TULAROSA BASIN AND SALT BASIN

REGIONAL WATER PLAN

2000 - 2040

Executive Summary

South Central Mountain RC&D Council, Inc.

May 2002

Prepared by

in association with

JOHN SHOMAKER & ASSOCIATES, INC.

LIVINGSTON ASSOCIATES, P.C.
Consulting Engineers

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SOUTH CENTRAL MOUNTAIN RC&D COUNCIL, INC.
CARRIZOZO, NEW MEXICO

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AND

JOHN SHOMAKER AND ASSOCIATES, INC.
WATER RESOURCE AND ENVIRONMENTAL CONSULTANTS

JUNE 28, 2002

TULAROSA BASIN AND SALT BASIN REGIONAL WATER PLAN

EXECUTIVE SUMMARY

INTRODUCTION

This Tularosa Basin and Salt Basin Regional Water Plan (RWP) was prepared by the South Central Mountain Resource, Conservation, and Development (RC&D) Council, Inc. of Carrizozo, NM, under contract to the New Mexico Interstate Stream Commission (ISC). An earlier, but less comprehensive, draft document was also prepared under a contract with the ISC by the RC&D Council. The latter project began in September, 1995, and concluded in June, 1997, with the publication of a document entitled "Tularosa Basin and Sacramento River Basin: Regional Water Plan: 2000 - 2040". The contract amount for the first effort was $20,000. The draft document emphasized the development of public awareness of regional water planning, resulted in the acquisition of public input in the draft plan, and dealt with the demand for water for the years 1995, 2000, 2020, and 2040 for the Tularosa Basin and the Sacramento River drainage only. No water supply assessments were performed at that time, nor were water supply alternatives developed for offsetting any shortfalls that might have been anticipated.

A second, follow-on agreement with the ISC in the amount of $20,000 was initiated in 1997 to begin an assessment of the water supply in the Tularosa Basin. That work was partially completed in early 1999.

The effort to prepare this document, which incorporates and updates all of the information in the first document and the follow-on effort, and adds all of the other information required by the "Regional Water Planning Handbook" published by the ISC in December, 1994, began in July, 1999. This final RWP was also expanded to encompass an evaluation of the water supply and demand, and an assessment of water resources and other water issues of the Salt Basin, which now includes the Sacramento River drainage area. The project that resulted in the publication of this final RWP was funded at a level of $45,000.

The RC&D Council selected the engineering consulting firm of Livingston Associates, P.C., of Alamogordo, NM, to prepare the earlier draft reports and this report, including information on the planning region background data, legal issues, water resource assessments, water supply and demand, and water plan alternatives for solving any water shortfalls between supply and demand. Livingston Associates subcontracted the hydrogeologic assessments and evaluations to John Shomaker and Associates, Inc. (JSAI) of Albuquerque, NM.

In order to guide the development of the plan and obtain direct participation by the various public entities located in the basins, the RC&D Council formed a steering committee that met approximately monthly to review progress and make decisions on the RWP content and its applicability. The public entities signed a cooperative agreement to participate and selected individuals to represent them. They represented communities, counties, state and federal agencies and the Mescalero Indian Tribe. A number of individuals representing the general public also participated in the committee meetings and provided invaluable information and major contributions to the content of the plan.

This document is divided into eight sections: (1) Introduction, (2) Documentation of Public Involvement in the Planning Process, (3) Strategy to Maximize Public Involvement, (4) Background Information, (5) Legal Issues for the Region, (6) Water Resources Assessment for the Planning Region, (7) Water Demand, and (8) Water Plan Alternatives.

GOALS AND OBJECTIVES OF THE RWP

Goals (Vision Statement)

> The goal of the Tularosa and Salt Basins RWP is to provide (through the implementation of one or more of the identified water supply and demand alternatives) a sufficient, sustainable water supply (at an economically sustainable price) to meet the agricultural, domestic, water association, municipal, industrial, commercial and other needs of the region, including consideration of the public welfare. The goal is also to make provisions for an adequate water supply to support reasonable growth in population and the economy (agricultural and non-agricultural) over the next forty years, in part through the application of economically viable conservation measures. Included in this goal is the utilization of the regional water resources in a manner that protects and maintains the resource and the environment for the future.

Objectives (Mission Statement)

It is the objective of the RWP to:

a) seek and obtain public input on the plan so that it represents a “grass roots” approach to the solution of the regional water issues,
b) identify, quantify (including yearly and seasonal variations), and estimate the quality of the existing water resources that are economically and practically available to the people of the region,
c) identify the projected water needs over a forty year time period for the region, especially at the local level,
d) quantify the shortfalls in water availability at the regional and local level, including consideration of the quality of the water,
e) identify various alternatives and estimate the cost of implementing those alternatives in order to create a condition in which available supplies equal or exceed the demand over time, and
f) prepare an implementation plan.

DOCUMENTATION OF PUBLIC INVOLMENT IN THE PLANNING PROCESS

A series of 17 public meetings was held between the start of the first phase of the regional water plan effort (1995) and the completion of the second phase (this document). Comments from the general public were recorded at each meeting and written comments were accepted.

More than 100 comments from a total list of attendees of about 280 were received, taken into consideration, and incorporated into the plan where appropriate. In addition to verbal and written comments provided by the general public at public meetings held throughout the region, a number of people representing different viewpoints on water issues attended regional water planning committee meetings. These individuals not only provided direct input to the document at the meetings, but, in some instances, were invited to submit a "position" paper incorporating their viewpoint. These viewpoints are included in Appendix 2.2. Four major papers included in Appendix 2.2 are (1) a simplified analysis of the safe yield of water from the Holloman Air Force Base's Boles Well field (a number which appears to be in disagreement with the OSE administrative model that has been run for the same conditions for that area), (2) another perspective on watershed management that includes the construction of small dams in selected canyons in the eastern basin in order to reduce flood damage, while, at the same time, allowing water to recharge the aquifer, (3) a viewpoint held by the Sacramento Mountain Water Restoration Corporation (SMWRC) on the issue of "public welfare", a viewpoint that includes more than just economics in the evaluation of "beneficial" use of water, and (4) a resolution adopted by the SMWRC regarding their position relative to the currently proposed location of a regional desalination plant, about the level of the TDS of the feed water to the plant, and about its alleged impact on the water supply in the mountain areas.

STRATEGY CHOSEN TO MAXIMIZE PUBLIC INVOLVEMENT.

The emphasis on maximizing public involvement was placed in three principal areas: public meetings, presentations at civic and social organizations meetings, and, of special effectiveness, an eight-page newspaper insert that resulted in the distribution in January, 2001, of the highlights of the RWP to over 10,000 households in the Tularosa Basin area. As a matter of course, handouts and meeting notices were used extensively to provide information before public meetings.

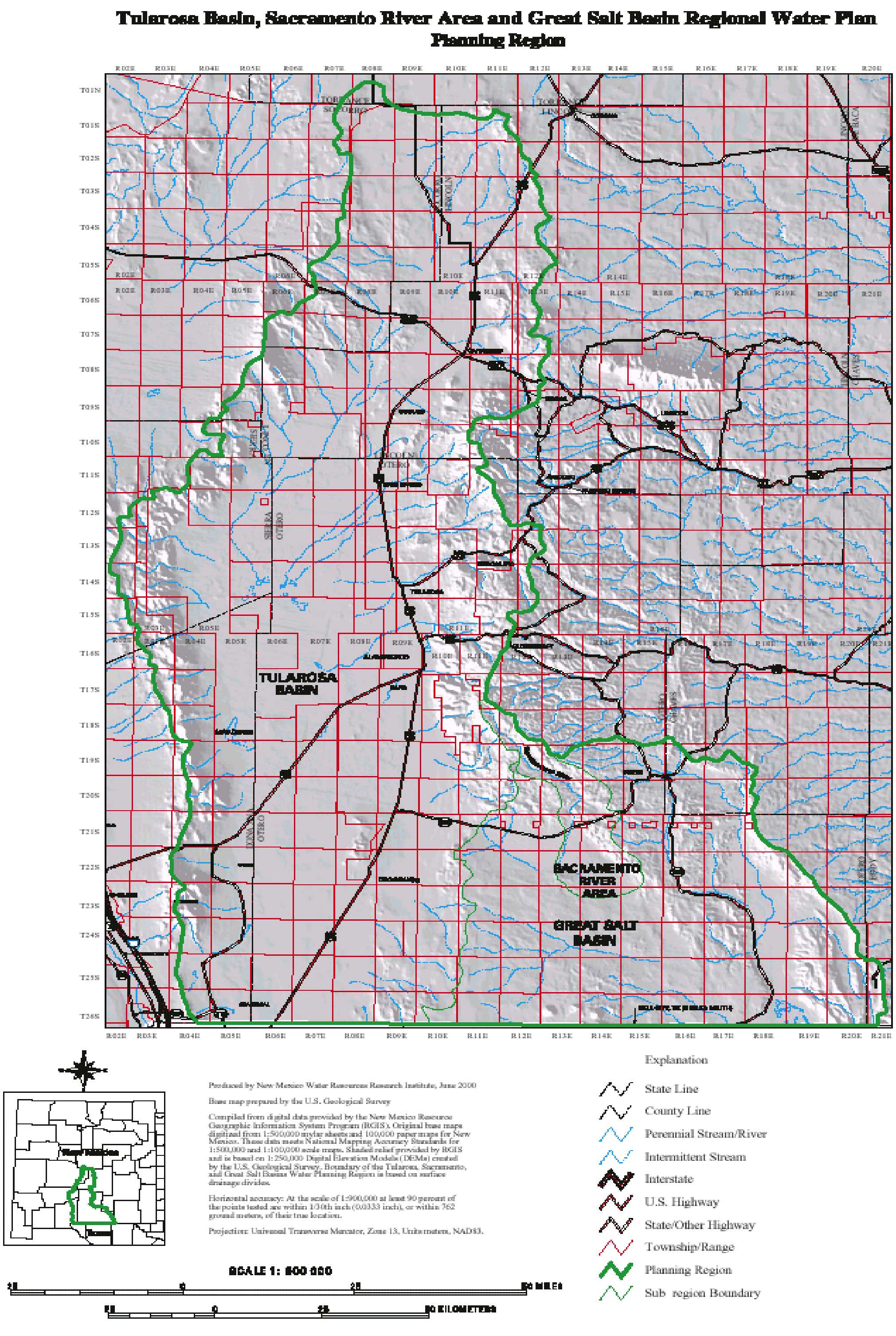
BACKGROUND INFORMATION.

