HIGH PLAINS-OGALLALA AQUIFER STUDY

NEW MEXICO*

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Although the research team is solely and totally responsible for statements and conclusions in this report, many people helped in the formulation of the analysis. They included representatives from the High Plains Associates: Camp, Dresser, and McKee (Harvey O. Banks, Jean Williams, and Joe D. Harris); Arthur D. Little, Inc. (Richard Feeley, David Land, Russell Fries, and Rufus Perkins); and Black and Veatch (Charles L. Banning and Carl A. Vansant).

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ABSTRACT

A large area of eastern New Mexico overlies a vast underground reserve of water, mainly from the Ogallala aquifer. The area is considered part of the High Plains region which extends over portions of six states. The utilization of these large water reserves has led to substantial economic growth, primarily growth in agriculture. However, this growth has placed a greater demand on the ground water and water levels have begun to decline.

New Mexico participated with five other High Plains states and the High Plains Associates in the Six-State High Plains-Ogallala Aquifer Area Study. The purpose of this study was to estimate the economic impacts of rapidly rising energy costs and the declining Ogallala aquifer water tables over a 40-year planning horizon.

Four management strategies including a baseline, voluntary water conservation, mandatory irrigation water supply reduction, and interstate importation were evaluated.

The findings of this study suggest that a continuation of current water management policies in eastern New Mexico will lead to large reductions in irrigated acreage and agricultural employment while regional income increases significantly. These effects would be most marked in the southern part of New Mexico's High Plains. Policies to control present water demands would significantly ameliorate these effects. A voluntary irrigation limitation program would be more beneficial than a mandatory one.

The Southern High Plains has been a major oil and gas producing area in the United States. However, by 2020, crude oil and natural gas production is expected to be about 1/10th of the 1980 production. This will extenuate the impact on the economy of the Southern High Plains.

KEYWORDS: *High Plains, *Ogallala Aquifer, *New Mexico, *management strategies, energy, water resources, on-farm impacts, regional impacts, gross output, employment, population, economic projections, resources, interdisciplinary.

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INTRODUCTION

Prior to World War II, land in the High Plains was used almost exclusively for dryland wheat and sorghum production and cattle grazing. It is part of the vast semiarid Great Plains country extending from Mexico to Canada. Yearly variations in the average annual rainfall, ranging from 10 to 25 inches, may cause uncertainty in each year's production from dryland farming and ranching. In the late 1930s, development of the Ogallala aquifer for irrigation purposes began to increase significantly in the Southern High Plains areas of Texas, Kansas, Oklahoma, Colorado, and New Mexico. Steady development continued after World War II, and then accelerated in the 1950s as low-cost natural gas became generally available for pumping irrigation water. The combination of a good water supply, low-cost energy, new irrigation technologies, deep fertile soils, relatively flat terrain, and favorable climate resulted in rapid expansion of irrigated agriculture and associated agribusiness.

The High Plains-Ogallala Aquifer region extends over large portions of eastern Colorado, western Kansas, central and western Nebraska, eastern New Mexico, northwestern Oklahoma, and western Texas (Figure 1). The area includes about 220,000 square miles of the six-state High Plains-Ogallala Aquifer region. Much of the area is underlain by the Ogallala Formation, a major aquifer supplying most of the area's water needs.

Irrigated acreage in the High Plains-Ogallala Aquifer study area expanded from less than 3.5 million acres in 1950 to more than 15 million acres in 1980, an average annual increase of about 400,000 acres over the 30-year period.

The development of feed grain production in the region triggered a related development in the regional economy--the massive feedlot industry now centered in the High Plains. By 1977, the region was marketing more than 9.0 million head of fed cattle annually, or about 38 percent of the national total production of grain-fed beef.

Expansion in irrigated acreage was accompanied by a dramatic increase in annual water use for irrigation. Water withdrawn annually from the Ogallala aquifer for agricultural purposes ranged from less

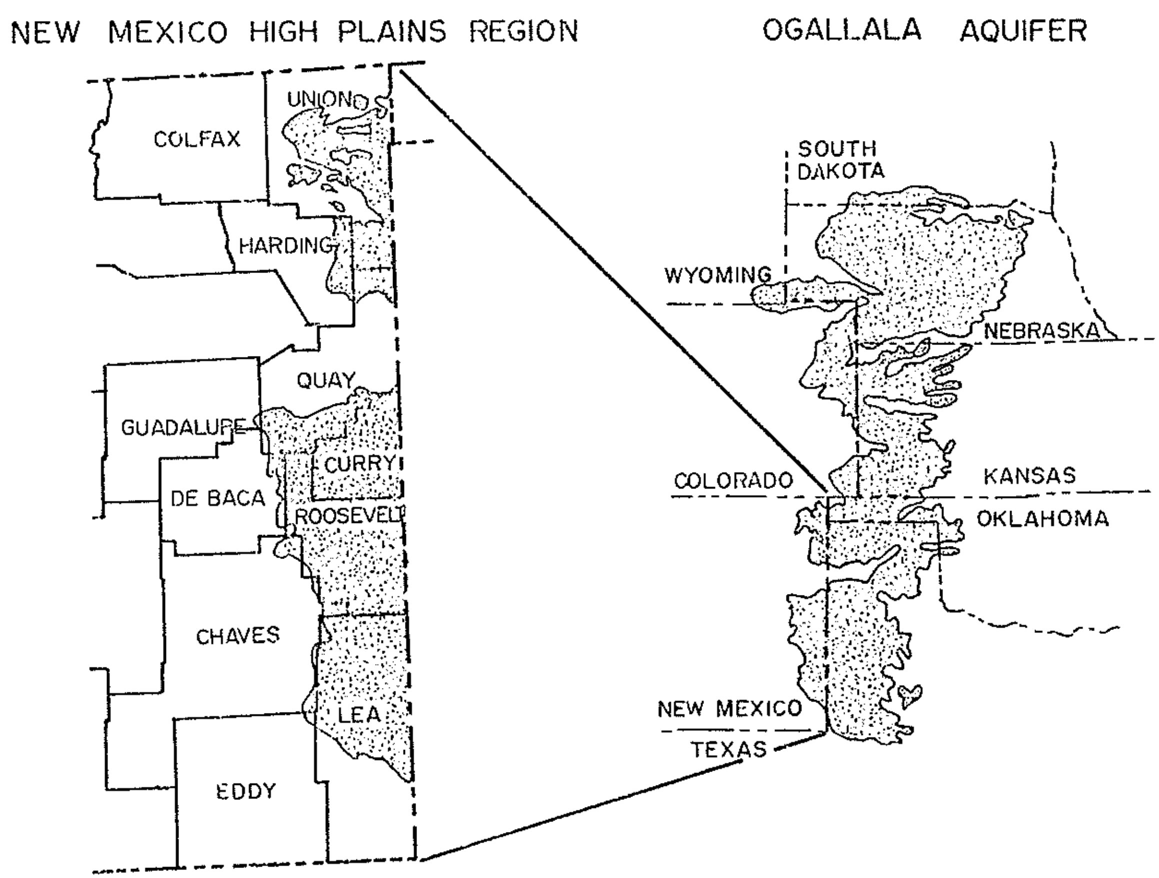

Figure 1. Ogallala Aquifer Region and New Mexico.

than seven million acre-feet of water in 1950 to more than 21 million acre-feet in 1980. Significant improvements in irrigation management and agricultural water use efficiency also took place during that period.

Because physical characteristics of the Ogallala aquifer vary widely, so do projections of its economic lifespan. This is the time remaining before the water resources of the region will be exhausted or depleted to the point where water levels fall below economically recoverable limits. In the Southern High Plains, the Ogallala aquifer is being depleted rapidly. In many instances, the aquifer has been exhausted and large areas have gone out of irrigated production.

A large part of eastern New Mexico is situated in the High Plains-Ogallala Aquifer region (Figure 1). Development of the extensive ground water (primarily the Ogallala aquifer) resources in the region has generated dramatic economic growth. This growth has exerted greater and greater demands on ground water supplies. Water levels have declined so much that some irrigated areas have gone out of production. In the New Mexico High Plains-Ogallala Aquifer region, the aquifer's saturated thickness ranges from about 50 feet to about 135 feet. The water table declines about one to three feet a year. If significant areas were to be forced out of irrigated production, the economy of the entire state could be adversely affected.

The Permian Basin of southeast New Mexico and west Texas has long been one of the major oil-producing provinces in the nation. It is anticipated that the future discovery rate will be more modest than in the past in this region. Primary regional energy resources of crude oil and natural gas are being depleted even faster than the Ogallala water.

This simultaneous decline of the ground water and energy resource base of the Southern High Plains region threatens long-term impacts on the area's socioeconomic structure. Impacts will be felt in reduced levels of income by the labor force directly involved with irrigation enterprises and associated agribusinesses. This, in turn, will result in reduced revenues to local, state, and federal governments from property, income, and other taxes. The integrity of long-term investments may be jeopardized. The viability of small towns and communities dependent almost exclusively on the region's irrigated economy also may be adversely affected. Public costs will increase to provide increased support for job training, income support, and certain health costs for the unemployed or underemployed. The impacts will be felt at the state and national level as well as locally and regionally.

There are choices remaining for the region. The water and energy resources are not gone, but they have been significantly diminished. The regional economy is still healthy, although it faces a declining resource base. In response to these concerns, New Mexico, along with five other states and the High Plains Associates (general contractor), participated in the Six-State High Plains-Ogallala Aquifer Area Study.

The general purpose of the study was to estimate key economic impacts over a 40-year planning horizon. The key indicators were regional income, employment, and population; irrigated and dryland cropping patterns; agricultural output; and farm income. They were evaluated under alternative sets of assumptions regarding public policy, water, energy costs and availability, and irrigation management practices.

This report presents a technical description of the models and impacts for the High Plains-Ogallala Aquifer study region in New Mexico. Results are presented for the baseline and three alternative management strategies.

MANAGEMENT STRATEGIES

Four management strategies, including a baseline, were evaluated--voluntary water conservation (Alternative Management Strategy 1), mandatory irrigation water supply reduction (Alternative Management Strategy 2), and supply augmentation (Importation) for those areas that physically exhaust their water supply under the voluntary strategy (Alternative Management Strategy 5A).

Baseline

The baseline was defined as "no new public action or deliberate change--continuation of current trends in water and agricultural management in both public and private sectors." It consistently has been assumed that under the baseline, neither states nor the federal government would initiate new policies or programs to reduce demands on the Ogallala or other resources, nor would they augment the water supply during the study period. It was further assumed that current trends in public and private sector resource demand and supply management would continue throughout the study period. Only those changes in resource management already underway and anticipated to continue as rational economic behavior would be considered to influence the long-term baseline projections. Under the baseline, the continuation of present trends in water conservation is expected to result in water savings of about 10 percent on sprinkler-irrigated lands over the study period. It is assumed that under baseline, there will be no reductions in water applications for furrow-irrigated croplands.

Voluntary Irrigation Water Conservation

This alternative adds to the baseline by assuming incentives will be provided for technological change and improved water and agricultural management practices at the farm level. This alternative assumes an accelerated rate of adoption of new and promising technologies. Changes in irrigation water and farm management practices are expected to occur through research and development, extension and education, and finally adoption of improved technology, improved farming practices, and improved plant varieties. The area of improved technology probably would include improved water conveyance and application systems. Improved farming practices would include techniques such as irrigation scheduling and evaporation reduction farming methods. Plant varieties might be adapted, through genetic research, to produce the same amount using less water. It is anticipated that these water conservation measures will result in an additional 12 percent reduction in sprinkler water applications from 1990 to 2020, while producing the same output as under the baseline. Furrow irrigation water applications are estimated to be reduced by 21 percent from 1985 to 2020, while producing the same output as under the baseline. Much of these water applications reductions are expected to occur in the latter years of the study.

Mandatory Irrigation Water Supply Reduction

The mandatory strategy builds upon the voluntary strategy by adding mandatory water supply management. This includes institutional regulatory changes requiring water conservation, improved water and agricultural management practices at the farm level, and/or restrictions on new irrigated agricultural developments.

This strategy would require a reduction of the irrigation water supply below what would be available in the voluntary strategy. By 1985, water supplies will be required to be reduced by 10 percent below the irrigation water applications in the voluntary strategy. Water supplies will be reduced by 20 percent by 1990 and by 30 percent by 2000.

Supply Augmentation (Importation)

Irrigation water will be imported from adjacent areas to fully supply those lands that physically exhaust their natural water supply by 2020. As part of the High Plains study, the U.S. Army Corps of Engineers studied, at a reconnaissance level, four importation routes--two from the Missouri River (routes A and B) and two from tributaries of the Mississippi River (routes C and D). The routes were sized to provide costs for a range of flows. Where possible, routes will be located to minimize environmental impacts.

Route D could provide water to New Mexico and parts of Texas and Oklahoma. Sources of water would be the White River at Clarendon, AR; the Arkansas River at Pine Bluff, AR; the Ouachita River at Camden, AR; the Red River at Fulton, AR; the Sulphur River at Darden, TX; and the Sabine River at Tatum, TX. These supplies of water would then route west and northwest across Texas into the Texas Panhandle to terminal storage west of Lubbock, TX. This route would require a canal about 860 miles long and would have 30 pumping plants to lift the water 2,700 feet along the route. The irrigation water will be available in the year 2000 and be applied in a manner consistent with the voluntary strategy technology.

GENERAL DESCRIPTION

The High Plains of New Mexico lie in the southeastern part of the state (Figure 1). The Northern High Plains of New Mexico consist of northern Quay, Union, and Harding counties. The Southern High Plains, or Llano Estacado, consist of Lea, Curry, Roosevelt, and southern Quay counties.

Northern High Plains

The Northern High Plains are in the northeast corner of New Mexico and are bounded on the north by Colorado and on the east by Oklahoma and Texas. Five sub-basins contribute surface drainage to the larger Arkansas-White-Red Basin in Colorado, Oklahoma, and Texas. Total area of the region is 3,328 square miles.

North of the caprock, most of the drainage is to the Canadian River which flows west to east in the northern half of the region. The landscape consists of mesas, canyons, arroyos, rolling plains, and pinon-juniper breaks on the edges of the caprock and deeper canyons. Intermittent tributaries such as Pajarito, Plaza Larga, Barranca, and Revelto creeks join the Canadian River from the south. Ute Creek joins the river from the north a few miles west of Logan. Ute Dam is located some four miles downstream from the confluence of these two streams. An extensive dune and sandhill area is located just north of the Canadian River.

The highest elevation in the region is 5,290 feet (MSL) on top of Mesa Redonda. A prominent landmark--Tucumcari Mountain--is 4,975 feet in altitude. The lowest elevation is about 3,500 feet where the Canadian River leaves the region and enters Texas. The western edge of the region is formed by the Canadian River which flows in a deep canyon with steep sides and high cliffs. Ute Creek and its tributaries of Mosquero and Tequesquite creeks drain the central and northern area of the region.

There are three life zones, namely: Transition, Upper Sonoran, and Lower Sonoran. The latter zone is confined to a small area in the lower reach of Ute Creek. Most of the vegetation consists of rolling grasslands. There is some ponderosa pine and pinon-juniper woodland in the Canadian River canyon and on the higher mesas. Vegetation is sparse in the sandhill area and consists of semidesert grasses and brush.

Southern High Plains

There are no permanent streams in the Southern High Plains. Surface drainage is not well defined, except to Frio and Running Water draws which flow intermittently east into Texas. In the extreme northern part, the caprock is exposed and drainage is toward the Canadian River in Quay County. Elevations range from about 4,600 feet (MSL) in the northern part to about 3,900 feet near the southern boundary.

The counties in the Southern High Plains lie partly in three major river basins: the Pecos Basin, 5,102 square miles; the Texas Gulf, 5,298 square miles; and the Arkansas-White-Red rivers, 441 square miles, for a total land area of 10,841 square miles.

The area contains the Upper Sonoran and Lower Sonoran life zones. Oak shinnery is the predominant vegetative type near the edge of the caprock and in all of the area south of Mescalero Ridge. Most of the plains are undulating grasslands interspersed with some oak shinnery (NMISC, 1975).

Climate

Northern High Plains

The Northern High Plains experience a semiarid climate characterized by clear, sunny days; large diurnal temperature ranges; low humidity; and moderately low rainfall. The mean annual precipitation averages about 14½ inches. The hot summer months are normally the wettest. Occasionally, thunderstorms are accompanied by hail which may damage crops and property. The average snowfall is light and the snows usually melt within a few days after occurrence. Moderate winds prevail most of the year, and strong winds are common from January to May.

Temperatures in the area average about 53 degrees Fahrenheit. Winters are usually mild and dry, and temperatures above 100 degrees

Fahrenheit are not uncommon in the summer months. The growing season usually begins in late April and lasts 170 days, ending in mid-October.

Southern High Plains

The Southern High Plains experience a semiarid climate characterized by clear, sunny days; large diurnal temperature ranges; low humidity; and moderately low rainfall. The mean annual precipitation averages about 18 inches in the north and 15 inches in the south. The hot summer months are normally the wettest. Occasionally, thunderstorms are accompanied by hail which may damage crops and property. The average snowfall is light and the snows usually melt within a few days after occurrence. Moderate winds prevail most of the year and strong winds are common from January to May (NMISC, 1975).

Temperatures in the area average from 50 to 60 degrees Fahrenheit. Winters are usually mild and dry. Temperatures above 100 degrees Fahrenheit are not uncommon in the summer months. The growing season usually begins in early April and lasts from about 190 to 215 days, ending in late October or early November (NMISC, 1975).

Land

Northern High Plains

The Northern High Plains consist of approximately 5.4 million acres of land. About 3 percent of the land is under federal ownership, 18 percent under state ownership, and 79 percent is privately owned. Approximately 90 percent of the land in Lea County is rangeland used for grazing and 8 percent is cropland (1.5 percent is irrigated and 6.5 percent dryland). Urban and urban fringe areas comprise slightly less than 1 percent and road systems also account for slightly less than 1 percent of the county land. The remainder of the land includes 5,230 acres of inland water, parks, and fish and wildlife preserves (NMISC, 1975).

Southern High Plains

The Southern High Plains consist of approximately 6.9 million acres of land. About 1.5 percent of the land is under federal ownership, 19.5 percent under state ownership, and 79 percent is privately owned. Approximately 76 percent of the land in Lea County is rangeland used for grazing and 21 percent is cropland (6 percent is irrigated and 15 percent dryland). Urban and urban fringe areas comprise about 1 percent and road systems also account for 1 percent of the county land. The remainder (1 percent) of the land includes inland water, military reservations, parks, and fish and wildlife preserves (NMISC, 1975).

Hydrology

Northern High Plains

Three main aquifers supply water to the high-yield wells that furnish water for irrigation in the Northern High Plains; namely, the Ogallala aquifer of Tertiary age, the Dakota-Purgatory aquifer of Cretaceous age, and the Morrison-Exeter aquifer of Jurassic age. The aquifers are in hydraulic continuity and, therefore, form an aquifer system.

Formations other than the Ogallala that yield large amounts of water to wells are alluvial deposits of Quaternary age, the Entrada Sandstone of Jurassic age, and the Santa Rosa Sandstone of Triassic age. The alluvium yields up to 325 gallons per minute, and the Santa Rosa Sandstone yields from 300 up to 500 gallons per minute.

Outside the boundaries of the Ogallala in the Northern High Plains, the formations consist of rocks of Cretaceous and Jurassic age. Yields from these formations are low and are used primarily to furnish water for rural domestic and livestock requirements.

As of January 1976, the depth-to-water in the Ogallala-Morrison-Exeter system ranged from 30 to more than 300 feet, with an average of 200 feet from the land surface. The saturated thickness of the ground water area ranged from 25 to 150 feet, with an average of approximately 50 feet. A typical irrigation well in this region will yield up to 900 gallons per minute with a specific yield of 40 gallons per minute per foot of drawdown. The pumping head is comprised of the depth-to-water from the land surface, plus the drawdown, plus any head that is to be delivered to the irrigation system, such as a sprinkler. Presently, the pumping head for a typical gravity flow system is approximately 215 feet in this area.

As of January 1975, the depth-to-water in Quay County ranged from 25 to more than 300 feet, with an average of from 70 to 100 feet from the land surface. The saturated thickness of the Ogallala ranged from 35 to 100 feet, with an average of approximately 50 feet. Irrigation wells will yield from 50 up to 700 gallons per minute although irrigation wells yielding 1,600 gallons per minute occur in the area. A specific well yield of about 40 gallons per minute per foot of drawdown and pumping lift of 80 feet are common.

Water level measurements have been maintained in this area by the U.S. Geological Survey since 1941 and 1966 and reported by the State Engineer in the report series, "Water Levels in New Mexico." The general rate of decline is approximately 0.3 foot per year.

The principal source of recharge to the Ogallala Formation is precipitation and infiltration into the aquifer. There is some discharge of ground water by natural means, such as through springs and seeps along the escarpments and by evaporation and transpiration; however, these are probably quite small in relation to the amount of water removed from the aquifer by pumping.

The amount and rate of recharge from precipitation depends on the amount, distribution, and intensity of the precipitation; the amount of moisture in the soil when rain or snowmelt begins; and the temperature, vegetative cover, and permeability of the materials at the site of infiltration. Because of wide variations in these factors and the lack of data, it is difficult to estimate the amount of recharge to the ground water reservoir. An unknown amount of water pumped from the Ogallala Formation for irrigation percolates back to the aquifer. This water does not constitute an addition to the supply water, but only a reduction in net discharge.

Southern High Plains

The Ogallala Formation is the principal source of ground water in the Southern High Plains. The extent of the Ogallala Formation in the Southern High Plains is outlined in Figure 1. The Ogallala is of Tertiary age and overlies older rocks of Cretaceous, Jurassic, Triassic, and Permian ages. The group of older formations yields comparatively small quantities of usable fresh water, but in places contains considerable saline water in storage (Ash, 1961).

The Ogallala is not present in the southern part of Lea County (Figure 1). In this area, ground water is obtained from the older formations noted above. Yields from these formations are not sufficient for irrigation use and barely provide enough for rural domestic and livestock requirements.

As of January 1976, the depth-to-water in the Southern High Plains ranged from 30 feet in Lea County to more than 400 feet in Curry County. The saturated thickness of the Ogallala ranged from 25 to 200 feet, averaging approximately 125 feet. A typical irrigation well in this region will yield up to 1,000 gallons per minute with specific well yields of 25 to 60 gallons per minute per foot of drawdown. The pumping head is comprised of the depth-to-water from the land surface, plus the drawdown, plus any head that is to be delivered to the irrigation system, such as a sprinkler. The pumping head for a typical gravity flow system is now about 80 feet (Akin and Jones, 1979).

Water level measurements have been maintained in this area by the U.S. Geological Survey since 1950 and reported by the State Engineer in the report series, "Water Levels in New Mexico."

The principal source of recharge to the Ogallala Formation is precipitation infiltrated into the aquifer. There is some discharge of ground water by natural means, such as through springs and seeps along the escarpments and by evaporation and transpiration. However, these are probably quite small in relation to the amount of water removed from the aquifer by pumping. An unknown amount of water pumped from the Ogallala Formation for irrigation percolates back into the aquifer. This water does not constitute an addition to the water supply, but only a reduction in net discharge. Havens (1966, p. F1) reports that the annual recharge on 1,400,000 acres in Lea County, New Mexico, during the period 1949-1960 was about 95,000 acre-feet, or about 0.8 inch.

Water Quality

Northern High Plains

The water is predominantly of the calcium magnesium bicarbonate type and ranges from moderately hard to hard. The water quality is generally satisfactory for livestock, domestic, and irrigation use.

One analysis of water from a well two miles north of Clayton shows an unusually high concentration of sulfate. The sulfate probably has its source in the Granero shale which is thought to be faulted downward into contact with the Dakota-Purgatory aquifer in this area.

Southern High Plains

The water is typically hard and has an objectionably high concentration of fluoride in many areas. The hardness, in addition to a high concentration of silica, makes it somewhat objectionable for domestic and many industrial uses. Except possibly in the vicinity of the playa lakes and in local areas where the ground water may have been contaminated by seepage from brine disposal pits (Ash, 1961, 1963, sheet 2), the water is satisfactory for irrigation. Only the excessive fluoride content makes it objectionable for public supply.

Water Use

Northern High Plains

Ground water from the Ogallala Formation in the region is used for irrigation, public supply, power generation, and domestic and livestock purposes. Surface water is used primarily for irrigation and livestock purposes.

Southern High Plains

Ground water from the Ogallala Formation in the region is used for irrigation, public supply, industrial supply, and domestic and stock purposes.

Water Rights Administration

Northern High Plains

New appropriations of surface water in the drainages of the Purgatory River, Dry Cimarron River, Carrizo Creek, Canadian River, and the Carrizo Creek drainage basins may be permitted only if the State Engineer determines, after consideration of the information available to him and additional evidence submitted in support of an application, that there is unappropriated water that could be appropriated without detrimental effect to existing rights. Conservation storage within the Canadian River, Carrizo Creek, and Canadian River drainages below Conchas Dam has been fully allocated. Changes in points of diversion, places, and purposes of use may be made, provided no detrimental effects to existing rights will result. Changes of existing rights or new appropriations of surface water require a permit from the State Engineer.

The west-central side of the region is within the Canadian River Underground Water Basin as declared by the State Engineer (see Figure 2). Permits from the State Engineer are necessary prior to drilling wells within the boundaries of the declared basin. No permit is required to drill in the portion of the region outside the declared basin.

Southern High Plains

Most of Lea County is within the boundaries of the Lea County, Jal, and Capitan underground water basins as declared by the State Engineer. Part of the northern portion of Roosevelt County, southwestern Curry County, and southwestern Quay County is within the Portales and Fort

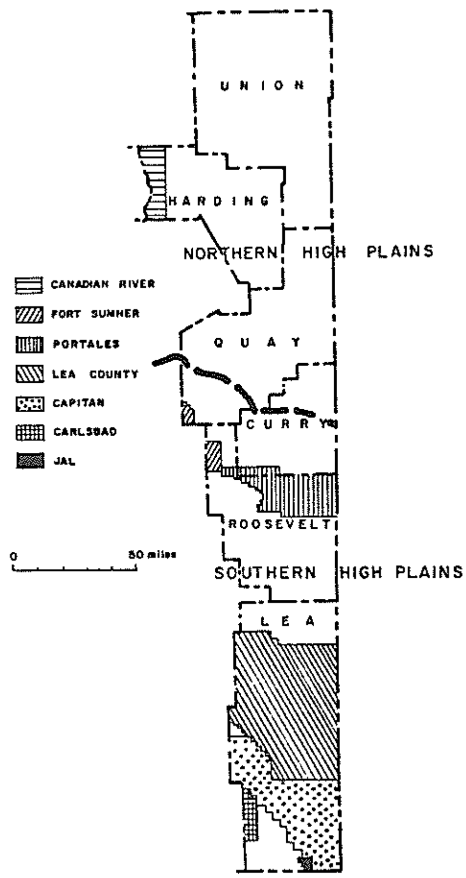

Figure 2. Declared Underground Water Basins, High Plains, New Mexico.

Sumner underground water basin as declared by the State Engineer. Permits from the State Engineer are necessary prior to drilling wells within the declared basin boundaries. No permit is required to drill wells in those portions of the county outside the declared basins (see Figure 2).

Energy

Energy production in the High Plains region of New Mexico is located in the Southern High Plains in Lea and Roosevelt counties. Lea County accounts for about 90 to 95 percent of all energy produced in New Mexico's High Plains region.

