47

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WATER RIGHTS IN AREAS OF GROUND-WATER MINING

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CONTENTS

ILLUSTRATION

TABLE

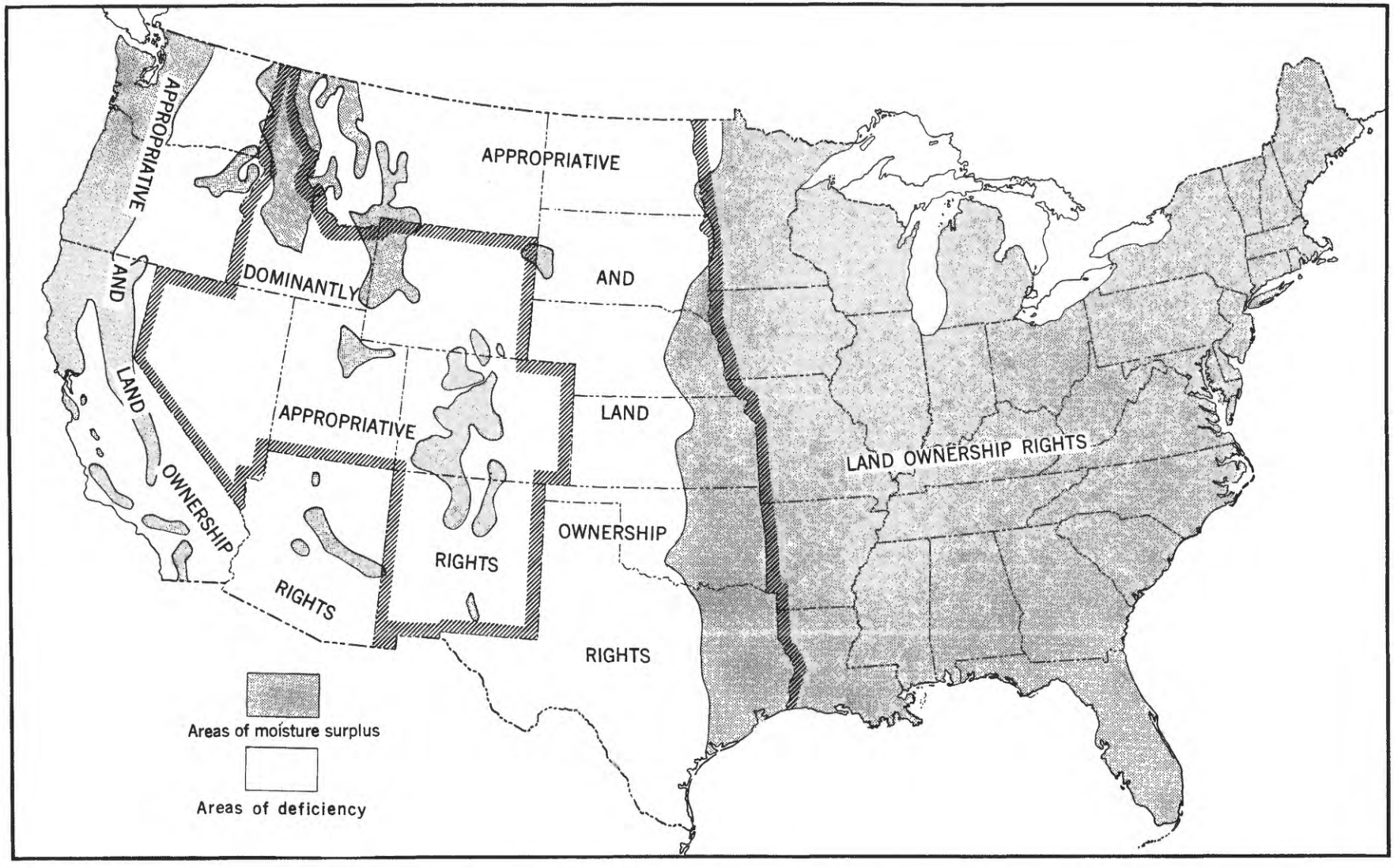

Figure 1. --Map of the United States showing areas of moisture surplus and deficiency as outlined by Thornthwaite and basis of water rights by States.

WATER RIGHTS IN AREAS OF GROUND-WATER MINING

By H. E. Thomas

ABSTRACT

Ground-water mining, the progressive depletion of storage in a ground-water reservoir, has been going on for several years in some areas, chiefly in the Southwestern States. In some of these States a water right is based on ownership of land overlying the ground-water reservoir and does not depend upon putting the water to use; in some States a right is based upon priority of appropriation and use and may be forfeited if the water is allowed to go unused for a specified period, but ownership of land is not essential; and in several States both these doctrines or modifications thereof are accepted, and each applies to certain classes of water or to certain conditions of development.

Experience to date indicates that a cure for ground-water mining does not necessarily depend upon the water-rights doctrine that is accepted in the area. Indeed, some recent court decisions have incorporated both the areal factor of the landownership doctrines and the time factor of the appropriation doctrine. Overdraft can be eliminated if water is available from another source to replace some of the water taken from the affected aquifer. In areas where no alternate source of supply is available at reasonable cost, public opinion so far appears to favor treating ground water as a nonrenewable resource comparable to petroleum and metals, and mining it until the supply is exhausted, rather than curbing the withdrawals at an earlier date.

INTRODUCTION

The average American citizen, particularly the urbanite, has no great problem in obtaining a continuing supply of water. Bills are presented to him periodically by some local governmental department or water company, and if he takes proper action the department or company will make every effort to assure a continued flow of water to his property.

The problem is more complex for the department or company that furnishes the water, or for the householder, farmer, or industrialist who develops his own water supply from wells, springs, streams, lakes, or reservoirs. These water users find that they must comply with certain requirements, which may be based on court decisions in their respective States or may be specified in statutes enacted by State Legislatures or other governmental units.

A common requirement, for instance, is that the use must be "beneficial," a term that does not lend itself to accurate definition, although there are numerous court decisions as to specific uses under a definite set of circumstances. There is a wide range in degree of beneficial use; and in the water laws of many Western States, certain types of use are given preference over other uses, on the basis of public need and welfare. In some States preferential use may be a determining factor in allocations of water during periods of shortage; in others preferential use may be considered only in competition between proposed new developments. Another common requirement is that the water use must be "reasonable" in relation to use by others who have access to the same source of supply. This term is also relative and variable; it is measured by the circumstances in each case, and the weight of local custom is important.

These specifications as to beneficial use, preferential use, and reasonable use represent restrictions in the exercise of a right to use water, and they correspond to the restrictions imposed upon the motorist by posted speed limits along a public highway. Before the motorist ventures upon the highway, he must establish his right to use it by obtaining licenses for his vehicle and for himself as a driver. Similarly, the use of water is dependent fundamentally upon a right to that use.

This paper is concerned with these fundamental water rights, particularly as they are construed in areas of progressive ground-water depletion. It includes a sketch of the development of the legal doctrines pertaining to water rights, and some comments on the degree to which the present systems of water rights are in accord with sound principles of hydrology.

CONTRASTING DOCTRINES OF WATER RIGHTS

A water right is a property right and is entitled to protection to the same extent as other forms of property. It is a right to the flow and use of water, a usufructuary right; and the water is generally considered to remain common property until it has actually been diverted from its natural course and reduced to private possession by means of artificial devices.

The law of water rights embraces two diametrically opposed doctrines and numerous modifications and combinations of those doctrines. In many States water rights are based on ownership of land contiguous to a stream or other source, or overlying a ground-water reservoir; the right does not depend upon putting the water to use, and thus is not lost by nonuse. In some States water rights are based entirely upon appropriation and actual use of water that has been declared to belong to the public; the rights are based on

priority in time, and may be forfeited if the water is allowed to go unused for a specified period, but ownership of land is not essential. And in several States both these doctrines or modifications thereof are accepted, and each applies to certain classes of water or to certain conditions of development.

The resulting systems of water rights in many States can best be described as complex. They may be confusing not only to the layman but to his legal representative, and also to scientists whose entire careers have been devoted to hydrology and water-resource development. A brief historical sketch is therefore appended.

Landownership

The doctrines based on landownership are the "common-law" doctrines, developed in judicial decisions in the absence of express legislative acts. One of the earliest quoted decisions in disputes on water is that of Mason v. Hill, 1/ which in 1833 abrogated the earlier custom in England of granting the right of use of water flowing through one's land to the first who appropriated it, and expounded the doctrine (subsequently termed the "riparian doctrine") that each owner of land along a stream is entitled to use the full natural flow, undiminished in quantity and unchanged in quality. The decision in Acton v. Blundell, 2/ also in England, stated that a landowner is entitled to unrestricted use of water from a well dug on his property.