Background information provided in this RWP for both the Tularosa and Salt Basins includes data on physical features of the planning region, the geography and landscape, the climate, major surface and ground water sources, demographics, and a brief review of the economics of the area.

As shown in Figure E-1, the Tularosa Basin is a closed hydrologic area that extends from the Texas state line in the south to the south boundary of Torrance County (generally west of the community of Corona) in the north. The Basin is bounded on the east by the Sacramento Mountains and on the west by the Franklin, Organ, Oscura, and San Andres mountains and the Chupadera Mesa. The Tularosa Basin encompasses 6,500 square miles, is roughly 155 miles north-to-south, and averages roughly 43 miles east-to-west. Precipitation ranges from 10 inches in the central part to 26 inches in the mountains. Surface elevations vary from about 3,900 feet in the barren alkali flats in the center of the Basin to 12,000 feet at the peak of Sierra Blanca Mountain.

FIGURE E-1

RELIEF MAP OF THE PLANNING AREA



The Salt Basin (Figure E-1), which is in the southeastern part of Otero County, is bounded on the east by the Guadalupe Mountain, on the west by the western crest of the Otero Mesa, on the south by the New Mexico State line, and on the north by a roughly east-west line of latitude located about 5 miles north of the community of Pinon. The Salt Basin encompasses roughly 2,400 square miles and is approximately 40 miles in north-south extent and about an average of 50 miles in east-west extent. Precipitation in this area ranges from about 10 inches in the central, desert part to 25 inches in the higher mountains. Surface elevations vary from about 3,400 feet on the playa lakes to 9,200 feet at Sunspot in the Sacramento Mountains. A major physical feature of the Salt Basin is the Sacramento River drainage area which appears to supply a major fraction of the underground water that flows into the southern part of the basin and into Texas. The Sacramento River originates in the northwest corner of the Basin and disappears into the San Andres Underground Aquifer as it flows southward from its headwaters. Historically, the average flow in the Sacramento River near Sunspot is estimated to be about 2,000 AFY.

Because of the hydrologic characteristics of the Tularosa Basin, it has been divided into three sub-basins and these three sub-basins have been further divided into major canyon drainages (watersheds) for purposes of more detailed water resources assessments for the region. The sub-basins and the drainages are shown in terms of their geographical locations in Figure E-2. The key hydrologic parameters for these drainages (precipitation, elevations, areas, stream flows, and watershed yields are listed in Tables E-1, E-2, and E-3. Table E-4 shows similar information for the Salt Basin

The northern sub-basin, which is defined by an area extending from the north end of the Tularosa Basin southward to an east-west line of latitude running approximately 5 miles north of the community of Three Rivers, is at the highest average elevation of the three sub-basins. Groundwater is predominantly in the bedrock aquifer, but south of Carrizozo significant groundwater lies in the alluvial fill, which continues to thicken as one proceeds to the south. Because of the topography, groundwater generally flows southward

The southern portion of the Tularosa Basin has been further divided into two parts, the eastern sub-basin and the western sub-basin. The line of demarcation between the two is created by the Jarilla Fault line that has a roughly north-south orientation as shown in Figure E-2.

The eastern sub-basin is characterized by extensive alluvial fill leading up to the base of the Sacramento Mountains on the east. The mountains create a rather abrupt escarpment incised by numerous canyons. Some of these canyons have perennial streams fed by springs that receive water from rainfall and snow pack arising in the mountains. The basin fill in this sub-basin is at least 2,500 feet thick and it acts as the primary aquifer for moderately good quality water in those areas at or near certain alluvial fans. Most of the population centers in the Tularosa Basin lie along the mountain front and get some of their water from springs located in the nearby canyons where the water quality is generally good. In general, as one goes westward from the mountains, the volume of stored water in the fill becomes high to very high in dissolved solids.