Electricity

Most of the High Plains region's electricity generation is also located in Lea County with the Maddox (New Mexico Electric Service Co.), the Cunningham (Southwestern Public Service), and the Lovington (Lea County Electric Cooperative) generating plants. The two other generating facilities in the region are Southwestern Public Service's Tucumcari station (formerly owned by the city) in Quay County and the City of Clayton's (Union County). In 1979, total generating capacity in the region was 545.8 MW, of which 522.2 MW, or 95.7 percent, originated from Lea County (Miller and Hill, 1981). The primary fuel for all generating units was natural gas. With the exception of the Tucumcari station, which was acquired by the city in 1939, all units were built in the 1950s and 1960s and have an average projected life of 35 years.

New combustion turbine capacity will be for peakload generation with an annual output of 1,500 full load hours; new combined cycle capacity will be for intermediate operation with an annual output of 3,500 full load hours (Miller and Hill, 1981).

Table 1 presents historical generating capacity and electricity sales for the High Plains region.

Oil Production

The Permian Basin of southeastern New Mexico and western Texas has long been one of the major oil-producing provinces in the nation. There are four oil and gas producing counties (Chaves, Eddy, Lea, and Roosevelt) in southeastern New Mexico. Two of the four, Lea and Roosevelt counties, are in the High Plains study area. Since the Permian Basin has been producing oil and gas since the 1920s, the future discovery rate in both Lea and Roosevelt counties is expected to be more modest than in the past. However, the degree to which crude oil and casinghead gas production continues to decline also depends upon a number of exogenous factors ranging from technological to economic aspects of production. The uncertainty of such factors causes production projections beyond 10 years to be highly speculative.

Table 1. Annual Historical Electric Energy Production, Electricity Sales, Crude Oil, Casinghead Gas, and Dry Gas Production in the High Plains, New Mexico, 1969-1980.

Year	Electricity Generation (kilowatt-hours)	Electricity Sales (millions of kWh)	Crude Oil (millions of barrels)	Casinghead Gas (billions of cubic feet)	Dry Gas (billions of cubic feet)
1969	454.2	892.32	93.85	253.94	171.08
1970	454.2	957.57	95.79	265.41	179.67
1971	454.2	983.09	86.71	264.28	177.71
1972	454.2	1,035.04	79.19	233.12	197.33
1973	454.2	1,084.53	72.39	225.03	202.83
1974	454.2	1,144.26	66.49	263.20	179.57
1975	534.7	1,213.98	62.64	259.16	161.57
1976	534.7	1,386.69	59.52	249.87	169.02
1977	542.0	1,511.73	55.32	234.13	172.85
1978*	534.1	1,422.93	52.45	219.49	155.38
1979	541.0	1,500.15*	49.31*	202.65*	149.29*
1980			46.17*	185.80*	143.20*

* Value was estimated or includes estimated value.

(Source: Miller and Hill, 1981.)

Lea County is the most prolific oil-producing county in the state. It accounted for 65.8 percent of the state's crude oil and condensate production in 1980, and produced 97 percent of the oil and condensate in the New Mexico High Plains study area. The historical crude oil production and casinghead gas is shown in Table 1.

Dry Gas Production

Historically, Lea and Roosevelt counties have long been primarily oil-producing provinces, and only in recent years has a major effort been made to explore for dry gas. The main area of exploration has been in the south of Lea County, much of which is located in the Delaware Basin. The Atoka and Morrow formations are the main producing horizons and as a general rule produce a rather high daily rate of gas. However, wells producing from these formations normally have relatively short production periods (7 years average) compared with an average life of 35 years in northwestern New Mexico's San Juan Basin.

During the 1970s, dry gas production in Lea and Roosevelt counties fluctuated yearly, making it difficult to detect any general trends (Table 1). For example, production levels in 1971, 1974, 1975, 1978, and 1979 were lower than the previous year's production level. In all other years, production had shown an increase. The completion of several additional wells could have the effect of increasing total production 10 percent or more. Due to the characteristics of this type of gas production, projections are extremely difficult to make. During the last 12 years, more than 99 percent of the dry gas production from the High Plains study area has come from Lea County with less than 1 percent being produced in Roosevelt County (Miller and Hill, 1979).

Other Mining

The development of carbon dioxide (CO_2) reserves in the Bravo Dome field would mean an economic boom for northeastern New Mexico. The renewed interest in the immense reserves, estimated at eight trillion cubic feet, stems from its potential use in the recovery of oil from reserves that no longer respond to direct pumping or flooding with water. Despite the size of the CO_2 reserves, there is not likely to be enough CO_2 to meet the potential market in the Permian/Delaware Basin. It appears that most of it would go to Texas where the oil fields have reached the Tertiary recovery stage and where Amoco's (the unit operator) oil fields are concentrated.

Agriculture

Northern High Plains

The Northern High Plains are potentially an important agricultural area in New Mexico. In 1977, it accounted for about 7 percent of the total irrigated acreage, about 2 percent of the total dryland crop acreage, and 10 percent of the cash receipts from crop sales. The important irrigated crops in the Northern High Plains were corn, grain sorghum, cotton, alfalfa, and small grains. According to 1977 published data, these five crops accounted for about 85 percent of the irrigated acreage and 7 percent of the total cash receipts from crops in the Northern High Plains (New Mexico Crop and Livestock Reporting Service, 1978). Grain sorghum and wheat were important dryland crops in 1977 (Lansford, 1979). These two crops accounted for about 80 percent of the dry cropland acreage and 13 percent of the total cash receipts from crops in 1977.

Southern High Plains

The Southern High Plains are an important agricultural area in New Mexico. In 1977, it accounted for about 33 percent of the total irrigated acreage, about 68 percent of the total dryland crop acreage, and 28 percent of the cash receipts from crop sales. The important irrigated crops were corn, grain sorghum, cotton, alfalfa, and small grains. According to 1977 published data, these five crops accounted for about 80 percent of the irrigated acreage and the total cash receipts from crops in the Southern High Plains (New Mexico Crop and Livestock Reporting Service, 1978). Grain sorghum, other sorghum, cotton, and wheat were important dryland crops in 1977 (Lansford, 1979). These four crops accounted for nearly all the dry cropland acreage and about 20 percent of the total cash receipts from crops in 1977.

METHODOLOGY

A regional economic model was utilized to evaluate the regional economic impacts resulting from the alternative management strategies (Figure 3). A regional input-output (I-O) table was developed for the High Plains region of New Mexico from a 1972 national I-O model (Young and Ritz, 1979). A second multiregional socioeconomic model developed by Brown and others (1980) generally referred to as the Southwest Water, Energy, Environment, and Population (SWEEP) model was used to project the regional total output, employment, and population for the baseline and alternative management strategies. The agricultural model was an

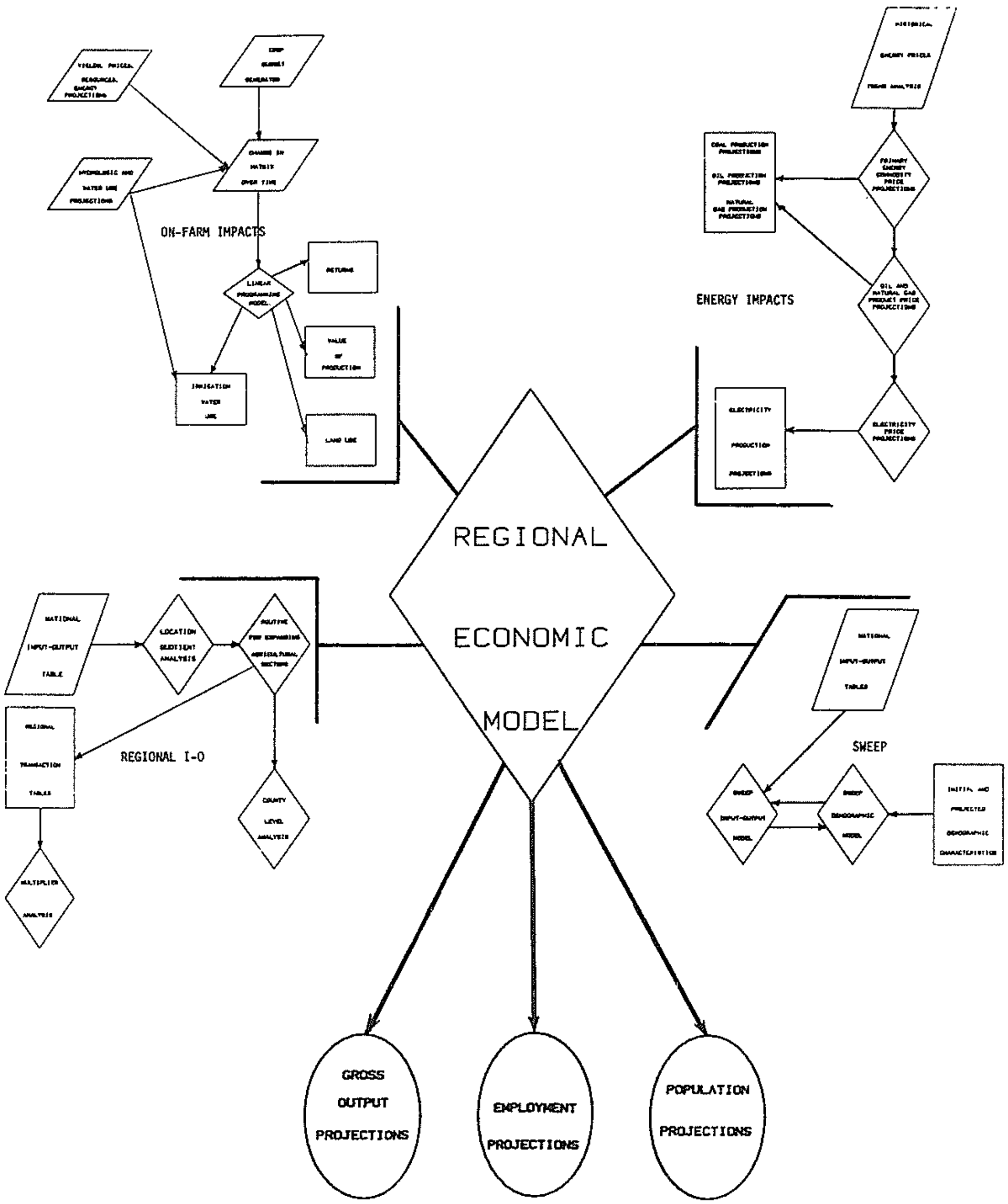

Figure 3. Regional Economic Model, New Mexico High Plains.

aggregate linear programming (LP) model. The LP model was structured in a diagonal cell framework which enabled local conditions and resource requirements (cropping patterns, irrigation technology, etc.) to be met while the model maximized the regional returns to land and management. Energy production projections were constructed for oil, natural gas, and electricity. The methodology for energy production projections was developed by Black and Veatch (1980).

The following is a detailed discussion of the various regional model components.

On-Farm Impacts

For the New Mexico agricultural model, the general methodology was to develop an aggregate linear programming (LP) model for those New Mexico counties that overlie the Ogallala Formation in the High Plains. The model was developed for the base year, 1977, and included alternative agricultural activities and production methods under various hydrological conditions (Figure 4). All six states involved in the study developed model procedures that were generally consistent. However, some aspects of each state's involvement required specific model functions or adjustments. In New Mexico, a great deal of emphasis was placed on achievement of adequate detail and flexibility in farm enterprise budgeting and irrigation cost estimation. Hence, separate and relatively complex computer programs to address these issues were adapted to the study and integrated into the overall LP model. A simplified flowchart (Figure 4) shows in general how the model is organized.

The LP model was designed to maximize returns to land and management from crop and livestock enterprises. The LP model was structured in a diagonal cell framework which enabled local conditions and resource requirements (cropping patterns, irrigation technology, etc.) to be met while the model maximized the regional returns. It included costs and returns budgets (crop yield and price projections, crop input and energy cost projections), a pumping cost model, and hydrologic data. Separate crop costs and returns budgets were compiled for each hydrologic subregion. The pumping cost model and hydrologic information were also

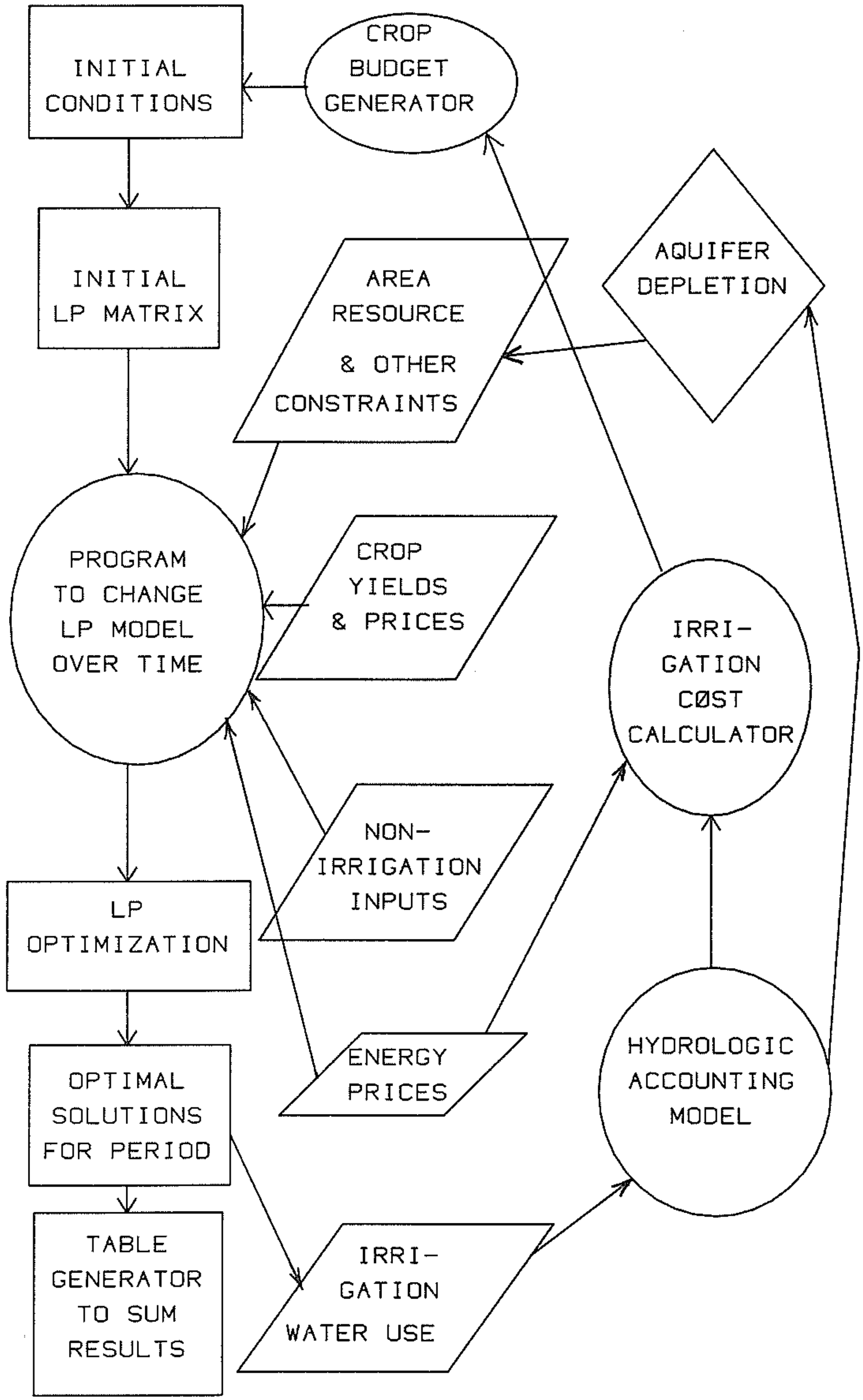

Figure 4. Schematic Conceptualization of Agriculture Sector LP Model, New Mexico High Plains Study.

designed to incorporate local conditions and resource utilization. Each crop and livestock activity contributes the net returns according to its level of profitability, while increasing energy and production costs and declining water table levels impose additional costs. In addition to the changing costs, the profitability of the crop and livestock activities change over time as crop yields and prices are expected to change.

The LP model was designed to simulate the following years: 1977, 1985, 1990, 2000, and 2020.

Budgets

Crop and range livestock enterprise cost and return budgets were developed for each county for 1977 conditions.

The budgets were based on "typical" farms and ranches with "average" management computed for the 15 areas in the two subregions. In the budgets, the trend to larger cropping machinery size was assumed to continue. It also was assumed that state or federal programs, such as those implemented during times of large surpluses, would not have an impact on production practices. Base per-acre budgets were constructed with typical equipment components (both items and cost) for the farm size and type in each area.

Yields

The 1977 crop yields were based on average county yields adjusted by area and irrigation type. Crop yields are expected to increase over the study period. The rate of increase in yields was not assumed to be constant over time or the same for all crops (Table 2). Increased crop yields over time are assumed to result in part from increased use of fertilizers. Fertilizer use on irrigated corn for grain, grain sorghum, and wheat is assumed to increase by 20 percent by 2020; on irrigated cotton by 10 percent by 2020; and fertilizer use on alfalfa was assumed to be constant over the study period. Yields by irrigation type (furrow or sprinkler) within each subregion were estimated. Also, sprinkler yields are expected to be higher than furrow, except where there are shifts in the subregion's cropping pattern.

Table 2. Yield Projections for the Southern and Northern High Plains Regions, New Mexico, 1977-2020--Baseline.

Crop	Unit	Southern High Plains					Northern High Plains				
		1977	1985	1990	2000	2020	1977	1985	1990	2000	2020
Furrow Irrigated											
Alfalfa	ton/acre	4.8	5.7	5.8	6.4	7.9*	3.3	3.9	4.1	4.5	5.5
Corn for Grain	bu/acre	113.0	140.7	147.8	138.2	155*					
Corn Silage	ton/acre	15.0*	15.3*	15.4*	15.8*	16.4*					
Cotton	lb/acre	425	486	523*	593*	463*	375	429	462	523	567*
Grain Sorghum	cwt/acre	41.4	36.5	40.1	45.6*	51.0*	25	30.4*	33.4*	38.0*	42.5*
Pasture	$/acre						60	60	60	60	60
Peanuts	lb/acre	2500*	2581*	2765*	2876*	3644*					
Wheat	bu/acre	43.4	54.7	59.4	70.2*	81.0*	25	30*	32*	44*	51*
Sprinkler Irrigated											
Alfalfa	bu/acre	5.2	6.1	6.3	7.0	8.6	4.2	5.0	5.2	5.6	7.0
Corn for Grain	bu/acre	120	143	154	176	176	110	136	146	160	179
Corn Silage	ton/acre	18.0*	18.4*	18.6*	18.9*	19.7*					
Cotton	lb/acre	424	486	523	593	642	400*	452*	492*	558*	605
Grain Sorghum	cwt/acre	46.3	57.6	63.6	70.6	76.6	40.5	48.0	40.7	46.1	51.4
Pasture	$/acre	1130	2260	2260*	2260*	2260*	1130	1130	1130	1130	1130
Peanuts	lb/acre	2632	2721	2872	3255	3745*					
Wheat	bu/acre	52.5	59.2	80.8	98.8	134.0	50	56	71	84	97
Dry Cropped											
Alfalfa	ton/acre						2.0	2.4	2.4	2.7	3.3
Cotton	lb/acre	216	250	270	307	334					
Grain Sorghum	cwt/acre	13.0	15.8	17.4	19.8	22.1	12.6	15.5	16.9	19.6	21.5
Wheat	bu/acre	13	16	19	23	26	13	16	19	23	26
Steers	$/acre	16.28	16.28	16.28	16.28	16.28	16.28	16.28	16.28	16.28	16.28
Cows	$/acre	5.15	5.15	5.15	5.15	5.15	5.15	5.15	5.15	5.15	5.15

* Not expected to be grown but were estimated.

Output Prices

The commodity price projections in constant 1977 dollars for the study period (1977-2020) were provided by the U.S. Department of Agriculture National Inter-Regional Agricultural Projections System (NIRAP) model results of October 16, 1980. These commodity prices were projected based on domestic and world demand and supply. The range in commodity price increases for the baseline between 1977 and 2020 is expected to range from 10 percent for cotton to 56 percent for wheat (Table 3). Prices are expected to increase 49 percent for corn for grain, 44 percent for grain sorghum, and 28 percent for feeder steers and alfalfa over the 1977 to 2020 study period. The same price increases are expected for voluntary reductions, with only slight variations in mandatory reductions, and almost none for importation.

Costs

The costs of producing each crop were divided into three general categories: machinery fixed costs, irrigation fixed costs, and variable costs. Per-acre machinery fixed costs from the 1977 budgets were assumed to remain constant in real terms over the study period. Changes in equipment technology resulting in higher farm fixed costs were assumed to be offset by increased farm sizes. Irrigation fixed costs were sunk costs (zero) in 1977, with 5 percent of the irrigation equipment being replaced each year. Thus, after 20 years, all irrigation fixed costs will be accounted for in the LP model.

Variable costs are expected to change over time in real terms (Table 4). The rate of change for the price of inputs over time were provided by the general contractor. Costs that are expected to remain constant include hybrid seed, insecticide (except for cotton), repair, labor, 80 percent of custom costs (excluding fuel costs), interest, and insurance. Machinery fuel cost, 20 percent of custom fuel cost, and irrigation water fuel cost will be increased at rates provided by the general contractor for energy price increases (Black and Veatch, April 1980). Cotton insecticide costs are expected to decrease slightly up to 1985, then remain constant over the remainder of the study period. Her-

Table 3. Adjusted NIRAP* Commodity Price Projections in Constant 1977 Dollars by Alternative Management Strategy for New Mexico, 1977-2020.

	Unit	1977	1985	1990	2000	2020	1985	1990	2000	2020
		(dollars per unit)					(dollars per unit)			
		Baseline					Voluntary			
Alfalfa	ton	62.00	63.53	64.90	68.52	76.23	63.48	64.69	68.01	75.80
Grain-Corn	bushel	2.10	2.74	2.79	2.98	3.12	2.74	2.81	3.03	3.15
Corn Silage	ton	13.00	13.32	13.61	14.37	15.98	13.31	13.57	14.26	15.89
Cotton Lint	pound	0.58	0.59	0.61	0.62	0.64	0.58	0.61	0.64	0.65
Cotton Seed	pound	0.05	0.05	0.05	0.06	0.07	0.05	0.05	0.06	0.07
Grain Sorghum	cwt	3.35	4.23	4.30	4.61	4.82	4.25	4.35	4.70	4.88
Pasture	$(index)	1.00	1.21	1.24	1.28	1.28	1.21	1.24	1.28	1.28
Peanuts	pound	0.25	0.26	0.26	0.27	0.29	0.26	0.26	0.27	0.29
Wheat	bushel	2.20	3.06	3.08	3.15	3.43	3.06	3.08	3.14	3.41
Feeder Steers	$(index)	1.00	1.21	1.24	1.28	1.28	1.21	1.24	1.28	1.28
Acre of Grazing	$/acre	30.00	30.74	31.41	33.15	36.89	30.72	31.30	32.91	36.68
		Mandatory					Importation			
Alfalfa	ton	62.00	63.48	64.69	68.23	76.23	63.53	64.90	68.78	76.99
Grain-Corn	bushel	2.10	2.74	2.81	2.99	3.12	2.74	2.79	2.95	3.07
Corn Silage	ton	13.00	13.31	13.57	14.31	15.98	13.32	13.61	14.42	16.14
Cotton Lint	pound	0.58	0.58	0.61	0.63	0.64	0.59	0.61	0.61	0.61
Cotton Seed	pound	0.05	0.05	0.05	0.06	0.07	0.05	0.05	0.06	0.07
Grain Sorghum	cwt	3.35	4.25	4.35	4.64	4.83	4.23	4.30	4.55	4.75
Pasture	$(index)	1.00	1.21	1.24	1.28	1.28	1.21	1.24	1.28	1.28
Peanuts	pound	0.25	0.26	0.26	0.27	0.29	0.26	0.26	0.27	0.29
Wheat	bushel	2.20	3.06	3.08	3.13	3.43	3.06	3.08	3.14	3.43
Feeder Steers	$(index)	1.00	1.21	1.24	1.28	1.28	1.21	1.24	1.28	1.28
Acre of Grazing	$/acre	30.00	30.72	31.30	33.01	36.89	30.74	31.41	32.28	37.26

* National Inter-Regional Agricultural Projections System.

Table 4. Price of Inputs That Change in Real Terms Over Time and Energy Price Assumptions, 1977-2020.

Item	1977	1985	1990	2000	2010	2020
	(index 1977 = 1.00)					
Machinery Fuel	1.00	2.05	2.07	2.14	2.21	2.26
Custom Operation	1.00	1.21	1.21	1.23	1.24	1.25
Cotton Insecticide	1.00	0.63	0.63	0.63	0.63	0.63
Herbicide	1.00	0.94	0.90	0.90	0.90	0.90
Cotton Seed	1.00	1.00	1.50	2.00	2.00	2.00
Wheat Seed	1.00	1.36	1.37	1.40	1.46	1.52
Alfalfa Seed	1.00	1.02	1.05	1.11	1.17	1.23
Peanut Seed	1.00	1.04	1.04	1.12	1.16	1.20
Nitrogen	1.00	1.98	2.77	2.85	2.95	3.04
Phosphorus	1.00	1.34	1.62	1.65	1.68	1.71
Irrigation Fixed Capital	0.00	0.40	0.65	1.00	1.00	1.00
Stocker Cattle	1.00	1.21	1.24	1.28	1.28	1.28
Hay	1.00	1.02	1.05	1.11	1.20	1.23
Grain	1.00	1.26	1.28	1.38	1.41	1.44
Protein	1.00	1.00	1.00	1.20	1.20	1.40
Energy:						
Machinery Gas ($/mcf)	1.32	3.31	4.89	5.06	5.26	5.45
Electric ($/kWh)	0.04	0.05	0.05	0.07	0.07	0.08
Diesel ($/gal)	0.43	0.88	0.89	0.92	0.95	0.97
LPG ($/gal)	0.32	0.53	0.61	0.63	0.65	0.67

bicide costs are expected to decrease by 10 percent up to 1990, then remain constant to 2020. The cotton seed price is expected to double from 1985 to 1995 because of hybridization. The price of wheat, alfalfa, and peanut seed is expected to change in relation to the price received for the crop output. Nitrogen and phosphorus fertilizer prices are expected to change with energy prices.

The method-determining prices ranchers paid for stocker cattle were provided by the general contractor and were tied to the prices paid for beef carcasses from NIRAP. The prices ranchers paid for hay, grain, and protein were adjusted by the prices farmers received for these commodities.

Returns

Returns were defined as the returns to land, management, and risk for areas using local water. They were based on gross returns from the sale of the crop less total operating expenses, which yield net operating profit. From net operating profit, an interest charge for the use of operating capital and machinery investment was subtracted to obtain net return to land, management, and risk. An interest charge for land investment and a fee for management was not included in the budgets. For areas where supply augmentation (imported surface water) is used in the importation strategy, the returns were defined as returns to land, management, water, and risk. In accordance with general contractor specifications, imported water was assumed to have a zero purchase cost, but pressurization costs for sprinkler systems were assessed.

Sensitivity Analysis

The sensitivity analysis of the on-farm impacts was performed by increasing and decreasing the following key elements:

(1) Crop prices gradually over time to a charge of from 4 to 7 percent (depending on crop) in 2020.

(2) Crop yields gradually over time to a charge of 20 percent in 2020.

(3) Energy costs for machinery and for pumping irrigation water are the high and low projection from Black and Veatch (April 1980).

Hydrologic and Irrigation Systems

The initial hydrologic data for 1977 were provided by the office of the State Engineer unless otherwise noted. The basic hydrologic data for the Northern and Southern High Plains are presented in Appendix Tables B-1 and B-2.

