Moore	17,250.29	0.00	24.57	139.86	0.00	9.86	604.71	779.00
Motley	1,754.86	2.57	0.00	0.00	105.00	22.43	505.14	635.14
Ochiltree	10,115.57	0.00	0.00	0.00	0.00	0.00	673.57	673.57
Oldham	2,537.29	0.00	0.00	0.00	0.00	0.00	610.71	610.71
Parmer	10,669.14	0.00	0.00	0.00	468.86	0.00	1,088.71	1,557.57
Potter	103,531.57	9,670.71	2,468.43	1,399.00	2,447.29	0.00	546.86	16,532.29
Randall	87,147.43	6,499.57	237.86	0.00	4,318.57	0.00	580.86	11,636.86
Roberts	1,091.43	0.00	0.00	0.00	0.00	0.00	508.00	508.00
Sherman	3,048.29	0.00	0.00	0.00	59.71	0.00	527.71	587.43
Swisher	8,889.71	747.43	0.00	0.00	0.00	0.00	871.86	1,619.29
Terry	14,760.29	1,424.00	0.00	0.00	399.86	0.00	37.14	1,861.00
Wheeler	6,809.29	0.00	0.00	0.00	28.57	0.00	1,499.29	1,527.86
Yoakum	9,249.57	0.00	0.00	0.00	0.00	0.00	30.43	30.43
TOTAL	1,067,618.69	95,514.98	9,183.98	4,004.43	25,494.70	779.72	22,656.42	**157,634.28**

COUNTY SUMMARY HISTORICAL WATER USE
OF SURFACE WATER
DURING THE 1990's
Average per Years Given for Decade
(Units: Acre Feet)

County	Population	Municipal	Manufact.	Power	Irrigation	Mining	Livestock	Total
Andrews	14,569.00	0.00	0.00	0.00	0.00	0.00	62.40	62.40
Armstrong	2,073.20	0.00	0.00	0.00	0.00	0.00	174.60	174.60
Bailey	7,110.60	0.00	0.00	0.00	0.00	0.00	377.00	377.00
Borden	814.80	4.60	60.60	0.00	32.20	0.00	230.60	328.00
Briscoe	1,953.40	119.00	0.00	0.00	0.00	0.00	51.00	170.00
Carson	6,618.00	0.00	0.00	0.00	0.00	84.80	281.40	366.20
Castro	8,966.80	0.00	0.00	0.00	0.00	0.00	1,234.00	1,234.00
Cochran	4,393.40	0.00	0.00	0.00	0.00	3.60	146.80	150.40
Collingsworth	3,680.80	8.20	0.00	0.00	130.20	0.00	577.00	715.40
Crosby	7,355.00	706.00	0.00	0.00	78.40	320.60	58.00	1,163.00
Dallam	5,557.80	0.00	0.00	0.00	0.00	0.00	554.00	554.00
Dawson	14,960.60	1,621.20	0.00	0.00	0.00	0.00	26.00	1,647.20
Deaf Smith	19,209.40	0.00	0.00	0.00	0.00	0.00	2,824.60	2,824.60
Dickens	2,583.00	322.20	0.00	0.00	9.80	0.00	558.20	890.20
Donley	3,688.60	549.80	0.00	0.00	0.00	0.00	652.00	1,201.80
Ector	121,119.20	14,766.60	685.80	0.00	335.20	0.00	12.20	15,799.80
Floyd	8,358.60	785.80	1.40	0.00	0.00	0.00	256.20	1,043.40
Gaines	14,266.80	0.00	0.00	0.00	0.00	0.00	184.60	184.60
Garza	5,221.40	626.80	2.00	0.00	19.80	0.00	355.20	1,003.80
Glasscock	1,514.40	0.00	0.00	0.00	0.00	0.00	45.60	45.60
Gray	24,162.80	1,881.40	0.60	0.00	0.00	0.00	2,158.20	4,040.20
[illegible]	35,212.40	1,546.40	37.40	0.00	9,596.80	0.00	312.40	11,493.00
Hansford	5,760.00	0.00	0.00	0.00	0.00	0.00	3,128.40	3,128.40
Hartley	3,646.40	0.00	0.00	0.00	0.00	0.00	2,300.40	2,300.40
Hemphill	3,674.60	0.00	0.00	0.00	0.00	0.00	1,005.80	1,005.80
Hockley	24,562.80	1,802.40	19.20	0.00	675.20	0.00	123.40	2,620.20
Howard	32,665.80	6,092.60	1,390.60	0.00	528.20	1,011.60	57.20	9,080.20
Hutchinson	25,952.40	1,208.00	1,585.80	0.00	0.00	0.00	715.00	3,508.80
Lamb	15,219.80	0.00	0.00	0.00	0.00	0.00	548.00	548.00
Lipscomb	3,172.00	0.00	21.40	0.00	12.00	0.00	813.60	847.00
Lubbock	227,786.20	30,046.20	1,029.40	343.00	3,504.60	0.00	466.60	35,389.80
Lynn	6,716.40	427.80	0.00	0.00	3,690.80	0.00	47.60	4,166.20
Martin	5,076.40	298.60	0.00	0.00	34.00	0.00	71.00	403.60
Midland	110,867.60	14,124.60	45.80	0.00	4,599.60	0.00	105.80	18,875.80
Moore	18,427.40	0.00	29.60	0.00	0.00	0.00	841.40	871.00
Motley	1,550.40	14.80	0.00	0.00	20.40	23.80	418.20	477.20
Ochiltree	9,052.80	0.00	0.00	0.00	0.00	0.00	1,412.00	1,412.00
Oldham	2,335.80	0.00	0.00	0.00	0.00	0.00	1,337.40	1,337.40
Parmer	10,011.20	0.00	0.00	0.00	0.00	0.00	1,630.00	1,630.00
Potter	100,499.40	12,790.80	2,418.20	260.20	3,162.40	0.00	669.60	19,301.20
Randall	92,796.00	9,690.60	297.80	0.00	1,338.80	0.00	773.00	12,100.20
Roberts	972.60	0.00	0.00	0.00	0.00	0.00	480.60	480.60
Sherman	2,901.00	0.00	0.00	0.00	0.00	0.00	682.80	682.80
Swisher	8,287.40	958.80	0.00	0.00	0.00	0.00	1,062.80	2,021.60
Terry	13,217.40	1,247.20	0.00	0.00	65.20	0.00	32.80	1,345.20
Wheeler	5,786.20	0.00	0.00	0.00	0.00	0.00	1,715.40	1,715.40
Yoakum	8,843.60	0.00	0.00	0.00	0.00	2,000.80	32.40	2,033.20
TOTAL	1,053,171.60	101,640.40	7,625.60	603.20	27,833.60	3,445.20	31,603.20	**172,751.20**

GROUND WATER RESOURCES

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PARMER
CASTRO
SWISHER
BRISCOE
MOTLEY
FLOYD
HALE
CAMB
LUBBOCK
CROSBY
DICKENS
HOCKLEY
TERRY
LYNN
GARZA
CAINES
DAWSON
BORDEN
ANDREWS
MARTIN
HOWARD
N
OGALLALA AQUIFER
0 10 20 30 40 50 MILES
SCALE

VOLUME OF WATER IN STORAGE IN 1990 AND ESTIMATED RESERVES THAT WILL BE AVAILABLE IN 2000 IN MILLIONS OF ACRE-FEET [*1]

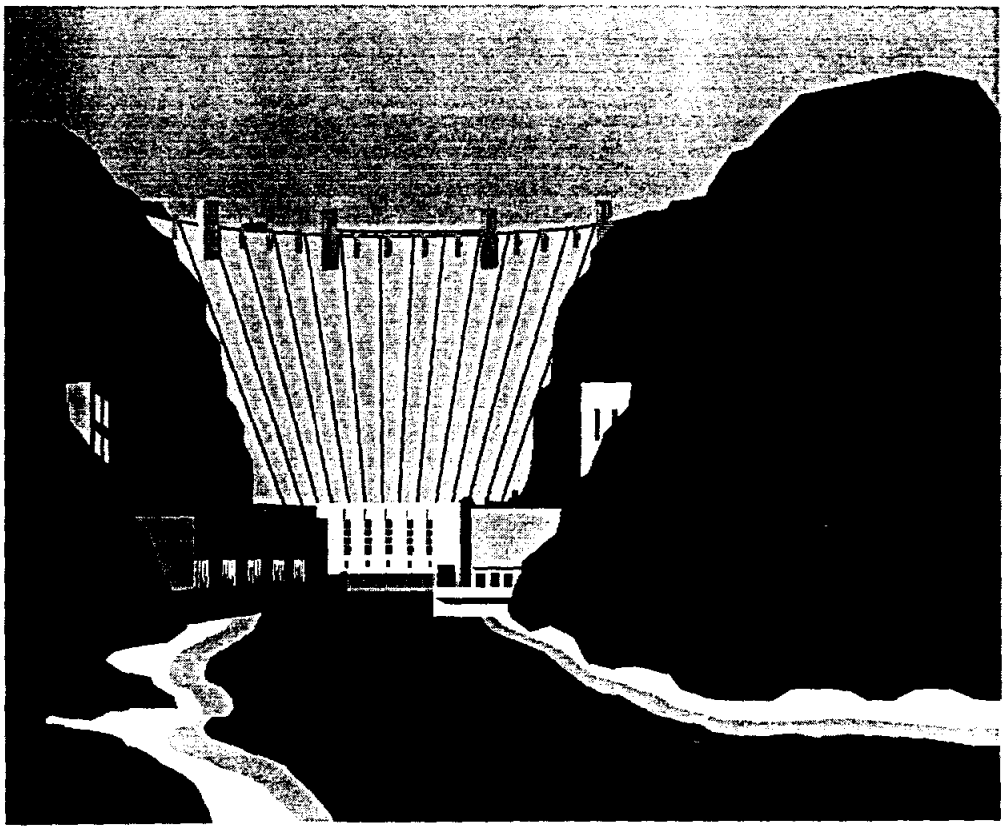
County	Unrecoverable	1990	2000
Andrews	1.23	4.92	4.77
Armstrong	0.50	3.64	3.50
Bailey	0.81	6.28	5.50
Borden	0.01	0.17	0.16
Briscoe	0.24	1.69	1.35
Carson	0.92	13.19	12.53
Castro	1.05	11.74	9.76
Cochran	0.83	4.06	3.37
Crosby	0.53	6.62	5.86
Dallam	1.71	29.97	25.71
Dawson	0.70	6.31	5.96
Deaf Smith	1.54	10.66	9.01
Dickens	0.04	0.93	0.85
Donley	0.64	8.09	8.10
Ector	0.45	2.31	2.27
Floyd	0.99	9.37	8.23
Gaines	1.37	13.63	12.27
Garza	0.07	0.71	0.67
Glasscock	0.14	1.73	1.71
Gray	1.02	12.96	12.30
Hale	1.12	12.32	9.99
Hansford	1.06	23.27	21.36
Hartley	1.61	27.82	26.06
Hemphill	0.93	16.57	16.74
Hockley	0.88	4.40	3.68
Howard	0.39	2.01	1.92

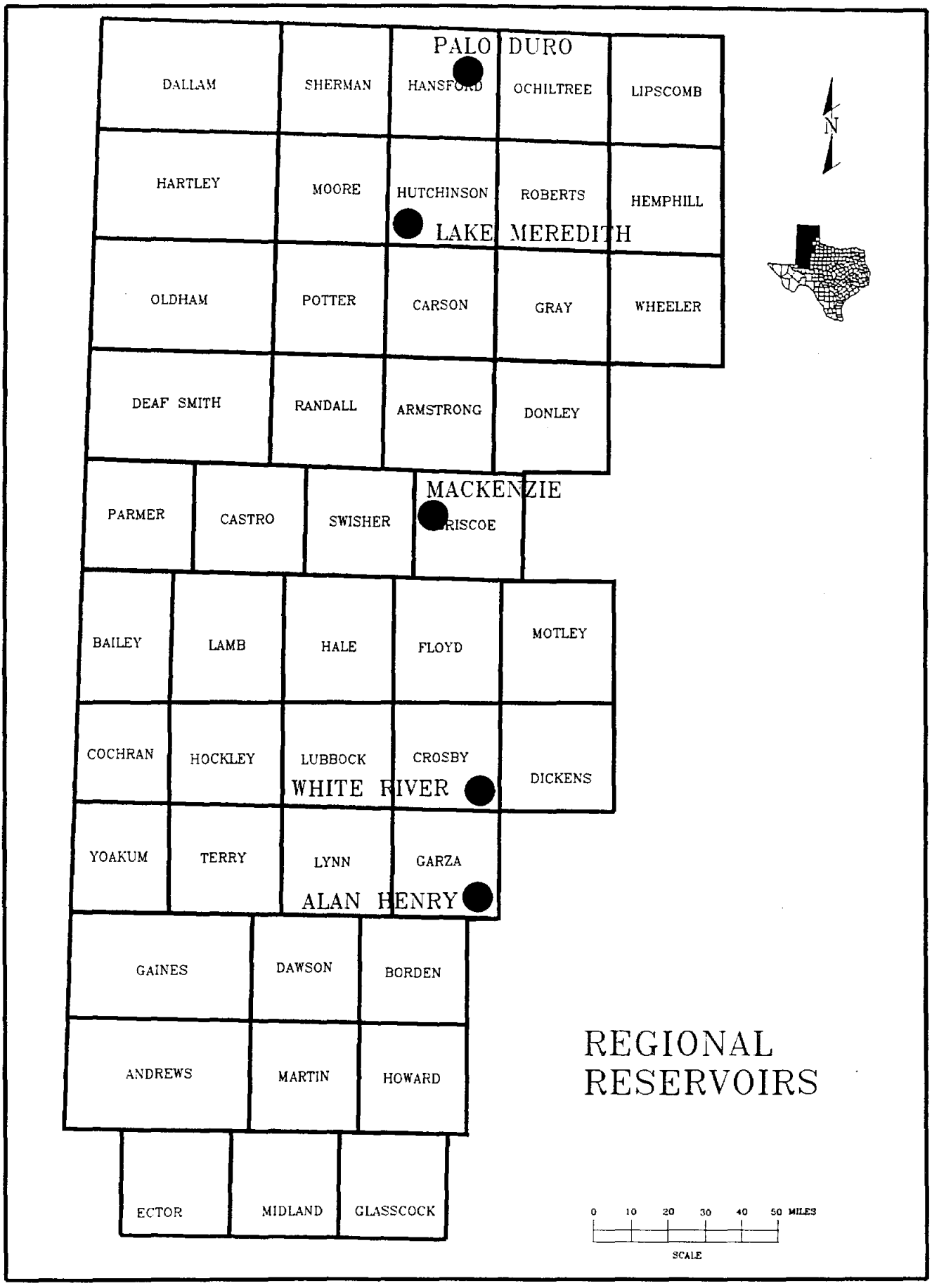
VOLUME OF WATER IN STORAGE IN 1990 AND ESTIMATED RESERVES THAT WILL BE AVAILABLE IN 2000 IN MILLIONS OF ACRE-FEET [*1]