FIGURE E-2
HYDROLOGIC AREA MAP

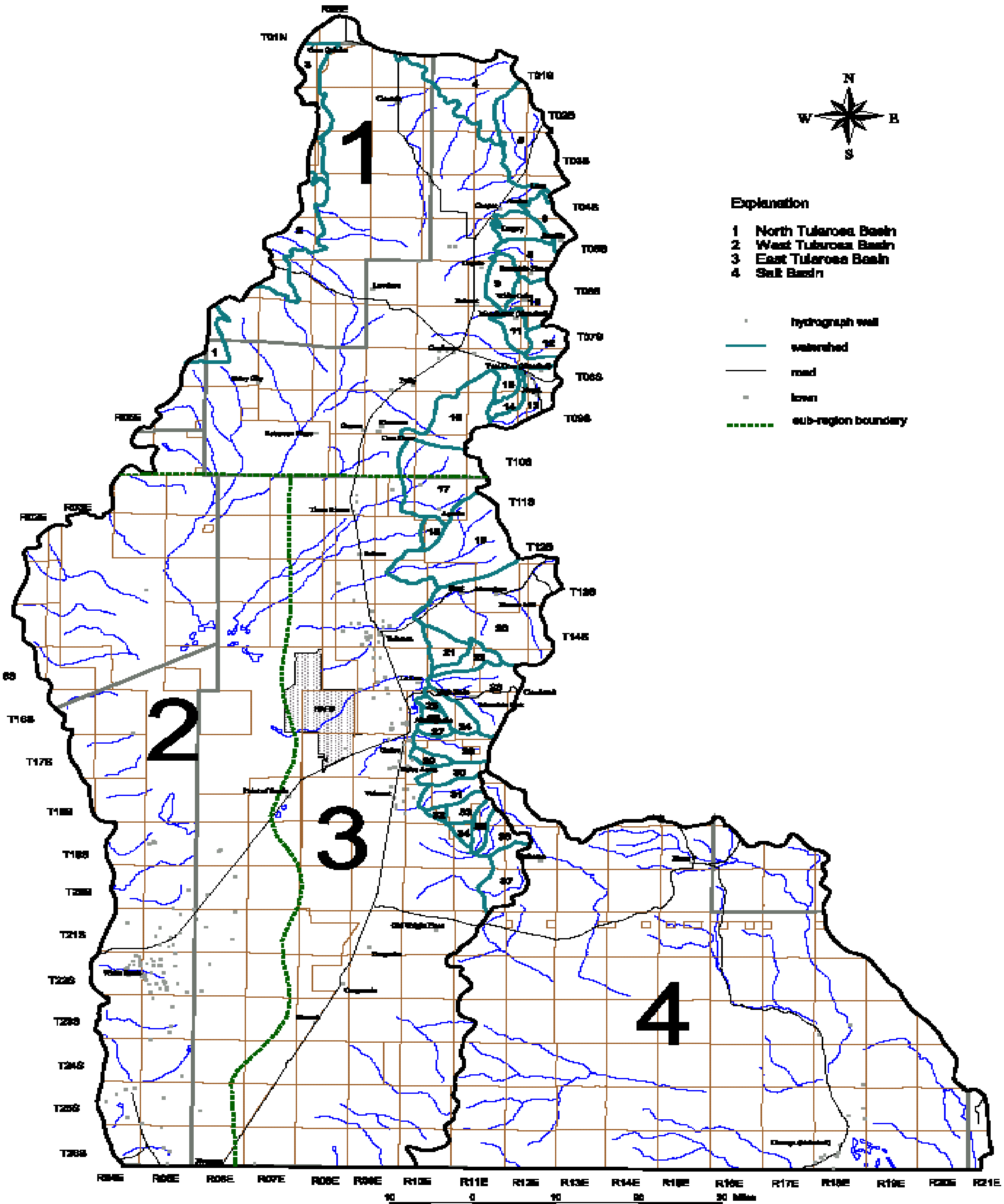


TABLE E-1

Major Watersheds in the Northern Tularosa Basin, and Summary of Watershed Data and Estimated Yield						
Watershed Name	**Map ID[2]**	**Mean Annual Precip, in/yr.**	**Mean Elevation, ft**	**Area, mi[2]**	**USGS[1] Estimated Mean Annual Streamflow, AFY**	**JSAI Estimated Watershed Yield, AFY**
Oscura Mountains	1	21.3	7,500	14.4	See N3	1,952
Turkey Ridge	2	17.2	6,500	33.5	See Red and Wagon Canyon	2,331
Chupadera Mesa	3	17.2	6,500	59.6	na	4,152
Pajaro & Pinatosa Canyons	4	19.5	7,000	67.7	na	6,860
Largo Canyon	5	18.0	6,600	74.5	na	6,028
Ancho Canyon	6	18.7	6,800	18.7	na	1,730
Pine Canyon	7	18.3	6,700	10.1	na	1,001
Coyote Canyon	8	18.0	6,600	24.0	na	2,066
Lone Mountain	9	20.5	7,070		na	
White Oaks Watershed	10	21.0	7,250	26.3	na	3,315
West Carrizo Mountain	11	22.8	7,800	11.3	na	1,292
Benado Canyon	12	22.5	7,622	16.6	na	2,417
Nogal Canyon	13	18.3	6,750	29.8	na	3,874
Tortolita Canyon	14	21.0	7,300	11.3	na	2,037
Diamond Peak to Godfrey Peak	15,16	21.3	7,500	50.4	na	5,788
USGS basins 1 through 8	15, 16	23.8	na	19.6	649	
N3 (44)	1	15.6	5,125	73.8	3,815	
Red Canyon N2 (45)	2	14.3	5,796	55.6	2,251	
Wagon Canyon N1 (46)	2	13.0	5,400	120.0	5,401	
Northern Basin Total					12,116 (3)	44,843

1 Waltemeyer (2001)
2 watershed map ID on **Figure** E-2
3 John Shomaker and Associates, Inc. estimate is 14,842 AFY and used throughout this Plan
na: not available

TABLE E-2

Major Watersheds in the Western Tularosa Basin, and Summary of Watershed Data and Estimated Yield					
Watershed Name	**Map ID[1]**	**Mean Annual Precip, in/yr.**	**Mean Elevation, ft**	**Area, mi[2]**	**USGS[1] Estimated Mean Annual Streamflow, AFY**
Oak Canyon (24)		14.85	5,716.73	8.94	203
Soledad Canyon (25)		15.88	6,335.22	15.56	485
Sotol Creek (26)		14.32	5,645.93	13.07	319
unnamed (27)		11.91	4,898.37	12.15	217
Bear Canyon (28)		11.80	5,740.51	15.38	290
Little San Nicolas Canyon (29)		12.00	6,154.62	7.35	109
Ash Canyon (30)		13.81	6,352.00	7.60	145
San Andres Canyon (31)		15.63	5,845.00	8.90	217
Mayberry Canyon (32)		15.49	5,695.00	11.53	304
Deadman Canyon (33)		14.33	5,576.00	16.07	427
Lost Man Canyon (34)		12.88	5,954.00	10.18	188
Hembrillo Canyon (35)		12.00	5,669.00	17.17	348
Grandview Canyon (36)		12.00	5,928.00	2.82	29
Sulfur Canyon (37)		12.04	5,770.00	30.29	746
Ash Canyon (38)		12.08	6,352.00	4.30	51
Workman Canyon (39)		12.66	6,141.00	5.99	94
Cottonwood Canyon (40)		13.73	5,791.00	45.29	1,600
Rhoades Canyon (41)		14.57	6,185.00	39.73	1,477
Good Fortune Canyon (42)		15.34	6,227.97	24.02	811
Thurgood Canyon (43)		13.80	5,588.74	37.21	1,231
Western Basin Total					9,291

1 refer to Waltemeyer (2001) for location of watersheds

TABLE E-3

Major watersheds in the Eastern Tularosa Basin, and Summary of Watershed Data and Estimated Yield

Watershed Name	Map ID[2]	Mean Annual Precip, in/yr	Mean Elevation, ft	Watershed area, mi^2	USGS[1] Estimated Mean Annual Streamflow, AFY	JSAI Estimated Watershed Yield, AFY
Three Rivers at Three R.	17	22.0	6,568	86.5	8,326	9,097
Boone and Salinas Draws	18	21.0	7,300	32.7	na	1,261
Rinconada Canyon	19	21.2	6,840	97.5	9,194	10,897
Tularosa Canyon at Tularosa	20	21.2	7,280	157.0	17,520	25,237
Domingo & Rancheria Canyons	21	17.1	6,410	34.4	na	1,249
Cottonwood Wash	22	18.3	6,750	15.4	na	2,149
La Luz Canyon	23	21.1	7,464	65.2	5,285	10,906
Dry Canyon	24	19.4	7,093	9.0	318	1,276
Beeman Canyon	25	15.3	5,930	2.0	na	87
Watershed between Beeman and Marble Canyons	26	15.5	6,015	4.5	na	175
Marble Canyon	27	17.1	6,237	3.5	72	232
Alamo Canyon	28	21.0	7,146	24.9	1,433	3,462
Mule Canyon	29	16.2	6,207	6.7	159	984
San Andres Canyon	30	21.7	7,467	14.8	746	2,532
Dog Canyon	31	20.8	7,392	10.5	442	1,679
Mountain front between Dog and Escondido Canyons	32	16.8	6,327	2.6	na	173
Escondido Canyon	33	19.9	7,083	11.0	434	1,448
Mountain front between Escondido and Bug Scuffle	34	15.5	6,090	8.6	na	585
Bug Scuffle Canyon	35	19.5	6,730	12.3	492	1,190
Grapevine Canyon	36	19.4	6,415	33.5	1,875	2,293
Pipeline Canyon		14.3	5,353	6.1	116	0
Culp Canyon	37	14.3	5,765	23.2	687	707
Eastern Basin total					**47,099**	**77,619**

1 Waltemeyer (2001)
2 watershed map ID on **Figure** E-2
na not available

TABLE E-4

Major Watersheds in the Salt Basin, and Summary of Watershed Data and Estimated Yield				
Name	**Mean Annual Precip, in/yr**	**Mean Elevation, Ft amsl**	**Area, mi^2**	**JSAI Estimated Watershed Yield, AFY**
Sacramento River	22.8	7,795	135	17,580
Pinon Creek	20.0	7,100	99	8,872
Small un-named watersheds and mountain front	17.2	6,500	124	8,626
Salt Basin Total				35,078

The western sub-basin is similar in nature to the eastern one but is hydrologically isolated from it by the fault. Since this portion is the location of the White Sands National Monument and the U.S. Army's White Sands Missile Range, it is sparsely populated. Here the basin fill, which is over 4,000 feet in thickness, contains, for the most part, vast quantities of stored water with very high TDS.

Population estimates developed for the planning region are shown in Table E-5. In general, population estimates are based on Bureau of Business and Economic Research (BBER) data for the smaller communities in the planning region. However, some of the larger population centers have developed their own estimates for population changes. Where they are available, the community's projection is used.

LEGAL ISSUES

The fundamental legal principles surrounding the diversion and use of water in the Tularosa and Salt Basins are identical to those in other parts of New Mexico. These principles are that (1) all surface and ground water belongs to the public and is subject to appropriation for beneficial use (an appropriator does not own the water, only the right to divert or impound and use it), (2) beneficial use is the basis, measure and limit of the right to use water, and (3) priority of appropriation is the better right.

