

a / Toward an economical allocation of water

Comparative effci. of water use

~~District~~

River

~~flow~~
year

Yr. or yrs,
& flow
(a-f)

Acres
irrigated

Value of
crops
products

Evidence
of waste

a-f. per
acre

~~Flow~~
Pumps?

Sources

Stanislaus: (total)
SSJ 7D

Tuolumne: (total)
Modesto 7D
Turlock 7D
S.F.

60% T/D,
water level
6.4 - 7.6 ft.
Elevation
710 ft. SW 16 p. 21A

Merced: (total)
Merced 7D.
Merced rip.s.

646,200
(11954)

594,800

51,400

107,329
(gross acres
are 163,864;
irrigable acres
are 143,075.

Spilled at
Exch, 92,600.

Spilled from
system,
73,400;
"Losses"
88,700
(mostly
seepage)

594,800
÷ 107,329

= 5.56

3,401 a, add'l,
by put. pumps.
M7D has pumps
which reclaimed
108,400 a-f., in
addn to flows
listed.

1954 final stat-
mt. & rpt eng.,
M7D, p. 6
(S. W 3)

Kings: (total)
Alta 7D.
Consol. 7D
Fresno 7D
Lemoore
People's Ditch
Others

1,100,000 ?
(S-W-1)

San Joaquin, above Friant
See next page

1953, 1,061,300
S. W 6, p. 12

San Joaquin below Mendota
(here is probably worst
waste of all)

1953
825,500 sub p/2
from D-M canal
alone (and small
Friant release incl)

Cftr. effie. of water use, p. 2

River or area	Flow. (8yr). a-f.	acres irrig.	Value of products	Evidence of waste	a-f. per acre	Pumps? Depth? Cost per a-f.	Source
Delta	c. 1 m a-f? (S.W. 6 p. 13) 1953						

OPTIMAL WATER ALLOCATION:
THE NORTH PLATTE RIVER*

By G. S. Tolley and V. S. Hastings

Water used from a river is often an important factor of production. Sometimes, like air, it is so plentiful that it can be used as a free good. However, on some rivers water is scarce in the sense that its use must be rationed by some means.

Although the water of the North Platte River is a scarce factor of production, there is no organized market system of buying and selling to guide its use. Historically based legal and administrative procedures largely influence how the water is allocated between competing uses. In this paper our purpose is to see how close the present allocation of water comes to maximizing economic product, thereby throwing light on possibilities for reallocations.

The present study is of interest because the North Platte is one of America's largest rivers and because, to our knowledge, there has been no attempt previously to apply this kind of analysis to a river. ^{1/}

The study concentrates on the following question: What is the optimal distribution of water, taking as given the major investments that have been made in dams, irrigation canals and other water facilities? In taking these investments as given we are motivated by realism inasmuch as the river has been quite fully developed by them. For less developed rivers our approach is potentially helpful in the planning of investments.

*E. O. Daggett of the Farmer's Irrigation District, A. W. Hall of the Central Nebraska Public Power and Irrigation District and others connected with water use on the North Platte River supplied helpful information. The study was begun when both of the authors were associated with a research project at the University of Chicago concerned with natural resources. That project was financed by Resources for the Future, Incorporated.

^{1/} Several persons have pointed out the type of problem we are dealing with. See Roy E. Huffman, Irrigation Development and Public Policy (New York: Ronald Press Company, 1953); W. K. McPherson, "Can Water Be Allocated by Competitive Pricing?" Journal of Farm Economics, XXXVIII (Dec. 1956), 1259-68; President's Water Resources Policy Commission, A Water Policy for the American People, Vols. I and II (Washington: Government Printing Office, 1950).

The first part of the paper brings out methodology for optimally allocating water and shows solutions for problem situations. These results are used in the second part of the paper, which examines water allocation in view of interrelations for the river system as a whole.

I. DETERMINANTS OF WATER VALUE IN THE BASIN

How to allocate water between power and irrigation. In the problem situation depicted in Figure 1, two canals are fed from a reservoir. On Canal A there is only irrigation. Canal B has identical conditions as to irrigation, but there is a power plant through which water flows before it reaches the irrigated lands along Canal B.

Our first task is to derive the demand schedule in the reservoir for water diverted to irrigation use along a canal. By "demand schedule in the reservoir" we mean the schedule relating (a) marginal product of water sent from the reservoir for a particular use and (b) amount of water sent to that use. This will be derived from an assumption as to productivity of water on irrigated land.

Suppose the marginal product m of water on an acre of land considering one irrigation season is

$$m = \$ (12 - 6q),$$

where q is the quantity of water measured in acre-feet. This is an estimate for average irrigated land in the areas of Nebraska being considered in this paper. 2/

2/ It would appear that farmers cannot profitably use more than about two acre-feet per acre in the normal year. Dawson shows the quantities taken at the farm headgate at a zero price in the Ainsworth area to be 2.03 acre-feet per acre. See John A. Dawson, "The Demand for Irrigation Water in the Ainsworth Area" (unpublished Ph. D. dissertation, University of Chicago, 1957). On the Kendrick project, in North Platte River Basin Operation Study, preliminary draft (Denver: Bureau of Reclamation, 1957), "Based on operation records obtained to date it appears that a realistic farm delivery requirement is 2.0 acre-feet per acre." The Bureau of Reclamation reports that the average farm delivery for the years in which there were no water shortages was 2.0 acre-feet on the North Platte Project. This type of information suggests one point on the linear approximation: namely at $q = 2$, $m = 0$.

Next consider the idea that the area under the demand curve may approximate the total product added by water. The total product is the sum of the marginals and is equal to the area under the marginal curve. (For further consideration of this idea, see fn. 1, p. 9). We may visualize the total product of the water to manifest itself in two ways:

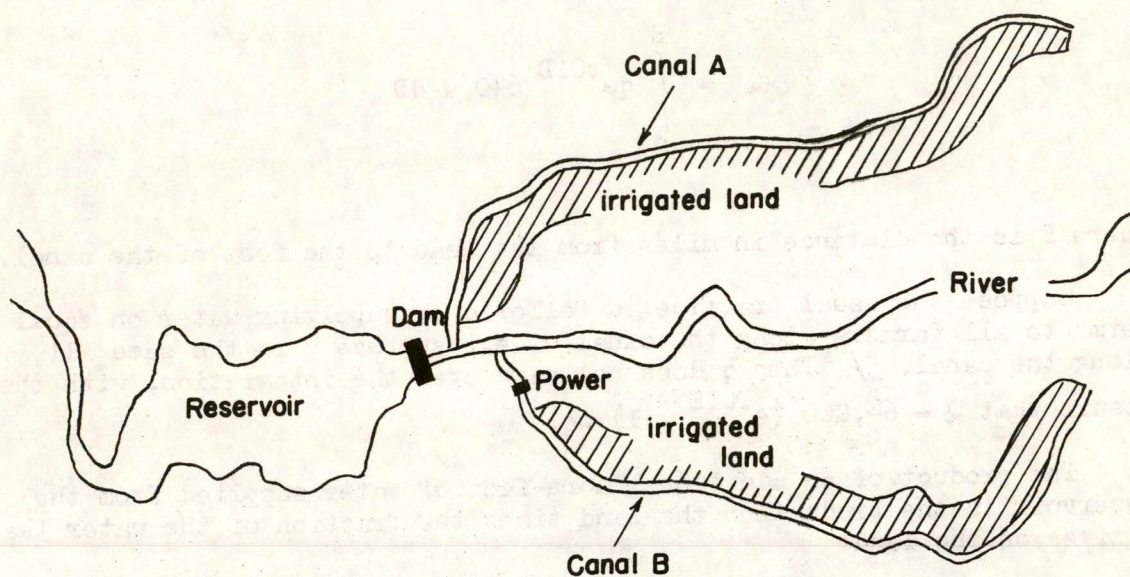


FIGURE I

In deriving the demand schedule in the reservoir, account must be taken of the fact that water is lost through seepage as it flows along a canal. We have arrived at a loss rate of 1 per cent per mile of the water remaining in the canal as an order of magnitude for canals in the North Platte Basin. ^{3/} If q_D is the amount of water sent out from the reservoir for an acre of land at distance D , $q_D = e^{-.01D} q$.

The amount of water sent to any incremental area will be q_D times the number of acres in the area, or $q_D 640 w dD$; where w is the width of the land served by the canal in miles, ^{4/} dD is the incremental distance in miles, and 640 is the factor to convert square miles to acres.

After combining the relations that have been given, we can integrate over the distance of the canal to arrive at total water sent out:

$$Q = \int_0^E q e^{-.01D} 640 w dD$$

where E is the distance in miles from the head to the foot of the canal.

Suppose the usual practice is followed of supplying water on equal terms to all farmers along the canal, i.e., suppose q is the same all along the canal. ^{5/} Then q does not vary over the integration, with the result that $Q = 64,000 (e^{-.01E} - 1) wq$.

The product of an additional acre-foot of water supplied from the reservoir is the product on the land times the fraction of the water that arrives on the land:

$$m \left[\frac{.01E}{(e^{-.01E} - 1)} \right],$$

(footnote 2 continued) (a) in payment of charges connected with irrigation and (b) capitalization of product over and above these charges into the value of the irrigated land. A charge on good land may be \$4.50 including repayment of construction costs, operation and maintenance charges and the like. This land might sell for about \$150 more than equivalent dryland farm land or, reduced to an annual basis with an interest rate of 5 per cent, \$7.50. Total product of the water is then \$12. This is the triangular area $\frac{1}{2} \times q\text{-intercept} \times m\text{-intercept}$, which gives $\$12 = \frac{1}{2} \times 2 \times m\text{-intercept}$; or $m\text{-intercept} = \$12$. The two points we have derived define the straight-line marginal product curve given in the text.

^{3/} See the Appendix.

^{4/} In this example, w is assumed to be constant throughout the length of the canal.

^{5/} Because of canal losses, this is a nonoptimal system of delivery. In the next section this system will be compared with an optimal system of delivery.

where the fraction results from dividing the amount of water applied, q 640 wE, by the amount of water sent out as presented in the preceding paragraph.

Substitution of the previous relations $m = 12 - 6q$ and $Q = 64,000 (e^{.01E} - 1) wq$ in this expression gives the result

$$\frac{.01E \ 12}{(e^{.01E} - 1)} - \frac{.01E \ 6Q}{64,000 \ w \ (e^{.01E} - 1)^2}$$

This is the schedule we are looking for that relates marginal product of water sent out from the reservoir and water Q sent for irrigation along the canal. It is the demand schedule in the reservoir for Canal A, as shown in the upper left of Figure II. 6/

Let us pass to consideration of the use of water for power generation. Assume that during a three-month irrigation season up to 100 thousand acre-feet of water can be used producing a value of \$.75 per acre-foot in "firm" commercial power. From 100 thousand acre-feet up to the plant capacity of 500 thousand acre-feet, additional or "nonfirm" power is produced at a value of \$.375 per acre-foot. 7/

6/ The width w of the land served by the canal is 1.25 miles, and its length E is 80 miles.

7/ It is assumed that an acre-foot of water can produce 150 kilowatt-hours. Firm commercial power is valued at one-half cent per kilowatt-hour, and additional power is valued at one-quarter cent per kilowatt-hour.

Facts in line with the assumptions are as follows. The North Platte Hydro-Electric Plant of the Platte Valley Public Power and Irrigation District has averaged 162 kilowatt-hours per acre-foot. The Jeffrey Plant of the Central Nebraska Public Power and Irrigation District has averaged 92.9 kilowatt-hours per acre-foot, Johnson Number 1 Plant 89.5 kilowatt-hours per acre-foot, and Johnson Number 2 Plant 116 kilowatt-hours per acre-foot. Regarding the Kortess plant in Wyoming, the Bureau of Reclamation states that "a factor of 172 kilowatt-hours per acre-foot was multiplied times the power water releases to obtain the plant generation." See North Platte River Basin Operation Study, *op. cit.*, p. 51.

The Bureau of Reclamation uses the following assumed average rates for power sold wholesale at load centers: Firm commercial, \$.055; nonfirm, \$.030; irrigation pumping, \$.025. See Glendo Unit, Vol. 1, Definite Plan Report (Denver: Bureau of Reclamation, 1952), "Substantiating Report," p. 111. With transmission losses of 7.5 per cent (*ibid*, p. 71) prices at the power plants are: firm commercial, \$.051; nonfirm \$.028; irrigation pumping, \$.023.

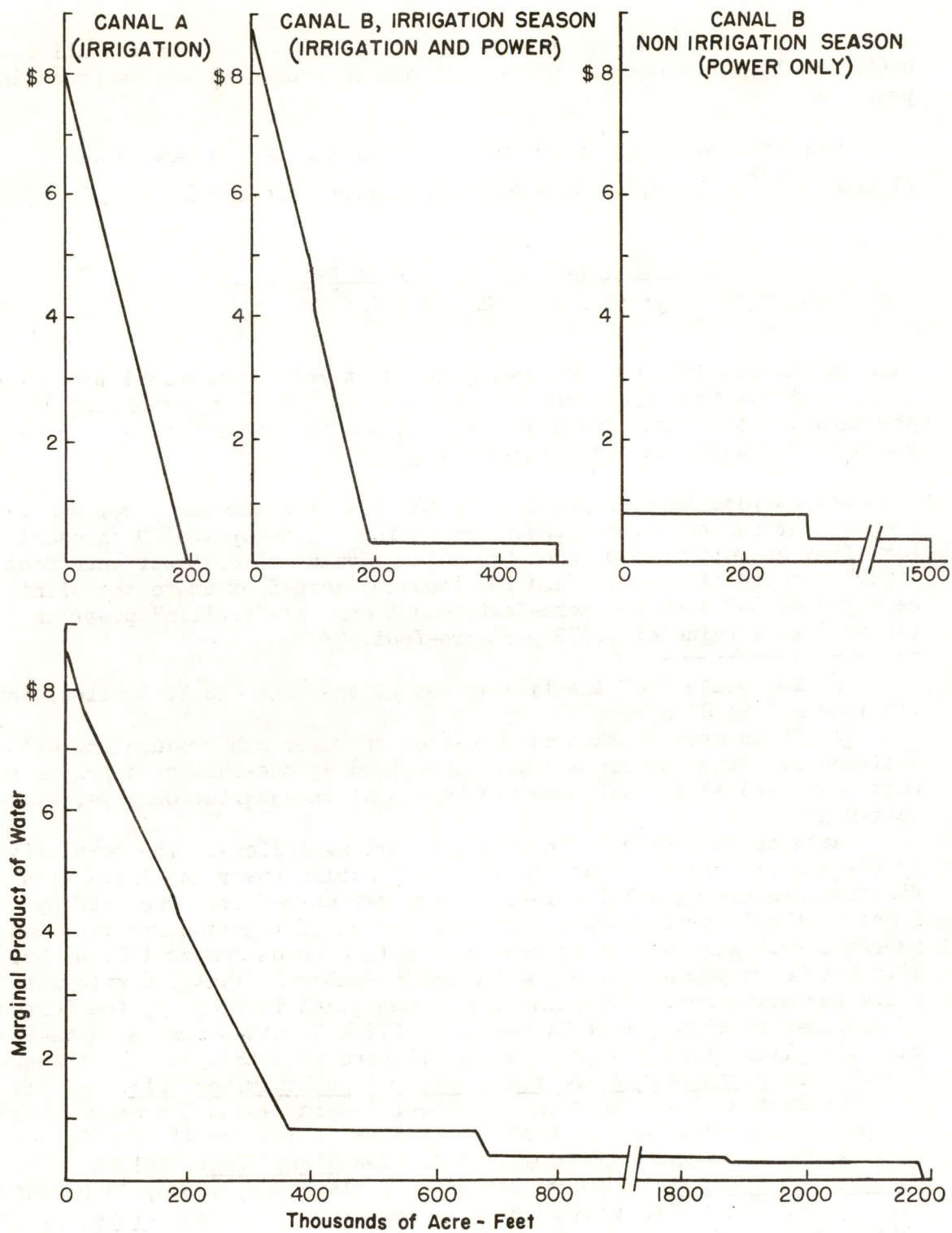


FIGURE II

It will be recalled that Canal B has, in addition to the power plant, irrigation conditions which are the same as those for Canal A. The demand schedule in the upper center of Figure II illustrates an important principle in water allocation: Marginal product schedules for water uses that are complementary should be added vertically. The schedule for Canal B during the irrigation season is the sum of the water values produced in irrigation and power.

The final alternative use of water to be considered is power release in the nonirrigation season. Because this season is three times as long as the irrigation season, the power generating capacity is trebled. Evaporation in the reservoir and an interest charge to allow for the delayed revenues if water is held over to the summer make the product per acre-foot of water in producing winter power a little higher than during the irrigation season. These assumptions lead to the demand schedule in the reservoir for Canal B for power in the nonirrigation season as shown in the upper right of Figure II.

In bringing the three schedules together to arrive at a solution for the allocation of water in the lower part of Figure II, we illustrate another important principle in water allocation: Marginal product schedules for water uses that are competing should be added horizontally. The schedule is the horizontal sum of the three schedules in the upper part of the figure.

To allocate water from the reservoir for maximum economic product, take the quantity of water available and find the marginal product corresponding to this quantity on the total demand schedule. Then the water can be allocated so that a marginal product as great as this is achieved in each competing use.

The demand schedule in the lower part of Figure II provides a building block to be combined with demand schedules for other points along the river. The interrelation between points on the river will be considered in the second part of the paper.

Taking account of delivery losses along a canal. The reader may have already noted that in the previous section water was not being allocated optimally on irrigated land. All the irrigated land along a canal was visualized to have the same intensity of water use. Since it takes considerably more water from the point of diversion to supply an acre-foot to land at the foot of the canal than to land at the head of the canal, optimal adjustment would be in the direction of less intensive water application on the far land and more intensive on the near land. This would be at odds with present practice, and our situation was supposed to approximate usual procedures.

Before, q -- the quantity of water applied per acre-- was a constant as we integrated over the distance of the canal. In order to allocate optimally, we must drop that assumption so that q depends on canal losses which vary with distance.

Let m_D be the marginal product of water sent out from the reservoir for irrigation of land at distance D . If water is to be allocated for maximum product, m_D must be equal for land at all distances. Making use of the equation given in the discussion of canal losses, $q_D = e^{.01D} q$ (page 3), we find $m = m_D e^{.01D}$. This new condition may be substituted into the original equation (page 3) pertaining to the productivity of water on land to obtain

$$q = 2 - \frac{1}{6} m_D e^{.01D}$$

The total amount of water sent out is then

$$Q = \int_0^X \left[2 - \frac{1}{6} m_D e^{.01D} \right] e^{.01D} 640 w dD.$$

Taking the integral, we arrive at the following schedule. 8/ For m_D between zero and $\$12/e^{.01E}$,

$$m_D = 24 \left[\frac{(e^{.01E} - 1)}{(e^{.02E} - 1)} - \frac{Q}{128,000 w (e^{.02E} - 1)} \right].$$

8/ Two different ranges may be noted for the marginal product in the reservoir, m_D . First, m_D may be relatively low so that all land along the canal is receiving water. Then we integrate over the entire distance of the canal; that is, the upper limit of integration X is then E . Second, m_D may be relatively high so that land near the head of the canal is receiving water but land near the foot of the canal is not. We saw above that $m = m_D e^{.01D}$. Suppose, with given m_D , m in the preceding expression would be greater than $\$12$ for some of the distances within the canal. At these distances water application would be zero. This is because, according to our assumptions, by the time marginal product on the land has risen to $\$12$ water application has fallen to zero. In this second range of relatively high m_D we integrate-- not over the entire distance of the canal-- but only to the distance where water application becomes zero. It can be shown that the upper limit of integration X is then $100 \ln 12/m_D$.

For m_D between $\$12/e^{.01E}$ and $\$12$

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$$m_D = 12 \left[1 + \left[\frac{Q}{128,000 w} \right] - \sqrt{2 \left[\frac{Q}{128,000 w} \right] + \left[\frac{Q}{128,000 w} \right]^2} \right].$$

Figure III shows the demand schedule whose segments we have just derived. ^{9/}

Let us compare this optimal situation with the usual situation where farmers receive water on equal terms regardless of the position on the canal. Suppose each farmer along the canal is being charged \$2.40 per acre-foot for water. This implies that each acre is receiving 1.6 acre-feet of water, with a total of 157,000 acre-feet being sent out. To re-allocate the water optimally, substitute this quantity into the demand curve for water that has just been derived. Then m_D is about \$1.50. The amount of water applied per acre is as high as 1.75 acre-feet for land near the head of the canal down to as low as 1.45 acre-feet for land near the foot. Instead of a uniform marginal product on the land of \$2.40 as in the nonoptimal case, it will range from as low as about \$1.50 on the nearest land to about \$3.30 on the most distant.

To estimate the gains from reallocation note that the dashed line in Figure III is the nonoptimal demand schedule for water in the reservoir, i.e., the same schedule as in the upper left-hand corner of Figure II. An estimate of the total product of the water in this situation is the area OFAC, or \$737,000. This estimate is based on the idea that total product is the sum of the incremental product. ^{10/} If the same amount of water

^{9/} As in our earlier example, the width of land, w , is assumed to be 1.25 miles, and the length of the canal, E , is assumed to be 80 miles.

^{10/} Consider the change in farming output as an increment of water is added. The change in farming output will be the marginal product of water-- as measured by the height of the demand curve for water-- times the incremental change in amount of water plus the marginal product of other inputs times the incremental change in them. The first part of the change is measured by the incremental area under the demand curve for water, but the second part of the change (after the word plus) is left out of consideration if we look only at the demand curve for water. If the marginal product schedules of other inputs are affected by the amount of water being used, these inputs may change as one moves along the demand curve for water. For instance, if water and other variable inputs tend to be complementary to one another in production, the other inputs will tend to be increased as we move toward greater amounts of water. Visualize the sum of the incremental changes in farming output from zero level of irrigation water up to the actual amount of irrigation water use. This sum must be the increase in output on the land that occurs in adding water. The part of the sum represented by the area under the demand curve for water is seen to include all the increase in output except that associated with changes in the other variable inputs.

That the area under the demand curve for water is in fact a relevant measure of the product of the water is suggested by observing that with competition one expects the prices of variable inputs to approximate their marginal product in alternative uses. Then any changes in output associated

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were reallocated optimally taking account of canal losses, the total product would be OGBC inasmuch as the solid line of Figure III is the demand schedule assuming optimal deliveries. The difference between the two areas, about \$1,300, is the gain from reallocation.

The reader may be surprised at the smallness of the gain. Even though three times as much water is required from the reservoir to deliver an acre-foot to the end of the canal as is required for the head, the gain in product from reallocation is less than a quarter of a per cent.

Two reasons primarily account for the result. First, a widely held belief is that application of water on the order of two acre-feet per acre is close to saturation, i.e., results in zero marginal product. This implies that gains quickly become small in increasing the deliveries to land having low canal losses. Second and more important, since irrigated land is worth a great deal more than dry land, earlier increments of water must add much to the product of the land. Hence taking away water from land having high canal losses soon makes large detractions from product. The two considerations together mean that there will be rapidly diminishing gains to water reallocation. Both considerations stem from well-known attributes of irrigation agriculture in the region and are reflected in our assumed demand conditions for irrigation water. 11/

The gain has been calculated over wide ranges of conceivable numerical assumptions and has been found to be quite insensitive to them. In addition to the linear demand schedule for irrigation water presented above, other forms had little effect including constant elasticity, kinked and discontinuous schedules. 12/

Effects of water rights. To some extent, water rights ration water use. The prior appropriation doctrine has meant that lands developed first obtained nonsaleable rights to natural flows of the river. Land developed later has had either to develop new supplies by catching winter run-off in reservoirs or to be burdened with inferior water rights where water supplies are unrestricted only in plentiful years when prior users do not utilize all the natural flow at their point of claim.

Suppose an irrigation canal of the type we have been considering has junior water rights, and suppose further that there is a water-short year so that the canal will receive no water. 13/ Let the marginal

Footnote 10 (continued) with changes in the nonwater inputs in irrigation farming would be just offset by changes in product of opposite direction in the rest of the economy. This indicates that the area under the demand curve estimates total increase in product for the economy as a whole associated with using the water in irrigation farming.

11/ See fn. 2, p. 3.

12/ That the assumption of linearity may be reasonable is suggested by Dawson, op. cit., who shows how differing proportions of crops as water price is varied can give a linear demand schedule.

13/ For a discussion of how water-short years have affected particular projects, see Glendo Unit, op. cit., "Supplemental Report of the Regional Director," pp. 4 and 5 and Thirtieth Biennial Report of the Department of Roads and Irrigation, Vol. II, pp. 11-14, and Thirty-first Biennial Report of the Department of Roads and Irrigation, Vol. II (Lincoln, Nebraska; 1956), pp. 12-17.

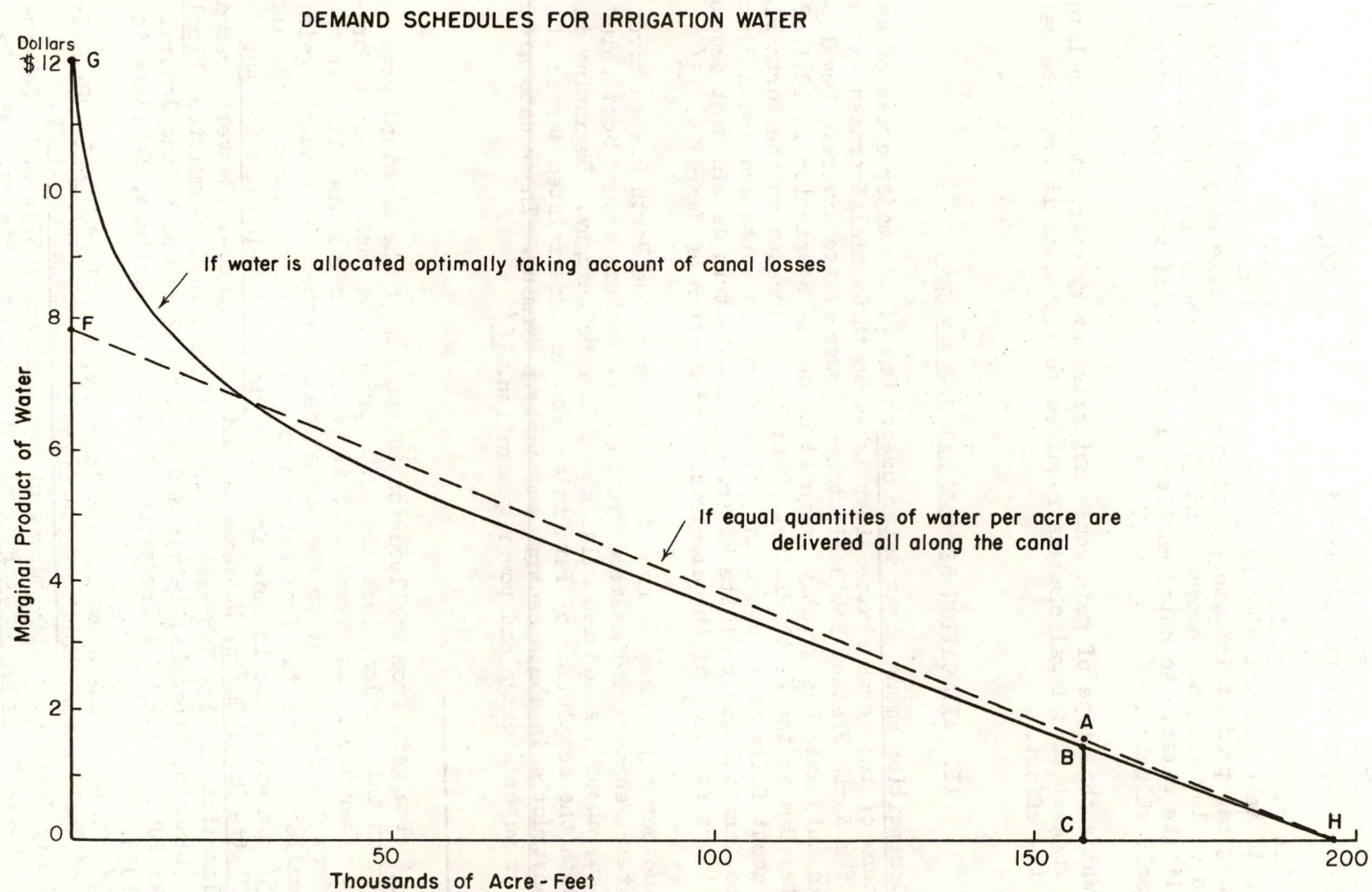


FIGURE III

12

product of water diverted to other projects be \$2.00 per acre-foot in this year. Then the gain from reallocating water to this canal so as to equalize marginal product would be about \$425,000. 14/

This gain is large for the same reasons that the gain from reallocating to take account of canal losses was found to be small. Equalizing marginal product in water-short years would take away from users in ranges of low marginal product and give it to those who would otherwise have little water. As noted earlier, increments of water near zero are extremely valuable.

While this type of gain would not arise every year, it is so large as to suggest that legal changes required to implement it would be well worth the effort.

II. ALLOCATION BETWEEN MAJOR WATER USES

Competition among eight water uses. One of the major areas of use of waters of the North Platte River is in South Central Nebraska extending along the North Platte, South Platte and Lower Platte Rivers. Development in this area has greatly expanded since the completion in 1941 of Kingsley Dam on the North Platte. This dam is located on the North Platte River about fifty miles above the point where the North and South Platte meet to form the Lower Platte River. Hydro-electric development accounts for a large fraction of the electricity production of Nebraska. 15/

Another major area of use of the waters of the North Platte River is in western Nebraska and eastern Wyoming. It centers around Scottsbluff, Nebraska, about one hundred miles above Lake McConaughy. Beginning in 1909 with the completion of Pathfinder Dam, an interrelated series of dams was constructed in south central and eastern Wyoming. These dams are used both for water storage and power generation. 16/

14/ The gain from reallocation is the sum of the marginal products of water on this project less the \$2.00 product on each acre-foot foregone in other uses. In Figure III, if we draw a horizontal line at \$2.00 from the y-axis out to the dashed demand schedule, then the gain from reallocation is the area between this line and the demand schedule.

15/ On water use in this area, see Plan of Development for the Lower Platte River Basin, Nebraska Report No. 7-1D OC-1 (Denver: Bureau of Reclamation, 1951); Nebraska Water Supply and Lands Committee, Final Report (Lincoln, Nebraska; 1954); and a pamphlet issued by the Central Nebraska Public Power and Irrigation District at Hastings, Nebraska in July, 1955.

16/ On water use above Lake McConaughy, see Glendo Unit, op. cit.; Bureau of Reclamation, North Platte River Basin Operation Study, preliminary draft (Denver: Bureau of Reclamation, 1957); U. S. Department of Interior, Surface Water Supply of the United States, 1953, Part 6B, Water Supply Paper 1280 (Washington: Government Printing Office, 1956).

Table 1. Determinants of Eight Major Uses of Water on the North Platte River

	Below Lake McConaughy	Above Lake McConaughy
Irrigation	Some water deliveries are limited by canal capacity. Projects which have rights to water in Lake McConaughy may furnish water to other irrigators below Lake McConaughy.	For participants in the storage program of the Wyoming dams, an important limit is the supply in storage. If it is not sufficient, water rights become pertinent.
Summer Power	Limited by amount of irrigation water released. Power plant capacities tend to exceed irrigation water releases.	Limited by plant capacities in the lower reservoirs of the Wyoming system, where more water is released for irrigation than can be used by the power plants.
Winter Power	There is some winter power from flows entering the river below Lake McConaughy. Most water tends to be saved for irrigation, as irrigation use is given first priority.	Much winter power is generated by flows within the Wyoming dam system. A limitation to winter power generation is the requirement that as much water as possible be stored for irrigation.
Storage	This is subject to administrative decision. Storage for irrigation has priority over the generation of winter power.	A residual. The amount of water which a claimant does not take of his legal share in any year becomes the common property of all participants.

Irrigation releases from the Wyoming reservoirs and other irrigation season inflows are virtually completely diverted for irrigation in the Scottsbluff area. Lake McConaughy further down the river thus receives no direct intentional releases. It receives the preponderance of its supply from return flows-- that is, run-off and seepage back into the river-- from irrigation in the Scottsbluff area.

Table 1 refers to existing procedures for allocating water. We wish now to discuss these in relation to optimal allocation.

Below Lake McConaughy. The hypothetical example of Figure II contains elements of many situations below Lake McConaughy. Yet allocation procedures shown in Table 1 do not correspond to the maximizing procedures presented in the example.