County	Unrecoverable	1990	2000
Hutchinson	0.69	10.54	9.97
Lamb	1.05	10.09	8.30
Lipscomb	0.96	20.82	20.74
Lubbock	0.80	5.11	3.97
Lynn	0.80	3.62	3.24
Martin	0.86	4.83	4.73
Midland	0.41	2.00	1.88
Moore	0.76	13.20	11.11
Motley	0.08	0.82	0.78
Ochiltree	0.90	18.57	17.67
Oldham	0.33	1.14	1.07
Parmer	0.98	9.64	7.98
Potter	0.36	3.07	2.76
Randall	0.91	4.51	4.00
Roberts	1.01	27.62	27.70
Sherman	1.05	21.88	19.79
Swisher	0.80	4.75	3.64
Terry	0.96	5.60	4.70
Wheeler	0.58	8.45	8.36
Yoakum	0.83	5.71	5.08
Total	**35.90**	**417.34**	**381.10**

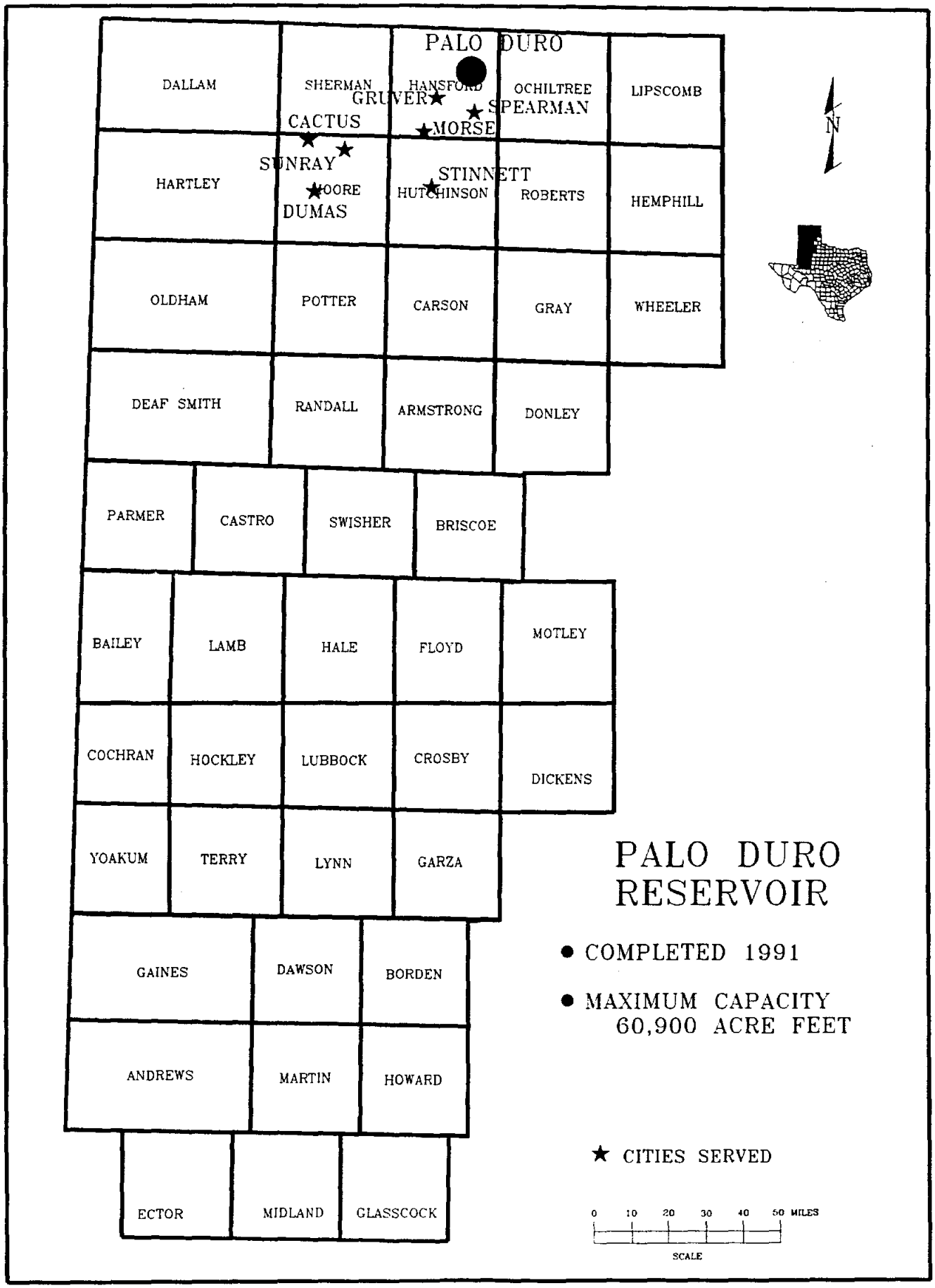
[*1] Texas Water Development Board Report 341, 1993

