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I. Introduction.

A. Summary.

Approximately 40% of the population of Utah resides within the incorporated and unincorporated areas of Salt Lake County. (See Figure 1 for location). As the population has increased, the demand for water proportionally increased. The easily accessible sources, mainly surface water, were the first to be developed. However, during times of drought or high demand, other sources were needed. Wells have become an integral source during times of scarcity or high demand. Some communities rely almost entirely on ground water. The supply of ground water, however, is not infinite. Static levels have declined and areas of contamination have been documented.

Historically the State Engineer has only utilized unappropriated water for part of his criteria in approving applications. In the case of Salt Lake Valley ground water, because of possible over appropriation and potential contamination, he plans to utilize quality and other management procedures to preserve a safe annual yield and minimize potential contamination.

B. General References.

Technical Publication No. 87, "Ground-Water Conditions in Salt Lake Valley, Utah, 1969-83, and Predicted Effects of Increased Withdrawals from Wells," by K.M. Waddell, R.L. Seiler, Melissa Santini, and D.K. Solomon, U..S. Geological Survey, 1987.

Technical Publication No. 89, "Chemical Quality of Ground Water in Salt Lake Valley, Utah, 1969-85," by K.M. Waddell, R.L. Seiler, and D.K. Solomon, U.S. Geological Survey, 1987.

Utah Code Annotated, 1953.

II. Salt Lake Valley Ground Water.

A. Aquifers. Ground water in Salt Lake Valley occurs in the basin alluvium. There are four aquifers (see Figure 2), namely (1) a shallow unconfined aquifer that sits over the majority of the central valley, (2) a deep unconfined aquifer that generally is near the mountain contact with the valley, (3) a deep confined (artesian) aquifer, and (4) localized unconfined perched aquifer. The deep unconfined aquifer serves to hydraulically connect all