The English doctrine of unlimited use by the owners of land overlying or contiguous to a source of water has been modified by decisions in numerous American courts. The New Hampshire Supreme Court in 1862 3/ ruled that a man's right to use water on his own land must be restricted to a reasonable use, in view of the similar rights of others; this is commonly called the American doctrine of reasonable use. The California doctrine of correlative rights, stemming from the decision in Katz v. Walkinshaw 4/ in 1903, requires reasonable use and also states that, wherever landowners have rights in a common water supply but that supply is insufficient for all, each is to receive a fair and just proportion.

The doctrine of unlimited use and the modifications of reasonable use and correlative use share in common the principle that ownership of land is the prime basis for the right to use water. The modifications have been evolutionary products of the increasing competition for water in some areas, and more modifications are to be expected in the future with further increases in demand for water. Judging by the record in the States of greatest water development, reasonable use or correlative use or licensed use (as, for example, in New Jersey) can be required by statute or by the courts even in areas where the landowners were once considered to have the right to unlimited use of water.

1/ 5 Barn. & Adol. 1, 110 Eng. Reprint 692 (1833).
2/ 12 M. & W. 324 (1843).
3/ Bassett v. Salisbury Mfg. Co., 43 N. H. 569, 82 Am. Dec. 179 (1862).
4/ Katz v. Walkinshaw, 141 Calif. 116, 70 Pac. 663 (1902), 74 Pac. 766 (1903).

Appropriation

The basic concept of the doctrine of appropriation, or Colorado doctrine, is that the landowner has no inherent right to use water from sources upon, contiguous to or underlying his land but that rights to these sources are based on priority in time of beneficial use and may be lost after the use ceases. This doctrine, obviously foreign to the doctrines based on landownership, nevertheless can be traced to a common ancestry and likewise has a common-law origin.

In common usage, an appropriator is one who takes exclusive possession of an article that had been recognized as common property or had been owned by others. Depending upon the reactions of the true owner, the courts may deem this act to be unlawful and criminal, or they may legitimize it by reason of either long-continued adverse use or the owner's consent. The inception of the appropriation doctrine as it now stands in the United States can be traced to the early miners in California, who took water from streams for use in placer mining on the public lands. In decisions concerning disputes over the water 5/ 6/ the California Supreme Court sanctioned the practice and justified it with respect to the accepted common-law doctrines of landownership: 7/ "... a prior appropriation of either (wood or water) to steady individual purpose, establishes a quasi private proprietorship, which entitles the holder to be protected in its quiet enjoyment against all the world but the true owner ..."

The right to appropriate water on the public lands, confirmed in these decisions, was recognized by Congress in its Acts of 1866 7a/ and 1870, 7b/ and protected even in those lands that were subsequently patented and passed to private possession. The Desert Land Act of 1877 was interpreted in 1935 by the U. S. Supreme Court 8/ to indicate the intent of Congress to dispose of the land and water of the public domain separately and to make all nonnavigable waters of the public domain subject to the plenary control of the States designated in that Act, with the right in each to determine for itself to what extent the rule of appropriation, or the common-law rule in respect of riparian rights, should obtain.

Each of the 17 Western States now recognizes the doctrine of appropriation to some extent. It was specified as the exclusive basis for water rights in the Constitution of Colorado in 1876, whence came the common designation as the "Colorado doctrine." Fifteen other States, either by statute or in their constitutions, have dedicated all or part of their undeveloped water resources to the public and made them available for

5/ Irwin v. Phillips, 5 Calif. 140, 63 Am. Dec. 113 (1855).
6/ Tartar v. Spring Creek Water & Min. Co., 5 Calif. 395 (1855).
7/ Idem.
7a/ Rev. Stat., sec. 2339, from Act of July 26, 1866, sec. 9, 14 Stat. 251, 253, now codified as part of 43 U. S. C. 661.
7b/ Rev. Stat., sec. 2340, from Act of July 9, 1870, sec. 17, 16 Stat. 217, 218, now codified as part of 43 U. S. C. 661.
8/ California Oregon Power Co. v. Beaver Portland Cement Co., 295 U. S. 142-164 (1935).

appropriation and use under State regulation. In Oklahoma there has been no dedication of unappropriated water to the public, but certain waters may be appropriated.

EVALUATION OF EXISTING SYSTEMS OF WATER RIGHTS

Logical Overall Pattern

The fundamental differences between the doctrines of water rights based on landownership and on appropriation reflect the contrasts in climate in the broad regions where they have been developed and applied. The general distinction between humid East and arid West has long been recognized, the humid areas being generally those having an average annual precipitation exceeding 30 inches. Thornthwaite 9/ has refined this distinction, and points out that water deficiency is habitual where the average potential evapotranspiration (the water that would be pulled back, if it were available, to the atmosphere by solar energy) exceeds the average annual precipitation. Where the precipitation exceeds potential evapotranspiration, there is a water surplus; and stream runoff is the evidence of it. As shown by figure 1, the 31 Eastern States comprise the principal region of water surplus, and the Pacific Northwest is another such region. Most of the 17 Western States are in a region where water deficiency is normal, and only the mountain ranges have a surplus.

In the humid States, property owners generally may be assured that the annual precipitation on their property is enough for agricultural need, with some surplus left over. If the water they take from rivers, wells, or springs does not originate on their property, at least their property generates other water for other property downgradient so that they are not likely to cause a net depletion of the supplies in the drainage basin. The concentrated needs of industries and large cities may create a problem, for which one solution is the reserving of sufficient watershed area, as New York City has done in its Croton and Catskill water-supply systems. At any rate, landownership can be a logical basis for water rights in the regions of surplus, and it is so in the 31 Eastern States, as shown in figure 1.

The three Pacific Coast States each have some humid areas: rainfall of 80 to 100 inches a year is not uncommon in northern California and western Oregon and Washington. On the other hand, most of California's valleys, and eastern Oregon and Washington, are arid or semiarid. In those three States there is a tendency toward acceptance of both the doctrine of landownership and that of appropriation as a basis for water rights. In Oregon, ground-water rights are based on appropriation in the arid region east of the Cascades, and on landownership in the humid region to the west.

In the arid region appropriation is the generally accepted basis for water rights. The Rocky Mountain States are arid and are committed rather generally to appropriation of ground water and entirely to appropriation of streams. In these States the inhabited areas are predominantly areas of low rainfall. There are very few places where the rainfall is sufficient for dry farming. Nearly everywhere, crops depend upon water from somewhere else for irrigation, and this is dependent upon surface- and ground-water supplies. If landownership were the basis for water rights here, so far as origin of precipitation is concerned, hardly any valley landowner would have enough water for his needs. The areas of surplus in the Mountain States are chiefly in the mountain ranges and, for the most part, are public lands. Water flowing from those public lands is appropriated in the inhabited lowlands that do not have sufficient supply. Utah and Nevada have declared all water to be subject to appropriation, and the water of streams is appropriable in all seven Mountain States.

The Great Plains, from Montana to Texas, have a semiarid climate, intermediate between those of the arid West and humid East. There is a tendency in most of these States to accept both doctrines of water rights to some extent. One hydrologic characteristic of the Plains States is that the major streams--the Arkansas, Platte, Yellowstone Rivers, and a few others--depend on water from the Rockies. The watercourses of these major streams are generally subject to appropriation within the Plains States. However, in large areas away from these streams the ground water is of local origin, for it is dependent on precipitation. Those ground-water sources have no connection with the Rocky Mountains and cannot be replenished by them. Generally rights to use of ground water in those States are based on landownership. Three States have supported by statute the common-law doctrine that the owners of the land have paramount rights to the "diffused surface water" derived chiefly from precipitation. Thus in the Great Plains the bases of water rights appear to be adjusted broadly to the two prevailing sources of water. So far as the larger streams and watercourses are concerned, the dominant source is the Rocky Mountains, subject to appropriation when it reaches the Plains State concerned; in the areas away from these watercourses the dominant source is the precipitation within the State, and water rights are based in most States on landownership.

We may conclude that the contrasting bases for water rights--landownership on the one hand and appropriation on the other--are both workable in the respective broad regions where they are recognized, because those regions have corresponding contrasts in climatic and hydrologic patterns. In other words, the broad concepts that have been developed in our existing compendium of statutes and court decisions have sound support in hydrology. This is most fortunate, for in many States the fundamental bases for water rights have been outlined by statutes or court decisions and are not likely to be reversed, although modifications are possible and even probable.

For those who may hope that the present complex situation may be superseded by a simplified uniform water code, two quotations may be pertinent. One is from an address by Chief Justice Lucien

9/ Thornthwaite, C. W., 1948, An approach toward a rational classification of climate: Geog. Rev., v. 38, p. 56-75.

Shaw of the California Supreme Court 10/ in 1922:

> The opponents of the doctrine of riparian rights had pointed out these results with much emphasis and repetition in the political campaign prior to the decision in Lux v. Haggin 11/ and they are still referred to as evidence that the doctrine is contrary to a sound public policy in states having the arid climate of California. The obvious answer on the question of policy is that the objection comes too late, that it should have been made to the legislature in 1850 prior to the enactment of the statute adopting the common law. When that was done the riparian rights became vested, and thereupon the much more important policy of protecting the right of private property became paramount and controlling. This policy is declared in our constitutions, has been adhered to throughout our national history, and it is through it that the remarkable progress and development of the country has been made possible.