Product might be increased if more irrigation water per acre could be applied along canals where power is produced than along canals where the water does not produce power. 17/

In addition, Table 1 indicates that irrigation use of water receives priority both in the current year and in provision for future years through storage, in preference to power. A maximizer's inclination is to question this absolute priority. However, there are circumstances where the effects of the priority are not so bad. First, in the range of low water utilization it would appear that the marginal productivity of water in irrigation is substantially higher than in power. In Figure II, below about 400 thousand acre-feet of water, the only power that will be produced under optimal conditions is that which is complementary to irrigation. 18/ In these ranges of low water availability, marginal productivity of water in irrigation is clearly dominant in determining optimal water use. Second, a principal determinant of the demand for storage-- which we have not dealt with rigorously in this study-- is the loss associated with possible future water shortages. Our earlier analysis for water-short years suggested that these losses are sizeable and hence that there may be large gains to storing water between years. Third, the marginal product of water in power generation seems in most instances to be less than one dollar. The differences in quantities used in irrigation when water has a value of one dollar and even when it is used as if it were a free good appear small. Hence the possible reallocations between irrigation and power to equalize marginal products appear small.

17/ Delivery capacity of canals sometimes limits water applies in situations below Lake Mc Conaughy where power is produced. When this situation occurs, then clearly canal capacity and not the considerations mentioned in the above paragraph will determine water application. We understand that plans are being made to expand the capacity of the limited-capacity canals, so that in terms of future allocations our analysis neglecting capacity considerations may become relevant to all situations.

18/ That is, there would be no summer power except what took place in conjunction with irrigation, and there would be no winter power at all.

These remarks do not mean that water can best be allocated by priority system. They mean only that the present priority system may come close to maximizing economic product in allocating between competing irrigation and power uses.

Above Lake McConaughy. There is little possibility for conflict between irrigation and power above Lake McConaughy. Irrigation releases in the summer appear to exceed the capacity of the generators. Hence in the relevant range the amount of power produced in the irrigation season would appear not to be an issue in water allocation.

With regard to winter power, the Glendo unit has now been constructed. It has increased the generating capacity and storage capacity of the Wyoming system so as to enable more generation of winter power while still permitting storage of water to the irrigation season. This has reduced conflicts between irrigation and winter power. For the same reasons as below Lake McConaughy, the conflicts were probably already unimportant.

Between the two areas. Irrigation water appears to be used more parsimoniously in the area below Lake McConaughy than above it. Charges to farmers sometimes do not depend on the amount of water they take. This gives an incentive to use water as if it were a free good.

The maximizer's impulse is to question this state of affairs, since water could be allowed to flow down the river to equalize marginal product in the two areas. However, the impulse ignores return flows. Water use for irrigation above Lake McConaughy is in part complementary with water use below Lake McConaughy. About half the water used in irrigation returns to the river by such means as run-off and seepage. The return flows from above Lake McConaughy are caught in the lake and re-used.

The value of water routed to irrigation above Lake McConaughy thus includes not only the marginal product in irrigation there but also about half the marginal product of water below Lake McConaughy. Water from the area below Lake McConaughy has no such additional source of value. ^{19/} Water should be routed directly down the river only if marginal product below Lake McConaughy becomes substantially higher than marginal product in irrigation above the lake-- in contrast with one's first impulse to try to bring the two marginal products just mentioned into equality.

Nonetheless, at present there is no real attempt to equalize the value of water above Lake McConaughy and below it. It might be desirable

^{19/} The return flows from below the lake apparently flow on to the Gulf of Mexico without ever having any appreciable marginal productivity.

to let water flow directly down to Lake McConaughy on occasions when the lake is low and a water-short year occurs. These flows might take place prior to the irrigation season, since they would permit the generation of additional power. 20/

III. CONCLUSION

Findings for the North Platte River. The historical basis of legal and administrative procedures for allocating water makes them appear at first glance to be at odds with maximizing economic product. Yet they may be sensitive enough to avoid gross malallocations. We guess the percentage gain in product from all the improvements suggested in this study would be 5 per cent at most.

The most important malallocations were found to be associated with unequal effects of water rights in water-short years. Other possibilities for improvement include: (1) Allocation of more irrigation water to land where power generation is associated with water deliveries. (2) Consideration of water losses in making deliveries along distribution canals constructed in the future-- but not necessarily along present canals. It could be a disservice to advocate costly reorganizations along present canals in view of the small prospective gains. However, reorganization costs are not a hindrance to making water use from the outset more intensive near the head of the canal. (3) Co-ordination of decisions between the two major areas of water use. Occasionally there might be planned releases from the Wyoming dams in the wintertime to Lake McConaughy.

The conclusions rest on the assumption that initial increments of irrigation water are very valuable compared with marginal product at ordinary rates of water use. The assumption is suggested by the high value of irrigated land in the North Platte basin and by previous studies of the demand for irrigation water. It implies large losses will be encountered as water deliveries are reduced to irrigated land. Hence it explains why losses are large from cutting off water to some land in water-short years and why there are limited gains to interfering with equal water deliveries along a canal.

Further applications. Analyses of marginal product of water might lead to larger gains when used in planning investments than when used to guide allocation within existing facilities. Though not considered in the foregoing, the question of what is optimal capacity of facilities needs to be faced on less developed rivers.

20/ Power generation from releases above Lake McConaughy in the irrigation season are apparently already at a maximum, as indicated in Table 1. In the nonirrigation season, releases would make use of power capacity not otherwise being used.

Water facilities have usually been developed on a piecemeal basis, with little effort to find an optimum set of investments taking account of interrelations between them. Using the approach exemplified in this study, planners could strive for capacity such that marginal product of water foregone at other points on a river equals marginal product of water produced on a project in question. Two approaches for doing this may be noted. Either approach might be especially helpful for areas of the West where there is basin-wide water scarcity.

First, demand schedules like those illustrated in this study could be estimated for interrelated points in a basin. They could then be used in formal mathematical programming.

A second procedure assumes that investments will continue to be made on a piecemeal basis. Past planning methods would be modified by including as a cost an estimate of marginal product of water foregone because of the project. The realism of assuming that piecemeal development will prevail is indicated by lack of data for detailed programming for an entire basin and by difficulties in changing the political process of approval of water projects. The suggested procedure might none the less impart a tendency for water investments to go toward an optimum, in the same sense that a market economy tends to be optimum. While water is not ordinarily bought and sold, planners would simulate a market for water and respond to incentives to economize it.

The procedure would be aided by noting that water can flow downstream freely but that to reverse the flow is virtually impossible. Hence marginal product of water for a project should be at least as high as any that will occur downstream from it. The optimum pattern is seen to involve declining marginal product as one moves downstream. Deductive hints like this may mean that future development in a basin needs to be predicted only in a general way to obtain adequate estimates of the pattern.

APPENDIX ON CANAL LOSSES

Data were obtained from an irrigation project in the North Platte basin with a view to estimating how losses of water vary with distance along a canal. It ought to be possible to make loss measurements directly through gauging canal flows at various points, but we were unable to obtain data of this kind.

Uses of water. Let Q_D be the amount of water delivered for irrigation of lands on the project. The assumption as to how Q_D varies with distance D is

$$dQ_D = adD,$$

where a is a constant. This assumption is good if irrigation land is distributed evenly and of about constant width along the canal, which appears to be the situation on this project. Integration gives $Q_D = aE$, where E is the length of the canal.

For this project during a certain period the amount of water delivered on the project, Q_D , was about 36,000 acre-feet.

An important difference between the project in question and those in the text is that this project delivers water at the foot of its canal for use by another project. Let the amount of this delivery be R . For the period covered by our data, R was about 17,000 acre-feet.

Supply of water. Let Q refer to the amount of water diverted from the river to the canal. Q was about 88,000 acre-feet. There is an additional supply because the project lies below other projects whose drainage provides water inflows. Let I be the total amount of these drainage inflows:

$$dI = bdD.$$

The constant b means that the drainage inflows are assumed to be distributed evenly along the canal. This appears to be roughly the real situation. Integration gives $I = bE$. I was about 15,000 acre-feet.

Solution for loss rate. Let k refer to the fraction of the water being lost per mile. If the amount of water that flows past a point along a canal is denoted by Y , then the water lost over an incremental distance is $kYdD$, that is, the percentage rate of loss per mile times the amount of water to which the percentage applies times the number of miles in the incremental distance.

Now note that

$$dY = dI - dQ_D - kYdD,$$

which says that the change in the flow in the canal as one moves an incremental distance down the canal is the inflow of drains from other projects minus water deliveries for irrigation minus water loss from the canal. In view of the previous assumptions,

$$\frac{dY}{b - a - kY} = dD.$$

As the distance D goes from zero to E , the amount of flow Y in the canal goes from the amount of river water diverted Q to the amount delivered out of the foot of the canal R .

$$\int_Q^R \frac{dY}{b - a - kY} = \int_Q^E dD.$$

Solving, we find

$$\ln \left[\frac{b - a - kQ}{b - a - kR} \right] = kE.$$

It was stated earlier that $I = bE$ and $Q_D = aE$. Thus a and b may be eliminated:

$$\ln \left[\frac{I - Q_D - kEQ}{I - Q_D - kER} \right] = kE.$$

Using the values already referred to for I , Q_D , Q and R , the solution for kE may be accomplished by iterative tries.

kE is 1.078. Since the length of the canal E is near 100 miles, k is about .01078. That is, our result is that the loss rate is about 1 per cent per mile.

The Irrigation Water Rental Market: A Case Study

By Raymond L. Anderson

Research on the market for irrigation water has been initiated to examine the institutional arrangements that have developed in certain areas to make irrigation water more readily transferable between farmers who have varying seasonal needs for water. This article outlines the manner and extent that farmers and irrigation companies in the South Platte Basin have developed arrangements for transferring water during a single crop season.

INTENSIVE AGRICULTURE in the semiarid West depends upon an adequate water supply. Even in areas where water is generally considered adequate, problems arise as to allocation of water among farms in most crop seasons.

During the last 60 years, the irrigation companies in the South Platte Basin have developed a rental procedure for transferring irrigation water from one user to another. The rental market evolved because of varying needs for available water and varying ownership of irrigation company stock.

The many reasons why water users may have insufficient or excess water include changes in crop patterns, development of irrigation wells, acquisition of additional water stock for insurance against short-water years, water stock split off when land was sold, development of additional land for irrigation, and need for more water stock than was originally anticipated.

Irrigation in the South Platte Basin was developed by privately owned irrigation companies. These companies are organized mainly as mutual companies in which the water users own the stock. Though the area has about 100 irrigation firms, 10 or 12 major companies cover a substantial part of the irrigated land.

Under strict appropriation doctrine, water is attached to the land by prior development of irrigation works. Whenever the appropriator fails to use the water or allows others to use it the right can be lost to another. Beneficial use is a requirement for retaining an appropriative right, but the question of what constitutes beneficial use is difficult to determine with any degree of precision, as any level of beneficial use is permissible. Modification of the appropriation doctrine through the evolution of a rental system under which water can be transferred to those who can make higher economic use of it allows a much more efficient use

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of limited water supplies. In this paper, "water rental" means seasonal transfer of water between water users.

Water rental is possible in this region because of (1) company ownership of water rights; (2) development of privately owned storage reservoirs; and (3) availability of supplementary water supplies from the Colorado-Big Thompson Project.

The importance of company ownership of the water right lies in the fact that water rights are not attached to any specific tract of land, as is common under the appropriation doctrine. Under the company-ownership arrangement, the water users own stock in the ditch company. They receive water dividends according to the amount of stock owned without regard to the amount of land under the ditch. These stocks are treated as personal property that can be bought, sold, or rented at will.

The development of privately owned reservoirs is the second factor that makes rental of water possible. Farmers own stock in these reservoirs and receive water according to stock held. This water can be delivered on a demand basis; it is particularly valuable for late-season irrigation.

The third factor permitting the rental of water is the Colorado-Big Thompson Trans-Mountain Diversion Project. Water delivered by the project is administered by the Northern Colorado Water Conservancy District and is freely transferable among water users anywhere in the conservancy district. The area in which effective water transfers can be made is bounded by Boulder on the south, Fort Collins on the north, and Fort Morgan on the east—a triangular area 70 miles wide at its western base and tapering to the northeast approximately 100 miles.

Rental Arrangements

Individual allotment holders of project water can readily transfer water for a season to anyone who wishes it by sending a water-transfer order to the conservancy district office. This office then turns the water to the renter's ditch on the day desired.

Municipalities and irrigation companies also rent water to water users from their allotments of project water.

Water rental practices vary by irrigation companies according to the size and historical development of the company. Rental procedures for representative companies in the South Platte Basin are presented in table 1. The smaller companies keep no record of transfers. Any exchange of water is an arrangement between individuals. The ditch rider is informed of changes to be made in water deliveries.

The large irrigation companies with from 100 to 300 stockholders maintain a rental service in the company office. Typically, water users who have excess water list it with the secretary, and those who need additional water contact the secretary to obtain it. In some companies, the rental price of water is set by the board of directors. Everyone who buys or sells water does so at the established price.

Other companies list the water available, together with the asking price. Users who need additional water take the lowest priced water, or haggle with the owner for a still lower price. If the season turns hot and dry, the price rises and more shares of water are likely to appear on the market. As the rental price rises, farmers who have low-return uses for water, such as pasture or hay land, will obtain a higher return by renting water to farmers who need water for such high-value crops as corn or sugar beets.

Most companies have water available for rent from different sources. One type is irrigation-company stock for a season—this is direct-flow and some reservoir water, depending on the company. The exact quantity of water delivered depends upon the flow of the river and must be used when available, or it is lost.

Another type of rental water is reservoir-company stock delivering a specified quantity of water from a privately owned reservoir. This water can be rented by day's run, which is normally 2 or 3 acre-feet, or by the share, which can vary in quantity from 10 to 100 acre-feet and is delivered on a demand basis. In certain instances, reservoir water can be transferred between adjacent companies.

Farmers can also rent project water to be delivered to their farms, independent of the parent company's water supply. Transfer of project water was described earlier. Water is commonly priced the same regardless of source.

TABLE 1.—*Representative water-rental procedures in the South Platte Basin*

Company	Method of renting	Method of pricing	Kind of water rented
Larimer and Weld Ditches, Eaton, Colo.	Available water is listed in company office. Secretary allocates to those wanting additional water.	Board of Directors sets price for season.	Reservoir water rented by day's run.
New Cache La Poudre Irrigating Co., Greeley, Colo.	Available water is listed in company office. Buyers contact secretary for water.	Secretary and Board of Directors set price for season.	Reservoir water rented by day's run. Few shares of direct-flow water rented each season.
Water Supply and Storage Co., Ft. Collins, Colo.	Shares of seasonal water are rented from the office. Small daily transfers are traded between farmers. No office record is kept.	Farmers set the price of both seasonal and daily rentals.	Both direct-decree water and reservoir water are rented by the day and the share.
North Poudre Irrigation Co., Ft. Collins, Colo.	Water for rent is listed on a board in office. Farmers who need water contact one of those listing water.	Asking price quoted along with number of shares each individual has for rent.	Shares of stock including both direct-decree and reservoir water are rented.
Greeley and Loveland Irrigation Co., Greeley, Colo.	Lists water only if requested. Most rentals are between farmers	Farmers set the price.	Mostly Colorado-Big Thompson water is transferred.
Bijou Irrigation District and Riverside Irrigation Co., Ft. Morgan, Colo.	Farmers arrange for transfers. Transfer orders are recorded in office.	Farmers negotiate price when arranging transfer.	Mostly reservoir water by the share, but some direct-decree water when farmer has well.
Farmers Reservoir and Irrigation Co., Denver, Colo.	Most water rented between farmers. Must submit water transfer order to company office to effect transfer.	Farmers set price.	Rent stock or acre-feet. Most rentals are reservoir water.

Size of the Water Rental Market

The Northern Colorado Water Conservancy District and five major companies in the area have made their water-rental records available for study. These records indicate that rental water is an important feature in the irrigated agriculture of the South Platte Basin.

During the 1959 season, 645 transfers of irrigation water took place in these companies, thus shifting the use of 16,353 acre-feet of water. In the conservancy district, 376 transfers totaling 73,967 acre-feet of water were completed. Although water is rented from March to October, the greatest activity occurs in July, August, and September (table 2).

Most rental transfers involve relatively small quantities of water. As shown in table 3, 88 percent of the transfers in 5 irrigation companies were below 50 acre-feet of water per transaction, and almost 75 percent below 30 acre-feet. The conservancy district records (table 4) show that

about 80 percent of the transfers were below 80 acre-feet in quantity and that 72 percent were below 60 acre-feet.

About 70 percent of the water volume transferred within mutual companies was in units of less than 60 acre-feet, while rentals of less than 60 acre-feet accounted for only about 9 percent of the water shifted in the conservancy district.

Rentals of more than 2,000 acre-feet per transaction account for 65.8 percent of the water transferred in the conservancy district, but only 3.2 percent of the transactions. These large transfers involve water allotted to municipalities by the conservancy district but which the cities do not now need. The cities rent large blocks of water to irrigation companies to supplement their water supplies. Cities can transfer the water to their own uses as need arises. This flexible arrangement allows for ease of transfer whenever domestic or manufacturing users require additional water.

TABLE 2.—*Water rentals by months for five irrigation companies and the Northern Colorado Water Conservancy District, 1959*

Month	5 irrigation companies			N.C.W.C.D.		
	Transactions		Amount of water	Transactions		Amount of water
	No.	Pct.	Acre-feet	No.	Pct.	Acre-feet
March.....	3	0.5	69	2	0.5	228
April.....	8	1.2	476	11	2.9	3,659
May.....	20	3.1	1,064	14	3.7	9,180
June.....	45	7.0	1,877	22	5.8	11,975
July.....	149	23.0	4,115	105	28.0	14,777
August.....	220	34.1	4,391	131	34.9	22,745
September.....	196	30.4	4,332	88	23.4	9,166
October.....	4	.7	29	3	.8	2,237
Total.....	645	100.0	16,353	376	100.0	73,967

Rental Rates and Value of Water

Under the assumptions of marginal theory, the allocation of resources in a competitive industry will be such that the value of marginal product of any factor is equal between firms. When water is distributed under the appropriation doctrine, the returns to water can vary considerably between firms. Rental provisions help to adjust this mallocation of water. In the process of reallocation, the price of rental water should reflect the value of the marginal product of water to both the renter and the rentee.

In 1959, much of the water was rented at a price that covered the yearly stock assessment plus interest on the market value of the stock. Two companies set the price of water for the season at \$2.70 and \$3.25 per acre-foot. For the companies that let the farmers set the price, the charge ranged from \$2.50 to \$5 per acre-foot at the beginning of the season and from \$4.20 to \$8 late in the season (table 5).

In dry years, when the supply of water is short, the price is reported to go as high as \$30 per acre-foot. Most irrigation officials and farmers think this is too high. Community pressure does not allow the market price to reach the level that farmers short of water would be willing to pay. Institutional restraints are one of the peculiarities

of the water-rental market. The customary price of rental water probably limits the quantity of water that is available in some years.

The economic value of this rental water is not known because use of the water transferred was not ascertained, but it is possible to estimate its value from the returns to irrigation water in this region. A recent linear programming study made at Colorado State University¹ showed marginal values of irrigation water varying from \$50 per acre-foot with a short water supply to \$15 per acre-foot with a full supply. These values were ascertained for typical irrigated crop systems. A second stage of this study found the value of marginal product with adequate water supplies ranging from \$32 per acre-foot on farms with soils of high productivity and high-value crops, down to \$9 per acre-foot on farms with poor soils and low-value crops.

Another study² on the average gross return from an adequate water supply on various crops gave gross values of \$72 per acre-foot when applied to sugar beets, but only \$10 when applied to oats.

¹ Whittlesey, Norman. Economics of Irrigation, Uncompahgre Project, Unpublished MS. Thesis, 1959.

² Unpublished data from the Northern Colorado Water Conservancy District.

TABLE 3.—*Number and amount of water-rental transfers in five irrigation companies,¹ South Platte Basin, 1959*

Size of transfer (acre-feet)	Trans- fers	Cumula- tive per- cent- age	Amount of water	Cumu- lative percent- age
	<i>Number</i>	<i>Percent</i>	<i>Acre-feet</i>	<i>Percent</i>
0 to 9.9.....	175	27.1	977	6.0
10 to 19.9.....	180	55.0	2,430	20.9
20 to 29.9.....	126	74.5	3,084	39.6
30 to 39.9.....	56	83.2	1,872	51.2
40 to 49.9.....	33	88.3	1,426	59.9
50 to 59.9.....	29	92.8	1,604	69.7
60 to 69.9.....	9	94.2	564	73.1
70 to 79.9.....	10	95.8	759	77.7
80 to 89.9.....	5	96.6	420	80.3
90 to 99.9.....	1	96.8	96	80.9
100 to 149.9.....	14	99.0	1,774	91.6
150 to 199.9.....	4	99.6	681	95.9
200 plus.....	3	100.0	666	100.0
Total.....	645	-----	16,353	-----

¹ North Poudre Irrigation Company, New Cache La Poudre Irrigation Company, Larimer and Weld Ditch Companies, Farmers Reservoir Company, and Bijou Irrigation Company.

Conclusions

It can be assumed that the water transferred moves to a higher value use. If, for example, the water transferred returned \$20 per acre-foot more at the new location and 60 percent of the water actually reached the farm, water rentals in the conservancy district and the five companies would add around \$1,000,000 to the gross return of the area. More water is actually rented in this area, but data cannot be obtained from some companies. These estimates indicate, however, that substantial returns are gained from seasonal transfers of water.

By using a market mechanism to allocate water within a framework of the appropriation doctrine, considerable losses in crop production have been avoided. The rental system also reduces the waste that occurs when water rights become involved in costly, time-consuming legal battles. One water user cannot bring suit against another for nonuse and transfer of irrigation water. Under the rental procedures used in the South Platte Basin, water can be transferred within irrigation companies by rental of stock and between or within irrigation systems by transfers of Northern Colorado Water Conservancy District water allotments.

These rules and customs, which developed during the last 60 years for company rentals and the

TABLE 4.—*Number and amount of water-rental transfers in the Northern Colorado Water Conservancy District, 1959*

Size of transfer (acre-feet)	Trans- fers	Cumula- tive per- cent- age	Amount of water	Cumu- lative percent- age
	<i>Number</i>	<i>Percent</i>	<i>Acre-feet</i>	<i>Percent</i>
0 to 19.9.....	102	27.1	1,082	1.5
20 to 39.9.....	101	54.0	2,726	5.2
40 to 59.9.....	67	71.8	3,130	9.4
60 to 79.9.....	30	79.8	1,953	12.0
80 to 99.9.....	8	81.9	658	12.9
100 to 149.9.....	27	89.1	2,888	16.8
150 to 199.9.....	3	89.9	503	17.5
200 to 499.9.....	17	94.4	4,913	24.1
500 to 999.9.....	7	96.3	4,882	30.7
1,000 to 1,999.9.....	2	96.8	2,602	34.2
2,000 to 2,999.9.....	3	97.6	6,141	42.5
3,000 to 4,999.9.....	6	99.2	18,780	67.9
5,000 plus.....	3	100.0	23,709	100.0
Total.....	376	-----	73,967	-----

TABLE 5.—*Variable cost and rental price of water per acre-foot, representative irrigation companies, 1959*

Company	Cash cost per acre- foot ¹	Rental price per acre-foot	
		Early season	Late season
North Poudre Irrigation Co.....	Dollars 2.50	Dollars 2.50	Dollars 4.20
New Cache La Poudre Irriga- tion Co.....	2.50	3.25 all season	
Greeley and Loveland Irriga- tion Co.....	2.87	3.00	5.00
Water Supply and Storage Co..	1.92	5.00	8.00
Farmers Reservoir and Irriga- tion Co.....	4.04	4.60	6.00
Larimer and Weld Irrigation Co. and Windsor Reservoir Co.....	{1.03 3.72	2.70 all season	

¹ The cash assessment divided by water delivered per share.

last 10 years for Conservancy District transfers, make possible a better adjustment of the land-water relationship than is normally found in western irrigated agriculture. They might well serve as examples for other areas in adjusting for the varying needs of water users.

- Mon. Progress toward ec. water allocation. Also retrogression. Utah had a fine system, under city cts, until c. 1880, made part prop. to frustrate Gentiles.
1. Municipalities, P.D.s, MWC, (P.U.? - no, static) Water becomes in law what is in nature, fungible. "during development pd."
Weakness in some, allow no export costs. EBMUD, e.g. (Nevada P.D., mainly just sells water)
P.D. can sell across border, rest no right.
Within, water goes to who will pay! Or, in cities esp., nation, by the year
arbitrary, but still better than vested, static rights.
2. Super-munic. - MWDSC, since '28, serves much agric.
 2. Water masters - adm, rather than judicial approach.
Kings R. But suits preceded.
Sacto R. plan - State Eng & BR, to forestall costly litig, getting all claims together hope to reconcile all w/o litig. But locals want to pay nothing for water, which means freezing out BR.
 3. In Ore., present movement to revoke unused water rts. - March statement of Lane Cty Farm Bureau.
 3. Taxing water rts? On the increase? March '54, Cal. cities began taxing water rts of P.D.s - one city did, Stanislaus. At very low valuation.
Many P.D.s were formed to spec in water rts - Coachella, Santa Ynez, Madera, etc.
✓ Dry Canals in Byron-Bethany
3. Fed., B.R. plans. Dealing thru P.D.s, not direct
ge contracts. - 40 yrs, which is rigid enough, but parasites not satisfied. Ore., P.U. type contracts.
Limit water rt to 160 acres. Resistance - which meant those who played ball got water. Hence PDA got Ivanhoe owner to object, ran thru ct, etc.
Outline plans, Txs, & c.v., canals & fluid water.
Water swapping - billiard ball movement.
 4. Interstate Compact: Still rigid, bad.
Colo. R. - settled little. Upstream states got much they don't use.
Ariz. after Cal. } Agric gets water, power & city pays.
Columbia Coming up } \$200,000/yr lobbying. Ariz v. Cal now at Supr. Ct.?
Delaware? Incoded.
 5. International.
Chapultepec - Mex got Colo R., us got Rio Grande, says Glaser

Integration.

Ec-sts' goal - how achieve best? - w-in or w/o farm unit?

Obviously some of ea. - gn. is, what is best done by individ; what by free mkt; what by society

Water does not lend self to free mkt. Must be individ., or society.

1. a. Powell recommended society: set up community of farms around water - all w. access to water. Thus ea. individual farm has water, the nec. complement to use other land. Also, live close together, have community life.
- b. Mormons, carried farther - much social control, community life. Settled areas otherwise uninhabitable. -- if only bes man, & esp. woman, is a social animal. But also because of need for community enterprises.

Ea. newcomer got = share of water, & land of all grades.

So ea. farm cd. be well integrated, w-in own boundaries.

No very pressing need for exchange. Emphasis on integr. via society,

& via individ. farm - not via free mkt.

c. I.D.s, MWC - via govt, common access to water

2. Massive holding, controllg water, & vast area around it. Owner is king, his own govt. Builds roads, basic utilities, if any - cornals. Perhaps goes as far as s-n plantation, w commissaries, gins, etc. Common pattern in West. Hence very large farms - in value as

well as area.

E & W est, Nev., 5-10% land controls 90-95% the range.

-- so called public lands.

Census figs.

Census map in lib. Large ave. size fm in w. In e, better lands conc., small fellows move up into hills. In w, small fellows usually can't get along in ~~worse lands~~ ^{worse lands} who access to water. Fold up.

3. Integration via free mkt?

N. E. for water itself. Only one seller, others can't count on him. If one controls water as prop, ~~keeps~~ ^{keeps} surrounding land worth more to him than anyone else.

But can xfer products of irrig. land to graz'g land.
Integrate via mkt. -- sell irrig-d feed to grazers.

or
Sell cattle from dry lands to wet lands. Range produces feeder cattle, sell to irrig. fm. for fatten'g.

(Here is another extended benefit from irrig.) (also, provide better common mkt, dry landers can use)

Shift labor among fms.

To a great degree, in arid area, free market cannot provide as good integration as single unit.

E.g. ~~dry farming - land idle every other year.~~ W

Esp. because of weather risk. Non irrig. fm doesn't know

if will get a crop. Maybe for several years, must wait out bad
yrs, waiting for good. Where? If going to maintain home, be
anything but suitcase fam, need a secure base, source of
income, so can pull in yr horns, still survive.

Poor mkts, hi. mket costs. Can't live like D-k.
Irrig. oasis may be mnpstc, not just for water, also
for products, in pinch.

Mulloy, Pleasant Valley
Water Co., says state law
makes incorp. water co.
charge all same rates,
regardless of ~~xp~~ ~~ex~~ ~~in~~ ~~sen~~
costs.

Fear of being declared P.U.
prevents MWC supply's
outside self.

p. 37, add

~~Licensee cannot sell something as good as he has, but in process of sale, title is weakened.~~

But ownership is not absolute,
State imposes many barriers &
conditions

Re need for wtr sts in persp.

In HongKong are
now hvg a building boom,
basis of returning invest
in a few yrs.

Land is cheap relative to
yield, why? Fear of
Communist seizure.

Cross purposes — mun. priority
vs. subsidy to ag. via B.R.

Urban subsidy — Hoover Dam, etc.
Reber Act.

Means of reducing farm output?

No, less farm can spare much & Δ production.

Munic. pref. policy - future expansion.

Munic. watershed land, hi cost,
work into analysis -- by taking
water from agric. far away, may take
less land from ag. nearby

Coopture with devmt - Modesto:

L.A. larger scale desirable. Agric.
should not blindly fight urban demand but
cooperate & benefit. There's enough water - need money.

Flexibility wd reduce aggreg. demand
for future water, based on fear of inflexible
allocations to others.

call number

HD 1375:s

U85.tb

#17

date and time due

author

Urban Land Inst.

title (if periodical, give date)

Water for Industry

vol.

copy

I agree to comply with library regulations

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☐ GR ☐ EXT

☐ GEN-SP ☐ REF

street

city and zone

M. MASON GAFFNEY
246 Cambridge Avenue
Berkeley 8, California
Landscape 4-3443

telephone

SEARCH RECORD

Date	By	Time

OVERDUE RECORD

Returned:	Notice Sent:
Fine:	
Bill Number:	

W. for Industry, cost \$5, 1737 K St NW, Wn 6 D.C.

ULI T.B. 17. 11-51.

By Milburn L. Forth.

p 29, list State Geologists.

Cal: Dr. Olaf P. Jenkins, Chief
Div. of Mines
Dept. of Nat Res.
Ferry Bldg, 5711

Mo: Dr. Edw. L. Clark, State Geologist
Div. of Geol. Survey & W Res.
Dpt. of Bus. & Ad.
Buehler Bldg
Rolla, Mo.

Miss R. near Mo, 6 states almost converge in 100 miles. Interstate
par excellence.

p 6. Arid areas, less % runoff from precip.

p 7. Cfs runoff & precip. maps. W-n mts lead in runoff.

Esp. n. coastal, long prong extends s., Sierras. But also Wasatch,
Black Hills,
1 Colo. Rockies, & Tetons, heavy runoff despite low precip.

p. 6 Table I. Wtr Use, '50, Est. by U.S.G.S. B. gals/day.

	Groundw.	Stream & Lakes	Total
Irrig.	18	61	79
Ind.	5	72	77
Munic.	4	10	14
Rural, non-irr.	3	1	4
Total	30	144	174
W. Pwr	—	1100	1100
Total		1244	1274

W. for Ind-y, 2

p. 8 Withdrawals are 4% runoff. W/o adj. for reuse.

No. E. uses surface w. more; S. & W. underground.

p. 9 2 USGS maps show by states how much ind-y & munics take, from surface & ground.

✓ Ind-y shares ground, except in Cal - probly an index to previous ag. & munic. commitment of surface w., & reason limiting Cal. ind.-l exp-n.

Int-g how much more w is used for w. pur than is consumed. - suggests problem of distrib. is major bar.

(Mo. & Tenn. ea. touch 8 other states - more than any other.)

Cal. municipal use is as large as Ill & NY, largest in U.S.

✓ But Cal ind.-l use is very small.

Ind-y ^{relatively} heavy on gnd w. cfd to surface w in Fla, ^{Ariz,} Minn, Cal, Hawaii, Idaho, NM, Okla, Ark, Wyo, SD, ^{Miss,} more or less in that order.

Mo. a surface w. State. Gnd w. sinking problem around Joplin.

✓ Gnd pattern, ind-y takes surface w. more, & munics take gnd. Reversed in Cal, Fla, Ariz, Minn, Okla, Ark

Colo. a surface w. State for both ind-y & munic. Nebr. gnd w. all plains tier heavy on gnd w.

W for Ind-y, 3

p. 11 U.S. & S. map. Ground w. areas, U.S.

Some areas sitting on top of huge storage res. - others not. Ozarks are a good one, but s. Mo not, except r. beds. Valuable & revealing map. Aquifers localized. So obviously problem is to use nat. res. for whole U.S. by distrib. nets, & spread'g grounds.

order Get the map! Compiled H.E. Thomas, Cons-n Fdtn, '50.
U.S. & S. Ground w. areas in the U.S. Write Cons. Fdtn.

