Chapter 5C Regional Water Management Strategies

Several strategies have been identified that will benefit multiple user groups across the region. These include subordination of downstream water rights, brush control and precipitation enhancement. This subchapter discusses each of these strategies and outlines the recommendations, quantities and costs associated for each user of the strategy. Detailed strategy evaluations are included in Appendix C.

5C.1 Subordination of Downstream Senior Water Rights

The TWDB requires the use of the TCEQ Water Availability Models (WAM) for regional water planning. Most of the water rights in Region F are in the Colorado River Basin. Chapter 3 discusses the use of the WAM models for water supply estimates and the impacts to the available supplies in the upper Colorado River Basin. The Colorado WAM assumes that senior lower basin water rights would continuously make priority calls on Region F water rights. This assumption is not in line with the historical operation of the Colorado River Basin and likely underestimates the amount surface water supplies available in Region F.

Although the Colorado WAM does not give an accurate assessment of water supplies based on the way the basin has historically been operated, TWDB requires the regional water planning groups to use the WAM to determine supplies. Therefore several sources in Region F have no supply by definition, even though in practice their supply may be greater than indicated by the WAM. According to the WAM, the cities of Ballinger, Brady, Coleman, Junction, and Winters and their customers have no water supply. The Morgan Creek power plant has no supply to generate power. The cities of Big Spring, Bronte, Coahoma, Midland, Miles, Odessa, Robert Lee, San Angelo, Snyder and Stanton do not have sufficient water to meet current demands. Overall, the Colorado WAM shows shortages that are the result of modeling assumptions and regional water planning rules rather than the historical operation of the Colorado Basin. This would indicate Region F needs to immediately spend significant funds on new water supplies, when in reality the magnitude of the indicated water shortages are not justified. Conversely, the WAM model shows more water in Region K (Lower Colorado Basin) than may actually be available.

One way for the planning process to reserve water supplies for these communities and their customers is to assume that downstream senior water rights do not make priority calls on major Region F municipal

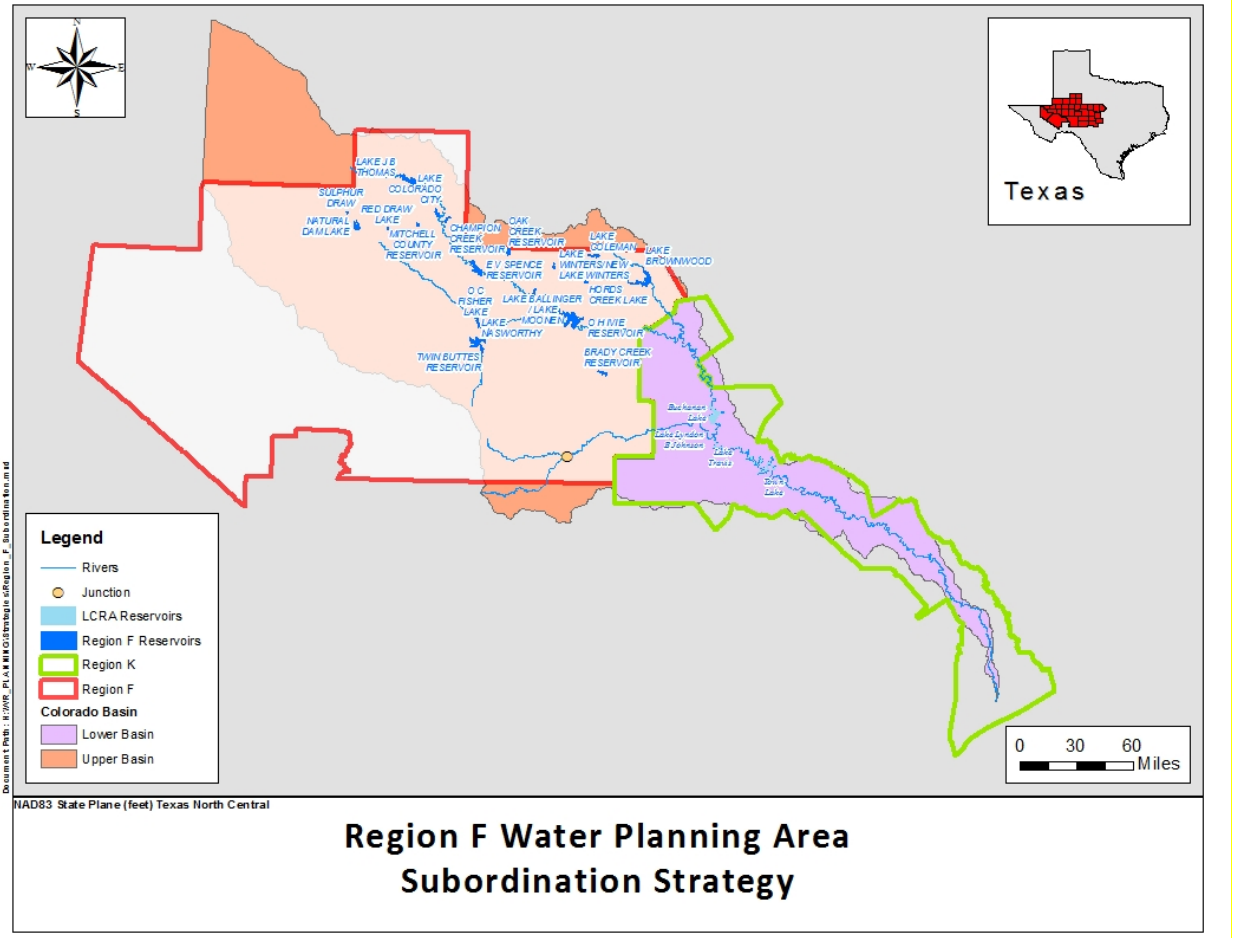
water rights, a process referred to as subordination. This assumption is similar to the methodology used to evaluate water supplies in previous water plans.