The initial hydrologic data changed over time as the water pumpage from each time period changed the depth-to-water and saturated thickness. Average pumping plant efficiencies were permitted to increase by one-half the difference between present efficiencies and "good" efficiencies each time period. The pressure of the sprinkler system was permitted to decrease from 65 psi in 1977 to 35 psi in 2000, and to 25 psi in 2020 to allow for the assumption of the adaptation of low pressure sprinkler technology. Also, as a result of the adaptation of low pressure sprinklers, the field efficiency of sprinklers was increased from 75 percent in 1977 to an expected 85 percent in 2020. Thus, in each hydrologic subregion, the depth-to-water, fuel prices, pumping plant efficiencies, and pressurization requirements changed in each time period. These data for each time period were provided to a fuel pumping cost model which calculates for each area the full cost of pumping irrigation water.

The maximum irrigated acreage was allowed to increase by 5 percent from 1985 through 2000.

Water Resources

Except for irrigation, baseline projections were obtained from tables published in county profiles in 1975 (see selected references). The profiles contain estimates of future water requirements for high, medium, and low levels of population projections. The low level projections (BEA-BBR) were used in this study because the growth rate for 1975, 1977, and the preliminary 1980 census data approximate this level of growth. Irrigation withdrawals for the three projections--baseline, voluntary, and mandatory--were estimated by the On-Farm Impact Research Group and the quantities of irrigation water were obtained from that research group.

Energy

Three projections were constructed: a high, a low, and a most likely. Additional details on energy impacts are presented in Appendix A. Appendix A also contains a sensitivity analysis on the three levels of production--high, expected, and low.

Electricity

Projections of electricity sales were based on the Southwestern Public Service Company's (SPS) projected peak loads for 1980 through 2020 for five of the six counties in the High Plains region. Their approach considered the price of electricity, conservation, and population growth by sales category.

Projections of installed electric generating capacity were developed by Black and Veatch based on utility plans for the units currently installed in the High Plains counties of New Mexico and possible new capacity additions in the counties. Additional generation capacity was not county-specific in the projections.

Oil and Natural Gas

The approach used to project oil and casinghead gas production to the year 2020 entailed the construction of sets of curves which show different rates of decline. Factors considered in constructing the curves included the history of past additions to reserves from new discoveries, assessments of future discovery possibilities, an assessment of production which might be expected from enhanced recovery, and decline rates in presently producing reservoirs. Selected economic factors affecting the oil and gas industry also were considered.

High projections show a 5 percent annual decline through 2020 in the production of both crude oil and casinghead gas for Roosevelt and Lea counties. This projection was based upon the assumption that drilling and completion of additional wells will continue at a fairly active rate in the future, and that more enhanced recovery projects will be started and will respond favorably.

Low projection (a 10 percent annual rate of decline for crude oil and casinghead gas production) is based on the assumption that drilling and completion of additional wells will occur at a very slow rate in the future, and a few new enhanced recovery projects will begin.

The annual rate of decline, under the most likely projection, differs slightly for crude oil and casinghead gas. Crude oil production is estimated to decline 7 percent annually through 2020, while casinghead gas production is estimated to decline 8 percent from 1980 through 1984, 9 percent from 1985 through 1989, and 10 percent from 1990 through 2020. These projections assume that drilling and completions will continue in the future, but at a lesser rate than what is assumed in the high projection, and secondly, that there will be a moderate increase in enhanced recovery production. The enhanced recovery helps explain the slightly higher decline rate of casinghead gas production because water flooding of an oil pool, which is one method of enhanced recovery, accelerates the depletion of casinghead gas over time.

Dry Gas

The approach used in estimating production entails the construction of curves showing different rates of decline. Factors considered in constructing the curves--past additions, future discovery possibilities, and decline rates--are largely the same as those considered in crude oil and casinghead gas projections.

The high projection of dry gas production assumes that some significant discoveries are made, possibly in deeper horizons than the Pennsylvanian Formation, and secondly, increased economic incentives in the 1980s will induce the development of marginal zones discovered previously. Under these assumptions, annual dry gas production is expected to decline 3 to 4 percent through 1985, 5 percent through 1990, and gradually reach a 10 percent rate of decline by 2011.

In contrast to the high projection, the low projection assumes that there will be substantially slower drilling and completion activity in the future, and that few new discoveries will be made.

For the most likely projection, it is assumed that there will be a slight decrease in the current drilling and completion activity; however, economic incentives will be greater (e.g., lifting of gas price controls), thereby inducing the development of marginal zones that were not economical in the past.

Regional Economic Impacts

An input-output (I-O) model was utilized to evaluate the regional economic impacts resulting from the five alternative management strategies. A regional input-output table was developed for the High Plains region from a 1972 national I-O model developed by Young and Ritz (1979). The national model had 496 producing sectors that were aggregated to 55 producing sectors.

The location quotient technique was used to regionalize the aggregated national table to represent the High Plains region of New Mexico. Information on the production functions for the agricultural crops developed from the on-farm impacts research for the baseline was utilized to disaggregate the original 14 agricultural sectors into 21 sectors (listed on following page). The 55-sector national model included six sectors that were not present in the High Plains regional economy (tobacco, farm machinery manufacturing, electrical machinery manufacturing, rubber and plastic products, miscellaneous plastic products, and glass products).

A second multiregional socioeconomic model developed by Brown, et al. (1980), generally referred to as the Southwest Water, Energy, Environment, and Population (SWEEP) model, was utilized to project the regional gross total output, employment, and population for the alternatives. These projections were based on the output levels for the agricultural sectors estimated by the on-farm impacts research and the oil and gas (mining) sectors by the energy impacts research. With the projections of gross total output from SWEEP and the expanded regional direct requirements coefficients from the national I-O, a High Plains regional interindustry transactions table was developed for each study year. Income, employment, and output multipliers were then developed for each of the project years for the alternatives.

Regional projections of gross total output, employment, and population for the High Plains region were distributed to the individual counties on the basis of the county-level, on-farm impacts research and the distribution of gross receipts. For the agriculture sectors, the on-farm impacts research provided the value of agricultural production for each county for each of the management strategies. For the remain-

Dairy Products	Dairy Products
Poultry Products	Poultry Products
Meat Animals	Range Livestock Feedlot Cattle
Miscellaneous Livestock	Miscellaneous Livestock
Cotton and Cotton Seed	Cotton and Cotton Seed - Irrigated Cotton and Cotton Seed - Dryland
Food and Feed Grains	Corn - Irrigated Wheat - Irrigated Wheat - Dryland Grain Sorghum - Irrigated Grain Sorghum - Dryland
Other Field	Hays - Irrigated Hays - Dryland Other Field
Tobacco	(Not in Regional Model)
Fruits and Tree Nuts	Fruits and Tree Nuts
Vegetables	Vegetables
Sugar and Miscellaneous Crops	Sugar and Miscellaneous Crops
Oil Bearing Crops	Oil Bearing Crops
Greenhouse and Nursery Products	Greenhouse and Nursery Products
Forestry and Fishery Products	Forestry and Fishery Products

ing sectors, the regional output was distributed to the counties based on the 1980 gross receipts distribution. The gross receipts for each county for 1980 were provided by the New Mexico Taxation and Revenue Department. This assumed that the economic activity of the counties in the High Plains region would have the same shares in the project years as they had in 1980. The employment was distributed to the counties in the region based on the ratio of the sectors output per employee. This assumed that sector productivity was the same in each of the counties. The population for the region was distributed based on the total employment in each county.

RESULTS

Results are presented for the economic impacts and key resources by management strategy--the baseline and three alternative strategies: voluntary water demand reduction, mandatory water supply reduction, and water supply augmentation for areas that physically exhaust their water supply.

Water Resources

In the Northern High Plains region, water from the Ogallala for irrigation purposes accounted for almost 99 percent of the water usage in 1977. This dominance is projected to continue, growing from 142.5 thousand acre-feet in 1977 to 191.6 thousand acre-feet in 2020. Water usage for other categories is of minor importance in the Northern High Plains. Water usage for categories other than irrigation is not expected to show any substantial increase through 2020.

Northern High Plains

As shown in Table 5, voluntary or mandatory measures are expected to have some impact upon reducing water usage in the Northern High Plains but are expected to have little positive impact on maintaining less depth-to-water or on the remaining saturated thickness in the aquifer.

Table 5. Estimated Withdrawals, Depth-to-Water, and Remaining Saturated Thickness of Ogallala Aquifer, Northern High Plains, New Mexico, 1977-2020.

Strategy and Category	Year 1977	1985	1990	2000	2020
Baseline					
Withdrawals (1,000 acre-ft.)					
Irrigation	(206.8)	(218.1)	(226.2)	(239.4)	(256.4)
Ogallala Aquifer	142.5	153.7	161.6	174.7	191.6
Non-Ogallala Aquifer	64.3	64.4	64.6	64.7	64.8
Urban	(2.5)	(2.8)	(3.1)	(3.4)	(4.2)
Ogallala Aquifer	0.7	0.8	0.9	1.0	1.3
Non-Ogallala Aquifer	1.8	2.0	2.2	2.4	2.9
Rural	(0.4)	(0.5)	(0.7)	(0.7)	(0.8)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.3
Non-Ogallala Aquifer	0.2	0.3	0.5	0.5	0.5
Manufacturing	(0.1)	(0.1)	(0.1)	(0.2)	(0.3)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.1
Non-Ogallala Aquifer	0.1	0.1	0.1	0.2	0.2
Mining	(0.1)	(1.6)	(3.0)	(4.0)	(8.2)
Ogallala Aquifer	0.0	0.3	0.3	0.3	0.5
Non-Ogallala Aquifer	0.1	1.3	2.7	3.7	7.7
Power	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.2
Non-Ogallala Aquifer	<0.1	<0.1	<0.1	<0.1	<0.1
Livestock*	(3.7)	(3.6)	(3.6)	(3.6)	(3.6)
Ogallala Aquifer	0.9	0.8	0.8	0.8	0.8
Non-Ogallala Aquifer	2.8	2.8	2.8	2.8	2.8
Recreation, Fish & Wildlife*	(15.5)	(15.5)	(15.5)	(2.5)	(2.5)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.0
Non-Ogallala Aquifer	15.5	15.5	15.5	2.5	2.5
Total Withdrawals	(229.3)	(242.4)	(252.4)	(254.0)	(276.2)
Ogallala Aquifer	144.5	156.0	164.0	177.2	194.8
Non-Ogallala Aquifer	84.8	86.4	88.4	76.8	81.4
Depth-to-water (ft.)					
Union	200.0	202.0	204.0	207.0	213.0
Harding	200.0	202.0	204.0	207.0	213.0
Remaining saturated thickness (ft.)**					
Union	50.0	48.0	46.0	43.0	37.0
Harding	50.0	48.0	46.0	43.0	37.0

* Includes surface water.

** Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Table 5 cont.

Strategy and Category	Year 1977	1985	1990	2000	2020
Voluntary Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	(206.8)	(215.8)	(218.9)	(224.7)	(232.0)
Ogallala Aquifer	142.5	151.6	154.7	160.7	167.7
Non-Ogallala Aquifer	64.3	64.2	64.2	64.0	64.3
Urban	(2.5)	(2.5)	(2.8)	(3.1)	(3.8)
Ogallala Aquifer	0.7	0.7	0.8	0.9	1.2
Non-Ogallala Aquifer	1.8	1.8	2.0	2.2	2.6
Rural	(0.4)	(0.5)	(0.7)	(0.7)	(0.8)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.3
Non-Ogallala Aquifer	0.2	0.3	0.5	0.5	0.5
Manufacturing	(0.1)	(0.1)	(0.1)	(0.2)	(0.3)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.1
Non-Ogallala Aquifer	0.1	0.1	0.1	0.2	0.2
Mining	(0.1)	(1.6)	(3.0)	(4.0)	(8.2)
Ogallala Aquifer	0.0	0.3	0.3	0.3	0.5
Non-Ogallala Aquifer	0.1	1.3	2.7	3.7	7.7
Power	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.2
Non-Ogallala Aquifer	<0.1	<0.1	<0.1	<0.1	<0.1
Livestock*	(3.7)	(3.6)	(3.6)	(3.6)	(3.6)
Ogallala Aquifer	0.9	0.8	0.8	0.8	0.8
Non-Ogallala Aquifer	2.8	2.8	2.8	2.8	2.8
Recreation, Fish & Wildlife*	(15.5)	(15.5)	(15.5)	(2.5)	(2.5)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.0
Non-Ogallala Aquifer	15.5	15.5	15.5	2.5	2.5
Total Withdrawals	(229.3)	(239.8)	(244.8)	(239.0)	(251.4)
Ogallala Aquifer	144.5	153.8	157.0	163.1	170.8
Non-Ogallala Aquifer	84.8	86.0	87.8	75.9	80.6
Depth-to-water (ft.)					
Union	200.0	202.0	204.0	207.0	213.0
Harding	200.0	202.0	204.0	207.0	213.0
Remaining saturated thickness (ft.)**					
Union	50.0	48.0	46.0	43.0	37.0
Harding	50.0	48.0	46.0	43.0	37.0

* Includes surface water.

** Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Table 5 cont.

Strategy and Category	1977	1985	Year 1990	2000	2020
Mandatory Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	(206.8)	(200.0)	(186.9)	(174.8)	(187.5)
Ogallala Aquifer	142.5	136.7	124.5	113.5	126.0
Non-Ogallala Aquifer	64.3	63.3	62.4	61.3	61.5
Urban	(2.5)	(2.1)	(2.3)	(2.6)	(3.2)
Ogallala Aquifer	0.7	0.6	0.7	0.8	1.0
Non-Ogallala Aquifer	1.8	1.5	1.6	1.8	2.2
Rural	(0.4)	(0.5)	(0.7)	(0.7)	(0.8)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.3
Non-Ogallala Aquifer	0.2	0.3	0.5	0.5	0.5
Manufacturing	(0.1)	(0.1)	(0.1)	(0.2)	(0.3)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.1
Non-Ogallala Aquifer	0.1	0.1	0.1	0.2	0.2
Mining	(0.1)	(1.6)	(3.0)	(4.0)	(8.2)
Ogallala Aquifer	0.0	0.3	0.3	0.3	0.5
Non-Ogallala Aquifer	0.1	1.3	2.7	3.7	7.7
Power	(0.2)	(0.2)	(0.2)	(0.2)	(0.2)
Ogallala Aquifer	0.2	0.2	0.2	0.2	0.2
Non-Ogallala Aquifer	<0.1	<0.1	<0.1	<0.1	<0.1
Livestock*	(3.7)	(3.6)	(3.6)	(3.6)	(3.6)
Ogallala Aquifer	0.9	0.8	0.8	0.8	0.8
Non-Ogallala Aquifer	2.8	2.8	2.8	2.8	2.8
Recreation, Fish & Wildlife*	(15.5)	(15.5)	(15.5)	(2.5)	(2.5)
Ogallala Aquifer	0.0	0.0	0.0	0.0	0.0
Non-Ogallala Aquifer	15.5	15.5	15.5	2.5	2.5
Total Withdrawals	(229.3)	(223.6)	(212.3)	(188.6)	(206.3)
Ogallala Aquifer	144.5	138.8	126.7	115.8	128.9
Non-Ogallala Aquifer	84.8	84.8	85.6	72.8	77.4
Depth-to-water (ft.)					
Union	200.0	202.0	204.0	206.0	210.1
Harding	200.0	202.0	204.0	206.0	210.0
Remaining saturated thickness (ft.)**					
Union	50.0	48.0	46.0	44.0	39.9
Harding	50.0	48.0	46.0	44.0	39.9

* Includes surface water.

** Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Southern High Plains

Projected water withdrawals for irrigation, urban, rural, manufacturing, mining, power, livestock, and recreational uses for the Northern High Plains and the Southern High Plains are presented in Tables 5 and 6, respectively. Tables 5 and 6 also show projections for depth-to-water (ground surface to water table) and the remaining saturated thickness of the Ogallala Formation for the years 1977, 1985, 1990, 2000, and 2020.

In the Southern High Plains, water used from the Ogallala for irrigation purposes accounted for almost 95 percent of the total water usage in 1977. Water for irrigation purposes is projected to maintain this dominant role, showing a decline in demand only as areas in the Southern High Plains go out of production. The only other categories projected to show substantial water demand increases are those for urban use and minerals extraction.

The voluntary projections for the urban category were estimated by reducing baseline projections by 10 percent. Mandatory projections were estimated by reducing the voluntary projections by an additional 15 percent (a total of 25 percent with respect to baseline quantities).

Most of the water used for minerals extraction is used for secondary oil recovery. This usage is expected to increase in the future. Projections were reviewed and concurred with by personnel from the New Mexico Energy and Minerals Department.

In the High Plains region of New Mexico, it is assumed that when the saturated thickness of the Ogallala aquifer in a given area becomes 25 feet or less, the water is no longer economically recoverable for irrigation purposes. However, even though the water in the lower 25 feet of the aquifer is no longer economically extractable for irrigation use, many widely spaced wells producing small amounts of water could continue to produce sufficient supplies for most urban and nonirrigation needs.

It can be seen from Table 6 that in the Southern High Plains, voluntary or mandatory measures are projected to have little effect upon reducing the demand for water for these purposes or upon expanding the life of the aquifer.

Table 6. Estimated Withdrawals, Depth-to-Water, and Remaining Saturated Thickness of Ogallala Aquifer, Southern High Plains, New Mexico, 1977-2020.

Strategy and Category	Year 1977	1985	1990	2000	2020
Baseline					
Withdrawals (1,000 acre-ft.)					
Irrigation	770.6	790.8	724.5	597.6	286.8
Urban	(20.0)	(23.0)	(28.1)	(43.4)	(61.1)
Ogallala Aquifer	18.5	21.2	25.9	40.7	56.8
Non-Ogallala Aquifer	1.5	1.8	2.2	2.7	4.3
Rural	(1.7)	(1.7)	(1.8)	(1.8)	(2.1)
Ogallala Aquifer	1.5	1.5	1.5	1.5	1.7
Non-Ogallala Aquifer	0.2	0.2	0.3	0.3	0.4
Manufacturing	(5.0)	(5.2)	(5.5)	(5.9)	(6.9)
Ogallala Aquifer	4.7	4.9	5.1	5.4	5.9
Non-Ogallala Aquifer	0.3	0.3	0.4	0.5	1.0
Mining	(18.6)	(22.2)	(30.2)	(41.6)	(57.5)
Ogallala Aquifer	3.4	4.7	9.2	15.6	22.9
Non-Ogallala Aquifer	15.2	17.5	21.0	26.0	34.6
Power*	13.9	14.0	14.0	14.6	14.6
Livestock**	(3.7)	(4.1)	(4.5)	(5.0)	(5.2)
Ogallala Aquifer	3.0	3.2	3.6	4.0	4.1
Non-Ogallala Aquifer	0.7	0.9	0.9	1.0	1.1
Military*	1.8	1.8	1.8	1.8	1.8
Recreation, Fish & Wildlife**	(0.2)	(0.3)	(0.6)	(36.3)	(36.7)
Ogallala Aquifer	0.1	0.2	0.5	36.2	36.5
Non-Ogallala Aquifer	0.1	0.1	0.1	0.1	0.2
Total Withdrawals	(835.5)	(863.1)	(811.0)	(748.0)	(472.7)
Ogallala Aquifer	817.5	842.3	786.1	717.4	431.1
Non-Ogallala Aquifer	18.0	20.8	24.9	30.6	41.6
Depth-to-water (ft.)*					
Lea	70.0	76.9	82.5	92.7	114.9
Roosevelt					
Causey-Lingo	70.0	77.1	80.3	88.1	>95.0
Portales-West	75.0	84.5	90.8	105.2	>125.0
Portales-East	50.0	71.0	85.0	113.0	>125.0
Blackwater-Draw	125.0	144.0	157.0	180.0	>224.0
Curry					
S.T./Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
S.T./50 to 100 ft.	350.0	375.4	391.4	>395.0	>395.0
S.T./More than 100 ft.	270.0	294.0	309.0	339.0	>370.0
Quay-South	100.0	108.2	112.3	118.5	>125.0
Remaining saturated thickness (ft.)*+					
Lea	135.0	128.1	122.5	112.3	90.1
Roosevelt					
Causey-Lingo	50.0	42.9	39.7	31.9	<25.0
Portales-West	75.0	65.5	59.2	44.8	<25.0
Portales-East	100.0	79.0	65.0	37.0	<25.0
Blackwater-Draw	125.0	106.0	93.0	70.0	<26.0
Curry					
S.T./Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
S.T./50 to 100 ft.	70.0	44.8	28.9	<25.0	<25.0
S.T./More than 100 ft.	125.0	101.0	86.0	58.0	<25.0
Quay-South	50.0	41.8	37.7	31.5	<25.0

* Ogallala Aquifer only.

** Includes surface water.

+ Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Table 6 cont.

Strategy and Category	Year 1977	1985	1990	2000	2020
Voluntary Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	770.6	768.1	678.7	527.7	319.6
Urban	(20.0)	(20.7)	(25.2)	(39.0)	(55.0)
Ogallala Aquifer	18.5	19.1	23.2	36.6	51.1
Non-Ogallala Aquifer	1.5	1.6	2.0	2.4	3.9
Rural	(1.7)	(1.6)	(1.7)	(1.7)	(2.1)
Ogallala Aquifer	1.5	1.4	1.4	1.4	1.7
Non-Ogallala Aquifer	0.2	0.2	0.3	0.3	0.4
Manufacturing	(5.0)	(5.2)	(5.5)	(5.8)	(6.9)
Ogallala Aquifer	4.7	4.9	5.1	5.4	5.9
Non-Ogallala Aquifer	0.3	0.3	0.4	0.4	1.0
Mining	(18.6)	(22.2)	(29.9)	(41.6)	(57.5)
Ogallala Aquifer	3.4	4.8	8.9	15.6	22.9
Non-Ogallala Aquifer	15.2	17.5	21.0	26.0	34.6
Power*	13.9	14.0	14.0	14.6	14.6
Livestock**	(3.7)	(4.1)	(4.6)	(5.0)	(5.2)
Ogallala Aquifer	3.0	3.2	3.7	4.0	4.1
Non-Ogallala Aquifer	0.7	0.9	0.9	1.0	1.1
Military*	1.8	1.8	1.8	1.8	1.8
Recreation, Fish & Wildlife**	(0.2)	(0.3)	(0.6)	(36.3)	(36.7)
Ogallala Aquifer	0.1	0.2	0.5	36.2	36.5
Non-Ogallala Aquifer	0.1	0.1	0.1	0.1	0.2
Total Withdrawals	(835.5)	(838.0)	(762.0)	(673.5)	(499.4)
Ogallala Aquifer	817.5	817.4	737.3	643.3	458.2
Non-Ogallala Aquifer	18.0	20.6	24.7	30.2	41.2
Depth-to-water (ft.)*					
Lea	70.0	76.9	81.5	91.8	111.3
Roosevelt					
Causey-Lingo	70.0	97.1	100.3	106.3	>115.0
Portales-West	75.0	84.5	89.8	103.1	>115.0
Portales-East	50.0	71.0	84.0	110.0	>115.0
Blackwater-Draw	125.0	144.0	156.0	175.0	210.0
Curry					
S.T./Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
S.T./50 to 100 ft.	350.0	375.2	391.9	>395.0	>395.0
S.T./More than 100 ft.	270.0	294.0	309.0	337.0	>370.0
Quay-South	100.0	107.2	110.3	117.5	>125.0
Remaining saturated thickness (ft.)*+					
Lea	135.0	128.1	123.5	113.2	93.7
Roosevelt					
Causey-Lingo	50.0	42.9	39.7	33.7	<25.0
Portales-West	75.0	65.5	60.2	46.9	<25.0
Portales-East	100.0	79.0	66.0	40.0	<25.0
Blackwater-Draw	125.0	106.0	94.0	75.0	40.0
Curry					
S.T./Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
S.T./50 to 100 ft.	70.0	44.8	28.9	<25.0	<25.0
S.T./More than 100 ft.	125.0	101.0	86.0	58.0	<25.0
Quay-South	50.0	42.8	39.7	32.5	<25.0

* Ogallala Aquifer only.

** Includes surface water.

\+ Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Table 6 cont.

Strategy and Category	1977	1985	Year 1990	2000	2020
Mandatory Strategy					
Withdrawals (1,000 acre-ft.)					
Irrigation	770.6	687.6	542.9	368.1	297.1
Urban	(20.0)	(17.3)	(21.0)	(32.6)	(45.9)
Ogallala Aquifer	18.5	15.9	19.4	30.6	42.7
Non-Ogallala Aquifer	1.5	1.4	1.6	2.0	3.2
Rural	(1.7)	(1.7)	(1.8)	(1.8)	(2.1)
Ogallala Aquifer	1.5	1.5	1.5	1.5	1.7
Non-Ogallala Aquifer	0.2	0.2	0.3	0.3	0.4
Manufacturing	(5.0)	(5.5)	(5.7)	(6.0)	(6.9)
Ogallala Aquifer	4.7	5.2	5.3	5.5	5.9
Non-Ogallala Aquifer	0.3	0.3	0.4	0.5	1.0
Mining	(18.6)	(22.4)	(29.5)	(39.8)	(54.2)
Ogallala Aquifer	3.4	4.9	8.5	13.8	19.6
Non-Ogallala Aquifer	15.2	17.5	21.0	26.0	34.6
Power*	13.9	14.0	14.0	14.6	14.6
Livestock**	(3.7)	(4.2)	(4.6)	(4.9)	(5.3)
Ogallala Aquifer	3.0	3.3	3.7	3.9	4.1
Non-Ogallala Aquifer	0.7	0.9	0.9	1.0	1.2
Military*	1.8	1.8	1.8	1.8	1.8
Recreation, Fish & Wildlife**	(0.2)	(0.3)	(0.6)	(36.3)	(36.7)
Ogallala Aquifer	0.1	0.2	0.5	36.2	36.5
Non-Ogallala Aquifer	0.1	0.1	0.1	0.1	0.2
Total Withdrawals	(835.5)	(754.8)	(621.9)	(505.9)	(464.6)
Ogallala Aquifer	817.5	734.4	597.6	476.0	424.0
Non-Ogallala Aquifer	18.0	20.4	24.3	29.9	40.6
Depth-to-water (ft.)*					
Lea	70.0	76.9	81.6	90.3	106.1
Roosevelt					
Causey-Lingo	70.0	77.1	80.3	85.6	>95.0
Portales-West	75.0	84.4	98.7	100.2	121.6
Portales-East	50.0	71.0	83.0	104.0	>125.0
Blackwater-Draw	125.0	144.0	155.0	170.0	195.0
Curry					
S.T./Less than 50 ft.	325.0	350.0	>350.0	>350.0	>350.0
S.T./50 to 100 ft.	350.0	375.2	389.1	>395.0	>395.0
S.T./More than 100 ft.	270.0	294.0	307.0	330.0	365.0
Quay-South	100.0	107.2	110.3	116.6	>125.0
Remaining saturated thickness (ft.)*†					
Lea	135.0	128.1	123.4	114.7	98.9
Roosevelt					
Causey-Lingo	50.0	42.9	39.7	34.4	<25.0
Portales-West	75.0	65.6	60.3	49.8	28.4
Portales-East	100.0	79.0	67.0	46.0	<25.0
Blackwater-Draw	125.0	106.0	95.0	80.0	55.0
Curry					
S.T./Less than 50 ft.	50.0	25.0	<25.0	<25.0	<25.0
S.T./50 to 100 ft.	70.0	44.8	30.9	<25.0	<25.0
S.T./More than 100 ft.	125.0	101.0	88.0	65.0	30.0
Quay-South	50.0	42.8	39.7	33.4	<25.0

* Ogallala Aquifer only.

** Includes surface water.

† Saturated thickness is defined as the thickness of a lens of saturated porous material existing below the water table, capable of yielding significant quantities of ground water to wells. The remaining saturated thickness reflects the impact of all ground water withdrawals on the quantity of water stored in the porous medium and, thus, the thickness of the lens.

Energy

Electrical Production

Table 7 presents the low, expected, and high band projections of electric generating capacity, production, and sales in the New Mexico High Plains region.