Think, how can tie up together all Mo. Miss Valley w. nat. res., & nat. rivers for distrib.

In Cal, gnd w is in valleys, not elsewhere, on whole. Except on Ore line, huge solid aquifer comes so. from Cal. plateau.

N.E.S.D. almost w/o any gnd w. Nebr. has it all.

Gusty, wtr shd flow westward. Rocky Mts wtr shd go west, never east. Fryingpan proj. fokey

p. 14 Denver & Pueblo mtg hurt by ~~pan~~ w. shortage.

p. 17 Pittsb, 32 air-conditioners put in, '31-50. Gnd w. occurred only in narrow strip, in Golden A.

Various cities legist. vs us'g much w. for air-cond-rs! In Chi, is plenty w, but overburden sewers! p. 18 Lawn sprinkling & swimming pool filling also discrim. against in droughts.

W for Ind-y, 4

p. 18 Cons-n Fdtn's study showed 59% plants used 15% w. of 3,000 surveyed. One shd correct for area for my analysis, but even so, very unequal use per acre raises qn re propriety of tax support. Esp. if one looks at it from ass-n of pvt prop. Not so much so otherwise, ec. view.

p. 22 Sacto area has "more unused ground w. storage available than in any other pt. of the State."

Salt accumulation a problem of irrig. near Fresno & Stockton.

LA area, local contam. of surface w. by ir.-return w. hi in chloride.

p. 25

St. Lo., ground w. of good quality lim-d. Source: Miss. R. ^{Mississippi}



JOHN ROBBINS spent his boyhood on the shores of Lake Erie; and on his recent return to Cuyahoga County after two years in Asia and the Middle East as an Ogden Reid Fellow, he was amazed to see what the Great Lakes industrial boom was doing to his ancestral country. There were demands all along the line for more and more water. The change he observed in his home country, which is rich in water, set him to thinking about the more drastic changes ahead in those areas where water is even now at a premium.

WATER: HOW FAST CAN WE WASTE IT?

by JOHN ROBBINS

1

A YALE UNIVERSITY study published in 1939 indicated that the minimum daily ration of water necessary for an individual was 20 gallons. It allotted one gallon for drinking, six for laundry, five for personal cleanliness (but without tub or shower), and eight for the toilet. Even if the individual takes an occasional 25-gallon bath in the tub, or a five-gallon-per-minute shower, he isn't likely to build up a total for personal use of more than 50 gallons a day. But all this is pure theory. The amount of water which an American is actually using in 1957 is something over 1500 gallons a day.

Most of the 1500 gallons is essential in the cultivation of the food he eats and in the manufacture of nearly every article he uses in his daily life. The production of a slice of bread, including the growing of the wheat, has been estimated to require 37.5 gallons of water. A steer, in order to create each pound of beef, must consume something like 4000 gallons, not so much from its drinking trough as from its pastureland.

Each ton of steel, in being produced, requires 40,000 gallons of water, or 160 times its own weight. Ten gallons of water are employed to refine one gallon of gasoline. The brewing of a gallon of beer takes eight gallons of water in addition to what actually finds its way into the bottles.

At an educated guess, we as a nation are now using around 275 billion gallons of water a day. Less than 10 per cent of the total is for domestic purposes, either through municipal water systems or from rural wells. More than a third, around 100 billion gallons a day, is necessary for irrigation. The rest, well over half, goes for the needs of industry.

There is nothing inherently alarming about the magnitude of these figures. America is well blessed with water resources. The average rainfall over the surface of the United States is 30 inches. About

70 per cent of this returns to the atmosphere by evaporating or by the transpiration of leaves. The equivalent of eight inches remains to flow through the streams and rivers to the ocean, or to soak into the ground, where it forms deposits in the porous subterranean formations. This annual increment to our surface water and our ground water is four times the amount of water we use in a year.

The disturbing aspects in all this are not generally appreciated. The first is the unequal distribution of our water resources. The second is the tremendous growth of our water usage, particularly by industry. The third is the possibility that a long-range change in the climate is going to dry up parts of the country that are already on a marginal basis. Taken together they add up to an almost inevitable conclusion: water is going to play an increasingly important role in determining the economic geography of the United States.

The uneven way in which nature has distributed our water resources must be obvious to anyone who has traveled any distance around the country. We have our deserts and we have our swamps and rain forests. In between we have a full range of climatological conditions, from Maine with 40 inches of rainfall annually, only 15 of which evaporate, to Arizona with 14 inches, 13.3 of which evaporate. The 17 westernmost states—North Dakota to Texas and westward—average less than four inches of water yield or runoff after evaporation a year. The 31 eastern states average 16 inches. Within the western states there is another general division. Eastern Texas, northern California, and the Northwest are generally well watered. But half the area of the 17 states, constituting a third of the territory of the United States, has a natural water yield of less than one inch.

In many parts of the country the water table, the top level of the underground storage water, is

falling. In most of these areas it isn't a case of drought but of overuse. In Milwaukee, for instance, when a large brewery recently began pumping at high volume from a big new well, water levels of another manufacturing plant seven miles away dropped 75 feet within a few hours. The spring water has sunk so deep in the city that the great breweries may have to switch to Lake Michigan from the wells that helped make their beer famous. Outside Phoenix, Arizona, Goodyear established a farm 35 years ago to grow high-grade cotton. Originally the irrigation water was brought a mere 20 feet to the surface by small pumps. With every passing decade the water table has dropped, and the pumps have had to be replaced with more powerful models. The lift is now more than 100 feet, and the table is still sinking.

The same pattern has been repeated in hundreds of other localities. Geologists have traced water in rare instances to limestone formations as deep as a mile below ground. The pumps to lift it more than 600 feet, however, are so expensive as to make the use of the water uneconomic.

A half century of growth in water usage was spelled out by the President's Materials Policy Commission (the Paley Commission) in 1952. In 1900, according to its estimate, we withdrew from our streams and wells about 500 to 600 gallons a day per capita. By 1950 our population had doubled, and so had our per capita use, quadrupling our total usage. As it did with other natural resources, the Paley Commission projected its estimates of water use forward to 1975 and predicted that it would nearly double again in the 25 years.

It already appears that the Commission underestimated the rate of growth. A second Hoover Commission study based on 1955 figures reported that in the five years since 1950 water use had soared from 185 billion gallons a day to 262 billion, almost halfway to the Paley Commission's 1975 estimate of 350 billion. Admiral Ben Moreell, chairman of the Hoover Commission task force on federal policy toward water resources, made a new stab at a 1975 figure — 453 billion gallons a day. In other words, less than 20 years from now our demand for water is likely to exceed our available supply by more than 25 per cent.

It is interesting to analyze where this growth is occurring. It isn't in personal use, although an increase in suburban lawn watering is putting a strain on some municipal systems. It isn't in irrigation. The lands most easily and economically irrigated have long since been utilized. Any suitable land left to be irrigated would require a large capital investment for a relatively small rate of profit. The application of irrigation to land is, in fact, a classic example of the law of diminishing returns.

The increase, then, is concentrated in the need of industry for cold, clear water — cold because 75 per cent of the water employed by industry is used

for cooling; clear because dirt, minerals, and salts clog up pipes, form deposits on boilers, corrode equipment, and generally raise hob.

The amount of water required by industry is staggering. Steam generators of electric power alone use 40 billion gallons a day for their boilers and for cooling their condenser coils. The steel industry last year used a total of five trillion gallons, and petroleum refining another two and a half trillion. Between Buffalo and Cleveland along the south shore of Lake Erie, power plants and chemical works built just in the past eight years use more water than the combined municipal water systems of both those cities.

New types of industries increase the use of water still further. Prime examples are the new synthetic plants. Rayon, nylon, and the miracle fabrics, for instance, need far more water than the cotton and wool they replace, and the manufacture of synthetic rubber needs American water instead of the rainfall in the jungles of Malaya.

Unlike irrigation water, which either evaporates or soaks into the soil, most industrial water is returned to its source or to the surface. It may or may not have been polluted by its use. It has certainly been heated. A big industrial plant, therefore, needs a big body of water so that the water temperature won't be raised beyond the point of efficiency.

Water has always been a factor in the selection of factory sites, either as a source of power or as a means of cheap transportation. Today it is a prime factor. The areas of the country with assured water supplies are enjoying the fruits of the economic boom. The shores of the Great Lakes, the banks of the Ohio River, and the borders of Lake Pontchartrain, for example, are sprouting with new power and chemical plants, and prosperous industrial complexes are building up around them.

This is not to say that even a heavy industry cannot settle in a water-short area in order to take advantage of some particular situation in relation to raw materials, labor supply, or markets. But it must pay the price. Any lack of water is reflected in increased costs for washing or cooling equipment. Kaiser Steel chose to settle in Fontana, California, for instance, knowing it would have to install a recirculating system able to use partially treated municipal sewage as a coolant. Even so, Kaiser can compete in West Coast markets with water-cooled eastern steel mills because of its lower transportation costs.

2

THE prospects of the water-short areas, and especially of the Southwest, are complicated by the possibility that the North American continent is growing warmer and drier. Weather records indicate that most parts of the northern United States during the past half century have warmed up by

two to three degrees. As to just what this means, there is wide disagreement. Some scientists think we have reached a "climatic optimum," and that the climate is about to reverse itself and start growing cooler. They suspect that the spring rains which flooded Texas this year and which, at least for the moment, have broken the five-year-old drought in the Southwest are the signal that a change has occurred. A second school, more noncommittal, talks only in terms of short weather cycles of seven years or so. A third group is convinced that the warming-up process is still under way.

A leader of the group predicting a 50-year cold-and-damp spell is Hurd C. Willett, professor of meteorology at Massachusetts Institute of Technology. He bases his reasoning on the sun-spot count. The U.S. Weather Bureau, led by Harry Wexler, chief of the scientific services division, takes the more cautious stand that long-range predictions are dangerous, and that the warming trend and the drought in the Southwest represent short-term cycles. A proponent of the warm-dry thesis is Paul Sears, head of the conservation department at Yale, whose studies have shown how changes in the glaciers affected the culture of the corn-eating "mound dwellers" by altering the rainfall pattern of the mid-continent.

In its report to Congress two years ago, the National Science Foundation noted: "Glacier studies have given clear indications that we are now in a cycle of warming which began about 1900. It is estimated that if the indicated warming continues for another 25 to 50 years, the ice will melt out of the Arctic Ocean in the summer, making it navigable. In addition, the warming cycle, if continued, may melt enough ice now tied up in glaciers to add to the sea level sufficiently to affect the lives of millions of people living along low coastal lands." Our shores may get plenty of water — all salt!

If America proves to be really drying up, the Southwest will be the first area faced with tragedy. Even to a greater extent than during the dust-bowl days of the thirties, families will be forced to leave their homes. The great investment in irrigation facilities, much of it subsidized by the taxpayers of other parts of the country, will be wasted. Even if the drought is broken and a damp wave is about to begin, the water capacity of the Southwest won't be able to keep up with the national expansion of water use. The attorneys of the American Bar Association who found the tap water at their Dallas meeting place last summer so salty that it ruined the taste of their whiskey aren't likely to advise industrial clients to expand into such a chancy area.

What is a sensible program for a country facing a tremendous increase in the load on a stable or declining water supply? A tempting suggestion is to recommend an all-out study by our scientists of how we can control the long-range climate or the short-range weather. Let them figure out, as an

East Coast newspaperman urged this spring, how to provide gentle rainstorms every Tuesday and Thursday, with sunshine between, especially over the weekends. His recommendation isn't so far-fetched as it might seem. The great mathematician John Von Neumann remarked shortly before his untimely death last year that the control of the force of the climate was the greatest challenge facing science today.

Unfortunately, the prospect in the field for the immediate future is bleak. Scientists aren't even sure what starts the climatological changes that affect the earth — solar radiation, cosmic rays, sun spots, or clouds of dust circling through the ionosphere in the wake of volcanic eruptions. Even the experiments on promoting rain by seeding clouds with dry ice or silver iodide look less promising than they did when the principle was first discovered a decade ago. After studying the evidence, the Council of the American Meteorological Society issued a gloomy statement this spring. Cloud seeding has been perceptibly effective, it said, only where conditions were such that natural rain might have occurred anyway. Over flat country it has been notably ineffective. "Present knowledge of atmospheric processes," it added, "offers no real basis for the belief that the weather or climate of a large portion of the country can be significantly modified by cloud seeding."

3

ANOTHER hope for the distant future is the conversion of sea water into fresh water. The minimum cost yet achieved for distilling the salt out of sea water is \$1.50 per 1000 gallons, even for large-scale operations. That is 30 times greater than the cost of treating the poorest grades of water now used by cities and industries. The Paley Commission recommended against investing in more research on distillation. The Interior Department went ahead and issued a cheery statement early this spring, indicating that new experiments would make large-scale conversion of sea water economically feasible in the near future. The Department's watchdog committee in Congress quickly came back with a report that officials of the Department were misleading the American people while letting the research program "drift along." And there the matter stands.

Two more likely paths to progress are efforts in the direction of conservation of water and pollution control. Government and industry, as they have become aware of the problems involved, have shown more willingness to spend money on programs of both sorts.

For industry, conservation means the use of more complicated equipment to recirculate cooling water, to reclaim used water, and to employ alternate methods of cooling such as refrigerants or air. For

governments, particularly at the state level, it involves stream regulation, anti-erosion devices, small dams, artificial recharging of ground water reservoirs, and the proper use of plant life.

Industry is also accepting anti-pollution measures as part of its normal production costs. Partly from public spirit and partly under the pressure of public opinion and state laws, most new industrial plants have incorporated waste treatment devices. General Petroleum's new refinery at Ferndale, Washington, releases an effluent so thoroughly cleaned that salmon have been caught 100 yards below the outlet. The installation of anti-pollution measures in older plants, however, is often such an expensive process that it throws their costs out of line with those of newer competitors. No town likes to see an industry shut down, cut off its payroll, and stop paying taxes. Industrial pollution, therefore, continues to exist.

The pollution problem for towns and cities is easily stated. Any government body can install sewage systems to keep from fouling its own or its neighbor's nest as soon as its voters are convinced that clean water is worth paying for. That conviction is slowly spreading around the country.

But neither conservation nor anti-pollution measures, wholesome though they are, can solve industry's need for water. The best solution at the moment seems to be the importation of water by pipeline from water-plus to water-minus areas. Such pipelines will be expensive. They aren't likely to be built in large numbers around the country until the shortage of water and the shortage of industrial space adjacent to bodies of water both grow more stringent than they are today.

The most famous existing water pipelines are those serving Los Angeles, a city which has outgrown its water supply. It now supplements its limited local reservoirs with water from the Owens River on the east side of the Sierra Nevada, 240 miles away; from Mono Lake, 350 miles away; and from the Colorado River, 450 miles away. It hopes to expand its system to reach the better watered, less densely populated northern part of the state.

An example of how a pipeline can be used to protect the interests of a regional economy is the story of Saginaw and Midland, two cities in central Michigan. After nearly dying along with the Michigan lumber industry 40 years ago, Saginaw, thanks to a set of General Motors factories and foundries, made a strong comeback. Midland, a younger city, grew from a small town with the expansion of the Dow Chemical Co. During World War II a serious water problem threatened both cities and their industries when the rivers through the towns grew so polluted and the water so hard that treatment was almost impossible. They joined forces after the war to build an 80-mile pipeline to Lake Huron. It cost the communities \$10 million, but it can deliver a total of 43 million gallons a day of pure, fresh water.

Added to existing supplies of ground water, that is enough for all their needs for years.

From an engineering point of view, Great Lakes water could be piped for hundreds of miles to thirsty cities outside their basin. Because of a legal technicality, it can't be. Thirty years ago when Illinois sought from Congress the authority to drain water out of Lake Michigan to flush Chicago's sewage into the Mississippi, the other Great Lakes states and Canada protested violently. They charged — with some reason — that any lowering of the lake levels would affect their trade and prosperity. The parties involved reached a compromise. Chicago got limited permission to dig its drainage canal, but by international agreement a complete prohibition was clamped on any other device that might move Great Lakes water outside the natural drainage area of the Lakes. The effect of the agreement is going to be felt, and soon.

In the Mahoning Valley in eastern Ohio, for instance, are clustered the steel mills of Youngstown, Warren, and Niles. Although the headwaters of the Mahoning River are within 25 miles of Lake Erie, the stream flows southeast into the Ohio. Twenty years ago the Mahoning had a world-wide notoriety among geographers as the hottest river in the world. The steel mills were so concentrated along its banks that they warmed its water beyond the point where it was useful as a coolant. New dams and reservoirs have corrected that situation for existing mills, but the possibilities of expansion of industry in the valley are inhibited by the limits of the water supply. To pipe Great Lakes water into the river would be technically simple and fairly cheap. Legally it can't be done.

Akron, on the other hand, lies just inside the edge of the Lake Erie basin. Should its need for water expand, some Akron and Cleveland interests have a plan for a 16-mile pipeline from the Lake through which water could be pumped into the Cuyahoga River at its source. The Cuyahoga flows south to Akron, then north to enter Lake Erie at Cleveland. Such a pipeline would only pose a problem in finance.

The Province of Ontario would like to open up the water-short area around Kitchener and Guelph to industry by piping water out of Lake Huron near Goderich and letting it drain into Lake Erie. The water would never leave the Great Lakes basin. It would, however, bypass Detroit, which needs every inch of depth in the St. Clair River for its harbor. Legally, the project is somewhat doubtful. Ontario might be able to swing a deal in which, as the quid pro quo, streams in the Hudson Bay watershed would be reversed and piped into Lake Superior.

Only circumstances will determine when such pipelines as these will be economically feasible to build and operate. By 1975, however, a network of water pipelines is likely to be growing that may eventually rival in scope the oil pipelines which now trace their way throughout the country.

General attitude expressed by Joe Martin Jr, head of SF PUCommish:

"We don't need the wtr rights we've got, but we've got 'em, so let's find a need for them." Simply do not want to relinquish control, bcs they might figure out some way of doing themselves some good with them. Political bargaining power is his idea. Hold a whip over customer counties -- he's ambivalent, sometimes he talks that way, other times about need for good will, good public relations.

155 Annual Rep't of Fuel
Xctns, I.D.s, p. 12

I.D.s spent \$2.8m on
"Water Purchases" in '55,
under M&O.

Suggests some xfrability
of water. Probly purchases from FK

Total expenses were \$33m

Orientation of study.

+ transferability of water.

Study e.g. of xfr of surplus,
e.g. SF's, achievements &
limitations

Watermaster
John F. Bendon, US D 9 BR
Patterson Bldg, Fresno.

~~Flow~~
Acres served under
Friant:

Water served:

Effects on economy

Isabella Dam.

Kaupke says Kings R. flow
= ~~Stanton~~ Tule River, but serves
4 times as much.

San Joaquin flow about
same, too, says Bendon.

But much Tuolumne goes to
S.F., & K's is mining water.

Madera Canal	150,000 acres
{ F-K	" 449,000 acres

1,700,000 a-f.

Supplemental. Very little new
land.

Write F. I. Bluhm for
copy of '53 report on
I.D.S. under canals.
Good stuff.

1.2 m a-f. is
total inflow to F-K
service area from
sources other than
F-K canal.

Bendom: how much water
is reserved for whom, & how
long? How disposed of
meantime? Rates of dev-mt. Adm.
discretion in rejecting dispaugh e.g.?

Disce. of scale: army travels
no faster than slowest man.

Methods of fin'g FK 7Ds?

Johnson, BR office at
Friant, regulates flow.

Doug Powell suggests

due to higher temp, more
sun, lower humidity.

Farther so, is more expiration, hence
higher need for water; simul, higher
growth potential. See S. W 2

In KR area, ground water is
deep, but is much pump'g. In
Merced etc, shallow but no pump'g.

Shows hi MP water in south.

From Census get pump depths, & value of crops by
rivers

Leg Floods

Hoyt, Wm L.
& Langbein, Walter B

Houk

Irrigation Eng'g

Higbee, Edw., The
Am. Oasis

applied
Leg. Hydrology

Ray K. Linsley Jr. ^{Stanford}
Max A Kohler ^{Prof.}

Joseph Paulhus

Superior to book I have
by him

Linsley & Franzini,

Elements of hydraulic
eng. — equally good

Harlan, Jack R.

Theory & Dynamics of
Grassland Ag.

Graham, Edward H.

Natural Principles
of Land Use

Carl Werner

State Div. of
Water Resources

Bendon recommends

Also, see EBMUP
people.

Cooley Slates Water Hearing

Aimed to Broaden Provisions of Watershed and Flood Legislation

The News and Observer Bureau.
1255 National Press Building.

WASHINGTON, Feb. 4 — Representative Harold D. Cooley, chairman of the House Committee on Agriculture, has scheduled 15 hearings for February 14 and subsequent days on legislation designed to substantially broaden the provisions of the Watershed Protection and Flood Prevention Act.

He said the committee will consider several bills to amend the act to meet the growing need for water and water conservation measures, particularly in the Eastern states.

Changes in the act which would be provided by the proposed amendments include:

1. Substantial broadening of the scope of projects which can be undertaken with federal assistance to include such non-agricultural phases of water conservation as municipal and industrial water supplies, recreation, fish and wildlife improvement, pollution abatement by stream flow regulation, and saline water intrusion control.

2. Provide authority for construction of multi-purpose structures for water storage and control where the storage capacity in excess of 5,000 feet is for purposes other than flood prevention and is paid for by non-federal agencies.

3. Provide that all the cost of structures for flood prevention be borne by the federal government. (under the act's present formula, this cost is divided between federal and local agencies on the basis of benefits conferred, but since virtually all benefits of flood prevention are national in scope, the necessity for determining local benefits under this formula has proved difficult and delaying.)

4. Authorize loans, at a low rate of interest for periods up to 50 years, to local agencies to help finance the local share of the cost of projects.

Deaths

(Other Deaths on Page Twelve)

MRS. O. H. ELLINGTON.

Mrs. Carrie H. Ellington, 67, of 2710 Everett Avenue, widow of O. H. Ellington, died Saturday at noon at the home of a daughter, Mrs. James Honeycutt of Charlotte. A member of the Forest Hills Baptist Church for 10 years, Mrs. Ellington was a charter member of the Phillips Fidelis Class of the Tabernacle Baptist Church. She is survived by four sons, Oscare Legrand Ellington of Raleigh, W. G. Ellington of Raleigh, Philip H. Ellington of Durham, W. J. Ellington of Miami, Fla; two daughters, Mrs. James Honeycutt of Charlotte and Mrs. A. E. Rackley of Raleigh; 10 grandchildren. Funeral services will be held Monday afternoon at the Forest Hills Baptist Church at an hour to be announced. The Rev. Douglas Aldridge will be in charge, and burial will be in Montlawn.

MRS. LILLIE B. STEGALL

MONROE — Mrs. Lillie Belle Stegall, 80, wife of the late W. T. Stegall of Marshville, died Saturday after two weeks serious illness. Funeral services will be held at 3 p.m. Sunday in Marshville Baptist Church, of which she was a member, by the Rev. R. V. Greer, pastor, assisted by the Rev. J. B. Little of Hartville, S. C., and the Rev. Wade Homes. Burial will be in Marshville city cemetery. Surviving are four sons, R. P., K. S., G. B. and R. C. Stegall of Marshville; three daughters, Mrs. J. E. Griffin of Marshville, Mrs. J. W. Grant of Wingate of and Mrs. James P. Austin of fin, Mrs. J. W. Grant of Wingate Peachland; 31 grandchildren; and 30 great grandchildren. The body will be taken to the church one hour prior to services.

ROBERT E. WARD.

DURHAM — Robert Edward Ward, 84, of Rose Hill died at the home of his daughter, Mrs. F. R. Dodson of Durham, Friday night following a brief illness. He was taken ill while visiting

Wed.

Often individ. farms can irrig. alone. Where job easy, river goes by door.
No storage needed. Or, in W. Texas c. Lubbock, & SJ valley, & SC, pump.

- there, have underground storage.

Over $\frac{1}{2}$ irrig. acreage by individ. farms

Where problems tougher, need org. Has come, local level,
long before B.R.

1. Sell to neighbor. Hawkins ditch. P.U.

2. Commercial

Early failures. Bear R. Now few. Farms prefer
co. they control

3. Coops. - 28% of all irrig. land.

Small projects, joint project, guaranteed mkt.

Early created from top, by subdividers. Had to buy in
to get any water, hence no problem of blank spots

Where most costs are variable, is good - also where
water valuable, needs rationing. - SC. Small stock assessments,
(rarely, large - Clark Colony)

Poor for projects w. hi fixed cost, low variable cost, abundant
basic water rights, large area, alternatives to irrig., spec.s.

Hard to raise M.

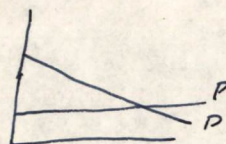
Underpaid mgrs, lax mgmt. group - too small, can't
join due to water rts, etc.

4. Districts.

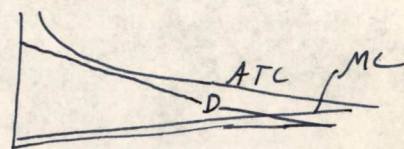
Most advanced form - ~~person~~ at first we just skim cream.
Then sharpen pencils ... & usually find undreamed of potentials

- Bonding
- Tax
- Minority joins

a. Collect cons. surplus



Expand idea. Hi FC, hence decr. costs



Early days esp., save cost of insig water. Give free.
Free water to users, small farms. Specs pay, until stop specig.

b. Consolidate settlement, thus lower ATC more.

Allowed to
exempt
improvements.
over

This is justification for enforced inclusion.
Early exempt improvements. Thus specs & oversized pay, subdivide. In
accord w last time's principle, equalize cost of hold's land. LA LA
Make it cheaper for immigrants. Extend credit to them.

c. Borrow easier (esp. w tax exemption & R FC)

Lands, 1st lien on. Bond together, solve credit problem -
like Danish farms

d. Collect for 2dary benefits - include cities. Perhaps vast
extended benefits, much greater than original direct benefits. New
factory, make a new area habitable, new l.v. As pop. Δ s, things become
ec. previously not so - whole new
society, (L.A.)

e. Mobilize water

Deliver to ea. 30 acres, e.g. Finance system.

Merced, Owens Valley

Get much more intensive land use, than if no irrg nec. Bes
less margin for spec. Hi type of rural civilization. Also back
than hist.

f. Provide non-salable benefits. - & collect for them.

E.g. groundwater recharge.

Water cons. districts - ... 2 Sta Clara - cities in.

all I.D.s raise groundwater - & can tax for that benefit, even to those who take no water. Consolid. ID.

B.R. issue. *Saylor v. Gray*.

Districts imp'tnt for other things, too. - schools, power, - some reasoning.

MWC often act like districts: free water, assess per acre. Natoma, Clark Col.

g. Super districts.

MWD SC.

Limited flexibility. - constituent towns can get away from legalism, sell surplus water temporarily.

Same basic principle as ID: cheap water & power.

h. ~~HA~~ Fed. projects.

CVP.

Rapid dev't of lands w-in ~~project~~ I.D.s. But few IDs buy'g from them. Slow overall dev't. Lacks tax power on included lands.

Australian squatters bid in
choic water, being 'freely accom. by
banks' s 398

Minor cause of idle land that IUT would cure:
suckers buy into MWC subdivision w/o water shares
discover they can't use land as is, haggle around
for shares a few years. & perhaps will never get water
for that land. If it were IUT land, couldn't make
suckers, no cap. values to deal in.

Hearing Set On East Bay Water Plight

The East Bay's increasingly acute water problem will be discussed at a public hearing tentatively set for November 7, it was announced yesterday by the Alameda county Board of Supervisors.

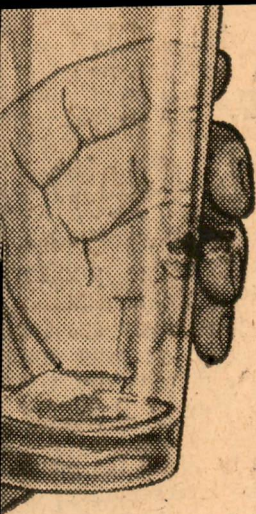
Invited to attend the meeting will be representatives of existing water system in the county, home and industrial builders, large water users and the Alameda County Land Development Committee.

Board spokesmen said an attempt will be made to chart a course of action guaranteeing adequate water supplies for the county in the face of anticipated urban development.

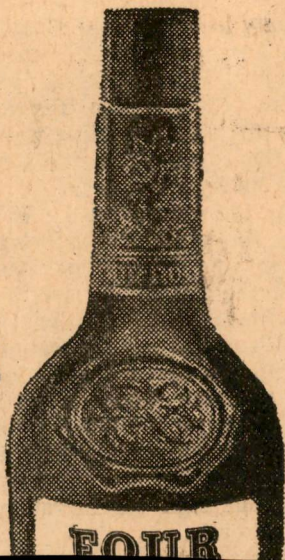
Water supplies already are so short in many parts of the county that Herbert G. Crowle, engineer of the Alameda County Flood Control and Water Conservation District, has proposed importing water to the county from the Central Valley Project.

At the same time the East Bay Municipal Utility District is seeking to obtain water from the Mokelumne river.

Crowle said wells in the southern and eastern sections of the county are being depleted and there is little chance to replenish them. In some areas, he said, wells already contain salt water seepage and high concentrations of minerals.



People are surprised to discover it
only pennies more to enjoy the
make it **FOUR ROSES** tonight—
or at your favorite bar.



Rod Hill

Folsom unit

c. 125,000 a. irrigable land
50,000 now irrigated.

Class 2 & 3 land, mostly 3 - irrigated pasture, shallow soil.

Repayment cap. = ^{direct} benefits - (farm. liv'g allowance + cap. acc.
allowance)

✱ Cost of labor not ~~counted~~ deducted from ben.
Int. on l.v. deducted from ben.

File, water article → Higher class land has lower ~~payment~~ water requirement,
but higher payment capacity. Rice, poor land.

Carey Act Grants:

B1 (settlement plans are doomed to financial failure, since you can get more from land by selling it in other ways, to big speculators &/or big farmers esp., & to suckers)(after all, the number of those with a small cap. & desire to set up a family farm is much more limited)

B1 ~ Gives very brief description, no analysis of why settlement was slow. Except to state, w/o drawing conclusions from it, that settler didn't get title until he had settled & improved -- & from this I infer it was hard for settlers to get credit, too -- esp. as they had to buy water stock first -- there is the thing -- if they had simply agreed to pay an annual charge that would be one thing, but in fact they had to buy all the stock at first in effect -- as I recall from other sources.

Other interesting topics covered, but no penetrating analysis

\$93,637,000 Development

East Bay Water System Expansion Outlined

SACRAMENTO, Oct. 22 (UP)—Plans for an ultimate \$93,637,000 development of Mokelumne river water supplies were outlined today by R. C. Kennedy, chief engineer for the East Bay Municipal Utility District.

Kennedy said it was the intention of the district to construct the project in stages. He said the first step would be construction by 1962 of a third aqueduct to keep water supplies in step with growing East Bay needs.

The engineer estimated the cost of the proposed 423,000-foot 88-inch aqueduct at \$43,000,000. It would complement the two ducts in which water is already carried from the Mokelumne to the East Bay.

Kennedy said an early decision on the district's application to divert an additional 125,000,000 gallons a day from the river was necessary to determine the exact capacity of the duct.

"It is urgent that we get the water in time to prevent a possible shortage," Kennedy said. "Consumption is increasing faster than expected."

Kennedy said the two ducts now handle a total of 156,000,-

000 gallons a day. He said the third duct would take the additional 44,000,000 gallons to which the district is currently entitled plus the additional 125,000,000 gallons requested.

Contract Extended Allocating Nevada Power From CVP

SACRAMENTO, Oct. 22 (UP)—The U. S. Bureau of Reclamation announced today it was extending a contract allocating 33,000 kilowatts of California Central Valley project power to Nevada.

Although Nevada has held the contract for some time it has been unable to get delivery of the power. No Federal Government transmission lines exist between Nevada and California, where the power is being generated.

Private California power companies, Pacific Gas & Electric Co. and Southern California Edison, have declined to use their lines to "wheel" the power to Nevada.

Extension of the contract gives Nevada until next June 1 to make arrangements to get the power to its residents.

Show Opens Friday

Cow Palace Is Readied For the Grand National

Workmen were busy at the Cow Palace yesterday, getting the huge auditorium ready for the opening Friday night of the 11th annual Grand National Livestock Exposition, Horse Show and Championship Rodeo.

The 10-day show is expected to draw more than 150,000 to the Cow Palace on Geneva avenue.

Top feature in this year's show will be the "Riders of the Andes," a crack outfit of the Chilean mounted military police, led by Lieutenant Enrique Arias. Captain William Heyer will also be back with his famed dancing horse, Starless Night, for the first time in five years.