Similarly, in the case of Bristor v. Cheatham, 12/ the Arizona Supreme Court says:

> It is claimed that if we do not change the law, ground waters will be exhausted, and the legislature is shackled and powerless to enact a ground-water code. If the legislature is shackled, it is the Constitution that imposes the impediment. The court has no right to pull the rug from under the owner and release the constitutional obstructions, if any. It is the court's duty to protect constitutional rights. Possibly the only source of power the legislature possesses is the police power for the general welfare.

Confusion in Details of Pattern

There is great variation in the present bases for rights to use of various types of water, and particularly is this true in the 17 arid Western States, which have been exceedingly prolific in water disputes and problems. As shown in the following table, the 31 Eastern States adhere to the doctrine of landownership, although the police power has been invoked in several of them to permit regulation and control of water development. In most of the 17 Western States landownership is an acceptable basis of rights to some water, and other waters are subject to appropriation. In the two States, Utah and Nevada, that have declared all water subject to appropriation, there have been no test cases establishing the paramount right of appropriators as against landowners to the water that falls as precipitation in source areas for surface and ground-water supplies. Indeed, the Utah Supreme Court in a recent decision 13/ has held that soil water is a part of the soil and not subject to appropriation if its movement cannot be traced to land other than that on which it is found and if that water in the natural state produces plant life and benefits the land.

The "classes" of water shown in the table have been developed largely in court decisions and thus constitute a legal classification rather than a scientific classification of water. Not only these legal classes but many common assumptions and definitions accepted in courts of law were developed many years ago and are still extant chiefly because of the predilection of the legal mind for precedent. In the light of present scientific knowledge they are archaic and unsound. In a specific case a decision based on erroneous assumptions might, by accident, work out very well under the hydrologic conditions of the area to which it pertained, but it might be thoroughly untenable as a precedent for decisions in regions of contrasting hydrologic characteristics.

Archaic legal classification of waters.—Hydrologists recognize that the ultimate source of practically all the fresh water on the continents is precipitation. In developing the concept of the hydrologic cycle, they have traced the movement and disposal of water upon or under the earth's surface and have shown that there are natural priorities in that movement. A brief sketch of the operations of the hydrologic cycle is quoted: 14/

> ... Except for the water that evaporates at the surface, the soil or mantle-rock has top priority upon the water that falls as precipitation. Overland runoff does not occur unless or until precipitation exceeds the capacity of that surface layer to absorb the water. The soil holds water against the force of gravity until it has reached its capacity for holding water by molecular attraction, and only then does water start to percolate downward under the force of gravity [root cavities, animal burrows, and soil cracks facilitate movement downward in many places, however]. In the intervals between storm periods soil moisture may be depleted by evaporation and transpiration, and this depletion must be made up during subsequent storms before there can be additional downward percolation.
>
> Ground-water reservoirs, including those perched upon impermeable rock layers, receive the water that percolates downward from the soil zone. These reservoirs, or aquifers, are composed of materials sufficiently permeable that water can move through them by gravity. Water accumulates until the reservoir is filled sufficiently to cause underground flow, which may ultimately be discharged into lakes or stream channels or oceans, or at the land

10/ Shaw, Lucien, 1922, The development of the law of waters in the West: 10 Calif. Law. Rev. 443, 455; 189 Calif. 779, 791.

11/ Lux v. Haggin, 69 Calif. 255, 4 Pac. 919 (1884), 10 Pac. 674 (1886).

12/ Bristor v. Cheatham, not yet reported.

13/ Riordan v. Westwood, 115 Utah 215, 203 Pac. (2d) 922 (1949).

14/ Thomas, H. E., 1951, The conservation of ground water: p. 17-18, New York.

Table 1.--Basis of water rights by States 1/

A--Appropriator (statutory)
A(L)--Appropriator, first preference to landowner
L--Landowner
Ls--Landowner (statutory)
P--Police power

State	Legal classification of water							Regulated areas
	Diffused surface water 2/	Percolating water 3/	Springs 4/	Springs flowing to watercourses	Water in defined underground channels	Watercourses 5/	Unconsumed water 6/	
PACIFIC COAST								
California	L	L, A	L	L, A	L, A	L, A	L, A	Pasadena
Oregon	A(L)	L, A	L	A	A	A	A(L)	
Washington	A	A	A	A	L, A	L, A	--	
ROCKY MOUNTAINS								
Arizona	L	L	A	A	A	A	L	
Colorado	A(L)	A	A(L)	A	A	A	A(L)	
Idaho	L	A	L	A	A	A	A	
Nevada	A	A	A	A	A	A	A	Las Vegas
New Mexico	L	A	L	A	A	A	--	9 districts
Utah	A	A	A	A	A	A	A	5 districts
Wyoming	L	A	A	A	A	A	L, A	
GREAT PLAINS								
Kansas	--	A	A	A	A	A	A	
Montana	--	L	A	A	A	A	A	
Nebraska	--	L	L	L, A	A	A	--	
North Dakota	Ls	L	L	L, A	L, A	L, A	--	
Oklahoma	Ls	A	L	L, A	L, A	L, A	L, A	
South Dakota	Ls	L	L	L, A	L, A	L, A	L	
Texas	L	L	L	L, A	L, A	L, A	L, A	3 districts
HUMID REGION								
Alabama	--	L	--	--	--	L	--	
Arkansas	--	L	--	--	--	L	--	
Connecticut	--	L	--	--	--	L	--	
Delaware	--	L	--	--	--	L	--	
Florida	--	P	--	--	--	L	--	Sarasota
Georgia	--	L	--	--	--	L	--	Savannah
Illinois	--	L	--	--	--	L	--	Champaign
Indiana	--	P	--	--	--	L	--	
Iowa	--	L	--	--	--	L	--	
Kentucky	--	L	--	--	--	L	--	Louisville
Louisiana	--	L	--	--	--	L	--	
Maine	--	L	--	--	--	L	--	
Maryland	--	P	--	--	--	P	--	
Massachusetts	--	L	--	--	--	L	--	
Michigan	--	L	--	--	--	L	--	
Minnesota	P	P	P	P	P	P	P	
Mississippi	--	L	--	--	--	L	--	
Missouri	--	L	--	--	--	L	--	
New Hampshire	L	L	--	--	--	L	--	
New Jersey	--	P	--	--	--	P	--	Camden, Perth Amboy

See footnotes at end of table.

Table 1.--Basis of water rights by States 1/--Continued

State	Legal classification of water							Regulated areas
	Diffused surface water 2/	Percolating water 3/	Springs 4/	Springs flowing to watercourses	Water in defined underground channels	Watercourses 5/	Unconsumed water 6/	
				HUMID REGION--Continued				
New York	--	P	--	--	--	P	--	Long Island
North Carolina	--	L	--	--	--	L	--	
Ohio	L	L	--	--	--	L	--	County control
Pennsylvania	--	L	L	--	--	A	--	
Rhode Island	--	L	--	--	--	L	--	
South Carolina	--	L	--	--	--	L	--	
Tennessee	--	P	--	--	--	L	--	Memphis
Vermont	--	L	--	--	--	L	--	
Virginia	--	L	--	--	--	L	--	
West Virginia	--	L	--	--	--	L	--	
Wisconsin	--	P	--	--	--	L	--	

1/ Sources: Hutchins, Wells A., 1942, Selected problems in the law of water rights in the West. U. S. Dept. Agr. Misc. Pub. 418, 488 p. McGuinness, C. L., 1951, Water law, with special reference to ground water: U. S. Geol. Survey Circ. 117, 30 p.

2/ Standing water and overland flow from precipitation; seeps, bogs, and marshes; sloughs and escaped flood waters; playas.

3/ Soil moisture in excess of field capacity, water moving vertically in the zone of aeration, subsurface storm flow, most ground water

4/ Not observed to contribute to a watercourse.

5/ Streams, including their underflow, and associated lakes, ponds, and marshes.

6/ Water used nonconsumptively; waste; return flow.

surface by springs or seeps. Where ground water is at shallow depth, it may be discharged by evaporation or transpiration.

Streams are the spillways of the hydrologic cycle and carry off the surplus water that is not stored in lakes or underground or returned to the atmosphere by evapotranspiration. They have the lowest priority on water that falls as precipitation, for water enters a stream only if it falls directly in the channel or if it cannot get into the ground by infiltration or if it is discharged into the stream from ground-water reservoirs. Even after water has reached the stream, it may be lost by evapotranspiration or disappear by seepage into underlying ground-water reservoirs.

The great differences in ground-water resources and in streamflow characteristics in various parts of the country are traced not only to differences in rates of rainfall and other climatic factors but to differences in the materials in and below the soil zone, through which the water may pass. In some places the soil is like a blanket over the earth, absorbing the rainfall even of intense storms until it can hold no more, so that some starts moving downward into underlying rock materials; in other places bare rock or other impermeable material or frozen or compacted ground cannot absorb the water even of moderate storms or of gradual snow melting, and the surplus may cause a stream to flood.