SALT LAKE VALLEY LOCATION MAP

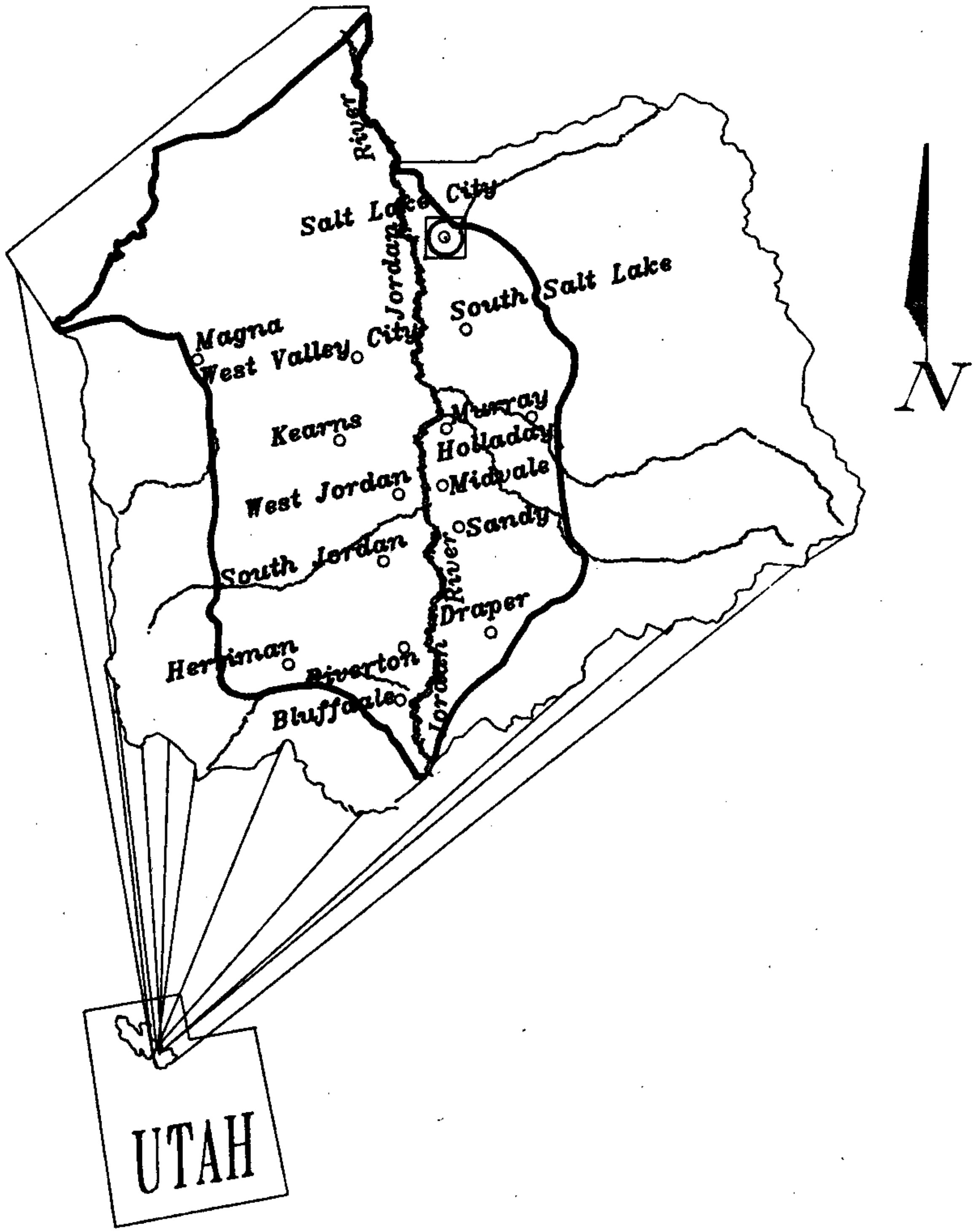
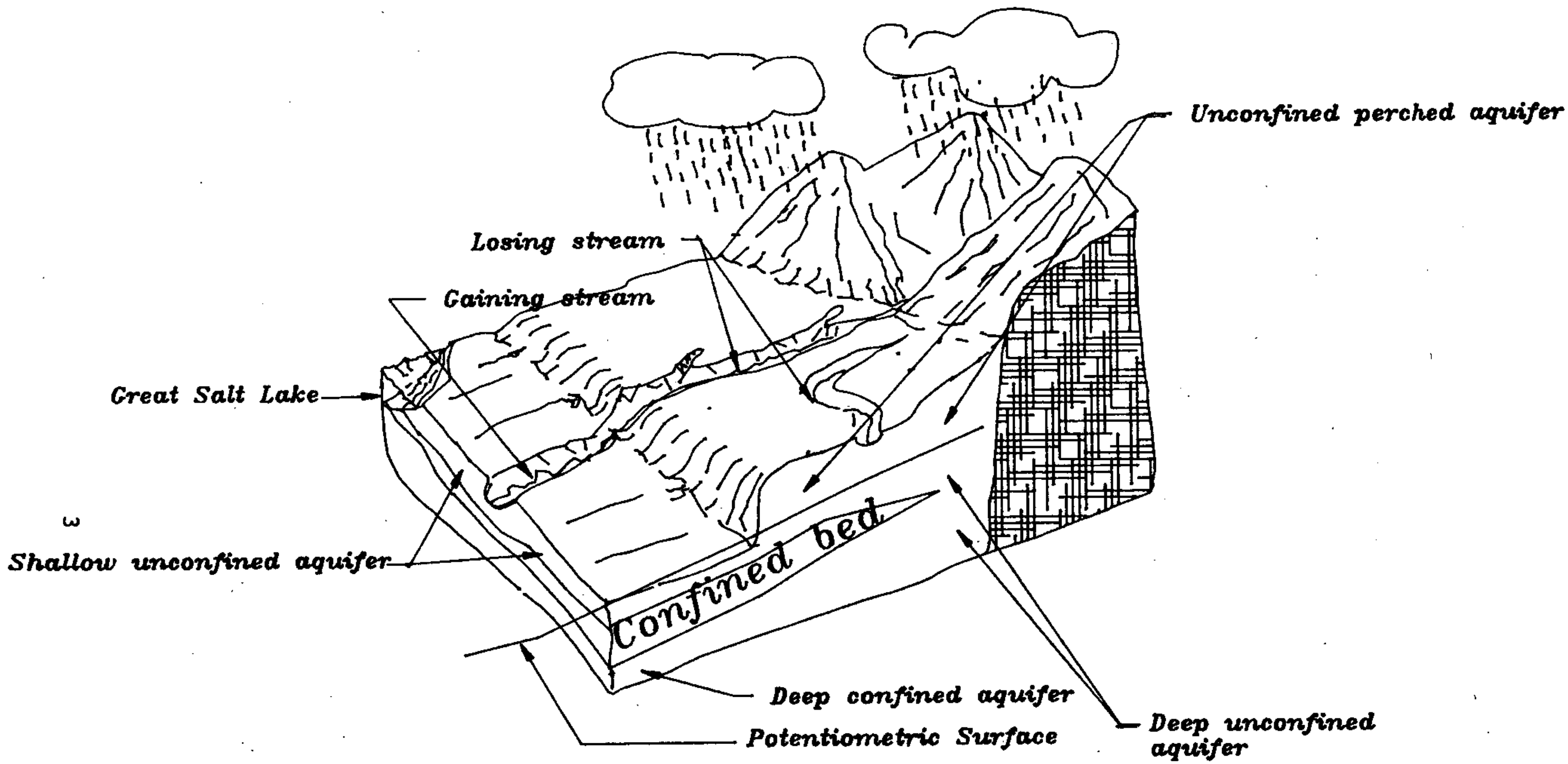