As the country's last big rodeo of the year, the Cow Palace rodeo is expected to determine national champion-

ships. Some 200 top cowhands will compete for the \$35,000 in prizes. There will also be some 2600 livestock entries, with \$88,235 awaiting owners of the best animals.

Inter-County AA To Celebrate 20th Anniversary

The San Francisco Inter-County Fellowship of Alcoholics Anonymous will celebrate its international organization's 20th anniversary Saturday night.

That will be the occasion of the group's first annual dinner meeting, dance and entertainment, at the Whitcomb Hotel.

The group embraces 64 unites in Marin and San Mateo counties and in San Francisco.

SHOP MACY'S SAN FRANCISCO MONDAY 9:30

Macy's

Berylwood Inv. Co. holds some land idle so
they can have the water rights.

Institutions for Land and Water Development

I. Introduction

A. Definition of institutions

Metaphorically, institutions are the channels or limits within which human beings act as free agents. More particularly, they are the laws which regulate human association and also the organizations of humans which grow up under those laws.

B. Purpose in studying institutions

1. To know the framework within which human beings are free agents, and hence within which those economic laws which postulate mobility can operate.
2. To determine which institutions best serve ultimate social objectives. We all have somewhat different ultimate social objectives, but each of us, whatever his viewpoint, can evaluate these institutions as it helps accomplish what he thinks is important.

II. Institutions

A. Water Law

The law fails to approach the economic ideal. Water is often more difficult to transfer legally than physically, and is not allocated to its most socially lucrative uses. Riparian law allows people to prevent others from using water they are not using themselves. Appropriative law, intended to remedy this abuse, encourages people to claim more water than they use, and to use more than they need.

Within each of the subgovernmental organizations (discussed in "B" below) water is allocated among the members on a more economic basis. But among these organizations, water allocation is subject to Riparian and Appropriative law.

1. Riparian law guarantees each riparian owner that the original stream flow, undiminished and unpolluted, will always pass by his property, regardless of whether he uses the water or not. This right is subject to the equal rights of other riparian owners. Rights of various riparians may be prorated among them by a court, to allow consumptive use of water. The riparian right is in proportion to the smallest single unsubdivided ownership that has ever existed, so that an owner may lose his water right by subdividing. This institution discourages water use and land settlement.

The power of riparian owners has been hardly reduced by recent court decisions, and it still requires a large legal investment to get a decision in one's favor.

2. Appropriative law grants ownership of water to him who diverts it and puts it to beneficial use. It was originally conceived as a "right of use," and was introduced to remedy the abuses of riparian institutions. The right was established by use and was supposed to be lost by nonuse (but rarely is so lost). Since 1913, all unused unclaimed waters have been state property, and it is necessary to file with the state to appropriate them.

Appropriative rights take priority in the chronological order they were established. In dry years, "junior" appropriators get no water at all, "senior" appropriators get their usual quota (except under the Mormon system of fractional water rights).

The appropriative system causes individuals to claim more water than they need, as there is no penalty for trying to take too much, and claim it sooner than they need it, to gain priority. It encourages aggressive litigation by anyone whose water rights might be threatened by a new diversion, since 5 years of "adverse use" establish the appropriative "prescriptive right." An appropriator does not know until he actually begins diverting water, that is, after he has laid out capital, that he may be enjoined from diverting and engaged in an expensive lawsuit by someone whose interests are threatened.

3. Both riparian and appropriative rights are very difficult to transfer, and utterly impossible to transfer in small and ever-changing quantities, such as would be required for economic allocation of water.

B. Local organizations for diverting and storing water and distributing it among individual farmers and financing these projects

1. Individual. Where individual's land is adjacent to or overlies water, and irrigation works are of small optimum size.
2. Individual who sells to neighbors. This rather natural evolutionary form is sharply discouraged because seller liable to be declared a public utility, required to continue serving water at regulated prices.
3. Individual who sells water to tenants or settlers on his subdivision (for example, Shoreland Properties, Pescadero; Hawkins Ditch, Hollister; Kern County Land Company; American Crystal Sugar Company, Oxnard). Seller not inhibited by being made a public utility, as he is paid for this through land rents or sales price.
4. The Mutual or Cooperative Water Company. An evolution of form 3. The development company which subdivides a ranch for irrigated farming builds the works, and forms the Mutual and turns it over to the settlers. (In Utah, they often developed as part of the Mormon plan of cooperative settlement) So far as I know, they rarely develop on the spontaneous initiative of people already settled, as the settlement is not usually possible without the water company.

Most Mutual Water Companies are in southern California and in Utah.

5. Commercial water companies. These are simply private enterprises which undertake to deliver water to farmers in certain areas. They are regulated as public utilities. Generally, they have proved financial failures, because the value they created in the lands they served could not be used to help finance them, and because they had no means of speeding land settlement. A few persist (North Fork Ditch Company, east of Sacramento; Clear Lake Water Company, west of Woodland).
6. Districts (Irrigation, Reclamation, Water, Water Conservation, Drainage, etc.)

Quasi-governmental agencies, empowered to issue bonds and levy taxes on the included land (improvements are usually exempted). Because of this bonding and taxing power, this form of organization has been used where very expensive projects are necessary. Irrigation districts have usually been formed by settlers who had previously been getting water by other means. Irrigation districts are characteristic of the Central Valley; reclamation districts of the delta; water conservation districts of unified basins with a common ground water supply, like both the Santa Clara valleys.

Districts also serve to force recalcitrant landowners to contribute financially to projects which they will not join voluntarily. District taxes have also often forced large landowners to subdivide and sell their land to settlers, speeding up the development of the project. As the landowners had to pay taxes on their land regardless of use, slow settlement did not doom projects to failure anyway.

Districts' tax power captures some of the extended benefits of projects to help finance them. Urban areas within districts are subject to their taxes. (San Jose, Fresno, Modesto, Tracy, and Merced are examples.)

Unlike other water user's organizations, irrigation districts can sell or lease water over their boundaries temporarily, without vesting any right in the buyer. This improves water allocation.

7. Federal Projects

Generally, federal projects have been turned over to the users, organized in irrigation districts under state law. This procedure will probably be followed with the Columbia Basin and Central Valley projects; although the Bureau of Reclamation may continue to operate the dams and interdistrict works, the distribution systems will be built by irrigation districts, and payments to the federal government will be made through irrigation districts. Thus, in federal projects the institutions important for land settlement are still irrigation districts.

Federal projects open vast new possibilities for a system of economic allocation of water. The Bureau of Reclamation is fighting to avoid vesting permanent water rights in particular districts. The Bureau visualizes a vast interconnected system to distribute water to where it is most valuable, without giving permanent rights to any locality, in the Central Valley.

Federal projects also entail the famous 160-acre limitation. This law has teeth. Water from federally subsidized projects is not to be delivered to more than 160 acres (320 acres for man and wife) under any single ownership. The owner must be a bona fide resident on the land. At the discretion of the Secretary of the Interior, the size limit may be reduced. Land in excess of 160 acres cannot be sold for more than its value before the project. Excess land may be taxed by districts in which located, even though it receives no water. Thus, large owners and absentees are virtually forced to subdivide and sell for a low price.

III. Irrigation Institutions and the Subsidy Question

All the institutions above except the commercial public utilities collect "subsidies" to help finance them. Irrigation water is subject to sharply diminishing returns. It cannot be sold for more than the value of the marginal units. The inframarginal values accrue to the lands served. Commercial companies cannot touch these increased rents, although they create them. But land development companies receive them when they sell the land. Mutual water companies can collect them through stock assessments. Districts can tax them. This sort of "subsidy" is economically rational, and should not really be called a subsidy, but a return for services rendered. It is a value created by the irrigating organization that cannot be recaptured through ordinary market mechanisms, a "nonsalable benefit."

IV. Irrigation Institutions and the Land Settlement Question

All of them except the commercial public utilities gave some attention to the problem, although none of them gave enough. Most of the commercial utilities built to serve lands they did not own and were ruined by slow settlement. Sometimes large landowners deliberately retarded settlement to break the water company, so they could buy it cheap.

Land development companies, whether they subsequently evolved into private utilities, mutual water companies, or irrigation districts, had some control over land settlement because they owned the land from the start. Some, like the Holland Land Company near Clarksburg, used this control to good advantage. They did not simply sell to the highest bidder (who might have been an absentee speculator); they "picked their settler and backed him to the limit." Others, like the Mutuals of Southern California, were not in a position to be much injured by slow settlement: their revenues were from water, and water was so valuable they could sell it all for a good price even before settlement was completed. Others, like the Canadian Pacific Railway, sold to speculators from Nome to Delhi, and found serious difficulties in settlement and finance.

Irrigation districts have what I consider the most effective means of speeding settlement. Their power to bond themselves and tax land constitutes a means of extending credit to settlers at lower rates and for longer terms than is possible in private lending. To visualize this, contrast a bonded irrigation district with a comparable project in which the irrigation works were all installed and paid for. In the paid up project, the anticipated future yields of the land would be capitalized into its present selling price, and the settler would have to buy all that on his own credit or financial resources. In the bonded district, the district has already done that borrowing on its own credit, at $4\frac{1}{2}$ or 5 per cent. The interest and amortization payments are made by the settlers in the form of land taxes extending over 30-40 years. These anticipated taxes are, of course, capitalized into the original selling price of the land, so the credit to the settler is given in the form of a low land price.

This credit does not solve all the settler's credit needs, of course. It is the credit by which he buys the irrigation system (which he must inevitably buy in one way or another). Without the irrigation district bonding and taxing system, he buys it in the form of high land prices; with that system he buys the irrigation works by paying taxes for many years. Furthermore, his ability to borrow to meet other needs is somewhat enhanced because he has not had to exhaust his personal credit and financial resources to buy high-priced land.

New irrigation districts usually provided water free, and taxed on land value, not improvement value. Settlers who used water and improved their farms paid no more than absentee owners and speculators. This hastened settlement and development. The remarkable development of the famous Turlock and Modesto districts occurred under this institution.

Irrigation districts can construct distribution systems (often through subsidiary local improvement districts) which bring water to every few acres at district expense. Thus, this institution is well suited to creating a cooperative community of small family farms, in areas where costly irrigation works are necessary.

V. Conclusion

The most useful irrigation institution is, in my opinion, the district. However, what is really socially useful is not the name "irrigation district," but the functions I have associated with that name. Some mutual water companies, such as the Clark Colony MWC at Greenfield, the Natomas MWC north of Sacramento, and the Senior Canyon MWC of Ojai, function more like districts, and some districts serve no function at all. Such districts as the south San Joaquin, east Contra Costa, Modesto, Turlock, Fresno, Consolidated, Alta. (in which Dinuba of Goldschmitt's study is located), and others represent the irrigation district at its best. We have much to learn from these outstanding examples of land settlement and water use.

S W 15, p. 10

"What about the statement that "all the people" have rights to Kings River Water? That statement is demagogic nonsense. "All the people" certainly have a right to demand that Kings River water shall be put to the most beneficial and economical use. It is being put to such use now, as the laws of California require. . . . "

Thus Kaupke admits that only maximum use justifies private property, and it is not an end in itself.

$$1 \text{ acre} = 43,560 \text{ sq. ft.}; \quad \sqrt{43,560} = 209 \text{ ft.}$$

$$(1 \text{ acre} = 160 \text{ sq. rods})$$

$$1 \text{ acre} = \frac{1}{640} \text{ sq. mile}$$

$$1 \text{ mile} = 5,280 \text{ ft.}$$

$$5,280^2 = 27,818,400 \text{ sq. ft., or one section.}$$

$$\frac{27,818,400}{640} = 43,575 \text{ --- (close, anyway) one acre}$$

$$1 \text{ acre-foot} = 43,560 \text{ cu. ft.} = 325,853. \text{ gals.}$$

$$1 \text{ gal} = 231 \text{ cu. in.} = \frac{231}{1728} \text{ cu. ft.} = .133 \text{ cu. ft.}$$

$$\text{or c. } 7\frac{1}{2} \text{ gals} = 1 \text{ cuft.}$$

$$10,000 \text{ cfs} = \text{c. } \frac{1}{4} \text{ a.f.-s.} \left(\frac{1,000}{4,356} = .229 \right) = 7.25 \text{ m. a.f. yr}$$

$$\text{How many sec/yr? } 60 \times 60 \times 24 \times 365$$

$$\begin{array}{r} 144 \\ 12 \\ \hline 288 \\ 144 \\ \hline 1728 \end{array}$$

$$\begin{array}{r} 43575. \\ 64 \overline{) 2783840.} \\ \underline{256} \\ 228 \\ \underline{192} \\ 368 \\ \underline{320} \\ 484 \\ \underline{448} \\ 360 \end{array}$$

$$\begin{array}{r} 229 \\ 4,356 \overline{) 1000.0} \\ \underline{8712} \\ 12880 \\ \underline{8712} \\ 41680 \end{array}$$

$$\begin{array}{r} 231 \overline{) 1728.} \\ \underline{1617} \\ 1110 \end{array}$$

$$\begin{array}{r} 1728 \overline{) 231.0} \\ \underline{1728} \\ 5820 \\ \underline{5184} \\ 6360 \\ \underline{6360} \\ 21,878,400 \end{array}$$

$$\begin{array}{r} 365 \\ 86400 \\ \hline 146000 \\ 2170 \\ \hline 2920 \\ 31,536,000 \\ \hline .23 \\ 94608000 \\ \hline 63072 \\ 72,532,800 \end{array}$$

$$\begin{array}{r} 21 \\ 21 \\ \hline 21 \\ 42 \\ \hline 441 \end{array}$$

$$\begin{array}{r} 208 \\ 208 \\ \hline 1664 \\ 4160 \\ \hline 43264 \end{array}$$

$$\begin{array}{r} 269 \\ 209 \\ \hline 1881 \\ 4180 \\ \hline 43681 \end{array}$$

On Census tour? encountered manyzanjeros. Maybe write them for technique.

G. W. Huhn, in office of R.D. 999, Clarksburg (Holland Land Co.) good fellow.

McKinnon, Sta. Barb. Water Works

Harris - write Alfredo where is?

Mr. Sillsbee, eng. for RD 1,000, (Natomas Co.) Forum Bldg, 6th & K,
extraord-ly agreeable Santa.

Palo Alto, --?

Almaden Water Co., commercial, serves small farms.

Clark Colony, Greenfield. Mr. Courtney, Mgr.

Pleasant Valley Water Co., Mr. Mulloy

Mound Water Co., Mr. Eaton

Montalvo Mutual W.C., Chas. Barnes

Check papers, Ventura etc, re water conservation. Write Jamison of Ventura Water Survey, for lit. on outcome of Conkling plan, etc.

Guy M. Turner, acctnt, Camarillo.

Joe Schreiber, Tapo MWC (Sta. Susana?)

Mr & Mrs Johnson, Kadota MWC, Sta. Sus.

Mr. Hess, Simi

Mr. Shaw, La Placentia MWC

Mr. Duncan, Simi Valley MWC

Mr. Robertson, Simi Valley Ranch

Mr. Lytle, Berylwood Inv. Co., Pt. Hueneme

✓ Meikle - ea. farm's ditch takes 15 sec-ft. Mains take 2200,
tho built for less.

Distrib. system inadequate to handle all flow it gets. (So there is
a MC now!)

Mr. Baker, of Turlock Public Lib, ret. USN w 10 acres, "likes to
irrigate". Maybe that's why some use too much. It's fun to
slosh water around.

Further Merced gns:

Suppose on same canal diff. crops, one wants freq. irrig-n,
another infreq. How handle? Send down 2 heads of water

Is cost of metering much? Wd be, probly. Also, if put price on water,
theft becomes problem.

Theft from peripheral pumping?

all developed?

Madera: Theft?

Time between order & delivery

Write Meikle:

1. Why do hi taxpayers not seek payments from hi water users?
2. Why not expand distr., use surplus water. Sell it?
3. Build ~~excess~~ A cap. into system, so fm can have water when he wants. (Note, re MC, shd run, that at peak load pels is a MC, at lows, none. Price shd fluctuate daily)

• Rancho-Ojai MWC
Meiners Oaks City Water Dist.

c. 35 irrig. connections

Changed to WD to band
selves.

Meiners Oaks:

Have rip. right to 231"
more than they ever use or
are prepared to use.

so beautiful? Work checking
on.

Redwood City Water works charges
higher rate to those to whom water must
be pumped - c. 1,000 ft. They can only
do this because these are outside city.
Within city, must charge all the same.

Ed Bailard, of Gobernador Land &
Water Co., says they gross - or net?
net? - \$350/acre from lemons. - on
16" of irrig. water.

November, 19

Contradicting himself.

Kings River Controversy

Straus vs. the Central Valley Farmers

By GEORGE VOIGT

Michael W. Straus is probably the most hated man in the Kings River Area of San Joaquin valley. He is a big, slouching man who heads one of the world's largest water - power - construction organ-

izations—the U. S. Bureau of Reclamation.

Diplomacy and public relations are not among his accomplishments. And this, perhaps, has made him more enemies in the valley than he might otherwise have had.

But the real basis for the enmity is the plan his bureau has for California water development. Actually the bureau's plan was evolved by the farmers of the central valleys almost a century ago and developed decades ago as the State Water Plan.

RESHUFFLE OF WATER

The plan today is known as the Central Valley Project, which proposes a gigantic reshuffling of the State's water supply—bringing the plentiful water of the north of the State's great central basin to the dry south and then exchanging it about in the south as needs demand.

But within the Central Valley Project is the Kings River Area, a well-developed water entity. And the farmers of the area want no part of Straus, the Bureau of Reclamation or the Central Valley Project.

The Kings River Area is a water-deficient area: The farmers need more water than is available to them. But they are better off than most farmers in the southern valley. And throughout years of battle with the bureau they have come to distrust the bureau, and particularly Straus, and want to remain outside any plans Straus might have for the Central Valley.

They say Straus is an empire builder who wants to bring their area into the CVP merely to expand his power. They doubt the CVP will do anything for them and they fear they may be deprived of the water they now have and to which they have established legal right over the years.

'HAUGHTY, ARROGANT'

Straus has done little to relieve them of their fears and suspicions. The farmers say this is because he is a haughty, arrogant, power-hungry bureaucrat with no regard for the private interests in conflict with him.

Straus' friends, though, see him as a dedicated man, honestly intent on improving the water-balance, and thereby the productivity and wealth of California, and a man who cannot see any but selfish, short-sighted motives in the opposition to his plans.

On paper, the bureau's plan would work to greater benefit of the State as a whole by providing more water for all areas of the valley.

Full integration and maximum use are terms Straus is fond of in discussing his position. They explain his public reasons for wanting Kings River drawn into the CVP.

EXCESS WATER

In wet years, even the water-deficient areas of the southern valley have an excess of water that is wasted and sometimes inflicts great damage in floods. Some of this excess water can be held behind dams and saved until it is

(The Kings river, one of California's great sources of wealth, has been the object of a monumental fight for decades. The battle engages Federal and State agencies, private corporations and individuals. The fight has delayed the full realization of the water and power wealth of the river and has cost the American taxpayers millions of dollars. This is the third in a series of stories outlining the history of the fight and the issues involved.)

needed, at the same time preventing excessive flood damage. This is what Pine Flat dam on the Kings river is being built for.

The bureau sees the Central Valley Project basically as a vast system of dams interconnected with giant canals that traverse the length and breadth of the valley.

Part of this plan is already completed and in operation: the canal that brings Sacramento river water down into the San Joaquin; Friant dam on the upper San Joaquin and the canals that run north and south from the dam.

Other parts of the overall plan are not even blueprinted yet, like the San Luis canal which is to run down the west side of San Joaquin valley.

The bureau would like to have Kings river and Pine Flat dam linked in this network. The agency feels that CVP has something to offer the Kings River Area and the area has something to offer the CVP in this gigantic plan.

The bureau always has been careful to state it has no intention of touching the water now available to the farmers of the Kings River Area but is interested only in making full use of extra water that will become available through excess storage in Pine Flat.

AN EXAMPLE

Here is how the bureau's full integration of facilities might work:

In any given year, the Kings River Area may have a deficiency of several thousand acre feet of water. In Friant dam at that time there might be a surplus of water. In such a case the Friant surplus could be released down the Friant-Kern canal, already in operation, and spilled into Kings river.

A similar exchange could be worked in reverse by directing excess Kings river water into the San Joaquin through Fresno slough and eventually into the proposed San Luis canal.

This is a greatly over-simplified example but this is what the bureau generally envisions when it speaks of full integration and maximum use.

The Kings River Water Association admits that the bureau's plans sound nice—on paper. But they call it socialistic and question the bureau's competence.

WATERMASTER SPEAKS

Charles L. Kaupke, Kings river watermaster for a quarter of a century, ticks off the reasons why:

"The bureau figures, in its maximum use theories, on having all the water in a river to manipulate through these canals. But you never get all the water. When you run water a hundred miles down a canal you lose a lot of water to evaporation, seepage and other causes.

"With their theories of how much water they should have at any one point, they've already sold a hell of a lot more water out of Friant dam than they'll ever have there.

"Another thing, the bureau talks of planned release of water. You can't plan how much water to run down these canals at any one time to any certain district.

"A farmer seldom knows far in advance when he'll need his water. Weather has a lot to do with when his cotton or grapes need water.

And a week's delay, even 48 hours' delay, can mean the loss of a crop under some conditions.

"Under our water rights and distribution arrangement each farmer knows when it is his turn to take water from the ditch. And he knows that if the water's too low at that time for him to get all he needs he's going to have to pump from underground.

"God help him if he was depending on the bureau's planned releases for his full supply and wasn't prepared to pump when he found himself short."

STRAUS ANSWERS

Straus dismisses this argument with a single word: "Nonsense."

"If we can show them that we can give them a better water supply and assure them that we will release the water as they need it, by their own calculation, what more do they want?"

Bill Elliott, KRWA's public relations head, has the ready answer: "We want the bureau to keep its hands off our water. We've gotten along well handling our own supply. We've spent over \$70,000,000, pre-inflation dollars, building a distribution system. And these guys in the bureau just don't understand the delicate balance under which the water is administered through this system."

The bureau argues that the real basis for the KRWA's opposition is greed and short-sightedness.

"They just want something for nothing," says Straus, with characteristic bluntness.

"They figure that if the bureau controls Pine Flat dam and other proposed projects on the Kings river, they'll have to pay their fair share of the costs for the irrigation benefits they receive."

POWER DEVELOPMENTS

"And they want to be free to take over power developments on the river to operate for their personal profit."

If the bureau controls the project it will build the power developments itself, directing profits from the sale of power to meeting the overall cost of the project. And if the Kings river is integrated into the CVP, then the power profits would go toward the overall cost of the entire CVP.

With the Army Engineers building Pine Flat dam, the cost allocated to irrigation benefits, which must be paid by the Kings river water users, will be smaller than under the bureau's system of allocating cost. And the Engineers have no interest in further developments for power.

The KRWA's answer to this is that it is prepared now to pay a fair price for the storage space made available at the dam to hold water for irrigation. The farmers will pay cash or time; they just don't want Straus and what they call his fumbling, socialistic planning interfering with their distribution.

FARMERS WATCH

Out in the fields, where the water flows through the rich land to produce the area's half-billion-dollar annual crop, the farmers who own the water rights watch this fight between their representatives and the Government with interest.

But the bitterness so evident in Fresno and Washington is not present in the fields. The arguments are not so bitter, nor so sharply defined.

Though Straus personally has few friends among the farmers, the bureau is not without grass-roots support in the fight.

The position of the farmers themselves will be discussed tomorrow.

Folsom Gives Blood

Special to The Chronicle

FOLSOM PRISON, Nov. 12 — More than 500 Folsom Prison inmates and employees volunteered to donate blood today but the Sacramento Mobile Blood Bank ran short of storage bottles after receiving 323 pints.

Medal Story Denied

White House Says Marine Hero's Father Is Mistaken in Implication

Exclusive to The Chronicle From the New York Herald Tribune

KEY WEST, Fla., Nov. 12—The White House today denied a retired Army captain's implication that because he had criticized President Truman politically his son, killed in Korea, had been refused posthumous award of the Medal of Honor.

Eugene R. Guild of Glenwood Springs, Colo., publicly announced yesterday he had written to the President asking if "political tampering" had blocked the award to his son, the late Lieutenant John Guild, a Marine, suggesting a reprisal for criticism of the President for "battlefield appeasement" in Korea.

He said his son and another Marine, Lieutenant Henry Commiskey, were side-by-side when wounded in the Korean fighting. Commiskey survived and was awarded the Medal of Honor. Guild died. A Navy Cross was awarded him posthumously.

Joseph Short, White House press secretary, told reporters here today:

"I just want to say one thing, and that is that the President holds the Medal of Honor to be so sacred that he would not tolerate anyone tampering with the procedures that are set up for giving this medal.

"You have heard the President say many times that he would rather have the Medal of Honor than be President. He meant what he said."

The President, Short pointed out, does not select candidates for the Medal of Honor. Recommendations for the award originate on the battlefield and come up to the Defense Department through a series of decorations boards.

As for any possible significance of Guild's political criticism, Short said, neither the President nor his staff had ever heard of Guild until his letter hit the front pages of the Nation's press today.

A reporter asked Short whether he thought Guild's pronouncement was a case of "using a son's body for political purposes."

"I am sure," he said, "that many fathers and mothers are deeply distressed by the loss of their sons in battle," Short said.

In Washington, Secretary of the Navy Dan Kimball late today issued a statement saying there was "no basis in fact" for Capt. Guild's inferences.

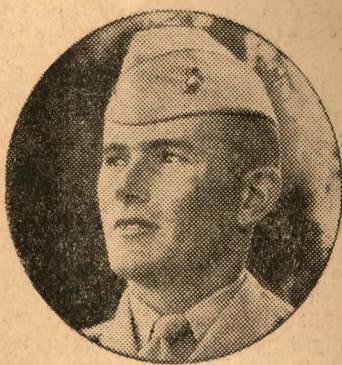
Kimball said both Commiskey and Guild initially had been recommended for the Navy Cross. Later, he said, the awards board at the headquarters of Vice Admiral Charles Turner Joy, Commander of Naval Forces in the Far East, had recommended that Lieutenant Commiskey be recommended for the Medal of Honor instead and that this move had been approved all the way up through the chain of command to and including the President.

"At no point in the chain of command was Lieutenant Guild ever recommended for the Medal of Honor," Kimball said.

Appraised of Kimball's and Short's statements, Captain Guild said he was "glad to hear from as many people as possible that there was nothing untoward in the awards" and that his suspicions apparently had not been justified. He added, though, "there must be an iron curtain against information going in or coming from the White House."

The captain took issue with the statement by Short that "neither the President nor members of his staff ever heard of him (Captain Guild) until this story broke."

It was this statement, the captain explained, which prompted his "iron curtain" remark and added: "that our point of view is not reaching the President is more serious than this Medal of Honor thing."



LT. JOHN GUILD



GEN. RANDOLPH M. PATE AND CAPT. EUGENE R. GUILD
Last May the captain accepted the Navy Cross for his dead son

Censorship Bias Denied By 8th Army

TOKYO, Nov. 13 (P)—A headquarters spokesman today (Tuesday) denied British accusations that Eighth Army censors in Korea are giving preferential treatment to American news.

ROBERT S. ATKINS

announcing our appointment as exclusive men's shop agents for neckwear

His Majesty
INC.
"THE AMERICAN MAN"

America's most distinguished ties—each an exclusive masterpiece of design and color

SHOWN HERE:
Royal Keys, 12.50
We Three, 8.50
Father Time, 7.50

Learn to DANCE



125,000,000 Gallons a Day Wanted

East Bay Asks Mokelumne River Water

The East Bay Municipal Utility District has filed application for water rights to an additional 125,000,000 gallons a day from Mokelumne river, Louis J. Breuner, district president, announced yesterday.

He said the project to add the new supply to the 200,000,000 gallons a day now available will require the construction of three new dams, the addition of spillway gates at Pardee Dam and the building of a third 93-mile aqueduct from the Mokelumne to the East

project is a long-range one, and to take many years. No

Breuner said completion of the project will give the East Bay a water supply adequate for 2,600,000 persons. The Utility District now serves about 950,000 persons.

Breuner explained that the District is "looking ahead 30 or 40 years" in making the application at this time. He said the application is the "culmination of an eight year planning survey by the district of the potential growth and water requirements of the East Bay area."

One of the new dams will be located about 11 miles below the Pardee Dam, near the town of Camanche. A second dam will be constructed at Middle Bar above

Pardee Reservoir and a third on the south fork of the Mokelumne in a narrow canyon near Railroad Flat.

The District already has adequate right-of-way for a third aqueduct into the East Bay area.

Breuner said no accurate estimates of the total costs of the project could be made now, but said he assumed it would exceed the \$61,000,000 combined cost of the original project and the two aqueducts.

Interesting news for small manufacturers! Read "Action Ads" class 161: Entrance 2nd floor, 65'x60'. Excl. light, good parking, elevator, loading platforms, storage space.

Ass
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35-D

Lloyd
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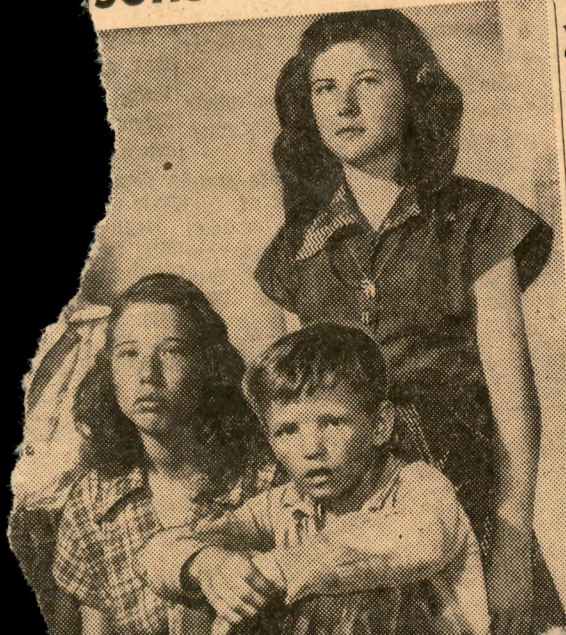
rest. Dykhuis

window. The de

minor cuts.

shop Monday 9:30 a.m. to 9 p.m.

ow With Two sons---at 14



1 Dies, 4 Hurt In Bayshore 3-Car Crash

An 80-year-old Texas attorney was fatally injured in a three-car collision at Bayshore boulevard and Silver avenue last night. His wife was critically hurt in the accident.

Hugh Cooper of Amarillo, who was pinned beneath one of the automobiles, died just before midnight at Mission Emergency Hospital. His wife, Bess, 78, was hospitalized with possible head injuries.

Cooper was the City's 35th traffic fatality of the year, compared with 38 at this time in 1951.

The Coopers were back seat passengers in a car driven by Thomas Morris, 43, an investment banker at 233 Edith avenue, Los Altos. Morris in the front seat was his wife, Dorene, 39, who is his niece.

Morris

on B

"S

S

Cities Are Cool To Sales Tax Hike To Aid Counties

FRESNO, June 14 (AP)—A proposal to increase the 3 per cent sales tax to give the counties a share of the proceeds met a cool reception from mayors and councilmen here yesterday at the closing session of a League of California Cities institute.

The majority opinion was in opposition to giving the counties any more taxes derived largely from city residents.

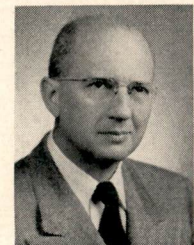
While no formal action taken, Richard Graves, the executive director of the league, said the question probably will be decided by the state legislature.

Test Run on Sacramento River Water Next Year

Hope Plan Will Avoid Suits

By John M. Luther

DISTRIBUTION of Sacramento River water through a trial program is to be put into effect next year with the objective of ultimately composing the water problems in the Sacramento Valley arising out of Shasta Dam operations. The plan is described by **Ed Ainsworth**, writer for the "Los Angeles Times," as "the 'biggest test run of water in the history of the country.'"



JOHN M. LUTHER

It is based on a proposal of the State Engineer to the United States Bureau of Reclamation following a request by the latter agency that the State Engineer assume greater responsibility for settling water rights problems of the Sacramento River and of forestalling controversies and costly litigation over water rights.

Strong Support

Water users representing some ninety per cent of the water diverted above Sacramento, acting through the Sacramento Valley Water Users Committee of the Flood Control Association, have agreed to support the proposal and have instructed their representatives to cooperate with the State Engineer and his staff to this end.

The current proposal was presented to members of the Water Users Committee of the Association early in October and follows closely procedures which have been applied successfully by the State Engineer in other parts of the State in settling surface water problems.

Diversion Estimates Sought

Prior to the start of the 1954 sea-

son, representatives of the State Engineer's office and of the Water Users Committee will confer with all major water users, requesting from each a statement of monthly water diversion requirements. Such requirements will be based on reasonable and beneficial use. The estimates of the major users, together with allowances for requirements of minor diverters, will be combined to compute a monthly diversion schedule.