The underlying rock materials may be very permeable and form part of a ground-water reservoir capable of transmitting large quantities of water for considerable distances, finally discharging the water at a fairly constant rate into streams. In

> other places, downward percolation may be stopped within a few feet or even a few inches of the surface by an impermeable layer, and the water collected above that layer may quickly reappear in streams only a short distance away, perhaps soon enough to contribute to floods in those streams.

Some "classes" of water indicated in the table differentiate between waters without regard to their close hydrologic relation, and others include waters of markedly contrasting genetic relations. Thus "diffused surface waters" include standing or flowing water on the surface resulting from precipitation, and also ground water rising in seeps or bogs and marshes, surface water escaped from stream channels, and playas, which may be formed by ground or flood water. "Percolating waters" were once defined 15/ as "vagrant, wandering drops moving by gravity in any and every direction along the lines of least resistance," and the term is still tainted by this definition which is based on the ignorance of a bygone era.

When one considers that the water from precipitation may initially form "diffused surface water," then "percolating water" which may eventually enter a "defined underground channel," and subsequently reappear at the surface as "springs" or as "diffused surface water" in a marsh, or even contribute to the base flow of a "watercourse," it is evident that the legal classification of waters can be a lawyer's paradise and a logician's nightmare.

Provincialism in leading decisions. – Each court decision that forms the basis for existing water law reflects the level of understanding of the principles of hydrology and details of water occurrence at the time the decision was rendered. These decisions are generally based upon all the hydrologic evidence that could be marshaled by the disputants, and they are likely to have a logical basis in the hydrology of the specific area, even though that hydrology is not fully understood. The decisions commonly reflect also the local attitudes toward water, and these attitudes vary tremendously, depending upon whether the area is one of habitual surplus, perennial deficiency, or alternating abundance and shortage.

When a decision is accepted as a precedent in subsequent suits, especially in jurisdiction far removed, it should be recognized that the leading decision is necessarily provincial, not only because of the specific hydrologic conditions but also because of the water philosophy at the place and time that the decision was rendered. This provincialism may not be fully recognized, particularly if the fundamental hydrology is not adequately understood.

A case in point is the riparian doctrine which originated more than a century ago in the humid British Isles. According to Hutchins 16/

> Under the riparian doctrine in its strict sense, the owner of land contiguous to a watercourse is entitled to have the stream flow by or through his land, undiminished in quantity and unpolluted in quality, except that any riparian proprietor may make whatever use of the water he requires for domestic and household purposes and the watering of farm animals.

As stated more recently by the U. S. Supreme Court in United States v. Gerlach Livestock Co. 17/

> Riparian rights developed where lands were amply watered by rainfall. The primary natural asset was land, and the runoff in streams or rivers was incidental. Since access to flowing waters was possible only over private lands, access became a right annexed to the shore. The law followed the principle of equality which requires that the corpus of flowing water become no one's property and that, aside from rather limited use for domestic and agricultural purposes by those above, each riparian owner has a right to have the water flow down to him in its natural volume and channels and unimpaired in quality.

Strict adherence to the requirement that the water be undiminished in volume and unimpaired in quality would prevent any use of the water, because it is axiomatic that the volume must be diminished by consumptive use and nonconsumptive use results in some impairment of the property for which the water is used--for instance, water becomes polluted by use for sanitation, it is warmed by use in cooling, and dissolved or suspended impurities are introduced by industrial processing and washing. In humid regions a reasonable facsimile of the requirements of this doctrine results from the tributary inflow and accompanying dilution that are characteristic of most streams as they flow toward the sea. But in regions of less abundance of water, the riparian doctrine must be modified somehow to permit any use of water.

Various modifications of the riparian doctrine have been made in court decisions in the several Western States. In California a riparian owner has a prior and paramount right to reasonable beneficial use of the water, and if necessary to effectuate it he is entitled to the full natural flow of the stream or its equivalent undiminished in quantity and unimpaired in quality. 18/ In Kansas each riparian owner has a primary right to use all the water he may require for domestic use and to water livestock; and after all other riparian landowners have been served for such primary uses of water, they are all equally entitled to a fair and equal share of whatever water may remain in the stream for irrigation purposes. 19/ In South Dakota, uses of water are divided into natural, for domestic use and stockwatering, and artificial, for manufacturing, mining, and irrigation; a riparian owner may exhaust the stream for the former purposes, but rights of all riparians for the latter uses are equal. 20/ In North Dakota the right to have water

15/ City of Los Angeles v. Hunter, 105 Pac. 755 (1909).

16/ Hutchins, Wells A., 1942, Selected problems in the law of water rights in the West: U. S. Dept. Agr. Misc. Pub. 418, p. 39.

17/ United States v. Gerlach Livestock Co., 339 U. S. 725, 744-745 (1950).

18/ Meridian v. San Francisco, 13 Calif. (2d) 424, 90 Pac. (2d) 537 (1939).

19/ Frizell v. Bridley, 144 Kans. 84, 58 Pac. (2d) 95 (1936).

20/ Lone Tree Ditch Co. v. Cyclone Ditch Co., 26 S. Dak. 307, 128 N. W. 596 (1910).

flow in natural quantity and purity is subject to the right of each riparian proprietor to make reasonable use thereof. 21/ In Texas riparian waters are considered to include only the ordinary flow and underflow of the stream; waters of a stream above the line of highest ordinary flow are regarded as flood waters, to which riparian rights do not attach. 22/

By contrast with the doctrines that have originated in humid regions, the water philosophy of the West characteristically reflects the prevailing water scarcity. If one can establish a right to use water, he is expected to "use it up," and unconsumed water may be a vexing problem. In some cases the courts have resolved this problem in introducing the term "fugitive water," defined by the Utah Supreme Court 23/ as water discharged by the owner from his irrigation system with an intent to abandon it. Any individual may scramble for the possession of fugitive water, and no one can obtain an exclusive right to its continued use.

Water nonconsumptively used includes return from irrigation, sewage, and "waste," which has been variously defined by numerous statutes and court decisions in the Western States. Many of these States permit appropriation of water that has been used but not consumed under other rights, but the original user is generally under no obligation to continue the "wasteful" practices, so that such rights may be insecure in most States. Some court decisions have permitted irrigation companies to "save," by means of canal linings or pipelines, the water that formerly seeped into the ground. In the case of Big Cottonwood Tanner Ditch Co. v. Moyle, 24/ for example, the Utah Supreme Court considered such improvements reasonable, even though their greater depth and swiftness made them dangerous for children, but evidently the court did not have an opportunity to consider the important hydrologic fact that this seepage occurred in the recharge area for a major ground-water reservoir, 25/ and that wells in that reservoir have long made beneficial use of, and therefore might be considered to have established a prior right to, the water "lost" from the irrigation canal. As pointed out elsewhere, 26/it is a

> ... common fallacy that water is "lost" when it seeps from a stream into a ground-water reservoir and that it can be "saved" by preventing the seepage. The terminology is an anachronism from the days when little was known about ground water. Actually water "saved" by being held on the surface is subject to loss by evaporation, while the water that disappears into the ground is generally not subject to evaporation losses and is usually recoverable.

Need for sound hydrology in findings of fact.—Scientists are generally devoted to research, which Webster's dictionary defines as "critical and exhaustive investigation or experimentation having for its aim the revision of accepted conclusions, in the light of newly discovered facts." Thus they are true disciples of the American philosophy of progress, with its admiration for the new and dissatisfaction with the old. By contrast, the legal profession treats precedent and tradition with great respect. The scientist may feel uncomfortable in this environment and irked by its inadequacy in specific instances that pertain to his particular field of research.

In the field of hydrology, it must be recognized that conservatism in the courts has given a general consistency to the broad pattern of water-law development in the United States. Nevertheless, as indicated above, the courts in some decisions have enunciated inconsistencies and inaccuracies in basic hydrology. These can generally be traced to the findings of fact rather than to the conclusions of law, as is to be expected, for the conclusions of law have been made by justices who are acknowledged as impartial and as experts at law; but the findings of fact have not been based upon a corresponding impartial, expert analysis of the hydrologic data.

The findings of fact in recent decisions may be weak because of indiscriminate reliance upon precedents established in decisions many years ago, when our knowledge of water and principles of its occurrence was far less than today. The elimination of obsolete concepts is a problem that requires hydrologic rather than legal training.

The established rules of evidence may also constitute a distinct handicap to a court in its efforts to reach sound conclusions concerning the water resources. The evidence in court hearings of water disputes is presented by partisans who may or may not deem it necessary to call upon hydrologic experts, but in any event the hydrologic testimony is likely to be incomplete and limited to that favoring one side. The court must decide on the basis of the evidence presented; although it can rule on the admissibility of evidence, its prerogatives ordinarily do not extend to calling for other data or demanding comprehensive studies in areas where existing knowledge is meager. Rarely does a court have the assistance of an impartial hydrologist in weighing the evidence and making findings of fact in water disputes.