SURFACE WATER RESOURCES





REGIONAL RESERVOIRS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GRUVER
SPEARMAN
CACTUS
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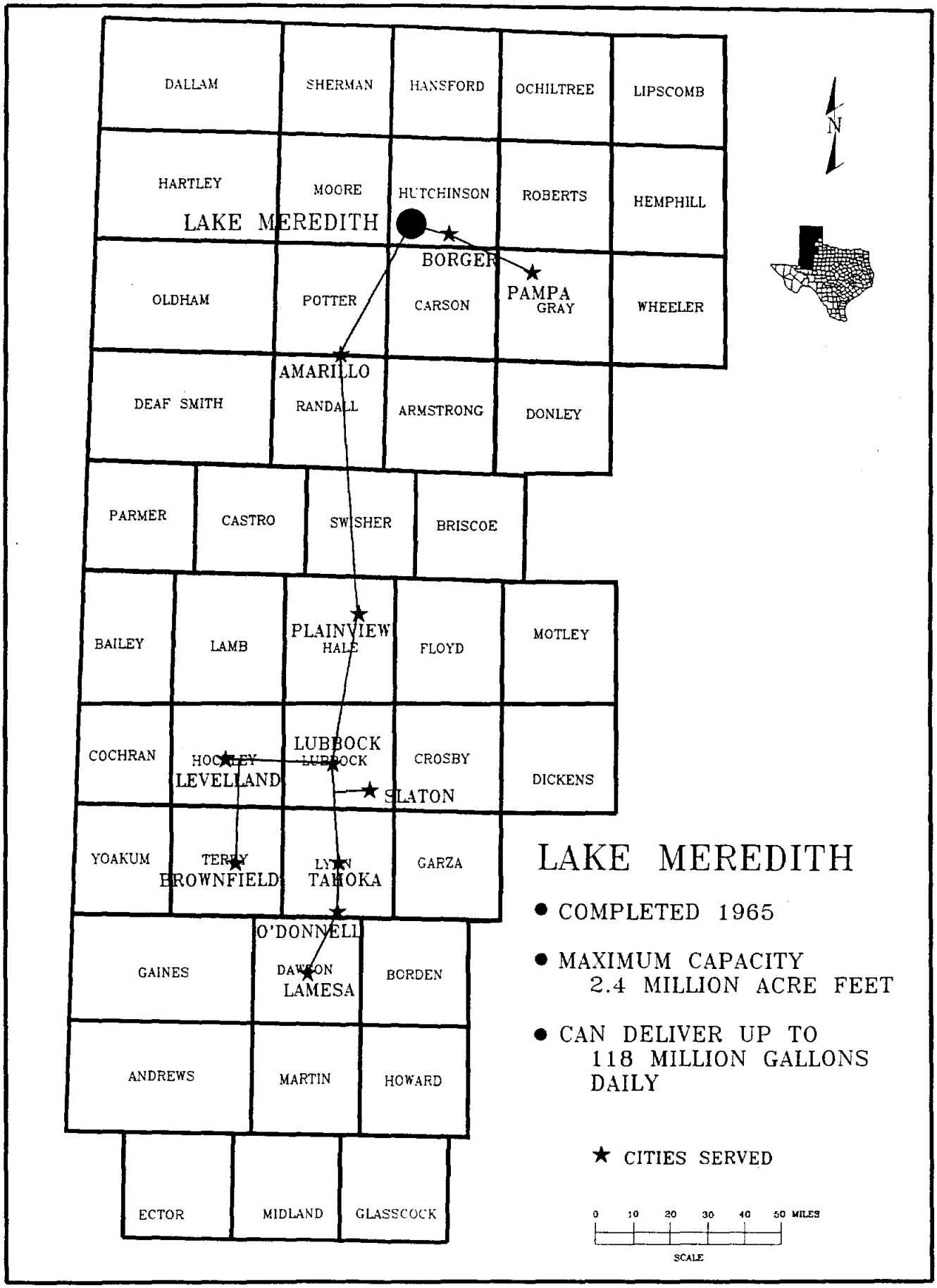
HARTLEY
STINNETT
MOORE
HUTCHINSON
ROBERTS
HEMPHILL
DUMAS
OLDHAM
POTTER
CARSON
GRAY
WHEELER
DEAF SMITH
RANDALL
ARMSTRONG
DONLEY
PARMER
CASTRO
SWISHER
BRISCOE
BAILEY
LAMB
HALE
FLOYD
MOTLEY
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
YOAKUM
TERRY
LYNN
GARZA
GAINES
DAWSON
BORDEN
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
PALO DURO RESERVOIR
• COMPLETED 1991
• MAXIMUM CAPACITY 60,900 ACRE FEET
★ CITIES SERVED
0 10 20 30 40 50 MILES
SCALE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BORGER
PAMPA
GRAY
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POTTER
CARSON
WHEELER
AMARILLO
DEAF SMITH
RANDALL
ARMSTRONG
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CASTRO
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BRISCOE
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LAMB
PLAINVIEW
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FLOYD
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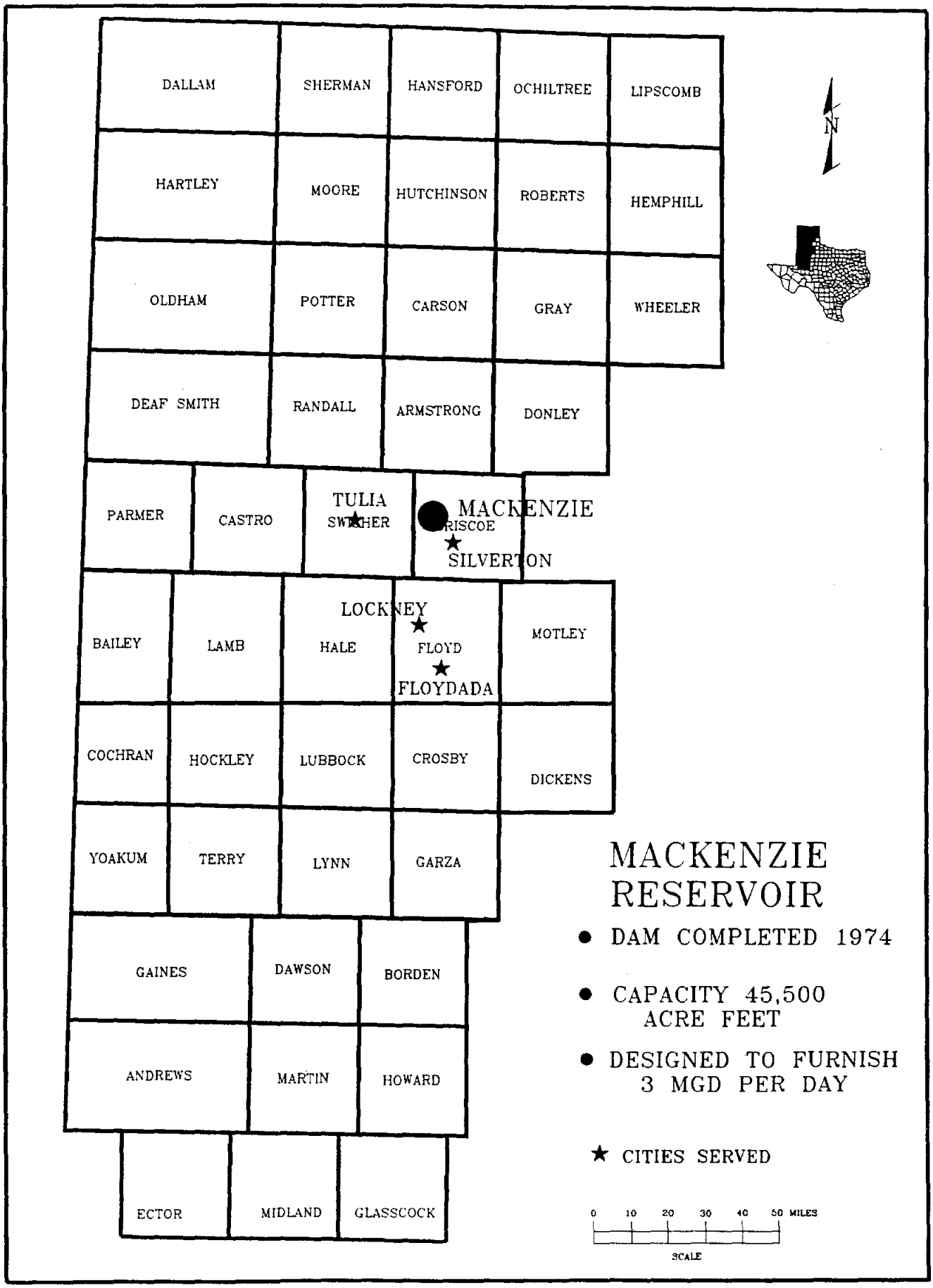
COCHRAN
HOCKLEY
LEVELLAND
LUBBOCK
LUBBOCK
CROSBY
DICKENS
SLATON
YOAKUM
TERRY
BROWNFIELD
LYNN
TAHOKA
GARZA
O'DONNELL
GAINES
DAWSON
LAMESA
BORDEN
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
LAKE MEREDITH
• COMPLETED 1965
• MAXIMUM CAPACITY 2.4 MILLION ACRE FEET
• CAN DELIVER UP TO 118 MILLION GALLONS DAILY
★ CITIES SERVED
0 10 20 30 40 50 MILES
SCALE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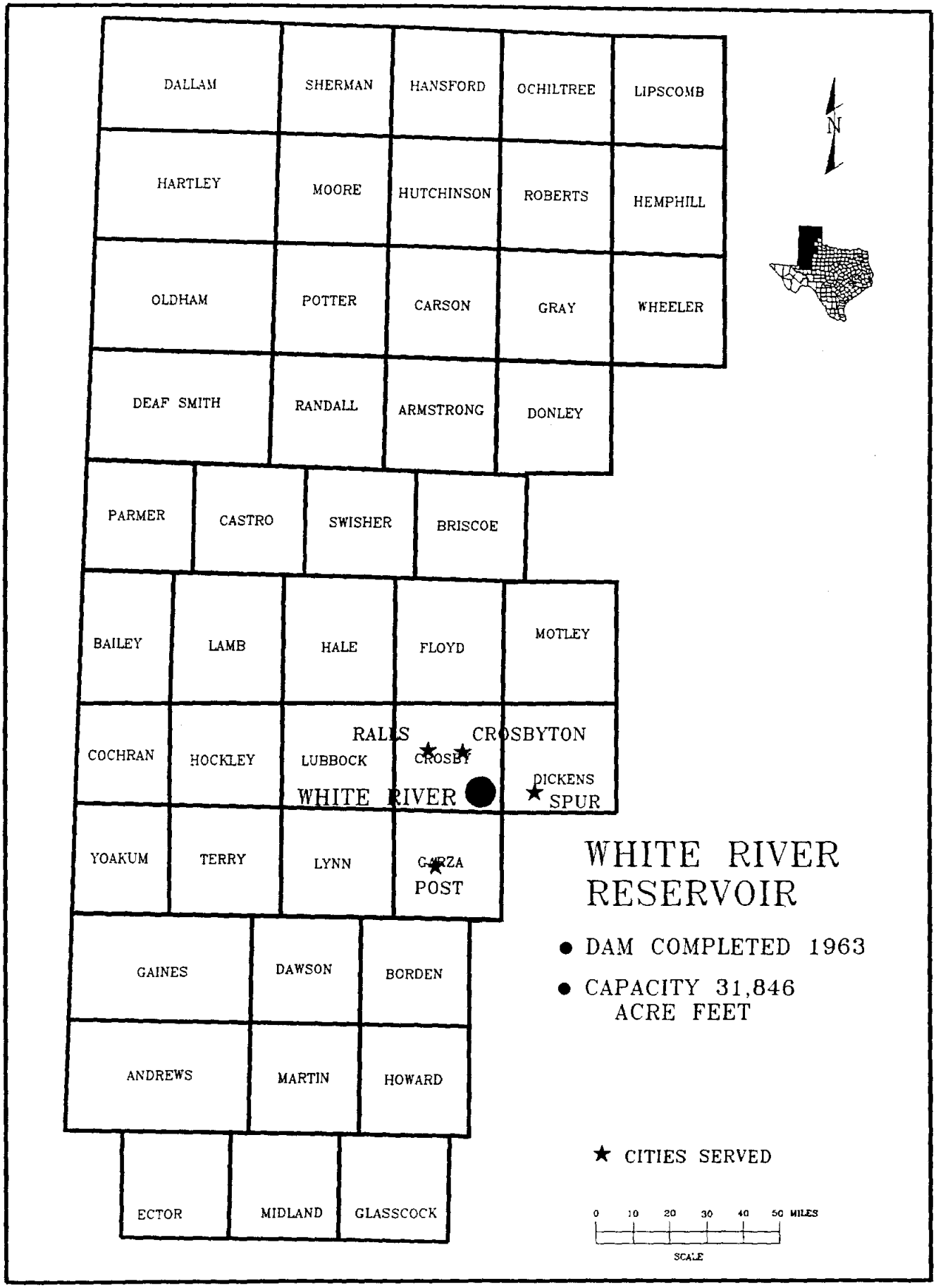
SWISHER
MACKENZIE
RISCOE
SILVERTON
BAILEY
LAMB
HALE
LOCKNEY
FLOYD
FLOYDADA
MOTLEY
COCHRAN
HOCKLEY
LUBBOCK
CROSBY
DICKENS
YOAKUM
TERRY
LYNN
GARZA
GAINES
DAWSON
BORDEN
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
MACKENZIE RESERVOIR
DAM COMPLETED 1974
CAPACITY 45,500 ACRE FEET
DESIGNED TO FURNISH 3 MGD PER DAY
CITIES SERVED
0 10 20 30 40 50 MILES
SCALE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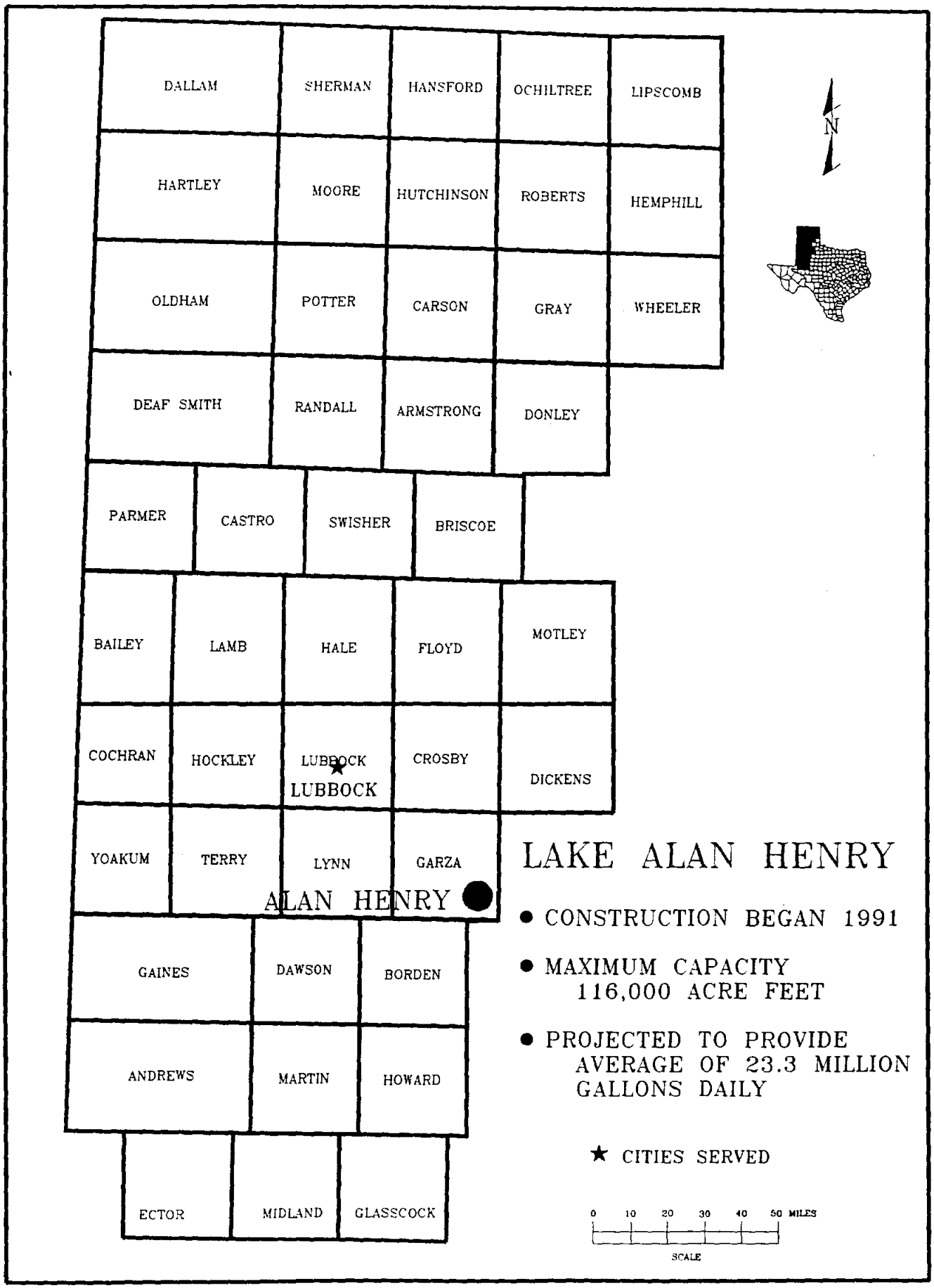
DICKENS
SPUR
WHITE RIVER
YOAKUM
TERRY
LYNN
GARZA
POST
GAINES
DAWSON
BORDEN
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
WHITE RIVER RESERVOIR
• DAM COMPLETED 1963
• CAPACITY 31,846 ACRE FEET
★ CITIES SERVED
0 10 20 30 40 50 MILES
SCALE