The State Engineer will confer with the Bureau of Reclamation, requesting that agency to estimate its Project requirements for the 1954 season. Conferences will be arranged between representatives of water users and the Bureau to establish procedures to be followed under the trial distribution plan. It will also be recommended that no charge be made for stored water (if any) used in the Sacramento Valley during 1954.

Continuing Program

Monthly records and computations to be made by the State Engineer's staff during the 1954 season covering the amounts of water used by both the Bureau of Reclamation and by the major water users will be compared on a current basis with the estimated diversions made at the beginning of the irrigation season.

Through these comparisons, information will be obtained during the first trial year on which diversion requirements for subsequent years can be based. When sufficient experience is gained, a permanent diversion schedule can be negotiated.

Benefits

Under this plan it is believed that water users will benefit by having a firm supply of water considerably greater than that available from the unregulated flow of the river, at reasonable cost.

The Bureau of Reclamation will benefit by having advance knowledge of water users' requirements, enabling the Bureau to determine the amounts of water available for other project purposes.

All Rights Protected

Before commencement of the trial period, principles designed to protect all existing rights both above and below Sacramento will be established and agreed upon with the Bureau of Reclamation. During the trial period, studies of water rights and diversions will be continued by the agencies concerned, and negotiations will be undertaken with Delta landowners to develop a similar plan applicable to the requirements of that area.

The plan contemplates adjustment of diversion schedules, as justified and required, as the season progresses. It is expected that, on the basis of the experience gained during the 1954 season, diversion schedules can be developed for succeeding sea-

sons, resulting in establishment of a workable program acceptable to all parties concerned.

Plan Logical Procedure

Since July, 1952, diversions of water from the Sacramento River and their effect on regulated and unregulated flows have been under intensive study by the State Engineer's staff and the water users. The Bureau of Reclamation has made studies of riparian, appropriative and prescriptive rights above Sacramento, which studies are still in process.

The foregoing work, together with the current proposal for a trial distribution resulted from the Memorandum of Understanding entered into by the three agencies July 7, last year.

Objectives of the Memorandum were to work out an equitable division of the waters available from the Sacramento River with a view of apportioning the water of the river in an equitable manner so that the Central Valley Project can function in the manner intended without injury to the water users, thus avoiding protracted and costly litigation.

WESTERN WATER NEWS

Published Monthly by the
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of the Irrigation Districts
Association of California.

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one in this country in developing power, and in many instances we feel that local people can do the job better and faster. If we ship . . . It is my belief that the Federal government should implicitly recognize water rights and the water laws of the states in to usurp those rights."—Douglas McKay, Secretary of the Interior, at San Jose, November 5, 1953.

WESTERN WATER NEWS



FORMERLY "CALIFORNIA WATER NEWS"

SAN FRANCISCO, CALIFORNIA, NOVEMBER-DECEMBER, 1953

50

No. 11

CALIFORNIA'S FUTURE TIED TO WATER

Speaking before the IDA convention at Palm Springs, State Controller Robert C. Kirkwood expressed the opinion that "the whole future of California is wrapped up in the solution of our water problems" and that "we are getting behind" in their solu-

Holiday Greetings

to friends of the

"WATER NEWS"



from



the Officers and Staff of the Irrigation Districts Association of California and the Water Economics Committee.

fresh water in the Sacramento Delta the key to the problem, he told the convention: "We must be planning for the years ahead and not for just the immediate future," and said that there was strong hope that the State of California could develop some of the projects for ultimate use of the waters of the State.

Leaves For Washington

Kirkwood left immediately after the convention to go to Washington for the conference between members of the Authority and representatives of the Department of the Interior, Department of Defense and the Bureau of the Budget relative to the CVP transfer.

Pointed to Water Board

Rich has followed the development of the water code and the legal aspects of the flood control and water development program in California for some forty-four years.

His vast experience and keen mind will make him a valuable member of the Water Resources Board. Rich, who retired as Senator in 1950, takes the place of Royal Miller of Sacramento, who resigned from the Board because of ill health.

BOARD MEMBERS

Members of the Board are: CHAS. GRIFFITH, Azusa, chairman; HOWARD F. COZZENS, Salinas; B. A. ETCHEVERRY, Berkeley; R. V. MEKLE, Turlock; PHIL D. SWING, San Diego; and CLAIR A. HILL, Redding. A. D. EDMONSTON, State Engineer, is secretary and engineer of the Board, and SAM R. LEEDOM is administrative assistant and major-domo.

Critical Water Problems Are Discussed at IDA Meeting

THE 1953 Fall Convention of the Irrigation Districts Association of California, held in Palm Springs this month, drew a registered attendance of 420—by far the largest number of persons ever to attend an IDA conference.

Participants included delegates from 76 districts; a host of engineers, managers and assessors; thirty-one attorneys; State and Federal government officials; and numerous representatives from other farm and civic groups.

Much Work—Keen Interest

In line with the prepared program, the delegates on the various committees and at the general sessions devoted themselves to the serious aspects of the State's present and future water problems with a zeal which fully occupied their time and discouraged any lurking desire to participate in the sunning activities which are to be found at such a meeting place in the desert.

For example, the Underground Water Committee became a small convention in itself, when some 77 interested persons eagerly attended the conference and joined in a lively discussion of proposed underground water legislation.

Resolutions

Five policy resolutions were adopted in the closing session of the three-day meet, dealing with the following matters:

SUPPORT TO ADMINISTRATION: President DWIGHT D. EISENHOWER and Secretary of the Interior DOUGLAS MCKAY were commended for the progressive water and power program which is being inaugurated under their leadership and for their "forthright declarations of policy." The IDA pledged its support to the Administration "in order that the development of the resources of the West may proceed on a sound and practical basis and in an atmosphere of harmony," (Continued on Page 2, Col. 3)

~~Leg. Henry Nash Smith, Virgin Land, Cambridge, '50~~ ~~7591~~ ~~555~~

N1981 Berry, W.I., The Cal Water Plom, Jnl Am WW ass. v. 42 n. 4 '50 p 381

~~MWDSC, Hist. & 1st an. rpt. '59~~

N1991 "Water", Power, Sept. '52 p 72

nigh Elder, C.C., "Det's Future Water Reg.", Jnl Am WW ass, v. 43 n. 2 '51 p 124

Contact R. B. Diemer, Engrngl chief eng, MWDSC

Snider, R. F., v.p., The Conservn Fdtn, NY

? D.s can xfr water accross boundaries w/o vesting permanent right? As says my 'metaphorically' paper.

Other obstacle to xfr: loss of extended ben. in bereft area, unrequited. Owens v. Gripes from cities of origin, & states, refused to release water, hold for vague future possibilities

Get some quote that 2dry ben. "all vague thy; no practice," counter with Owens v. & cities in ? D.s

1913, Cal., unused unclaimed waters become state's, must file w. state to get them.

xfr in small, ever-changing quants nec.

Deadlocks, loggerheads, like Madera.

✓ Re-read S. T. Hardy, Water rts for irrig-n, for stuff on watermasters.
Talk to Hardy.

Costly, protracted Ariz-Cal. squabble.

Store flood waters of SJ? Rips have legal rt to be flooded! — colorful way to put it.

Cannot assure ben. use by requirement of it. Universal failure. Make 'em pay.

No interfere w navig-n.

Water article.

- ✓ Get stream flows from G.S. No of acres served by stream,
value of products, etc, from Census. (Use in showing faults of present
system)
Try to work out actual output from water of to potential by ~~linear~~ ~~programming~~, or other.

Ans for Kaupke, E. G. Brown, etc. BR men

1. Do approp. have em. domain? How gnrly get access to stream?
2. are app rts. gnrly freely xfible?
3. Technique of programming water flows. (conc. on discussion w-in exist'g units, avoid leasing 'em)
4. Water rts. Taxable?
5. Present status q-e contracts, etc.
6. Is CVP water all signed for? Who got in first?
7. Import water, let pumpers pay most tax. Others spread, obviate spread'g grounds. I suffer from not hav'g water just when they want it.

Biggest obstacle of all to
water xfer: impossibility of
agreeing on a price, due to
 Δ l.v. ~~the~~ Selling area could
never split up price among
landowners, & buying area
couldn't organize so as to pay
the full worth of water
by land taxes.

Here is an entering
wedge, too.

3, a.

As watermaster's instructions read now, when flow reaches such & such a rate various people are cut in. Same could be worked out for my system. When the flow is such, cut in all the \$6. bidders. When such more, all the \$5, etc. Just as now they cut in certain people at certain rates of flow

complicating provisions from lawsuits. He has stability - for snrs. But little else.

✓ How about allocating power this way? Now you have firm power or 2d class power, fixed rates. How about letting rates fluctuate, give customer inf. range of choice re what kind of power he gets. (This is shrt run, assumes const. facilities for supply. Not compatible w. present system of rate regulation, which requires const. rate. Is a possibility that opens up when have public power, all the way, integrated control) (Thus is argument pro public power)

✓ ✓ "Rate of flow" can be refined in various ways. Maybe rate per week. But fm doesn't want slow trickle all week, probly, nor all at once either. Is some opt. delivery rate, to convenience him, allow max. saturation, min. labor time. Maybe small storage facilities on ea. fm good. Or one large central storehouse maybe better, big damn? Or maybe inconvenience of programming is less than cost of storage. All individual matters to work out, individ. cases.

**SCANNED
AS
FOUND**

S Brown Clarifies County-of-Origin Water Ruling

Attorney General Edmund G. Brown ruled yesterday that a county claiming the waters within its boundaries doesn't have any right to dams or canals someone else built.

If the county appropriates the water for its own use, it must pay for the use of whatever storage and distribution facilities it needs, Brown said.

The opinion, an elaboration of one handed down earlier this year, was sought by Sonoma county authorities in connection with the Russian River dam project.

The ruling made clear that the county where water originates does not have any rights to physical projects that may exist.

Jeff Donnell, stage-film-television star who portrays Alice, the wife of George Gobel, on the comedian's TV show, will do a little cutting up in Hillsdale down the Peninsula tomorrow.

Miss Donnell, accompanied by her screen-actor husband, Aldo Ray, formerly of Crockett, will cut the ribbon at the ceremony that will officially open Harris & Frank's new Hillsdale store at noon.

The store is located in the Hillsdale Mall adjacent to the west parking lot and west of Macy's Hillsdale. Orchids will be given women visitors.

S. F.-Tiburon Crossing Plans To Be Studied

By Jackson Doyle

SACRAMENTO, Aug. 29
State Highway Engineer

Marquis, RH, Freeman, RM & Heath, Milton S. Jr. "The Movement
for New Water Rts Laws in the Tenn. V. States". 23 Tenn. Law Rev.
197
(Apr. '55)

Low rain has led to move for replac'g rip. w. app. rts.

p. 1-2 So. Car. almost passed app. law, mak'g all unused waters public,
open for filing.

p. 4 To get water, ind-y need only buy rip land. Cite Belts in Fortune,
"ind-y" not worried. (But of course that means big corps)

p. 7 Cite Huffman, p. 71 & Engelbert p. 89-90 of Proceed'gs, '53, re
freez'g water. (Workout simile, ice, frozen as ice, etc)

p. 7 Cite Paley Comm., The Pres's Materials Policy Comm., Mfr produced
50 times more \$ per gal of water than agr. — & ind-y not
consumptive. Resources for Freedom, vol. V, p. 86, ~~90~~, 94.
Strongly recommend shift'g water from ag. to ind-y
chang'g "antiquated priorities system". p. 94

p. 25 Several states have priority by use. Irrig-n usually ahead of mfr, (except in TxS)

p. 26. Ariz, Cal, Ore., cities can acquire excess water, let others use it temp. w/o perm. rt. Also Denver, special Colo Act. TxS, all appn. subject to exp. w/o comp. by any city.

p. 28 Appn. rts orig. freely xfrable, recent trend make appurtenant to land, xfr only by approval of state's adm. agency.

(My article cd go in S-n ex fol, due to active int. there in new water law.) (Orient it so)

Resources for Freedom, 1951, v. II, p. 94: "More & more of future water needs must be solved by recirculation, reclamation & better use of existing supplies. In particular, the West must soon decide whether its future must be sacrificed by its antiquated priorities system in water use."

Marquis, Freeman & Heath, suggest caution in tak'g appn. doctrine as the answer.

Wu.

Says Comm. Chinese
emphasizing new irrig-ⁿ &
water conserv-ⁿ msres.

Ask for source of
info.

King's R. — Facts & Falsehoods.

3
K-s R Water Ass., Fresno, '50.

p. 4 K-s R. "service area" about = its drainage area, 1.1 m. acres.

Now, c. .9 m a. actually "under irrig-n" 35,000 fms. ave. < 30 a.

First diversions late 1850s. First I.D. was Alta, 1887, 2d I.D. formed under Wright Act.

31 I.D.s, MWC, & c. agencies diverting & distrib. K. R. water. c. \$70m in distr. systems. All completely free of debt.

I.D. & MWC cover 95% service area.

Flowall used, except in floods, ave. 12-15 yrs apart. (so?)
1944 Cong. auth. Pine Flats flood control.

p. 5 Ave. annual runoff = 1.7 m a-f. Max. 5.2, min. .3

Ave. am. loss by floods = 10% am. runoff, or .17 m a-f.

1901, 1906, 1916, 1938. { 1950, autumn.
(~~1951~~, when Pete & Bob & Dave & I got stopped)
(p. 4 said no floods came oftener than once in 10 yrs)

Most yrs runoff is below ave.

$$\frac{1.7 \text{ m a-f}}{.9 \text{ m a}} = 1.88 \text{ a-ft per acre per yr.}$$

Subtract evap. & seepage (but that's pumped back), leaves 1.5 a-f. per yr. Most crops "require" 2.5.

16,000 wells & pumps. Water table falling.

p. 6 They are trying to prove that Pine Flats is to have small irrig-n ben., mainly flood control.

p. 6 '49, K.R.W.A. enlarged, added 8 irr. agencies, & for 1st time since diversions of water began, no lawsuits or pending ones.

Members of KRWA execute a "Water Rte. Indenture", of public record. Began working it out in 1918 under State Eng & Div. of W.R.

USGS gauge at Piedra is basis of schedule

Schedule is 12 pp. of figs, ~~one~~ one for ea. mo. Public record, seen at offices of Ass, & Fresno, Kings & Tulare Chis., & member agencies.

Schedule for May

Piedra	Fresno Dist	People's Ditch	Empire Weir #2. (Tulare L. Basin)
1,000 second feet	650 s.f.	183 s.f.	0
5,000 "	1,450	400	0
7,000 "	1,450	500	0
9,000 "	1,475	550	849
10,000 "	1,628	597	1,024

"Firm" water,
after 5,000

ave. season, KR ~~lives~~ exceeds 7,000 s.f. only a mo.

During May, water master allots water daily by this schedule.

KRWA wants to contract w. BR to use storage space in Pine Flat res., but not to buy the salvaged flood waters, which are "theirs already".

Upper $\frac{1}{2}$ of res. space must be reserved for flood control. WA wants to rent lower $\frac{1}{2}$.

offered \$10m lump sum. BR wants $14\frac{1}{4}$ m., & maybe more.

They fear BR will declare KR navigable, or trib. to navig., hence no
 prt water rts. via White Bill, which wd reauthorize CVP to include KR, &
CVP authorized inter alia to improve nav.

Gerlach case, water was already taken, G. sued for comp., got it,
 after spending much M. Ct. emph. decision not binding on rest of C.V.
Congress could if it wished, I believe. Pres. no Congress can abandon its const. powers.

160 a. law, probly evade by dummy corps, h.c.

They insinuate Communist plot. This & other prop. devices
 & internal inconsistencies cast doubt.

(fr. rts. mean risk, like variable gt. plains. Lands w. them, e.g.
 Tulare basin, go to big specprobly)

1

Cal. Water Code, Div. ~~A~~ 2, Pt 4, on distrib. of water in w-master
service areas, specifies no techniques. He is just to adm. ct. decisions.

Only mentions that in apportioning any owner rt. to store water,
350 a-f. rt. = 1 cu. ft./sec.

(Pine Flat finished May '54. Isabella not finished then.)

Taylor, Paul S., "Whose Dam is Pine Flat". Pacific

Spectator, v. 8 #4, Aut. '54. p. 349 - 59

Cusser land mpp in 19th w. strong quotes from contemp.
papers. 1819, 320 acre lim. was in state const. (so?)

In Tulare Lake Basin water distr. 25 corps. own 165 sq.
mi., or 105,000 acres. Is a 300 sq. mi. distr., w. ^{"virtually"} no farm home
on it. (p. 353. No source. ask him.)

They will get from Pine Flat a "half water supply"
worth c. \$200/acre.

McKay tries to circumvent 160 a. law.
(An incendiary outburst, but good)

AES, Knoxville

U. of Tenn. Farm Ec. Bull No. 4, by L. J. Strickland, strong
propaganda vs. rip. system, no change, needed by study to
start immediately. (Write for job?)

My system shd also allow for intertemporal pricing. ^{assuming storage exists.} So if antic. shortage, district withholds, & storage, to ~~not~~ get higher prices later. This cd also be fn of fmr. He cd in early mo. buy water & store it in distr. res. for later delivery.

Probbly better to have watermaster do this, bec he can predict future better. ?

Another Supreme Court Decision Bears Watching

Savannah River Case Emphasizes Need for S 863

WASHINGTON, D.C. (Special to the "Water News")—Western water rights may be further endangered by a very recent decision handed down by the U.S. Supreme Court, according to Senator Frank Barrett of Wyoming. Barrett, in collaboration with other western senators, has introduced S 863 which aims to have Congress reaffirm the rights of the western states to control of their own waters under state laws.

In the case, known as the Savannah River case, the Supreme Court had before it decisions from two circuit courts both holding that just compensation includes the value of the land as a potential power site where the United States exercises the power of eminent domain to obtain a privately owned power site on a navigable river.

Split Decision

"By a 5 to 4 decision," the Senator declared, "the Supreme Court held that the Fifth Amendment did not

require compensation for the land's peculiar and especial value as a site for hydroelectric power in addition to the value of the bare land itself where Congress has authorized construction of a dam for multiple purposes, one of which was the improvement of navigation.

"According to the majority it is no answer to say that these private owners had interests in the water that were recognized by state law.

"This has serious implications in the field of western water rights, especially in view of the position taken by the Supreme Court that water rights are not compensable unless Congress so especially provides by law."

With respect to the constitutional power, the majority decision said:

"The interest of the United States in the flow of a navigable stream originates in the Commerce Clause. That Clause speaks in terms of power, not of property. But the power is a dominant one which can be asserted to the exclusion of any

(Continued on page 6, col. 4)

competing or conflicting one. The power is a privilege which we have called 'a dominant servitude' or 'a superior navigation easement.'

"The legislative history and construction of particular enactments may lead to the conclusion that Congress exercised less than its constitutional power, fell short of appropriating the flow of the river to the public domain, and provided that private rights existing under state law should be compensable or otherwise recognized. Such were U.S. v. Gerlach Livestock Co., and FPC v. Niagara Mohawk Power Corp. . . . We have a different situation here, one where the United States displaces all competing interests and appropriates the entire flow of the river for the declared public purpose."

On the specific question of just compensation, the majority said:

"It is no answer to say that these private owners had interests in the water that were recognized by state law. We deal here with the federal domain, an area which Congress can completely preempt, leaving no vested private claims that constitute 'private property' within the meaning of the Fifth Amendment. Location of the lands might under some circumstances give them special value, as our cases have illustrated. But to attach a value of water power of the Savannah River due to location and to enforce that value against the United States would go contra to the teaching of Chandler-Dunbar—that the running water in a great navigable stream is capable of private ownership is inconceivable."

The Barrett Bill—known as the "Water Right Settlement Act of 1956"—has been amended and is now being circulated among State Engineers and Attorneys General for comment. It is anticipated that hearings on the bill will be held this spring. Congressman Clair Engle of California has introduced identical legislation in the House of Representatives.

over those persons who feel that they have vested water rights—property rights—lawfully acquired under the laws of the states, and those who believe that the Federal Government has a superior right to all of the water in all of the streams of the United States.”

Davis told the group that “the Committee has only undertaken to do that which it believes is sound, is reasonable and is presently practicable.”

Need More Data

Discussing the specific sections of the report, Davis noted that the first section elaborates substantially upon the absolute necessity of increasing the appropriations to the scientific agencies for the production, correlation and evaluation of basic data regarding streamflows, rainfall, soil conditions, hydrology and other elements which control the quantity, the usability and the desirability of water

The fourth section of the report deals with water rights. The Committee recommends that there be a joint Federal-State study of this problem of water rights to determine the relationship between the establishment of property rights to water and the economic and social development of the Nation as it is projected into the future.

The Committee recommended that regulations relating to the use of underground water should remain a matter of state concern.

In the three final sections of the eight-section report the Committee deals constructively with the problems of evaluation of water resource projects, the problems of authorization and the problems of participation in costs.

Urge Uniform Methods

On the question of evaluation Davis said: “The Committee feels that there has been far too wide a discrepancy between the Federal agencies in their methods of evaluation; quite naturally, in many cases have adopted an optimistic; and that projects evaluated by agency would not meet the adequate standards under the methods another.”

in connection with the authorization

WESTERN WATER NEWS—FEBRUARY,

MOVE WITH “Do-It-Yourself” Projects

The Tri-Dam

A Major “Do-It-Yourself” Job Where Solid Planning, Dominant Courage and Persistent Effort by the Citizens of a Community Pay Off in a Big Way.

This is a summary of a story of persistent effort on the part of two California Irrigation Districts to develop badly needed water supplies for themselves as told by **Ralph A. Tudor**, president



Ralph A. Tudor, president of the Tudor Engineering Company of San Francisco, former Undersecretary of the Department of Interior and leading participant in a Committee sponsored by the Engineers Joint Council to study and prepare recommendations for a national water policy.

The account of the Tri-Dam Project was prepared jointly by Tudor and **B. W. Goodenough**, the latter consulting engineer for the South San Joaquin and Oakdale Irrigation Districts, and was the subject of a major address at the convention of the Irrigation Districts Association of California recently held in San Diego.

Tribute to Local Men

“It covers a period of more than thirty years,” Tudor began. “These were years of growth of ideas from their first nebulous form to complete engineering plans. They were years of ever-increasing need for the water and years filled alternately with high hopes and apparent defeat. But now success has been assured and the dams that will conserve the water and make it available to the Districts

under construction. This success



WIDE INTEREST IN WATER RIGHTS SUMMARY

Requests for copies of the supplement entitled "Irrigation Water Rights," included with the January issue of the "Western Water News," have come to the office of the Irrigation Districts Association in great numbers. In fact, more requests have been received for additional copies of this pamphlet than for any of the other 30 folders and reprints distributed by the Water Economics Committee during the past nine years.

The Water Rights supplement, prepared by WELLS A. HUTCHINS of the U.S. Department of Agriculture, will be made available so long as the supply lasts.

* * *

Larger Works

Hutchins has completed work on the big manuscript entitled "THE CALIFORNIA LAW OF WATER RIGHTS," which is being reviewed in the office of the General Counsel of the USDA in Washington. Arrangements are being made to have the manuscript printed by the State Division of Water Resources and made available for public distribution. The work may involve two volumes of book size.

1956

TH VIGOR

am Project

plained his Company's method of proceeding with construction of a project of this nature by setting up what is termed a "check list." This check list, prepared when the Company first becomes associated with the work, is revised from time to time thereafter. It includes not only the things for which his Company is expected to be responsible but also those things for which the attorneys, the owners, the financiers and other participants are responsible.

Major Features of Tri-Dam

Briefly, the Tri-Dam Project is a joint development of the Oakdale Irrigation District and the South San Joaquin Irrigation District. When completed it will comprise three dams — Donnells Dam, farthest up-

Garnsey, Morris E. 'Water: West' aapss 281 (5-52): 163-71

Cites a symposium, MIT, June 4-6, '51, "Hydrodynamics in Modern Techn."

Cites vol II of '50 WPC, 10 Rs in Am's future, 306-7, Rio Grande 20% of presently irrig-d 2m acres shd be retired. Oversubdivn, dense pop.

Cites US Cong, The Colo R., H. Doc. 419, 80th, 1st, '47. p.14
44% of R. presently being taken.

consider possibility of exporting 3m a-ft.

p168 Mo R., ultimate 9m kW cap., 10m acres irrig (cf. 5 now)

p169 Colo Compact restricts use of exported Wa to State (of Colo)
5m kW possible, Ark-White-Red Basin.

An Interagency Comm. has bn set up here, tho, in advance
of pw by any, so is hope.

p170 Pro huge exports Columbia R wtr. - 50m a-ft.

(At Mo, one cd study mp of w in Mo basin, probly
justify Mo getting much, keep locals happy.

Water Everywhere, But How to Use It?

Science and Need Will Lead Man to 'Tame' Water as He Tamed Land and Animals

Roscoe Fleming in the
Oil, Chemical and Atomic
Workers Union News

Earth's teeming billions of tomorrow will literally have to "manufacture" much of their fresh water, life's prime natural necessity next to the air itself. This will probably be with the aid of atomic or solar energy, and will be on a scale now undreamed of.

Man has never really emerged from the hunting stage so far as water is

concerned. Essentially he still runs down the wild water that Nature provides, and drags it home like a captured animal.

But tomorrow he will tame water, as he learned thousands of years ago to farm wild grains, and to pasture animals for their milk and meat.

Agriculture permitted an enormous increase in man's numbers — from a few hundred thousand hunters, to the nearly three billion people of today. Just so, the "cultivation" of sure and plentiful water, to make it available in all the now dry spaces of earth, will permit the next century's enormous population increase. And it will open up new land for settlement.

Cheapening power from the atom will coincide with the enormously-increasing value of water. Future water-taming projects will make TVA look like a toy. For example, Dr. Walter Lowdermilk long ago proposed that a canal be cut to turn the Mediterranean sea into the Dead Sea Valley in a fall eight times as high as Niagara. The falling water would provide for irrigation and factories.

Plentiful and Polluted

All such things are now technically possible — turning Death Valley into a lake, spotting lakes in the low places of the Libyan desert, etc.

Actually, this new age has already begun. A half-million people have already moved in the last decade into what was formerly barren desert in Arizona and Nevada. Australia's great dry spaces are beginning to fill up. The lure of oil is attracting thousands of people into the Sahara. Israel's Negev desert is producing food.

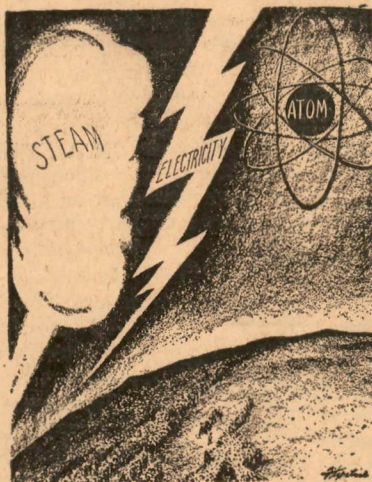
But the beginnings of any vast national water-program will necessarily be small and humble. For example, we still use only about 15 per cent of the five billion acre-feet (an acre-foot is 325,851 gallons) which fall from the sky yearly on the U. S. Water has been so plentiful that we have splashed in it like pigs in a puddle, and polluted more than we have used.

The Department of Health, Education and Welfare, charged three years ago with stopping pollution, has just gotten around to ordering two cities of nearly 100,000 people each, to stop dumping their raw sewage into the already-overburdened Missouri river.

Just cleaning up rivers, etc., would provide a large new supply of fresh water, but we Americans traditionally overlook anything so humble, and relatively so cheap. Now our noses are being forced to the grindstone as regards pollution. The time will come soon when cities — as many manufacturing concerns have already done — may go on a virtual closed cycle as regards water. They will cleanse and re-use it, and will need only "make-up water."

Other ways that water may be saved or increased:

Eliminating useless vegetation, par-



—Post-Dispatch, Aug. 28, 1955.

Yesterday, Today and Tomorrow

ticularly the "phreatophytes," or water-wasting plants like the tamarisk, which waste enough water to nurture 75,000,000 people.

Preventing seepage, which now wastes nearly half the water in the reservoirs before it can reach the fields or cities.

Encouraging thriftier water-habits by all citizens.

Preventing evaporation by building pipelines rather than open ditches, or by keeping reservoirs covered with cetyl alcohol, the magic substance that spreads out just one molecule thick, but can largely stop evaporation.

Cutting mountain forests selectively to bring to the ground some of the billions of tons of snow that now stay up on the evergreen branches and vanish directly into the air on the warm winds of spring.

Making "snow reservoirs" by covering huge mountain snow-drifts with something that will slow down evaporation. Plain sawdust seems best.

Seeding the clouds to increase rainfall. The President's Committee on

Weather Control found that in mountainous country this could increase rainfall over all by 10 to 15 per cent.

But the planet's great reserve is in the 314,000,000 cubic miles of the seas — enough to cover the whole earth 9000 feet deep — and in the salt water on and under the crust of the land. Ways to freshen salt water are thoroughly known, and are already being used to provide millions of gallons daily in communities like Kuwait and Aruba, where natural fresh water is out of reach.

The limiting cost is the expense particularly of power — it takes just so much power to separate the water from the salt or vice versa. If the power of the atom is eventually to provide man with low-cost, virtually boundless energy, here is the great field in which it will go to work to spread green vegetation — and people — over the whole world.

Freshened for Us

The world's total water supply is nearly 325,000,000 cubic miles — a cubic mile contains about 3,380,000 acre-feet, of 325,851 gallons each.

Of this total, 314,000,000 cubic miles is in the oceans; about 5,900,000 cubic miles is locked up in the ice-caps and glaciers; about 2,400,000 cubic miles is in the depths of the crust.

The rootzone or upper three feet of the soil contains about 3000 cubic miles, fresh water lakes about 30,000; the amount flowing at any one time in rivers and streams is only about 75 cubic miles. Suspended in the air above us, also at any one time, are about 3100 cubic miles — or actually less than the total of the Great Lakes!

In other words, the planet's total supply is limitless but the water Nature has freshened so that we can use it directly is only the tiniest fraction of that total. Our problem is to make better use of the fresh water, and after that, to freshen what we need.

Between Book Ends Sicker Than Queeg

THE VELVET KNIFE, by Irving Shulman. (Doubleday, 336 pgs., \$3.95.)

A character with the improbable name of Phil Hamm Schlager is "The Velvet Knife" of Irving Shulman's novel. The blade, however, is warped, that is to say, Phil Hamm Schlager is sick, sick, sick. Not since Wouk's Captain Queeg, do we recall a character as morbidly ill as Shulman's leading man. And it is this very illness which brings the book one step too far from healthy fiction and one step too close to Wilhelm Stekel case history.

Shulman manages his usual competent delivery and avoids the lurid sex-passages that other novelists writing of Hollywood have featured (Mailer's "The Deer Park," Hubler's "The Shattering of the Image"). Yet Shulman here uncovers a core of rottenness even more sensational and offensive. He describes a man in love with a woman obsessively and beyond the range of all reason.

The object of Hamm Schlager's distorted affection is Mary Scott, America's beautiful songstress and, strangely enough, not the pure-and-true ivory

idol our Phil believes her to be. After a series of infinitely patient and pathologically cunning maneuvers, Hamm Schlager brings his worship (it is beyond devotion) to the point of realization.

Shulman's villain has the evil Hollywood genius that Budd Schulberg says is "What Makes Sammy Run?" But unlike Schulberg's Sammy, Phil only jogs, tirelessly and relentlessly jogs. And also unlike Sammy, he is disarming, self-effacing and oleaginous.

The wind-up of the story is psychologically gory though no real blood is let. It appears to permanently prohibit the possibility of "The Velvet Knife" being faithfully conveyed to celluloid. This wind-up may be beyond reader acceptance, but one cannot deny that the author has come up with a neat "twist." This "twist" and the altogether twisted behavior of Phil Hamm Schlager, however, are only bootstraps by which Shulman has failed to pull himself up. They lie unsupported in a story which is sometimes wordy and in no particular sequence brilliant.

The novel is recommended mostly by certain sections dealing with the device and subterfuge in writer-producer relationships and is less favored by its consideration whether all is fair in pathological love.

Robert Friedman

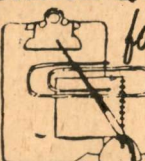


Irving Shulman
too close to Wilhelm Stekel

cific agreement reached at last month's conference at Camp David is even more imprecise, and therefore more open to varied interpretation, than the agreements at Yalta, Potsdam and Geneva.