FIGURE 1



CROSS SECTION SALT LAKE VALLEY

FIGURE 2

aquifers. Most of the wells obtain their water from the deep confined and deep unconfined aquifers.

The shallow unconfined aquifer overlies the confining layer. The shallow unconfined aquifer is recharged by downward infiltration from precipitation, canals, streams and irrigated lands and upward leakage from the deep confined aquifer. This aquifer yields fairly small quantities of water. It is contaminated in much of the valley. Its main uses are for irrigation and livestock.

B. Recharge. Figure 3 gives reference to the volumes of recharge and their sources. A large part of the recharge to Salt Lake Valley is from the bedrock in the mountains adjacent to the basin fill. All of this recharge enters the deep unconfined aquifer which is generally tributary to the other aquifers. The next major source of recharge is the seepage flow from canals and irrigated lands. Most of this flow occurs in the southwestern part of the valley and adjacent to the Jordan River.

C. Direction of Flow. Generally the movement of ground water in Salt Lake Valley follows the elevation contours of the valley. The shallow unconfined aquifer flows toward the Jordan River and then to the Great Salt Lake. Near the lake the unconfined water is forced to the surface and flows directly into the Great Salt Lake. Throughout much of the valley there is an upward gradient from the principal aquifer to the shallow unconfined aquifer.

D. Quantity of Water. Figure 4 summarizes the water withdrawn or naturally flowing from all these aquifers from 1969

Salt Lake Valley

Ground-Water Recharge

(acre-feet per year)

Bedrock		157,000
Channel Underflow		4,000
Seepage:	Creeks	16,000
	Canals	24,000
	Irrigation	48,000
	Lawns, Gardens	28,000
	Rain/Snow	71,000
	Other	4,000
Total		352,000

Figure 3

Salt Lake Valley

Ground-Water Discharge

(acre-feet per year)

Evapotranspiration	54,000
Springs, Seeps, Drains:	
Jordan River	143,000
Magna area drains	5,000
For use	19,000
Major Canals	10,000
Other	2,000
Subsurface flow to Lake	2,600
Wells	117,000
Total (Rounded)	353,000

Figure 4

through 1989. The discharge from wells is increasing and consequently inflow to the Jordan River and evapotranspiration are decreasing. The largest increase in ground water discharge has been to wells, increasing from 105,000 acre-feet in 1969 to almost 140,000 acre-feet in 1988. It is anticipated the reliance on ground water will continue to grow.

E. Quality of Water.

1. Changes of Chemical Quality. The U.S. Geological Survey from 1979 through 1984 resampled 35 wells that had been sampled during 1962-1967. The purpose of the study was to determine if water quality had changed. The dissolved solid concentration of the water from 13 of the wells had increased by more than 10%. The increases have come generally from contamination in the recharge areas. Water from the western part of the valley has been affected by mining related operations which stored mine effluent in ponds and reservoirs in recharge areas. The concentration of dissolved solids and sulfate has increased in wells between the mouth of Bingham Canyon and the Jordan River. On the east side of the valley a large amount of urban development has taken place. Much of the precipitation that formerly went to recharge now flows into storm drains that discharge directly to the Jordan River. Much of the recharge, both on the east and west sides of the valley, is irrigation water. Most of this water contains fertilizers and other added materials which could be causing chemical changes in ground water downgradient. Some of the increase in sodium and chloride concentrations may be due to

storage and use of road salt in the recharge areas and in the canyons of the Wasatch Range.