Under all scenarios, production within the study region is projected to diminish as existing units are retired or put on stand-by (Figure 5). The cost and availability of water and fuel (i.e., coal) were considered in the analysis.

Under the low projections, electricity sales in the study area are anticipated to increase from 1,768.87 million kWh in 1980 to 5,053.97 million kWh in 2020, or an overall 186 percent increase. The underlying assumption of this scenario is that regional electricity sales will continue to increase, but at a decreasing rate. For example, electricity sales increased 59 percent from 1969 through 1978 while sales are projected to increase only 57 percent for the 1980-1990 time frame. Higher electricity price is the primary factor expected to reduce the growth rate. Population, conservation, and previous consumption patterns were also considered to be contributing factors by SPS.

The most likely projection shows electricity sales to increase substantially in 1985 (Figure 6). During the 1980-1985 time frame, sales are expected to increase by 59 percent under this scenario compared with a 29 percent increase under the low projection. Carbon dioxide development in the Bravo Dome area (Union, Harding, and Quay counties) accounts for this larger increase. By the year 2020, electricity sales are projected to reach 5,597.09 million kWh, which is about 10 percent greater than the sales level under the low scenario.

Oil Production

The annual rate of decline, under the most likely projection, differs slightly for crude oil and casinghead gas (Figure 7). Crude oil production is estimated to decline 7 percent annually through 2020, while casinghead gas production is estimated to decline 8 percent from

Table 7. Projected Generating Capacity, Electricity Sales, and Electric Energy Production in the High Plains, New Mexico, 1980-2020.

Year	Generating Capacity Low	Generating Capacity Likely	Generating Capacity High	Electricity Sales Low	Electricity Sales Most Likely
	(MW)			(millions of kWh hours)	
1980	541	541	541	1,768.87	1,768.87
1985	522	522	522	2,277.82	2,820.93
1990	447	447	697	2,781.77	3,324.89
2000	-0-	250	500	3,745.66	4,288.78
2020	-0-	250	500	5,053.97	5,597.09

Year	Electric Energy Production Low	Electric Energy Production Expected	Electric Energy Production High
	(gigawatt hours)		
1980	2,885	2,885	2,885
1985	1,886	1,886	2,074
1990	887	887	1,262
2000	-0-	375	1,250
2020	-0-	375	1,250

1980 through 1984, 9 percent from 1985 through 1989, and 10 percent from 1990 through 2020 (Table 8). This set of projections assumes that drilling and completions will continue in the future but at a lesser rate than what is assumed in the high projection, and secondly, that there will be a moderate increase in enhanced recovery production. The latter assumption helps explain the slightly higher decline rate of casinghead gas production. That is waterflooding of an oil pool, which is one method of enhanced recovery, accelerates the depletion of casinghead gas over time.

Under the high projection assumptions, annual crude oil production in 1985 is estimated to be 37.28 million barrels and is expected to decline to 6.2 million barrels in 2020, or a decrease of 83 percent from the 1985 level of production. Casinghead gas production also drops off 83 percent during this time frame, from 153.3 billion cubic feet in 1985 to 25.5 billion cubic feet in 2020. Under the low projection, both

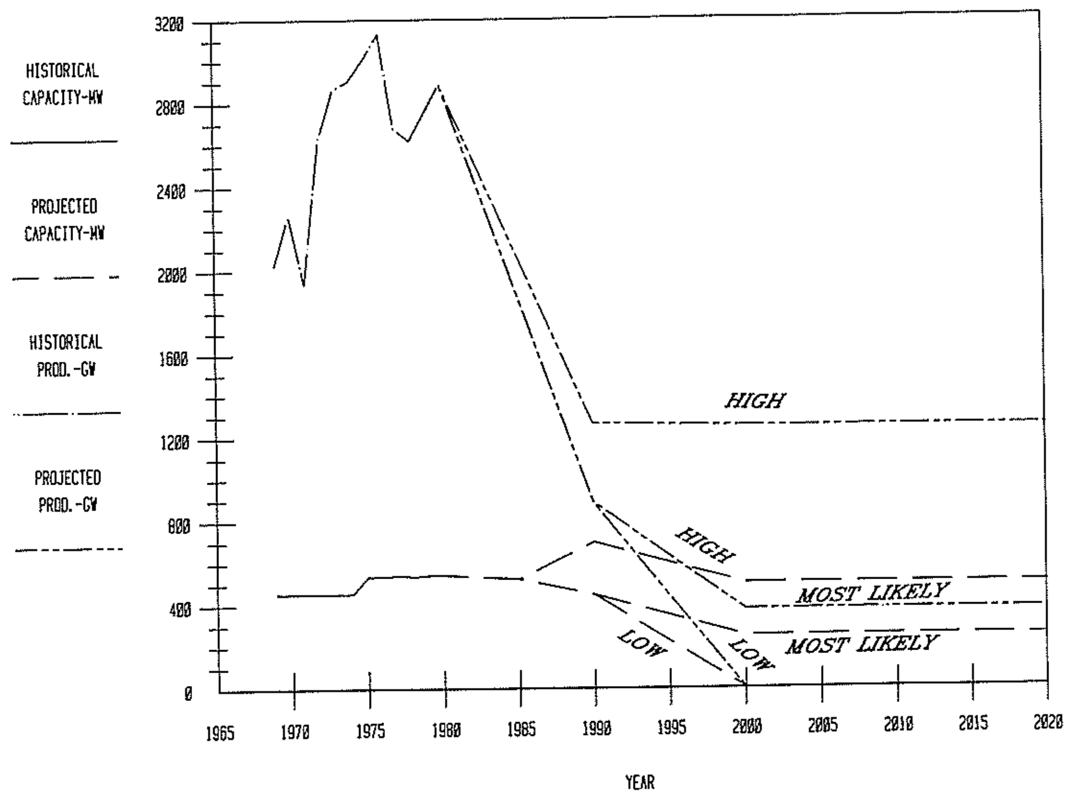

Figure 5. Electricity Generation and Production, Historical and Projected Levels.

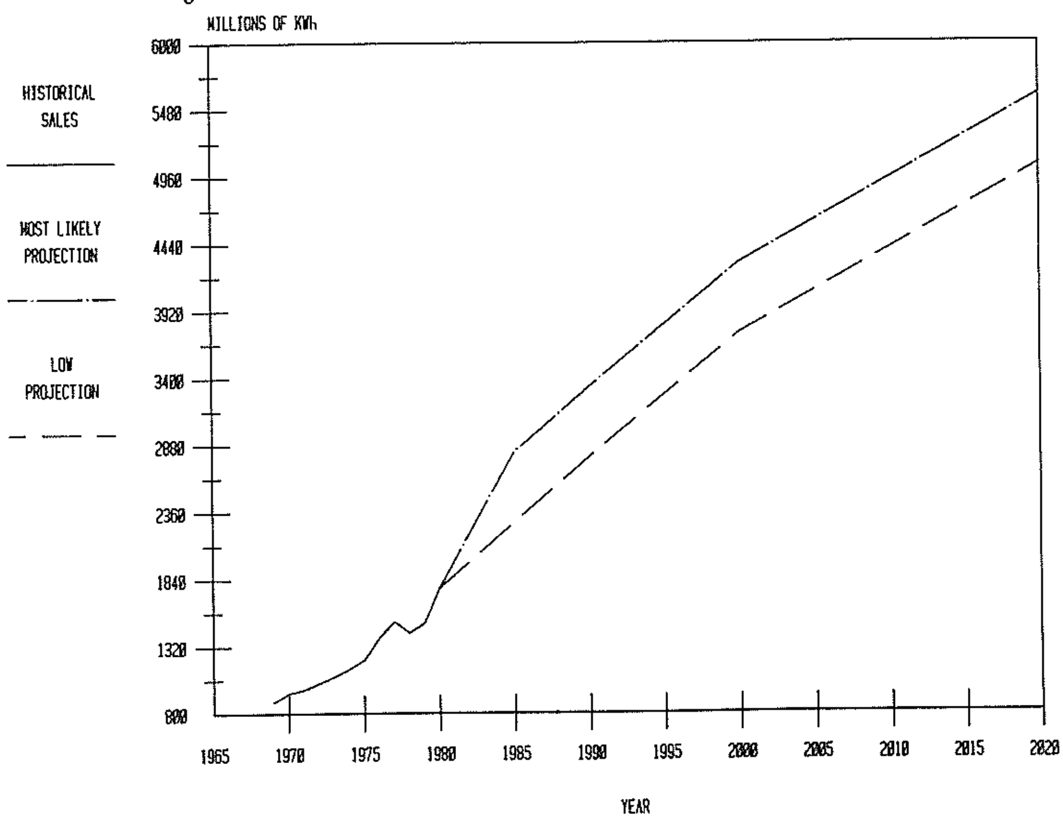

Figure 6. Electricity Sales, Historical and Most Likely Projection.

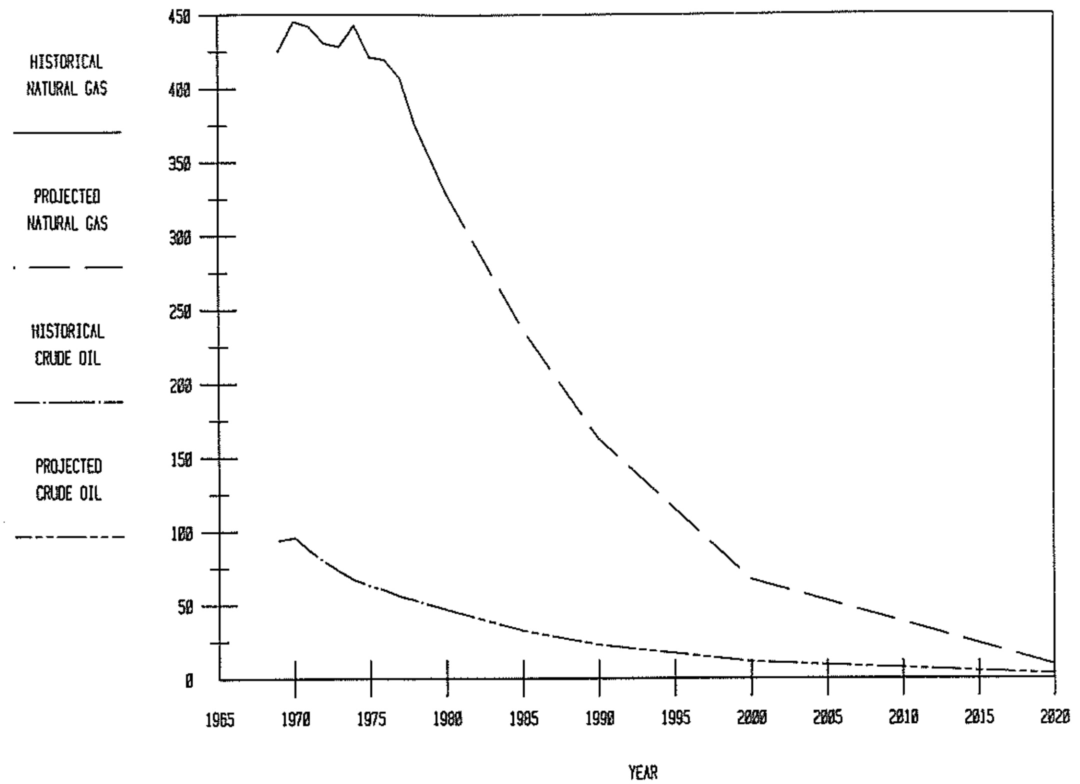

Figure 7. Oil and Natural Gas Production, Historical and Most Likely Projection.

crude oil and casinghead gas production are expected to decline 97.5 percent by 2020 from the 1985 production levels (i.e., 25.5 million barrels of oil and 105 billion cubic feet of casinghead gas). Under the assumptions used in the most likely projections, crude oil production is expected to drop off to 2.53 million barrels in 2020, which is a 92 percent reduction from the 1985 production level of 32.12 million barrels. Casinghead gas production is estimated to be 122.4 billion cubic feet in 1985 and is expected to decrease to 97 percent by 2020 to 3.4 billion cubic feet.

Under the high projection, production levels of dry gas in the High Plains by the year 2020 are expected to amount to 7.2 billion cubic feet, or a 94 percent reduction from the 1985 level of 124.3 billion cubic feet (Table 8). The annual rates of decline under the low projection assumptions show a 5 percent decline in 1985 which incrementally increases to 10 percent by 2020. The level of production in the High

Table 8. Projected Crude Oil, Casinghead Gas, and Dry Gas Production in the High Plains, New Mexico, 1985-2020.

Year	Crude Oil Production Low	Crude Oil Production Most Likely	Crude Oil Production High	Casinghead Gas Production Low	Casinghead Gas Production Most Likely	Casinghead Gas Production High
	---(millions of barrels)--			-(billions of cubic feet)-		
1985	25.53	32.12	37.28	105.0	122.4	153.3
1990	15.08	22.34	28.84	62.0	76.4	118.6
2000	5.26	10.81	17.27	21.6	26.6	71.0
2020	.64	2.53	6.19	2.6	3.2	25.5

Year	Dry Gas Production Low	Dry Gas Production Most Likely	Dry Gas Production High
	-(billions of cubic feet)-		
1985	102.9	114.4	124.3
1990	68.5	85.8	98.2
2000	27.2	40.3	50.1
2020	3.2	5.8	7.2

Plains in 2020 is expected to be only 3.2 billion cubic feet, or 97 percent lower than the 1985 production level of 102.9 billion cubic feet. Under the most likely projection, dry gas production in 1985 is expected to be 114.4 billion cubic feet. By the year 2020, production is expected to have dropped to 5.8 billion cubic feet (Table 8).

On-Farm Impacts

The on-farm impacts include a discussion by management strategy of the on-farm impacts (irrigated and total value of production as well as returns to land and management); land resources--including cropland and cropping patterns (irrigated, dry cropland, and rangeland); and the utilization of ground water for irrigation. A sensitivity analysis was performed on the on-farm impacts of crop prices, crop yields, and energy costs on the irrigated agricultural economy of the High Plains region of New Mexico.

Value of Production and Returns to Land and Management

Northern High Plains

The 1977 total agricultural value of production (irrigated, dryland, and rangeland) in the Northern High Plains was estimated to be about $81.6 million (Table 9 and Figure 8). Irrigated value of production for the baseline is expected to follow an increasing trend that continues through 2020. In 2020, the value of production is expected to be 3.4 times the 1977 amount (Figure 8). Dryland value of production is expected to increase by 137 percent by 2020 and range livestock value of production to increase by 27 percent (Table 9).

The total agricultural value of production follows almost identical trends to those for irrigation for all management strategies (Figure 8). The voluntary strategy follows an almost identical pattern to the baseline except the value of production for irrigation is expected to be higher and rangeland lower due to more land being in irrigated production in each time period (Figure 8). Because more irrigated land is retained, there is a decrease in rangeland acreage. Irrigated value of production under the mandatory strategy is expected to be less than the baseline or the voluntary strategy (Figure 8). This general reduction in the value of production is due to changes in cropping patterns, farm management techniques, and irrigation technology necessary to meet the mandatory water reductions. Similarly, the value of production for dryland crops is expected to be slightly greater under the mandatory strategy due to some areas converting to dryland from irrigation.

Total returns to land and management are expected to increase from 1977 through 2020 under all management strategies (Figure 9). Under baseline, the increase in returns from 1977 to 2020 is expected to be significant, about 208 percent. Dryland returns are also expected to show significant gains in returns over the study period. The dryland returns to land and management in 2020 are expected to be more than six times the returns in 1977 under all strategies. The rangeland returns

Table 9. Value of Production and Returns to Land and Management* by Management Strategy for Selected Years, Northern High Plains, New Mexico, 1977-2020.

Strategy and Item	1977	1985	1990	2000	2020
	---(1,000 dollars)---				
			Value of Production		
Baseline	81,589	106,863	114,096	125,894	145,132
Irrigated	16,413	26,943	31,392	39,434	56,266
Dryland	5,298	7,394	8,424	9,879	12,555
Rangeland	59,878	72,526	74,280	76,581	76,311
Voluntary	81,589	106,784	114,582	127,340	147,955
Irrigated	16,413	26,969	32,015	41,158	59,346
Dryland	5,298	7,394	8,424	9,879	12,555
Rangeland	59,878	72,421	74,143	76,303	76,054
Mandatory	81,589	105,625	110,727	121,643	137,285
Irrigated	16,413	25,611	27,372	34,227	46,553
Dryland	5,298	7,589	9,203	11,096	14,661
Rangeland	59,878	72,425	74,152	76,320	76,071
Importation	81,589	106,784	114,582	127,089	147,605
Irrigated	16,413	26,969	32,015	40,939	58,957
Dryland	5,298	7,394	8,424	9,847	12,594
Rangeland	59,878	72,421	74,143	76,303	76,054
			Returns to Land and Management		
Baseline	15,008	23,668	25,787	32,823	46,221
Irrigated	2,445	5,836	6,416	11,393	22,850
Dryland	1,130	2,274	3,102	4,498	6,896
Rangeland	11,433	15,558	16,269	16,932	16,475
Voluntary	15,008	23,738	26,210	33,786	48,108
Irrigated	2,445	5,928	6,869	12,418	24,793
Dryland	1,130	2,274	3,102	4,498	6,896
Rangeland	11,433	15,536	16,239	16,870	16,419
Mandatory	15,008	23,512	25,717	32,509	44,152
Irrigated	2,445	5,644	6,127	10,614	19,837
Dryland	1,130	2,331	3,349	5,021	7,893
Rangeland	11,433	15,537	16,241	16,874	16,422
Importation	15,008	23,738	26,210	33,355	47,757
Irrigated	2,445	5,928	6,869	12,199	24,404
Dryland	1,130	2,274	3,102	4,466	6,934
Rangeland	11,433	15,536	16,239	16,690	16,419

* Areas where imported surface water was utilized for crop production in 2000 and 2020 under importation, the returns were to land, management, and water.

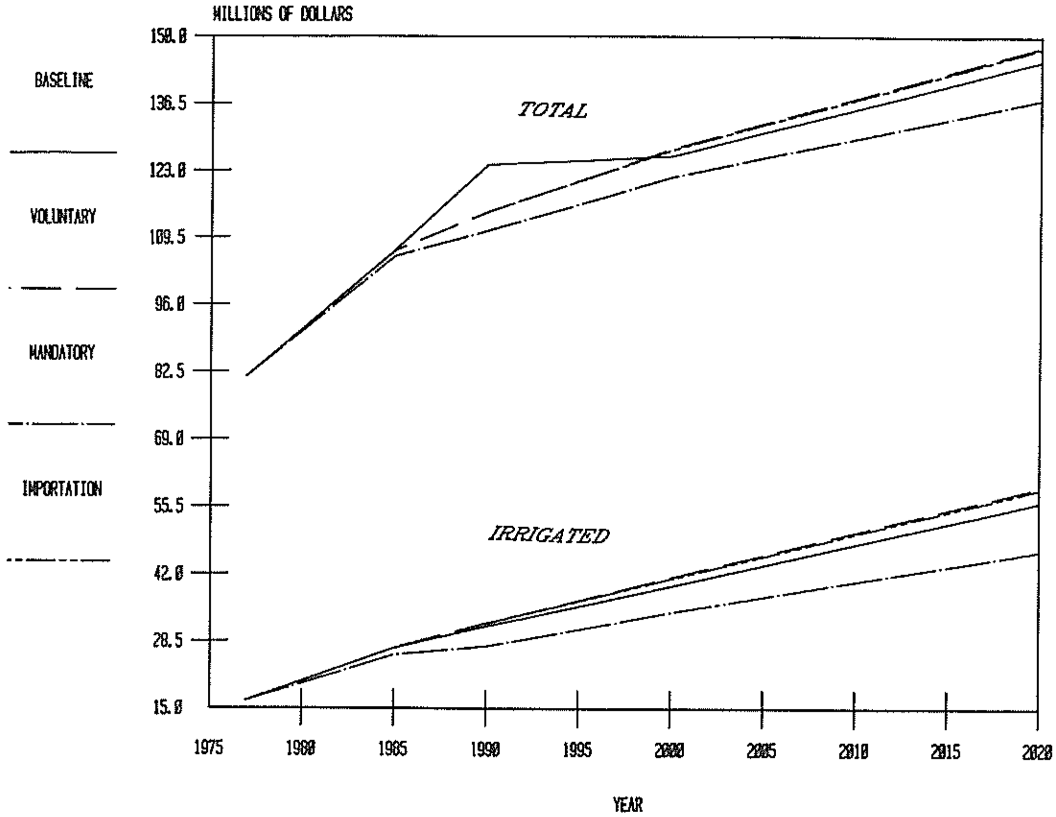

Figure 8. Total and Irrigated Value of Production, Northern High Plains, 1977-2020.

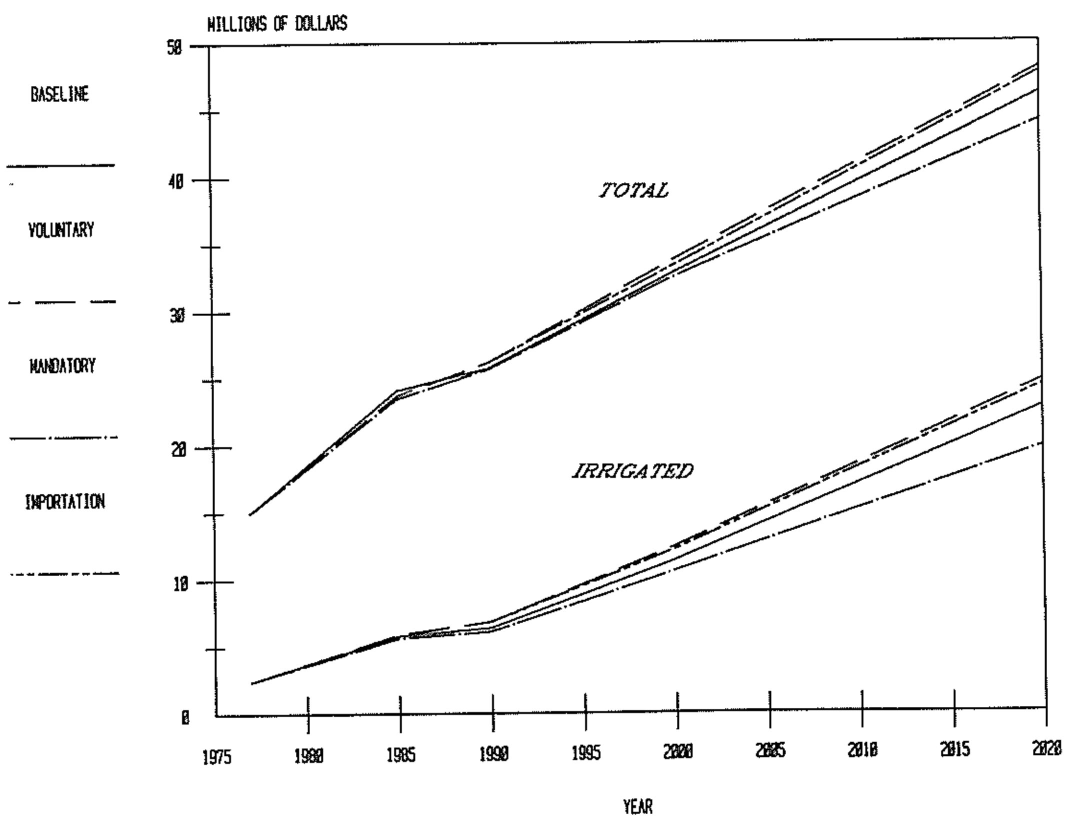

Figure 9. Total and Irrigated Returns to Land, Management, and Risk, Northern High Plains, 1977-2020.

also are expected to be up 1.4 times the 1977 amount for all strategies. Irrigated returns to land and management are also expected to increase over time for all strategies (Figure 9). Under baseline, the irrigated returns to land and management are expected to increase from 1977 through 2000, but decrease in 2020 (Figure 9). The increase in irrigated returns from 1977 to 2020 is expected to be about 835 percent, despite the decline from 2000 to 2020. Under the voluntary strategy, irrigated returns are projected to increase by an even larger amount than under the baseline. Irrigated returns under the voluntary strategy are projected to increase to $24.8 million, or an increase of 914 percent over the 1977 level (Table 9, Figure 9). Irrigated returns are projected to be the lowest under the mandatory strategy for all time periods (Table 9, Figure 9).

Three expected changes are responsible for the general reduction in both the value of production and returns in 1985, 1990 and 2000 under the mandatory strategy from the baseline and the voluntary strategy. The changes are expected to be in cropping patterns, farm management techniques, and improvements in irrigation technology necessary to meet the mandatory water reduction. These reductions indicate that it will be more expensive to grow crops under the mandatory water reductions. Both the value of production and returns to land and management for dryland crop production are expected to be greater under the mandatory strategy. This is due to some areas converting to dryland from irrigation. Irrigated returns under the importation strategy are projected to be slightly less than under the voluntary strategy but greater than those under the baseline or mandatory strategies. It is projected that they will increase to $24.4 million, or an increase of 898 percent over the 1977 amount.

Southern High Plains

The 1977 total agricultural value of production in the Southern High Plains was estimated to be about $151.9 million (Table 10 and Figure 10). The total agricultural value of production is expected to increase to 2000, then decline slightly to 2020 as irrigated cropland goes out of production (Figure 10). The irrigated value of production

Table 10. Value of Production and Returns to Land and Management* by Management Strategy for Selected Years, Southern High Plains, New Mexico, 1977-2020.

Strategy and Item	1977	1985	1990	2000	2020
	(1,000 dollars)				
			Value of Production		
Baseline	151,867	210,568	214,864	224,216	216,254
Irrigated	82,969	122,026	117,260	111,787	80,621
Dryland	19,785	29,120	36,724	49,628	72,832
Rangeland	49,113	59,422	60,880	62,801	62,801
Voluntary	151,867	209,983	215,244	223,218	227,687
Irrigated	82,969	121,428	117,630	110,771	96,527
Dryland	19,785	29,133	36,734	49,646	68,359
Rangeland	49,113	59,422	60,880	62,801	62,801
Mandatory	151,867	201,345	200,541	204,701	230,510
Irrigated	82,969	112,178	101,253	90,716	104,663
Dryland	19,785	29,740	38,337	51,051	62,846
Rangeland	49,113	59,427	60,951	62,934	63,001
Importation	151,867	209,983	215,244	255,829	300,722
Irrigated	82,969	121,428	117,630	152,625	188,725
Dryland	19,785	29,133	36,734	40,403	49,196
Rangeland	49,113	59,422	60,880	62,801	62,801
			Returns to Land and Management		
Baseline	32,797	64,394	70,959	87,650	101,191
Irrigated	17,952	39,680	39,944	46,474	42,993
Dryland	4,612	10,840	16,502	26,064	43,441
Rangeland	10,233	13,874	14,513	15,112	14,757
Voluntary	32,797	64,692	72,690	88,721	107,647
Irrigated	17,952	39,987	41,702	47,564	52,119
Dryland	4,612	10,831	16,475	26,045	40,771
Rangeland	10,233	13,874	14,513	15,112	14,757
Mandatory	32,797	62,338	67,202	79,026	104,882
Irrigated	17,952	37,417	35,451	37,021	52,592
Dryland	4,612	11,045	17,221	26,861	37,485
Rangeland	10,233	13,876	14,530	15,144	14,805
Importation	32,797	64,692	72,690	106,031	149,238
Irrigated	17,952	39,987	41,702	69,770	105,206
Dryland	4,612	10,831	16,475	21,149	29,275
Rangeland	10,233	13,874	14,513	15,112	14,757

* Areas where imported surface water was utilized for crop production in 2000 and 2020 under importation, the returns were to land, management, and water.