One unique feature of water use in the two basins is the fact that the water supply (source) is often far removed from the area of need (demand); consequently, a number of pipelines have been built to convey water from the source to the area of use. The ownership and maintenance obligations on these pipelines have been of some legal concern. It is fully anticipated that this transportation of water supplies will continue into the future and will require that legal issues be worked out with all parties, those who own the water rights, those who have beneficial use for the water, and those across whose property the pipeline must go.

TABLE E-5

Projected Populations for 2000, 2020 and 2040				
	Population			
Area/Year	**1995**	**2000**	**2020**	**2040**
Alamogordo	30,136	35,969	46,366	56,137*
Holloman Air Force Base	5,547	5,786	5,234	5,234
Tularosa	3,029	3,512	6,594	12,162*
Carrizozo†	1,056	1,490	1,490	1,490
Rural Water Systems Users	3,968	4,200	5,040	5,880
Rural Domestic Well Users	8,746	9,400	11,280	13,160
TOTALS	**52,482**	**60,357**	**76,004**	**94,063**
Great Salt Basin				
Timberon	255	331	593	837
Pinon MDWUA	200	210	250	290
Rural Domestic Well Users	200	200	240	280
TOTALS	**655**	**741**	**1,083**	**1,407**

*From separate studies
† Assumed

A second legal issue with the appropriation of water rights in the Tularosa Basin relates to the administrative constraints imposed by the OSE on the withdrawal of water in the vicinity of Tularosa and Alamogordo where the irrigation and municipal demands are highest. A two-dimensional ground water flow model of this area, developed by Morrison (1989) (NMOSE), is used by the OSE for administration of water in the area. The administrative area is roughly defined by the area contained within Townships 13 through 18 South and Ranges 8 through 10 East. The administrative criteria limit available water rights to the model-predicted drawdown of 100 feet aver a 40 year planning period, or dewatering of approximately one-quarter of the available fresh water thickness.

No water adjudication is underway at this time in the Tularosa Basin, although there are protests regarding water rights and impairment.

WATER RESOURCE ASSESSMENT

Surface Water

Surface water in the planning region occurs as both seasonal and perennial run off. Most of the perennial streams originate from springs in a few major canyons on the western slopes of the Sacramento Mountains, although the Sacramento River is a major source of surface water at the south end of the mountain chain. Snowfall, which is presumed to account for the supply of most surface water (other than short, heavy rain storms in the summer months), is very variable in the region; consequently, the surface water availability will vary considerably on an annual basis. As of this writing, the surface water in the form of spring sources has shown a severe decline in availability over the entire western and southern slopes of the Sacramento Mountains over the last few years. Many of these springs are boxed and the water is piped to communities located along the base of the mountains. Tables E-6 lists the major surface water sources for both basins.

No natural or manmade lakes exist in the planning region, although an attempt was made to construct a dam in order to form a storage lake on the Sacramento River some years ago. However, high underground seepage has resulted in the creation of a marsh which does not serve as storage for surface water.

The total supply of surface water in the entire Tularosa Basin is estimated to be about 68,500 acre feet per year, as a long-term overall average. The quality of the surface water is generally good, the TDS values ranging from 678 ppm; 1,418 ppm; 830 ppm; and 1,005 ppm for the Three Rivers, Tularosa Creek, La Luz/Fresnal Creek, and Alamo Canyon, respectively.

TABLE E-6

Summary of Available Surface Water Data in the Planning Region			
Station Name	**Period of Record**	**Annual Mean Streamflow, ac-ft/yr**	**Reference**
Three Rivers near Three Rivers, NM	1956-58	na	USGS database
Indian Creek near Three Rivers, NM	1956-58	na	USGS database
Rio Tularosa at Mescalero, NM	1910-11	na	USGS database
Tularosa Creek near Bent, NM	1948-95	9,495	USGS database
Rio Tularosa near Tularosa, NM	1939-46	11,091	USGS database
Rio La Luz near La Luz, NM	1911-12	8,536	USGS database
Rio Fresnal near Mountain Park, NM	1911-12	1,050[a]	USGS database
Rio La Luz at La Luz, NM	1910-13; 1982-89	8,694	USGS database
Alamo Creek at Woods Ranch, near Alamogordo, NM	1933-50	1,283	USGS database
Salt Creek	1996-99	580	USGS database
Sacramento River near Sunspot, NM	1984-89	2,173	USGS database

Bonito Lake located east and outside of the planning area in the Sacramento Mountains, provides court decreed amounts of water to communities along and at the end of a 90- mile-long pipeline. The water is apportioned as follows: the community of Nogal (1.48 AFY); the Village of Carrizozo (131.5 AFY); the City of Alamogordo (1,449 AFY); and Holloman Air Force Base (1,449 AFY). The Southern Pacific Railroad (now the Union Pacific) owns rights to 58 AFY from this source. The quality of Bonito Lake water is particularly good: the TDS is about 300 ppm.

In the Salt Basin, the only perennial surface water is that flowing in the Sacramento River. Data from the years 1984 to 1989 indicate a mean, annual, stream flow of roughly 2,173 AFY near Sunspot, but it is subject to wide fluctuations. The water quality of 296 ppm TDS is very good. The rights to Sacramento river water at the Sacramento Lake diversion point are apportioned as follows: U.S. Army (67.2 AFY), the community of Orogrande which is located toward the middle of the Tularosa Bassin (234.4 AFY), and the Stahmann Ranch (44.8 AFY), with lesser amounts totaling 21.6 AFY going to some other ranches and the United States Forest Service, but the estimate of the total amount of water available at that diversion point is 680 AFY. The total appropriated water rights are about 360 AFY; consequently, there would appear to be unappropriated water available. However, the river flow is so low at the present time that current demands cannot be met. Moreover, the 42-mile-long pipeline that was built to carry water from the Sacramento River to the community of Orogrande is in such a state of disrepair, is so corroded, and has such a large amount of salt scale-up that the amount of water provided from this source is insufficient to meet current needs in that community.

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Groundwater.

There are very large quantities of water stored in all three sub-basins of the Tularosa Basin, some in basin fill and some in the bedrock. Tables E-7, E-8, and E-9 show the total volumes by TDS range. As can be seen, most of this water has a high TDS content. In terms of recoverable, potable water (defined herein as less than 1,000 parts per million TDS), the northern, western, and eastern sub-basins have stored volumes of water of 5,754,000 acre feet (bedrock only), 6,153,000 acre feet (basin fill only), and 5,789,000 acre feet (bedrock and basin fill), respectively. However, such large quantities of saline water (>1,000 parts per million) exist (124,648,000 acre feet) that, with some type of desalination processing of the water, essentially an infinite supply is available for municipal and other uses. This situation is the motivation for utilizing desalination as a major alternative to deal with drought conditions, to allow for growth, and to isolate the supply of water as much as possible from the variability of precipitation year to year in this area. Many existing municipal well fields draw water from sources in the 1,200 to 1,500 ppm TDS range, which is at the high end of potability. A common practice, therefore, is to blend this underground water with surface water of generally better quality in order to achieve good quality water for distribution.

In the salt basin there are estimated to be about 15,000,000 acre feet of recoverable water in storage in the bedrock aquifers. With a TDS value of < 1,000 ppm, this value is about one half of the total amount of water in storage having < 1,000 ppm TDS, as indicated in Tables E-10.

Ground and Surface Water Yields.

Total sustainable yields from watershed surface and underground sources for each of the three sub-basins and for the Salt Basin are shown in Tables E -11 through E-14, inclusive. The total estimated yield for the entire region (both basins) is about 469,918 AFY, assuming that the drop in the water table meets the criteria of not exceeding 2.5 feet per year, in general, or not exceeding more stringent criteria around specified population centers. However, by contrast, the total <u>recharge</u> for both basins is estimated to be only 121,000 AFY. This would be the limit of sustainability if mining of groundwater is not allowed.

It should be noted that, although the total amounts of water available from both aquifer storage and watershed yield (469,918 AFY), from watershed yield alone (167,000 AFY), and from recharge alone (121,000AFY) are large numbers compared to the current and future demands for water, the conclusion that there are no water issues would be highly misleading. In fact serious water shortages exist at the present time at the local level. This inconsistency occurs for several reasons. One is that the watershed inflow occurs over very large areas consisting mostly of the western and southern slopes of the Sacramento Mountains. Although many communities are located in or near a few mountain canyons, the supply from these canyons alone is insufficient for local needs. Secondly, inflow of water into the aquifers along the mountain fronts is diffuse and is difficult to capture except where springs exist. The rest of the water flows through the aquifer and into the alluvial fans and then into the basin fill. The farther it flows into the basin the more saline it generally becomes. Thus an impractical number of wells would be required to capture it all. As would be expected, the best water and most easily recoverable is from springs, and then, after that, from wells located in the alluvial fans at the base of the major canyons. Even in many alluvial fans the water has become somewhat saline. Thirdly, although water from the alluvial fans could be and is captured by wells, long pipelines are and would be required to transport the water to population centers. Considerable capital and maintenance costs would be incurred.