2. Susceptibility to Contamination. Not all of Salt Lake Valley is as susceptible to ground water contamination as others. Influences, namely geology, rate of ground water movement, and vertical hydraulic gradients, divide the valley into four general areas. Both the eastern and western fringes of the valley are most susceptible. In these areas contaminants can move directly into the principal aquifers. The other two areas of the valley are less susceptible because the principal and shallow unconfined aquifers are separated by confining layers. The area bordering the Jordan River is probably the least susceptible because the vertical hydraulic gradient is upward, barring the infiltration of contaminants through the confining layer. Back from the river lies a zone that is moderately susceptible. Here the shallow unconfined and principal aquifers are separated by a confining aquifer, which impedes the downward migration of contaminants. The vertical hydraulic gradient here is either downward into the principal aquifer or is relatively low. A decline in the water levels in the area bordering the river could decrease the upward gradient and make it as susceptible as the neighboring area having the confining layer with no upward gradient.

3. Areas of Ground Water Contamination.

a. Area East of Copperton: Copper, molybdenum, gold, silver, lead and zinc have been mined from the Bingham Mining District in the Oquirrh Mountains near Copperton in the southwest part of Salt Lake Valley. Reservoirs have been constructed to store mine drainage and waste water from ore-leaching facilities. Evaporation ponds located 4.5 miles east of the reservoir sites have been constructed to contain mine-waste waters during periods of high runoff. It appears that significant quantities of the water in the principal aquifer between the mouth of Bingham Canyon and the Jordan River have been contaminated by seepage from the reservoirs and evaporation ponds. Many domestic and irrigation wells in the area produce water with concentrations of dissolved solids exceeding 2,000 milligrams per liter. Kennecott Minerals Company, Utah Copper Division, is at the present time evaluating alternatives to reverse environmental problems caused by past mining practices.

b. Area in South Salt Lake: From 1951 through 1964, the Vitro Chemical Company of America processed uranium ore for sale to the U.S. Atomic Energy Commission at a mill in South Salt Lake. The plant was dismantled during 1970, and the radioactively-contaminated materials from the processing operations remained on site. Leaching of the tailings has resulted in increases of concentrations of dissolved solids and heavy metals in the ground water beneath and downgradient from the tailings. The major effect of the leachate from the uranium-mill tailings on water in the shallow unconfined aquifer downgradient from the tailings area was the contribution of measurable quantities of dissolved solids, chloride, sulfate, iron, and uranium. Dissolved solids in upgradient wells were recorded as 1,650 mg/l while downgradient concentrations ranged from 2,320 to 21,000 mg/l. The major effect of the tailings on water in the deep confined aquifer was the contribution of measurable quantities of dissolved solids, chloride, sulfate, and iron.

c. Potential for Migration of Saline Ground Water from near Great Salt Lake: Both the deep confined aquifer and the shallow unconfined aquifer occur in the northwestern part of Salt Lake Valley. Water movement in the deep confined aquifer generally is toward the northwest and upward, and it discharges into the shallow unconfined aquifer or into the Great Salt Lake. The concentration of dissolved solids in both the confined and unconfined aquifers is variable, but greatly increases towards the lake. Based upon the model, increased withdrawal of ground water in the northwestern part of Salt Lake Valley would not induce movement of saline water farther into the valley, because of the low permeability of the material in this area.

III. Problem.

The ground water problem of the Salt Lake Valley is that it is over appropriated on paper, demand is increasing from a growing population, the supply of good quality ground water is limited, and current data indicates that the aquifers are becoming contaminated.

A. Water Right Filings. Figure 6 is a listing of the water right situation in Salt Lake Valley. The total of all perfected rights in the valley, if pumped to capacity, would yield 393,000 acre-feet of water. In addition to these rights, there are 303,000 acre-feet of approved, unperfected filings. The two total 696,000 acre-feet.

