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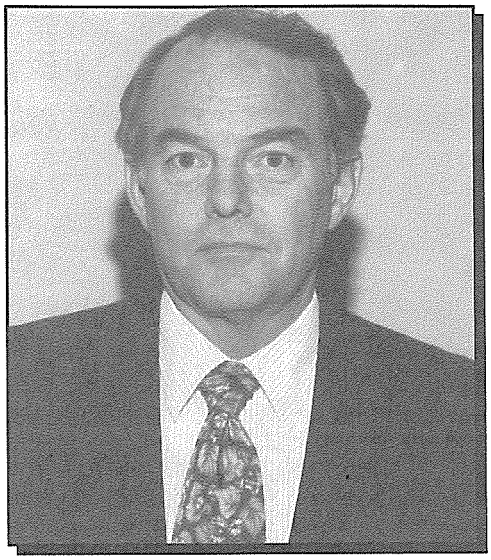

WHERE HAS ALL THE WATER GONE?

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Within the past year the residents of the City of Albuquerque have been shocked to learn that there is not as much water available to us as we had been led to believe. Many people believed that the city was sitting on a vast underground reservoir of water that was virtually inexhaustible. Some called it a vast underground lake or river, and the water was there for the taking.

So what happened? Where has all the water gone? The answer is multifaceted, and I'd like to discuss some of these.

- First—there was never as much water present as we believed.
- Second—the city's method of calculating water use is misleading.
- Third—we have done a couple of things that have hurt our water supply.

Figure 1 shows where the problem may have started. The misconception about the city's water supply probably can be attributed to State Engineer Technical Report 21 written by Bjorklund and Maxwell and published in 1961. The cross section shows the Santa Fe Group (QTs) more than 5000-feet thick beneath the entire city, and the authors stated that this aquifer was locally as much as 6000-feet thick. While they did not quantify the amount of water present in the aquifer, they likewise did not indicate a shortage of available groundwater. They reported sufficient water present for development. Apparently the Bjorklund and Maxwell report was all the information that the city fathers needed, and they never looked back. However, the scientific community soon began shedding doubt on the report.

Twenty-four years ago, in 1970, the U.S. Geological Survey (USGS) determined that there was a large amount of saline water present in the aquifer (Kelly, Myers and Hershey 1970). Even if Bjorklund and Maxwell were right about the quantity