The basic water data collected by the Geological Survey, and by other Federal and State agencies concerned with basic data, have been generally accepted in the courts and quoted by both sides in water disputes. However, these agencies generally have not been expected to furnish personnel to serve in the capacity of a friend of the court and to advise as to interpretation or overall adequacy and comprehensiveness of the data presented. Nevertheless, in some recent cases discussed below, the data collected by these governmental agencies have constituted the essential basis for the decisions of the court.

21/ McDonough v. Russell-Miller Milling Co., 38 N. Dak. 465, 165 N. W. 504 (1917).

22/ Mott v. Boyd, 116 Tex. 82, 286 S. W. 458 (1926).

23/ Smithfield West Bench Irr. Co. v. Union Central Life Ins. Co. et al., 105 Utah 468, 143 Pac. (2d) 1866 (1943).

24/ Big Cottonwood Tanner Ditch Co. v. Moyle, 174 Pac. (2d) 148 (1946).

25/ Taylor, G. H., and Leggette, R. M., 1949, Ground water in Jordan Valley, Utah: U. S. Geol. Survey Water-Supply Paper 1029, p. 24-30.

26/ Thomas, op. cit., p. 252.

WATER RIGHTS AND PROBLEMS IN SOME AREAS OF GROUND-WATER MINING

The development and use of water have given rise to a host of problems. By careful selection, Hutchins 27/ was able to present in 488 pages an outstanding analysis of the major problems of the Western States. McGuinness 28/ has summarized several of the outstanding current problems that pertain especially to ground water. The following discussion is limited to one type of ground-water problem, which is considered by many to be the most serious water problem of all--that of persistent overdraft from a ground-water reservoir. In such reservoirs, wells and springs year after year draw water in excess of the annual replenishment, and the excess must come from storage. In other words, the water in the reservoir is being mined. The ground-water reservoirs with persistent overdraft are principally in the southwestern part of the country, extending from California to the lower Mississippi Valley. 29/

The extraction processes of a mining economy do not constitute a moral problem for other mineral resources. It is taken for granted that our use of steel, coal, copper, gasoline, or sulfuric acid means a depletion of the mineral reserves from whence they come. This does not deter us, although we are becoming increasingly aware of the value of these resources, and wasteful methods of extraction are not condoned as they were in the early days of exploitation.

Water, because it is generally a renewable resource, is commonly grouped with the soil and the timber and forage and food that soils can produce perennially by good management rather than with the irreplaceable mineral resources. The water in areas of ground-water mining, however, may have great storage volume but negligible replenishment, and thus may not qualify as a renewable resource. As a specific example, the water underlying the High Plains of Texas and New Mexico (p. 15, 11) has much more in common with the petroleum in an oil field than it does with water in the nearby Roswell Basin, which has a large perennial supply.

To a hydrologist, the water rights acquired by landownership are a function of area, or, more broadly, volume, and those acquired by appropriation are a function of time. Both these variables are important in the evaluation of the hydraulic characteristics of a ground-water reservoir, and indeed a water right is ordinarily expressed as a rate, or the product of volume by time. Recent cases in California and New Mexico suggest that both factors may ultimately be deemed essential in determination of rights in a fully developed or overdeveloped ground-water reservoir, regardless of whether appropriation or landownership is the currently favored basis for a water right.

California

California recognizes water rights acquired by landownership and also to some extent water rights acquired by appropriation. The general rule of water rights to streams has been that the riparian right is (1) coordinate with the rights of other riparian owners, (2) subordinate to appropriative rights previously acquired on public land, and (3) superior to appropriative rights subsequently acquired. 30/ The rights to ground water are comparable insofar as overlying landowners are concerned, for they have equal rights to use of water on their lands and are entitled to an equitable apportionment if the supply is not enough for all. However, appropriation of ground water for distant uses is permitted only to the extent that there is a surplus over the reasonable requirements of the overlying landowners; the landowner's right to water for use on his land has been recognized as paramount to that of a taker for distant use. 31/ In the case of Pasadena v. Alhambra 32/ the California Supreme Court gave judicial approval to a stipulated agreement for adjudication of all water rights in the Raymond Basin, whether those rights were acquired by landownership or by appropriation.

The Raymond Basin is a part of the San Gabriel Valley in southern California, but the ground water in it is separated from that in the rest of the valley by the Raymond fault. The land overlying this basin includes parts of Pasadena and four other incorporated cities, plus a few small agricultural areas. Alhambra and several other cities beyond the limits of the basin have long been using water pumped from the Raymond Basin. Available records indicate that the draft upon the basin began to exceed the replenishment about 1916. In 1938 the city of Pasadena initiated an action for adjudication of all ground-water rights in the basin, and upon petition of many of the 31 parties involved in the suit, the court referred the case to the State Division of Water Resources for a report on the physical facts. In 1943 the Division reported that recharge was about 70 percent of draft. 33/

By the terms of the adjudication, the only recognized water rights were those based upon actual development and use of water from the Raymond Basin, and unused rights based on ownership of land ceased to exist. As pointed out by Conkling, 34/ the California Supreme Court ruled in effect that those who were using water as overlying users were also appropriators and gave all users correlative rights in the source. In finding actual use to be a criterion for a water right, the court accepted one of the tenets of the appropriation doctrine and repudiated landownership rights to that extent. By recognizing the rights developed prior to the trial, the court also recognized the criterion of time but did not follow the appropriation doctrine to the extent of differentiating as to priority of individual rights, for all recognized rights were considered equivalent. The right of each water user was reduced to 70 percent of his previous actual pumpage. This reduction was accomplished without denying anyone his water supply, because Pasadena can depend upon the

27/ Hutchins, op. cit.
28/ McGuinness, op. cit.
29/ Thomas, op. cit., plate 2, p. 36-97.
30/ Hutchins, op. cit., p. 34.
31/ Hutchins, op. cit., p. 160.
32/ Pasadena v. Alhambra, 33 Calif. (2d) 908, 207 Pac. (2d) 17 (1949); certiorari denied, 339 U. S. 937 (1950).
33/ Report of Referee, Pasadena v. Alhambra, Pasadena C-1323, Superior Court of Calif.
34/ Conkling, Harold, Oral discussion of "Statutory control of ground-water draft" by S. T. Harding, at the convention of the Am. Soc. Civil Engineers, San Francisco, March 1953.

Colorado River as developed by the Metropolitan Water District of Southern California. As a member of the District, Pasadena intends to do no pumping from the Raymond Basin. Those who do pump will pay Pasadena for the proportionate share that they pump under Pasadena's rights. Thus imported water makes up the difference between past demand and allowable draft from the Raymond Basin.

New Mexico

The State of New Mexico adheres to the appropriation doctrine for surface water and for practically all ground water. According to the U. S. Supreme Court, 35/

> To appropriate water means to take and divert a specific quantity of water therefrom and to put it to beneficial use in accordance with the laws of the state where such water is found, and by so doing to acquire a right under such laws, a vested right to take and divert from the same source and to use and consume the same quantity of water annually forever.

This is the accepted usage of the term in the Western States, where it was applied first to surface water and then to all water; renewability of the resource is inherent in this definition.

An essential part of an appropriative right is its priority, because this determines who shall have the water when the supply is insufficient to meet all demands. Surface water is readily adapted to the appropriation doctrine, for the water can be apportioned strictly on a priority basis. A dry stream bed is the undebatable answer to any unsatisfied junior appropriator who would like to develop water in excess of the perennial yield of the stream. By contrast, many ground-water reservoirs contain far more water than the quantity that flows into them in an average year and it is physically possible, by drawing from this permanent storage, to take far more than the perennial yield--for a time. Nevertheless, ground water can be apportioned in perpetuity as required under the appropriation doctrine only if a balance is maintained between the average recharge to and the average discharge from the ground-water reservoir.

In areas of persistent overdraft there is no possibility of guaranteeing rights forever. Under a mining economy, some of the water is removed from storage under the land, and although the stored quantity in some reservoirs may be large, it is nevertheless a finite quantity and subject to eventual exhaustion.

Several of the problems of ground-water mining under appropriative rights are exemplified in the appeal of Luther Cooper against the State Engineer's denial of his applications for wells in Lea County, 36/ although that appeal never got beyond the District Court, and the decision has not yet (1953) been finalized by the presiding judge. The appeal led to a modification of the State Engineer's regulation of overdeveloped ground-water reservoirs and also gave some insight into public opinion concerning mining. Following is a brief summary of the testimony: 37/

C. D. Harris, Special Assistant to the Attorney General of New Mexico, announced that the State would attempt to prove: (1) that the Lea County underground basin has reasonably ascertainable boundaries and comes within the purview of the State ground-water law, Section 77-1107 to 107, (2) that there is no unappropriated water in that basin, and (3) that the Luther Cooper permits would impair prior existing rights. J. O. Walton, attorney for Cooper, announced that he would attempt to prove: (1) that the State Engineer has no jurisdiction because the boundaries of the basin are not reasonably ascertainable, (2) that the basin cannot be administered on the basis of appropriation or of impairment of existing rights, and (3) that the State Engineer discriminated against Cooper in denying his application.