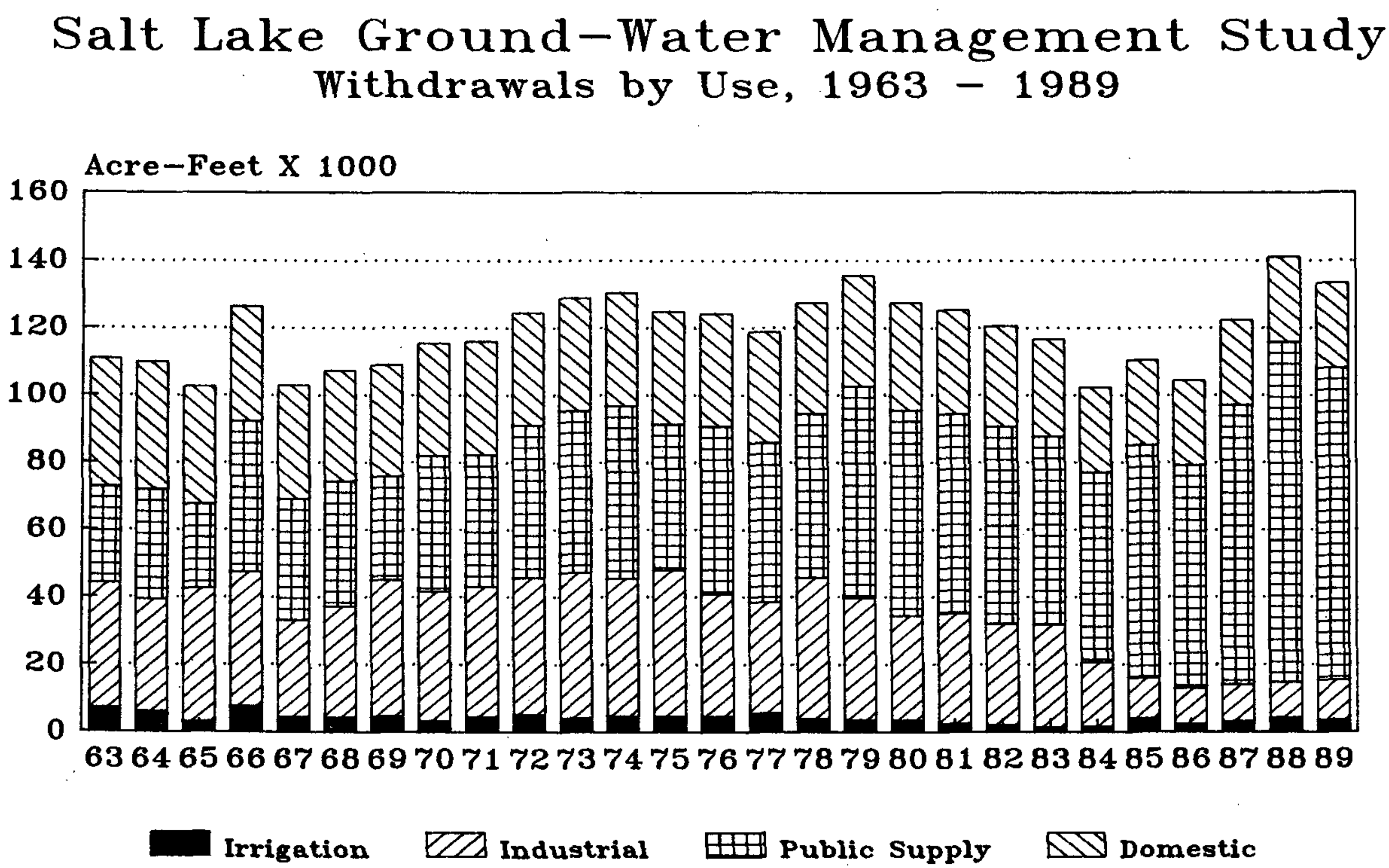

Salt Lake Ground-Water Management Study
Withdrawals by Use, 1963 - 1989
Acre-Feet X 1000
160
140
120
100
80
60
40
20
0
63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89
Irrigation
Industrial
Public Supply
Domestic

Figure 5

Salt Lake Valley

Ground-Water Rights by Status

(acre-feet per year)

USE TYPE	STATUS		
	Perfected	Approved	Unapproved
Municipal	189,000	242,000	100,000
Industry	105,000	25,000	9,000
Domestic	69,000	26,000	21,000
Irrigation	30,000	10,000	8,000
Subtotal	393,000	303,000	138,000
Total	696,000		

Figure 6

B. Population Growing, Demand Increasing. The population of the Salt Lake Valley continues to grow. With a growing population comes increased demands for water for homes, industry and services. A tradition of large lawns and gardens is predominant.