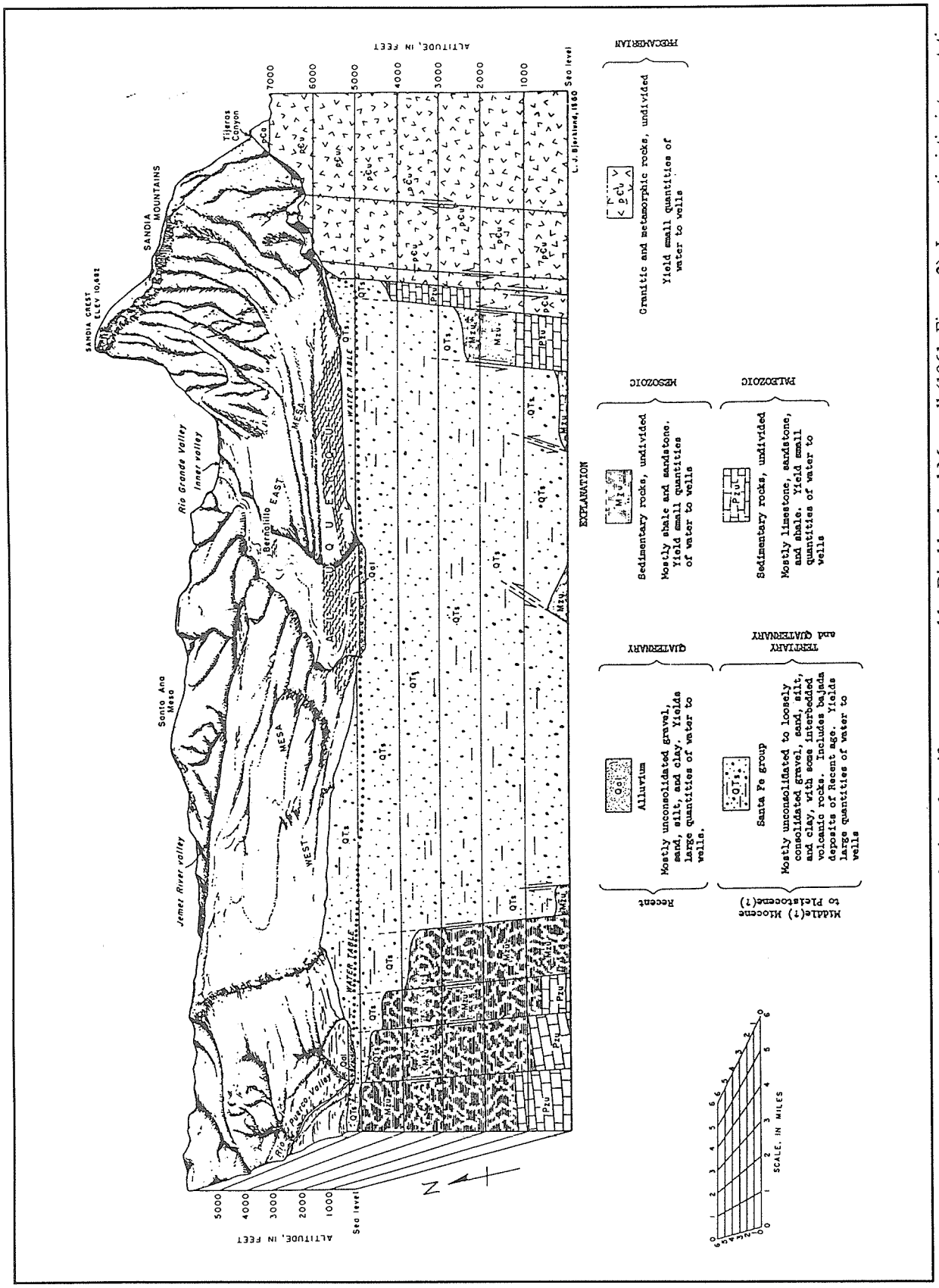

Figure 1. The early concept of the Albuquerque basin and aquifer was prepared by Bjorklund and Maxwell (1961, Figure 3). Less optimistic interpretations of the aquifer began to evolve in the scientific community shortly after this report was published.

present, they certainly failed to recognize the amount of non-potable water that was present.

In 1974, 20 years ago, the USGS published a report stating that as much as 4000 feet of the aquifer contained water that would not meet current Drinking Water Standards (Kelly 1974).

In 1979 the Hydrologic Engineering Center of the U.S. Corps of Engineers in Davis, California, hired two Albuquerque consulting firms to determine the effects of development on the aquifer. The report, written by Leedshill-Herkenhoff Engineering and Geohydrology Associates, Inc., stated that there was locally more than 130 feet of drawdown in the aquifer between 1960 and 1978. The rate of decline was more than 7 feet per year. This report was published 14 years before the USGS made their revelation in 1993.

In 1982 Kelly (1982, p. 351-355) stated that approximately 4 billion cubic yards of the aquifer had been dewatered, and that about 370,000 acre-feet of groundwater had been mined from the aquifer. This was 12 years ago.

Then, of course, came the 1993 report (Thorn, McAda and Kernodle 1993) that raised such a fervor. Well, it may have been a surprise to the city fathers, but as shown in these earlier publications, it wasn't a surprise to the USGS or to the scientific community.

Bjorklund and Maxwell used the best available data in preparing their report, but since 1961, our understanding of the subsurface geology of the Albuquerque basin has greatly improved. We now know that the lithology of the Albuquerque aquifer is much more complex than envisioned by Bjorklund and Maxwell. The highly productive zones are much thinner than originally believed and not nearly as areally extensive. As a result, the most prolific portions of the aquifer have already been depleted.

This interpretation of the Albuquerque basin, as we now know it, was prepared by Hawley and Haase (1992). In this cross section, the darker the stippling, the higher the permeability (Figure 2). The highest permeabilities are shown in black. This is a far cry from the cross section in Figure 1 that was prepared 33 years ago. Figure 2 shows that there are reasonably productive zones west of the Rio Grande, but this also is the part of the aquifer with higher mineralization, including locally high arsenic levels in the groundwater.