DALLAM
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CARSON
GRAY
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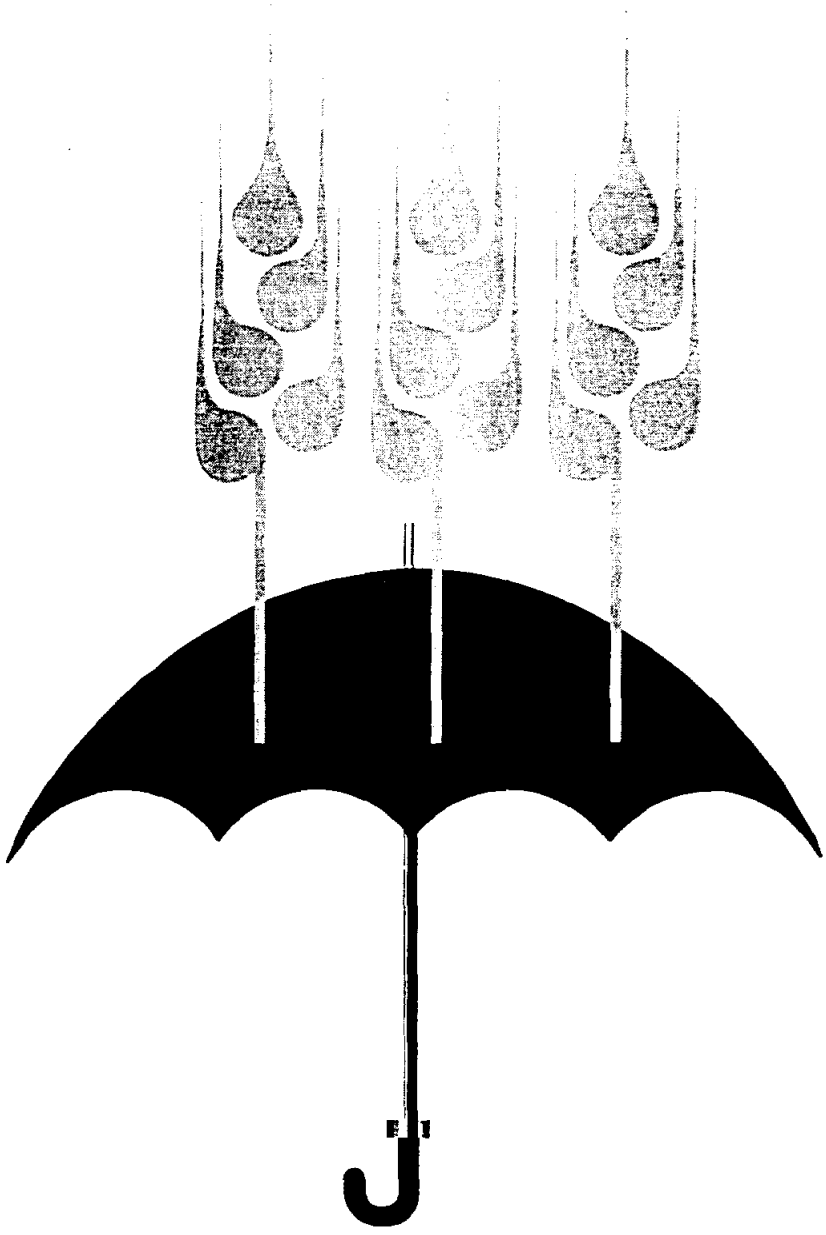
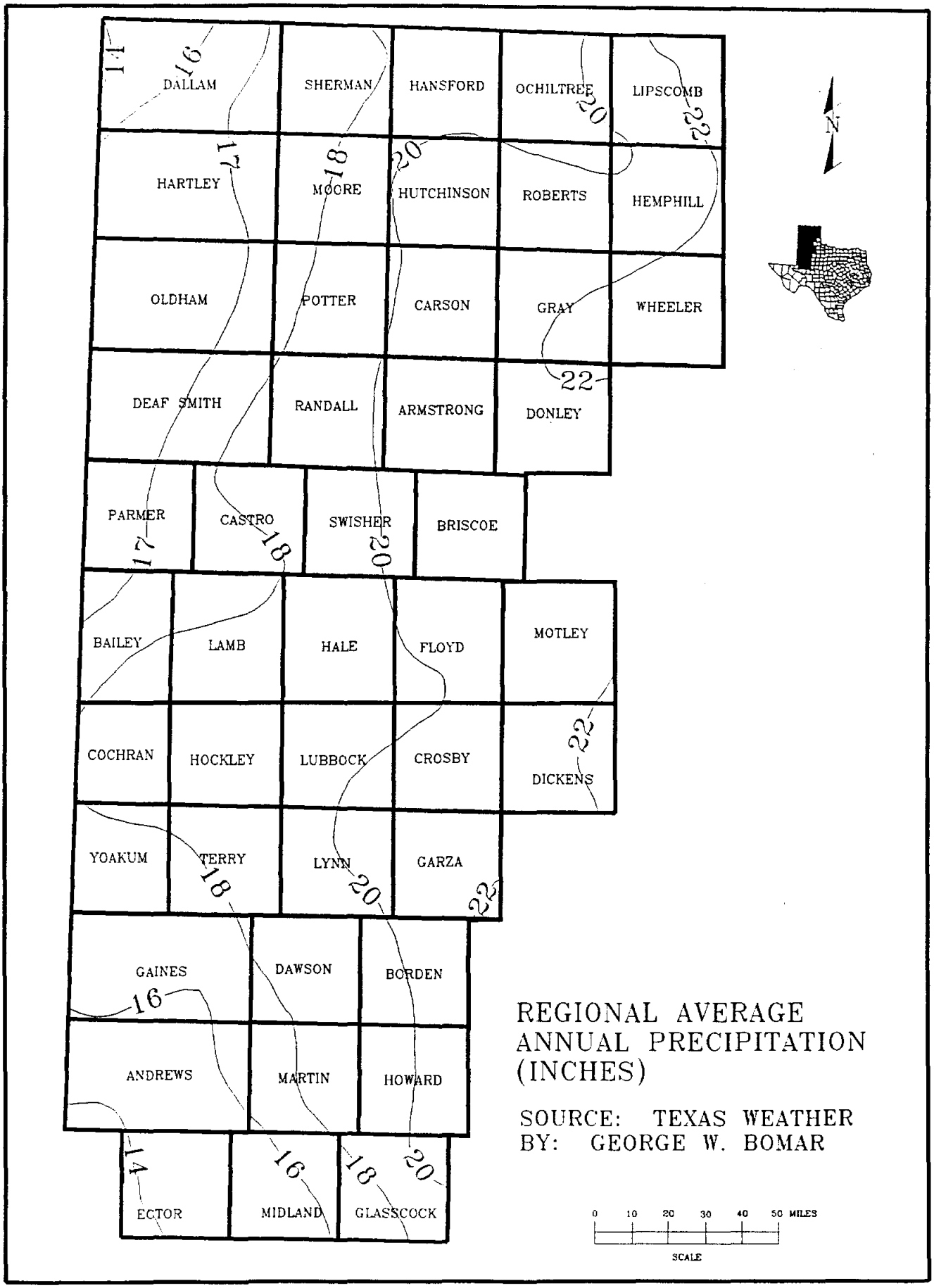
FLOYD
MOTLEY
COCHRAN
HOCKLEY
LUBBOCK
LUBBOCK
CROSBY
DICKENS
YOAKUM
TERRY
LYNN
GARZA
ALAN HENRY
GAINES
DAWSON
BORDEN
ANDREWS
MARTIN
HOWARD
ECTOR
MIDLAND
GLASSCOCK
N
LAKE ALAN HENRY
• CONSTRUCTION BEGAN 1991
• MAXIMUM CAPACITY 116,000 ACRE FEET
• PROJECTED TO PROVIDE AVERAGE OF 23.3 MILLION GALLONS DAILY
★ CITIES SERVED
0 10 20 30 40 50 MILES
SCALE

PRECIPITATION

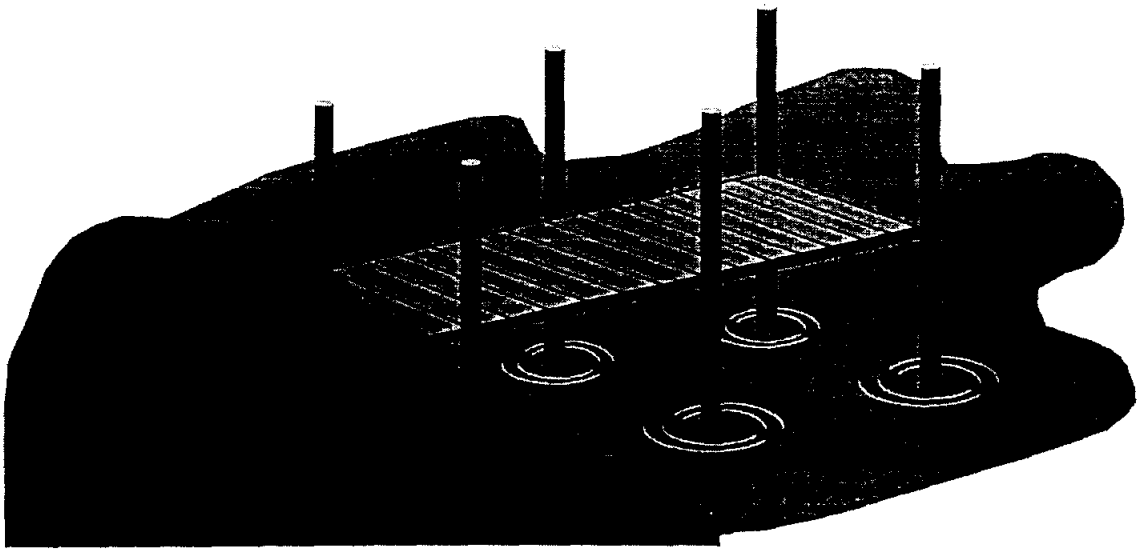




REGIONAL AVERAGE ANNUAL PRECIPITATION (INCHES)

SOURCE: TEXAS WEATHER
BY: GEORGE W. BOMAR

WATER CONSERVATION



AGRICULTURAL WATER CONSERVATION

Opportunities to Maximize the Utilization of Water by Irrigators

IRRIGATION SYSTEMS

Low Energy Precision Application Systems (LEPA) - 86 to 90 percent efficiency.
Surge Valves - improve furrow irrigation efficiency by 10 to 40 percent; can cut irrigation amounts by 50 percent.
Tailwater - elimination.
Underground Pipes - improves efficiency 15 to 20 percent.

MANAGEMENT TOOLS

Soil Moisture Monitoring - improves irrigation management and scheduling and rainfall utilization.
Potential Evapotranspiration (PET) - provides daily predicted crop water use for improved irrigation scheduling.
Deficit High Frequency Irrigation - the application of a portion of the PET, under evaluation.

TILLAGE

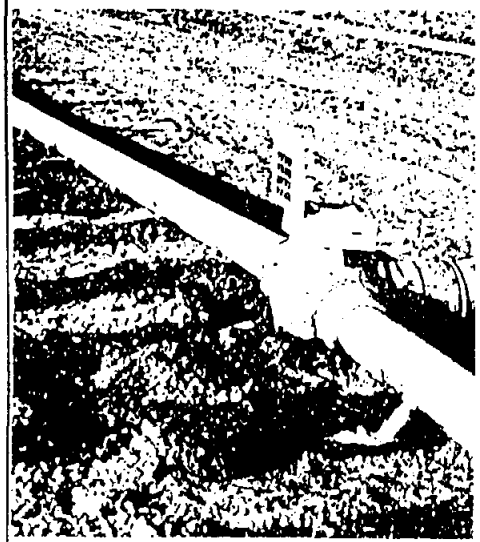
Furrow Dikes - retain 10 to 15 percent more of average rainfall.
Conservation Tillage - uses less plowing and crop residues to contain precipitation and hold existing soil moisture.
Ridge Till - conserves soil moisture and rainfall; under evaluation.

FURROW IRRIGATION

60% Efficiency

A solid set irrigation pattern results in almost two-thirds of the field having a full water surface area exposed to evaporation.

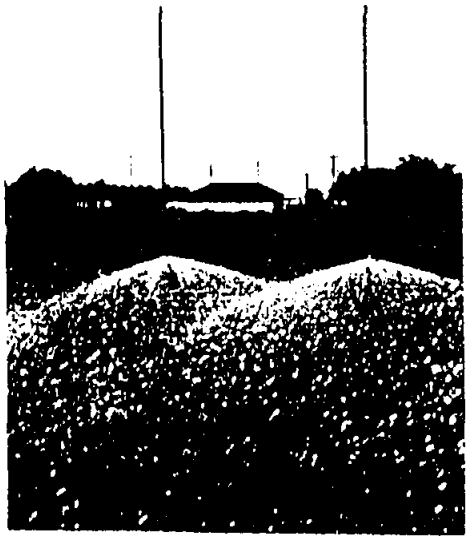
SURGE IRRIGATION



80% Efficiency

Water savings from 10 to 40 percent have been measured after the addition of surge valves to conventional furrow irrigation systems.

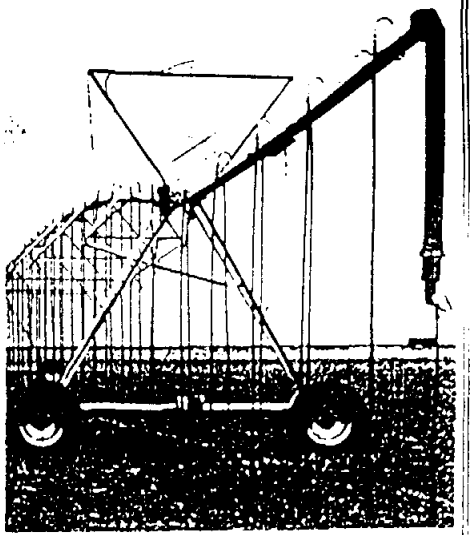
MODIFIED LEPA



80% Efficiency

Nozzles located four feet above the soil surface have the same efficiency as surge irrigation during a normal year.

LEPA



95% Efficiency

Nozzles located in the furrow just above the soil surface reduce losses from evaporation and wind drift.

URBAN WATER CONSERVATION

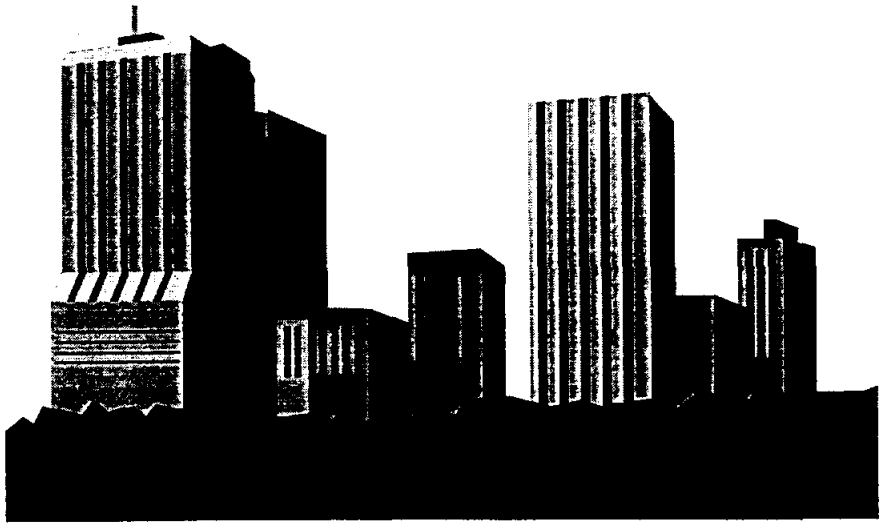
Opportunities for Home Owners to Maximize Water Use

WATER USE HABITS - promotion of water conservation practices for use in the home, this is the most readily-available and lowest cost method of water conservation promotion.

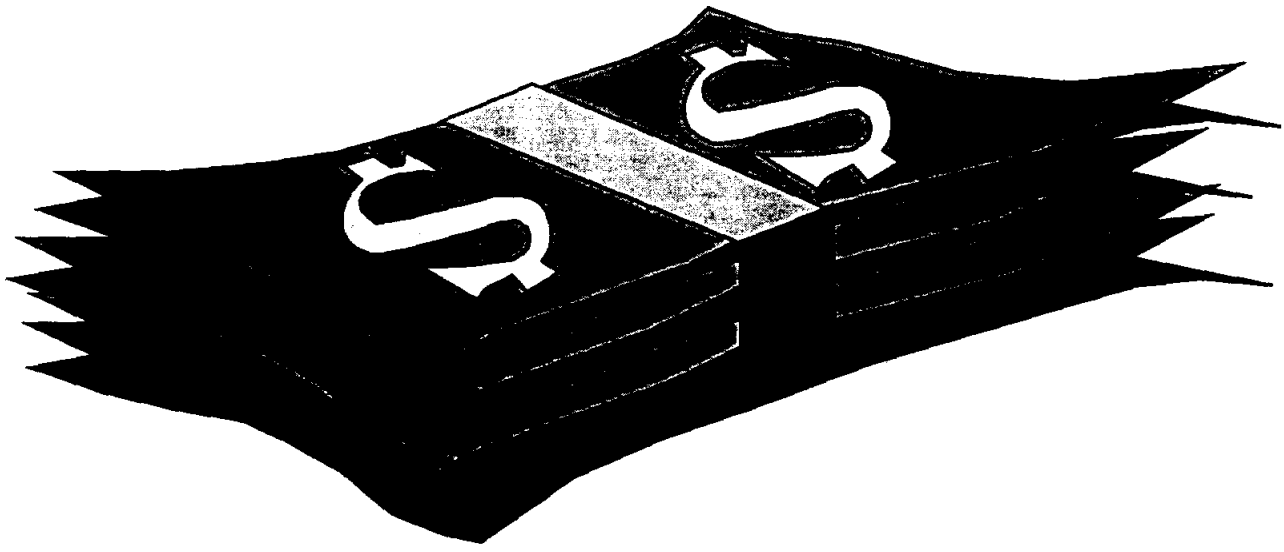
NEW CONSTRUCTION - installation of water conserving fixtures in all new homes and businesses.