TABLE E-7

Estimated Total and Recoverable Volume of Ground water Stored in the Northern Tularosa Basin Area

Total Volume of Water in Storage			Basin Fill	Bedrock	Basin Fill	Bedrock
TDS range, mg/ L	**Area Inside Basin Fill, mi^2**	**Area Outside Basin Fill, mi^2**	**Total Volume in Storage, AF**	**Total Volume in Storage, AF**	**Recoverable Volume in Storage, AF**	**Recoverable Volume in Storage, AF**
>10,000	0	0	0	0	0	0
5,000-10,000	35.64	5.04	1,140,480	161,280	285,120	80,640
4,000-5,000	52.56	31.68	1,681,920	1,013,760	420,480	506,880
3,000-4,000	160.20	146.88	5,126,400	4,700,160	1,281,600	2,350,080
2,000-3,000	42.84	191.16	1,370,880	6,117,120	342,720	3,058,560
1,000-2,000	47.52	953.28	1,520,640	30,504,960	380,160	15,252,480
<1,000	0.00	359.64	0	11,508,480	0	5,754,240
total water			10,840,320	54,005,760	2,710,080	27,002,880

Notes:
Total volume of water stored in basin fill is based on 250 ft average saturated thickness and porosity of 0.2
Total volume of water stored in bedrock is based on 1,000 ft average saturated thickness and porosity of 0.05
Total volume of recoverable water stored in basin fill is based on ability of the aquifer to liberate one half of the total in storage to wells and specific yield of 0.1
Total volume of recoverable water stored in bedrock is based on ability of the aquifer to liberate one half of the total in storage to wells and storage factor equal to 0.05

TABLE E-8

Estimated Total and Recoverable Volume of Ground water Stored in the Western Tularosa Basin Area			
TDS Range (mg/ L)	**Basin Fill Area (mi^2)**	**Basin Fill Total Volume in Storage AF**	**Basin Fill Recoverable Volume in Storage AF**
>10,000	125.28	24,053,760	4,008,960
5,000-10,000	991.80	190,425,600	31,737,600
4,000-5,000	117.36	22,533,120	3,755,520
3,000-4,000	150.12	28,823,040	4,803,840
2,000-3,000	289.44	55,572,480	9,262,080
1,000-2,000	76.68	14,722,560	2,453,760
<1,000	384.56	24,611,840	6,152,960
Total water		**360,742,400**	**62,174,720**

Notes:

Total volume of water stored in basin fill is based on 1500 ft average saturated thickness
And porosity of 0.2
Total volume of fresh water stored in basin fill is based on 500 ft average saturated thickness
And porosity of 0.2
Total volume of recoverable water stored in basin fill is based on ability to dewater 50 percent of the average saturated thickness (500 ft) and specific yield of 0.1

TABLE E-9

Estimated Total and Recoverable Volume of Ground Water Stored in the Eastern Tularosa Basin Area						
TDS Range (mg/ L)	Area Inside Basin Fill (mi^2)	Area Outside Basin Fill (mi^2)	Basin Fill Total Volume in Storage (acre-feet)	Bedrock Total Volume in Storage (acre-feet)	Basin Fill Recoverable Volume in Storage (acre-feet)	Bedrock Recoverable Volume in Storage (acre-feet)
>10,000	21.60	0.00	2,764,800	0	691,200	0
5,000-10,000	365.52	0.00	46,786,560	0	11,696,640	0
4,000-5,000	173.88	0.00	22,256,640	0	5,564,160	0
3,000-4,000	211.68	18.72	27,095,040	599,040	6,773,760	299,520
2,000-3,000	53.28	54.36	6,819,840	1,739,520	1,704,960	869,760
1,000-2,000	351.00	364.68	44,928,000	11,669,760	11,232,000	5,834,880
<1,000	123.12	477.36	7,879,680	7,637,760	1,969,920	3,818,880
total			158,530,560	21,646,080	39,632,640	10,823,040

Notes

Total volume of water stored in basin fill is based on 1000 ft average saturated thickness and a porosity of 0.2

Total volume of water stored in bedrock is based on 1,000 ft average saturated thickness and porosity of 0.05

Total volume of fresh water stored in basin fill is based on 500 ft average saturated thickness and porosity of 0.2

Total volume of recoverable water stored in basin fill is based on ability of the aquifer to liberate one half of the total in storage to wells and specific yield of 0.1

Total volume of recoverable water stored in bedrock is based on ability of the aquifer to liberate one half of the total in storage to wells and storage factor equal to 0.05

TABLE E-10

Estimated Total and Recoverable Volume of Ground water Stored in the Salt Basin Area (New Mexico side)				
TDS Range (mg/ L)	**Bedrock Aquifer Total Volume in Storage AF**	**Bedrock Aquifer Recoverable Volume in Storage AF**	**Basin Fill Alluvial Aquifer Total Volume AF**	**Crow Flat Basin Fill Aquifer Recoverable AF**
>10,000	0	0	0	0
5,000-10,000	0	0	0	0
4,000-5,000	0	0	0	0
3,000-4,000	1,840,320	920,160	0	0
2,000-3,000	12,458,880	6,229,440	512,000	256,000
1,000-2,000	13,219,200	6,609,600	2,176,000	1,088,000
<1,000	29,954,880	14,977,440	230,400	115,200
Total	57,473,280	28,736,640	2,918,400	1,459,200

Total volume of water stored in bedrock is based on 750 ft average saturated thickness and porosity of 0.05
Total volume of recoverable water stored in bedrock is based on ability of the aquifer to liberate one half of the total in storage to wells and confined storage factor equal to 0.05

TABLE E-11

Estimated Sustainable Yield for the Northern Tularosa Basin	
Component	**Quantity, AFY**
Supply	
Total estimated watershed yield	44,842
Estimated ground-water yield for entire sub area *	63,600
Losses from Supply	
Non-salvageable watershed yield (stream flow not captured)	14,842
Captured stream flow (evaporation from springs, etc.)	1,000
Estimated maximum sustainable yield for Northern Tularosa Basin area	92,600

* Based on the ability to dewater the ground water in storage at an average rate over 100 years, with a TDS less than 3,000 mg/L, uniformly across the Northern Tularosa Basin area.

TABLE E-12

Estimated Sustainable Yield for the Western Tularosa Basin	
Component	**Quantity, AFY**
Supply	
Total estimated watershed yield	9,291
Estimated ground-water yield for entire sub area *	89,300
Losses from Supply	
Non-salvageable watershed yield	0
Captured stream flow (evaporation from springs, etc.)	1,000
Estimated maximum sustainable yield for Western Tularosa Basin area	97,591

- Based on the ability to dewater the ground water in storage at an average rate over 100 years, with a TDS less than 3,000 mg/L, uniformly across the Western Tularosa Basin area.

TABLE E-13

Estimated Sustainable Yield for the Eastern Tularosa Basin	
Component	**Quantity, AFY**
Supply	
Total estimated watershed yield*	77,610
Estimated ground-water yield for entire sub area **	63,250
Losses from Supply	
Non-salvageable watershed yield	10,511
Captured stream flow (evaporation from springs, etc.)	1,000
Estimated maximum sustainable yield for Eastern Tularosa Basin area	129,349

* Includes stream flow and recharge to bedrock aquifer

**Based on the ability to dewater the ground water in storage at an average rate over 100 years, with a TDS less than 3,000 mg/L, uniformly across the Eastern Tularosa Basin area.

TABLE E-14

Estimated Sustainable Yield for the Salt Basin	
Component	**Quantity, AFY**
Surplus	
Total estimated watershed yield	35,078
Estimated ground-water yield for entire sub area *	107,300
Inflow from Penasco Basin	8,000
Losses	
Captured stream flow (evaporation from springs, etc..)	0
Non-salvageable watershed yield	0
Estimated maximum sustainable yield for Salt Basin area	150,378

* Based on the ability to dewater the ground water in storage, with a TDS less than 3,000 mg/L, uniformly across the Salt Basin area. Much of the ground water in storage is in areas of low well yield, and the estimate does not account for potential rapid dewatering of localized high permeability zones.

CURRENT WATER DEMANDS.

The current diversions within the Tularosa Basin total 46,951 AFY as shown in Table E- 15. Approximately 75 % of the total is from groundwater supplies and 25 % from surface water supplies. Irrigated agriculture accounts for most of the diversions (58 %) and public water systems accounting for 29 %. For the Salt Basin, total diversions are 10,740 AFY, with 95 % of it coming from groundwater. In terms of use, 95% of it goes to agriculture as shown in Table E-16.