Because this strategy impacts water supplies outside of Region F, coordination with the Lower Colorado Regional Water Planning Group (Region K) was conducted. For the development of the 2006 regional water plans, a joint modeling effort was conducted with Region K and an agreement was reached for planning purposes. In subsequent planning cycles, Region K developed its own version of this subordination strategy, called the "cutoff model" that modified the priority dates for all water rights above Lakes Ivie and Brownwood. Region F has adopted the premise of the Region K's cutoff model with only minor variations for purposes of the subordination strategy in this plan. The Region F model makes two major assumptions 1) water rights in the lower Colorado basin (Region K) do make priority calls on the upper basin, and 2) these upper basin water rights do not make calls on each other. Figure 5C-1 shows the divide between the upper and lower basin and depict which reservoirs were included in the subordination modeling. The hydrology developed by TCEQ through December 2013 was used for the subordination modeling.

The Region F model differs from the Region K model by including the City of Junction's run-of-river rights in the upper basin. Other refinements to the subordination modeling include modifications for the Pecan Bayou. As discussed above, the assumption that upper basin water rights do not make calls on each other is consistent with general operations in the basin, but it may not be appropriate for determining water supplies during drought in the Pecan Bayou watershed. To better reflect reality, an assumption was made that the upstream reservoirs hold inflows that would have been passed to Lake Brownwood under strict priority analysis if Lake Brownwood is above 50 percent of the conservation capacity. This scenario provides additional supplies in the upper watershed while allowing Lake Brownwood to make priority calls at certain times during drought.

Two reservoirs providing water to the Brazos G planning region were included in the subordination analysis. Lake Clyde is located in Callahan County and provides water to the City of Clyde. Oak Creek Reservoir is located in Region F and supplies a small amount of water to water user groups within the region. Oak Creek Reservoir is owned and operated by the City of Sweetwater, which is in the Brazos G Region. Both Clyde and Sweetwater have other sources of water in addition to the supplies in the Colorado Basin.

Figure 5C-1
Region F Subordination Strategy: Upper and Lower Colorado River Basins



The subordination strategy modeling was conducted for regional water planning purposes only. By adopting this strategy, the Region F Water Planning Group does not imply that the water rights holders have agreed to relinquish the ability to make priority calls on junior water rights. The Region F Water Planning Group does not have the authority to create or enforce subordination agreements. Such agreements must be developed by the water rights holders themselves. Region F recommends and supports ongoing discussions on water rights issues in the Colorado Basin that may eventually lead to formal agreements that reserve water for Region F water rights.

Over 50,000 acre-feet of additional supply is available through this strategy in 2020 and over 46,000 acre-feet in 2070. Table 5C- 1 compares the 2020 and 2070 Region F water supply sources with and without subordination.