It stated merely that future diplomatic conversations on Berlin should be subject to no time limit, but that they should not go on "indefinitely." Left at that, the agreement is almost an invitation to a disagreement,

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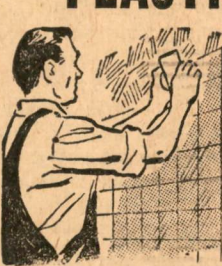
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batim, proposed that Khrushchev come to the United States in August. It was delivered to the Soviet Premier when he was whistle-stopping through Poland, and was undoubtedly a factor in his decision to cancel his Scandinavian trip a few days later. Incidentally, Khrushchev refused to come in August because it is "too hot" at that time.

Fortunately for future historians, the presence of interpreters in all the private talks between the President and Khrushchev will mean that there will be a fairly complete record of

Continued on Page 3, Col. 1.

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19-member committee on science and technology of the Democratic advisory council. The subject matter will range from space to the whole gamut of defense research, including civil defense.

The committee, headed by Dr. Ernest C. Pollard, chairman of the department of biophysics at Yale, will chastise the Republicans for "permitting" Russia to outdistance this country in many fields.

IN A SERIES of reports and "position papers" it also will offer an affirmative Democratic party program for scientific development.

In addition, the reports are expected to deal with disarmament and futuristic modes of warfare—from nuclear to biological.

To present a unified voice, Democratic scientists have been co-ordinating their work with the party's foreign policy experts.

A subcommittee of the scientific group met at Democratic advisory council headquarters yesterday to begin four days of intensive review and polishing of the material to be discussed and released Sunday.

AMONG OTHER THINGS, the national party leadership has asked the scientific brain trust to formulate a science plank for the 1960 Democratic platform.

The committee is composed of 18 scientists and one industrialist, Trevor Gardner, who resigned as the Pentagon's chief of Air Force research two years ago and has been critical of the Eisenhower Administration's science policies.

Among the others are Drs. Polykarp Kusch of Columbia University and Harold C. Urey of the University of California, both of whom have won Nobel prizes; Dr. Samuel K. Allison, former head of the Enrico Fermi institute of nuclear studies at the University of Chicago; Dr. Harrison Brown, professor of geochemistry, California Institute of Technology, and Dr. Frank Goddard, head of the jet propulsion laboratory at the California institute.

ISRAEL GETS U.N. CENSURE FOR OUSTING BEDOUINS

© New York Times News Service

JERUSALEM, Oct. 8—Israel was condemned yesterday by the United Nations truce supervision organization for driving 350 Bedouins out of Israeli territory in mid-September.

In a report issued here, the Egyptian-Israeli Mixed Armistice Commission charged that Israeli troops had killed "some of the Bedouins," burned their tents, and forced them out of the western Negev into Egyptian territory.

Earlier in September an Israeli officer was killed in this area while on patrol. The Israelis contended that members of this Bedouin tribe had murdered the officer.

Israeli troops were sent in search of the killers. The Israeli army version holds that these troops were fired on by the Bedouins. The troops retaliated and three Bedouins were killed. The others "fled" across the border.

Since the Sinai campaign Israel has boycotted the Egyptian-Israeli Mixed Armistice Commission. No Israelis were present at yesterday's meeting.

The group, called the tee on Program and also indorsed a propos national agreement for militarization of outer

Its 8500-word report tional Security and made public by the R National Committee, is prehensive statement of and defense policies, mended as guide lines party planning.

IN THE FOREIGN field, the report favored gressive shifting of for nomic aid from g grants to private in and loans, (2) condition with the Communist st will "help thaw the co and (3) creation of a gency military force United Nations in the crisis.

The committee adv maintenance of a bala rounded defense with of weapons for either limited wars, but with ed States striving cons disarmament agreemen "We seek to insure

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Journal of the
SANITARY ENGINEERING DIVISION
Proceedings of the American Society of Civil Engineers

ROLE OF PRICE IN THE ALLOCATION OF WATER RESOURCES^a

by Lawrence G. Hines¹

SYNOPSIS

This paper examines the price-cost function in the allocation and utilization of water resources in the United States and consists of analysis of (1) the market valuation process, (2) the factors affecting the determination of municipal water rates, and (3) the shifts of costs that result from different water uses.

INTRODUCTION

Water prices in the United States are a hybrid of economic and social forces. The unusual versatility of water as a low-cost economic good permits it to satisfy a great variety of private and collective wants, but also leads to special problems in pricing and allocation. These problems are related to (1) the frequent failure of direct water charges to cover total costs of production and distribution, (2) the modification or neutralization of market direction of water allocation through legal arrangements and existing customs, and (3) the inability of the private market process to identify and compensate for all costs that arise in the development and exploitation of water resources. This paper examines problems (1) and (3)—the consequences of the failure of direct water

Note.—Discussion open until June 1, 1960. Separate Discussions should be submitted for the individual papers in this symposium. To extend the closing date one month, a written request must be filed with the Executive Secretary, ASCE. This paper is part of the copyrighted Journal of the Sanitary Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 86, No. SA 1, January, 1960.

^a This is a revision of a paper delivered at the Academy of Science meetings, Dallas, Tex., December 1957. The author is indebted to J. J. Flannery for suggestions in the preparation of this paper.

¹ Prof. of Economics, Dartmouth College; Consultant to Div. of Water Pollution Control, U.S.P.H.S.

charges to cover total costs and the nature of the transfer costs of water use.²

NATURE OF WATER RESOURCES AND THE VALUATION PROCESS

In both its physical and economical aspects, water is one of the most renewable of natural resources. Water can be reused, sometimes without artificial treatment, and it is replenished in the normal course of the hydrologic cycle. An average of 2.5 ft of water falls to the earth annually in the United States, with a run-off of approximately 1,200,000 mgd. National water supply averages are deceptive, however, in a country as large and diverse as the United States, because rainfall and storage facilities differ substantially from one region to another. Storage of water occurs in two physical forms: surface supply, which is the more important source of our water, and ground water deposits, which recently have become increasingly important.³ Ignoring the possibility of "mining" ground water, the aggregate physical supply of water in the United States is the annual precipitation-runoff of 1,200,000 mgd. This figure does not represent the upper economic limit of our supply, however, since major portions of a given rainfall are repeatedly reused in the more populated areas before they are lost as runoff to the sea. Water scarcity is only locally—and generally temporarily—the result of physical shortage, and our water problems are largely due to maldistribution of existing supply and deterioration of water quality following industrial, municipal, and agricultural use. Because of water's transportability and amenability to quality improvement through treatment, the limiting factor in water shortage is invested capital quite as much as the physical supply of water.

The renewability of water increases the economic flexibility of its supply. Although water resembles other flow resources, such as air and sunlight, unlike such resources a given quantity of water can be held captive as well as reused.⁴ A major exception to non-depletive water use occurs in farming.

² Extensive analyses (and debate) are available on the economic implications of water-rights doctrines. See, for example, "Some Economic Issues in Water Rights," by S. V. Ciriacy-Wantrup *Journal of Farm Economics*, Vol. 37, No. 5, December 1955, pp. 875-85; "The Law of Water Allocation in the Eastern United States" edited by D. Haber and S. W. Bergen, New York: Ronald Press, 1958; "The Case for Private Decision-Making in A System of Water Law," by J. W. Milliman, Santa Monica: Rand, September 1958; "Water Resource Law: Report Volume 3" by The President's Water Resources Policy Commission, Washington: Government Printing Office, 1950.

³ In 1955 surface Water sources supplied 194,000 mgd and ground water deposits contributed 46,000 mgd in the United States. "Estimated Use of Water in the United States," by K. A. MacKichan, *Geological Survey Circular 398*, U. S. Dept. of the Interior, Washington, D. C., 1957, p. 1.

⁴ The water supply is replenished by rainfall and renewed by natural streamflow or artificial treatment. Water treatment may take place before used water is reintroduced into a stream through interception by a pollution abatement system or before the water is reused through settlement, filtration, chlorination, and related processes. There are of course limits beyond which water cannot be restored to usefulness by either natural or artificial treatment. A build-up of dissolved solids may impair water usefulness over a wide range and some pollutants cannot be readily removed from water. For example, no practicable method of completely removing detergents from water has been developed, resulting in sudsing tap water for some communities that obtain their water supply from treated waste water.

Agricultural water use, which constitutes approximately half the demand for water in the United States, results in the loss of water to the plant and culture media with only slight possibility of recapture from runoff or transpiration.⁵

Water uses differ not only in the effect that a given use has upon the residual supply, but also in the nature of the control surrounding its allocation. In order of decreasing private market control, the major water demands in the United States arise from (1) municipal, (2) industrial, (3) agricultural, and (4) recreational uses. Industrial and agricultural water uses, frequently contrasted because water is an ingredient of these different kinds of production, are subject to different degrees of market and public control. Water for industrial purposes may be obtained from municipal sources under various price arrangements as well as self-supplied through capital investment, while to a lesser extent similar arrangements may at times take place in some of the specialized types of agriculture, such as truck and irrigated farming.

Increasing and sometimes competitive demand for water for different uses has led to the assignment of "values" for water in different uses, generally with little regard for the process of incremental or marginal analysis. The Paley Commission, for example, assesses the value of water in agricultural use as equal to approximately 10 cents for 1,000 gal., whereas manufacturing use is said to average \$5.00 per 1,000 gal. used in 1952.⁶ Such calculations are suspect on at least two counts: (1) they derive a water value in different uses primarily from the ratio of water inputs to the worth of the finished product, thus ignoring the contribution of other factors of production, and (2) they contrast the value productivity of a given water use for a particular water market area with different water uses in other market areas where the supply and alternative opportunities for employing water may be quite dissimilar.

A ratio of water input to value of the finished product (or to "value added" in the productive process) merely indicates whether water is used in an economic process that produces a high or low value. It does not justify an inference that all resources used in such processes derive higher value than those employed in producing less highly priced finished products. One might reasonably contend that the contribution (and value) of common labor in the steel industry is greater than similar labor in the packing-house industry because

⁵ A depletive water use, such as farming, makes a net reduction in the water supply, whereas a non-depletive use may impair the quality of the water but not appreciably affect the quantity of water available for reuse. Water supply data and literature usually identify a depletive use as consumptive and a non-depletive use as non-consumptive. Consumptive and non-consumptive are not satisfactory economic designations, however, since any water use (whether depletive or non-depletive) constitutes economic consumption. Professor Timmons has proposed a host of categories for the classification of water uses. He makes an initial separation between consumption and production uses, and a breakdown of the latter into existential non-exhaustive and potential non-exhaustive. "Theoretical Considerations of Water Allocation Among Competing Uses and Users," by J. S. Timmons, *Journal of Farm Economics*, Vol. 38, No. 5, December 1956, pp. 1245, 6. Timmons' basic distinction between production and consumption appears to be essentially arbitrary and may lead to confusion with the more familiar usage of consumptive water use.

⁶ "Water for United States Industry," by J. R. Barnes, *The President's Materials Policy Report*, Washington: Government Printing Office, Vol. 5, 1952, p. 86. See also "Relative Economic Returns from Industrial and Agricultural Water Uses," by S. T. Powell, *Journal of the American Water Works Association*, Vol. 48, August 1956, p. 991.

the finished price of steel is higher than meat products. Any resource that can be varied independently of other factors in the productive process⁷ will be added to the point where the increment of revenue from its use is equal to the added increment of cost, that is, where marginal cost equals marginal revenue. In carrying the use of a factor such as water to the margin where the value output from the discrete input is equal to its cost, different enterprises will not employ the same ratio of water inputs to finished product, but the value of water to any given enterprise within a continuous water supply area will be essentially the same. Adjustment of firm water demand to changes in the price of water presumes that the individual firm does not control the price of water, but much the same process takes place in the case of self-supplied water supply where the firm equates its water production and use with the cost (price) of production.

The aggregate effect of equating incremental factor cost with factor return by water users in a given market area establishes the supply price (value) of water. If the price of water rises, whether from decreased physical supply, increased demand, or both, water users will react to the price change differently depending upon the essentiality of water in the productive process and the worth of the product produced. Higher water price may thus be expected to curtail its use in certain industries, such as agriculture, where the quantity of water used is large and the price of the finished product low in comparison with competing demands. At any one point of time, however, the value of water in one productive process in the same market will be roughly equivalent to that of any other process. Only as the price of the factor is raised will there be imposed upon water users the necessity of a higher yield that will shift

⁷ The possibility of varying a given factor independently of other factors is a crucial requirement for value determination by marginal or incremental analysis. Independent variability of factor application necessitates some degree of physical divisibility of factors, which is well satisfied in the case of the water resources, and a technical process that is not characterized by large elements of fixed production coefficients. Since the nature of production coefficients varies for different industrial processes, generalization is hazardous, but the likelihood of flexibility in production coefficients is enhanced as the period of time available to the firm for modification of production arrangements is lengthened.

Inconclusive but significant evidence of the potential range of production coefficient flexibility in water use has been collected by Fortune magazine in a small statistical sample of representative firms in large water-using industries. The Fortune survey asked: "If water were to become, say, twice as expensive as it is today, (at one of your newer plants), presumably it would pay you to increase the amount of water re-used or recycled. Under such circumstances, by about what per cent could you reduce the plant's demand for fresh water?" The replies were tabulated as follows:

Industry	Percentage	
	Minimum	Maximum
Steam Power	0	95
Steel	0	40
Chemicals	10	60
Petroleum	0	12
Pulp & Paper	0	26

Source: Editors of Fortune, "The Mighty Force of Research" by the editors of Fortune, New York, McGraw-Hill, 1956, pp. 120-1.

water-resources from lower to higher productivity employments. Although a shift in resource allocation may in some cases result in the total elimination of some kinds of economic activity, for the most part water use curtailment will not be terminal or symmetrical for different firms and industries, restoring equilibrium where marginal returns in various uses are approximately equal to marginal costs.

As emphasized above, the evaluation and allocation process cannot be extended beyond the relevant market. Generalizations on the economic priority and value comparisons for broad categories of water uses for the economy as a whole are of limited validity. Aggregate data on water demand and supply are useful primarily as rough indicators of the extent of water exploitation in the economy, not as measures of the efficiency of resource allocation. The economic efficacy of a given water allocation arrangement can be determined only through an analysis of the limited range of opportunities for employing a given water supply. Higher productivity and greater yield from water use in one section of the country is not acceptable evidence of "inefficient" water use in another section of the nation where equivalent opportunities for use and similar supply conditions do not exist. Water has different values in different markets—and the market arrangement resembles that of non-competing labor groups. An abundant supply of common labor will not appreciably affect the productivity and wage return of highly trained technicians because little occupational movement occurs from one labor group to another. So in the case of distinctly different water markets: where mobility of resources is absent, the high demand and limited factor supply of one region cannot be transferred as a cause of "inefficient" resource use to areas where similar conditions do not prevail.

The foregoing analysis should not be misinterpreted to confer sanction upon the use of a factor in a lower-productivity capacity when its supply is insufficient to satisfy its demand by higher-productivity employment. Resource rationing to the point of exclusion of some uses occurs primarily as a result of increased factor marginal productivity (value). Institutional arrangements that impair the flow of resources from lower to higher productivity alternatives violate the strictly economic standard of resource allocation. Disregard of the economic standard is sanctioned at times to attain objectives other than economic efficiency. Water-rights law and the promotion of the "family farm" may illustrate instances where non-economic objectives are attained that excite greater approval among Congressmen and their constituents than among economists.

Inefficient allocation of the water resource occurs not only when a more productive alternative use is foregone, but also when the current development endangers a future water supply that will be employed at substantially greater yield than achieved by present exploitation.⁸ Water deficiency may arise, as

⁸ A later yield must exceed present return by an amount sufficient to compensate for the futurity of its occurrence.

it has in some parts of the Southwest,⁹ when ground water is extracted more rapidly than it is replenished by rainfall. Whether an overdraft of ground water is economically desirable or undesirable, however, cannot be answered by simple reference to the normal balance of the water table.¹⁰ The critical question is whether the mined water is devoted to the most productive use within the opportunities available during the present and the discounted prospects of the future. Depletion of a given ground water supply is little different economically from the exploitation of an exhaustible mineral. The essential consideration is whether society can put the resource to a higher use, now or in the future, plus recognition that if the overdraft is continued indefinitely both the resource base and the economic activity created by the resource may be irreversibly impaired. In ground-water mining special problems may arise in areas where salt-water intrusion is likely to occur when the overdraft lowers the water table to below sea level. At times destruction of large amounts of water by intrusion pollution may take place under the stimulus of relatively small incremental gain. In such cases the social loss may be great in comparison with moderate private gain,¹¹ unfortunately establishing a pattern of

⁹ Regional water shortages and ineffectual control of pollution are evidence of either inadequate planning, insufficient investment, or both. As an example of regional water deficiency, Arizona—among the 17 western states that are using approximately 70% of the water supply that can be developed with economic feasibility—has reached beyond the dependable supply within its borders, and California, Texas, Louisiana, and Arizona are pumping heavily from ground water supplies. As a result, in regions such as the Texas High Plains the ground water withdrawal rate may be as high as thirty times the inflow and the overdraft for the Southwest as a whole is in the neighborhood of 5 bgd. In spite of the fact that in 1953 many communities imposed some form of restriction in water use, the United States is not running out of water as many popular and semi-popular articles imply. The water "problem" in the United States is the result of one or a combination of the following factors: (1) regional shortage, (2) non-economic pricing of water, (3) ineffectual control of pollution (that is, insufficient capital investment) and unsolved technical engineering problems.

¹⁰ J. H. Snyder contends that "Economic forces . . . have stimulated groundwater mining—that is, annual draft rates on ground water beyond the safe yield level—creating overdraft and decline in ground-water levels. The ground-water flow resource or recharge volume of a ground-water basin, expressed as an annual average, is equivalent to the physically determined safe yield of that basin. It represents the amount of water that may be withdrawn from ground-water storage indefinitely for man's use without significantly affecting the character or volume of the reservoir.

Safe yield draft rates, merely to preserve the physical character of the resource, do not automatically become a policy goal of ground-water utilization programs."—"On the Economics of Ground-Water Mining—A Case Study in an Arid Area," by J. H. Snyder *Journal of Farm Economics*, Vol. 36, No. 4, November 1954, p. 600.

¹¹ The extent of private gain from ground-water mining will vary for different regions and different times. No generalization is possible, but an illustration of the magnitude of private gain from overdraft is found in a study of the Antelope Valley, California, region. "In dollars and cents terms, Valley farmers have profited from ground-water mining. For example, using the ground-water stock at a safe yield rate (draft-recharge) and devoting the entire amount to alfalfa production, it is estimated that operators' earnings from alfalfa for the period 1927-1950 would have totaled less than \$5,000,000. Actually, for only the period 1947-1950, alfalfa operators' earnings alone totaled \$4,500,000. Thus income generated by mining the ground-water stock resources may easily exceed a perpetuity income resulting from maintaining balance between recharge and draft."—*Ibid.*, pp. 609-10.

commercial exploitation that cannot easily be reversed. The physical nature of ground-water deposits, which permits private owners to compete for a larger share of a given water supply, frequently encourages an antisocial rate of withdrawal.¹² Public control of the rate and method of water extraction, similar to that imposed in some oil regions facing much the same problem, may at times be necessary to bring private exploitation practices in line with social objectives.

The optimum social rate of exploitation of ground water requires the distribution of supply between present and future so as to maximize the return to society over both periods. This rule may be generally applied to natural resource development whether the exploitation involves "mining" or not. The determination of the rate of present resource exploitation, which is dependent upon the discounted returns from future use, also establishes the appropriate rate of conservation. The frequent identification of conservation as "wise use" of resources requires amplification to give it meaning, just as does the economist's short-hand expression of "efficient" or "optimum" allocation of resources. It is apparent, however, that the conservation problem is an extension of the economic problem. Both emerge because of scarcity, but to the extent that they can be separated the economic problem must take priority because no choice between present and future arises if materials, manpower, and capital are unlimited.¹³

Pressure of scarcity compels society and individuals to choose what to produce in the present as well as what to withhold for the future, and allocation of resources achieving a socially satisfactory distribution between the present and future is attained only when the market mechanism accurately reflects the relative values of resources. A price that does not correctly measure the scarcity of a resource distorts the use of the resource in relation to other factors. Analysis of socially inappropriate pricing, generally limited to non-competitive situations, seldom considers the problem of rationing commodities or resources in other than the present. It follows, however, that a price that is non-competitively high restricts the use of resources and the supply of commodities in the present, thus making available a larger supply of an exhaustible resource for the future. A price that is "too low" shifts part of the cost of product production to other factors or institutional sources of revenue and draws more heavily upon the fixed resource stock than would otherwise be the case.

In instances of resource underpricing, the use of a resource may be pushed to the physical limit of supply without satisfying effective demand. The failure of price to rise as the resource becomes more scarce and as physical depletion rates increase impairs the rationing function of the pricing system,

¹² "Commonality, the Price System, and Use of Water Supplies," by J. W. Milliman, *Southern Economic Journal*, Vol. 22, No. 4, April 1956, p. 429. Professor Milliman treats the consequences of competitive withdrawal of ground water as a "spill-over" cost.

¹³ In the formal sense, the conservation problem involves a special application of capital theory, although there may be important instances in which the market does not satisfactorily "solve" the conservation problem just as there are times when it fails in the solution of the economic problem.

which generally winnows low-value resource uses from the market and apportioning supply among higher-value uses. Sluggish response of price to increasing scarcity disorganizes the operation of the market, resulting in: (1) uneconomic employment of factors, (2) the need for administrative direction or resource allocation, and (3) a bias in favor of present (versus future) resource use.

Although the market cannot be expected to accommodate all social goals, automatically establishing prices that are simultaneously private incentives and social objectives, the market does promote conservation when private and social goals coincide. The market is likely to underrate the need for conservation in cases where (1) market prices reflect individual choices that do not coincide with social objectives,¹⁴ (2) institutional arrangements inhibit the ideal operation of the system and (3) knowledge of society's future needs is less complete and accurate than information of present requirements. (Point 3 may also lead to a rate of conservation that is at times too high.)

MUNICIPAL WATER PRICING

Water pricing in the United States, while differing among communities and uses, generally reflects some element of subsidy to the consumer. Although there is obvious need to promote certain social and sanitary uses of water through low price,¹⁵ it is the thesis of this paper that the higher volume of water use in the present and future would closer approximate the social optimum allocation if more emphasis were placed on orthodox principles of pricing. Along with an increase in the market price for most water uses,¹⁶ extra-market cost transfers should be assessed and imposed upon those responsible for depletion and degradation of the water resource.

In 1953, 1,072 communities in the United States experienced some degree of water shortage, generally resulting in various administrative restrictions upon water use, but infrequently leading to significant price adjustment.¹⁷ The

¹⁴ It should be re-emphasized, however, that producer's private interest in non-competitive price may lead to distribution of resource use in favor of the future. For other considerations, "Economics and the Public Interest," by L. G. Hines, *Land Economics*, Vol. 31, No. 2, May 1955, p. 108.

¹⁵ See Note 18, below.

¹⁶ Data on the costs of water production are meager. "The 15,400 waterworks . . . do not report their operations to any single agency. This is unfortunate. The Federal Power Commission collects from all electric and gas utilities, both publicly and privately owned, a large amount of statistical data permitting comparisons of the rates and relative operating efficiencies of these essentially noncompetitive utilities It is essential that all water works utilities, both publicly and privately owned, be required to report, on a uniform accounting and statistical basis, all fundamental and statistical data which can be compiled in one office and made available to all waterworks managements and to other interested agencies and persons." "A Water Policy for the American People: The Report of the President's Water Resources Policy Commission," Washington: Government Printing Office, Vol. 1, 1950, pp. 180-1.

¹⁷ Water shortages in New York City have resulted in review of this community's problem more thoroughly than most, but careful investigation of the role of price upon water consumption appears to have been neglected. A study by the Mayor's Committee on Management Survey of the City of New York, "Future Water Sources of the City of New York: Report of the Engineering Panel on Water Supply," New York, July 1951,

market approach to this problem would be a rationed reduction in water use through price increase, curtailing consumption to the point where no economic shortage existed. Clearly the market solution may be socially inappropriate in some cases, but in failing to price water according to its scarcity, cumbersome administrative restrictions that generally require active consumer cooperation for success must be imposed to prevent over-depletion of existing water supplies. In view of the special circumstances surrounding the fixing of water rates by most communities, more attention might profitably be given to the consideration of the economic aspects of water pricing.

Municipal water rates are the most unscientifically determined price in the public utility field.¹⁸ Rate determination in the water industry is complicated by such factors as: (1) the dual function of fire protection and supply of water that most systems perform, (2) the political influences that at times take ascendancy over economic considerations, and (3) the feeling held by many that water should be priced nominally.¹⁹ Even though water charges generally represent a small proportion of the consumer's total budgetary outlays, there is evidence that changes in water rates result in modification of the amount purchased. This is particularly apparent when consumption is made a function of price, as in the case where a fixed annual charge is replaced by metered rates. The use of metered rates has reduced water consumption by as much as 50% and meter installation has sometimes been recommended as a means of avoiding the necessity of expanding water installation capacity.²⁰

The opportunity to disregard market pricing practices is afforded by the high proportion of publicly owned and operated water systems in the United States. Slightly less than twenty per cent of the water systems in the United States are privately owned and controlled, and public ownership in this field greatly exceeds that in other utility industries. Although generalization in the water utility field is risky because of meager information and the diversity of service arrangements, one of the important reasons for the predominance of

totally ignores this aspect of the problem except to the extent that metered rates may be expected to curtail consumption. The report is concerned almost exclusively with the physical supply of water in terms of how it can be augmented from additional sources and how loss can be decreased by improving main maintenance and correcting faulty plumbing.

¹⁸ "Public and Private Ownership of Water Supply Utilities," by R. B. Eutsler, The Annals, Vol. 201, January 1939, p. 94.

¹⁹ "Municipal Finance," by A. E. Buck, New York: Macmillan, 1926, p. 516 *et seq.*

The major justification for nominal water charges is to encourage its use for sanitary purposes. This objective may be achieved, however, and at the same time permit price to ration water for less essential uses. Instead of the decreasing unit charge with increased consumption (or a flat rate), typical of many water rate structures, a low initial charge for an estimate of the amount of water necessary for household sanitary requirements might be imposed, followed by a progressively increasing charge to curtail non-sanitary water uses.

²⁰ "Economics and Public Utilities," by E. W. Clemens, New York, Appleton-Century-Crofts, 1950, p. 124.

Eutsler cites studies in Ohio indicating that meters may be expected to reduce the average daily consumption of water from 170 to 90 gal. in villages and from 170 to 100 gal. in cities.—*op. cit.*, p. 93. It should be noted, however, that the initial reduction in water consumption following a price increase or metering of water may not persist in full force indefinitely.

public ownership appears to be inadequate return on private capital investment—a further indication that water is underpriced. In reviewing the historical trend toward public ownership in the water industry, Eutsler says²¹

Privately owned water works . . . encountered difficulties in charging rates sufficiently high to cover the costs of supplying water. Private capital therefore tended to seek more profitable fields of investment, and left this field undeveloped. If water were to be supplied, it was up to the municipality to do it. Moreover, municipalities sometimes found it possible to shift some of the costs of construction to property owners by assessment, and some of the current costs of operation, especially interest on bonded indebtedness, to the taxpayers in the form of taxes.

Further evidence that publicly-owned water utilities have not generally followed orthodox market practices in pricing water is revealed in an exhaustive study of water works statistics by H. F. Seidel and E. R. Baumann.²² Although Seidel and Baumann did not undertake the analysis of the statistical data periodically collected by the American Water Works Association as an investigation of the pricing policies of water utilities, the study of various aspects of private and public water companies reveals important differences in pricing policy, rate of return, and other economic features. On the whole, private water utilities have charged higher water rates and adjusted more quickly to

²¹ Op. cit., p. 91. Clemens concurs that one of the factors responsible for the disproportionate public ownership of water systems is "The business is so frequently unprofitable that it is unattractive to private capital."—op. cit., p. 124. Troxel contends "Private investors apparently are not so anxious to invest in water systems as in electric, gas, and telephone plants. A private water company has the customary responsibilities of a utility firm, and in addition it is obligated to provide plant capacity for an expanding population. A water company can be confronted with increasing costs of operation as it expands . . . If the unit costs of an expanding system are increasing, the private company wants higher and higher water prices as it expands. But while a city government wants more water, it also may try to prevent increases in water prices, ignoring the connection between higher prices and additional investments in the water plant. "Economics of Public Utilities" by Emery Troxel, New York: Rinehard, 1947, p. 651.

Bello states that "For the last 100 years private utilities have been getting out of the water business, primarily, it appears because the ratio of capital investment to sales is unattractive?" "How are We Fixed for Water?" by Francis Bello, *Fortune*, Vol. 49, No. 2, March 1954, italics added, p. 125. Although water utilities have an abnormally high ratio of capital investment to operating revenue—approximately 10 to 1 as compared with other public utility ratios of 5 to 1 and ordinary manufacturing of roughly 10 to 7—the relationship of capital to revenue is of no significance in encouraging or dissuading investment in a given field. In instances of low capital turnover, as in the case of water utilities where sales are small compared with capital investment, a larger proportion of sales revenue must be earmarked for capital amortization, but the rate of return on capital must be equivalent to other opportunities for investment, consistent with the risks and uncertainties of the enterprise, in order for capital to be attracted to and retained by the firm.

²² "A Statistical Analysis of Water Works Data for 1955," by H. F. Seidel and E. R. Baumann, *Journal of the American Water Works Association*, Vol. 49, No. 12, December 1957, pp. 1531-66. The statistical data cited in this section have been obtained from the above source, but not the interpretation of these data.

rising prices than publicly-owned water utilities. Analysis of the 1955 data indicates that the monthly charge per 1,000 cu. ft. of water differs in the order of \$2.62 for public utilities and \$3.70 for private utilities.²³ Direct charges for water service in general have been lower for public utilities, with private utilities allowing on the average 10% less water on a minimum bill while maintaining 33% higher charges; private utility fire service rates were one-third higher.²⁴ Seidel and Baumann conclude that "... since 1950, publicly owned utility earnings have been keeping up with cost trends, while privately owned utilities have been doing mildly better. Both have still to make up the considerable ground lost during 1945-50. If the relationship between costs and earnings in 1945 was satisfactory (and there is no reason to believe it was better than that) further rate increases appear mandatory."²⁵

Although aggregate investment and revenue data for the water industry may conceal case differences of significance, an analysis of 1956 data for publicly-owned water utilities indicates that an increase in revenue of \$1.714 billion would be necessary to break-even for that year. This would require an increase of 47.5% in gross operating revenue to achieve an annual return of 4.17% of the investment (replacement) value of publicly-owned water utilities in the United States.²⁶

TRANSFER COSTS IN WATER USE

The supply of water, which is to say the cost of water, is a function of quality quite as much as quantity. Because of the unique renewability of the water resource, which generally permits the same water to be reused, the cost of water to a given user (or community) is determined partly by the pollution load carried by the water from other population centers. When the water supply source is a flowing stream, the use of this watercourse as a low-cost means of waste disposal forces the resource to serve dual and antagonistic purposes. Since it is usually possible for a community or industrial water user to separate the withdrawal of stream water from the area of waste disposal, any one community may minimize its costs by untreated stream disposal of wastes. This separation permits a varying portion of such costs to be shifted to other (downstream) communities. Because most communities are "downstream" to other communities, however, whether a given community gains or loses from following a policy of treating its water and not treating its waste depends upon how large and how far away is the upstream community, the nature of the

²³ *Ibid.*, p. 1533.

²⁴ *Ibid.*, p. 1547 and Table 22, p. 1563.

²⁵ *Ibid.*, p. 1566. "Earnings," as used by Seidel and Baumann, is apparently equivalent to the economist's "gross revenue," not the net concept of the public utility analyst.

²⁶ "Financial Requirements of Water Utilities" by W. L. Picton, New York: American Water Works Association, Inc., October 1958, pp. 8-9. I am greatly indebted to Mr. Walter L. Picton, Director of the Water and Sewerage Industry and Utilities Division of the U. S. Department of Commerce, Washington, D. C., for extremely helpful information and discussion on water utility investment problems.

wastes, the flow variations of the stream, and a variety of similar considerations.²⁷

To answer the question of whether society gains or loses from using watercourses alternately as sources of water and for disposal of untreated wastes requires a comprehensive survey of the economic gain and loss to all parties. As a theoretical starting point, the prohibition of any pollution may be taken to represent the condition under which no transfer of cost would take place. But although enforcement of a "no pollution" ban has become increasingly appropriate as a tenet of public policy, the application of such restriction ideally should be determined by the particular conditions that obtain in specific watercourses. After allowance for the generally increasing demand for water as a result of population growth and industrial development, which establishes a strong presumption in favor of more rather than less investment in pollution abatement facilities, prevailing conditions in certain areas may justify elimination of pollution in order to maximize society's welfare. This condition differs from that typical of the early development of our economy when industries and communities did not contribute substantially to the pollution load of watercourses and when the increased industrial output or community convenience outweighed the economic loss and social distress caused by pollution. The location of community and industrial installations in an area essentially isolated from other population concentrations may still satisfy these conditions. But it is obvious that such situations are of decreasing likelihood.