Data available from the two basins indicate that depletion factors vary from 45 to 60 percent (averaging 50 %) for public water supply systems, are about 45 % for domestic water use, vary from 60 % to 100 % for the few industrial activities that are in operation, and are about 45% for commercial activities, (although one golf course in this category has an estimated 92 % depletion factor). In the agriculture sector, irrigation efficiencies vary from 60 % to 85 % depending on the type (flood, sprinkler, or drip) and depth to water. From a practical standpoint, return flow that is calculated from the depletion factors is not available to most non-agriculture users to offset diversions. For agriculture, whether or not return flow is of practical value depends on the aquifer from which it is taken.

Although significant conservation measures are taken in several communities, especially Alamogordo, where, among other conservation measures, waste water is recycled for use in parks, these undertakings principally reduce diversions only, since the recycled water either evaporates or goes into groundwater in areas far from the well field. Also, return flows generally enter the basin fill and pick up salts that increase the salinity markedly or enter aquifers that are already high in TDS content; consequently, these return flows are not considered to be available to public water supplies. To be on the conservative side, the regional water plan assumes that the current demand for water in both basins is equal to the total diversions, which are 57,600 AFY for the year 2000.

TABLE E-15

Summary of Present Diversions (Tularosa Basin) (Year 2000)				
Use	**Surface Water (AFY)**	**Ground Water (AFY)**	**Total Diversion (AFY)**	**Percent of Total Diversion (%)**
Public Water Systems	5,874	7,832	13,706	29
Domestic (self supplied)	0	962	962	2
Irrigated Agriculture	5,693	21,590	27,283	58
Livestock	149	266	415	<1
Commercial	20	555	575	1.2
Industrial	0	25	25	<1
Stock Pond Evaporation	0	3,965	3,965	8
Mining	0	20	20	<1
Totals	**11,716**	**35,235**	**46,951**	**~ 100**

TABLE E-16

Summary of Present Diversion (Salt Basin) (Year 2000)				
Use	**Surface Water (AF)**	**Ground Water (AF)**	**Total Diversion (AF)**	**Percent of Total Diversion (%)**
Great Salt Basin				
Public Water Systems	30	44	74	1
Domestic (self supplied)	0	22	22	<1
Irrigated Agriculture	0	10,171	10,171	95
Commercial	473	0	473	4
Totals	**503**	**10,237**	**10,740**	**100**

FUTURE WATER DEMANDS.

The demand for water in the Tularosa and Salt Basins is expected to increase over the next 40 years as a primary result of a population increase. This situation results in increases in the demands on public water systems. Agriculture, on the other hand, is expected to grow relatively slowly in both basins (a 30 % increase in total demand over the 40 year period in the Tularosa Basin and a 10 % increase in total demand over 40 years in the Salt Basin). By contrast, the population increase is expected to be about 54% over the forty year planning period (2000 to 2040), as was seen in Table E-5. As a result of this growth, the total demand for water, as shown in Table 17, is expected to increase from its present rate of 57,600 AFY to 73,009 AFY in the year 2040.

WATER DEMAND AND SUPPLY AT THE LOCAL LEVEL

Although the hydrologic data indicate that the average, annual inflow of water (watershed yield) into the Tularosa Basin (in terms of the planning region as a whole, in terms of the three individual sub-basins, and in terms of selected watersheds within the northern and eastern sub-basin) is adequate at the present time to meet all demands, a significant fraction of this inflow (supply) is not, in general, recoverable for use by municipalities, by small communities, or by small water associations from a practical and cost effective standpoint, as noted above. Inflow is defined here as the total amount of precipitation that becomes surface water and/or enters the underground aquifer. The inflow will, of course, vary from year to year depending upon the precipitation, particular the snowfall levels. Capture of the water is made difficult by the diffuse nature of the source, by the fact that a significant amount of underground water flows down the western slopes of the Sacramento Mountains in limestone beds in solution or fracture zones which are difficult to find, and by the fact that the water becomes more saline as it spreads out into the valley alluvial fill, principally along the alluvial fans.

In order to develop a more realistic evaluation of the potable water supply relative to demand, an analysis has been made of the actual supplies available to some selected population centers in the basin. The analysis is based upon current well field and surface water yields. In this case, the definition of a potable water supply is that amount of water that can cost-effectively be captured, and that has a TDS value of 1,000 ppm or less. In addition, it assumes that the water that can be economically recovered would require only treatment by sedimentation/filtration and disinfection, at most, to render it safe for human consumption.

From this standpoint, most population centers in the Tularosa Basin have an average, annual, sustainable water supply that is only slightly larger than the demand or, in some cases (especially under drought conditions), less than the demand. This fact implies (and it is obvious from an analysis of the daily supply and demand data kept by various municipalities) that a shortfall already exist in the summer months. It is this shortfall that must be addressed by the RWP through the application of one or more of the alternatives that are identified below. Some of the alternatives are already used in order to meet the water needs of the community on a seasonable basin. One of these alternatives is blending, wherein the existing supply of potable water (which generally has a moderately low TDS load) is blended with well water which usually has a TDS of greater than 1,000 ppm. The blended water will then generally meet potability requirements.

Location of Critical Water Supply Conditions.

The population centers where the water situation is critical at the present time are Timberon, Orogrande, Tularosa, and, most significantly (because of the population density) the area around the City of Alamogordo which consists of the City itself, Holloman Air Force Base, Boles Acres, La Luz Canyon, other populated canyons, and some small county subdivisions. Two other communities where conditions may become critical in the near future are Carrrizozo and Nogal which depend to a great extent on their limited water rights to water in the Bonito pipeline. Since all of the water in the pipeline is appropriated, there is no flexibility in this source, and water for the summer months and for the future must come from other sources unless the water in the pipeline or water rights can be bought.

TABLE E-17

Summary of Projected Future Water Diversions

	Diversion (AFY)		
Use/Year	**2000**	**2020**	**2040**
Tularosa Basin			
Public Water Systems and Domestic	14,772	17,088	20,867
Irrigated Agriculture	27,000	31,255	35,000
Others	5,000	5,030	5,060
Totals	**46,772**	**53,373**	**60,927**
Great Salt Basin			
Public Water Systems and Domestic	128	197	262
Irrigated Agriculture	10,200	10,700	11,220
Commercial	500	550	600
Totals	**10,828**	**11,447**	**12,082**
Grand Total	**57,600**	**64,820**	**73,009**

Water Supply Conditions for the City of Alamogordo and the Surrounding Area

Table E-18 lists the estimated annual, average supply of potable water for the Alamogordo area by source and compares it to the current demand and the anticipated demand for the year 2040. Five currently utilized sources are identified, and the amount of water that can be withdrawn from each on a sustainable basis is estimated. The total is about 14,460 AFY, a rate which is only slightly above the estimated annual average water demand of about 11,424 AFY for the area for the year 2000 and below the estimated need of 15,007 AFY for the year 2040. The demand includes estimated domestic and commercial requirements as well as the needs for the City itself, small public water suppliers, and other nearby communities, all of which depend on basically the same water supply and recharge area.

Water Supply Conditions in Carrizozo, Nogal, and the Surrounding Area

Table E-19 shows the amount of water available to these two communities. Both have small amounts of water rights to the water in the Bonito pipeline. However, as can be seen from the estimated demand for the year 2000 and from the projected demand for the year 2040, the Bonito pipeline supply alone is insufficient in terms of water rights to that supply. Carrizozo has wells which have been utilized to augment the Bonito pipeline water and blending has been done. The City of Carrizozo is in the process of preparing an application to the OSE to drill additional wells. Nogal, on the other hand, has been purchasing from the City of Alamogordo additional water in the pipeline (over and above their existing water rights) in order to meet ongoing demand. Whether or not this remedy can continue is open to question as the demand for water in the Alamogordo area continues to increase as noted above.

Water Supply Conditions in the Village of Tularosa and the Surrounding Area

Table E-20 shows the water supply and demand condition for the Village of Tularosa. As can be seen, the demand of 948 AFY for the year 2000 for water is only slightly less than the supply on average. During the summer months, the demand is greater and exceeds the amounts of water to which the Village has water rights in Tularosa Creek, even though water appropriated to others may still be available in the creek. This is the situation that requires the Village to purchase water from the Tularosa Community Ditch Corporation in order to meet its needs, and will require it to do so as long as water is available from that source. The current water situation is sufficiently severe that the Village has placed a moratorium on new connections outside of the Village. The Village has one well within the Village limits which has a capacity of 450 gpm, but the TDS in the water is greater than 1,000 ppm; consequently, blending with water from Tularosa Creek is used. Consideration is being given to drilling another well with similar capacity.