The Lea County ground-water basin.—Practically all ground water pumped in Lea County comes from the Ogallala formation of Pliocene age. This formation is composed chiefly of stream-deposited sediments, including sand, silt, gravel, clay, and secondary caliche; it is unconsolidated or weakly consolidated and has a maximum thickness of 300 feet and an average thickness of about 175 feet. R. S. Cave aptly quoted an early geologist's description of the Ogallala as "homogeneous in its heterogeneity." It was deposited upon an eroded surface having a relief of probably more than 50 feet and is generally underlain by Triassic red beds, although Cretaceous shales underlie the Ogallala in places. The Ogallala is the surficial formation in most of the High Plains in Lea County, but thin deposits of windblown or slope-wash material lie upon it in places. About 60 percent of Lea County, which includes some lands beyond the

35/ Arizona v. California, 283 U. S. 423 (1931).

36/ Application of Luther Cooper on appeal from State Engineer of New Mexico: Transcript of testimony, Fifth Judicial District Court, Lea County, N. Mex., Jan. 29-30, 1952.

37/ Evidence introduced during the hearing of the Luther Cooper appeal included a considerable amount of unpublished records, charts, and interpretive conclusions. The ground-water conditions in Lea County have been described in the following publications:

Nye, S. S., 1930, Shallow ground-water supplies in northern Lea County, N. Mex.: N. Mex. State Engineer's 9th Bienn. Rept., p. 363-387.

_____ 1932, Progress report on the ground-water supply of northern Lea County, N. Mex.: N. Mex. State Engineer's 10th Bienn. Rept., p. 229-251.

Theis, C. V., 1934, Progress report on the ground-water supply of Lea County, N. Mex.: N. Mex. State Engineer's 11th Bienn. Rept., p. 127-153.

_____ 1938, Progress report on the ground-water supply of Lea County, N. Mex.: N. Mex. State Engineer's 12th, 13th Bienn. Repts., p. 121-134.

Conover, C. S., and Akin, P. D., 1942, Progress report on the ground-water supply of northern Lea County, N. Mex.: N. Mex. State Engineer's 14th, 15th Bienn. Repts., p. 285-309.

boundaries of the High Plains, is "scab land" unsuitable for agriculture.

Water in the Ogallala is unconfined and apparently forms a continuous water table under most of the High Plains in Lea County, although a perched water table is recognized in the southern part of the county. The water table under natural conditions has a gradient of about 15 feet per mile to the east and southeast, except along the western edge of the plains. The rate of movement of water down this slope has been estimated to be about 1 foot per day. The water throughout the Ogallala is of good quality, but the small quantities of water in the underlying Triassic red beds are commonly saline.

It is generally agreed that the only possible source of recharge to this aquifer is precipitation upon the High Plains. The aquifer is cited as an outstanding example of an isolated aquifer and was so recognized by Judge Anderson. The amount of recharge in Lea County is estimated to average 25,000 acre-feet a year, which is balanced by equivalent movement eastward from the county. State Exhibit S-15 indicates that recharge may be nil in perhaps 8 years out of 10; the 25,000-acre-foot average is maintained because several times that amount may be added to the reservoir in exceptional years like 1941 and, in lesser degree, 1932 and 1946. There is, at least as yet, no prospect of increasing this recharge significantly by artificial means.

Pumpage from the Lea County basin was 15,000 acre-feet or less in each year prior to 1947; it increased to more than 25,000 acre-feet in 1947 and then rose rapidly in the next 3 years, approaching 120,000 acre-feet in 1950 and 200,000 acre-feet in 1953. This pumping is practically all from storage and the natural discharge presumably has continued at an undiminished rate. The effects of pumping since 1947 are shown by State Exhibit S-17 and are the basis for the finding of fact that the first appropriator will be adversely affected to some extent by each subsequent appropriation of water from the basin.

Problem of unappropriated water. —One might well argue that there never has been any water available for appropriation in the High Plains of Lea County, because the natural discharge was not initially diminished, and has not yet been diminished, by pumping and therefore continues at a rate sufficient to balance the average recharge. All water pumped from this aquifer is taken from storage, the water in storage is a finite and diminishing quantity, and when it is gone "that is it." Thus, none of the irrigation water rights in the basin are perennial rights as conceived under the appropriation doctrine. The basic problem is that the basin is on a mining economy and will continue to be so with only the rights heretofore granted; but existing New Mexico law (like that in other States adhering to the appropriation doctrine) recognizes no such economy and provides no guidance for the development of ground water in aquifers where storage volume is large but recharge is negligible.

This lack of guidance poses a tough practical problem for the administrative officer. In Lea County even the water developed before 1931 (the vested rights) should perhaps be classed as nonrenewable, although the quantity pumped under those rights is small and the depletion in storage probably negligible. Until the end of 1947 the pumpage was less than the estimated average recharge, and the graphs of State Exhibit S-15 indicate that all the storage depletion resulting from pumping was more than offset by the recharge in 1941; even the recharge after 1946 appears to have restored the quantity withdrawn by pumps in the preceding 2 years.

The mining economy began in 1948. If the State Engineer had closed the basin when pumpage exceeded 25,000 acre-feet in 1947, it might have been argued that he was following the letter of the law, but he probably would not have been supported in this by either the public or the courts because he would not have had sufficient evidence of the effects of overdevelopment. By permitting the development to continue until the end of 1948, he obtained abundant proof of the effects of accelerated pumping upon the reservoir. Still, none of the holders of existing rights protested the Cooper applications, and Judge Anderson's memorandum opinion leans toward expansion rather than restriction of development.

Problem of reasonably ascertainable boundaries. — A good deal of testimony was concerned with boundaries, both lateral and in depth, and it is a question whether the lawyers did better at confusing the scientists, or vice versa. The gist of it all was that some of the declared boundaries are based on economic pumping lifts that are no longer valid; some boundaries are indefinite because the aquifer is not accurately mapped, but those boundaries could be defined if funds and time were provided for geologic and geophysical studies, including test drilling; other boundaries could be set up, based on variations in hydrologic characteristics of the aquifer, but additional scientific investigation would be required before such boundaries could be drawn on any firm basis.

Boundaries are necessarily of great concern in administering renewable water resources under the appropriation doctrine, particularly if it is desired to achieve a balance between average recharge and discharge in a hydrologic unit. On the principle of "unity of the basin," it is desirable to include all lands where wells may affect this balance and exclude unrelated areas so that owners of those lands are not subjected to unnecessary restriction.

The eastward movement of water in the High Plains in New Mexico and on into Texas is recognized by all. Much testimony was devoted to this movement of water, and it complicated the situation out of all proportion to its magnitude. Judge Anderson in his findings of fact mentions the differences in the basin that lead to differences in movement and follows this with a recommendation for further study in order to subdivide the basin into logical irrigation districts. Assuming an annual recharge of 25,000 acre-feet, on the average, less than 1 percent of the precipitation moves through the zone of aeration and into the reservoir. The water under 1 square mile of land probably would take 12 to 15 years to move naturally into the next section. And the quantity that gets away from New Mexico into Texas each year, like the recharge, is negligible compared to the total that is left in New Mexico storage. On all counts the movement of water is of very small stature in comparison with the storage of water. If this movement were ignored entirely in administration of the

basin, it would be possible to forego the expensive detailed studies of variations in permeability in the aquifer that would be required for subdividing the basin on the basis of differences in rates of underground flow.

Problem of impairment of existing rights. —The chief impairment of existing rights appears to be the fact that under the mining economy now extant they are not perennial rights comparable to those that are characteristically earned under the appropriation doctrine. Actually they are extraction rights, properly measurable as a total volume of water rather than as a certain quantity to be pumped annually forever.

The degree of impairment of existing rights, or better, the mutual impairment of rights, can be gaged readily and progressively as extraction continues. State Exhibit S-17 shows, for instance, the effect of 4 years of mining. In the several areas of heavy pumping, the pumps must be yielding less water (unless the original well and pump have been replaced by larger facilities) and lifting it farther than they did in 1947. Additional wells in or near these areas of storage depletion would inevitably hasten the decline of water level and intensify the impairment of the existing rights. On the other hand, in most of the declared basin of Lea County, pumping so far has not produced a dent in the storage. The effects of pumping in the present developed areas will of course extend into larger areas in time, but slowly. Large quantities of water remain in storage in these unaffected areas, available for development, but this water cannot be extracted economically by pumping from existing wells, for some of it is 5 to 10 miles from those wells.

Problem of transfer of rights. —Any decision to permit pumping and extraction of water in the currently undeveloped areas would require also a decision as to who should be permitted to pump this water. This poses the problem, when the basin is being developed by mining, of how to evaluate rights that were earlier assumed to be perennial. The problem is complicated by the likelihood that some of the earlier established rights might have been at least quasi-perennial had it not been for the great increase in development beginning in 1947. The few records offered as exhibits suggest that the storage depletion resulting from all the pumping prior to 1941 may have been erased entirely by the recharge in that single year.