LANDSCAPE DESIGN - promotion of xeriscape, native plants, and low water use plant materials; good lawn watering techniques and installation of efficient irrigation systems.

WATER HARVESTING/GRAYWATER - educate homeowners of ways to harvest precipitation for maximum use and examine use of graywater in landscape irrigation.



ECONOMICS OF CONSERVATION AND SECONDARY SOLUTIONS



Economic Considerations in Plan

1) Economics in Proposed Water Plan

- Plan—Technical, Volumetric, Economics, Environment
- Economic—Which Alternatives are "Best"
  * Rank Order Options
  * Information for Decision Makers
- Example: El Paso Water Plan

2) Economic Evaluation Process

- Classification of Projects
- Steps in Project Evaluation
- Decision Rules (all are related)
- Example: Furrow Diking

3) Private and Social Benefits and Costs

- Private B/C and Market Functions
- Social B/C and Market Failure
- Solutions to Social B/C and Unique Role of UGWCD
- Example: Weather Modification

Example: Furrow Diking

Source of Data: *Avalanche-Journal*, June 2, 1996, and others

Furrow Diking

1) Runoff = 3.00 inches without furrow diking
2) Benefits to furrow diking (runoff reduced by 2.00 inches)
   - Yield increases (per acre) of 2.00 inches

Cotton 100-200 lbs	P corn = .80/lb
Sorghum 600-800 lbs	P sorghum = $6/100 lbs
Wheat 4-6 bushels	P corn = $5.5/bushel

3) Costs of furrow diking = NA

Alternative (Increase Pumping 2.00 inches)

1) Benefits to 2.00 inches more Ogallala pumpage (see above)

2) Costs of increased pumping = $3.00-4.50/inch of water for energy costs only

Evaluation Criteria

1) Payback period (undiscounted)—furrow diking

2) Cost effectiveness—furrow diking vs. increased irrigation

Example: Weather Modification Private/Social Benefits and Costs

1) Use of ground generators and/or airplanes to seed clouds with silver iodide

2) **Identify** private/social benefits and costs

Benefits (10% increase in precipitation)

Private

Social

Costs (10% increase in precipitation)

Private

Social

Decision Rules (All Related)

Let $B' = \sum_{t=1}^{N} \frac{E(B)}{(1+r)^t}$ and $C' = \sum_{t=1}^{n} \frac{C}{(1+r)^t}$

1) NPV = B′ - C′ yields net dollar return

2) Profitability or $\frac{B}{C} = \frac{B'}{C'}$ yields percentage return or profit

3) IRR; NPV = O or B′ = C′ yields internal I return (%)

4) Payback PB = $\frac{C'}{B'}$ yields number of years to recover I (i.e., 3.0 years)

5) Cost effectiveness
$B_1 = B_2$
$C_1 < C_2$

Compare 2 or more projects with same return. Yields least cost option as choice.

Sample of Firms: Primary/Secondary Rules

	Primary	**Secondary**
NPV	9.8	25.8
IRR	53.6	14.0
B/C	2.6	2.2
PB	34.0	58.0
	100.0	100.0

Social and Private Benefits and Costs

1) Private

- Costs—incurred by decision maker; includes market transactions and private opportunity costs (own labor, capital)

- Benefits—captured by decision maker; includes market returns (P_c, P_s, P_w) and private opportunity benefits (lifestyle, environment)

2) Social

- Costs—costs incurred by third parties, do not necessarily go through marketplace (pollution, depletion)

- Benefits—benefits received by third parties, do not necessarily go through marketplace (playa management, quality)

3) Responses to Social Costs; Benefits

- Government—Command and control
- Markets—Put market incentives to incorporate SG, SB

4) Role of UGWCD—Regional alternative

- Consider regional impact of decision makers

- Rule making—to balance regional and decision makers' interests

Example: Weather Modification Private/Social Benefits and Costs

1) Use of ground generators and/or airplanes to seed clouds with silver iodide
2) Identify private/social benefits and costs

Benefits

Private

Crop yield
Livestock
Reduced irrigation costs
Quality of water

Social

Reservoir increases
Runoff increases
Downwind beneficiaries
Aquifer depletion reduced
Higher humidity, lower evaporation
Quality of water
Secondary benefits (multiplier to region)

Costs

Private

Direct costs—capital, operations, maintenance

Social

"Theft of rain"
Public opinion
Silver iodide accumulation
Local flooding
Cost recovery—Who pays?

Economic Evaluation Methodology

Classification of Projects

1. Replacement
2. Cost Reduction
3. Safety/Environmental
4. Expansion
5. Operating

Steps in Project Evaluation

C 1) Cost of Project or Alternative

B 2*) Expected Net Returns or Benefits of Project

$$B = Bp - Bw/op$$

r 3) Determine Appropriate Discount Rate

B′ 4) Convert Net Returns into PV of Returns

5) Compare PV (or B′) with Costs C

*Most Difficult Part

Example: Weather Modification Private/Social Benefits and Costs

1) Use of ground generators and/or airplanes to seed clouds with silver iodide

2) **Identify** private/social benefits and costs

Benefits (10% increase in precipitation)

Private

Social

Costs (10% increase in precipitation)

Private

Social

☆ AGRICULTURE

Economics:

The economic value for harvesting one inch of precipitation currently lost to runoff if stored in the soil for crop production in the regional management area could result in substantial regional crop yield increases. As an example, for each additional inch of water above the basic water needed for plant development, cotton will yield from 30 to 40 pounds of lint per acre ($18 to $24); grain sorghum will yield 300 to 400 pounds per acre ($12 to $15); wheat will yield two to three bushels per acre ($7 to $10 increase); and corn 3 to 5 bushels per acre ($7 to $12). On the 3.2 million acres of cotton grown in the region, an increase of 35 pounds of lint per acre would have a value of $67.2 million. On the 930 thousand acres of grain sorghum grown in the region, an increase of 350 pounds per acre of grain sorghum would have a value of $12.5 million. On the 2.5 million acres of wheat grown in the region, an increase of 2.5 bushels per acre of wheat would have a value of $21.2 million. On the 850 thousand acres of corn grown in the region, an increase of 4 bushels per acre of corn would have a value of $8.0 million. There are additional varieties of crops grown in the region, which likely would have increased production, thus increasing value. The four crops listed above are major crops grown in the area. The combined increase in the value of increased production from salvaging one inch of water for the four crops would be $108.9 million per year.

Value of Water Saved:

Lumping the acreage of the four major crops (7.48 million acres) and dividing the sum into the increased value of crops produced ($108.9 million) with one additional inch of water, indicates an average increase of $14.55 per acre.

Using the same value per acre inch of water for water which might be saved by

improving irrigation application efficiency, the 1 million acre-feet of water used now or in the future would return $174.6 million.

Increasing precipitation by 2 inches over the 22 million acre (3.66 million acre-feet) regional area with a precipitation enhancement program would increase the area's water supply by 3.66 million acre-feet. Adding two inches of water to the 7,480,000 acres of the four major crops grown in the area could result in a water savings of 1.25 million acre-feet if this replaced irrigation water that would otherwise be pumped from the aquifer. The increased production made possible with this increased water supply used on the 7.480 million acres of the four major crops grown in the area at $14.55 per acre inch would be $217,668,000. The remaining 2.41 million acre-feet would increase production on rain-fed farming and pasture. Some would be collected in playa basins where a part would recharge the aquifer. The increased surface water supply would enhance wildlife production.

Summary:

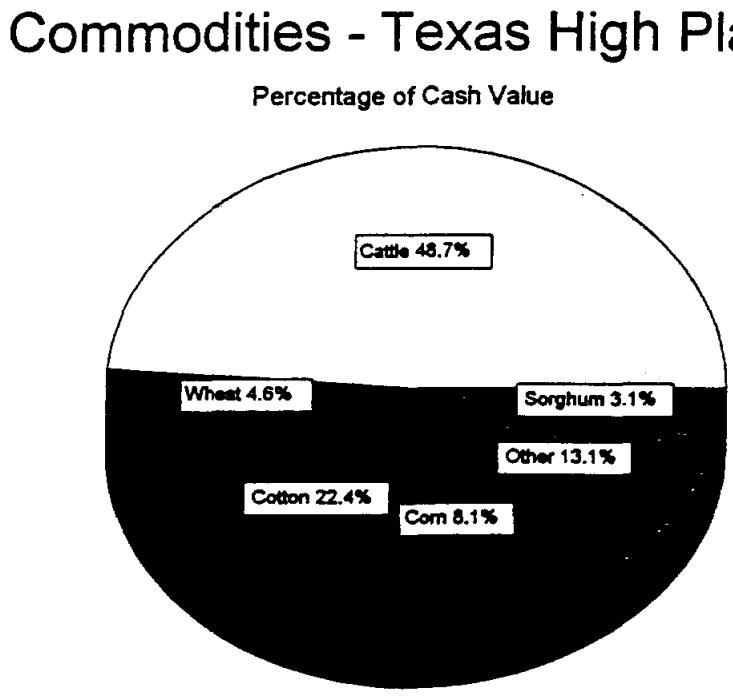
We assumed we have a shortfall of 3.2 million acre-feet and that we could harvest one additional inch of precipitation on the 7.48 million acres currently farmed in cotton, corn, grain, sorghum, and wheat. This could reduce the shortfall by 623,333 acre-feet. We further assumed we can improve irrigation application efficiency from 70 percent to 90 percent. If we do so, then on the 5 million acre-feet pumped we could save an additional one million acre-feet of water. Also that we can implement a precipitation enhancement program that will increase the annual water supply to the area. Two inches on the 7.48 million acres of the four major crops could further reduce the shortfall by 1,246,000 acre-feet. Two inches on the remaining acreage could result in increased recharge of 100,000 acre-feet. The potential savings added together would be about 3.0 million acre-feet, which

is 200,000 acre-feet below the estimated shortfall. The estimated increase in gross agricultural products could be as much as $500 million for the area.

Agricultural Commodities from the Texas High Plains Area

		$ Cash Value
Cattle	3,658,000 animals	1,987,000,000
Cotton	3,400,000 acres	914,000,000
Corn	850,000 acres	329,000,000
Wheat	3,200,000 acres	186,000,000
Sorghum	1,100,000 acres	127,000,000
Others*	300,000 acres	535,000,000
Totals		**4,078,000,000**

* Vegetables, Soybeans, Hay, Sugarbeets, Peanuts, Alfalfa, Grapes

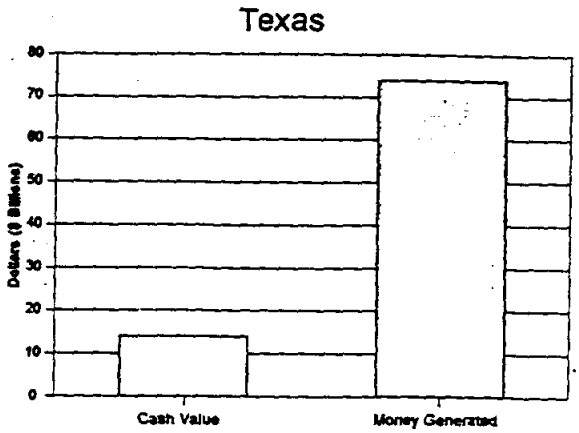


IMPORTANCE OF AGRICULTURE

FACTS AND FIGURES

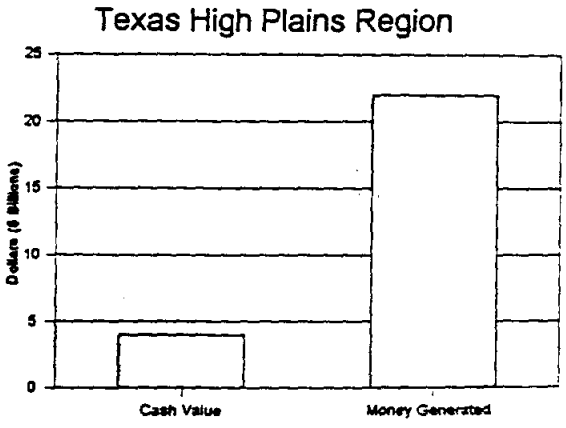
STATE OF TEXAS

- ✓ Agriculture provides 20% of all jobs in Texas
- ✓ Agriculture generates more than $74,000,000,000 in business to Texas each year
- ✓ The cash value of all agricultural commodities in Texas is $14,000,000,000



HIGH PLAINS AREA

- ✓ $22,000,000,000 is generated each year from our agriculture commodities
- ✓ 35% of Texas agribusiness is from the 41 counties surrounding Lubbock and Amarillo
- ✓ 30% of the agricultural cash receipts for commodities in the state come from the Texas High Plains Area
- ✓ 9,000,000 acres of crops are planted in these 41 counties (35% of Texas total)
- ✓ 20 - 30% of income for Lubbock and Amarillo citizens comes directly from agriculture
- ✓ 20% of the U. S. cotton crop is produced on the 20 counties around Lubbock
- ✓ 20% of U. S. cattle feedlot production is from 20 counties around Amarillo



☆ PRECIPITATION ENHANCEMENT

Precipitation Enhancement Efforts in Texas
June 1996

By George W. Bomar
Senior Technical Specialist
Watershed Management Division
Texas Natural Resources Conservation Commission

The worsening drought in Texas has prompted some organizations to consider, and implement, a program of seeding clouds to try to generate additional rainwater.