Water Supply Conditions in Timberon and Orogrande

Timberon has experienced a severe reduction in the spring flows and well capacity in the area in the last year or so. Springs that historically provided 600 gpm are now producing only 75 gpm. Two existing wells now produce only 40 and 22 gpm from depths of 450 to 480 feet, respectively. To date, three new wells have been drilled, but no significant flow rates have been achieved. There are plans to continue well drilling.

The current demand for water for Timberon is about 220 AFY. Current supply is about 137 AFY; therefore severe water use restrictions are in place, particularly for golf courses and swimming pools. Timberon is expecting to grow significantly in population in the next 40 years as a result of the construction (currently going on) of a paved highway to the community. The population grew 15% in the last year and one half and is expected to continue this rate of growth as a result of the paved highway access. Thus a severe water shortage exist at this time and would be projected to only get worse if steps are not taken to offset the shortfall. Table 21 shows the Timberon supply and demand conditions.

TABLE E-18

LA LUZ TO DOG CANYON RECHARGE AREA [1] WATER SUPPLY/DEMAND

(ESTIMATED ANNUAL AVERAGE SUSTAINABLE POTABLE WATER SUPPLY) [2]
(YEAR 2000)

SOURCE	AMOUNT (ACRE-FEET/YEAR)
1. La Luz/Fresnal Stream System	7,366 [3]
2. Alamo Canyon	1,100 [6]
3. Bonito Lake	2,898 [7]
4. HAFB Well Field	1,679 [14]
5. Boles Acres	1,417 [8]
TOTAL	14,460

(ESTIMATED ANNUAL AVERAGE POTABLE WATER DEMAND)

LOCATION	AMOUNT (ACRE-FEET PER YEAR) YEAR 2000	YEAR 2040
1. City of Alamogordo	7,400 [9]	10,375 [9]
2. HAFB	2,502 [9]	2,502 [9]
3. Boles Acres	158 [10]	221 [13]
4. La Luz/Laborcita Canyons	500 [11]	700 [13]
5. La Luz MDWCA	185 [10]	259 [13]
6. Domestic	481 [4]	673 [13]
7. Commercial	100 [5]	140 [13]
8. Other Public Water Supplies	98 [12]	137 [13]
TOTAL	11,424	15,007

FOOTNOTES FOR TABLE E-18

(1) Includes all of the La Luz canyon recharge area (65 square miles), in addition to the area southward to and including the Dog Canyon recharge area (9 square miles). Includes the major communities of Alamogordo, Holloman Air Force Base, the Community of La Luz, the residents of the La Luz and Laborcita Canyons, Boles Acres, and the residents of Fresnal Canyon (High Rolls and Mountain Park)

(2) Potable Water is defined as water that has a total TDS content less than or equal to 1,000 ppm, is safe for human consumption, and requires no more than a sedimentation/filter removal step for turbidity control and a chlorination step.

(3) See report by John Shoemaker and Associates, Inc. (JSAI), dated March, 2001, page 9. See also "Detailed Flow Study of La Luz/Fresnal Stream System", Daniel Engineering Company, March 16, 1982. The latter document estimates the flow at about twice the JSAI value, but is generally considered an overestimate.

(4) Estimate based on assumption that one half of the population (7,962) that is using domestic water supplies is located in the area whose water supply is from the La Luz to Dog Canyon recharge area (inclusive).

(5) Estimate of commercial use requiring potable water within the La Luz to Dog Canyon recharge area (inclusive).

(6) 1999 Data from City of Alamogordo

(7) City of Alamo & HAFB Water Rights

(8) Estimated from well field data

(9) See Table 7.24, Page 7-25

(10) See Draft RWP, page 27, Dated Approximately May, 2001

(11) Personal Communication

(12) Sum of use by entities not covered above. See Draft RWP, page 12, Dated Approximately May, 2001

(13) Assume a 40% growth in population between 2000 and 2040.

(14) See S. D. Theodosis, "Water Supply Program Projections, Holloman AFB, Dec., 1967, p 5

TABLE E-19

CARRIZOZO RECHARGE AREA WATER SUPPLY AND DEMAND

ESTIMATED ANNUAL AVERAGE SUSTAINABLE POTABLE WATER SUPPLY
(YEAR 200)

SOURCE	AMOUNT (ACRE FEET PER YEAR)
1. Bonito Lake (Carrizozo)	130.0
2. Bonito Lake (Nogal Water Assoc.)	1.5
Total	131.5

ESTIMATED ANNUAL AVERAGE POTABLE WATER DEMAND

LOCATION	AMOUNT (ACRE-FEET PER YEAR)	
	YEAR 2000	**YEAR 2040**
1. Village of Carrizozo	330	330
2. Nogal Water Association	5	15
Total	335	345

TABLE E-20

TULAROSA RECHARGE AREA WATER SUPPLY AND DEMAND

ESTIMATED ANNUAL AVERAGE SUSTAINABLE POTABLE WATER SUPPLY
(YEAR 2000)

SOURCE	AMOUNT (ACRE-FEET PER YEAR)
1. Tularosa Creek	965
2. Purchase from Ditch Corporation	Variable

ESTIMATED ANNUAL AVERAGE POTABLE WATER DEMAND

LOCATION	AMOUNT (ACRE-FEET PER YEAR)	
	YEAR 2000	YEAR 2040
1. Village of Tularosa	948*	2476**

* See page 4-2 of the Village of Tularosa Comprehensive Water Study, September 1996
** Linear Extrapolation of Data from the Year 2000 to the Year 2040, op.cit.

Although there would not appear, from a geographical standpoint, to be a connection between the water issues in Timberon and Orogrande, in fact Orogrande's water supply comes via pipeline from the same watershed as that for Timberon.. The drought conditions in the Sacramento River drainage that are impacting the Timberon water supply are affecting the supply of water to Orogrande as well. Orogrande has water rights to 234 AFY, but only about 22 AFY is available from the pipeline if it is operating. Since Orogrande is located in the central area of the Tularosa Basin, their only other practical water supply at present is well water, but that water tends to be high in TDS, of the order of 2,000 ppm or more. The flow from wells is typically only about 25 gpm.

ALTERNATIVES FOR MEETINGS SHORTFALLS IN DEMAND.

A number of alternatives were identified for offsetting the shortfall of water at the local level. Some are applicable in one case but not necessarily in others. Most of them are long-term fixes on the problem, and short-term crises may remain for awhile. The development type alternatives identified are: (1) watershed management, (2) weather modification (cloud seeding for both rainfall and snowfall), (3) desalination, (4) aquifer storage and recovery, (5) the development of new well fields in and near selected alluvial fans where relatively freshwater may exist (more detailed hydrologic studies may indicate that the withdrawal rate from existing fields may be increased), (6) leak-proof, long-term storage catchments at the foot of canyons that have both perennial streams and significant flood flows during storms, (7) the use of reclaimed water, and (8) the blending of good quality water with well water that may have a high TDS content so that the resulting water meets portability requirements. The latter alternative is already widely practiced. Among management alternatives are: (1) residential and commercial conservation, and (2) agriculture water conservation.

TABLE E-21

ESTIMATED ANNUAL AVERAGE POTABLE WATER SUPPLY (YEAR 2000)

SOURCE	AMOUNT (AFY)	
Carrisa Springs	75 (current)	600 (historical)
Supplemental Wells	62 (current)	0 (historical)
Total	137 (current)	600 (historical)

ANNUAL AVERAGE POTABLE DEMAND

SOURCE	AMOUNT (AFY)	
Carrisa Springs	220* (Year 2000)	800* (Year 2040)

*Information provided by the TWSD on11/17/01.
Population = 350 (2000) and 4,500 (2040)

The list of candidate residential and commercial measures are: (1) public education, (2) metering and stepped rate-structures, (3) water audits, leak detection, and repair, (4) water pressure reduction, (5) low-flow fixtures, (6) xeriscaping, (7) water waste ordinances, and (8) time-of-day/day-of-use for outside watering. Many of the residential conservation options are already being used.

For agriculture the major conservation measures are: (1) changing from flood irrigation to high-efficiency sprinklers for row crops, (2) laser land leveling, (3) soil moisture monitoring and (4) switching to drip irrigation systems where appropriate for the crop type.

Table E-22 lists the above mentioned development-type alternatives, provides estimates of the amount of water that might be "created" or saved, and shows the estimated cost per acre foot per year. Table E-23 shows the evaluation of each alternative in terms of seven parameters and also estimates the physical, hydrological , and environmental impacts. In addition, Table E-23 provides a suggested implementation schedule.