The State Engineer was questioned by Judge Anderson as to whether ultimate transfer of existing rights might be a conscious part of his method of denying or granting permits. The answer was negative. It is possible that a policy of denying new rights while transferring older rights would be subject to charges of discrimination, particularly if the transferred rights were acquired in 1948, for instance, when the basin had embarked definitely on a mining program.

Some minor legal problems. —The New Mexico ground-water law evidently leaves an opening for extended debate as to how to classify ground water in each area of dispute. Attorney Walton wanted the State Engineer to "elect whether or not the waters in Lea County are an underground stream or channel or artesian basin or a reservoir or a lake. ' Judge Anderson overruled this and ably disposed of the issue in his findings of fact by adopting a compound title. The wording of the law includes classifications both scientific and colloquial but all these classifications are likely to be immaterial to the main problems of ground-water development.

Attorney Harris argued that the burden of proof was upon Cooper to show that there is unappropriated water, but it had been determined at a pretrial conference that the State would assume the burden of proof and that procedure was followed. Ignoring the legal points involved, this appears to be a just procedure in any State that has assumed the burden of obtaining the technical data. Ground-water hydrology is so complex as to make it difficult for an individual to amass the evidence necessary to prove his point, and requiring him to do so might well be tantamount to shutting off any appeal from determinations of the administrative officer.

Aftermath of the hearing. —The hearing indicated that pumping in Lea County since 1948 has been far in excess of the recharge and that the excess has come from storage; but on the other hand, large volumes of water remain in storage, and much of it cannot be extracted by existing wells, The memorandum opinion of the court, and the absence of protests from owners of existing wells, indicated that public opinion was not hostile to drilling of additional wells for mining of more water; no one seemed to favor a reduction in pumpage to bring it closer to the meager rate of recharge.

Accordingly, the State Engineer extended the boundaries of the declared basin to include the entire ground-water reservoir in the Ogallala formation in Lea County and set 40 years as a minimum period for depletion of the reservoir. Applications for new wells are now approved in townships where existing wells would not unwater the formation within that period, and encouragement is given to transfer of rights from areas of more concentrated pumpage into those relatively undeveloped townships. Thus the factor of area has become a criterion in appropriative water rights in Lea County, for new wells can be drilled only in the parts of the reservoir where the water could not be extracted by wells under prior permits.

Nevada

Nevada's statutes declare all water to be public property and subject to appropriation. Ground water is currently being mined in Las Vegas Valley, near the southern tip of the State. In recent years the draft on the Las Vegas artesian basin has ranged from 35,000 to 40,000 acre-feet a year, which is estimated to be about 10,000 acre-feet greater than the average annual replenishment. 38/ The water used nonconsumptively--in irrigation, and sewerage in the vicinity of the city of Las Vegas--enters a shallow ground-water reservoir, from which evapotranspiration is estimated to average about 8,000 acre-feet a year.

38/ Robinson, T. W., personal communication.

Artesian pressures in representative wells have been declining steadily since 1925. 39/ The rate of decline averaged about 1½ feet a year since 1941. Since 1949 the State Engineer has prohibited the drilling of new irrigation wells in a 42-square-mile area which includes Las Vegas and about 90 percent of the area of ground-water development.

Las Vegas, with its increasing number of people, evaporative coolers, and swimming pools, is understandably concerned over the limitations imposed by nature on its water supply. Furthermore, its efforts at conservation have been affected by a State law which prohibits metering of water by municipalities having a population of more than 4,500.

Fortunately, another source of water is available to Las Vegas Valley: Lake Mead on the Colorado River is only 25 miles from Las Vegas, and the State of Nevada has been allocated 300,000 acre-feet of water from this source. Currently the Henderson industrial area in the southeastern part of the valley is using about 13,000 acre-feet of water from Lake Mead. In September 1953 Las Vegans voted overwhelmingly in favor of extending the existing pipeline which can provide as much as 15,000 acre-feet of additional water to the city. As in the Raymond Basin of California, the overdraft on ground water in Las Vegas Valley can undoubtedly be eliminated when ample water is available from this new source.

Utah

Utah, like Nevada, has declared all water within the State to be public property and subject to appropriation. Several of the problems of control to prevent ground-water mining are epitomized in the histories of Cedar City Valley and Escalante Valley, in the southwestern part of the State.

Cedar City Valley.—The ground water in Cedar City Valley was considered to be fully appropriated at the time the Utah ground-water law was passed in March 1935, and the State Engineer approved no additional development pending investigation. In 1940, after investigation, he concluded that all ground water was appropriated in a designated area that includes practically all of the irrigation wells in Cedar City Valley, and this area has been closed to additional development except for domestic and stock wells. 40/ The small streams tributary to Cedar City Valley have been fully appropriated for many years.

The ground-water reservoir in the closed area is recharged chiefly by Coal Creek, which drains water from precipitation upon the Kolob Plateau. Many of the wells are used to supplement stream supplies for irrigation, and the annual pumpage in the closed area varies with runoff. Thus in 1951, when Coal Creek runoff totalled 9,100 acre-feet, about 17,800 acre-feet was pumped from wells; but in the following year when runoff exceeded 40,000 acre-feet, the pumpage dropped to 11,500 acre-feet. The water levels in wells also reflect the trends in precipitation and runoff: declines in dry years are attributed both to decreased recharge and increased pumpage, and conversely water levels commonly rise in wet years. Studies indicate 41/ that irrigation season runoff from Coal Creek must be 10,000 acre-feet greater than pumpage in order to prevent depletion of ground-water storage. In 1946 and again in 1951, the runoff was less than 10,000 acre-feet, and water levels in wells would have declined even if all pumping had been prohibited in the closed area.

Recent trends in water levels in the closed area have been downward. By the end of 1951 they reached record lows, dropping more than 3 feet lower than in the preceding year, and lower than at the end of the 1933-36 drought. Although water levels in representative wells rose several feet in 1952, they declined to new lows during 1953. Unquestionably drought conditions have been an important factor in this decline: Since 1942 precipitation at Cedar City has been less than the 1906-51 normal in every year except 1947, and runoff was below the 1934-51 average except in 1944, 1947, 1949, and 1952. Although the declining water-level trends in the past decade indicate depletion of storage, there is still uncertainty as to whether present development and use exceed the average replenishment to the closed area.

Escalante Valley.—Pumpage from wells in Escalante Valley increased from less than 20,000 acre-feet in years prior to 1945 to about 80,000 acre-feet annually in 1950-53. The most spectacular increase--from 2,600 acre-feet in 1940 to 5,800 in 1945 to 51,000 acre-feet in 1950--occurred in the Beryl-Enterprise district in the southern part of the valley. Currently about 16,000 acres is irrigated from wells in this district.

White's studies in 1927 42/ indicated that the average annual ground-water replenishment in the Beryl-Enterprise district was probably less than 10,000 acre-feet. The district and its tributary drainage basin were therefore closed to further appropriation of water (except for domestic and stock-watering purposes) by proclamation of the Governor of Utah in April 1946. However, the drilling of wells under applications approved prior to that date has continued to the present. In 1953, 179 irrigation wells were operating in the district, compared with 163 in 1950 and only 37 in 1945.

It is evident that ground water is being mined in the district, for water levels in most wells have declined progressively since 1945, and the rate of decline is greater in areas where wells are most concentrated, and greater also in years of increased pumpage.

However, as stated by Lofgren, 43/

39/ Maxey, G. B., and Jameson, C. H., 1948, Geology and water resources of Las Vegas, Pahrump, and Indian Springs Valleys, Nev.: Nev. State Engineer's Water Res. Bull. 5, 121 p.

40/ Thomas, H. E., Nelson, W. B., Lofgren, B. E., and Butler, R. G., 1952, Status of development of selected ground-water basins in Utah: Utah State Engineer Tech. Pub. 7, p. 22-34.

41/ Thomas, H. E.,and others, op. cit., p. 29-33.

42/ White, W. N., 1932, A method of estimating ground-water supplies based on discharge by plants and evaporation from soil: U. S. Geol. Survey Water-Supply Paper 659, p. 1-105.

43/ Thomas, H. E.,and others, op. cit., p. 47.

> There is no likelihood of early or sudden exhaustion of the ground-water reservoir unless the rate of pumping is increased markedly above that in 1950. The quantity of water in that reservoir is not yet known, but present information shows that there is probably at least several million acre-feet, and each million acre-feet would be enough for about 2 decades of pumping at 1950 rates. Further, the water table in the pumping district is declining at a rate of less than 2 feet a year, so that the energy requirement for lifting the water is increasing only rather slowly. If the reservoir extends to sufficient depth, the economic factor of pumping cost, rather than the hydrologic factor of reservoir exhaustion, may set the date for reduction or cessation of pumping....
>
> Mining of ground water from areas remote from the areas of natural discharge is one method, and perhaps the most feasible method, of making the maximum beneficial use of the water resources while salvaging as much of the water now lost by natural discharge as may be practicable. It has been stated that pumping to date has probably not made any material reduction in evapotranspiration because the water table has not been lowered where it is closest to the surface, and has been lowered less than 3 feet where it was once within 12 feet of the surface. But in comparison with the effects of pumping in many areas in certain other states, the water table has not yet been lowered very much in any part of the district.