C. Quantity of Water Available. Figure 3 indicates that the annual supply of good quality ground water from the bedrock aquifer is 157,000 acre-feet. The amount of ground water diverted in 1988 was 140,000 acre-feet. Demand is rapidly approaching the supply of good quality water (see Figure 5).

D. Migration of Pool Quality Water. Increased pumping rates in the good quality areas and aquifers could cause migration of inferior quality water, resulting in the contamination of the aquifers.

IV. Solution.

A. Finding the Problem. In 1986 legal counsel for a community requested the State Engineer's help in finding a solution to a ground water appropriation problem. They were in court with another city litigating an interference question. Through the studies of this problem a computer search was made and a quantification of ground water rights in Salt Lake Valley was made. The results are shown in Figure 6. A comparison of the existing legal water rights to the quantity of ground water available for diversion commanded everyone's attention. A series of public meetings was held to bring the potential problem to the attention of water wholesalers, retailers, and individual water users in the valley. An agreement among municipal water users in a township solved the original problem and initiated a valley-wide study.

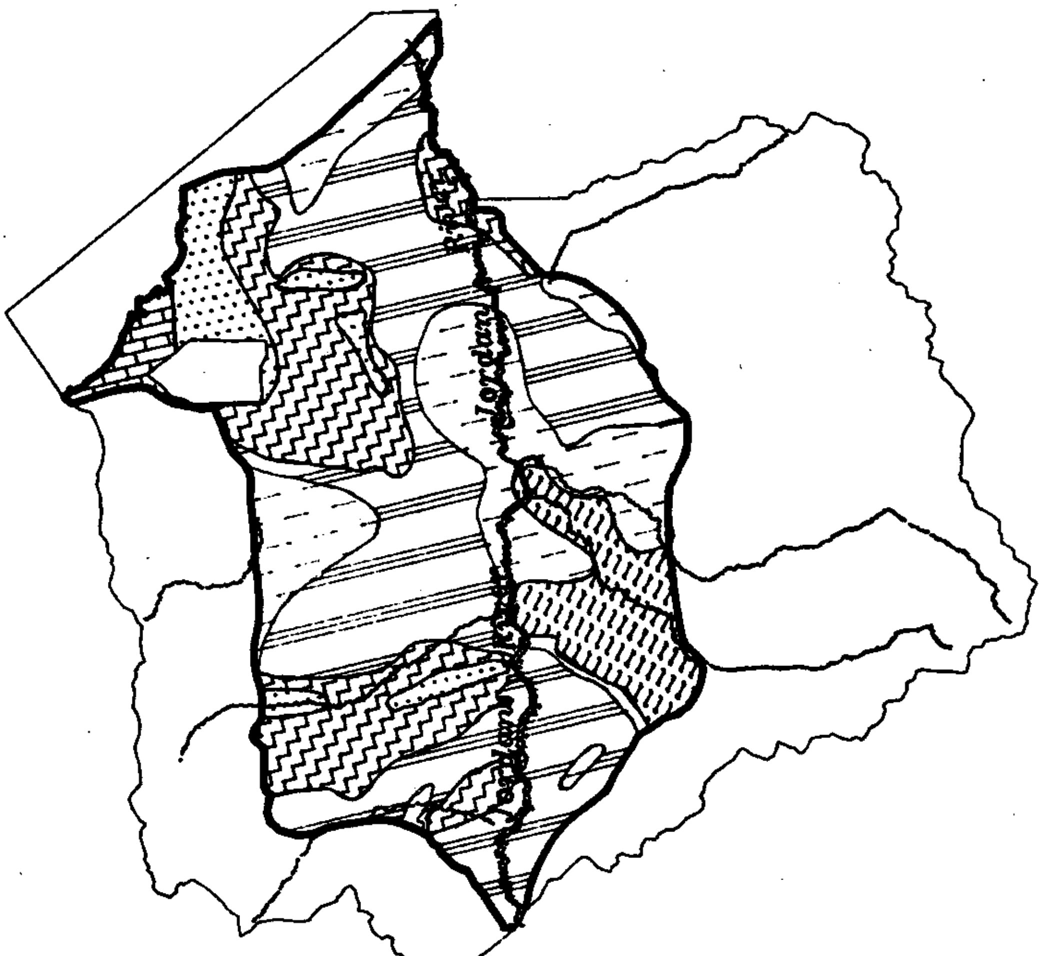
This initial agreement was used to help formulate a potential management plan for the entire valley.