Table 5C- 1
Region F Surface Water Supplies with and without Subordination

Reservoir	2020 Supply WAM Run 3	2020 Supply Subordination	2070 Supply WAM Run 3	2070 Supply Subordination
Lake Colorado City	0	2,240	0	1,940
Champion Creek Reservoir	0	1,480	0	1,380
Colorado City/Champion System	*0*	*3,720*	*0*	*3,320*
Oak Creek Reservoir	0	1,493	0	960
Lake Ballinger	0	779	0	750
Lake Winters	0	191	0	170
Twin Buttes Reservoir/Lake Nasworthy	0	2,797	0	2,342
O.C. Fisher Reservoir	0	1,538	0	1,030
San Angelo System	*0*	*4,335*	*0*	*3,372*
Hords Creek Reservoir	0	358	0	300
Lake Coleman	0	2,915	0	2,740
Coleman System	*0*	*3,273*	*0*	*3,040*
Lake Clyde	0	150		150
Brady Creek Reservoir	0	1,892	0	1,700
Lake Thomas	0	4,864	0	4,779
Spence Reservoir (CRMWD system)	0	23,116	0	22,982
Spence Reservoir (Non-system)	0	1,475	0	1,467
Spence Reservoir Total	*0*	*24,591*	*0*	*24,449*
Ivie Reservoir (CRMWD system)	18,152	17,242	15,583	14,681
Ivie Reservoir (Non-system)	17,878	16,981	15,347	14,459
Ivie Reservoir Total	*36,030*	*34,223*	*30,930*	*29,140*
CRMWD Total (Thomas, Spence & Ivie)	*36,030*	*63,678*	*30,930*	*58,368*
Lake Brownwood	18,760	25,741	*18,060*	23,600
City of Junction	0	412	*0*	412
TOTAL	***54,790***	***105,664***	***48,990***	***95,842***

A list of the water user groups that could potentially benefit from subordination and the amount assumed for planning are shown in Table 5C- 2 The reduction in supplies shown for Midland is associated with a reduced safe yield of Lake Ivie with the subordination assumptions. These reductions also impact the subordination supplies to San Angelo. The contracts for water for both of these cities is based on a percentage of the safe yield of Lake Ivie.

Table 5C- 2
Subordination Supplies by WUG

WUG Name	Additional Supplies Made Available through the Subordination Strategy					
	2020	2030	2040	2050	2060	2070
Bronte	Need to update after allocation #s from Reg G					
Robert Lee	Need to update after allocation #s from Reg G					
Coke County Mining	38	36	34	32	30	28
Coke County SEP	Need to update after allocation #s from Reg G					
Coleman	2,102	2,061	2,024	1,985	1,938	1,891
Coleman County SUD	214	211	206	202	202	203
Coleman County Irrigation	743	743	743	743	743	743
Odessa	11,671	7,523	10,146	13,053	16,214	19,491
Ector County Irrigation	189	110	134	156	178	196
Big Spring	3,677	2,190	2,682	3,115	3,523	3,885
Howard County Mining	1,000	1,000	1,000	982	320	43
Junction	412	412	412	412	412	412
Stanton	253	160	202	249	292	330
Brady	1,892	1,854	1,816	1,778	1,740	1,700
Millersview-Doole WSC	517	302	369	236	267	294
Midland [1]	8,527	(299)	(298)	(297)	(297)	(296)
Mitchell County Steam Electric Power	1,480	1,460	1,440	1,420	1,400	1,380
Ballinger	752	675	693	563	558	554
Miles	112	124	121	119	119	119
Winters	186	182	178	174	170	165
Runnels County Manufacturing	11	10	10	11	11	11
Snyder	1,268	807	1,030	1,280	1,544	1,812
San Angelo	3,271	3,090	2,909	2,737	2,561	2,389
Tom Green County Manufacturing (Sales from San Angelo)	428	404	396	378	361	343
BCWID (non-allocated)	6,981	6,693	6,405	6,117	5,829	5,540
CRMWD (non –allocated)	5,527	20,834	17,318	13,566	10,225	6,444
Total	**51,251**	**50,582**	**49,970**	**49,011**	**48,340**	**47,677**

[1]Due to assumptions concerning the priority date of Lake Ivie in the TCEQ WAM and the subordination model, Lake Ivie has less yield under subordination since it must pass water to other Region F water right holders. Thus, in certain cases, the yield from the subordination strategy is negative.

The reliability of this strategy is considered to be medium based on the uncertainty of implementing this strategy. The subordination strategy defined for the Region F Water Plan is for planning purposes. If an entity chooses to enter into a subordination agreement with a senior downstream water right holder, the details of the agreement (including costs, if any) will be between the participating parties. Therefore strategy costs will not be determined for the subordination strategy. For planning purposes, capital and annual costs for the subordination strategy are assumed to be $0.