These findings help to explain why the water table beneath the city is declining at an ever-increasing rate. But who is using all the water? In an Op-Ed editorial in the *Albuquerque Journal* on October 17, 1994, Mayor Martin Chavez states, "Albuquerqueans are among the highest water users in the desert Southwest."

Well it all depends on how you keep your books!

Figure 3 shows a bar graph comparing Albuquerque's water use with other cities in the Southwest. According to this graph, which was prepared by the City, the average water usage in Albuquerque is 250 gallons per person per day. This usage figure is obtained by taking the total number of gallons pumped and dividing it by the population. But Figure 4 shows how the water is billed. Seventy-one percent of the water is billed to residential users, 17 percent to commercial establishments, 9 percent is institutional usage, and 3 percent is industrial use. Although the City claims that the comparison shown in Figure 3 is valid, this comparison would only be valid IF all of the southwestern municipalities had the same proportion of commercial, institutional, and industrial usage. We know, for example, that Santa Fe has minimal industrial use whereas El Paso is a major industrial center. Thus the comparison made in Figure 3 is not valid.

While most of the usage categories are self-explanatory, "institutional" needs a little clarification. Institutional usage includes water for four golf courses, twelve swimming pools, water for municipal greenbelts and parks, and water for schools and athletic complexes. In addition, both the University of New Mexico and Kirtland Air Force Base have their own water systems, and yet they both purchase large quantities of water from the City to meet their needs. This is all part of the institutional usage.

So when the City claims that each resident is using 250 gallons per day, they are including all of the commercial, all of the industrial, and all of the institutional usage. As residents, we are being credited with water that is being used to keep Kirtland's parade ground green! When you calculate the true residential use, which is 71 percent of the total pumpage, then the consumption drops to about 200 gallons per person per day.