When Technical Publication 89 (TP 89) was published, a new parameter was introduced (see Figure 7). The ground water supply would not only be limited by the volume of water available, but also by the movement of poorer quality ground water into good quality aquifers. The data used in preparing TP 89 was not sufficient to accurately predict movement. This led the Division of Water Rights, Department of Health, and several water suppliers in the valley to enter into an agreement with the U.S. Geological Survey to prepare a water quality model that could be used in conjunction with the water quantity model to predict the effects of ground water withdrawals on water quality.

Much of the discussion during the public meetings revolved around eliminating the unperfected approved filings and then reducing potential withdrawals under the perfected rights. This solution, however, was not popular with those owning very few perfected rights, while relying on unperfected rights to meet the demands of growing populations. To modify the perfected rights, the water users would have to agree to any reduction. Several drafts were circulated, but it became very apparent that a consensus would not be reached, and, without total basin-wide agreement, no plan to voluntarily limit withdrawals could be implemented.

B. <u>Determining a Solution</u>. Without basin-wide agreement, the only potential solution would be to distribute water based upon priority, which is a basic principle of western water law. The

SALT LAKE VALLEY GROUND WATER QUALITY



Dissolved–solids concentration, in milligrams per liter, 1979–84

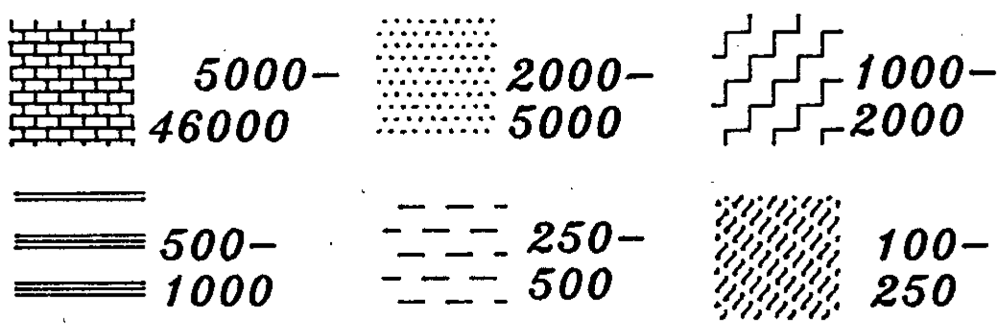


FIGURE 7

policy would be temporary until better data was generated and until the quality/quantity model was functional.

C. Interim Ground Water Policy.

1. Volume of Withdrawals. Ground-water withdrawals from the principal aquifer in each management area, as denoted and set forth on the attached map, shall not exceed the allowable annual withdrawal in any calendar year. The combined allowable annual withdrawals for management areas 1 through 5, inclusive, is approximately the amount of high quality recharge from bedrock and other sources. Withdrawals should be distributed over the valley to ensure that localized interference and water quality problems do not result. In administering the water rights in the ground-water basin, the State Engineer will distribute the water in accordance with the priority dates of the respective rights. In distributing the water in accordance with priority, the State Engineer will also consider the following factors:

a. Cumulative Effects of Withdrawals. The cumulative effects of withdrawals from wells in a particular area on both water quantity and quality will be considered. If it is determined that such withdrawals unreasonably affect the water quality of the principal aquifer, withdrawals in that area may be limited even though total withdrawals in the management area do not exceed the allowable withdrawal limit.

b. Isolated Wells. A well located in an isolated area and which does not significantly affect other water rights or the water quality of the principal aquifer may be permitted to divert water, even though in other portions of the management area or valley, wells with an earlier priority date have been ordered to stop diverting water.

c. Withdrawals from Shallow Aquifer. Additional withdrawals above the allowable withdrawal limits set forth on the map will be allowed if such withdrawals are from the shallow aquifer, provided that such withdrawals do not have an adverse affect on other water rights.

2. Applications to Appropriate Water and Segregation Applications. Applications to appropriate water from the principal aquifer will be considered for single family uses in non-subdivision areas where water is not available from a water supply system. Applications to appropriate water will be limited to a maximum annual diversion of 1.0 acre-foot. The uses under such application shall not exceed the domestic purposes of one family, the irrigation of 0.10 acres, and/or the stock watering of a maximum of 10 head of livestock. Such rights shall be approved as fixed time applications for a ten-year period and upon the condition that when a public water system is available, the users will connect to the system, the well will be sealed, and the water right abandoned. Upon expiration of the ten-year period, if a public water supply system is still not available, such application will be extended upon proper filing of a request for extension.