The West Texas Weather Modification Association (WTWMA) was formed in March 1996 to organize and put into operation a summer-long cloud-seeding program covering more than 5 million acres in southwest Texas. The Association is currently made up of water districts in six counties (Glasscock, Sterling, Reagan, Irion, Crockett, and Schleicher), though other nearby counties are holding meetings and may join the organization in the weeks ahead. The Association is based in Mertzon, with Dale Bates of San Angelo serving as Chairman. Bates is also the Vice-Chairman of the Irion County Underground Water Conservation District.

To date, the Association has raised $211,000 for the cloud-seeding operation. The money is being contributed by the six water districts using ad valorem taxes ($0.04/acre). The University of Texas of the Permian Basin has contributed an additional $50,000. The amount needed to conduct a full-fledged program for the summer and early autumn is $411,000. At the moment, the cities of San Angelo and Midland are contemplating joining the program and contributing money. The Texas Natural Resources Conservation Commission (TNRCC) issued a permit to the Association's contractor, Weather Modification Inc of Fargo, North Dakota (WMI). The Association began cloud-seeding immediately and intends to continue the program until October 1, unless a shortage of funds (and more cooperative weather) forces it to conclude much sooner.

Another cloud-seeding project is underway in a 3,600 square-mile area in the South Plains region.

This program, sponsored and conducted by the Colorado River Municipal Water District of Big Spring (CRMWD), is in its 26th year. It is designed to put additional rainfall runoff into Lake J.B. Thomas near Snyder and E.V. Spence Reservoir at Robert Lee. The CRMWD, which pays for the program with revenues from water sales, recently received a new four-year permit from the TNRCC to conduct cloud-seeding operations in Dawson, Borden, Scurry, Howard, and Mitchell Counties.

A third cloud-seeding project is planned for much of the region underlain by the Ogallala Aquifer in northwest Texas.

The High Plains Underground Water Conservation District No. 1 of Lubbock is now doing a feasibility study of seeding clouds using ground-based silver iodide dispensers in its service area. (The CRMWD and WTWMA programs use aircraft to dispense silver iodide for cloud seeding). The District envisions getting its program in place before year's end.

Such an array of weather modification activities is

obviously being prompted by the continuing and worsening drought. Yet, it has been stressed to these organizations that the efficacy of cloud-seeding is most limited during drought spells. Obviously, more opportunities (suitable clouds) for seeding occur in normal times and certainly in wet periods. Still, it has been the experience of the TNRCC staff that even in drought, numerous occasions occur for beneficial cloud seeding to be attempted.

The TNRCC is involved in weather modification because it has a statutory mandate (Chapter 18 of the Texas Water Code) to administer the Weather Modification Act, passed by the Legislature in 1967. The act charges the agency with promoting research and development of cloud-seeding technology and with regulating the use of cloud-seeding through a licensing and permitting process.

We currently have five firms licensed in Texas by the TNRCC to perform weather modification. Permits to the CRMWD and WTWMA are valid.

What are the prospects that the seeding will have success? Simply put, quite good. For some years now, thanks to a grant from NOAA, we have been conducting research on the CRMWD's rain enhancement program.

Though funding has been enough to allow us to work in the field (Big Spring area) for only a few weeks each summer, we have accumulated (and published professionally) evidence (corroborated scientifically using measurements of clouds obtained from specifically-instrumented aircraft) that timely seeding with silver iodide enables convective clouds to live longer, process more moisture, and produce significantly more rainfall (up to 50 percent with some times of convective clouds).

There is <u>no evidence</u> that seeding causes clouds to grow taller and produce unwanted effects (such as hail, damaging winds, flash floods). To the contrary, the seeding appears, in our judgement, to contribute to more gentle, widespread, and longer-lasting rains.

We did do statistical assessments of the CRMWD program several years ago and found that rainfall (averaged over the growing season) in the area where seeding was concentrated had been increased by 20 to 30 percent during that time. We also did a similar analysis of rainfall data from a five-year cloud seeding program conducted by the City of San Angelo (1985-1989) and found that rainfall had increased 25 to 42 percent in the area where seeding was concentrated.

There is still a need to continue researching this work to learn how these rain increases are being produced. A $70,000 grant was awarded to the WTWMA by the Texas Water Development Board on May 16 to enable research to resume at the site of the Association's cloud-seeding operation (between San Angelo and Midland) in the late summer of 1996. A research plane with scientific probes will fly through seeded and unseeded convective clouds and collect more valuable cloud-physics data. In addition, the research intends to "experiment" with a new type of flare (hygroscopic) believed to be more effective as a seeding agent in times of drought. Additional funding will be needed in autumn 1996 to have these research data thoroughly analyzed.

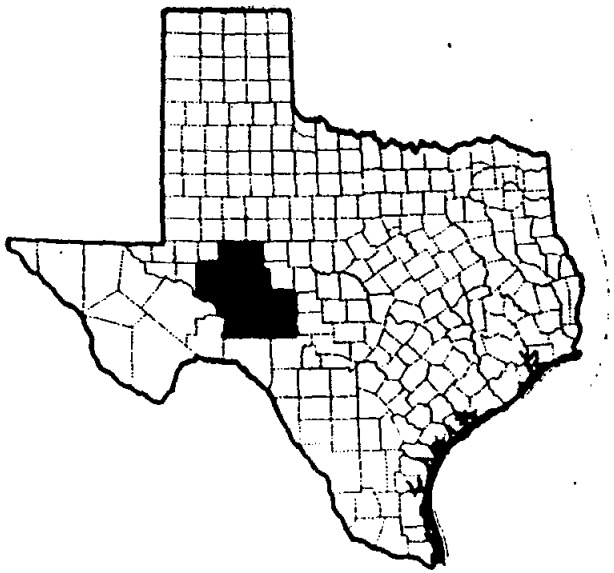
The new West Texas Weather Modification Association hopes to have other water districts elsewhere in West and South Texas implement similar cloud-seeding programs. Other cloud seeding nearby would undoubtedly augment the Association's efforts to positively affect the weather on a regional scale. There has been some recent discussion involving several State leaders about having the State become a partner to regional weather modification alliances to achieve such an aim.

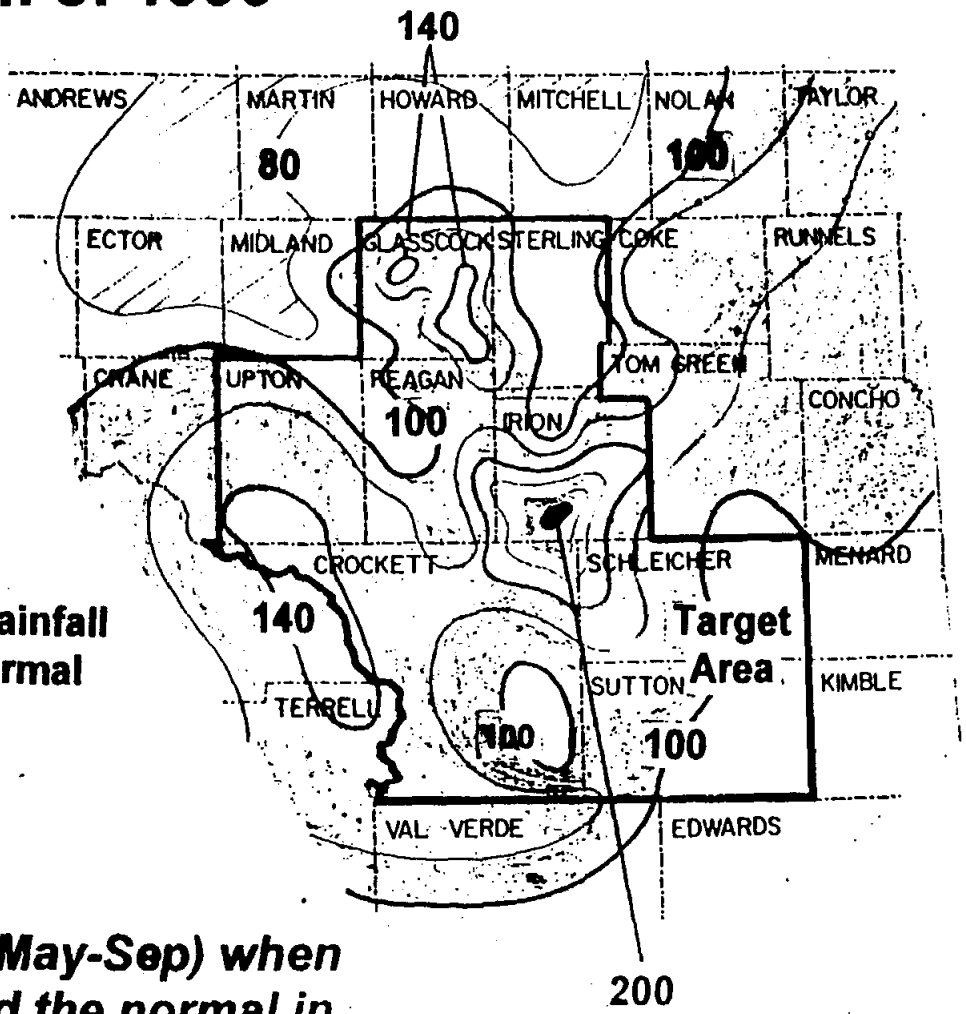
The Mexican state of Coahuila (adjacent to the Texas Big Bend) will soon launch a cloud-seeding program to generate additional rainfall. The state government and industry in the region are sharing the cost of this projected $1 million program, and scientists from the U.S. National Center for Atmospheric Research (NCAR) in Boulder, Colorado, have been contracted to run the program.

Also, the State of Oklahoma has designated considerable funding to initiate a study on the feasibility of a statewide drought alleviation effort using cloud-seeding.

Rainfall Assessment

of the West Texas Rain-Enhancement Program of 1996



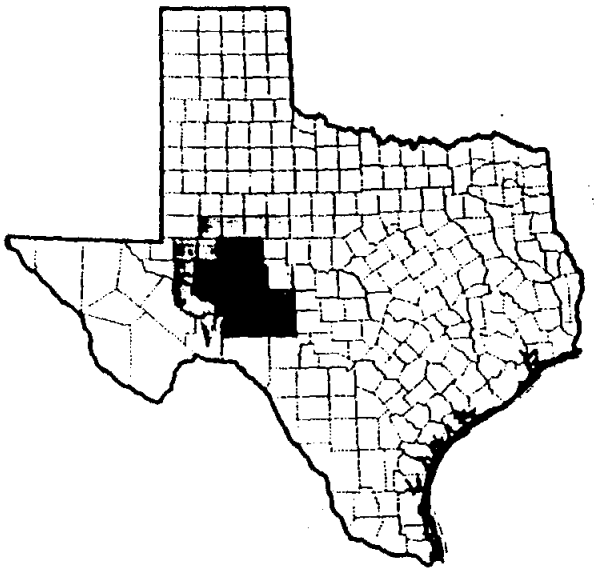


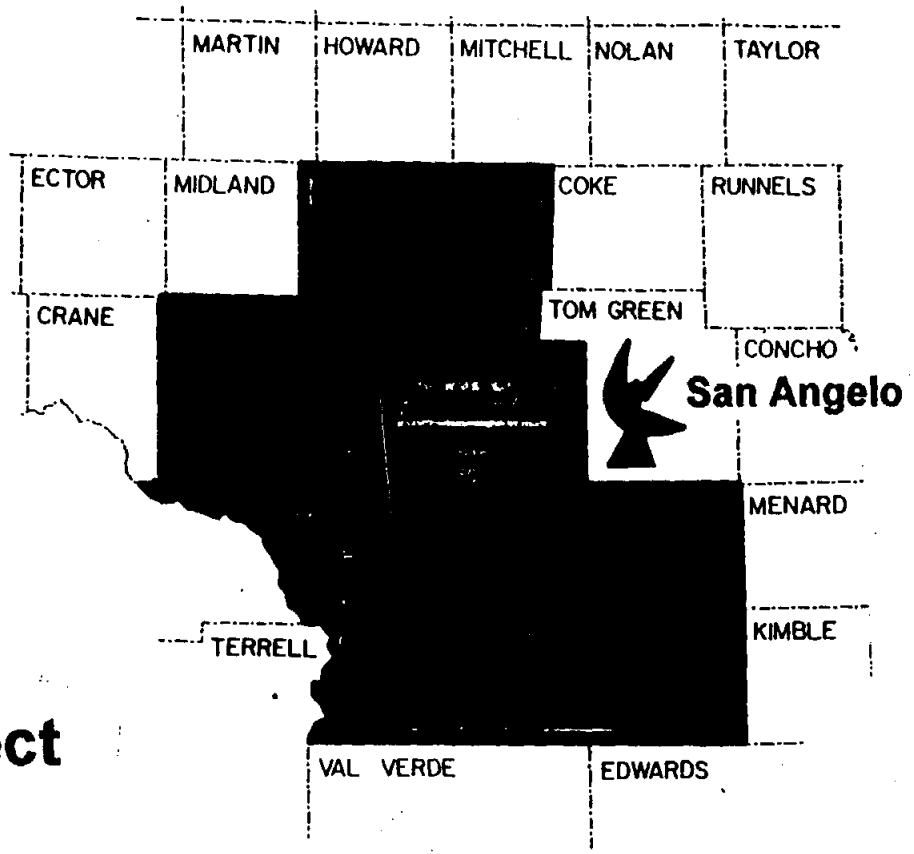
May-Sep Rainfall as % of normal

"Rainfall during the 5-month period (May-Sep) when seeding was performed . . . exceeded the normal in some locales by as much as 30 percent"