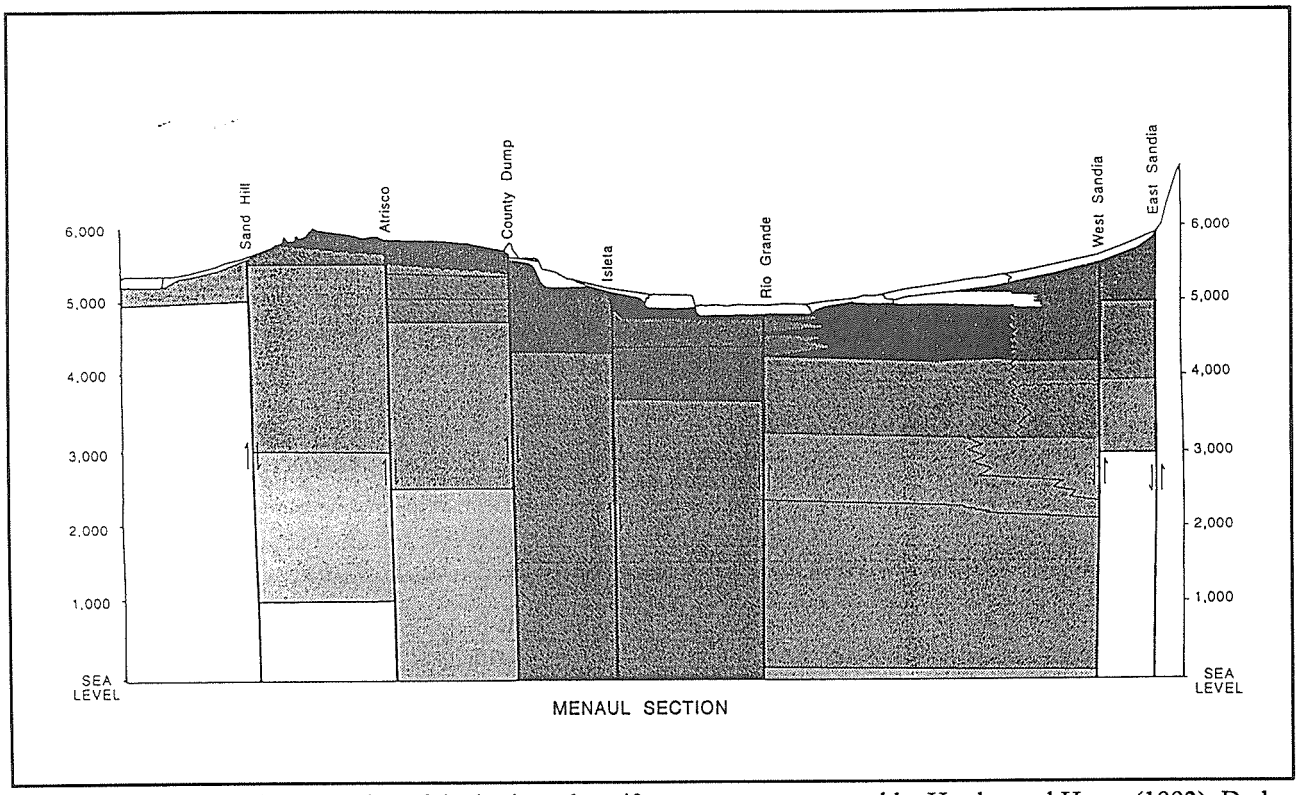

Figure 2. The current interpretation of the basin and aquifer system was prepared by Hawley and Haase (1992). Darker areas show highest permeability. Most of the black area has been dewatered by the existing municipal wells.

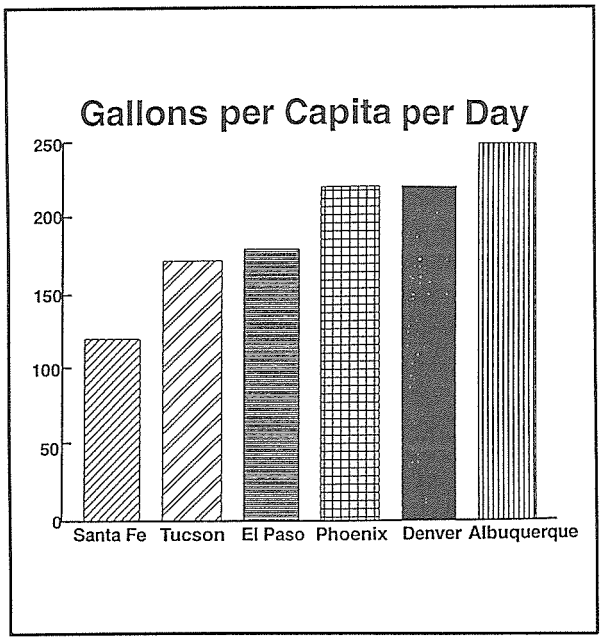

Figure 3. This chart, prepared by the City of Albuquerque, shows water consumption of major southwestern cities in 1992.

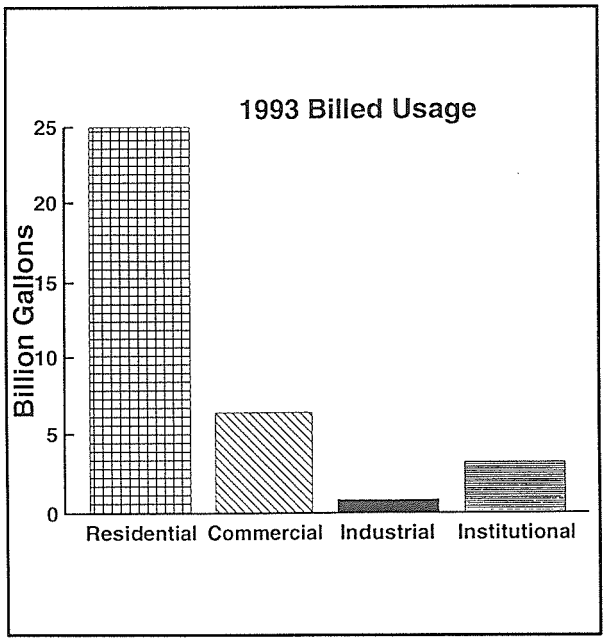

Figure 4. Water usage, as billed by the City of Albuquerque. Eleven percent of the water pumped is lost and not billed.

There is another problem. The City cannot account for 11 percent of the total water pumped. This is water that is lost through breaks in the lines, faulty meters, perhaps some illegal taps, and other losses that are unexplained. But it is NOT the residents who are losing the water. So if a separate category is set up for Water Loss, or it is prorated to the other categories and not to the residents, then the realistic use by Albuquerqueans is down to about 172 gallons per person per day.