SPECIFIC RECOMMENDATIONS TO OFFSET SHORTFALLS AT THE LOCAL LEVEL.

(1) Alamogordo Area.

Construct a desalination plant in the vicinity of Alamogordo of such a size as to produce enough potable water to meet the current and near-term shortfalls in the area, including those in the La Luz Canyon region. Under agreed-upon financial arrangements, some or all of the water currently collected in these canyons from spring flow could be left in the stream or diverted from the collection boxes in order to meet the needs of the canyon residents. Allowance for increasing the capacity of the desalination plant should be included in the design for future growth in the area.

(2) Timberon

Carry out ecologically responsible watershed management in the area, particularly in the Monument and Sacramento River Canyons in order to increase recharge into the aquifer. In the immediate future, cloud seeding from either ground or aerial sources should be undertaken. At the present time, the community has received a permit to drill supplemental wells to capture more water.

(3) Orogrande

Build a small desalination plant to meet current and future potable water needs.

TABLE E-22

Summary of Water Supply Alternatives							
Alt. No.	**Alternative Description**	***Potential* Diversion (AFY)**	**Water Quality (TDS)**	**Capital Cost (M)**	**Annual O&M (M)**	**Water Cost ($/1000 Gals)**	**Water Cost ($/AFY)**
1	Watershed Management	15,000*	<1,000	$100	$0.01	$0.71	$230
2a	Rainfall/ Snowpack Augmentation	22,000*	<1,000	$1.0	$0.03	$0.01	$4
2b	Rainfall/ Snowpack Augmentation	1,700**	<1,000	$1.0	$0.03	$0.14	$44
3	Brackish Water Desalination	10,000	<800	$15	$1.0	$0.65	$211
4	Alamogordo Aquifer Storage And Recovery (ASR)	2,000	<1,000	$2.0	$0.1	$0.30	$98
5	Flood Control Diversion Aquifer Recharge	500	<1,000	$2.0	$0.01	$0.74	$240
6	Tularosa Creek Reservoir	3,000	1,500	n/a	n/a	n/a	n/a
7	Reclaimed Water Reuse	1,000	1,500	$2.0	$0.05	$0.46	$150
8	Municipal/ Industrial Water Conservation	4,400	<1,000	$6.0	$0.03	$0.13	$41
9	Irrigated Agriculture Water Conservation	5,000	<3,000	$4.0	$0.38	$0.31	$100
10	Fresh Water Wells	4,000	<1,000	n/a	n/a	n/a	n/a

TABLE E-23

Evaluation of Water Development Alternatives							
Alternative	**Technical Feasibility**	**Political Feasibility**	**Legal Feasibility**	**Financial Feasibility**	**Social and Cultural Impacts**	**Suggested Implementation Schedule (year)**	**Physical, Hydrological, Environmental Impacts**
Watershed Management	High Studies indicate highly feasible	High Would benefit mountain communities	High	High Costs are shared with USFS grants	Low Improves fire safety/ water	2002 Some small projects on-going	Low Helps forest health, watershed and fire safety
Rainfall/ Snowpack Augmentation	High Has history of use in eastern NM	High Would benefit mountain communities	High	High Costs are low and may be shared	Low None expected	2004 funding sources need to be identified	Medium Increased runoff may cause floods
Brackish Water Desalination	High Pilot study shows feasible	High Regional support	High	Good Funding may be available	Low None expected	2005 funding sources need to be identified	Low No impacts expected
Aquifer Storage and Recovery	High Pilot study shows feasible	High Benefits domestic users and Alamo	High	High Costs are low	Low None expected	2002 Alamo project has been started	Low No impacts expected
Alamogordo Flood Control Aquifer Recharge	High Is used in other areas	High Benefits domestic users and Alamo	Medium	High Part funding may be available	Low None expected	2010 Corps of Engrs. to complete design	Low No impacts expected
Tularosa Creek Reservoir	Needs to be studied	Fair Some opposition from Creek residents	Needs further evaluation	Needs further evaluation	Medium Some view socio/econ impacts	Study and funding sources need to be identified	Needs further evaluation
Reclaimed Water Reuse	High Is used in other areas	High Conserves water	High	High USBR funding is available	Low None expected	2003 Begin study for HAFB and Carrizozo	Low No impacts expected
Municipal/ Industrial Conservation	High Is used in other areas	High Conserves water	High	High Costs are low	Low None expected	2003 Begin educational pgm	Low No impacts expected
Agricultural Conservation	High Is used in other areas	High Conserves water	High	Fair Needs funding	Low None expected	2004 Begin educational pgm	Low No impacts expected
Fresh Water Well Fields	Needs to be studied	N/A	Low OSE Areas	N/A	N/A	2003 Begin detail study	Low No impacts Expected

(4) Carrizozo

Appropriate additional underground water by filing with the OSE, and drill additional wells. If the well water is above 1,000 ppm TDS, blend it with water from the Bonito pipeline up to the limit of their rights in that water. A second option is to development some type of partnership or participation in the regional desalination plant project in order to offset the withdrawal of additional water from the Bonito pipeline beyond their current water rights.

(5) Nogal

File with the OSE to acquire additional underground water rights and drill a well that will make up the current and projected future shortfalls.

(6) Tularosa

Develop some type of partnership or participation in the desalination project and obtain rights to a specified number of acre-feet per year to offset current and anticipated future shortfalls. The community is also planning to drill more wells.

RECOMMENDED FUTURE PROJECTS TO SUPPORT IMPLEMENTATION

Some additional studies and projects are recommended beyond the current contract in order to provide more information that would expedite the implementation of the alternatives and make available more detailed understanding of the water resources in the Salt and Tularosa Basins. These projects and studies are as follows:

1. Collect field data on soil types, plant types, animal types, climate, geology, hydrology, etc. in order to develop a western and southern Sacramento Mountains version (generally between White Oaks and Pinon) of the Ecological Dynamics Simulation (EDYS) model. Run the EDYS model in order to predict the effects of watershed management, cloud seeding, and other forest management procedures (including canyon catchment dams) on the amount of surface and groundwater that might be realized from these actions.

2. Combine EDYS and MODFLOW models in order to have a complete mathematical tool for evaluating the water resources of the basins.

3. Perform a meteorological study of the Tularosa and Salt Basins region in order to determine the feasibility of cloud seeding by means of either aerial or ground sources or both. Estimate the effects of local cloud seeding on surrounding regions. Estimate the increases in rainfall and snowfall as a result of these weather modification processes. (The recommendation is made that this study be cost-shared with the Pecos Valley Water Users Organization).

4. Conduct a study and prepare a report dealing with the legal and administrative procedures that the region would have to establish in order to manage any waters that

might be reserved on behalf of the region by the ISC and to outline the administrative relationship that the region would to have with the ISC and the OSE under existing legislation.

5. Perform field studies and hydrologic studies to determine more exactly the hydrology of the Salt Basin, especially to establish the amount of underground water that originates in the New Mexico part of the basin and flows to Texas.

6. Develop an improved water level and water quality monitoring program in order to be able to predict trends in the water resource throughout both basins.

7. Add and maintain additional stream gauging stations to various streams in the regions.

8. Perform a detailed hydrologic study of the La Luz and Fresnal Canyon drainage areas in order obtain an improved understanding of the water resource and the aquifer characteristics.

CONCLUSIONS TO TULAROSA AND SALT BASINS WATER SUPPLY PLAN

1. The region's population has increased by 20 percent over the last 10 years. The current Otero County population of approximately 62,300 relies heavily on surface water for municipal supply.

2. All of the fresh water (<1,000 mg/L TDS) in the region is from surface water that issues from the Sacramento Mountains and from a small reservoir (2 million AF) of ground water south of Alamogordo. Additional surface water is not available for increasing municipal demand. The mining of fresh ground water is limited by NMOSE administrative rules, physical quantity, and land ownership (more than half of the fresh ground water south of Alamogordo is under military lands).

3. Slightly saline ground water, primarily used for agriculture, is abundant in the planning region, and drought tolerant.

4. Desalination of slightly saline ground water is needed to meet municipal demands, even after exercising all conservation and reuse alternatives. There is plenty of slightly saline ground water (1,000 to 3,000 mg/l TDS) for a sustainable supply without impacting agricultural economy. Desalination is the best alternative for meeting municipal demands, reducing the reliance on drought-limited surface water, and developing a sustainable supply.

5. Future management of water resources will need to include watershed management in the Sacramento Mountains that supply fresh surface water and recharge to the region. This effort should include detailed assessment of the hydrogeologic system and water budgets, options for watershed restoration, and developing limits on growth.