Since 1950 the annual pumpage has been about 10 percent less than it was in that year. This reduction probably reflects economic factors other than the cost of pumping, for pumping lifts are increasing only slightly each year. Similarly in the future it is likely that the rate of mining will be determined by the overall cost of production in relation to value and marketability of produce.

Arizona

Arizona has long held the water of streams, springs, and defined underground channels to be subject to appropriation. Hence, the Supreme Court decision in the case of Bristor v. Cheatham, 44/ declaring landownership to be the exclusive basis for rights to "percolating" water, created some furor when it was announced in March 1953. Undoubtedly the protection of appropriative rights in springs and streams will provide some complex problems in places where those sources are dependent partly upon "percolating" water, if the landowners develop the "percolating" water at will; but such a situation is inevitable wherever mankind undertakes to apportion water without deference to the hydrologic cycle.

The Court suggested that the only recourse of the State in regulation of ground-water development and use might be to exercise its police power for the general welfare. Such power has been exercised for regulation of ground-water development by many States, chiefly in the humid regions, chiefly in areas of local overdraft, and chiefly to prevent further overdraft. Overall reduction in draft by legislative action or court order is practically unheard of, unless there is an alternate source of supply to meet the built-up demand, as in the Raymond Basin in California.

Many of Arizona's ground-water reservoirs are being mined, as is shown by progressive decline of water levels in wells. 45/ The water users in some of these areas can see no feasible alternative supply, either now to reduce the current ground-water draft, or ultimately to meet the demand when the ground water reservoir is emptied. In other areas there is hope for diversions from the Colorado, which however would be at considerable expense and would have to be in accordance with the terms of a settlement of the Arizona-California dispute, not yet in sight.

Wherever there is no alternate source of water supply, the mining of ground water is likely to continue. The prospects for these areas are thus similar to those of Lea County, N. Mex. Several ground-water reservoirs in Arizona have an advantage over Lea County in that they receive appreciable recharge each year and are therefore capable of a larger yield perennially. Insofar as mining is concerned, however, measurements of the total water in storage and the quantity mined each year are enough to show by simple calculation how long the stored water will last. Of course, some parts of the reservoir will be drained earlier than others, unless measures are taken as in Lea County to distribute the depletion proportionately throughout the reservoir. Inasmuch as "percolating" water is declared to be private property in Arizona, the water rights will be determined by landownership, rather than by priority of use as in New Mexico. Economics adjusts for this difference, however, for a water right increases the value of land whether the right comes from an underlying aquifer or from a pioneer ancestor.

Texas

Texas, like Arizona, recognizes "percolating" water as private property, and like Arizona has several areas in which ground water is being mined. The State Legislature in 1949 provided for the creation of underground water conservation districts and prescribed the powers, functions, and limitations of such districts. Three districts have subsequently been created, all in west Texas. These districts have the power to regulate the drilling, spacing, and production of wells yielding more than 100,000 gallons per day. It is provided, however, 46/ that the "owner of the land, his heirs, assigns or lessees, shall not be denied a permit to drill a well on his land and produce

44/ Bristor v. Cheatham, not yet reported.

45/ Halpenny, L. C. and others, 1952, Ground water in the Gila River basin and adjacent areas in Arizona--a summary: U. S. Geol. Survey open-file report, 224 p.

46/ Act of the regular session of the 51st Legislature of the State of Texas, 1949, H. B. 162, amending Chapter 25 of the Acts of the 39th Legislature, and adding section 3(c).

underground water therefrom subject to rules and regulations promulgated hereunder to prevent waste, as herein defined."

Underground Water Conservation District No. 1 comprises the southern High Plains, or Llano Estacado, where the principal aquifer is the Ogallala formation, the same as in Lea County, N. Mex., and where water is being mined similarly, but on a grander scale. As summarized by Gaum: 47/

> Throughout the Llano Estacado, pumping so far exceeds any quantity replaceable by natural recharge that obviously most of the water is pumped from storage. On the assumption that the total water stored in the Ogallala formation is about 400 million acre-feet, this total supply would be enough for almost two centuries of pumping at the [then current] rate of 2 million acre-feet a year ....
>
> The declining trends of water level in the past suggest the means for most effective utilization of the ground-water reserves under the Staked Plain--a pattern for distribution of wells and for rates of pumping that will assure the most efficient extraction of the water, and at the same time best serve the needs of the lands, municipalities, and industries dependent upon that water. By optimum spacing of wells, interference between them can be held within bounds so as to minimize pumping lifts and pumping costs. Effectuating any such program will be complicated because two States are involved, Texas and New Mexico.
>
> The preceding discussion assumes that "mining" may continue until the ground-water reservoir is emptied, even though that can be done only by lifting the water as much as 500 feet at some places. It is recognized that the cost of pumping versus the value of resulting products is a controlling factor in the use of ground water; in many areas, cost would be the decisive factor. However, in the Llano Estacado there are two considerations that make predictions on this score inadvisable. First, there is no obvious alternate source of water sufficient to supply the present demand. Second, in parts of the irrigated area, at least, oil and gas reserves which are close at hand provide sources of power so cheap that the cost standards of other regions may not apply.

47/ Gaum, C. H., 1953, High Plains, or Llano Estacado, Texas-New Mexico, in Subsurface facilities of water management and patterns of supply--type area studies: The Physical and Economic Foundation of Natural Resources, [part] IV, Interior and Insular Affairs Committee, House of Representatives, U. S. Congress, p. 103-104.

TENTATIVE CONCLUSIONS

If one may venture a conclusion on the basis of the very limited observations above, it is that a cure for ground-water mining does not necessarily depend upon the water-rights doctrine that is accepted in the area. Overdraft can be eliminated if water is available from another source to replace some of the water now taken from the affected aquifer, or to recharge that aquifer artificially; the "new" water may come from streams or lakes, or from another aquifer, or even from another part of the same aquifer. If there is no alternate source of supply, public opinion so far seems to favor letting nature take its course now and deny water users their "rights" as the mined reservoir is exhausted, rather than curbing the withdrawals at an earlier date.

The States where mining of ground water is greatest are accepting the practice. In Arizona the only denial may be the eventual natural exhaustion; in Texas and New Mexico the development seems likely to be regulated to the extent of encouraging maximum extraction by spacing of wells. The appropriative rights in mined areas of New Mexico have ceased to be perennial rights; for they, like landownership rights in other States, are necessarily limited to the quantity of water underlying the land.

The prevention of ground-water mining is far easier than is the cure in areas where mining is already under way, although it too is difficult enough, as indicated,in the history of the described areas in Utah and in other States and areas not mentioned above. In Western States committed to the appropriation doctrine, several ground-water reservoirs have been declared to be fully appropriated, and new developments are not permitted. There are several such areas in New Mexico and Utah.

In several States adhering to landownership doctrines of water rights, the police power has been invoked for regulation of ground-water development in designated areas. Indiana, New York, and Tennessee are examples; in the regulated areas in New Jersey, new wells may be licensed for a certain draft over a specified number of years. 48/ As stated by Barksdale, 49/

> In New Jersey we are coming rather rapidly to a combination of appropriative and landownership bases for ground-water rights because of the increasing tendency of overdevelopment in substantial areas, which leads to an exercise of authority by the State, based pretty largely on prior appropriation. The power under which the State does this may very well be a police power, but the effect on water rights in the so-called protected areas is the same, or nearly the same, as if the doctrine of prior appropriation were the basic one.

48/ Critchlow, H. T., 1948, Policies and problems in controlling ground-water resources: Am. Water Works Assoc. Jour., v. 40, p. 775-781.

49/ Barksdale, H. C., 1953, personal communication.

A prerequisite to prevention of mining is effective regulation timely applied, and that in turn requires recognition of the shadow of approaching overdevelopment. An adequate knowledge of the hydrology of the reservoir, and of the development and use of water, is essential for such recognition.

By its creation of underground water conservation districts, Texas has given the power of regulation to the local groups who are primarily concerned with the use and conservation of their water supplies. The idea is not new, for several States permit the organization of local water districts: Ohio authorizes counties to establish, within themselves or in cooperation with other counties, districts for regulation and conservation of water; and in several Western States water conservation districts have been functioning for many years. The districts in Texas, however, are exceptional in that their boundaries are required to be "coterminous with an underground reservoir or subdivision thereof," which would make them coextensive with a hydrologic unit. They are also exceptional in the degree of responsibility delegated to them, for in most other States the major responsibilities in water administration remain at State level.

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