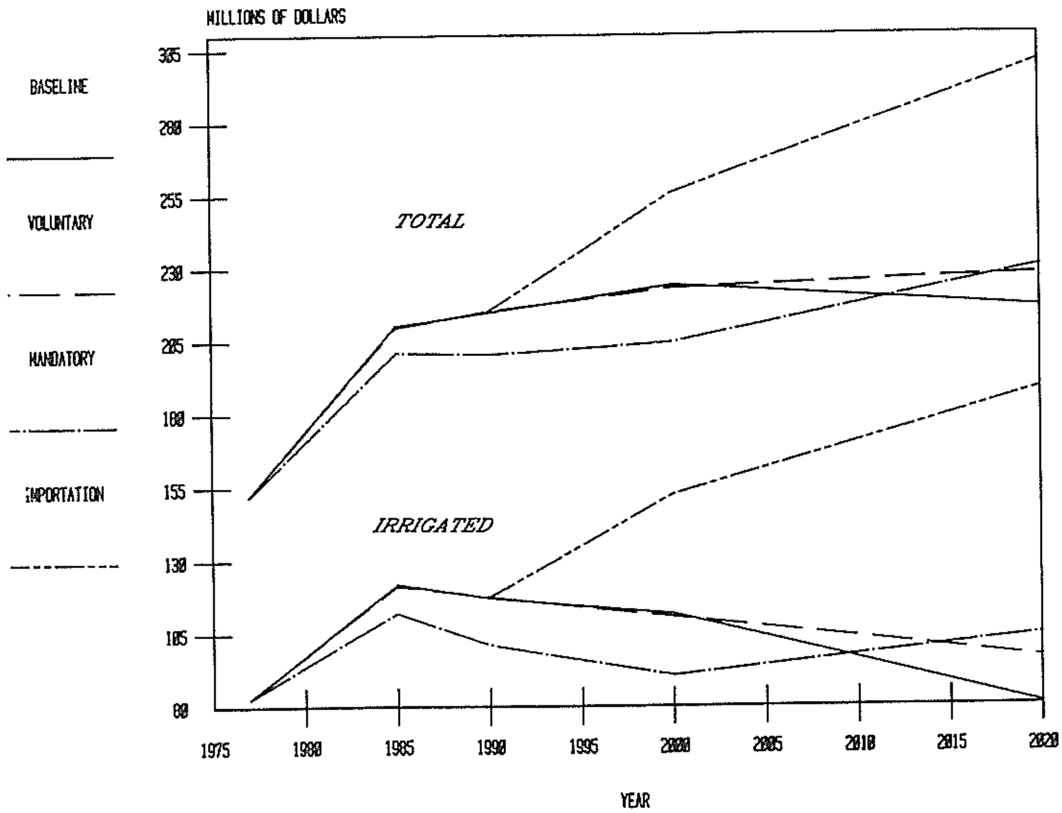

Figure 10. Total and Irrigated Value of Production, Southern High Plains, 1977-2020.

for the baseline is expected to peak in 1985, then begin to decline through 2020, where it is expected to be slightly less than the 1977 value (Figure 10). The dryland value of production is expected to increase under the baseline by 268 percent by 2020. The range livestock value of production is expected to increase by a modest 28 percent over the study period.

Under the voluntary strategy, an almost identical pattern to the baseline emerges. However, in 2020, the value of production for irrigated crops is expected to be higher and the dryland value of production lower. This is primarily due to more land being left in irrigated production because of increased water availability in 2020.

Irrigated value of production under the mandatory strategy is expected to be less than the baseline through 2000, but higher in 2020, since more irrigated land remains in production longer (Figure 10). Under importation, the irrigated value of production is projected to be the greatest amount. The availability of imported water for irrigated agriculture allows producers to maintain production through 2020. This results in the irrigated value of production being over $108 million more than under the baseline in 2020.

Total returns to land and management (irrigated, dryland, and rangeland) are expected to increase under the baseline from 1977 through 2020 (Figure 11). The increase in total returns from 1977 to 2020 is expected to be about 209 percent. Dryland returns are also expected to show significant gains in returns over the study period. The dryland returns to land and management in 2020 are expected to be more than 9.4 times the returns in 1977. The rangeland returns also are expected to be up by 44 percent. Irrigated returns to land and management are expected to increase from 1977 through 2000, but decrease in 2020 (Figure 11). The increase in returns from 1977 to 2020 is expected to be about 140 percent, despite the decline from 2000 to 2020. Under the mandatory strategy, the value of production and returns are lower than both the baseline and voluntary strategies in 1985, 1990, and 2000. Three expected changes are responsible for the general reduction in both the value of production and returns in 1985, 1990 and 2000 under the mandatory strategy from the baseline and the voluntary strategy. The changes are expected to be in cropping patterns, farm management techniques, and improvements in irrigation technology necessary to meet the mandatory water reduction. These reductions indicate that it will be more expensive to grow crops under the mandatory water reductions. Both the value of production and returns to land and management for dryland crop production are expected to be greater under the mandatory strategy. This is because some areas convert to dryland farming from irrigated farming.

Total and irrigated returns are expected to be the greatest under the importation strategy. The availability of imported water allows producers to maintain irrigated agriculture. This results in the highest total and irrigated returns of all strategies.

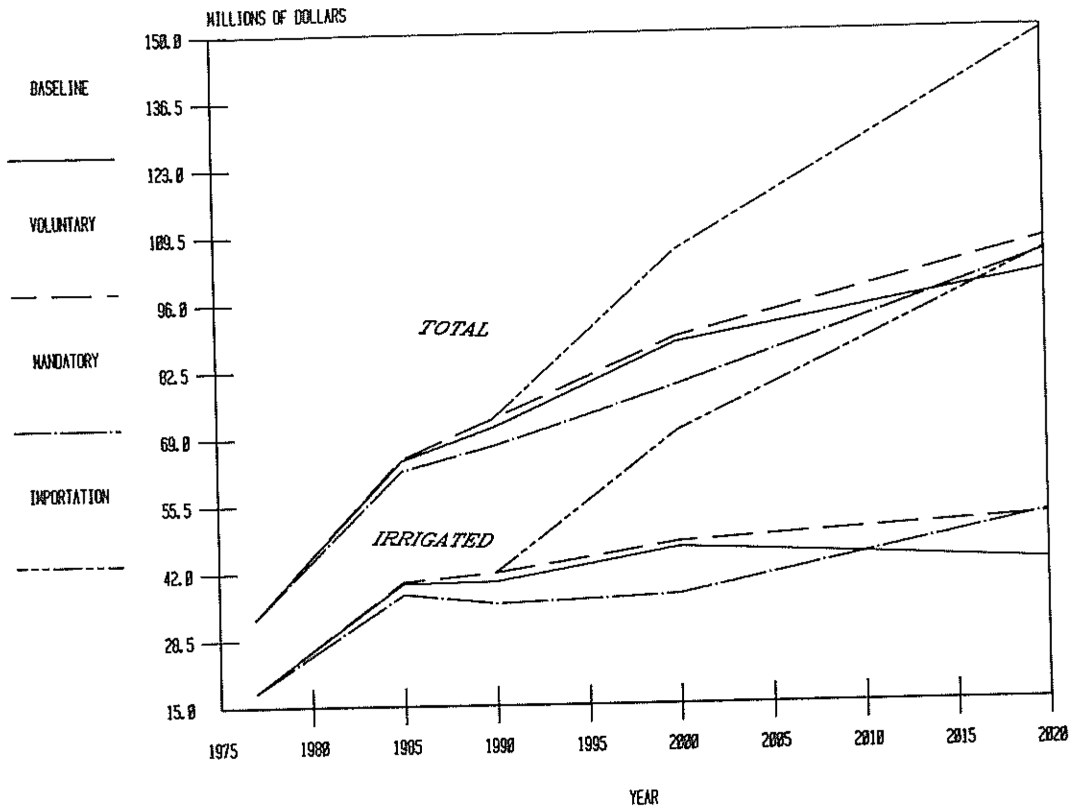

Figure 11. Total and Irrigated Returns to Land, Management, and Risk, Southern High Plains, New Mexico, 1977-2020.

Irrigation Water

Northern High Plains

Under all management strategies except the mandatory strategy, significant increases in the quantity of irrigation water diversions are expected over the study period (Figure 12). Reductions are expected for the mandatory strategy because of mandatory irrigation water application reductions.

The largest irrigation water diversions are expected to occur under the baseline in 2020. Diversions are expected to increase almost steadily from about 193,000 acre-feet in 1977 to 256,000 acre-feet in 2020. The diversions are expected to maintain about a 25/75 percent furrow/sprinkler relationship through 2000, but in 2020 they are expected to be more than 75 percent sprinkler.

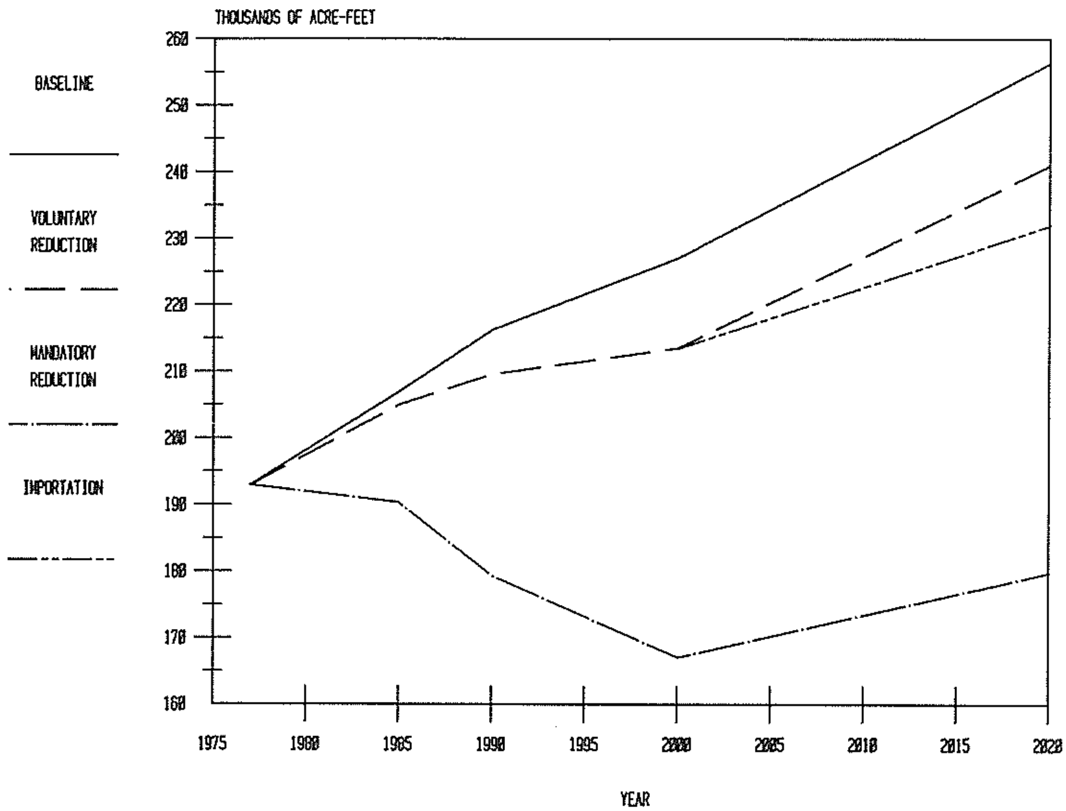

Figure 12. Quantity of Irrigation Applied, Northern High Plains, 1977-2020.

Under the voluntary and the importation strategies, decreases in water diversions are expected when compared to the baseline. However, an increasing trend in water applications from 1977 to 2020 similar to the baseline is still expected. However, the flood/sprinkler relationship is expected to change (significantly less for furrow irrigation).

Water applications per acre for all crops except pasture are expected to decline for all management strategies over time due to increasing field efficiency. The average water applications per acre are expected to decline 0.49 acre-foot per acre under the voluntary and importation strategies and 0.65 acre-foot per acre under the mandatory strategy due to mandatory supply controls. Despite the reduction in per-acre applications, the total water applications are expected to increase under the baseline, the voluntary, and the importation strategies owing to greater irrigated acreage.

Southern High Plains

Significant reductions are expected in the quantity of irrigation water diversions over the study period due to aquifer exhaustion and increases in field irrigation efficiency for all management strategies (Figure 13). The greatest reductions are expected to occur in the baseline, followed by the mandatory strategy. In 1985, diversions are expected to exceed 790,000 acre-feet under the baseline and then decline to less than 300,000 acre-feet by 2020, due primarily to aquifer exhaustion. In addition to the reduction in diversions, significant changes in the furrow/sprinkler mix are also expected. In the baseline case, water diversions are expected to maintain about a 50/50 furrow/sprinkler relationship through 2000, but by 2020 the water diversions are expected to be 100 percent sprinkler.

Annual water diversions for the voluntary strategy are expected to be lower than the baseline except in 2020, where the diversions are expected to be about 32,000 acre-feet more than under the baseline (Figure 13). This is also due to the availability of irrigation water in some areas where the aquifer is expected to be drawn down in the baseline case. In 2020, the voluntary strategy is expected to have more than 100,000 acre-feet of furrow irrigation due to the improved economic position of furrow relative to sprinkler irrigation.

Irrigation water diversions for the mandatory strategy are expected to be less than the voluntary strategy in all years. Significant reductions in water diversions are expected under the mandatory strategy through 2000, but in 2020 the diversions are expected to be only about 26,000 acre-feet less than the voluntary strategy due to mandatory irrigation water diversion reductions. Furrow irrigation is also expected to be significantly reduced after 1977 to meet the mandatory water reductions.

Water applications per acre for all crops under all management strategies are expected to decline over the period from 1977 to 2020 due to increasing field efficiency. The greatest per-acre water reduction over the study period is expected to occur under the mandatory strategy for all crops but wheat. Even though there is a constant decline in per-acre water applications under the baseline, the average per-acre

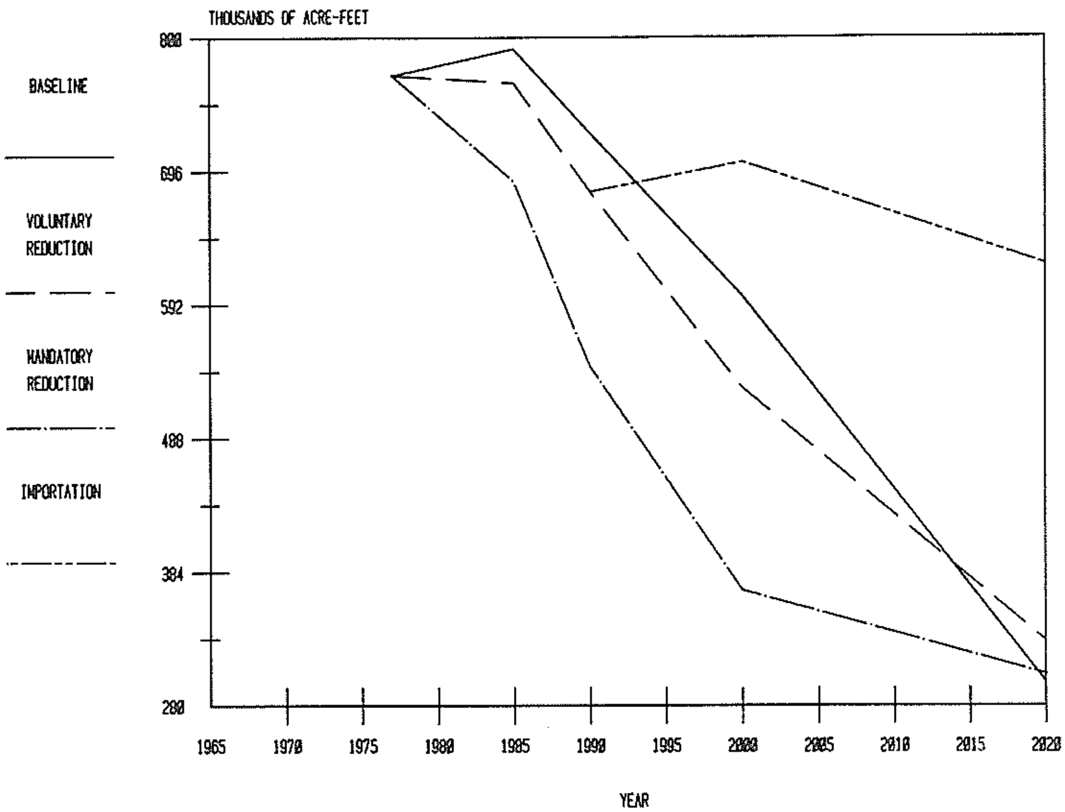

Figure 13. Quantity of Irrigation Applied, Southern High Plains, 1977-2020.

water applications are expected to increase, due to a change in cropping pattern and increased irrigated acreage in some areas. Of the original nine irrigated areas, only three are expected to remain in production in 2020 under the baseline. These three irrigated areas have a high percentage of alfalfa, corn, and peanuts, all significant water-using crops. The average per-acre water application for the alternative management strategies declines despite the influence of the high percentage of higher water-using crops. This is due to voluntary or mandatory conservation measures and the influence of some additional areas that remain in production. The average per-acre water applications are expected to decline 9 percent under the voluntary, 32 percent under the mandatory, and 19 percent under the importation strategy.

As part of the High Plains study, the U.S. Army Corps of Engineers studied, at a reconnaissance level, four importation routes--two from the Missouri River (routes A and B) and two from tributaries of the Mississippi River (routes C and D) (Figure 14). The routes were sized

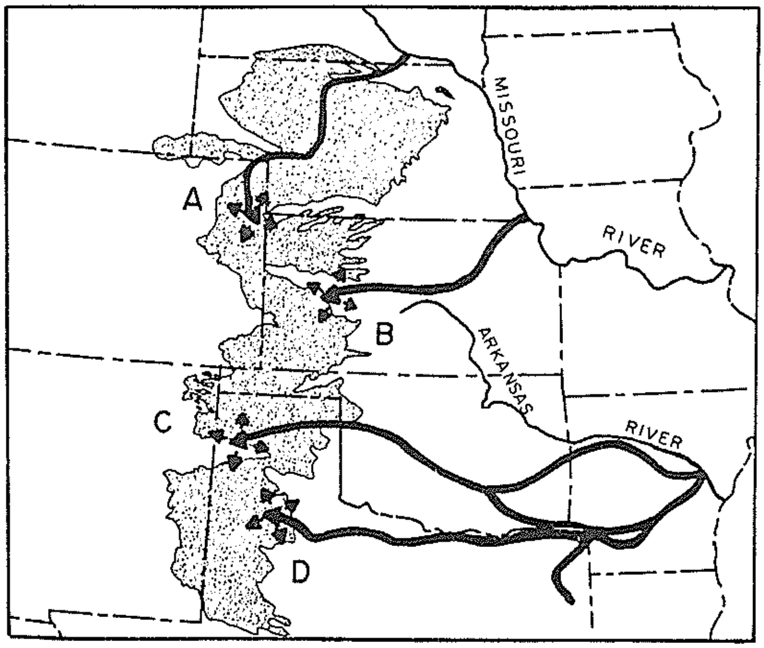

Figure 14. Proposed Water Transportation Routes, High Plains, New Mexico.

to provide costs for a range of flows. Where possible, routes will be located to minimize environmental impacts.

Route D could provide water to New Mexico and parts of Texas and Oklahoma. Sources of water would be the White River at Clarendon, AR; the Arkansas River at Pine Bluff, AR; the Ouachita River at Camden, AR; the Red River at Fulton, AR; the Sulphur River at Darden, TX; and the Sabine River at Tatum, TX. These supplies of water would then route west and northwest across Texas into the Texas Panhandle to terminal storage west of Lubbock, TX. This route would require a canal about 860 miles long and would have 30 pumping plants to lift the water 2,700 feet along the route.

Water diversions under the importation strategy are expected to be the same as those under the voluntary strategy through 1990. After imported water becomes available in 2000, water diversions are expected to be significantly increased. Water diversions under the importation strategy in 2020 are expected to be about 300,000 acre-feet more than under the voluntary strategy and over 330,000 acre-feet more than under the baseline. Diversions in 2000 are expected to be more than 50 percent furrow applied under the importation strategy, but by 2020 diversions are expected to be more than 75 percent sprinkler applied.

Crop Acreages

Northern High Plains

Under all management strategies, the total cropped acreage is expected to increase steadily over time, by county and by strategy (Figure 15). The acreage irrigated in 2020 is expected to be the greatest under the voluntary strategy (127,740 acres) and lowest under the mandatory strategy (108,400 acres) (Table 11). The baseline strategy is estimated to have 155,854 irrigated acres in 2020. Under the baseline and the voluntary management strategy, no acreage is expected to be transferred from irrigated to dryland. Under the mandatory strategy, transfers from irrigated acreage to dryland over the study period are expected to be about 19,400 acres to meet the mandatory water reduction defined under this management strategy. Water is not expected to be imported to the Northern High Plains because no irrigated areas are expected to go out of production due to aquifer exhaustion.

Southern High Plains

Under all management strategies, the total cropped acreage in the Southern High Plains is expected to vary only slightly (Table 12). However, significant shifts from irrigated to dryland production are expected. The baseline strategy is expected to have the greatest acreage transfer from irrigated to dryland over the period 1977 through 2020. About 37,000 more acres are expected to remain in irrigation under the voluntary strategy than under the baseline case in 2020 due to water conservation. Under the mandatory strategy, about the same irrigated acreage as the baseline is expected through 2000, but by 2020 about 75,000 more irrigated acres are expected to be utilized. The irrigated acreage is expected to be almost constant under the importa-

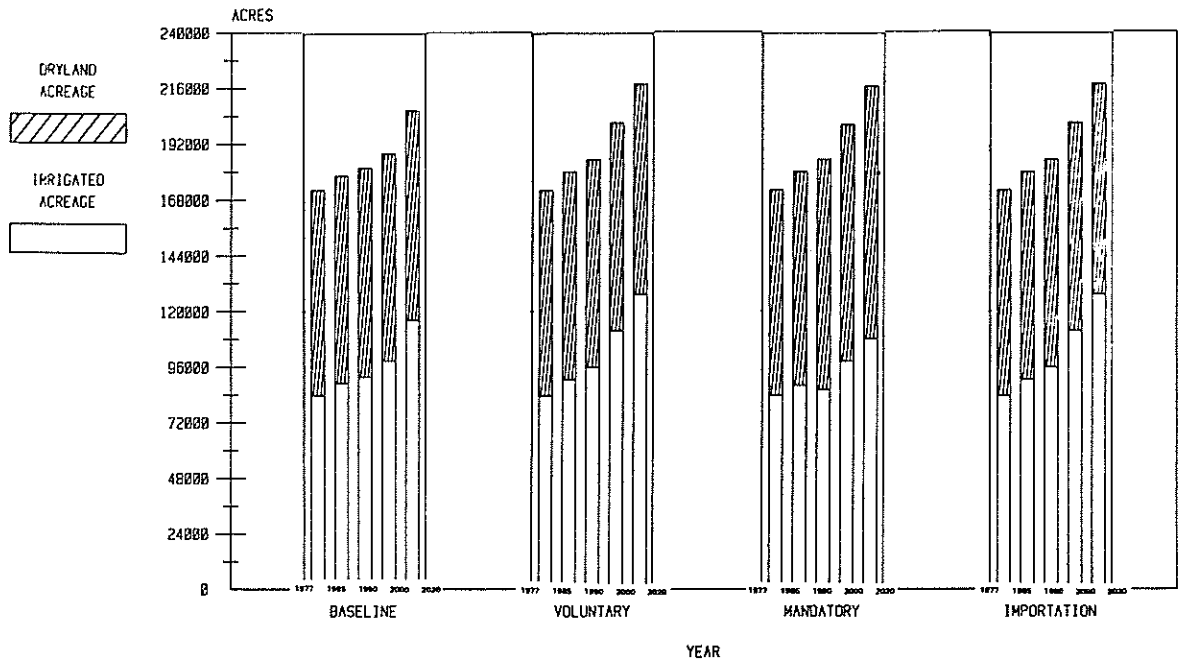

Figure 15. Total Cropped Acreage, Northern High Plains, 1977-2020.

tion strategy, except for a decline in 1990 due to the exhaustion of the water supply in part of Curry County before the imported water becomes available in 2000 (Figure 16).

By the year 2020, no irrigated cropland is expected in Curry County, nor in the southwestern portion of Quay County. By 2020, the acreage in Roosevelt County will be drastically reduced to about 38 percent of the 1977 acreage, and no irrigated cropland is expected to be farmed after the year 2021.

Cropping Pattern

Northern High Plains

Irrigated cropping patterns are affected less in the Northern High Plains than in the Southern High Plains because no area in the Northern High Plains is expected to run out of water. The acreages of corn and

Table 11. Estimated Crop Acreages by Management Strategy for Selected Years, Northern High Plains, New Mexico.

Management Strategy	Irrigated							Dryland				Rangeland		
	Alfalfa	Grain Corn	Cotton	Grain Sorghum	Wheat	Other*	Total	Alfalfa	Grain Sorghum	Wheat	Total	Steers	Cows	Total
1977 Acreages	16,501	17,430	2,096	26,595	13,143	7,653	83,417	13,776	27,904	47,680	89,360	3,004,877	2,127,826	5,132,703
Baseline														
1985	20,195	24,376	3,930	26,832	11,510	2,238	89,081	15,097	30,576	44,056	89,729	3,007,719	2,130,657	5,138,376
1990	22,032	29,125	5,240	11,381	21,746	2,448	91,972	15,956	11,995	61,940	89,891	3,005,943	2,129,460	5,135,403
2000	24,252	32,000	5,291	11,376	22,551	2,699	98,169	16,071	32,009	42,098	90,178	3,002,168	2,126,894	5,129,062
2020	27,977	39,750	5,618	11,719	28,603	2,187	115,854	16,250	12,031	62,344	90,625	2,991,544	2,119,611	5,111,155
Voluntary														
1985	21,278	24,376	4,117	27,241	11,586	2,238	90,836	15,097	30,576	44,056	89,729	3,003,367	2,127,652	5,131,019
1990	24,744	29,125	5,900	12,702	20,956	2,448	95,875	15,956	11,995	61,940	89,891	3,000,406	2,125,493	5,125,899
2000	29,187	32,000	7,800	16,393	23,429	2,699	111,508	16,071	32,009	42,098	90,178	2,991,431	2,118,691	5,110,122
2020	32,554	39,750	7,800	16,084	28,274	3,280	127,740	16,250	12,031	62,344	90,625	2,981,597	2,112,070	5,093,667
Mandatory														
1985	20,858	23,339	4,117	26,410	11,285	2,085	88,092	15,174	31,867	45,248	92,290	3,003,523	2,127,781	5,131,304
1990	13,043	24,611	5,900	12,528	27,849	2,077	86,009	16,098	13,818	69,357	99,273	3,000,770	2,125,791	5,126,561
2000	16,334	26,101	7,800	37,053	9,038	2,004	98,329	16,243	39,109	47,054	102,406	2,992,073	2,119,216	5,111,289
2020	28,844	30,719	7,800	15,966	23,313	1,732	108,374	16,374	15,659	76,963	108,996	2,982,229	2,112,587	5,094,816
Importation														
1985	21,278	24,376	4,117	27,241	11,586	2,238	90,837	15,097	30,576	44,056	89,728	3,003,367	2,127,652	5,131,019
1990	24,744	29,125	5,900	12,702	20,956	2,448	95,876	15,956	11,995	61,940	89,890	3,000,406	2,125,493	5,125,899
2000	29,187	32,000	7,800	16,393	23,430	2,699	111,508	16,071	32,009	42,098	90,178	2,991,431	2,118,691	5,110,122
2020	32,554	39,750	7,800	16,084	28,273	3,280	127,740	16,250	12,031	62,344	90,626	2,981,597	2,112,070	5,093,667

* Includes pasture.