West Texas Rain-Enhancement Project of 1996

7.2 million acres



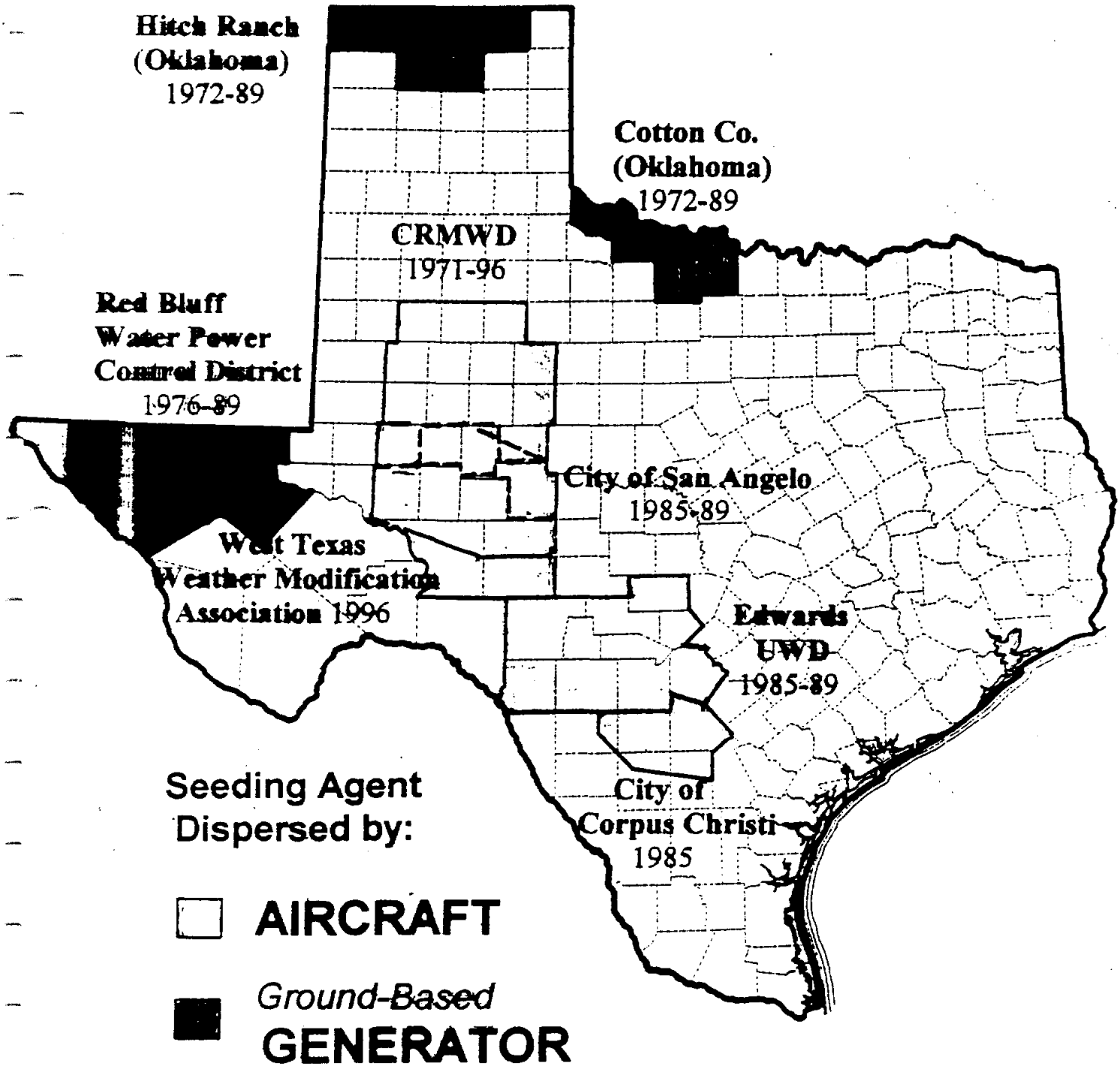


Area of Intended Effect

Base of Operations

PROJECT COST:
$ 0.057/acre

Rain-Enhancement Projects since 1985

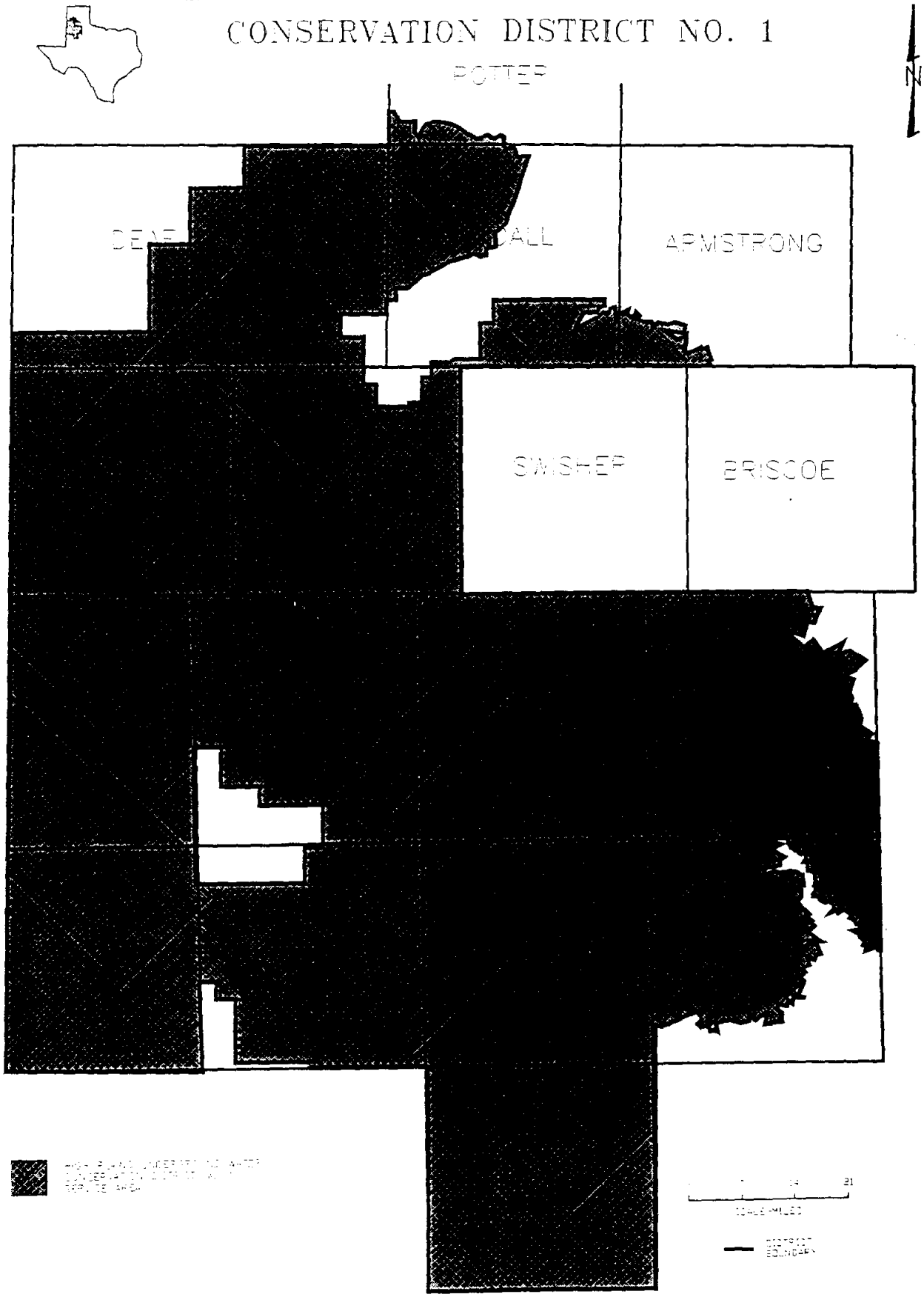


Research Findings

(Big Spring: 1987-1990)

	Experimental Units		***Ratio***
	Seed (93)	**No-Seed** (90)	
CELL HEIGHT (Km)	10.1	9.4	1.1
REFLECTIVITY *(Maximum; dBz)*	45.8	45.3	1.0
RAIN AREA (Square km)	82.2	57.6	1.4
DURATION (Minutes)	60.0	44.1	1.4
MERGERS	3.2	1.6	2.0
RAIN VOLUME (Thousands of cubic meters)	**249.2**	**108.3**	**2.3**

HIGH PLAINS UNDERGROUND WATER CONSERVATION DISTRICT NO. 1



COST:

1) Federal & State.

2) Alternatives:

- Horizontal equity (equal): Landowner A & B are equal.
- Vertical equity (unequal): Rural benefits vs. urban (larger pay proportion).

CONCLUSION:

$19 benefit for the cost of 6¢ an acre. Economics look very promising.

ECONOMIC BENEFITS OF PRECIPITATION ENHANCEMENT
Notes From Presentation By Dr. James Jonish
Ogallala Regional Water Management Plan Meeting
Texas Tech University
December 6, 1996

Benefits of a precipitation enhancement program are:

PRIVATE:
- Crop yields.
- Livestock.
- Reduced irrigation costs.
- Water quality.

SOCIAL:
- Increased runoff to reservoirs.
- Beneficiaries downwind of target area.
- Reduced aquifer depletion.
- Higher humidity and lower evaporation rates.
- Water quality.
- Secondary benefits (multiplier effect on region).

Costs associated with a precipitation enhancement program are:

PRIVATE:
- Direct costs: capital, operations, and maintenance.

SOCIAL:
- "Theft of rain."
- Public opinion: barrier to program.
- Silver iodide accumulation.
- Localized flooding.

Within the 46 county High Plains Ogallala region, a 10% increase in precipitation could mean the following:

Crop	Acres	Direct Benefit	Regional Benefit
Cotton	3,465.00	$ 162,421,500	$ 266,371,260
Wheat	1,211.00	$ 37,841,500	$ 43,517,725
Sorghum	1,016.00	$ 21,431,000	$ 39,891,750
Corn	810.50	$ 26,594,500	$ 39,891,750
Total	6,502.50	$ 248,288,500	$ 381,891,750

* DOESN'T INCLUDE LIVESTOCK OR IRRIGATION SAVINGS.

☆ CONSREVATION RESERVE PROGRAM

Conservation Reserve Program

Environmental Benefits Index (EBI)

The equation for signup 15 is:

EBI = Wildlife Habitat Benefits + Water Quality Benefits from Reduced Erosion, Runoff, and Leaching + On-farm Benefits of Reduced Erosion + Likely Long-Term Benefits Beyond the CRP Contract Period + Air Quality Benefits from Reduced Wind Erosion + Benefits of Enrollment in CPA's + Cost

Factor	Wildlife Habitat Benefits	Water Quality Benefits from Reduced Erosion, Runoff and Leaching	On-farm Benefits of Reduced Erosion	Likely Long-Term Benefits Beyond the CRP Contract Period	Air Quality Benefits from Reduced Wind Erosion	Benefits of Ernoll-ment in CPA's	Cost
Points	0 - 100	0 - 100	0 - 100	0 -50	0 - 25	0 - 25	/1

/1 Determined after signup ends.

Wildlife Habitat Benefits: (cover factor/50) multiplied by ((Cover (0 - 50 points)) plus (endangered species area (0 - 15 points)) plus (wetland proximity (0 - 10 points)) plus (adjacent protected areas (0 - 10 points)) plus (contract size (0 - 5 points)) plus (upland/wetland ratio (0 - 10 points)))

Water Quality Benefits: (priority area (0 - 30 points)) plus (groundwater quality (0 - 20 points)) plus (surface water quality (0 - 40 points)) plus (cropped wetlands (0 - 10 points))

On-Farm Erosion: Erosion Index (0 - 100 points)

Long Term: Estimated retention period (0 - 50 points)

Air Quality Benefits: Air quality component (0 - 25 points)

CPA: CPA component (0 or 25 points)

Cost: (Bid Factor (0 - 100 points) plus (preestablished cover factor (0-10 points))

GROUNDWATER SAVINGS DUE TO CRP ACREAGE					
COUNTY	CRP ACRES	1 AC FT/YR	10 YRS	6 AC IN/YR	10 YRS
ANDREWS	33,870	33,870	338,700	1,6935	169,350
ARMSTRONG	43,764	43,764	437,640	21,882	218,820
BAILEY	100,587	100,587	1,005,870	50,293.5	502,935
BORDEN	8,735	8,735	87,350	4,367.5	43,675
BRISCOE	46,413	46,413	464,130	23,206.5	232,065
CARSON	46,360	46,360	463,600	23,180	231,800
CASTRO	51,293	51,293	512,930	25,646.5	256,465
COCHRAN	83,981	83,981	839,810	41,990.5	419,905
CROSBY	37,074	37,074	370,740	18,537	185,370
DALLAM	107,301	107,301	1,073,010	53,650.5	536,505
DAWSON	110,377	110,377	1,103,770	55,188.5	551,885
DEAF SMITH	156,898	156,898	1,568,980	78,449	784,490
DICKENS	44,004	44,004	440,040	22,002	220,020
DONLEY	27,216	27,216	272,160	13,608	136,080
ECTOR	0	0	0	0	0
FLOYD	97,950	97,950	979,500	4,8975	489,750
GAINES	166,388	166,388	1,663,880	83,194	831,940
GARZA	25,050	25,050	250,500	12,525	125,250
GLASSCOCK	13,793	13,793	137,930	6,896.5	68,965
GRAY	38,437	38,437	384,370	19,218.5	192,185
HALE	107,118	107,118	1,071,180	53,559	535,590
HANSFORD	46,126	46,126	461,260	23,063	230,630
HARTLEY	60,007	60,007	600,070	30,003.5	300,035
HEMPHILL	19,357	19,357	193,570	9,678.5	96,785
HOCKLEY	109,730	109,730	1,097,300	54,865	548,650
HOWARD	44,913	44,913	449,130	22,456.5	224,565
HUTCHINSON	8,215	8,215	82,150	4,107.5	41,075