Keep in mind that the same amount of water is being withdrawn from the aquifer whether you accept the City's figure of 250 gallons per day or the more realistic 172 gallons per capita per day that I have used. But to save water, you have to know where the water is going, and that is difficult to do when you only use a single category—**residential**. It would be more realistic for the City to set goals for reducing each category by a certain percentage, and recognize water loss for what it is.

So if we assume a more realistic figure of 172 gallons per person per day for Albuquerqueans, how do we compare with our neighbors? Residents of Paradise Hills have a daily consumption rate of 111 gallons while residents in Rio Rancho use 107 gallons per person per day. The Sandia Heights Subdivision in the Northeast Heights, uses 93 gallons per person per day. This subdivision encourages natural landscaping and there are very few swimming pools in the neighborhood.

A statewide overview of water use is shown on Figure 5. Comparing Albuquerque use with other cities, note that Roswell and Deming have water consumption very similar to Albuquerque, and Clovis comes in with a whopping 319 gallons per capita per day.

In the middle Rio Grande area, daily consumption ranges from only 60 gallons per person in Socorro to a high of 266 gallons in Bosque Farms. Los Lunas residents use about 132 gallons per day while Belen residents consume about 143 gallons per day. Bosque Farms usage exceeds that of Albuquerque, but this probably is due in part to the number of acreages and large gardens that are grown in the village.

A word of caution—not all communities calculate water consumption in the same way, so these numbers should be used for comparative purposes only.

While Albuquerque's consumption may not be the highest in the state, it still exceeds that of many neighboring communities. Figure 6, taken from the USGS report, shows the growth of groundwater withdrawal by the City of Albuquerque between 1933 and 1992. Note that there is a very gradual increase through the mid-40s. Since that time there has been a steady increase with only slight changes. Certainly the publication of the Bjorklund and Maxwell report did little to change water consumption patterns following its publication in 1961.

Figure 7 shows a comparison between population growth on the upper graph and the increase in businesses in the City of Albuquerque from 1960 to 1990. Population growth has been relatively uniform throughout the period. However the increase in the number of manufacturing and service industries in the city has shown dramatic growth.

Since the curve of water production by the City, shown in Figure 6, is similar to that of population growth shown here, then this would indicate that industrial growth has little or no affect on total water use. OR, another possibility, it also could be argued that increased water use by industry has been offset by a decrease in the amount of residential use.

In examining the Bjorklund and Maxwell report, it is interesting to note the number of industrial or commercial water users that have switched to municipal water. These include the La Posada Hotel, many linen and laundry services—even the Bernalillo County Courthouse had its own well in 1961. A large number of schools had private water systems at that time. Both St. Joseph and Presbyterian Hospitals had their own water wells in the 1960s.

The fact that many of these water users have switched from private to a municipal water system probably says more about the rate structure than about aquifer impacts. The same relative amount of water is being pumped, but it is being withdrawn from municipal rather than private wells. Presumably it is cheaper to purchase water from the City than it is to operate a private well. Urbanization is hard on an aquifer system.

Rainfall is precious in the Southwest and certainly in Albuquerque. But the aquifer only benefits from precipitation when there is sufficient water and time for it to enter the ground as recharge.