Table 12. Estimated Crop Acreages by Management Strategy for Selected Years, Southern High Plains, New Mexico.

Management Strategy	Irrigated								Dryland				Rangeland		
	Alfalfa	Grain Corn	Cotton	Grain Sorghum	Peanuts	Wheat	Other*	Total	Cotton	Grain Sorghum	Wheat	Total	Steers	Cows	Total
	(acres)														
1977 Acreage	30,691	91,136	40,685	75,006	9,200	103,104	7,579	357,400	10,653	136,085	268,562	415,300	2,284,491	2,314,909	4,599,400
Baseline															
1985	47,813	105,258	33,511	87,617	10,337	64,093	6,742	355,371	14,368	106,186	300,535	421,090	2,284,313	2,314,605	4,598,918
1990	50,425	101,260	23,760	84,688	10,957	50,861	-0-	321,951	18,040	95,549	343,402	456,991	2,283,730	2,313,977	4,597,757
2000	51,085	75,040	24,300	57,328	12,311	36,251	-0-	256,315	18,287	106,210	401,673	526,170	2,282,211	2,312,439	4,594,650
2020	29,700	36,793	24,300	-0-	15,543	25,050	-0-	131,386	22,303	128,829	487,346	638,478	2,282,211	2,312,439	4,594,650
Voluntary															
1985	46,459	103,904	32,157	91,678	10,337	64,093	6,742	355,371	14,368	107,802	298,920	421,090	2,284,313	2,314,605	4,598,918
1990	54,039	98,428	27,768	84,215	10,957	46,544	-0-	321,951	18,040	97,982	340,969	456,991	2,283,780	2,313,977	4,597,757
2000	47,923	72,158	28,019	56,878	12,311	39,026	-0-	256,315	18,287	108,610	399,273	526,170	2,282,211	2,312,439	4,594,650
2020	39,000	43,010	24,300	18,600	15,543	28,133	-0-	168,586	19,327	121,707	460,244	601,278	2,282,211	2,312,439	4,594,650
Mandatory															
1985	33,081	101,421	36,754	92,193	10,337	70,188	2,777	346,751	14,447	109,475	306,442	430,364	2,284,546	2,314,795	4,599,341
1990	14,915	82,874	34,758	93,764	4,596	67,399	-0-	298,306	18,209	101,273	357,504	476,986	2,286,398	2,316,804	4,603,202
2000	3,420	59,782	47,089	75,279	197	61,745	-0-	235,130	18,476	111,023	410,215	539,714	2,286,959	2,317,538	4,604,497
2020	26,382	51,600	38,961	39,185	15,543	34,926	-0-	206,597	19,829	110,434	420,515	550,777	2,289,309	2,320,233	4,609,542
Importation															
1985	33,081	101,421	36,754	92,193	10,337	70,188	2,777	346,751	14,447	109,475	306,442	430,364	2,284,313	2,314,605	4,598,918
1990	14,915	82,874	34,758	93,764	4,596	67,399	-0-	298,306	18,209	101,273	357,504	476,986	2,283,780	2,313,977	4,597,757
2000	56,894	111,368	28,019	94,477	12,311	54,046	-0-	357,115	18,287	93,490	313,593	425,370	2,282,211	2,312,439	4,594,650
2020	57,702	103,018	24,300	89,518	15,542	66,091	-0-	356,171	18,594	94,488	316,126	429,208	2,282,211	2,312,439	4,594,650

* Includes pasture and corn silage.

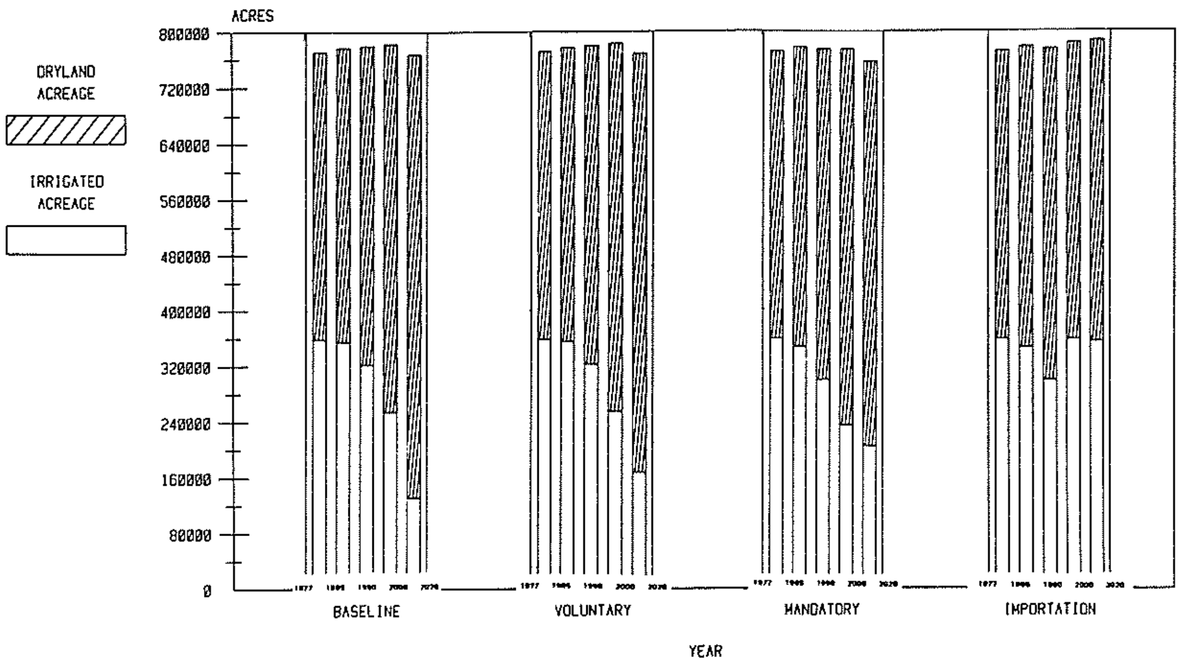

Figure 16. Total Cropped Acreage, Southern High Plains, 1977-2020.

wheat are expected to be larger under the baseline, voluntary and importation strategies (Table 11). Cotton acreage under all management strategies is projected to increase to the year 2000, then remain constant to 2020. Grain sorghum acreage is basically expected to decline and alfalfa acreage is expected to increase over the study period under all of the management strategies.

Of the dryland crops in the Northern High Plains, wheat and alfalfa are expected to follow a generally increasing trend while grain sorghum generally declines. However, there is expected to be a large shift from wheat to grain sorghum in 2000 then back to wheat in 2020. There is expected to be a slight decrease from the baseline to the other management strategies in 2020 in range livestock. This is because more land is converted from rangeland to irrigated cropland (Table 11).

Southern High Plains

Generally, irrigated crops produced under the baseline and the voluntary strategy are expected to follow similar patterns--irrigated feed grains and forage crops are expected to initially increase in acreage from 1977 to 1985 or 1990 before significant declines in acreage are expected to occur by 2020 (Table 12). Irrigated small grains and fiber crop acreages are expected generally to decline over time. The importation strategy is expected to follow a similar pattern as the voluntary strategy until imported water becomes available. When imported water becomes available, feed grains, forage crops, and small grains are projected to increase, while cotton acreage is projected to decline. Irrigated forage crops under the mandatory strategy are expected initially to increase in acreage in 1985, exhibit significant declines by 2000, then increase tremendously by 2020. Fiber crops acreage is expected to fluctuate a great deal, but in the end be almost the same as it was in 1977. Feed grains and small grains are expected to follow a generally declining trend in acreage.

Dryland crops under all management strategies are expected to follow similar patterns (Table 12). Dryland small grain acreage is expected to increase under all strategies--significantly under some strategies. Dryland fiber crops are expected to increase in acreage slightly over time while dryland feed grain crops are expected to have acreage declines over time. Acreage devoted to range livestock is not expected to change for the baseline, voluntary, or the importation strategies, but acreage is expected to increase for the mandatory strategy.

Sensitivity Analysis

Sensitivity analyses were performed for three key on-farm assumptions. Analyses were performed on crop prices, crop yields, and energy costs to determine the effects of increases or decreases of these three items upon acreage irrigated, water applications, value of production, and returns to land and management.

Northern High Plains

In the Northern High Plains region, the sensitivity analysis indicates that irrigated cropland and water applications will not be affected to any great extent by lower or higher crop prices, crop yields, or energy costs (Table 13).

The analysis indicates that the value of production and returns to land and management will be greatly reduced when energy prices are higher than those assumed under the baseline. Lower energy prices will not cause significant increases in the value of production or returns.

The analysis further indicates that when crop yields are smaller and crop prices are lower than those that were assumed under the baseline, the value of production and returns to land and management will be significantly lower.

The analysis indicates that if there are larger crop yields and higher crop prices than those assumed under the baseline, returns will be significantly higher.

Southern High Plains

For the Southern High Plains region, the analysis indicates that larger crop yields will have the greatest overall economic impact (Table 14). Higher crop yields will cause irrigated acreage, water applications, the value of production, and returns to increase significantly. Smaller crop yields will have a negative impact upon the value of production and returns by significant amounts.

The analysis also indicates that irrigated cropland, water applications, the value of production, and returns will continue to increase regardless of whether crop prices are larger or smaller than those assumed under the baseline conditions.

Analysis of energy costs indicates that higher prices will have a negative impact upon irrigated cropland and upon water applications. The value of production will be affected only slightly. However, returns are expected to drop significantly under the high energy price scenario. Lower energy prices will not affect the number of acres irrigated, water applications, or the value of production, and will not cause returns to land and management to be significantly higher.

Table 13. Sensitivity Analysis, Northern High Plains.

Item	Irrigated Cropland	Percent	Water	Percent	Value of Production	Percent	Returns	Percent
	(acres)		(acre-ft)		(millions)		(millions)	
Crop Prices								
Increased	0.0	0.0	0.0	0.0	+10.25	+18.2	+ 3.12	+13.7
Decreased	0.0	0.0	0.0	0.0	-10.32	-18.3	- 3.08	-13.5
Crop Yields								
Increased	0.0	0.0	0.0	0.0	+ 4.28	+ 7.6	+10.26	+44.9
Decreased	0.0	0.0	0.0	0.0	- 3.08	- 5.5	-10.14	-44.9
Energy Costs								
Increased	-3858	-3.3	-6389	- 2.5	- 5.03	- 8.9	-14.87	-65.1
Decreased	0.0	0.0	+ 982	+.004	+ 1.16	+ 2.1	+ 1.79	+ 7.8

Table 14. Sensitivity Analysis, Southern High Plains.

Item	Irrigated Cropland	Percent	Water	Percent	Value of Production	Percent	Returns	Percent
	(acres)		(acre-ft)		(millions)		(millions)	
Crop Prices								
Increased	+37,200	+28.3	+72,874	+24.4	+22.42	+27.8	+12.83	+29.80
Decreased	+37,200	+28.3	+74,673	+25.1	+12.61	+15.6	+ 3.72	+ 8.70
Crop Yields								
Increased	+37,200	+28.3	+78,398	+26.3	+38.57	+47.8	+27.68	+64.39
Decreased	+ 2,361	+ 1.8	+16,895	+ 5.7	-18.20	-22.6	-15.60	-36.30
Energy Costs								
Increased	-19,392	-14.8	-23,073	- 7.7	- .13	-.002	-11.50	-26.80
Decreased	0.0	0.0	0.0	0.0	0.0	0.0	+ 2.20	+ 5.00

Regional Impacts

Baseline

The baseline assumes the continuation of current trends and no new public agricultural policies or programs. Under the baseline, the continuation of present trends in water conservation is expected to result in water savings of about 10 percent on sprinkler-irrigated lands over the study period. The on-farm impact results and the energy impact results were incorporated into the county impacts analysis.

Gross Output - Northern High Plains

Total gross output of all goods and services projected for the Northern High Plains economy is reported in Table 15. It was about $457 million in 1977. Under baseline, it is projected to be $570 million in 1985, $625 million in 1990, $712 million in 2000, and $905 million in 2020.

Agricultural. The agricultural sectors in the Northern High Plains are projected to have a major impact on the local economy. They are expected to increase between 1977 and 2020 with about $379 million in 1977 and $608 million in 2020. This growth is projected to be relatively stable over the period (Figure 17). The agricultural sectors accounted for about 83 percent of the total output in 1977, and are projected to account for 82 percent in 1985, 80 percent in 1990, 76 percent in 2000, and 67 percent in 2020.

Mining. The mining sectors (primarily sand and gravel) in the Northern High Plains are projected to increase their total output from 1977 to 2020. In 1977, the mining sectors accounted for about $7.0 million, or about 1.5 percent. By 1985, they are projected to account for $11.1 million, or 1.9 percent; in 1990, 2.4 percent; in 2000, 3.3 percent; and in 2020, 5.3 percent. The development of CO_2 reserves in the Bravo Dome area is projected to result in from 300 to 1,000 wells and pipelines to the Permian/Delaware Basin of Texas and southeastern New Mexico.

Table 15. Gross Output by Major Sector for Each of the Alternative Management Strategies, Northern High Plains, New Mexico, 1977-2020.

Sector	Gross Output ($1977)				
	1977	1985	1990	2000	2020
	(millions of dollars)				
Baseline					
Agriculture	379.454	469.824	501.670	540.317	607.781
Mining	6.988	11.099	15.201	23.413	48.122
Manufacturing	5.554	7.414	9.268	12.981	20.435
TCU*	7.574	10.110	12.638	17.702	27.866
Construction	17.123	19.693	22.261	29.111	35.960
FIRE**	6.837	7.863	8.888	11.623	14.358
Trade	18.311	24.444	30.557	42.798	96.871
Services	14.655	19.564	24.456	34.253	53.921
Total	456.496	570.011	624.939	712.198	905.314
Voluntary					
Agriculture	379.454	469.800	502.694	540.081	608.647
Mining	6.988	11.099	15.201	23.413	48.122
Manufacturing	5.554	7.414	9.268	12.981	20.435
TCU*	7.574	10.110	12.638	17.702	27.866
Construction	17.123	19.693	22.261	29.111	35.940
FIRE**	6.837	7.863	8.888	11.623	14.358
Trade	18.311	24.444	30.557	42.798	96.871
Services	14.655	19.564	24.456	34.253	53.921
Total	456.496	569.997	625.963	711.962	906.160
Mandatory					
Agriculture	379.454	469.869	502.771	541.556	608.437
Mining	6.988	11.099	15.201	23.413	48.127
Manufacturing	5.554	7.414	9.268	12.984	20.449
TCU*	7.574	10.122	12.665	17.859	28.388
Construction	17.123	19.693	22.266	29.138	36.122
FIRE**	6.837	7.867	8.895	11.661	14.507
Trade	18.311	24.448	30.574	42.881	97.554
Services	14.655	19.569	24.471	34.334	54.422
Total	456.496	570.081	626.111	713.826	908.006
Importation					
Agriculture	379.454	469.800	502.694	541.042	608.106
Mining	6.988	11.099	15.201	23.415	48.134
Manufacturing	5.554	7.414	9.268	12.988	20.465
TCU*	7.574	10.110	12.638	17.869	28.561
Construction	17.123	19.693	22.261	29.297	36.590
FIRE**	6.837	7.863	8.888	11.699	14.746
Trade	18.311	24.444	30.557	43.037	98.861
Services	14.655	19.564	24.456	34.435	55.127
Total	456.496	569.987	625.963	713.782	910.589

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

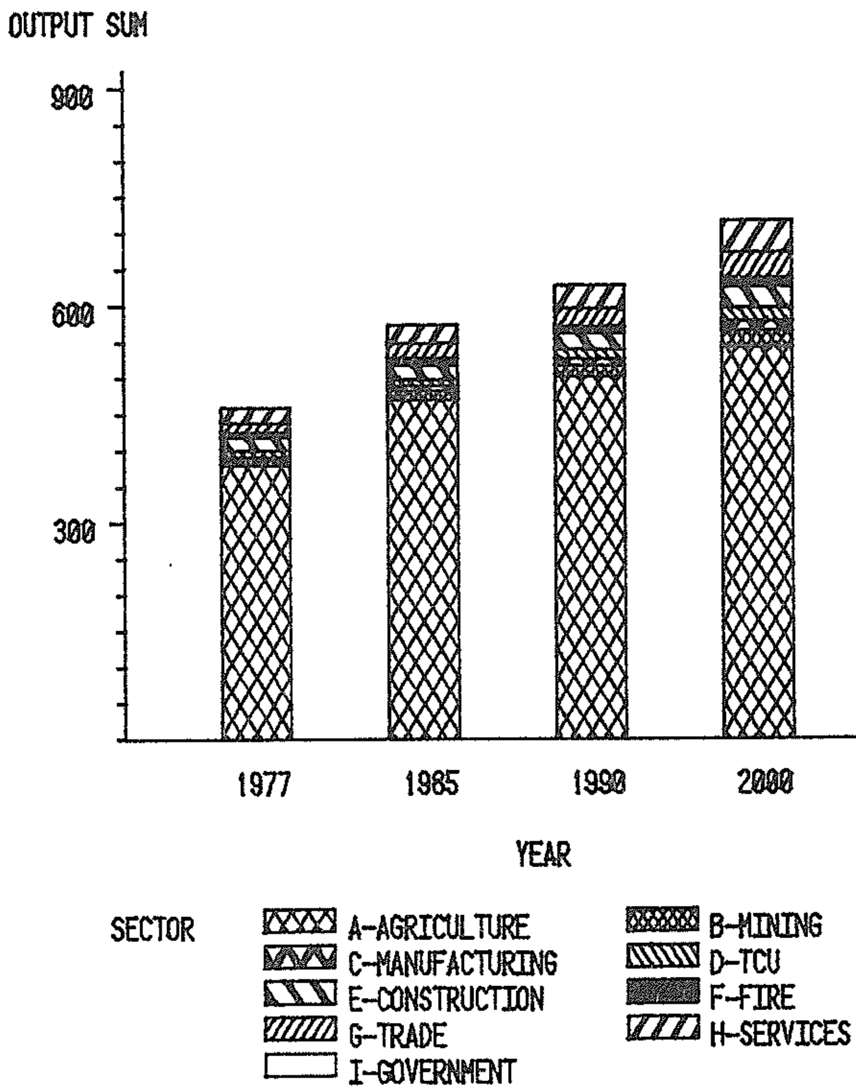

Figure 17. Projected Gross Output, Northern High Plains, Baseline Conditions, 1977-2020.

Manufacturing. The manufacturing sectors in the Northern High Plains are projected to increase from $6 million in 1977 to about $20 million in 2020. The contribution of the manufacturing sectors to the total was about 1.2 percent in 1977, and is projected to be 1.3 percent in 1985, 1.5 percent in 1990, 1.8 percent in 2000, and 2.3 percent in 2020 (Table 15).

Transportation, Communication, and Utilities (TCU). The TCU sectors in the Northern High Plains, taken together, generally show an increase over the period. These sectors are projected to increase from

$7.6 million in 1977 to $27.9 million in 2020 (Table 15). The contribution of these sectors to the total was about 1.7 percent in 1977 and is projected to account for 3.1 percent in 2020.

Construction. The construction sectors in the Northern High Plains are projected to increase between 1977 and 2020 (Figure 17). These sectors accounted for about $17 million in 1977. They are projected to reach $20 million in 1985, and then increase to $36 million in 2020.

Finance, Insurance, and Real Estate (FIRE). The FIRE sectors in the Northern High Plains are projected to increase between 1977 and 2020, increasing from $6.8 million in 1977 to $14.4 million in 2020 (Table 15).

Trade. The trade sector in the Northern High Plains is expected to expand between 1977 and 2020 (Figure 17). In 1977, it accounted for about 4 percent of the total and by 2020 it is projected to be about 11 percent.

Service. The service sectors in the Northern High Plains are projected to increase between 1977 and 2020 (Figure 17). In 1977, they accounted for about 3 percent of the total and by 2020 they are projected to be about 6 percent.

Gross Output - Southern High Plains

The total gross output of all goods and services projected for the Southern High Plains economy is reported in Table 16. It was about $2,056 million in 1977. It is projected to be $3,519 million in 1985, $3,298 million in 1990, $2,438 million in 2000, and $2,275 million in 2020.

Mining. The mining sectors (primarily oil and gas extraction) in the Southern High Plains are projected to have a major impact on the regional economy (Figure 18). In 1977, the mining sectors accounted for about $975 million, or about 47 percent of the total, and by 1985 they are projected to account for $1,595 million, about 45 percent of the total. The major expansion in the oil and gas extraction activities (mining sectors) is expected to be a driving force in the local economy with the construction, trade, and service sectors responding to the growth in mining (Figure 18). After 1985, the mining activity is ex-

Table 16. Gross Output by Major Sector for Each of the Alternative Management Strategies, Southern High Plains, New Mexico, 1977-2020.

Sector	Gross Output ($1977)				
	1977	1985	1990	2000	2020
	(millions of dollars)				
Baseline					
Agriculture	379.341	489.997	517.929	553.091	586.987
Mining	974.507	1,584.912	1,433.644	807.067	335.258
Manufacturing	144.516	212.753	242.237	300.270	518.246
TCU*	141.188	189.859	234.989	188.354	242.438
Construction	44.344	423.834	124.120	59.108	66.439
FIRE**	134.088	198.459	232.448	151.234	136.790
Trade	107.210	242.122	223.844	168.801	172.900
Services	130.944	176.891	288.908	209.592	215.862
Total	2,056.138	3,518.827	3,298.119	2,437.517	2,274.920
Voluntary					
Agriculture	379.341	490.010	518.702	551.964	586.290
Mining	974.507	1,584.912	1,433.644	807.067	335.258
Manufacturing	144.516	212.753	242.237	300.270	518.246
TCU*	141.188	189.859	234.989	188.354	242.438
Construction	44.344	423.834	124.120	59.108	66.402
FIRE**	134.088	198.459	232.448	151.234	136.790
Trade	107.210	242.122	223.844	168.801	172.900
Services	130.944	176.891	288.908	209.592	215.862
Total	2,056.138	3,518.840	3,298.892	2,436.390	2,274.186
Mandatory					
Agriculture	379.341	490.131	518.938	553.335	588.654
Mining	974.507	1,584.916	1,433.650	807.073	335.269
Manufacturing	144.516	212.756	242.258	300.326	518.472
TCU*	141.188	189.981	235.262	189.334	245.020
Construction	44.344	423.839	124.142	59.150	66.639
FIRE**	134.088	198.504	232.555	151.594	138.005
Trade	107.210	242.141	223.919	169.023	173.751
Services	130.944	176.915	288.999	209.889	217.114
Total	2,056.138	3,519.183	3,299.723	2,439.724	2,282.924
Importation					
Agriculture	379.341	490.010	518.702	552.906	587.926
Mining	974.507	1,584.912	1,433.644	807.136	335.313
Manufacturing	144.516	212.753	242.237	300.426	519.010
TCU*	141.188	189.859	234.989	190.117	248.475
Construction	44.344	423.834	124.120	59.487	67.604
FIRE**	134.088	198.459	232.448	152.222	140.476
Trade	107.210	242.122	223.844	169.745	176.452
Services	130.944	176.891	288.908	210.705	220.687
Total	2,056.138	3,518.840	3,298.892	2,442.744	2,295.943

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

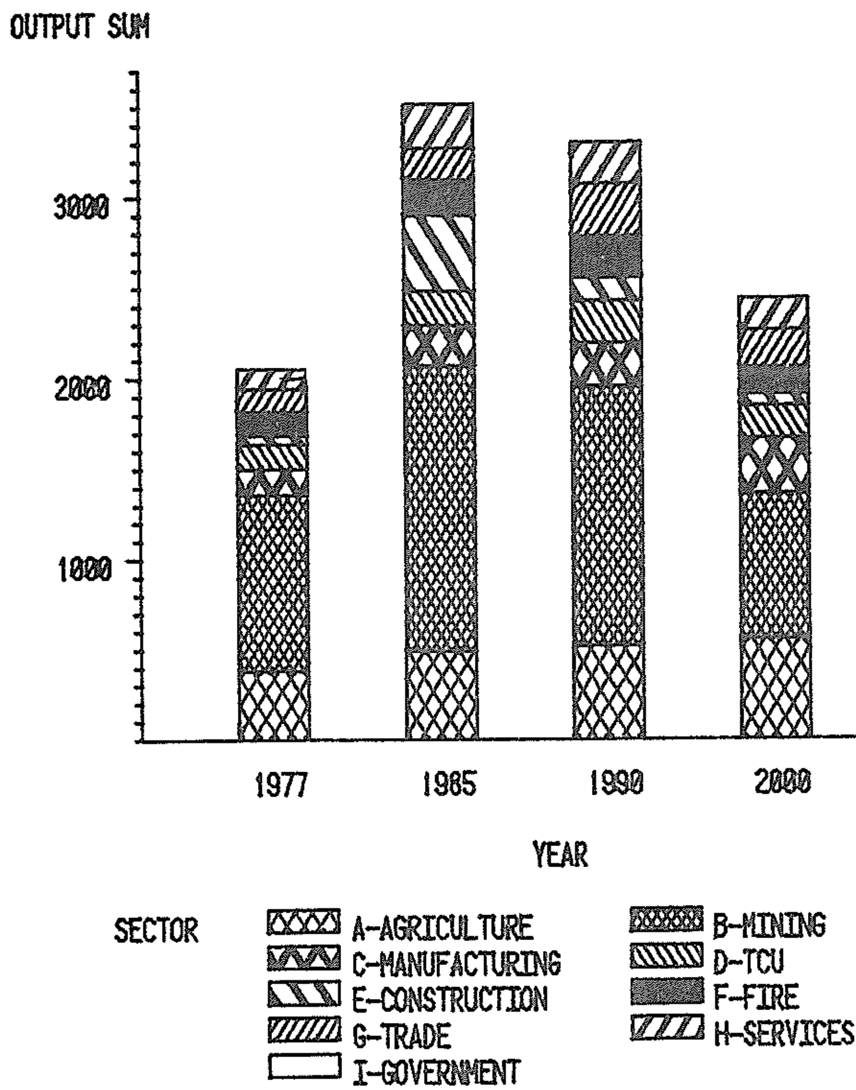

Figure 18. Projected Gross Output, Southern High Plains, Baseline Conditions, 1977-2020.

pected to decrease to about $1,434 million in 1990, $807 million in 2000, and $335 million in 2020. Crude oil production and casinghead and dry gas production are projected to decline.

The annual rate of decline, under the most likely projection, differs slightly for crude oil and casinghead gas. Crude oil production is estimated to decline 7 percent annually through 2020 (Figure 18), while casinghead gas production is estimated to decline 8 percent from 1980 through 1984, 9 percent from 1985 through 1989, and 10 percent from 1990 through 2020 (Figure 18). Dry gas production in the High Plains is expected to go from 146.8 billion cubic feet in 1980, to 113.3 billion cubic feet in 1985, and 7.1 billion cubic feet in 2020 (Figure 18).

Electrical Production. Most of the New Mexico High Plains region's electricity generation is located in the southern area. In 1979, total generating capacity in the region was 545.8 MW, of which 522.2 MW, or 95.7 percent originated from Lea County. The primary fuel for all generating units is natural gas. The projection of electricity sales is expected to increase substantially and to reach 5597.09 million kWh in 2020 (Figure 18). Nearly all new electricity will come from outside the High Plains region.

Additional details on energy impacts are presented in Appendix A. Appendix A also contains a sensitivity analysis on three levels of production--high, expected, and low.

Agricultural. The agricultural sectors in the Southern High Plains are expected to increase between 1977 and 2020 with about $379 million in 1977 and $587 million in 2020. This growth is projected to be relatively stable over the period (Figure 18). The agricultural sectors accounted for about 19 percent of the total output in 1977 and are projected to account for over 26 percent in 2020.