LAMB	134,901	134,901	1,349,010	67,450.5	674,505
LIPSCOMB	50,202	50,202	502,020	25,101	251,010
LUBBOCK	52,620	52,620	526,200	26,310	263,100
LYNN	62,982	62,982	629,820	31,491	314,910
MARTIN	78,260	78,260	782,600	39,130	391,300
MIDLAND	16,278	16,278	162,780	8,139	81,390
MOORE	50,141	50,141	501,410	25,070.5	250,705
MOTLEY	32,600	32,600	326,000	16,300	163,000
OCHILTREE	74,565	74,565	745,650	37,282.5	372,825
OLDHAM	40,443	40,443	404,430	20,221.5	202,215
PARMER	857,322	57,322	573,220	28,661	286,610
POTTER	11,436	11,436	114,360	5,718	57,180
RANDALL	78,599	78,599	785,990	39,299.5	392,995
ROBERTS	12,312	12,312	123,120	6,156	61,560
SHERMAN	91,573	91,573	915,730	45,786.5	457,865
SWISHER	114,719	114,719	1,147,190	57,359.5	573,595
TERRY	122,117	122,117	1,221,170	61,058.5	610,585
WHEELER	54,376	54,376	543,760	27,188	271,880
YOAKUM	76,412	76,412	764,120	38,206	382,060
TOTAL	2,846,812	2,846,812	28,468,120	1,423,406	14,234,060

CONSERVATION RESERVE PROGRAM (Signups 1-12) - HPUWCD #1

COUNTY	CONTRACTS TOTAL	ACRES TOTAL	ACRES EXPIRING BY YEAR 1997	1998	1999	2000	2001	2002
ANDREWS	49	33,870	33,870	0	0	0	0	0
ARMSTRONG	190	43,764	40,649	3,116	0	0	0	0
BAILEY	333	100,587	100,534	0	0	0	53	0
BORDEN	41	8,735	5,661	1,729	0	153	910	284
BRISCOE	174	46,413	46,388	0	25	0	0	0
CARSON	182	46,360	26,479	10,151	9,024	0	706	0
CASTRO	180	51,293	38,711	4,707	7,146	0	729	0
COCHRAN	226	83,981	83,822	0	159	0	0	0
CROSBY	199	37,074	22,974	5,685	3,705	507	2,307	1,896
DALLAM	275	107,301	96,111	8,539	2,652	0	0	0
DAWSON	508	110,377	62,395	25,969	14,546	902	1,286	5,279
DEAF SMITH	430	156,898	121,811	21,183	10,050	2,107	963	785
DICKENS	236	44,004	43,434	570	0	0	0	0
DONLEY	188	27,216	27,216	0	0	0	0	0
ECTOR	0	0	0	0	0	0	0	0
FLOYD	472	97,950	69,157	19,365	7,263	402	1,401	363
GAINES	469	166,388	159,126	7,262	0	0	0	0
GARZA	132	25,050	16,669	4,219	761	1,257	1,892	1,052
GLASSCOCK	45	13,793	6,716	4,171	489	610	843	964
GRAY	198	38,437	24,094	9,945	4,399	0	0	0
HALE	696	107,118	81,231	13,229	5,716	0	1,414	5,529
HANSFORD	179	46,126	30,077	8,482	6,248	650	604	66
HARTLEY	152	60,007	42,763	6,893	5,244	307	2,505	2,294
HEMPHILL	102	19,357	11,047	3,323	4,987	0	0	0
HOCKLEY	524	109,730	63,835	19,738	5,978	4,089	5,780	10,311
HOWARD	241	44,913	16,401	6,155	8,609	1,425	2,800	9,523
HUTCHINSON	36	8,215	6,108	1,159	455	0	427	65
LAMB	746	134,901	106,804	10,839	6,199	2,292	2,804	5,964
LIPSCOMB	198	50,202	50,146	0	0	0	56	0
LUBBOCK	344	52,620	26,290	7,848	4,652	2,441	4,264	7,125
LYNN	262	62,982	35,734	11,810	8,024	1,516	3,464	2,434
MARTIN	294	78,260	48,457	19,728	7,364	366	2,345	0
MIDLAND	86	16,278	6,742	5,215	1,948	0	1,111	1,262
MOORE	150	50,141	41,336	2,530	5,869	0	138	269
MOTLEY	144	32,600	28,655	3,945	0	0	0	0
OCHILTREE	277	74,565	46,596	14,130	13,621	0	218	0
OLDHAM	110	40,443	38,731	49	1,663	0	0	0
PARMER	253	57,322	43,297	5,181	8,268	276	300	0
POTTER	56	11,436	5,580	3,107	2,147	0	0	602
RANDALL	299	78,599	42,958	28,557	7,084	0	0	0
ROBERTS	39	12,312	8,565	2,406	1,340	0	0	0
SHERMAN	249	91,573	75,202	9,054	6,687	0	0	630
SWISHER	594	114,719	104,465	9,936	169	0	149	0
TERRY	503	122,117	91,777	19,253	10,391	0	496	0
WHEELER	323	54,376	47,019	6,023	1,334	0	0	0
YOAKUM	214	76,412	76,267	145	0	0	0	0
TOTALS	11,598	2,846,812	2,201,695	345,345	184,417	19,299	39,163	56,693
PERCENT BY YEAR			77.3	12.1	6.5	0.7	1.4	2.0

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ARMSTRONG	190	43,764	40,649	3,115	0	0	0	0
BAILEY	333	100,587	100,534	0	0	0	53	0
BORDEN	41	8,735	5,661	1,729	0	153	910	284
BRISCOE	174	46,413	46,388	0	25	0	0	0
CARSON	182	46,360	26,479	10,151	9,024	0	706	0
CASTRO	180	51,293	38,711	4,707	7,146	0	729	0
COCHRAN	226	83,981	83,822	0	159	0	0	0
CROSBY	199	37,074	22,974	5,685	3,705	507	2,307	1,896
DALLAM	275	107,301	96,111	8,539	2,652	0	0	0
DAWSON	508	110,377	62,395	25,969	14,546	902	1,286	5,279
DEAF SMITH	430	156,898	121,811	21,183	10,050	2,107	963	785
DICKENS	236	44,004	43,434	570	0	0	0	0
DONLEY	188	27,216	27,216	0	0	0	0	0
ECTOR	0	0	0	0	0	0	0	0
FLOYD	472	97,950	69,157	19,365	7,263	402	1,401	363
GAINES	469	166,388	159,126	7,262	0	0	0	0
GARZA	132	25,050	16,669	4,219	761	1,257	1,892	1,052
GLASSCOCK	45	13,793	6,716	4,171	489	610	843	964
GRAY	198	38,437	24,994	9,945	4,399	0	0	0
HALE	696	107,118	81,231	13,229	5,716	0	1,414	5,529
HANSFORD	179	46,126	30,877	8,402	6,248	650	604	66
HARTLEY	152	60,007	42,763	6,893	5,244	307	2,505	2,294
HEMPHILL	102	19,357	11,047	3,323	4,987	0	0	0
HOCKLEY	524	109,730	63,835	19,738	5,978	4,089	5,780	10,311
HOWARD	241	44,913	16,401	6,155	8,609	1,425	2,800	9,523
HUTCHINSON	36	8,215	6,108	1,159	455	0	427	65
LAMB	746	134,901	106,804	10,839	6,199	2,292	2,804	5,964
LIPSCOMB	198	50,202	50,146	0	0	0	56	0
LUBBOCK	344	52,620	26,290	7,848	4,652	2,441	4,264	7,125
LYNN	262	62,982	35,734	11,810	8,024	1,516	3,464	2,434
MARTIN	294	78,260	48,457	19,728	7,364	366	2,345	0
MIDLAND	86	16,278	6,742	5,215	1,948	0	1,111	1,262
MOORE	150	50,141	41,336	2,520	5,869	0	138	269
MOTLEY	144	32,600	28,655	3,945	0	0	0	0
OCHILTREE	277	74,565	46,396	14,130	13,621	0	218	0
OLDHAM	110	40,443	38,731	49	1,663	0	0	0
PARMER	253	57,322	43,297	5,181	8,268	276	300	0
POTTER	56	11,436	5,580	3,107	2,147	0	0	602
RANDALL	299	78,599	42,958	28,557	7,084	0	0	0
ROBERTS	39	12,312	8,565	2,406	1,340	0	0	0
SHERMAN	249	91,573	75,202	9,854	6,687	0	0	630
SWISHER	594	114,719	104,465	9,936	169	0	149	0
TERRY	503	122,117	91,777	19,253	10,591	0	496	0
WHEELER	323	54,376	47,819	6,023	1,334	0	0	0
YOAKUM	214	76,412	76,267	145	0	0	0	0
TOTALS	11,598	2,846,812	2,201,895	345,345	184,417	19,299	39,163	56,693
PERCENT BY YEAR			77.3	12.1	6.5	0.7	1.4	2.0

☆ WILDLIFE

Wildlife Habitat in the Texas High Plains

Givens:

* About 2 million waterfowl and 350,000 to 400,000 sandhill cranes use this area--particularly its historic wildlife use areas. Protection of historical areas is important.
* Pheasants are an economically important gamebird in irrigated areas, but their numbers have declined and fluctuate widely with weather and habitat conditions.
* Virtually all wildlife habitat in the High Plains is on privately-owned farm and ranch land. The continued support of this land base is vital to wildlife.
* Upland game and waterfowl are a residual "crop" on farm or ranch land. Game numbers are impacted by crop and livestock culture, weather, and economics.
* Quail and big game hunting occur mostly in range areas where rainfall is a limiting factor.
* Pheasant and waterfowl also depend on rainfall for ideal conditions, but irrigation farming allowed them to boom. The best hunting and habitat for them is closely associated with irrigation. Decline of irrigation may also spell a decline in these species.
* Altering management to improve habitat may mean about the same water use can allow the landowner to recover added income through wildlife--if the landowner will expend the effort required.
* Practices such as leaving standing stubble, ridge-till, etc. allow crop residue to trap and hold more moisture in the soil. The standing residue benefits wildlife and added moisture helps farming.
* Adapted species such as Afghan pheasants have had limited success in the Southern High Plains of Texas.
* You get from an enterprise in proportion to what you put in.

Number and Total Area of Playas in 39 Counties of the Southern High Plains of Texas

County	No. of Playas	Acres
Andrews	298	--------
Armstrong	676	14,193
Bailey	598	4,772
Briscoe	787	12,266
Carson	535	17,615
Castro	621	19,756
Cochran	395	1,815
Crosby	925	18,278
Dallam	220	2,858
Dawson	702	7.074
Deaf Smith	451	14,069
Donley	114	1,684
Floyd	1783	40,605
Gaines	65	210
Garza	283	4,676
Gray	752	12,482
Hale	1,383	23,263
Hansford	345	6,928
Hartley	123	3,184
Hemphill	9	91
Hockley	1,171	8,388
Howard	185	3,738
Hutchinson	167	2,669
Lamb	1,280	13,405
Lipscomb	18	235
Lubbock	934	15,503
Lynn	842	9,172
Moore	195	4,316
Ochiltree	590	15,462
Oldham	75	2,964
Parmer	455	9.935
Potter	69	4,840

Randall	564	16,606
Roberts	20	99
Sherman	219	5,058
Swisher	910	20,117
Terry	532	3,022
Wheeler	10	-------
Yoakum	38	187
Total	19,339 playas	341,722 acres

Areas Identified As Historically Important For Waterfowl and Sandhill Cranes Playa Lakes Region of High and Rolling Plains of Texas

1. Lake Rita Blanca-Coronado Feeders Lake --Dalhart area
2. Cactus Lake--Etter
3. Palo Duro Reservoir--Spearman
4. Lake Marvin and Canadian River--Canadian, TX
5. Lake Meredith--Fritch--north of Amarillo
6. Milkweed Playa--Vega
7. FSW Cattle Co. and Wildorado-area lakes--Wildorado
8. Amarillo-Canyon area effluent playas
9. Holly Sugar Ponds and Sugarland Feed Yard Playa--Hereford
10. Happy Feedlot--Happy
11. Dead Horse Lake--at Bartlett Feedyard No. 2 --north of Hereford
12. Fry Lake on Frio Draw near Friona
13. Armstrong Playa--Dimmitt
14. Simpson Lake--north of Dimmitt Feed Yard-- Dimmitt
15. Bud Hill Feedlot--Dimmitt
16. Ivy Lake, east of Easter,--Castro County
17. Beefco Cattle Feeders--near Easter
18. Pat Robbins pasture lake--Summerfield
19. Great Plains Feedlot-- Flagg area in Castro County
20. Rafter 3 Feedyard, west of Dimmitt
21. Paco-Bovina Feedyards, Hub, and western Parmer County
22. Excel Packing, Friona- west of Friona
23. Hill Feedlot & Hart Playa--Hart
24. Lake Mackenzie--Silverton
25. Muleshoe NWR--Needmore
26. Bull Lake--Littlefield
27. Hale County Feedlot--Hale Center
28. Excel Packing, Plainview--Plainview
29. Buffalo Springs, Ransom Canyon--Lubbock
30. Various City Park Lakes--Lubbock
31. White River Lake--Crosbyton
32. Rich & Mound Lakes--Brownfield
33. Tahoka-Gordon Lakes--Tahoka
34. Frost & Gooch Lakes--South of Lubbock

35. Cedar Lake--Seagraves
36. Winchester Lakes--Knox & Haskell Counties
37. Natural Dam & Mustang Lakes--Big Spring
38. Lake Pauline--Quanah
39. Santa Rosa & Kemp Lakes--Vernon-Wichita Falls
40. Millers Creek Reservoir--Wichita Falls
41. Stamford Lake--Haskell County
42. Lake J.B. Thomas--Snyder
43. Lake Fort Phantom Hill--Abilene

Hunter Participation & Revenue By Species
Texas Panhandle/Rolling Plains Region

(Based on an expenditure of $1022 per hunter, except for $150 per hunter for doves.)

QUAIL- 41,581 hunters VALUE: $42,495,782

PHEASANT- 38,256 hunters VALUE: $39,097,632

DOVES- 34,432 hunters VALUE: $5,164,800

WATERFOWL- 5,000 hunters VALUE: $5,110,000

SANDHILL CRANES- 1,677 hunters VALUE: $1,713,894

DEER- 750 hunters VALUE: $766,500

ANTELOPE- 100 hunters VALUE: $102,200

OVERALL IMPACT FROM HUNTING:
> $94.1 MILLION