5C.2 General Water Management Strategies

5.C.2.1 Brush Control

Brush control has been identified as a potentially feasible water management strategy for Region F. It has the potential to create additional water supply that could be used for some of the unmet needs in the Region as well as enhance the existing supply from the Region's reservoirs.

In 1999 the TSSWCB began the Brush Control Program. In 2011, the 82nd legislature replaced the Brush Control Program with the Water Supply Enhancement Program (WSEP). The WSEP's purpose is to increase available surface and groundwater supplies through the selective control of brush species that are detrimental to water conservation. The WSEP considers priority watersheds across the state, the need for conservation within the territory of a proposed projection based on the State Water Plan and if the Regional Water Planning Group has identified brush control as a strategy in the State Water Plan as part of their competitive grant, cost sharing program. Three primary species are eligible for funding from the WSEP: juniper, mesquite and salt cedar.

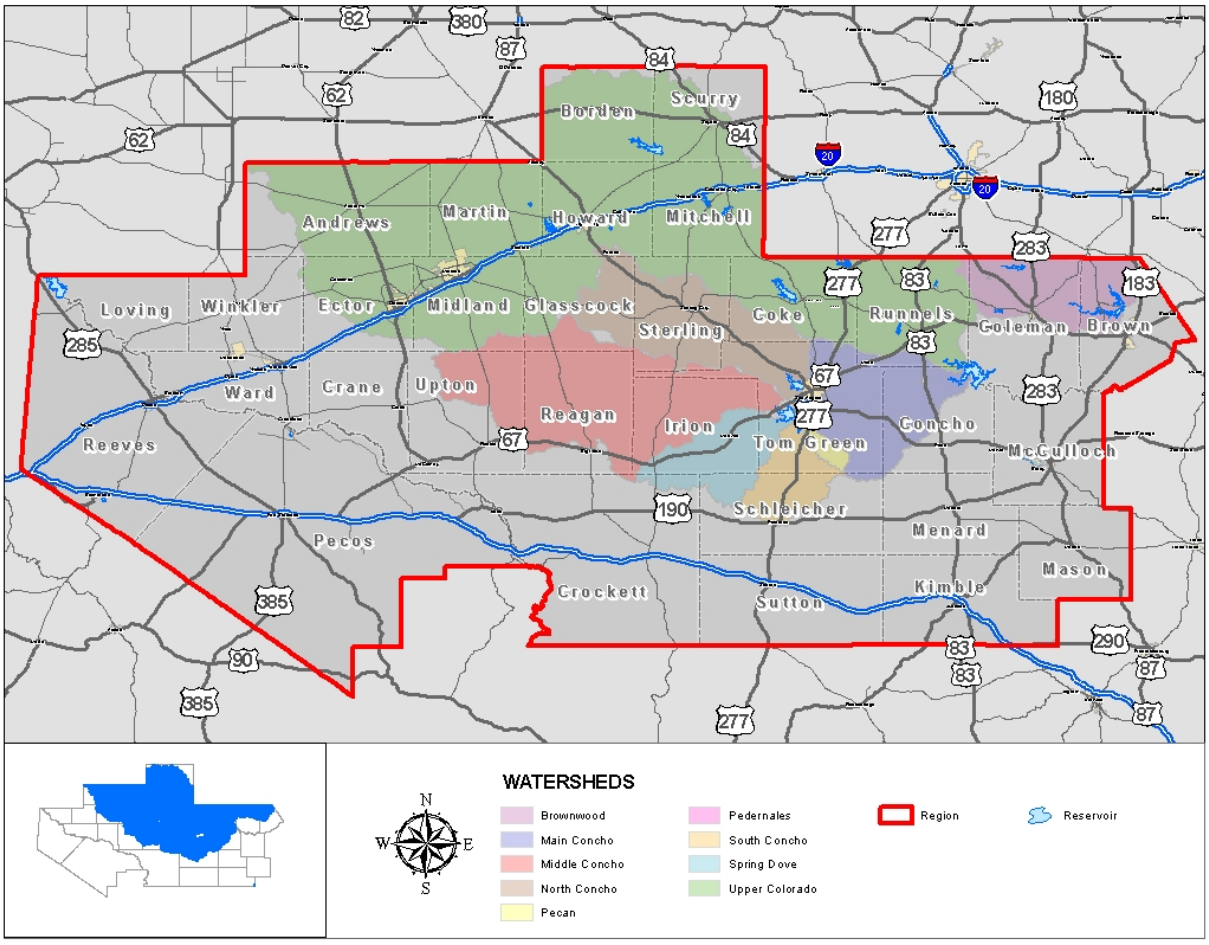
In order for a watershed to be eligible for cost-share funds from the WSEP, a feasibility study must demonstrate increases in projected post-treatment water yield as compare to the pre-treatment conditions. Feasibility studies have been conducted and published for the following watersheds in Region F and are shown on Figure 5C-2:

- Lake Brownwood
- North Concho River (O.C. Fisher Lake)
- O.H. Ivie Reservoir (Upper Colorado River and Concho River)
- E.V. Spence (Upper Colorado River)
- Lake J.B. Thomas (Upper Colorado River)
- Twin Buttes Reservoir (including Lake Nasworthy)

Feasibility studies within region F that are in progress at the time of writing of this plan include:

- O.H. Ivie Reservoir lake basin (salt cedar specific)
- Upper Llano River, including South and North Llano Rivers and Junction City Lake

Figure 5C-2
Brush Control Watershed Feasibility Studies



Active brush removal has been implemented in several watersheds, but to be an effective and reliable long term water production strategy, areas of brush once removed, must be maintained. These maintenance activities qualify as brush control for purposes of this plan.

Although many studies have illustrated the benefits of brush control, until recently it has been difficult to quantify the benefits in the context of regional water planning. This quantification is very important because in most areas that the program is being implemented, hydrologic records indicate long term

declines in reservoir watershed yields (some as much as 80%). Region F has been in critical drought conditions during most of the time that the region's brush removal programs have been in place, so the monitoring programs associated with these projects may not have shown significant gains due to the lack of rainfall events. Also, the benefits from brush control are long term; it takes time for aquifers to recharge and for watersheds to return to pre-brush conditions.

For purposes of this plan, brush control is recommended for the following sponsors and watersheds. The quantity of water directly associated with brush removal under drought conditions is none, but it is assumed that this strategy will increase the reliability of the surface water supplies made available through subordination.

Table 5C- 3
Region F Brush Control

Sponsor	Watershed	Annual cost
CRMWD	O.H. Ivie, E.V. Spence and J.B Thomas	$200,000
San Angelo and UCRA	North Concho River and Twin Buttes Reservoir	$200,000
BCWID	Lake Brownwood	$200,000

5.C.2.2 Weather Modification

Weather modification is a water management strategy currently used in Texas to increase precipitation released from clouds over a specified area typically during the dry summer months. The most common form of weather modification or rainfall enhancement is cloud seeding. Early forms of weather modification began in Texas in the 1880s by firing cannons to induce convective cloud formation. Current cloud seeding techniques are used to enhance the natural process for the formation of precipitation in a select group of convective clouds.

Weather modification is most often utilized as a water management strategy during the dry summers in West Texas, with the season beginning in March and ending in October. The water produced by weather modification augments existing surface and groundwater supplies. It also reduces the reliance on other supplies for irrigation during times of normal and slightly below normal rainfall. However, not all of this water is available for water demands. Some of this precipitation is lost to evaporation, evapotranspiration,

and local ponds. During drought years the amount of additional rainfall produced by weather modification may not be significant.

The amount of water made available to a specific entity from this strategy is difficult to quantify, yet there are regional benefits. Four major benefits associated with weather modification include:

- Improved rangeland and agriculture due to increased precipitation
- Greater runoff to streams and rivers due to higher soil moisture
- Groundwater recharge
- Hail suppression

In Region F, there are two ongoing weather modification programs: the West Texas Weather Modification Association (WTWMA) project and the Trans Pecos Weather Modification Association (TPWMA) program. Figure 5C-3 shows the counties that are currently participating in weather modification programs.

Based on data collected from the WTWMA program, precipitation increases in 2013 varied from slightly less than 1 inch to over 2 inches in the year. This represents a 9.6 percent increase in rainfall. In the Trans Pecos area, the rainfall increases were less, averaging 0.27 inches of increased rainfall.

While it is difficult to quantify the benefits to individual water user groups, weather modification is a recommended strategy for irrigated agriculture for counties that currently participate in an active program. It is assumed that the increase in rainfall will offset irrigation water use. To determine the water savings associated with this strategy, an estimate of the increase in rainfall over the growing season (7 months) is applied directly to the irrigated acreages. These savings are shown by county in Table 5C- 4.