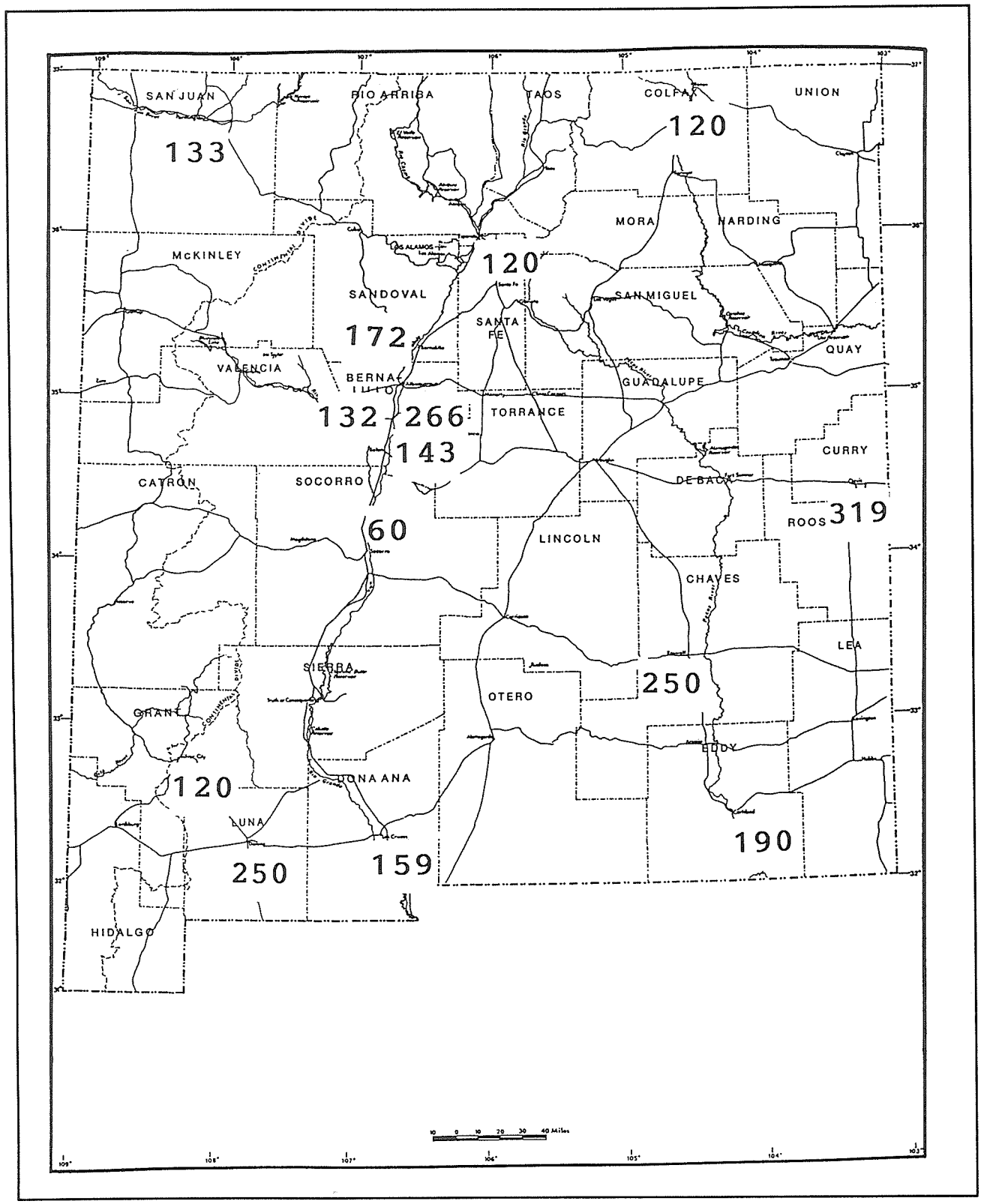

Figure 5. Water usage by various communities in New Mexico. Highest consumption is 319 gallons per capita per day in Clovis; lowest of the communities shown is Socorro with 60 gallons per capita per day. Per capita consumption in Bosque Farms also exceeds Albuquerque's use.