Economic loss resulting from pollution may be classified in two categories: (1) that resulting from community action which may affect other communities and private individuals and enterprises and (2) pollution by individuals and enterprises which may affect communities and other individuals and enterprises. These two types of cost-shifting may be distinguished on the basis of whether the transfer takes place, as in (1), from one portion of the public to another or, as in (2), where the shift is between individuals or from the individual to the public. The former transfer (1) is generally identified as a "spill-over" cost, whereas the latter (2) is more specifically defined as a "social" cost.²⁸ The following situations are suggestive of the possible cost transfers that may take place.

²⁷ If the upstream community is small and distant, some kinds of waterborne wastes may be oxidized before reaching the source of the water for the downstream community. If the intervening surface waters are not significantly affected or intensively used, no appreciable cost shift will take place in this hypothetical situation. Unfortunately, such a situation becomes increasingly hypothetical with growth in population. Basic data on the extent and nature of water pollution in the United States are somewhat incomplete. The most frequently quoted publication is "Water Pollution in the United States," Washington, D. C., U. S. Public Health Service Publication No. 64, 1951.

See also, The Water Pollution Control Program of the U. S. Public Health Service, 1957-1958, Washington: Department of Health, Education, and Welfare, 1958, and Inventory of Municipal and Industrial Waste Facilities in the United States, Washington, D. C., U. S. Public Health Service Publication No. 622, 1959.

²⁸ Kapp defines "social" costs as including "... all direct and indirect losses suffered by third persons or the general public as a result of private economic activities." "The Social Costs Private Enterprise," by K. W. Kapp, Cambridge: Harvard University Press, 1950, p. 13.

The distinction between "spill-over" and "social" costs is useful for purposes of determining remedial action.

- (a) Pollution of a community water supply by an industrial firm.—Social cost imposed upon the community.
- (b) Pollution of one community's water supply by an upstream community.—Spill-over cost transferred to downstream community.
- (c) Pollution by a community of a portion of the adjacent watercourse (presumably below the community's water supply intake) impairing the utility of the water resource for some members of the same community.—Spill-over cost from community to some of its constituents.

In assessing the nature and magnitude of such cost transfers, a monetary equivalent of the value of the water use impaired or destroyed by pollution represents the ultimate goal of economic analysis. Unfortunately, automatic measurement of the value loss to individuals and society in monetary units is complicated for numerous water-using activities because they do not involve transactions carried out within the purview of the market. At the same time, quality standards for different water uses vary widely—resulting in equivalent variation in the magnitude of the loss from cost transfer in cases of different uses. The cost of water production for human consumption, for example, increases in rough proportion to the degradation of the water quality. Assuming that for some human needs and certain industrial processes there is no satisfactory substitute for water, the price of this resource would be established at whatever height was necessary to cover its cost of production. From the development of the valuation process in the first section of this paper, however, it is apparent that the nature of water supply is not sufficiently limited to result in establishing water value exclusively on the basis of such priority needs. The total demand for water is made up of many other uses for which there are somewhat less than completely satisfactory technical substitutes, although such substitutes may not be less attractive economically. The substitute for loss of water uses from pollution is an investment in pollution abatement installations, thus imposing the cost for water degradation upon the agency responsible. As population increases and industry expands, the benefits impaired and destroyed by pollution of water increases and the loss from pollution to individuals and society increases. These changing values must be measured and the costs assessed in order to prevent inequitable transfers of burdens within society and to insure optimum allocation of water resources in our economy.

CONCLUSIONS

A primary function of the private market—the apportionment of resource supply to different uses—is not accomplished satisfactorily in the allocation of water resources in the United States. The significance of pricing water below cost has been discussed in Part II above, but the attainment of a socially optimum allocation of water resources may also be inhibited by the operation of

certain water rights doctrines²⁹ and the inability of the private market to encompass the full range of cost transfers that take place in the economy. In important instances, the market is not capable of measuring and relating to other water-using activities certain essential needs, such as those of health, sanitary, and recreational water use.

It is concluded that a closer approximation of the socially optimum allocation of water resources requires the following considerations:

- (1) A low water price for that portion of personal consumption essential for health and sanitary purposes. (A subsidy will be required for this purpose.)
- (2) A water price for other uses that covers the full costs of production, except in cases where specific public policy objectives are to be served.
- (3) The elimination of water pollution in cases where:
 - (a) A health hazard is involved,
 - (b) Although pollution is the result of a public agency, the gain to society from abatement is greater than the cost of abatement,
 - (c) Abatement eliminates inequitable and substantial cost transfers between communities that otherwise cannot be satisfactorily adjusted,
 - (d) The individual or enterprise shifts to society or important segments of the public the costs of waste disposal through the impairment of public or private welfare, and
 - (e) Gross inequities result from private shift of costs of water disposal of wastes that benefit through low price the users of certain products, but injure through impairment of water resources other private parties.

²⁹ See J. F. Timmons, op. cit., p. 1256, and "Discussion: Can Water Be Allocated by Competitive Prices?" by R. Barlowe, *Journal of Farm Economics*, Vol. 38, No. 4, December 1956, p. 1279. Barlowe contends that "In our appropriation doctrine states, and even in our riparian doctrine states, one's supply of water is much more dependent upon his possession of a water use right than upon his ability to bid up water prices. A person or industry with great need for water can often buy the land and water rights of others. But even so, it may be observed that the holders of water rights often use their water resources in a lavish or even wasteful manner at times when these same resources could be put to more productive use by other operators or other enterprises." —Ibid., p. 1280. In cases where water rights holders use water wastefully in comparison with alternative opportunities, the resource owner is acting irrationally or capriciously, does not have adequate information, or is confronted with indivisibilities in the transfer of water rights.

The Political and Economic Framework of Water Resource Development Research

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PROBLEMS OF WATER DEVELOPMENT AND CONTROL must be studied and solved within a framework that is both political and economic. It is necessary therefore, to understand the nature of both of these disciplines as they relate to water resources and the relationship of each to the other. The purpose of this paper is to describe the nature of the relationship between the political and economic frameworks of water resource development problems. In order to accomplish this task, it will first be necessary to discuss two methods of resource allocation—one economic and one political. Secondly, we will look at goals from these two points of view. Thirdly, notice must be taken of the special characteristics of water and, finally, the significance of the simultaneous existence of two analytical frameworks¹ will be considered.

1. Methods of Resource Allocation

In order to analyze problems concerning water resource development, it is necessary to consider the ways in which resources are allocated. All resources are allocated under one of the following methods or some combination of them: (1) by following customs, (2) by decisions of authorities, (3) by people buying with dollars in the market place, and (4) by people voting with ballots at the polls.

Allocations which are determined by authorities and those made by custom may be omitted from this discussion, as their importance is limited. The discussion then narrows to two principal methods of resource allocation—by buying and by voting, i.e., price allocation in the market and vote allocation in the legislature²—the economic and the political allocating systems.

The economic or market allocations are made by people who make purchases in the market place. Consumers register preferences for one product over another through their purchases of the favored product. In the

process of satisfying that consumer demand, producers allocate resources, through their purchases of raw materials required to produce the desired product. This choice-indicating and resource-allocating process is the basis of contemporary economic price theory.

The political system provides another resource allocating process. Resources are allocated by legislators when they vote for and pass laws which state definite objectives concerning resources, appropriate funds, and provide for a means for achieving the objectives. Further allocations within the political systems may be made by judges and administrators when they interpret the legislatures' statutes through judicial opinions and administration directives.

Although the final allocative decision is made by the legislators, judges, or administrators, the resource allocating process includes all the discussions and debates in public meetings, in columns of newspapers and among neighbors, which takes place prior to the formal political process. Just as the preference indicator and resource allocation method which operate in the market place constitute the core of economic price theory, so the choice indicator and resource allocation process which operate through political institutions constitute the core of the political resource allocating theory.³

These two resource allocating processes refer to two distinctly different types of problems. The market allocation of resources is generally associated with private ownership of resources, with the production of consumer goods, and with the production of capital equipment necessary for producing consumer goods.

The legislative allocation of resources is associated with a number of situations which may be classified into four type situations. The four type situations are:

1. Government-owned resources are allocated by the government units which own and control the resource. This type of political allocation is of importance in western states (U.S.A.) where the amount of land that is controlled by the political institutions is nearly 50 per cent of the total land area. Also, it is important in water resource development programs as water and water courses are usually owned by state governments and their appropriation and use controlled by state statutes.
2. Resources necessary for the attainment of paramount public goals are allocated through the political process. Land needed to construct a reservoir



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Photos Courtesy Ontario Department of Planning and Development

Figure 1. Many of the early forest plantations in Norfolk County in the Big Creek Region Conservation Authority are now yielding returns in the form of poles, pit props and pulpwood. Thinning from the 25-year-old red pine plantation on the left yielded a net return of \$100 per acre. The 30-year-old jack pine plantation on the right is being thinned for pulpwood.

or dam site for public purposes is taken by the federal or state government, or their agencies, under the right of eminent domain.

3. Resources required for regional development projects are allocated through the political process when the scope of the development is in excess of what would be feasible for private enterprise to undertake. A multiple-purpose development program such as the Tennessee Valley Authority must be built by a public authority, as many of its aspects are not profit oriented (e.g., flood control, soil conservation, malaria eradication), and so beyond the scope of private enterprise.
4. Scarce resources which are considered to be essential for life must be allocated or rationed by political institutions. Water in an area where the supply is relatively short in relation to need and accustomed rate of use is usually rationed by a government authority under police power.

2. Goals of Resource Development

All goals concerning resource development may be divided into two categories—private and public. Private economic goals are the goals set by individual entrepreneurs, by owners and managers of business firms. In economic theory, private goals are usually assumed to be the maximization of profit. Other goals such as

minimizing losses or maintaining good will are also encompassed in micro-economic theory. There are no private goals in political economy as this field is a study of groups organized and participating in the political process.

Public goals are the resultant of the competition among the goals of all of the organized economic groups in the body politic.⁴ Public goals have both an economic and a political aspect. In a major program of water resources development for instance, the public goals might include the following: (1) to control floods, (2) to develop irrigation, (3) to supply water to municipalities, (4) to provide transportation, (5) to provide habitat for wildlife and aquatic life, (6) to provide recreational facilities, (7) to supply water to industry, (8) to dispose of domestic and industrial wastes; and (9) to produce electricity. Each of these goals is a public goal as a group of citizens with a common *economic* interest is organized to support and promote that interest in the *political* arena.⁵

Even though public goals are based on and derived from private goals, they are clearly distinct from private goals. Private goals concern individual firms; public goals concern organized groups of people. Private goals are achieved by private planning, investing, management; and activities in product and factor markets. Public goals are achieved through public planning,

Figure 2. Water recreation facility in Boyd Conservation Area developed by Metropolitan Toronto & Region Conservation Authority. As many as 6,500 people visit this area on a warm summer day.

Photo by Leo Pylawsky



legislative enactments, legislative appropriations, judicial decisions and the actions of public administrators.

General and Specific Public Goals

All public goals may be further divided into two classes, with respect to the degree of abstraction of the concept concerned. One class consists of goals which are *abstract, general, ultimate, or theoretical*. The other category consists of goals which are *concrete, specific, immediate, or practical*. An example of a general goal is the goal of "full development of water resources." A specific goal is the goal to build a dam at Ferguson's Crossing. General goals are goals which must be further defined in terms of specific situations before they take on an objective meaning, i.e., a meaning which several people can understand in the same way. For instance there is general agreement on the general goal of "full development of water resources." However, what this term means to people with various economic interests would vary according to those interests in a specific situation. Some people would say that this general goal may be implemented by constructing a dam at Ferguson's Crossing. Others would say, "No—this general goal can be implemented by pursuing the specific goal of constructing a dam at Roger's Creek." In either case the specific goals are sufficiently definite to permit all interested parties to determine their interests in the proposal.⁶

This duality of goals is of critical importance because it involves acts of valuation. A value judgment is in-

volved when one translates a general goal into a specific goal. In order to interpret the general goal of "full development of water resources" into terms of a specific goal such as a dam on Roger's Creek, it is necessary for the interpreter to make a value judgment to the effect that the constructors of a dam on Roger's Creek will contribute to the general goal of "full water resource development." Another person with different interests might use a different value judgment, make a different interpretation, and say that the general goal would better be obtained by locating the dam at a different place. Although there may be agreement on the general goal of "full" development, different *economic* interests and different value judgments may lead to diametrically opposed specific goals concerning the project required to bring about "full" development.

This distinction between general goals and specific goals is of critical importance as all tools of economic analysis designed for use in problem-solving assume that goals are specific in nature. General goals are not definable in terms which a large number of people will agree upon. Hence, they are not precision concepts of the type necessary for economic analysis, planning or research. On the other hand, specific goals *are* amenable to use with the tools of economic analyses and research. It would be conceptually difficult, for instance, for an economist to say what would promote a general goal such as "the maximum economic development of a watershed." On the other hand it would be possible for him

to state how a municipality could obtain a certain quantity of water most economically.

There is no suggestion here that abstract or general goals are unimportant. They are as important in our culture as the specific goals. It is necessary to understand the process by which individuals, economic interest groups and legislators move from abstract goals to specific goals in order to discover the starting point for economic research on complex problems and in order to focus the research on the strategic aspects of a situation.

The Determination of Specific Public Goals

The formation of specific goals is accomplished by groups of people organized on the basis of common economic interests communicating through political institutions to legislators who enact statutes. Each economic-interest group is a sector of the political economy and its goal may become a part of the public goals. For instance, the farmers in the lower valley of the Red River want more water for irrigation. They organize and proceed to explain their interests to local voters and legislators. A group of consumers of electricity in the same watershed may argue that the public interest can better be served by the production of low-cost power. The consumers will try to influence the electorate and other political agencies to promote hydro-electric power development. A third group may wish to have a reservoir built to provide recreational facilities which will enhance land values. This group will try to influence legislators according to this interest. A large number of

other special-interest groups also will organize to promote specific goals. Municipalities, conservationists, the Corps of Army Engineers, power companies, chambers of commerce, and other groups will make their interpretation of the specific goals required to implement the general goal of maximizing water resource development. Each group will present and argue its case through conventional political institutions. To parallel the level of abstraction used in economic terminology, we would say that under conditions of "pure and perfect" legislation the law that results from this process will maximize social satisfaction. *In practice, legislatures are probably as efficient in allocating resources in accord with public demands as markets are in reflecting consumer demands.*

Conflicts Among Goals

Both economic and political resource development research would be simple if public goals came ready-ordered into a neat hierarchy. Such is not the case. Public goals are invariably multiple, often conflicting, and frequently diametrically opposed.

There are three approaches which researchers may take in situations of multiple or conflicting public goals. The researcher may (1) solve the problem by assumption, (2) arbitrate the disagreement over goals, or (3) investigate the problem further to find an ordering among the goals.

The question of goals is solved by assumption when an assumption is made that "everyone favors wildlife conservation" or any other specific goal. Arbitration of conflicts over goals is conducted by mediators. The science and art of collective bargaining is based on this approach. A third approach by political economists is to investigate goals. Goals may be investigated by use of the same techniques employed in the study of any other social science phenomena.

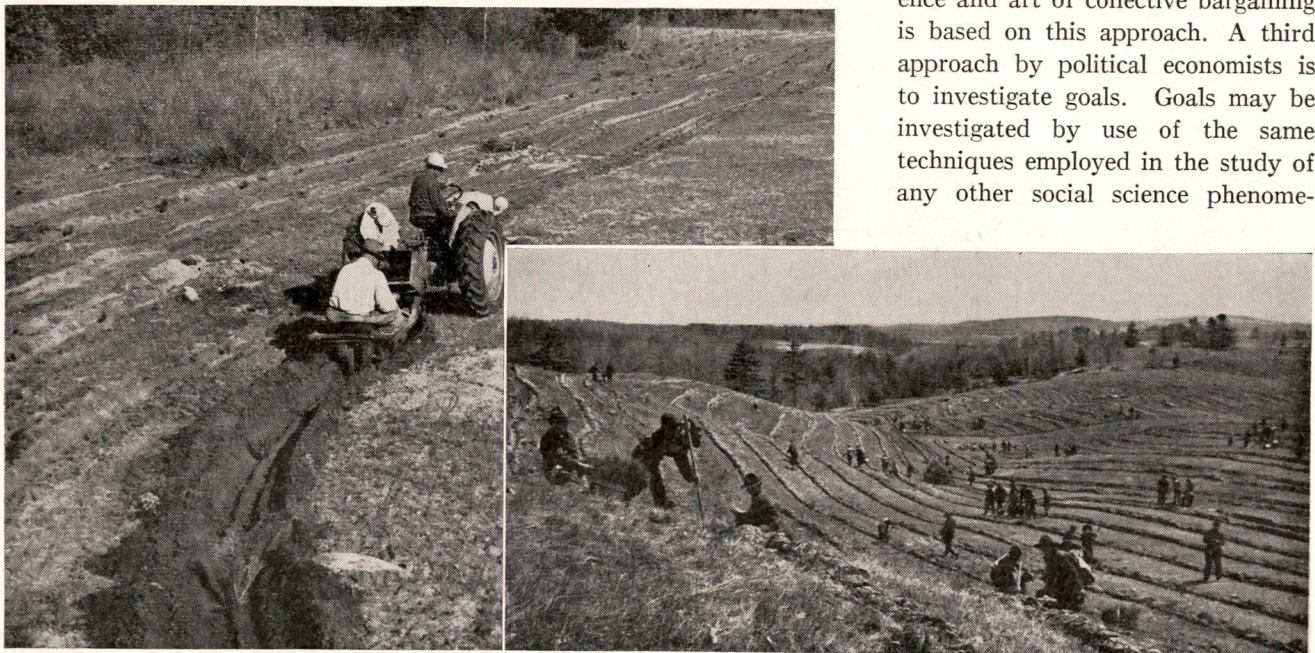


Figure 3. *Right.* Boy Scouts by the hundreds assist in tree planting on the contour under the auspices of the Ontario River Valley Authority. *Left.* Under its private reforestation assistance program the Grand Valley Conservation Authority planted 348,000 trees in the spring of 1959. The equipment and two men are supplied free of charge provided the owner agrees to maintain and protect his plantation.

Photo Courtesy Ontario Department of Planning and Development

non. It requires special training, experience, and know-how to identify and categorize the multiplicity of public economic interests, but these special analytical techniques are now fairly well developed and are employed with a high degree of success.

3. Unique Characteristics of Water

Water resources have four unique characteristics which limit the nature of analytical tools which may be used in analysis of water problems. In the first place, water is generally characterized by group ownership. This is generally true wherever water is scarce. Ownership is often divided among the federal government, the state governments, and local associations and sub-divisions of state government.

Another important characteristic of water is that it can be changed from an economic good to a disutility by a change in the supply. In time of flood, water becomes a public menace and must be treated like an invading army of an enemy nation, i.e., the threat must be alleviated without immediate concern over costs. Problems of allocating costs of flood prevention specifically to individuals or units of government become secondary to the task of flood prevention itself.

Another aspect of water resources is that most of the many projects for the development of resources must be carried out on such a large scale that it is necessary for the state or federal government to provide assistance in planning and financing. This is necessitated not only by the scale of water resource development projects, but also by the fact that water is associated with so many uses, some of which, such as flood control, sewage disposal, malaria eradication, are not profit producing or profit orientated.

4. Implications for Economic Research

- Water is generally allocated by the political system.
- Water resource development goals are characteristically multiple and conflicting.
- Water is significantly different from other economic goods in critical ways.

These facts necessitate the use of special research techniques in the study of water problems. Analytical techniques applicable to business firms that buy and sell in a market economy, that seek to maximize profits, are understandably inadequate in the study of a resource such as water. Water is less influenced by prices of factors or products. Water has a number of simultaneously conflicting uses, both private and social, and it can become a public nuisance or scourge with a change in supply.

The fact of legislative allocation of water resources requires that economic analysis be conducted within a dominant political framework. The function of the

economist becomes that of evaluating benefits, costs and incidence of costs of alternatives proposed within the political framework or ones which are sufficiently feasible to be proposed. A municipality, for instance, in considering the installation of a water supply system, is not concerned with alternative investment opportunities but rather in the lowest-cost politically-acceptable way to achieve the goal specified by the tax-paying voters in their vote for a water bond issue. The allocation of water for municipal use is determined by the voters before an analysis is made of the least cost method of supplying water.

The multiplicity of goals and the unique characteristics of water present additional special problems not encountered in analyses in which goals are simple and assumed to be given. To handle this problem the economist must commence his research with an investigation and evaluation of the goals held by various groups. To do this it is useful first to identify the economic and special interest groups as well as the various levels of taxpayers and voters who may have a direct or an indirect interest. After identifying the various "publics" it is necessary to weigh each in terms of political influence, numbers, and direct and indirect monetary interest in terms of taxes, investment and benefits. This is a complicated process but the methodology of this type of analysis has been worked out in considerable detail until it is now fairly routine for those with specialized training.

The end product of research in water resource development problems is often quite different from the end product in other, more conventional, types of economic analysis. The actual nature of the research product will depend upon the situation. It may take the form of an analysis of the economic implications of proposed programs or schemes. It may take the form of a new policy proposal suggested by an examination of the nature of goals held by interested groups and the potential for development of the resource base. The economist, if successful, may become involved in the planning process as an "expert". His research product, then, will be indistinguishable from the contributions of the many other professional planners. In any case his contribution will be in the nature of critical appraisals of proposed plans, studies of analogous situations, suggestions of new legislation to change the framework of resource allocation or economic analyses of administration procedures and programs.

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- ¹ This paper is addressed to some of the major theoretical issues concerning the applicable theoretical framework for the analysis of water resource development problems. These issues have been discussed and debated extensively by agricultural economists and others in books, journals, and conferences. As examples of this debate see: W. L. McPherson and Raleigh Barlowe, "Can Water Be Allocated by Competitive Prices?" *Journal*

of *Farm Economics*, Vol. XXXVIII, No. 5, December 1956; Emory N. Castle and Irving F. Davis, Jr., "The Applicability of Marginal Analysis to Problems of Resource Allocation," *Water Resources and Economic Development of the West*, Western Agricultural Economics Research Council, Report No. 5, December 20, 1956, Berkeley, California; S. V. Ciriacy-Wantrup, "Resource Conservation Economics and Policies," University of California Press, 1952, p. 241 in various passages; John F. Timmons and Clyde E. Stewart, "Policy Aspects of Water Resource Development," *Water Resources and Economic Development of the West*, Report No. 2; Institutions and Policies, Western Agricultural Economics Research Council, Bozeman, Montana, 1954; John F. Timmons and Earl O. Heady, "Iowa's Water Resources," Iowa State College Press; and Raymond J. Penn "Public Interest in Private Land" in *Land Problems and Policies*, edited by John F. Timmons and William G. Murray.

² Cf. John R. Commons, *The Economics of Collective Action*, The Macmillan Company, 1950, Chapter III.

³ It is, of course, recognized that market resource allocation takes place within a legal framework and that legislature allocation is

usually influenced by market considerations. The point here is to call attention to these two basic resource allocating processes in order to suggest that economic or political theory developed from study of one process may be ill adapted for solving problems occurring primarily within the other process. For another point of view concerning this subject, see Erich W. Zimmermann, *World Resources and Industries*, revised edition, Harper Brothers, 1951, pp. 21-30. Zimmerman divides our economy into three categories, the private sector, the public sector, and the "third economy" in which private and public interests are both involved.

⁴ The concept of the "public" used here was developed by John Dewey. See *Intelligence in the Modern World*, Random House, Inc., 1939, pp. 365-370.

⁵ Cf. Kenneth J. Arrow, *Social Choice and Individual Values*, John Wiley & Sons, 1951, Chapter 1.

⁶ F.S.C. Northrop makes a similar classification which he terms "Normative Social Theory" and "Factual Social Theory." See *The Logic of the Sciences and the Humanities*. Macmillan, 1957, Chapter XXI, pp. 328.

Riparian rights.

1928 amendm., 135 Peabody Valley.

Before, stop upstreamers, take from downstreamers, sue exorbitantly.

Decl. inj. still possible, good farmer.

M&L vs. Madera; Woodbridge vs EIS.

7.5%. But vast possibilities, big tracts, M&L.

Appr. rights.

Chaos.

1913.

Defects: stop him from using it. 5 yr prescr. rt. Aggressive rip.

he tries to use more than needs, sooner than needs. Neg. price of water.

Individuals no eminent domain.

Xfer.

Rip. non xt.

Appr. becoming so.

Rip. land hard to subdivide

Chanel losses, inferior land.

Coop. - hindered by many causes, Kings & S.
hazards of jr. righters.

Ord. water.

Storage not sole benefit. IOs solve partly.

Underuse not probl. Indiv. cost < soc. cost. A pump costs & compressed aquifer

IOs: Cond. power

Sell outside, no right est.

Inside, pretty fungible. Various systems. - assignment by land value, to straight sale.
No export charges. recent growth of later

Demand doesn't det. price, price just set, other rationing used.

Ord. water saved. storage made ec. (KCh same, any large unit)

Differential taxation could be used to reduce pumping.

Bringing land into use. Stopping spec. Cutting down large holdings. Preventing waste of
depletion. Tax has done it, where applied. Depr. delinq. Has encouraged development.
~~Evidence in text.~~ tax not reduced with depl.

But cannot expect local govt. to tax away all land values. Will tax newcomers.

Hastens subdivision. Carrichael. W. Stam. & B-C.

Other reasons. - irrig. takes cap. intensive. Role of taxing just to cut spec.
motive. 30 acre farms.

THE UTILIZATION OF LAND AND WATER IN CALIFORNIA.

An economists evaluation of existing institutions and suggestions for improvement.

CONTENTS:

I. The Established Pattern

A. Water ownership and distribution

Tax exemption of ID prop bad, esp. when used to hold water idle.
Bond exemption subsidy. Bond default subsidy. We have more irrig. than
ec. - some that land tax subsidy underused.

CVP. 2m a-f/yr. 2 classes water, harder rty of supply.
No vested int. 40 yrs.

Tulare is Kern Cty, e.g., 1/2 of IDs broken probly. But this is a
political distrib. somewhat, too bad. Many will hold out always.
Needs to tax land, to stop h.o.
160 acre law doesn't force to sell.

See paper for rest.

Early IDs ^{foolish}
on public
lands?

Israelson, Irrig. Principles & Practice, 1932

Avooring Hutchins. Many IDs hit because they counted on involuntary inclusion of public lands ~~included~~ encompassed. Now they are generally liable. - i.e. public lands are liable to be included.

1928, 7m acres in 407 operating IDs, 4m of which got water.

p. 290

Several states have bought ID bonds to help the boys along. Wash. & Oreg. were repudiated, Wyo. not.

Bennison, Ground Water, 1947.

In Katz vs. Walkinshaw a Cal. court announced a new doctrine, of "correlative rights". It is by this that rival owners are subject to proration. It followed the general American line of 'reasonable use' of ground water, which was first advanced in an 1862 N.H. case & spread. Eng. system, by contrast, was riparian, unlimited use.

Value of
imperfect
cap. rights.

(could be that imperfect cap. rights, like restriction in general, serve a useful purpose in sparing society - I see our people invest in new, experimental things that may not pay off for years. A subsidy to experiment.)

? —

If, by Katz vs. Walkinshaw, courts may prorate scarce ground water, we can restrict pumping now. But we don't. Why? In east, has not been applied at all he says, has resulted in much waste drying up, salting in.

Restrictive Water
law

In NJ & NY, must get state approval for new well. - if you are to supply the public. But if you are industry, is ok!

Doctrines of 'reasonable use' & 'correlative rights' not recognized widely enough to solve. He suggests applying appropriation doctrine to solve it. In west this possible because state constitutions or laws say waters belong to public. Some e. states do - Mass., Ohio.

Watershed
control

Sanpete Valley, Utah, depended on mts for water, they were denuded by overgrazing, water crisis. 1903, US Forest Service took over, restored vegetation. Moreover, by controlled grazing, kept as many cattle on it as ever -- range management. Forest Service "had to be forced on the people", but has been of incalculable benefit. Who forced it, pray tell?

Mormon canals were usually cooperative community undertakings. When church decided to colonize a new area, a leader was chosen, primarily for religious zeal, also because of knowledge of irrigation. But settlers themselves would decide if this leader were to be on elected committee which handled irrig. matters, and settlers decided how much land should be brought under canal.--i.e. how high a line the canal should follow.

Usually they started out with a low line canal, then as more settlers came, built higher & higher, so today have a series of them, instead of one high line with laterals, which would be best if one were starting from scratch with lots of people and capital.

The lands of a valley were divided among different settlements and, while occasionally a person in one town owned land also in another, "it was not a common thing".

Where canal served two or more towns, all towns would work on it until it reached the first town, then "an accounting of the work done was had and the water from the canal divided accordingly among the different towns" -- wow, no wonder they pitched in and worked! Then they proceeded to the next town, and so on, the first community having dropped out.

Farmers maintained canals with own labor, little labor hired, same methods used to present.

D2 Each settler possessed a small farm. Large claims not allowed. This made close settlement possible, and thereby made canals possible, also supplied labor to build them, for they worked themselves, canals all built with no bonded debt of any kind. p. 27 *Too bad*

1910, 1m irrig. acres in Utah, of which 222,000 irrig. by indiv. & ptns. canals, 687,000 by cooperative canals.

The remaining 9% he doesn't specify. Cost, \$11.22/acre.

✓ - Ave. farm: 33 acres. *Poor land, small farms.*

Not until 1869 did Federal survey get out to Utah. State of Deseret, and Territory of Utah, didn't feel they had rights to dispose of lands permanently, residents were only squatters they knew. (?)

D2 Plan of Salt Lake applied to all Mormon towns. 10 acre blocks, cut into 8 lots of $1\frac{1}{4}$ acres each, on which you were supposed to have vegetables, orchard, residence, etc. Barns, too -- so our midwestern farm unit system is unknown out in Utah. Idea was to establish a village community system -- necessary for protection vs. Indians. Also allowed social life. Close environs laid out in 5-10 acre lots, with enough left over for later settlers. Beyond this, irrigable land divided into 10-20-40 acre

lots. In the older parts of the State, cultivated land near cities is still held in 5-10-20 acre lots. In some cases, where nature of crops made larger units better, has been some consolidation. Church authorities would not allow speculation in early days, and one not allowed to claim all the land he wanted. (tho I'm sure the church itself was glad to claim lots of land as vs. gentiles)

Allotments were made to single major males and to married ones, proportionately to those dependent on them -- i.e. the more kids, the more land. More wives, more land. If more land subsequently brought under higher line canal, additional allotments made (so each man owned two separate pieces? Clumsy)

In low spots in valleys near streams, wild grass might grow. Each settler allotted a portion of this -- of the land, not the grass. Was also common pasture, on which cattle herded by townsman during day, returned to barns at nite to prevent theft by Indians.

1852, in default of Fed. action, Territorial leg., which was controlled by church, passed land laws, declaring titles good, said a man could get title to open land by fencing and recording it -- this limited size of claims, because it was colossal work to fence land.

Many transfers of claims -- system was not rigid, evidently -- and church &/or territory had them give quit-claim deeds.

They couldn't claim their land under Pre-emption Act of 1841, because minimum to be claimed under that act was 40 acres; and you had to reside on your land, which they didn't, and couldn't because of Indians. Under homestead, min. was 80, and resid. still required. But all this was got around, in 1869 when land office set up, they sent one man to apply for 160 acres on which 30-60 families lived, then he would split it up among them. They would build a cabin at the 4 corners, sleep in it one nite, etc. All this done openly with connivance of govt officials, tho literally illegal.

Chap. 4: Water Legislation, 1849-80

So Cal. not the first. Cal. adopted rip. rts despite Utah's good eg. Riparian rights rejected from start. Appropriation under special acts, limited to reasonable use, and changeable if amount proved too much, etc etc.

1853, Provo Canal & Irrig. Co. first corp. chartered in Utah, with water rights and power to sell water.

1854, Territorial Legislature approved a canal w. of Jordan from Utah L. To SLCity. It recognized the propensity of people to hold land next to canal without buying water in hopes of bankrupting co. and later getting water at bankruptcy prices, p. 49. It tried to prevent this by forcing ~~adj~~ benefited lands to take the water and pay for it. But the settlers had no title to their lands, and if they refused to pay, only remedy was to shut off water. He's not too clear on details, but spirit of his remarks is wonderful, I must stop in U. Utah lib. in SLC and look for more of his works. This is an early recognition of the principle embodied in i.d. leg., he says. Also idea of Carey Act, requiring new settlers to assume burden

of canal construction upon entry.

/ The authority for canal co. to have a lien on land was lacking, but he thinks that was what they had in mind.