Manufacturing. The manufacturing sectors in the Southern High Plains are projected to increase from $145 million in 1977 to about $518 million in 2020, a growth of about 259 percent. The contribution of the manufacturing sectors to the total is expected to be about 6 percent in 1985, 7 percent in 1990, 12 percent in 2000, and 23 percent in 2020 (Table 16).

Transportation, Communication, and Utilities (TCU). The TCU sectors in the Southern High Plains, taken together, generally show an increase over the period with a decrease occurring in 2000. These sectors are projected to increase from $141 million in 1977 to $242 million in 2020 (Table 16). The contribution of these sectors to the total was about 7 percent in 1977 and is expected to reach 11 percent in 2020.

Construction. The construction sectors in the Southern High Plains are projected to increase significantly between 1977 and 1985, then decline to 2020 (Figure 18). These sectors accounted for about $44 million in 1977. They are projected to reach $425 million in 1985 (almost a 10-fold increase), and then decline to $66 million in 2020.

Finance, Insurance, and Real Estate (FIRE). The FIRE sectors in the Southern High Plains are projected to increase between 1977 and 1990, then decrease to 2020 as the total economy begins slowing down in the area (Table 16).

Trade. The trade sector in the Southern High Plains is expected to expand rapidly between 1977 and 1985, then decline through 2000 followed by a recovery in 2020 (Figure 18). In 1977, it accounted for about 5 percent of the total and by 2020 it is projected to reach almost 8 percent.

Service. The service sectors in the Southern High Plains are projected to expand rapidly between 1977 and 1990, then decline in 2000 followed by a recovery in 2020 (Figure 18). In 1977, they accounted for about 6 percent of the total and by 2020 they are projected to be more than 9 percent.

Employment

Northern High Plains. Total employment in the form of jobs for each alternative for each sector by year is reported in Table 17. Employment projected for the baseline is summarized by major sector in Figure 19. The total jobs were 5,342 in 1977, and are expected to increase to 6,509 in 1985, 6,861 in 1990, 7,172 in 2000, and 7,901 in 2020. Agriculture was the largest employer in 1977 accounting for about 37 percent. The percentage is expected to be about 30 percent in 1985, 27 percent in 1990, decreasing to 26 percent in 2000, and 22 percent in 2020. Trade employed about 21 percent in 1977, and is expected to employ 23 percent in 1985, 24 percent in 1990, 24 percent in 2000, and 27 percent in 2020. The government sector employed 18 percent in 1977 and is expected to employ 21 percent in 1985. It is expected to decline to 20 percent in 1990, 15 percent in 2000, and 11 percent in 2020. The mining sector accounts for less than 1.5 percent of the jobs throughout the period. Construction provided about 9 percent of the jobs in 1977. In 1985 and 1990, it is expected to contribute almost 10 percent, then increase to 13 percent in 2000 and 14 percent in 2020 (Table 17).

Table 17. Employment by Major Sector for Each of the Alternative Management Strategies, Northern High Plains, New Mexico, 1977-2020.

Sector	Jobs 1977	1985	1990	2000	2020
	(number of jobs)				
Baseline					
Agriculture	1,994	1,965	1,856	1,868	1,719
Mining	26	54	74	99	117
Manufacturing	60	89	85	78	71
TCU*	118	174	199	205	175
Construction	482	626	699	897	1,077
FIRE**	114	131	144	179	198
Trade	1,140	1,489	1,653	1,707	2,119
Services	461	644	797	1,077	1,573
Government	947	1,337	1,354	1,062	852
Total	5,342	6,509	6,861	7,172	7,901
Voluntary					
Agriculture	1,994	2,052	1,953	1,912	1,878
Mining	26	54	74	99	117
Manufacturing	60	89	85	78	71
TCU*	118	175	199	208	175
Construction	482	628	704	905	1,081
FIRE**	114	132	145	180	199
Trade	1,140	1,493	1,667	1,724	2,130
Services	461	648	803	1,087	1,581
Government	947	1,345	1,360	1,069	855
Total	5,342	6,616	6,990	7,262	8,087
Mandatory					
Agriculture	1,994	1,980	1,883	1,815	1,775
Mining	26	54	74	99	117
Manufacturing	60	89	85	78	71
TCU*	118	177	199	210	179
Construction	482	628	704	905	1,086
FIRE**	114	132	146	181	201
Trade	1,140	1,494	1,669	1,728	2,146
Services	461	648	804	1,090	1,596
Government	947	1,345	1,361	1,070	859
Total	5,342	6,547	6,925	7,176	8,030
Importation					
Agriculture	1,994	2,052	1,949	2,048	2,045
Mining	26	54	74	99	117
Manufacturing	60	89	85	78	71
TCU*	118	175	199	210	180
Construction	482	628	704	911	1,101
FIRE**	114	132	145	181	204
Trade	1,140	1,493	1,667	1,734	2,176
Services	461	648	803	1,093	1,615
Government	947	1,345	1,360	1,073	867
Total	5,342	6,616	6,986	7,427	8,376

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

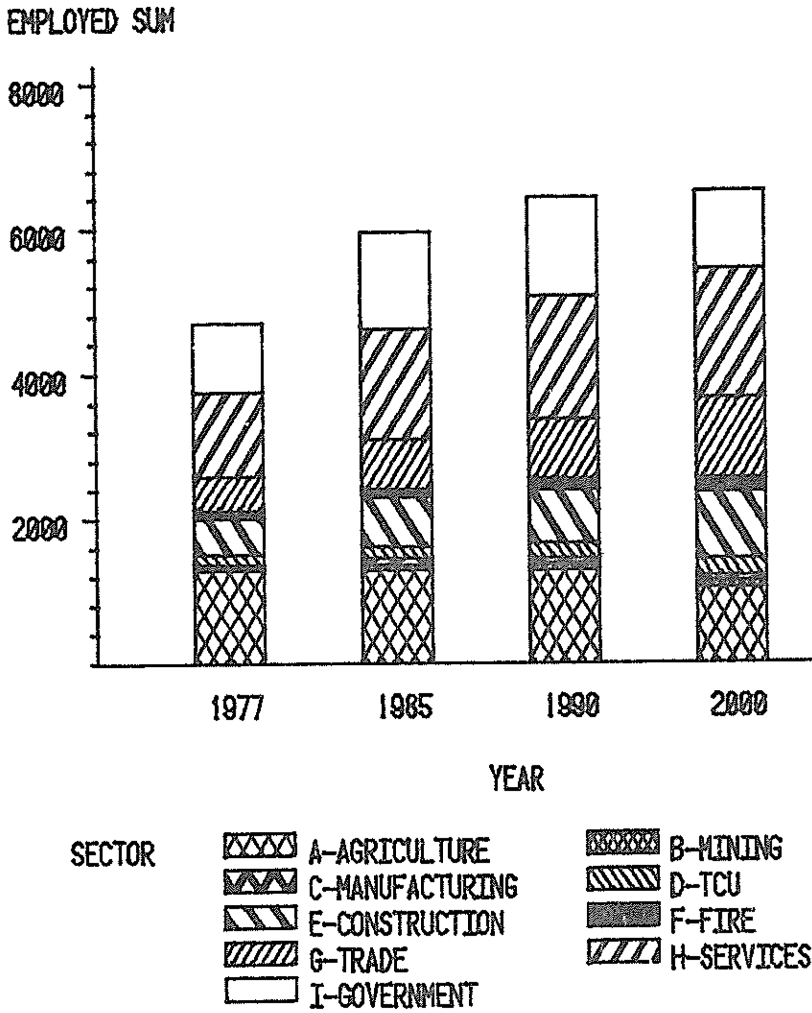

Figure 19. Projected Employment for Northern High Plains.

Southern High Plains. Total employment in the form of jobs for each alternative for each sector by year is reported in Table 18. Employment projected for the baseline is summarized by major sector in Figure 20. The total jobs were 31,907 in 1977, and are expected to increase to 64,518 in 1985, then decrease to 55,670 in 1990, 35,927 by 2000, and 27,081 in 2020. Government was the largest employer in 1977 accounting for about 26 percent. It is expected to account for about 18 percent in 1985, 25 percent in 1990 and 2000, and 27 percent in 2020. The trade sector employed about 21 percent in 1977, and is expected to employ 23 percent in 1985, 22 percent in 1990, 19 percent in

Table 18. Employment by Major Sector for Each of the Alternative Management Strategies, Southern High Plains, New Mexico, 1977-2020.

Sector	Jobs 1977	1985	1990	2000	2020
	(number of jobs)				
Baseline					
Agriculture	1,995	2,048	1,915	1,911	1,662
Mining	3,746	7,756	6,945	3,410	816
Manufacturing	1,563	2,541	2,221	1,802	1,781
TCU*	2,185	3,273	3,694	2,192	1,523
Construction	1,249	13,490	3,901	1,821	1,989
FIRE**	2,225	3,326	3,795	2,323	1,890
Trade	6,673	14,747	12,113	6,733	3,783
Services	4,116	5,823	9,429	6,596	6,299
Government	8,155	11,514	11,657	9,139	7,338
Total	31,907	64,518	55,670	35,927	27,081
Voluntary					
Agriculture	1,995	2,139	2,015	1,954	1,815
Mining	3,746	7,757	6,945	3,410	816
Manufacturing	1,563	2,545	2,228	1,808	1,783
TCU*	2,185	3,311	3,712	2,220	1,530
Construction	1,249	13,505	3,923	1,837	1,996
FIRE**	2,225	3,344	3,809	2,345	1,899
Trade	6,673	14,793	12,217	6,800	3,803
Services	4,116	5,849	9,491	6,651	6,332
Government	8,155	11,580	11,713	9,199	7,367
Total	31,907	64,823	56,053	36,224	27,341
Mandatory					
Agriculture	1,995	2,065	1,943	1,853	1,715
Mining	3,746	7,757	6,945	3,410	817
Manufacturing	1,563	2,545	2,228	1,810	1,786
TCU*	2,185	3,311	3,715	2,233	1,547
Construction	1,249	13,505	3,923	1,839	2,004
FIRE**	2,225	3,344	3,811	2,350	1,916
Trade	6,673	14,794	12,220	6,808	3,822
Services	4,116	5,849	9,493	6,660	6,365
Government	8,155	11,581	11,716	9,208	7,395
Total	31,907	64,751	55,994	36,171	27,367
Importation					
Agriculture	1,995	2,139	2,011	2,094	1,977
Mining	3,746	7,757	6,945	3,411	818
Manufacturing	1,563	2,545	2,228	1,812	1,792
TCU*	2,185	3,311	3,712	2,240	1,571
Construction	1,249	13,505	3,923	1,849	2,033
FIRE**	2,225	3,344	3,809	2,360	1,950
Trade	6,673	14,793	12,217	6,837	3,884
Services	4,116	5,849	9,491	6,683	6,466
Government	8,155	11,580	11,713	9,238	7,465
Total	31,907	64,823	56,049	36,524	27,956

* Transportation, Communication, and Utilities.
** Finance, Insurance, and Real Estate.

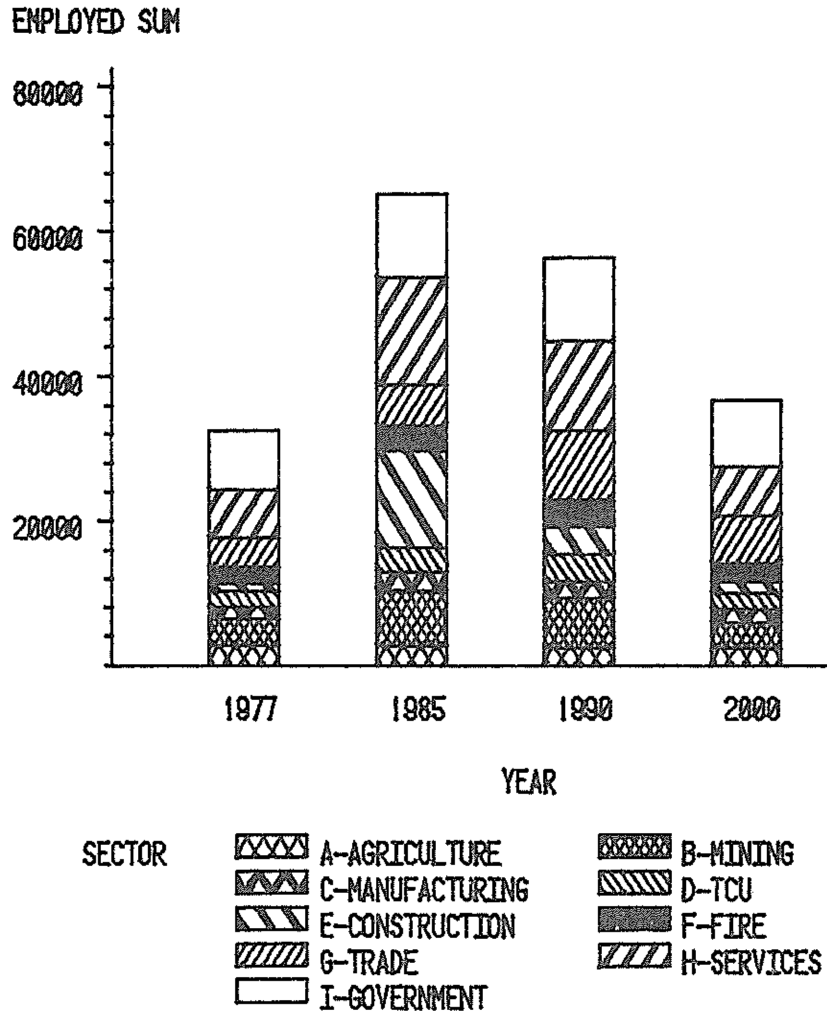

Figure 20. Projected Employment for Southern High Plains.

2000, and 14 percent in 2020. Services employed 13 percent in 1977 and is expected to employ 9 percent in 1985. It is expected to increase to 17 percent in 1990, 18 percent in 2000, and 23 percent in 2020. The mining sector accounted for 12 percent of the jobs in 1977, 12 percent in 1985 and 1990, 9 percent in 2000, and is projected to decline to 3 percent in 2020. Construction provided about 4 percent of the jobs in 1977, but in 1985 is expected to contribute more than 20 percent, then decrease to 7 percent in 1990, 5 percent in 2000, and then increase to 7 percent in 2020 (Table 18).

Population

Northern High Plains. The total population for the Northern High Plains region for the baseline alternative is presented in Table 19. The region is projected to lose 677 people between 1977 and 1985, a decrease of about 3 percent. However, between 1985 and 1990, the population is projected to increase by 2,011, or about 11 percent. By 2000, the population is projected to be just above its 1977 level at 24,349 people. In 2020, the population is projected to increase even further to 26,606. This is about a 36 percent increase from the 1977 level.

Southern High Plains. The total population for the Southern High Plains region for the baseline alternative is presented in Table 19. The region is projected to gain 70,281 people between 1977 and 1985, an increase of about 60 percent. This is an annual growth rate of about 7.5 percent. However, between 1985 and 1990, the population is projected to decrease by 17,610, or about 9 percent. By 2000, the population is projected to be just above its 1977 level at 121,973 people. In 2020, the population is projected to decrease to 91,192. This is about 78 percent of the 1977 level.

Alternative Management Strategies

Gross Output

Northern High Plains. The gross output by major sector for each of the alternative management strategies is also summarized in Table 15. For 1977, all output estimates for the management strategies were the same as the baseline.

By 2020, output under the voluntary management strategy is expected to be $846,000 greater than the baseline. Output is projected to increase by $866,000 in the agricultural sectors. The projected output under the mandatory management strategy is $2.692 million greater than under the baseline. Agriculture is projected to increase by $656,000 from the baseline. All the other sectors are projected to increase by $2.036 million.

Table 19. Summary of Population Projections for Northern and Southern High Plains for Each of the Management Strategies, 1977-2020.

	1977	1985	1990	2000	2020
Baseline					
Northern High Plains					
Quay	6,414	6,725	7,638	8,851	9,661
Union & Harding	13,131	12,143	13,241	15,498	16,945
Subtotal NHP	19,545	18,868	20,879	24,349	26,606
Southern High Plains					
Lea	63,055	130,930	100,917	51,893	33,923
Roosevelt	7,197	7,241	9,613	10,572	8,388
Curry	46,078	48,450	58,425	58,934	48,238
Quay	410	400	456	574	643
Subtotal SHP	116,740	187,021	169,411	121,973	91,192
Total High Plains	136,285	205,889	190,290	146,322	117,798
Voluntary					
Northern High Plains					
Quay	6,414	6,772	7,712	8,922	9,767
Union and Harding	13,131	12,383	13,553	15,685	17,478
Subtotal NHP	19,545	19,155	21,265	24,607	27,245
Southern High Plains					
Lea	63,055	131,200	101,455	52,181	34,209
Roosevelt	7,197	7,310	9,723	10,653	8,530
Curry	46,078	48,761	58,880	59,330	48,715
Quay	410	405	462	576	657
Subtotal SHP	116,740	187,676	170,520	122,740	92,111
Total High Plains	136,285	206,831	191,785	147,347	119,356
Mandatory					
Northern High Plains					
Quay	6,414	6,752	7,701	8,904	9,786
Union and Harding	13,131	12,204	13,369	15,400	17,237
Subtotal NHP	19,545	18,956	21,070	24,304	27,023
Southern High Plains					
Lea	63,055	131,161	101,445	52,109	34,162
Roosevelt	7,197	7,273	9,685	10,604	8,508
Curry	46,078	48,635	58,784	59,225	48,784
Quay	410	402	456	566	646
Subtotal SHP	116,740	187,471	170,370	122,504	92,100
Total High Plains	136,285	206,427	191,440	146,808	119,123
Importation					
Northern High Plains					
Quay	6,414	6,772	7,713	9,003	9,959
Union and Harding	13,131	12,383	13,542	16,116	18,147
Subtotal NHP	19,545	19,155	21,255	25,119	28,106
Southern High Plains					
Lea	63,055	131,200	101,465	52,417	34,794
Roosevelt	7,197	7,310	9,724	10,789	8,751
Curry	46,078	48,761	58,879	59,736	49,582
Quay	410	405	462	588	681
Subtotal SHP	116,740	187,676	170,530	123,530	93,808
Total High Plains	136,285	206,831	191,785	148,649	121,914

By 2020, output under the importation strategy is projected to be $5.275 million greater than under the baseline, and $4.429 million greater than under the voluntary strategy. Agricultural output is projected to be $325,000 greater than under the baseline and $541,000 less than under the voluntary strategy.

Southern High Plains. The gross output by major sector for each of the alternative management strategies is also summarized in Table 16. For 1977, all output estimates for the management strategies were the same as the baseline.

By 2020, output under the voluntary management strategy is expected to be $734,000 less than under the baseline. Output is projected to decrease by $697,000 in the agricultural sectors. The projected output under the mandatory management strategy is $8.004 million more than under the baseline. Agriculture is projected to increase $1.667 million and all the other sectors are projected to increase by $6.337 million.

By 2020, output under the importation strategy is projected to be $21.023 million more than under the baseline and $21.757 million more than under the voluntary strategy. Agricultural output is projected to be $939,000 more than under the baseline and $1.636 million more than under the voluntary strategy. Output for all other sectors is projected to be $20.084 million more than under the baseline and $20.121 million more than under the voluntary strategy.

Employment

Northern High Plains. Employment in the form of jobs for each of the alternative management strategies is also summarized in Table 17 by major sector. The number of jobs were the same for all management strategies in 1977.

In 2020, the voluntary strategy is projected to result in 186 more jobs than the baseline. By sector, agriculture is expected to result in 159 more; mining, same; manufacturing, same; TCU, same; construction, 4 more; FIRE, one more; trade, 11 more; services, 8 more; and government, 3 more. The mandatory strategy is expected to result in 129 more jobs than the baseline in 2020; agriculture, 56 more; mining, same; manufacturing, same; TCU, 4 more; construction, 9 more; FIRE, 3 more; trade, 27 more; services, 23 more; and government, 7 more. The importation strategy is projected to result in 475 more jobs than under the baseline and 289 more than under the voluntary.

Southern High Plains. Employment in the form of jobs for each of the alternative management strategies is also summarized in Table 18 by major sector. The number of jobs were the same for all management strategies in 1977.

In 2020, the voluntary strategy is projected to result in 260 more jobs than the baseline. By sector, agriculture is expected to result in 153 more; mining, same; manufacturing, 2 more; TCU, 7 more; construction, 7 more; FIRE, 9 more; trade, 20 more; services, 33 more; and government, 29 more. The mandatory strategy is expected to result in 286 more jobs than the baseline in 2020; agriculture, 53 more; mining, one more; manufacturing, 5 more; TCU, 24 more; construction, 15 more; FIRE, 26 more; trade, 39 more; services, 66 more; and government, 57 more. The importation strategy is projected to result in 1,223 more jobs than under the baseline and 839 more than under the voluntary strategy.

Population

Northern High Plains. The total population for each of the management strategies is also summarized in Table 19. For 1977, all projections for the management strategies were the same. For 1985, population under the voluntary and importation strategies is projected to be 287 greater than under the baseline. The mandatory strategy is projected to result in 88 more people than the baseline in 1985. In 1990, voluntary is projected to result in 386 more people than the baseline, and importation is 10 less than voluntary. In 2020, voluntary is expected to result in 639 more people than the baseline, and mandatory is projected to result in 417 more people than the baseline. Also in 2020, importation results in 861 more people than voluntary. The importation strategy is expected to result in the greatest population in 2020 in the Northern High Plains with 28,106. This is only 1,500 more than the baseline which has a 26,606 projected population.

Southern High Plains. The total population for each of the management strategies is also summarized in Table 19. For 1977, all projections for the management strategies were the same. For 1985, population under the voluntary and importation strategies is projected to be 655 greater than under the baseline. The mandatory strategy is projected to result in 450 more people than the baseline in 1985. In 1990, voluntary is projected to result in 1,109 more people than the baseline, and importation is 10 more than voluntary. In 2020, voluntary is expected to result in 919 more people than the baseline, and mandatory is projected to result in 908 more people than the baseline. Also in 2020, importation results in 1,697 more people than voluntary. The importation strategy is expected to result in the greatest population in 2020 in the Southern High Plains with 93,808 people. However, this is only 2,616 more than the baseline which has a 91,192 projected population.

SUMMARY

The economy of the High Plains region of eastern New Mexico is highly dependent upon mining (oil and gas production) and agriculture. These two sectors together accounted for about 69 percent of the total gross output in 1977. The mining sector is projected to expand significantly by 1985, but then begin declining. By 2020, it is expected to be about 39 percent of its 1977 level. Agriculture is expected to increase between 1977 and 2020 and become the mainstay of the area's economy.

In terms of the jobs provided by the sectors, agriculture, even though it accounted for between 32 and 44 percent of the gross output in 1977, only provided about 6 to 10 percent of the employment. By 2020, it is expected to provide about 10 percent of the jobs in the local economy. The total employment level can be expected generally to follow the total gross output levels. Even though the gross output is expected to be higher in 2020, the number of jobs in 2020 is projected to be less than the 1977 level.

The area's population also is expected to follow the projected patterns of the output and employment. The population is expected to increase initially, then decline to about 86 percent of the 1977 level by 2020.

The Permian Basin of southeastern New Mexico has long been one of the long-term major oil-producing provinces in the nation. Annual rates of decline, under the most likely projections, differ slightly for crude oil and casinghead gas. Crude oil production is estimated to decline 7 percent annually through 2020, while casinghead gas production is estimated to decline 8 percent from 1980 through 1984, 9 percent from 1985 through 1989, and 10 percent from 1990 through 2020. Dry gas production in the High Plains is expected to go from 148.6 billion cubic feet in 1980, to 124.3 billion cubic feet in 1985, to 7.2 billion cubic feet in 2020.

Most of the New Mexico High Plains region's electricity generation is located in the southern area. In 1979, total generating capacity in the region was 541.0 MW, of which 517.4 MW, or 95.6 percent, originated from Lea County. The primary fuel for all generating units was natural gas. The most likely projection shows electricity sales increasing substantially in 1985. During the 1980-85 time frame, sales are expected to increase 59 percent. By the year 2020, electricity sales are projected to reach 5597.09 million kWh. The overall results of the electric projections indicate increasing electricity sales but at a decreasing rate. Nearly all new electricity is expected to come from outside the High Plains region.

In the Southern High Plains of New Mexico, a continuation of past trends (the baseline case) is estimated to result in the greatest reduction of irrigated acreage, on-farm employment, reductions in irrigation water diversions (about 500,000 acre-feet), declines in both the value of production and returns to land and management; and the least increase in total returns of any of the management strategies examined. If voluntary water demand reduction policies are implemented, increased irrigated acreage, water diversions, on-farm employment, and increases in both value of production and returns in the latter part of the study period are expected.

Implementation of a mandatory water supply reduction policy on the Southern High Plains is expected to result in the least reduction in irrigated acreage (unless water is imported). However, this would be accomplished only with an anticipated reduction in water diversions and on-farm employment almost equal to that of the baseline case. Significant reductions in returns ($275 million) are also expected during the first half of the study period with slightly higher returns and irrigated acreage in 2020 than for the baseline or the voluntary strategy.

If the natural water supply in the Southern High Plains is augmented with imported water during the last half of the study period, it is expected to result in the greatest increase in total and irrigated returns, irrigated acreage, water diversions, and on-farm employment.

If the natural water supply in the Southern High Plains is augmented with imported water under the conditions of voluntary water demand reductions during the last half of the study period, it is expected there would be the least impacts on irrigated acreage, water diversions, and on-farm employment. In addition, it is anticipated that this policy would result in by far the greatest increase in both total and irrigated returns in the latter part of the study period.

Under the importation strategy, irrigated value of production and returns to land, management, and water are expected to increase significantly in 2000 and 2020. This is because imported water will enable previously irrigated areas that had been dewatered to restore irrigation. In addition to the acreage restored to irrigation, there is expected to be no water cost associated with the imported water which further increases net returns. The irrigated value of production and returns to land, management, and water are expected to be the highest of any management strategy in 2000 and 2020 under the importation strategy. The importation strategy, therefore, is expected to provide for the greatest economic recovery.

The cost of importing water appears to be prohibitive based on the Corps of Engineers estimates and the ability of farmers to pay. Route D's costs, as proposed by the U.S. Army Corps of Engineers, are expected to range from $320 to $370 per acre-foot. In addition to these costs, $200 to $400 per acre-foot would be needed to construct local distribution systems to deliver water from terminal storage to farm headgates. Farmers can only afford to pay about $150 per acre-foot.

	Ability to Pay in 2020		
	(Acres)	($/Acre)	($/Ac-Ft)
Portales East	25,500	251.43	164.33
Curry County	157,900	231.78	151.49
Quay County (House Area)	5,000	43.68	21.31
TOTAL	188,400		
Weighted Average		$229.45	$149.77

The dryland value of production and net returns to land and management for the importation strategy and for 2000 and 2020 are expected to be less than the other management strategies. This is due to the restoration of previously irrigated, presently dryland acreage back into irrigation with imported water. The value of production and returns to rangeland for the importation strategy are estimated to be the same as for the voluntary strategy.

Local water supply augmentation and intrastate water transfers will not furnish enough water to alter the time when irrigation goes out of production by more than a year or two.

Surplus water supplies available for interstate transport for the adjacent areas must be determined before any import scheme can be considered. If water supplies were available, a project of this magnitude would require many years to complete. Water from an interstate transport scheme probably would not be available to the High Plains until about 2020. Even if it is determined that surplus water could be brought to New Mexico's High Plains and that political, legal, environmental, and other problems could be put to rest, it is unlikely that such a project could be completed in time to save much of the irrigated economy. As indicated previously, much of the presently irrigated land in southern Quay, Curry, and Roosevelt counties will have gone out of production by 2020.