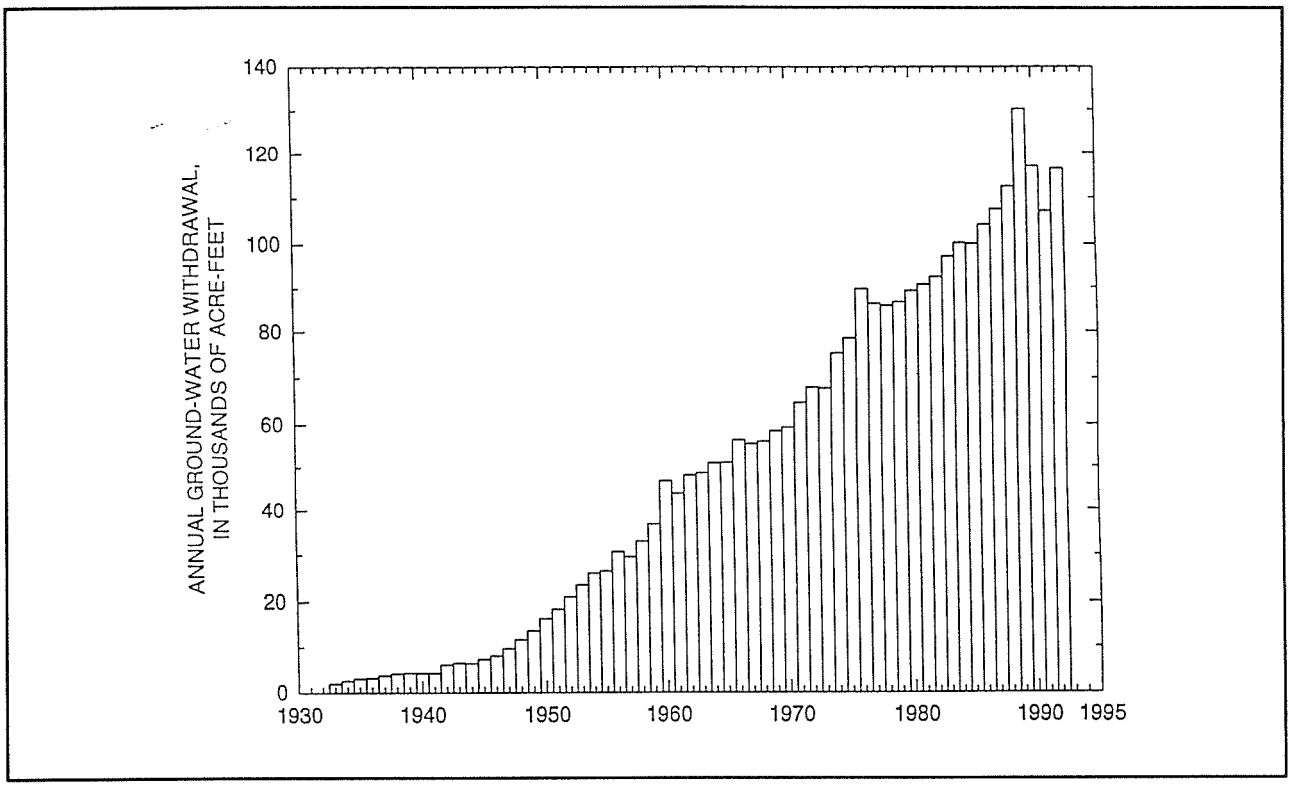

Figure 6. Annual groundwater withdrawal for the City of Albuquerque, 1933-1992 (Thorn, McAda and Kernodle 1993, Figure 23).

Through the normal process of urbanization, vast areas of landscape are covered by homes, parking lots and streets. Even our so-called southwestern landscaping is frequently underlain by plastic which prevents infiltration. The runoff therefore is much higher from an urban area than from an undeveloped area, and recharge is reduced. The USGS has determined that the Albuquerque Metropolitan Arroyo Flood Control Authority (AMAFCA) North Floodway Channel has a mean annual runoff of 6,700 acre-feet, or about six percent of the amount of water that is being mined annually by the City. While it can be argued that this amount of runoff goes back into the Rio Grande and is available for recharge, the bulk of the recharge would occur downstream from the city limits and not directly benefit the aquifer where it is being depleted.

Since 1964 the AMAFCA has lined 50 miles of channels in the metropolitan area. In so doing, the Authority has undoubtedly saved the City millions of dollars in flood damage, but they also have prevented a good deal of recharge from entering the aquifer.

The USGS report indicates that infiltration from the arroyos is minimal, yet work for the Corps of Engineers (Geohydrology Associates, Inc. 1982) indicates that appreciable recharge may occur. Seepage runs made on the Sile Main Canal and Cochiti East Side Canal indicate infiltration losses of 1.5 acre-feet per mile per day and 2.8 acre-feet per mile per day respectively from the canals. The beds of these canals are similar to those of the arroyos in the Albuquerque area. If we assume an average loss of 2.1 acre-feet per day per mile, and AMAFCA has lined 50 miles of channel, then there would be a loss of 107 acre-feet of recharge per day while the channels are running. On the average, there is flow in Tijeras Arroyo about 30 days per year. Thus there could be a loss of as much as 3,200 acre-feet of recharge per year to the Albuquerque aquifer as a result of lined arroyos.