Figure 5C-3
Current Weather Modification Programs

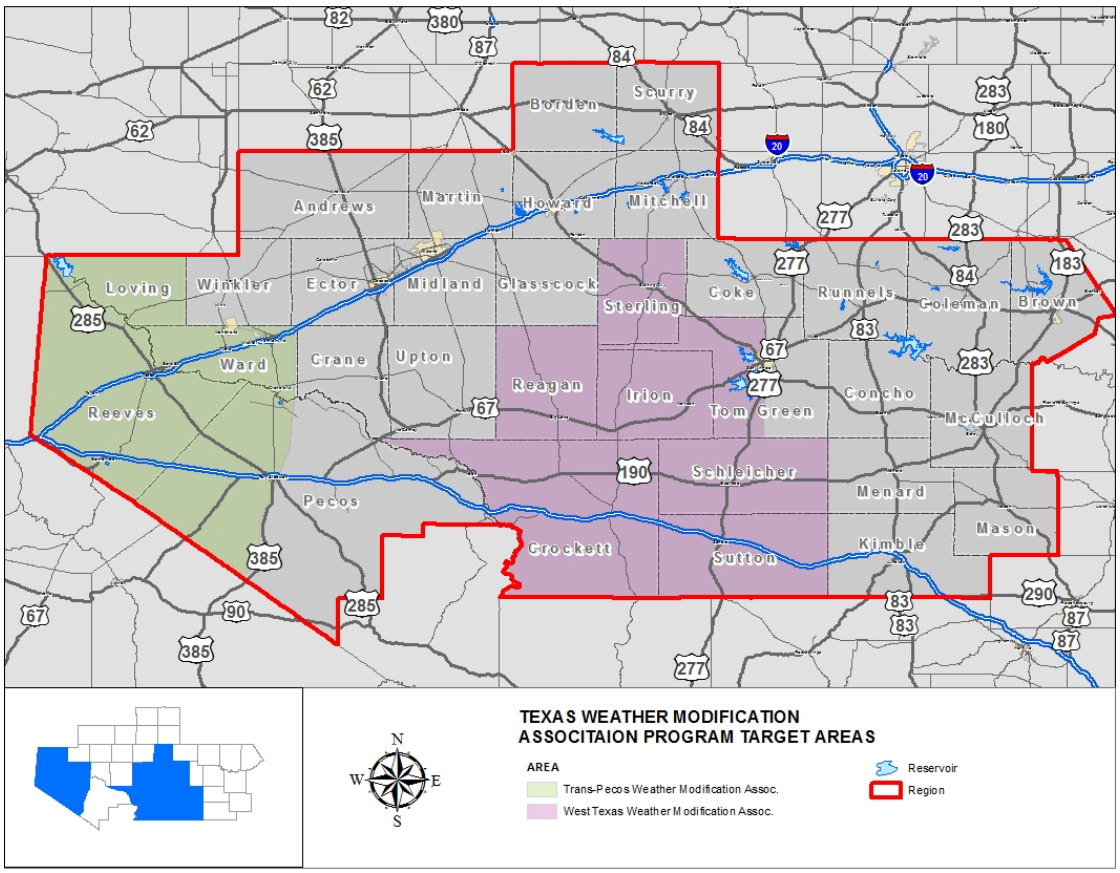


Table 5C- 4
Weather Modification Water Savings and Cost

County	Irrigated Acreage	Annual Increase (Feet)	Water Savings (Ac-Ft/Yr)	Cost
Crockett	153	0.09	8	$9
Glasscock	25,576	0.11	1,654	$1,535
Irion	829	0.18	86	$50
Pecos	28,566	0.01	153	$1,714
Reagan	10,793	0.18	1,154	$648
Reeves	16,997	0.04	347	$1,020
Schleicher	889	0.08	41	$53
Sterling	440	0.08	21	$26
Sutton	563	0.12	38	$34
Tom Green	38,386	0.14	3,209	$2,303
Ward	1,381	0.02	19	$83

The reliability of water supplies from precipitation enhancement is considered to be low for two reasons. First, it is uncertain how much water is made directly available per water user. Second, during drought conditions precipitation enhancement may not result in a significant increase in water supply. However, water saved due to precipitation enhancement will preserve local groundwater for future use.

The cost of operating Texas weather modification programs are approximately four to six cents per acre. The WTWMA operates at 6 cents per acre. These costs are supported by local municipalities, groundwater districts, irrigation districts, and land owners. The cost shown in Table 5C- 4 are based on the program cost for the irrigated acres. Actual costs would be higher when considering the entire program areas.