	Year Irrigation Ceases		
County	Baseline	Voluntary	Mandatory
Union	2060	2060	2100
Harding	2063	2063	2108
Quay (House Area)	2010	2013	2016
Curry	2015	2017	2023
Roosevelt	2021	2027	2041
Lea	2085	2096	2114

In the Northern High Plains of New Mexico, no aquifer is expected to be exhausted by 2020. Therefore, the proposed policies to import water are estimated to have little effect except for minor adjustments caused by changing crop prices. The baseline case is expected to result in only minor increases in irrigated acreage, the greatest increase in water diversions, and an increase in on-farm employment. Total returns and returns on irrigated agriculture are anticipated to increase significantly over the study period. The proposed voluntary water demand reduction policy is expected to result in the greatest increase in irrigated acreages with a reduction in irrigation water diversions, and a slight increase in on-farm employment. The returns under this policy are estimated to be the greatest under any policy. If the mandatory irrigation water supply reduction policy is implemented, it is expected to result in a reduction of irrigated acreage, water diversions (52,000 acre-feet), and on-farm employment, as well as the anticipated growth in returns.

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APPENDIX A
ENERGY IMPACTS

This section contains a summary of the electrical energy impacts and the oil and casinghead gas energy impacts on the High Plains region of New Mexico (extracted from Miller and Hill, 1981). All of the energy production in the High Plains is located in Lea and Roosevelt counties. Lea County accounts for about 90 to 95 percent of all energy produced on the High Plains.

ELECTRICAL ENERGY IMPACTS

Electric Generating Capacity

Generating capacity projections were made on a region-wide basis and gave considerable weight to assessments made by the utilities and cooperatives serving the High Plains region. It could reasonably be argued, however, that additional capacity will most likely continue to be concentrated in the Southern High Plains region, given the more diverse structure of the local economy and its proximity to fuel sources.

Electric Energy Production

The projected unit performance for 1980 and 1990 is summarized in Table A-1. New combustion turbine capacity would be for peakload generation with an annual output of 1,500 full load hours; new combined cycle capacity would be for intermediate operation with an annual output of 3,500 full load hours.

The low, expected, and high band projections of electric energy production by power plants in the New Mexico High Plains are presented in Table A-2 and generating capacity in Table A-3 (Figure A-1). In these projections, the 1985 values are linear interpolations between the 1980 and 1990 values.

Under all scenarios, production within the study region is projected to diminish as existing units are retired or put on standby. The cost and availability of water and fuel (i.e., coal) were considered in the analysis.

Table A-1. Projected Performance in 1980 and 1990 for Power Plants in the New Mexico High Plains.

Station (Units)	Capacity	1980 Performance	1990 Performance
North Lovington Diesel (Lea County)	19	Average of 1977 and 1978 capacity factors	Retired
North Lovington S-1 & 2 (Lea County)	49	Average of 1977 and 1978 capacity factors	Peakload: 1,500 full-load hours
Maddox 1 (Lea County)	118	Average of 1977 and 1978 capacity factors	Intermediate: 3,500 full-load hours
Maddox 2 (Lea County)	66	Average of 1977 and 1978 capacity factors	Peakload: 1,500 full-load hours
Cunningham 1 (Lea County)	75	Average of 1977 and 1978 capacity factors	Retired
Cunningham 2 (Lea County)	190.4	Average of 1977 and 1978 capacity factors	Peakload: 1,500 full-load hours

Table A-2. Projected Annual Electric Energy Production for the High Plains, New Mexico, 1985-2020.

Year	Electricity Production		
	Low Band	Expected Band	High Band
	(gigawatt-hours)		
1985	1,886	1,886	2,074
1990	887	887	1,262
2000	0	375	1,250
2020	0	375	1,250

Table A-3. Projected Annual Electric Energy Generating Capacity for the High Plains Region, New Mexico, 1985-2020.

Year	Electric Energy Production		
	Low	Most Likely	High
	(MW-hours)		
1985	522	522	522
1990	447	447	697
2000	0	250	500
2020	0	250	500

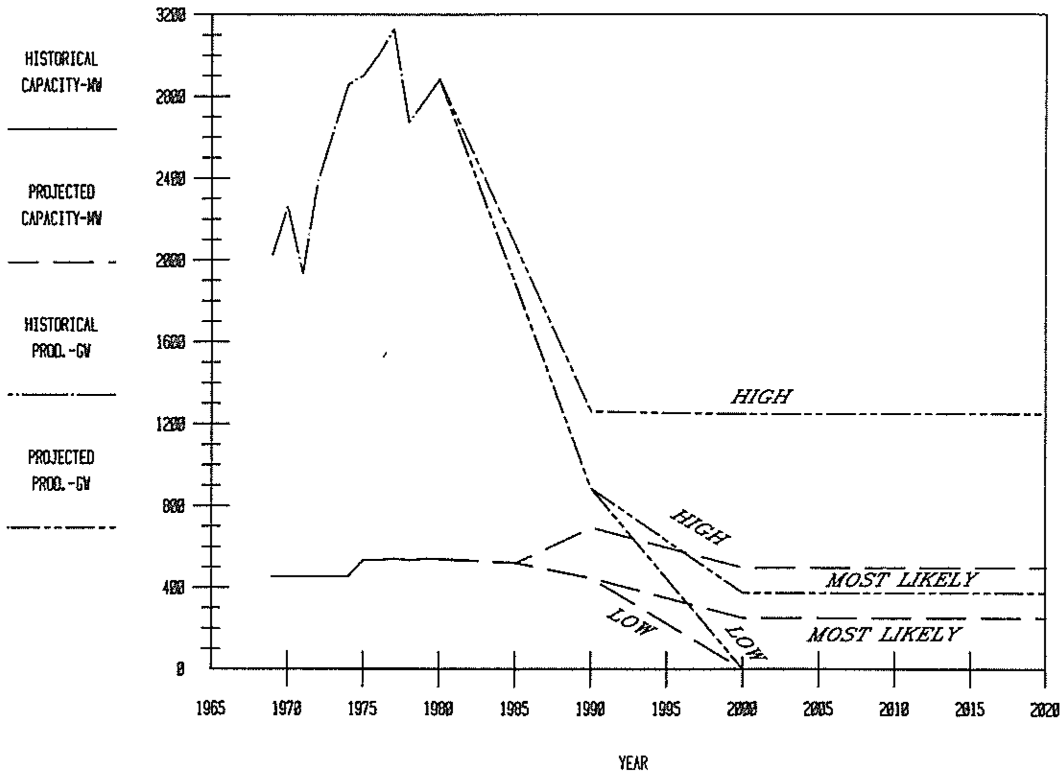

Figure A-1. Electricity Generation and Production, Historical and Most Likely Projected Levels, High Plains Region.

Electricity Sales

Historical and projected electricity sales for the High Plains region are presented in Table A-4 and Figure A-2. Electricity sales for 1969-78, on a county-level basis, are included in Appendix B of the final New Mexico energy report by Miller and Hill (1981).

Under the low projections, electricity sales in the study area are projected to increase from 1,768.87 million KWh in 1980 to 5,053.97 million KWh in 2020, an overall increase of 186 percent. The underlying assumption of this scenario is that regional electricity sales will continue to increase, but at a decreasing rate. For example, electricity sales increased 59 percent from 1969 through 1978 (Table A-5), while sales are projected to increase only 57 percent for the 1980-1990 time frame. Higher electricity price is the primary factor expected to reduce the growth rate. Population, conservation, and previous patterns

Table A-4. Projected Annual Electricity Energy Sales for the High Plains Region, New Mexico, 1985-2020.

Year	Electricity Sales	
	Low	Most Likely
	----------(million kilowatt hours)---------	
1985	2,277.82	2,820.93
1990	2,781.77	3,324.89
2000	3,745.66	4,288.78
2020	5,053.97	5,597.09

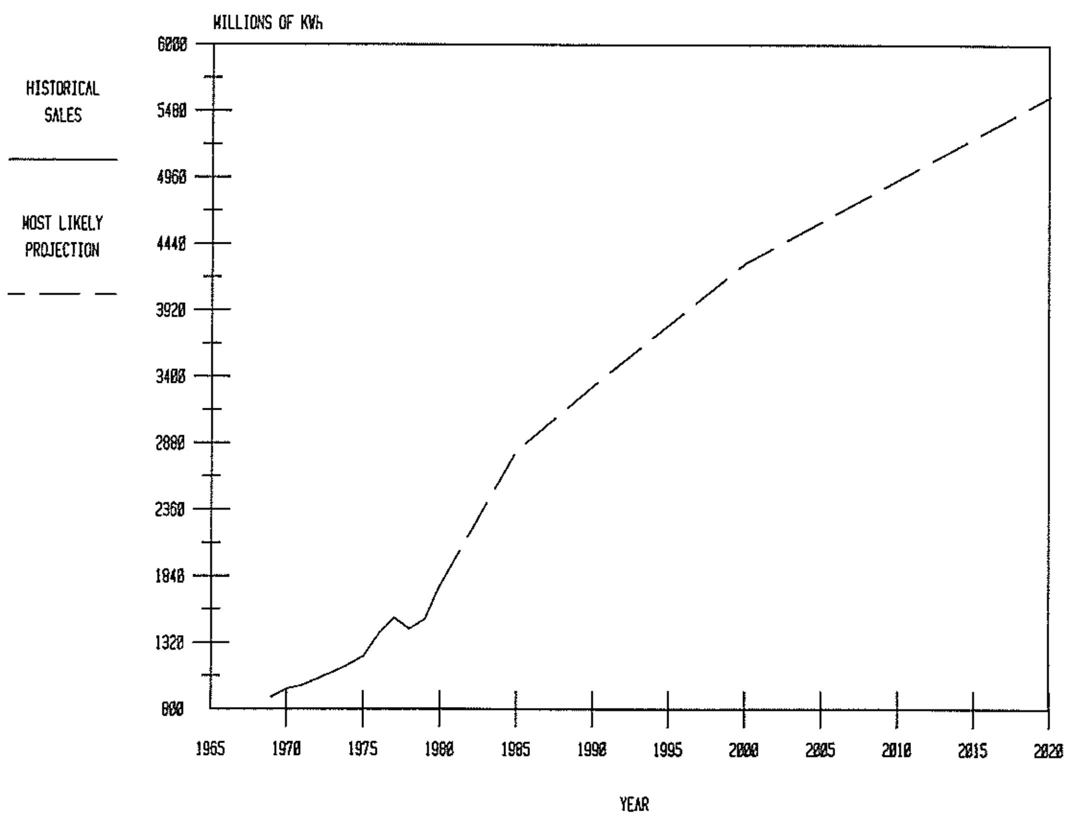

Figure A-2. Historical and Projected Electric Sales for the High Plains Region, New Mexico, 1969-2020.

Table A.5. Historical Electric Energy Production in the New Mexico High Plains, 1969-1978.

County	Utility	Plant	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
			(gigawatt-hours)									
			Annual Electricity Generation									
Lea	Lea County Elec. Coop.	N. Lovington	253.00*	265.14	278.08	278.88	-	281.45	295.24	341.51*	387.78	294.08
	N.M. Electric Service	Hobbs	560.38	617.16	0.01	0.01	-	0.01	0.01	0.01*	0.01	-
		Maddox	-	-	478.17	559.53	-	591.48	585.18	669.92*	759.66	689.06
	Southwestern Public Service	Cunningham	1,174.06	1,343.62	1,139.84	1,499.00	-	1,935.50	1,970.40	1,944.40*	1,927.88	1,634.41
Quay	Southwestern Public Service	Tucumcari	38.00*	38.00	38.00	38.00	-	40.30	42.30	42.30	42.30	42.30
Union	City of Clayton	Clayton	0.95*	0.95	0.95	0.44	-	12.87	11.44*	10.00	12.49*	14.98
Total			2,026.39*	2,264.87	1,935.05	2,375.86	2,623.73*	2,861.61	2,904.57*	3,008.14	3,130.12*	2,674.83

* Value is estimated or includes estimated values.

Source: Data from Electrical World, Directory of Electric Utilities, various years, as compiled by Black & Veatch, Kansas City, Missouri.

were also considered to be contributing factors by Southwestern Public Service Company.

The most likely projection shows electricity sales increasing substantially by 1985. During the 1980-85 time frame, sales are expected to increase 59 percent under this scenario compared to a 29 percent increase under the low projection. Carbon dioxide development in the Bravo Dome area (Union, Harding, and Quay counties) accounts for this larger increase. By the year 2020, electricity sales are projected to reach 5,597.09 million KWh, which is about 10 percent greater than the sales level under the low scenario. The overall impact of these projections is increased electricity sales at a decreasing rate. This corresponds with most other electricity demand projections which were reviewed in the course of the study.

OIL AND CASINGHEAD GAS IMPACTS

High Plains Crude Oil and Casinghead Gas Production

A 5 percent annual decline through 2020 in the production of both crude oil and casinghead gas is expected under the high projection assumption (Figure A-3). Annual crude oil production in 1985 is estimated to be 37.28 million barrels and is expected to decline to 6.19 million barrels in 2020, or a decrease of 83 percent from the 1985 level of production (Table A-6). Casinghead gas production also is expected to drop off 83 percent during this time frame, from 153.3 billion cubic feet in 1985 to 25.5 billion cubic feet in 2020 (Figure A-4). Under the low projection, both crude oil and casinghead gas production are expected to decline 97.5 percent by 2020 from the 1985 production levels (i.e., 25.53 million barrels of oil and 105.0 billion cubic feet of casinghead gas) (Table A-6).

The most likely projections of crude oil production are expected to drop off to 2.53 million barrels in 2020, which is a 92 percent reduction from the 1985 production level of 32.12 million barrels. Casinghead gas production is estimated to be 122.4 billion cubic feet in 1985 and is expected to decrease 97 percent by 2020 to 3.2 billion cubic feet (Figure A-4).

Dry Gas Production

The dry gas production projection under the high projection production levels of dry gas in the High Plains region by 2020 is estimated to amount to 7.2 billion cubic feet, or a 94 percent reduction from the 1985 level of 124.3 billion cubic feet (Table A-7).

The annual rate of decline under the low projection scenario indicates a level of production in the High Plains in 2020 to be 3.2 billion cubic feet, or 97 percent lower than the estimated 1985 production level of 102.9 billion cubic feet (Figure A-5).

Under the most likely projection, dry gas production in the High Plains region in 1985 is estimated to be 114.4 billion cubic feet. By the year 2020, production is projected to have dropped to 5.8 billion cubic feet.

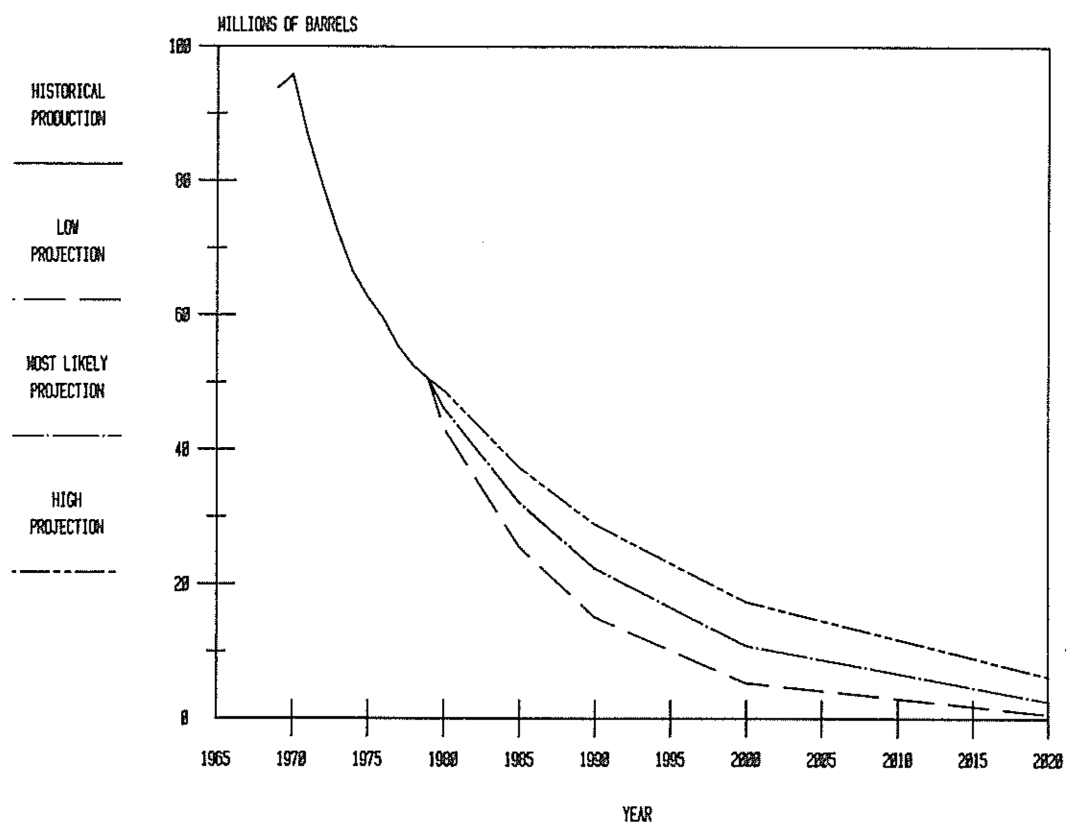

Figure A-3. Crude Oil Production for the High Plains Region, Historical and Projected Amounts, 1965-2020.

Table A-6. Projected Annual Oil Production and Casinghead Gas for the High Plains Region, 1985-2020.

Year	Oil Production Low	Oil Production Most Likely	Oil Production High	Casinghead Gas Production Low	Casinghead Gas Production Most Likely	Casinghead Gas Production High
	----(millions of barrels)----			---(billions of cubic feet)--		
1985	25.53	32.12	37.28	105.0	122.4	153.3
1990	15.08	22.34	28.84	62.0	76.4	118.6
2000	5.26	10.81	17.27	21.6	26.6	71.0
2020	.64	2.53	6.19	2.6	3.2	25.5

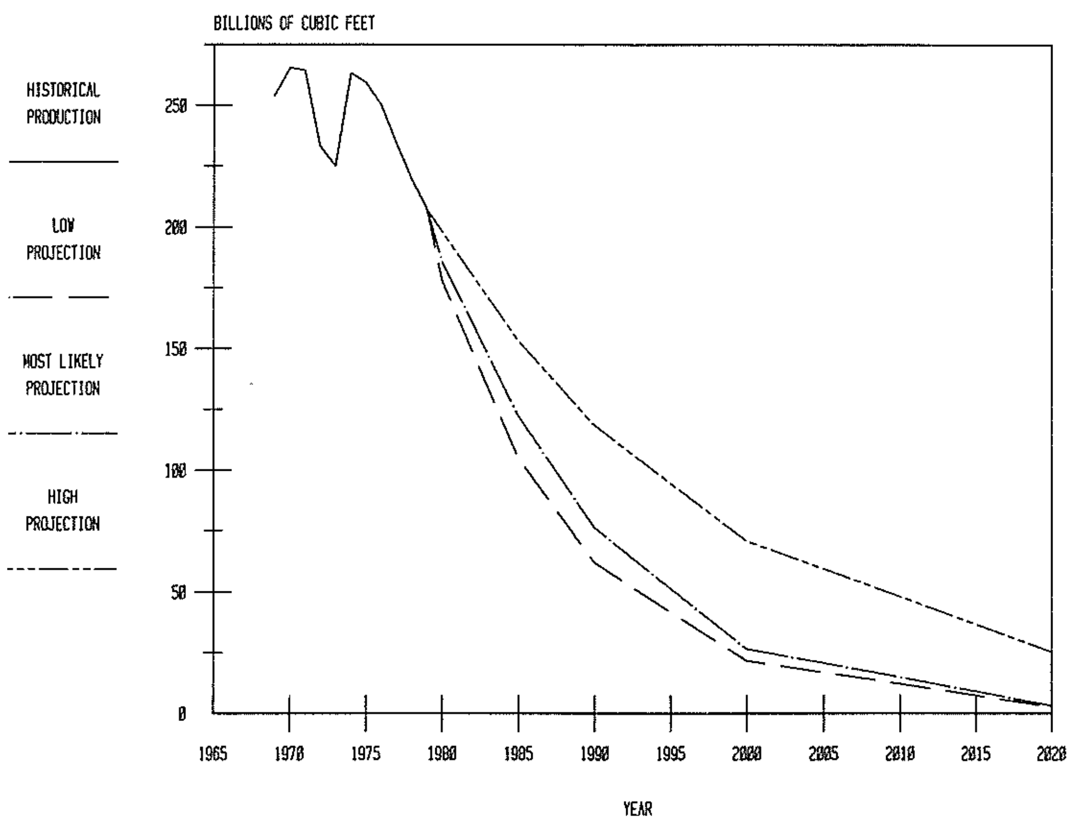

Figure A-4. Casinghead Gas Production for the High Plains Region, Historical and Projected Amounts, 1965-2020.

Table A-7. Projected Dry Gas Production for the High Plains Region, 1985-2020.

Year	Dry Gas Production		
	Low	Most Likely	High
	(billions of cubic feet)		
1985	102.9	114.4	124.3
1990	68.5	85.8	98.2
2000	27.2	40.3	50.1
2020	3.2	5.8	7.2

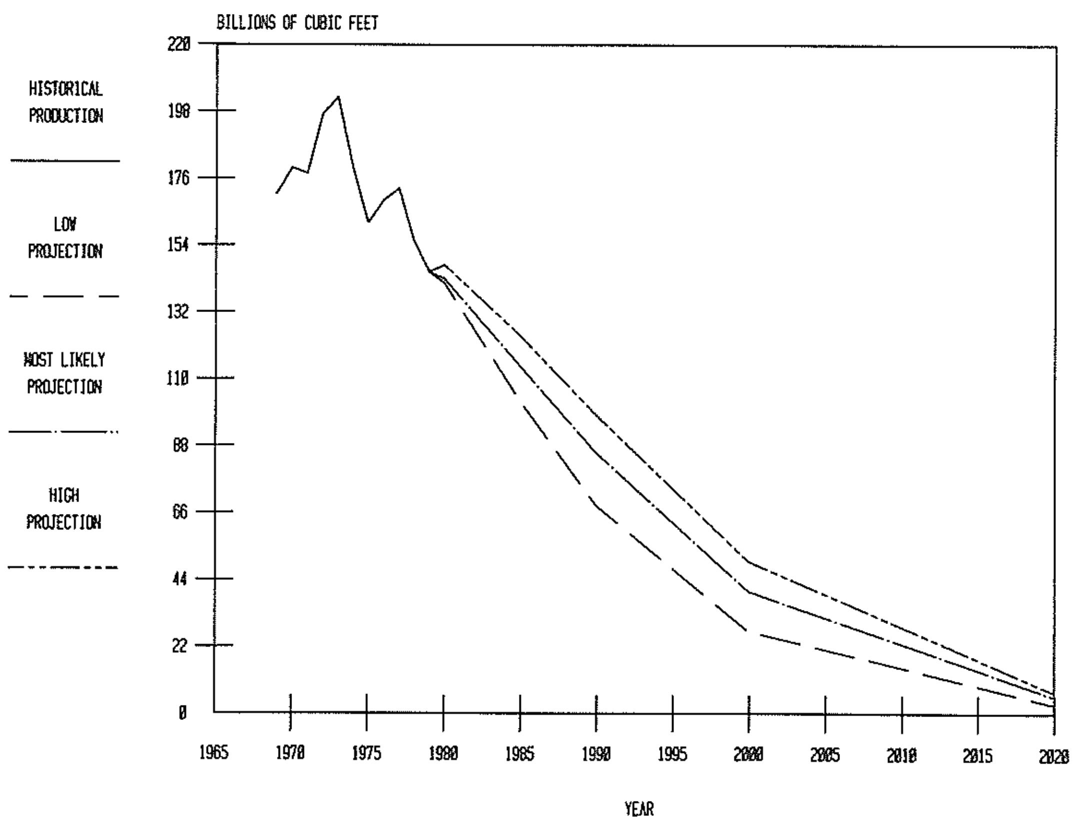

Figure A-5. Dry Gas Production for the High Plains Region, Historical and Projected Amounts, 1965-2020.

Table B-1. Hydrologic and Irrigation System Information, Baseline Conditions, Northern High Plains, 1977.

Item	Units	Quay County: Porter/ San Jon*	Quay County: Arch Hurley**	Quay County: Nara Visa South	Quay County: Logan Nara Visa*	Union/Harding Counties: ground water	Union County*+: Dry Cimarron
Hydrologic Information							
Saturated thickness	feet	100	N/A	100	100	50	100
Maximum irrigated acreage	acres	1,200	26,200	2,820	800	49,800	2,600
Depth-to-water	feet	70	10	300	130	200	65
Average water withdrawals (1977 base)	acre-feet	1,800	50,200	5,900	1,100	113,500	7,200
Average water decline	ft./yr.	.50	N/A	.50	.50	.30	.10
Gallons per minute							
flood	gpm	--	--	--	--	--	700
sprinkler	gpm	800	800	1,800	650	900	--
Specific Capacity	gpm/ft. drawdown	80	N/A	40	40	40	80
Irrigation Systems							
Type							
flood	percent	--	75	--	--	--	100
sprinkler	percent	100	25	100	100	100	--
Pumping plant fuels							
natural gas	percent	--	--	--	--	78	--
electricity	percent	100	--	--	--	5	--
diesel	percent	--	100	--	100	10	--
LPG	percent	--	--	100	--	7	100
Average pumping plant efficiencies++							
natural gas	percent	--	--	--	--	11.5	--
electricity	percent	36.9	--	--	--	55.1	--
diesel	percent	--	11.1	--	11.1	16.6	--
LPG	percent	--	--	10.4	--	15.5	16.6

* Estimated by the researchers.
** Surface water supplied area, information is for pressurization of surface water to sprinklers.
+ Combination surface and ground water area.
++ Good efficiency.

APPENDIX B

HYDROLOGIC AND IRRIGATION SYSTEMS INFORMATION

Table B-2. Hydrologic and Irrigation System Information, Baseline Conditions, Southern High Plains, 1977.

Item	Unit of Measure	Lea County	Roosevelt County				Curry County Saturated Thickness			Quay County
			Causey-Lingo	Portales East	Portales West	Blackwater Draw	50 ft.	50-100 ft.	100 ft.	House-Wheatland
Hydrologic Information										
Saturated thickness	feet	135	50	100	75	125	50	70	125	50
Maximum irrigated acreage	acres	82,600	8,800	24,800	36,200	36,500	33,000	66,000	56,000	5,000
Depth-to-water	feet	70	70	50	75	125	325	250	270	100
Average water withdrawals (1977 base)	acre-ft.	227,100	12,900	51,800	82,400	71,200	64,400	132,300	112,900	13,900
Average water decline	ft./yr.	0.8	1.0	2.4	1.2	2.4	3.0	3.0	3.0	1.0
Gallons per minute										
flood	gpm	820	--	700	400	--	800[1]	650	850	680
sprinkler	gpm	580	400	760	400	850	400	550	850	450
Specific capacity	gpm/ft. drawdown	60	15	40	40	40	40	40	40	40
Irrigation Systems										
Type										
flood	percent	40	--	17	59	--	50	73	80	10
sprinkler	percent	60	100	83	41	100	50	27	20	90
Pumping plant fuels										
natural gas	percent	65	--	--	40	--	92	92	92	--
electricity	percent	35	100	84	60	93	8	8	8	80
diesel	percent	--	--	5	--	3	--	--	--	5
LPG	percent	--	--	11	--	4	--	--	--	15
Average pumping plant efficiencies*										
natural gas	percent	10.0	--	--	9.3	--	7.8	7.8	7.8	--
electricity	percent	47.9	50.4	44.4	44.5	46.1	37.4	37.4	37.4	36.3
diesel	percent	--	--	13.4	--	13.9	--	--	--	10.9
LPG	percent	--	--	12.5	--	13.0	--	--	--	10.2

* Estimated by the researchers.