All future segregation applications will be critically reviewed on their individual merits, according to current statutory provisions.

3. Extensions of Time for Applications to Appropriate Water. The State Engineer will critically review all future

extension requests on approved applications to appropriate water pursuant to Section 73-3-12 of the Utah Code. In reviewing extension requests, if the State Engineer finds unjustified delays or a lack of due diligence, he may grant the request in part (including a reduction in the quantity of water available under the application), reduce the priority date, or deny the extension of time request.

4. Change Applications. Change applications will be considered and evaluated on their own individual merits. In considering change applications, the State Engineer will quantify and determine, among other statutory considerations, whether the proposed change will adversely affect the water quality of the ground-water basin. Change applications which propose to transfer water rights historically supplied from the shallow aquifer to the principal aquifer will not be approved.

The secondary objective of the interim ground-water management plan is to guide future development and to uniformly distribute the ground-water withdrawals over the valley. In accordance with this objective, the State Engineer has developed a map showing the maximum allowable withdrawals for nine management areas throughout the valley. The allowable withdrawal figures set forth on this map will be used as a guide to determine whether transfers will be allowed into a particular area.

5. Proof of Appropriation/Change. In conjunction with all proof of appropriation or proof of change, the State Engineer shall require that the total volume of water to be certificated has in fact been developed and placed to beneficial use. The

requirement shall apply to all applications regardless of use. The State Engineer will review the total operation of a system or water user to ensure the intent of this requirement is met.

6. Well Spacing and Flow Rate. Well spacing and maximum flow rates of wells drilled after the adoption of this management plan shall be determined and shall be regulated so a well, when pumped at its maximum permitted flow rate, will not cause more than 12 feet of drawdown on any well with an earlier priority date. Users in a particular area may enter into an agreement to provide a variance from this requirement if it does not interfere with third party rights and also subject to approval by the State Engineer.

7. Metering. All wells which withdraw or could potentially withdraw, within the water right limitations, 50 acre-feet or more annually shall be equipped with a meter capable of measuring the instantaneous flow rate and total volume pumped through the meter. For wells which withdraw or could potentially withdraw, within the water right limitations, 250 acre-feet or more annually, the owner shall also submit an annual water quality report for total inorganics. If monthly well water levels are taken, it is requested that such measurements also be submitted. Water level measurements should be made on or about the first day of each month.

8. Annual Reporting. All water users meeting the criteria under number 7 above shall submit an annual report to the State Engineer by March 1 of each year setting forth the quantity of water diverted for each of their wells during the previous

calendar year, along with the water quality reports, if applicable. Such reports shall summarize the monthly withdrawals for each well operated. If the water user submits an accurate and complete annual Utah Water Use Data Form it shall fulfill this requirement.

V. Legal Issues.

The proposed ground water management plan for the Salt Lake Valley aquifers may require the curtailment of pumping in general (or in some specific wells) in order to prevent the spread of lesser quality water. Unlike many other western states, Utah does not have a comprehensive ground water management statute. Normally in times of shortage, water rights are cut off based on priority date, but the management of a complex ground water system does not lend itself to such simplistic solutions. Question may arise as to whether the State Engineer has authority to curtail pumping to protect the quality of water--as opposed to the quantity.

Under the general powers of the State Engineer set forth in Section 73-2-1, Utah Code Annotated, the State Engineer has the general administrative supervision of all waters of the state, both surface and underground, and has the authority to prevent the waste, loss, or pollution of that resource. See also United States v. District Court, 238 P.2d 1132 (Utah 1951). Section 73-5-9, Utah Code Annotated, gives the State Engineer more specific authority to control the waste, pollution, or contamination of the ground water.

There is always the chance that the State Engineer's authority in this regard might be challenged in court. However, the State Engineer feels that from both a legal and policy standpoint, he must have the authority to coordinate and administer the withdrawal of ground water resources in the Salt Lake Valley and elsewhere in the state in order to protect the resource and to maximize the beneficial use of the ground water resource--specifically in areas along the Wasatch Front where municipalities rely on high-quality ground water for much of their supplies.

Proposed Distribution of Ground-water Withdrawals in Salt Lake Valley, Principal Aquifer