While this amount of recharge may seem inconsequential, any amount of recharge is important when the water table is dropping at the rate of as much as 13 feet per year and restaurants are being asked not to serve water with meals. Loss of

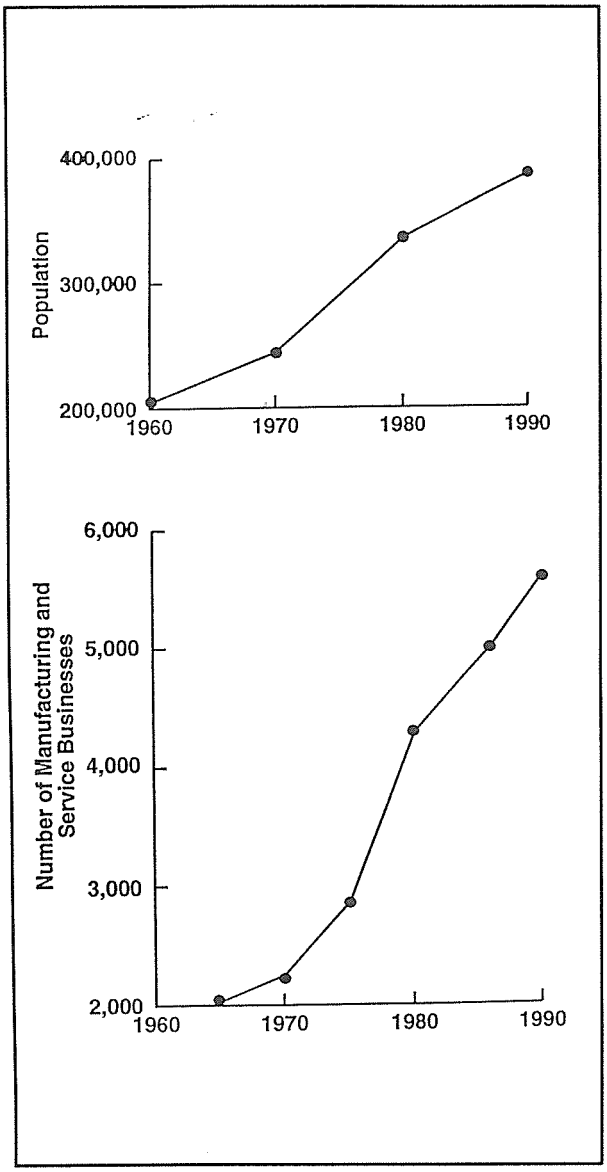

Figure 7. Manufacturing and services businesses have increased at a greater rate than population growth. Many 1960 private water systems have been abandoned in favor of purchasing water from the City of Albuquerque.

recharge is a natural consequence of urban sprawl. There is nothing that can be done to eliminate this loss. But as the city expands, its planners should recognize this loss and plan accordingly. This loss of recharge must be made up in reduced consumption.

In summary, Albuquerque's optimistic outlook on water was dashed by the recent USGS publication. Unfortunately the overly optimistic outlook was based on the best available data, circa 1960. Since then the scientific community has learned a great deal more about the aquifer system.

How much water is actually being consumed by Albuquerqueans depends on how you count the beans. A realistic figure is about 172 gallons per person per day and not the 250 gallons reported by the city. At 172 gallons per capita per day, Albuquerqueans are not using as much water as residents in many southwestern cities, and are not even the highest water users in the State of New Mexico.

The City's goal of reducing water consumption by 30 percent is realistic. But it would be easier to reach this goal by recognizing that conservation should be achieved by industrial, institutional, and commercial usage as well as reducing the water loss. By implying that residents are responsible for water being used on Kirtland's parade ground is somewhat misleading.

Urbanization has been detrimental to the amount of recharge reaching the City's aquifer system. This is one of the consequences of growth. AMAFCA has lined 50 miles of arroyos, and saved millions of dollars in flood damage, but reduced the recharge in so doing.

Finally, the wells are not going to go dry—but they are going to go deeper and be less productive—so the cost of water is going to go up. In addition, the quality of the water is going to get worse, so treatment may be required and this will further increase the cost. Ultimately the city may have to import water.

So where has all the water gone? It is a complex answer. But one thing is certain—it is time to start conserving.

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