He describes other systems, all different. Mutuals, corps with power to sell water all over, etc. Finally, 1862, Jordan Irrig. Co., to take from Jordan 12 miles above Temple St. and serve both sides, tax lands benefited, and sell stock also, the stockholders but not the land owners to have voice in co.

1867, last of special charters. Because Congress then forbade legislatures of territories from special charters, all chartering had to be by general act, open to all.

(One could study the records of these various old co.s with their special legislation, get contrasting results)

Most of these above, tho, were only contemplated, never constructed. It was the small mutuals that fruited. Irrigation District Act of 1865 was passed because so few large canals were constructed under existing institutions, but were needed. Also, big canals -- e.g. Big Cottonwood Canal -- were subsidized from public treasury. (which was filled with prop. taxes?)

By Act of 1852, County Courts had been given power over water in Utah, water being recognized as public property, they were to administer it for most public benefit. (they could do this because they had a form of restriction of benefits, i.e. to Mormons) In "more remote" counties, county courts didn't exercise this power, because water was so plentiful relative to pop. In Salt Lake, Utah, Sanpete, Weber, Davis, Box Elder, and Cache Cties, they did.

retrogression By 1880 law this was ended, and water became private property. Previously it had been appurtenant to lands, now it was separate from them, could be transferred at owner's will. Thomas disapproves. Could not change place of use of water if that interfered with rights of another, tho. Thomas thinks this will make owners of water masters of owners of land. Purpose of act was because power was being turned over to Non-Mormons by congress, they were not interested in ag., so to prevent making govt deal with water, they just declared it private prop. and left future disputes to courts.

1880 Act required 7 yr.s of non-use to abandon right.

Streams have not ever been carefully measured and rights adjudicated.

Ch. 5, County courts and control of irrig. water.

W p. 60. Water masters were paid, & ditches maintained, by an acreage tax.

State of Deseret granted water rights. When turned down for admission, Territory of Utah organized, 1852, and promptly reenacted all Deseret legislation.

The county courts kept control of water rights, distributed water for general welfare, never for a few. Never allowed large appropriations, even if water wasn't being presently used, looked forward to keeping some for later arrivals.

When water grants were made, they were to be in canals planned by watermaster, he to have in mind overall plan.

If a grantee didn't use his water, it was taken from him sometimes, if someone else applied for it.

I would say in criticism of cty. ct. adm. that individuals couldn't make plans, there were no fixed principles of law, the cty. court was absolute. It could take away what it had already given, even.

Many canals & dams etc were financed from donations by cty. or church. But only Salt Lake & Weber Cties. ever donated.

Many transfers of water between persons and lands and diversion points occurred on informal swapping basis. Courts formally insisted that such get the r approval, but many didn't.

Where rights est. before cty. courts were in excess of reasonable use, they cut them down, did it often. -- here is a good precedent for Calif. in dealing with Miller & Lux etc. p. 83

Streams were commonly divided in fractions of the flow, not in quantities with priorities -- aha, here is a good feature that my proposed system sharew. Risks shared among all. I wonder if this still is system?

p. 91. It was not possible to appropriate waters not presently needed in hope that at some future date they would be useful, thus retarding development of others. And legal service was not expensive.--it was free, in fact.

Chap. 6: City control of water.

In effect, the contributions of individuals in building canals did not determine how much water they got. All got what they needed, regardless. For community would have to support them anyway, if they denied them water. (this sort of communism must have restrictions on membership somehow)

New members were taken in and given water w/o requiring work. Was understood they would work to widen canal if it became ned. (no wonder system broke down)

SLC, Ogden, Logan, Provo, Am. Fork, had city control of water in city and considerable environs. They assessed lands benefited for works, & maintenance. Logan assessed lands not directly benefited, too.

When IDs were formed they came into conflict with city jurisdiction in Provo, and city stayed supreme, i.d.s folded. City still controls all water from Provo R., taxes farm lands and city lots. For industrial use it grants franchises. American Fork also keeps control. Other cities have lost it. Because Provo & Am. Fork are controlled by farmers. No danger that city will take water from their lands.

pp. 112-6, describes taxation to finance irrig. works. It was on acreage and on lots, flat rates. Mentions that in 1871 Logan shifted to gen. prop. tax in part. (So the same tendency obtains in Utah as in all the west, to shift away from land taxes!) These land taxes were quite universal, were main financing of canals. Water not

Shift from
LVT

sold for any charge, not even the proportion to work done on canal. The Logan shift of 1871 was just within the city, for maintenance of canals within city -- which served farmers outside city. Is the the first blush of monopoly consciousness?

Chap. 7: Irrigation Districts

By 1865 Act they had no bonding power. He implies that some of them actually did build canals, and tax land. (I suppose the no bonding provision jibed with mormon faith not to borrow) But a state court decision said they must tax all lands included, they promptly disorganized, for most land included was not irrigable. Works taken over by mutuals.

Present i.d. laws of Utah as bad as any state he thinks, meaning by bad they can be "promoted", bonds sold w/o much regulation, etc.

Ch. 8: County water commissioners.

They, under 1880 Law, succeeded the county court as water controllers -- except they didn't control as courts had done. They gave claimants as much water as they asked for provided no one else objected. Many very large water rights thus created.

1880 Act recognized vested water rights. 7 yr. open use gave "primary" right. Flood water users had 2dary rights. Except these 2dary rights were often not flood waters, but unused waters subject to primary claims, and they ripened into primary claims when this became evident.

*Pro fractional
water rights.* p. 143, describes how fractional system saved the crops for all, instead of all for some, none for others. in dry years.

1880 Act also authorized corporate form, and the larger canals were turned into it, which means mutuals I'm sure, and expenses were met by levies on shares of water stock -- still no mention, absolutely no mention, of water tolls. I wonder if they use them now?

Ch. 9: The district or trial courts & irrigation.

After 1880, suits came to them. They tried to follow policy of limiting claims to beneficial use, but made exceptions. Sometimes it would take an expensive lawsuit to lay claim to waters running to waste.

Ch. 10: Supreme Ct. decisions & Irrig: rip & appr. rights.

Rip. doctrine rejected from start. Toward 1890, when water began to get scarcer, and later comers contested for a share, and earlier comers claimed priority -- note the evolution toward a closed system --- earlier they welcomed the newcomers --- courts granted them priority.

At first, as to ground water, any owner could take any amount regardless -- tho only a case or two ever arose. But in 1912, in Gans vs. Rollins, followed Katz vs. Walkinshaw, which Thomas calls epoch-making, limited each to reasonable beneficial use.

p. 179-180, water users do not own the water, they merely have a right of use.

Chap. 11: 1880-1918 irrig. legislation.

Chap. 12: The Bear River Canal

A big project. Bear R. flows thru rocky steep gorge from Cache Valley to Bear Valley (Brigham City etc) 150,000 acres of desert thereby reclaimed. Asked for fed. aid, no luck. Diversion dam planned up in Cache V., for height.

Purpose of Carey Act was to withdraw public lands from entry and make them subject to a lien for water, thus preventing their being held by speculators.

CP owned much land of valley. Sold to Corrinne Mill Sheep Run Co., which hired promoter, offering him half proceeds of land sales if he would finance it. John R. Bothwell. It proved a success for the settlers, but the British investors lost all. -- Scotch Quakers. Engineers: Sam'l Fortier, Elwood Mead.

A Causes of loss to bondholders: High promotional defalcations; the canal co. didn't own any of the land it served. It was originally inspired by one big landowner to be sure, but it had no guarantee that even it, much less the others, & the ones it sold to, would buy water rights, which was the system used. As a matter of fact many of them didn't. Many buyers were speculators, p. 217, who didn't use the water. Long period of waiting w/o revenues broke the co.

It was the first large commercial undertaking in Utah, one of first in west, and typical of many.

Chap. 13: State projects & assistance

Piute Project, near Provo, made landowners sign contracts to take water before built anything.

Chap 14 Carey Act

Soils away from river bottoms generally have less alkali and better drainage than river bottom lands. He is thinking too of mesas or valley shoulders -- what do we call them? -- which are alluvial in a sense.

No reclamation under Desert Land Act, with its 640 acre claims, because no provision for cooperative action.

p 233 & p. 234, again describes process of attrition by which settlers and speculators delayed buying water for purpose of bankrupting canal co., and succeeded. Until finally private cap. wouldn't invest in irrigation without special safeguards. Carey Act was to allow private cap. to invest.

p. 236 Most W. States had same provision as Utah, that no govt unit should subscribe to securities in any r.r. or other promotion.

Skipped Ch. 15, Reclamation Service, Ch. 16, Drainage -- except to note they financed them thru

over

bonding and land taxes, after long difficulties in courts;
and Ch. 17, the 1919 legislation.

Logan, Utah. Mormon - worshipers.

Widstoe, Principles of Irrig. Practice, 1915.

p. 446, Hammurabi; great irrig. works; code of laws re irrig.
recently unearthed for Babylon, very 'refined'.

S. Am Indians had canals 500 miles long! (is this Mormon mythology?)

Irrig. everywhere, past & present. Persia, India, Japan, China, etc etc.
c. 400-600 AD, Roman law codes stressed irrig.

"Rival" comes from "rivers"; an irrig. ditch, users rivalled each other.

Moor, c. 800-1000, took Spain, gave irrig. - added to it, i.e.

✓ Italy, 12th c., great irrig. activity in Po. Old Roman works restored

✓ Egypt, 1820, under Mehmet Ali Pasha, great revival of
irrig. construction. - & British

✓ India, 1846, 1818, end of big famine, started considerable
projects. 1877-1897, irrig. area Δ d to 7.5% arable
land - from 6%.

etc etc. Takes 1880 as birth of modern irrig, world over.

1870-90, era of speculative developments that went best.

1910, structures existed that irrig. 14 m acres, & could irrig 20 m

WATER —Supply, Demand, and the Law

By
Irving K. Fox



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WATER—SUPPLY, DEMAND, AND THE LAW

BY IRVING K. FOX

It is my impression that most individuals have an inaccurate or at best an unclear understanding of the water supply-demand outlook for the United States and the nature of the water problems confronting the American people. Many with whom I talk feel that the nation is confronted with the prospects of a widespread water shortage, and that only heroic measures will save us from dire consequences. Unfortunately this view is so far from correct that it interferes with the kind of public action required by the wide variety of quite serious problems which we are called upon to solve.

One of the objectives of this paper is to identify relevant features of the water supply-demand outlook in the United States. In the interest of brevity, my analysis will not cover navigation, flood management or hydroelectric power, although these purposes should be considered in a comprehensive treatment of this subject.

A second objective of this paper is to suggest some of the implications of the water outlook for policies governing the allocation of water to individuals and to different uses. These are ambitious goals. The nation's water supply-demand picture has so many ramifications that to provide a reasonably accurate portrayal in a brief paper is extremely difficult. For one who has no legal training to speak of a water allocation policy—which is almost always expressed through legal processes—may be presumptuous. I only hope that my observations will be provocative of a stimulating exchange among those concerned with the science, economics, politics and law of water management.

In my judgment there are six features of the nation's water supply-demand outlook which are of paramount importance in the design of water resources policy. These emerge from an analysis of current water use, prospective population and economic growth, the role of technology in the water field, and the availability of water supplies in the United States.

My first point is that the concentration of demand in relatively limited geographic areas, and in particular the concentration of demand in areas where pressures upon

available resources are already great, will be responsible for our major water supply difficulties. It is reasonable to expect that by 1980 the population of the United States will increase by approximately 75 million. During this period economic output measured in terms of gross national product should about double. To serve this population and economy, withdrawals from streams and underground sources for municipal, industrial, and irrigation purposes may also double. This fact by itself is relatively unimportant because the nation uses but a small fraction of its available fresh water resources. According to the U.S. Geological Survey, in 1955 water withdrawals for municipal, industrial and irrigation purposes totaled about 20 per cent of the average annual runoff. The net depletion as a consequence of water development and use activities—withdrawals minus return flow—was about 6 per cent of average annual runoff. Even if withdrawals increase 100 per cent by 1980, net depletions should not exceed twelve or thirteen per cent of average annual runoff. To understand the supply problem, the geographic incidence of demand requires examination.

The map I put up over here [indicating] prepared on the basis of estimates made by Douglas Woodward of the U.S. Geological Survey, compares total supplies with withdrawals and net depletions by regions. For each major river basin the bars represent for 1955 (1) average annual runoff, (2) estimated withdrawals for irrigation, municipal, and industrial purposes, and (3) estimated net depletions. This map does not serve our purpose as well as we would like, because for some of the major river basins such as the Arkansas and the Columbia, serious deficiencies in parts of these basins are overshadowed by surpluses in others. Also, non-withdrawal demands cannot be reflected in this type of presentation. Nevertheless, some striking comparisons can be made. For example, in the Colorado-Great Basin region, where supplies are scarce, withdrawals exceed average annual runoff and net depletions equal about two-thirds of average annual runoff. At the other extreme in the southeast, where sup-

plies are large, withdrawals in 1955 were about 5 per cent of average annual runoff and net depletions were a third of one per cent of average annual runoff.

In brief, these data suggest the following: First, throughout the 31 eastern states there are abundant supplies of fresh water awaiting development. If there are problems, and there are some, it is not because of quantitative shortages. Second, in the West the reverse is true. Except for the Pacific Northwest, net depletions in 1955 were dangerously close to the natural supplies available to the region. In some localities, dependent upon ground-water sources, depletions far exceed the average rate of recharge of the aquifers.

Looking to the future, we anticipate that population growth will occur almost entirely in urban communities and, for the most part, in metropolitan areas. About half the increase will probably occur in the north-east-midwest manufacturing belt where we already have such a large concentration of population and industry. In general, a relatively large increase in the population of the eleven western states can be anticipated. It should not be surprising if the population of the western states should double by 1980.

It follows that increases in municipal and industrial water demand will be much greater in some regions than in others; in all regions demands will be particularly heavy in the vicinity of metropolitan agglomerations; municipal and industrial demands will multiply in the water-scarce West.

The outlook for irrigation demands is more difficult to specify. Since the West has many millions of acres which would be highly productive if water were applied, the only limitation on western irrigation is the availability of low-priced water. In the East irrigation is growing rapidly but it is not at all clear how much growth we should expect because we still do not know enough about the economics of humid land irrigation. It is evident that eastern irrigation will tend to concentrate more in some areas than others, in part because of proximity to markets, and in part because of land suitability. The Atlantic Coastal Plain and the Alluvial Valley of the Mississippi

appear to be among the most promising areas for large-scale irrigation expansion.

Our economy functions on the basis of an abundant supply of low-priced water. The irrigator can seldom afford to pay much more than a penny a ton for water at his head gate. Most home owners are accustomed to having clean water delivered to their bath and kitchen for about a nickel a ton. Water cannot be transported very far for these prices. Can we continue to supply the areas of concentrated demand—the metropolitan regions, the industrial complexes, the irrigated areas, the whole arid and semi-arid West—with an abundance of reasonably low-price water?

This brings us to the second point about the water supply-demand outlook. Although promising progress is being made in research on desalinization and weather modification, it is still too early to base policy and development plans on the assumption that large additional low-cost supplies can be assured from these sources. Desalinization costs are still in excess of a dollar per thousand gallons for sea water. Brackish water, which may have from five to ten per cent as much salt as sea water, can be sweetened for around 30 cents a thousand gallons. To be economic, these costs must be brought to four or five cents a thousand gallons for irrigation and to around 25 cents a thousand gallons for most municipal and industrial uses. The conversion of brackish water is nearly economic and the prospects are that in many western areas, cities and industries near brackish sources will be able to use this technique.

On the other hand, with minor exceptions, a major technological break-through not now on the horizon will be necessary to make the desalinization of sea water economically practicable for either irrigation or large-scale municipal and industrial purposes.

It is the conclusion of the President's Advisory Committee on Weather Control that rain can be artificially induced at relatively low cost in the mountain areas of the West. This group also concluded that in the non-mountainous and eastern areas of the country the evidence that weather modification efforts produced rain was inconclusive. Today weather modification

still is not a dependable means for increasing the nation's water supply. The proper cloud formations are necessary to produce rain and when the techniques are applied it is not entirely clear as to where or how much rain will occur. Since there is some uncertainty as to whether weather modification may alter the location of rainfall, the technique raises some interesting legal issues.

In making these observations about desalinization and weather modification, I do not wish to minimize the promising progress which has been made. Undoubtedly some cities and industries will soon benefit from desalinization of brackish sources. This progress indicates that support for further research in these fields is justified because of the hope that artificial supplies of low-cost fresh water will eventually become available. The fact that prospects are still somewhat remote for supplementing natural supplies with large quantities of low-cost fresh water produced by artificial means leads me to what I view as the new role of water in western economic development.

My third point about the water supply-demand outlook is that, in the future, the economic growth of the West will be identified less with irrigation and more with the use of available supplies for municipal, industrial, and possibly recreation purposes. As our map illustrates, in many parts of the West existing demands are pressing hard upon total supplies. In drouth years many water users are experiencing severe hardships. Yet, the growth of the West—and in particular the Southwest—continues apace. Between 1940 and 1955 the population of the eleven western states increased 83 per cent in comparison with a 24 per cent increase for the nation as a whole. In my judgment, the West is destined to continue to enlarge its share of the nation's total population and economic activity. Most of this growth will not be dependent upon an expansion of irrigation. If this is a valid conclusion, the major function of western water management is not to promote western development but to accommodate the growth that now seems certain to occur.

The western economy, because of its historic reliance upon irrigation, requires a

large amount of water to support its population. Again, some comparisons are revealing. In 1955 the eleven western states supported about 25.5 million people by withdrawing from surface and underground sources an average of about 104 billion gallons of water per day. On the other hand, the eleven most populous eastern states with 78.5 million people withdrew an average of 68.5 billion gallons per day. Stated another way, the eleven western states had a per capita use of 4,112 gallons per day and eleven eastern states had a per capita use of 872 gallons per day. This difference in per-capita use between East and West can be attributed almost entirely to the enormous requirements of irrigation.

In the absence of new sources of low-cost water, ways must be found for supporting more people with a given quantity of fresh water if the growth of the West we anticipate is to be accommodated. There are many ways of helping to bring this about, such as the adoption of water conservation practices, the desalinization of brackish supplies where this is economic, and increased use of saline water. Yet, in the final analysis the pattern of water use in the West must change. In 1955 almost 90 per cent of the withdrawals in the eleven western states were for irrigation purposes and less than 9 per cent were for industrial uses. In the future it seems certain that these proportions will be altered significantly in view of the fact that an acre foot of water dedicated to industrial use—and possibly to recreation—will provide more income and employment and thus support more people than an acre foot dedicated to irrigation.

In the future as in the past, irrigation agriculture should remain an important bulwark of the western economy. In some areas it will expand; in some areas it may remain static; but in large areas irrigation seems destined to give way—as it already has in southern California, Arizona, and New Mexico—to urban and industrial growth. In view of this varied outlook, the task of the policy maker is to provide a policy environment which will facilitate an orderly transition in water use where such a transition is desirable.

My fourth point deals with what I con-

sider to be the most arresting feature of the water supply-demand outlook, both East and West. It is the rapid increase in water use for recreation purposes and a growing recognition of the importance of preserving the aesthetic characteristics of the nation's water resources. Since World War II, while the national economy has been growing at a rate of about 4 per cent a year, recreation use of water areas has been increasing at a much faster pace. For example, during this period use of T.V.A. reservoirs increased at a rate of 15 per cent per year, while use of the reservoirs of the Corps of Engineers increased at a rate of 28 per cent per year. All signs now point to a tremendous increase in recreation water use during the next two decades. Since we now have about 20 million fishermen and approximately five million outboard motors, there can be no doubt about the economic importance of water-based recreation activity.

But of even more significance than the economic activity which stems from recreation is the importance of outdoor play and relaxation to our highly urban and industrialized society. Yet the demand for clean waters is not related entirely to recreation. As forests and fields give way to factories, houses, and highways, and as areas become more densely populated, it is increasingly important for lakes and streams to be aesthetically pleasing. Thus we consider the polluted waters of the Potomac a disgrace to the nation's capital—not alone because of the menace to public health and aquatic life, but because a dirty river is incongruous with the Washington Monument and the Lincoln Memorial. As our society becomes more prosperous, as well as more densely populated, I anticipate a widespread insistent demand that the intrinsic beauty of the nation's water resources be maintained.

A fifth point about the future water supply-demand situation is that in areas of concentrated demand the cost of using water can be expected to rise. This prospective increase can be attributed primarily to two factors. First, the lowest cost sources of supply are naturally developed in advance of the more costly sources. Many eastern cities have been able to get

along by using convenient ground-water sources or the unregulated flows of nearby streams. Mounting demands for all purposes have often proved these sources to be inadequate. With increasing frequency more distant sources, involving greater transportation costs, must be tapped. Reservoir storage to regulate flows is becoming more and more necessary to meet growing requirements. Storage can be costly in the intensively developed eastern areas because the valley lands have generally been appropriated for farms, factories, cities, or transportation facilities.

A second factor is the likelihood that water treatment costs will increase. As illustrated by the chart which is up here, the pollution of our streams continues to grow. Of equal significance is the fact that while organic pollution to streams increased over 80 per cent between 1920 and 1955, the potential organic pollution increased about 280 per cent during this period. In other words, pollution abatement measures have mitigated a large proportion of the total potential organic pollution but these have not been sufficient to prevent a large increase in the stream pollution load.

Organic pollution is only one aspect of the problem. Inorganic wastes, the heating of streams and now nuclear wastes are even more serious in some localities. In industrialized areas the same water may be reused several times. In these areas pollution must be minimized to realize fully the reuse potentialities. Because of the need for clean water by cities, industries, and for recreation purposes, it will be necessary to do a better job of treating effluents than has been done in the past. Such treatment will mean an increase in the cost of using water.

Earlier in this talk I noted that an important question was whether areas of concentrated demand can continue to secure an abundance of low-priced water. Subsequently I suggested that desalinization and weather modification do not offer an immediate prospect of providing a large increase in low-cost water supplies. My sixth point is that even though water-use costs can be expected to rise, technology offers promise that the supply-demand relationship can be balanced without inhibiting economic growth or causing significant personal in-

convenience. The insatiable appetite of industry and the modern home for water is the result of technological innovation. Past experience suggests that technology, through the development of new uses, will create new types of water demand. Yet, the most significant point about technology is the flexibility it offers to adjust demands to meet a wide range of supply situations without inhibiting economic productivity.

We all know the story of the Fontana Steel Plant which uses 1,300 gallons of water per ton of steel produced, whereas some eastern plants use 65,000 gallons per ton. Today the average fuel electric power plant requires nearly 40 per cent less water per kilowatt hour of electricity produced (even if the water is not recirculated) than the average plant in 1940. It is significant that 20 per cent of the water used by industry in 1955 was saline water.

Low-cost canal linings which reduce seepage losses; air-fin cooling systems which eliminate the need for water; metals which permit the use of saline water with a minimum of corrosion; the monomolecular film which reduces evaporation losses from reservoirs; and many other developments make it possible to maintain a reasonable balance between supply and demand.

In this connection it is important to recognize that the price of water is an important determinant of the extent to which water conservation practices are adopted. We use so much water because in the past the price has been so low. Studies reveal that water use for irrigation can be substantially reduced below widespread practice without impairing yields when there is an incentive to do so. As water becomes just a little more costly industry finds it profitable to recirculate, to use saline water, or to substitute other materials or processes for water. Such adjustments frequently involve some additional costs, but there is no evidence that these costs are great enough to have a material effect upon the over-all production costs of American industry.

The implications of the foregoing supply-demand outlook for water policy are manifold. It suggests large investments in water facilities such as storage reservoirs, aqueducts, and sewage treatment plants. It un-

derscores the need for continuing research to foster more efficient water use and the desirability of learning more about such things as the location and behavior of ground water. It means that full advantage should be taken of the benefits of multiple purpose river basin development.

But, what may be of more interest to this audience, the water supply-demand outlook heralds the need for creative activity in the field of water law, activity which will reflect in the law a correlation of what we now know about supplies with the social and economic requirements of the kind of society we expect to have in the decades ahead. I wish to examine a few of the implications of this outlook for policies imbedded in water allocation law.

As indicated earlier, the pressure upon water supplies will vary widely among geographic areas. The pressures will be greatest in the arid and semi-arid West. In humid regions pressures will be great in the industrialized areas and in localities where irrigation is extensively practiced. On the other hand, in many areas of the nation water supplies available for use will continue to be large in comparison with demand. I believe it is important that the policy reflected in water allocation law take into account the different kinds of supply-demand situations we can now foresee.

In the past we have done this in a general way through application of the appropriation doctrine in the arid and semi-arid West and the riparian doctrine in the East. However, the rapid growth of water use in the humid regions has resulted in local shortages and created demands for the establishment of more precise water allocation machinery than we have under common law. In those basins where pressures upon the resource are great, relatively precise allocation procedures appear necessary for two reasons: first, in order that the individual user may have a clear definition of his property rights in water; and, second, so that the public interest in the resource can be adequately protected.

Where supplies are abundant in comparison with demand, there seems to be little point in setting up an elaborate procedure for establishing water rights. Therefore, in those areas which will continue to have

abundant supplies, is there good reason for modifying the common-law procedures of the riparian doctrine? I can understand that it may be desirable to modify riparian law to permit non-riparian owners to establish a water right wherever this cannot now be done. Yet where changes in the riparian doctrine are being considered, might it not be desirable to limit the application of more elaborate water allocation procedures to those states or parts of a state where competition for the resource requires relatively precise allocation machinery?

A second conclusion I draw from the supply-demand picture is that in the future a paramount objective of water allocation law should be the protection of the public interest in the utility of the resource for recreation purposes, and in the maintenance of its aesthetic qualities. All regions now have a large economic stake in the recreation use of water resources. Of even greater importance is the fact that an urban-industrial, affluent society places a high premium upon beautiful lakes and streams as part of the human environment. The time has come when streams cannot be polluted or dewatered, reservoirs drained, or lake levels altered without recognizing that such action may have serious social and economic consequences. I am well aware that in the West efforts to manage streams and reservoirs to maximize recreation values may conflict with long established water rights, rights which cannot and should not be impaired without compensating the owners. However, where additional supplies are being developed and new rights are being granted, the public interest in recreation and aesthetic values warrants serious consideration.

The East with its more abundant supplies faces a somewhat easier task in meeting this problem. Where new water allocation procedures are being devised it is still generally possible to protect minimum stream flows, preserve lake and reservoir levels, and limit pollution. This means that in granting new rights it may be necessary that use be contingent upon treatment of the effluent to maintain specified quality standards. It also may mean that the right should be contingent upon provision of storage to regulate stream flows. However,

it is important that where demands are multiplying, reservations to protect recreation and aesthetic values be made soon before it becomes necessary to displace or modify established uses to accomplish this objective.

A third conclusion I draw from the supply-demand picture is that in areas of relatively intensive competition for water, the objective of water allocation law (in addition to protecting the public interest in recreation and aesthetic values) should be to allocate the resource to those agricultural and industrial activities which will make the most productive use of the water available for these purposes. In other words, where the supply must be rationed—as we ration land, minerals, forests and other resources—our task is to design allocation procedures which will select the most productive uses from among all possible allocations and encourage the most economically efficient use of the supply available to each user.

From my study of this subject, I am led to believe that market forces can probably make the allocation among commercial uses most efficiently. Where there is competition for water, it is doubtful that there is a better way of determining the most productive use than through the willingness of a prospective user to pay as much for a water right as a current user considers he must receive to relinquish it. Most of us, no doubt, would have more confidence in determinations made in this way than through the deliberations of an administrative or judicial agency. Certainly the task of deciding whether a given supply should be allocated to one factory or another or to a farmer instead of to a manufacturer is an unenviable responsibility for any administrative or judicial body.

A relatively free market in water rights should also encourage water conservation practices. Where market forces operate the price a user is willing to pay for a water right will tend to reflect its value. Where water is scarce, prices will be relatively high and the user will be encouraged to adopt water conservation practices to the extent economically justified. As already noted, technology offers many ways of making better use of available supplies, pro-

vided the economic incentives exist to adopt them. A market would not only foster application of existing technology but would encourage further innovation.

To develop institutions which will permit a market in water rights to function effectively is a difficult task indeed. This is due in part to the complexity of the hydrologic cycle. Water availability at a given time and place cannot be predicted with complete accuracy. The relationship between ground and surface supplies is not always clear. Unlike land and minerals, water is an elusive resource. It is also difficult to establish a market in water rights because of the problem of defining a right in terms that apply to a variety of water uses. For example, if an irrigator sells his water right to a fuel power plant, what is he selling? Irrigation results in a large net depletion of the amount diverted; the power plant may deplete only two per cent of the amount diverted. The irrigator wants a seasonal supply; the power plant wants a continuous supply. Irrigation increases stream salinity while a power plant increases stream temperature. To find a satisfactory solution to these problems will require a cooperative endeavor among hydrologists, engineers, and lawyers. My view is that a solution will involve the following:

First, a full recognition in the law of the interrelatedness of all phases of the hydrologic cycle. For example, it will be necessary that the law recognizes that surface and ground waters are interrelated and that the use of one may influence the availability of the other.

Second, the definition of a water right in terms of an effect upon the hydrologic cycle. In other words, it would seem desirable to try to get away from a definition in terms of quantity diverted, point of diversion, time of diversion, and type of use.

Instead it would seem preferable to move toward a definition in terms of the effect upon either minimum flows, water yield, or a combination thereof and the effect upon water quality including chemical content, organic content, and temperature. Unless such a definition is practicable, it will be difficult for market forces to function effectively.

Finally, arrangements for a judicial or administrative body to approve each change in use or change in ownership of the water right. No matter how precisely water rights are eventually defined, regulation by a public body will continue to be necessary to protect the public interest and to make certain that a change in use or ownership does not violate the terms of the right and thereby infringe upon the rights of others.

As I understand the situation, the laws of several western states permit a relatively free market in water rights. However, with a few exceptions, western water law does not recognize the continuity of the hydrologic cycle and since rights are generally in terms of irrigation use, the problem of defining rights in more generally applicable terms has not been solved. Nevertheless, it appears that the appropriation doctrine establishes a good basis from which to move toward a legal framework that permits a relatively free market in water rights. In the eastern states, where water rights are not precisely defined, there is considerable latitude to develop a system of water law best suited to the kind of supply-demand situation we can now foresee.

The modernization of water allocation law is, I believe, essential if we are to make best use of the nation's water resources. Certainly there are few more challenging opportunities for creative public service open to the legal profession.

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FACE CRISIS

Prosperity brings pressure on nat. resources, pushing up price, will bring rapid dev. mt., collapse of spec. prices.

Feuds Flare as Water Shortage Menaces Vast Areas of Nation

By ROGER D. GREENE

WASHINGTON, Oct. 2.—Fifteen years ago the residents of Grand Rapids, Mich., complained bitterly at the expense of building a 35-mile-long pipeline to bring water to the city from Lake Michigan.

Today the city's taxpayers are grumbling: "Who built that one-horse system back in 1940? Now we've got to build one a lot bigger."

A 48-state survey by the Associated Press shows the Grand Rapids episode is typical of hundreds of U.S. cities and towns.

Caught in a three-way squeeze between fast-growing population, booming industry and recurring dry spells, countless communities are suddenly discovering their water facilities just won't do the job any more.

Many are outmanned. Most are inadequate to cope with peak demands. During the 1933 drought, for example, only three states in the entire country—Idaho, Mississippi and Rhode Island—reported no water shortage problems.

CONFLICTS FLARE

Inequities, smoldering feuds and open conflicts have arisen in many areas as water supplies run low. Laws involving water rights have become so complicated and conflicting from state to state as to constitute a nightmarish legal jungle. In the East where the old Roman and English law of riparian rights prevails, you can be sued by just about anybody who thinks your use of the water is "unreasonable."

In the West, which still clings mostly to the pioneer law of "first come, first served," some water rights date back to the goldrush era.

Just a few months ago, in Texas, the State Supreme Court ruled that the city of Corpus Christi acted within its rights when it pumped huge quantities of water from wells near the town of Pleasanton and transported it via the Nueces River more than 100 miles to Corpus Christi—even though the Pleasanton wells suffered from the city's invasion.

TEXAS DESPERATE

Texas is desperate for new water supplies and even Michigan, surrounded on three sides by 87,170 square miles of fresh water, has its tongue hanging out in many places.

In the booming Detroit area, some 20 outlying communities which have sprung up in the mass march to the suburbs have been tapping the city's water

(Editor's note: With water resources dropping and no help in the demands from an increasing population and booming industry in sight, many U.S. communities are uncomfortably close to a crisis. Here's a report on the Nation's chief water shortage areas.)

supply. As a result, Detroit has been forced to install a new 200-million-gallon pumping station, and police-enforced water bans have been clamped down in the area.

Detroit's giant auto industry is watching the situation with serious concern. It takes 15,000 gallons of water, mostly for cooling hot metals, to produce one automobile.

In Arizona, officials report that unless new water supplies can be found, 800,000 acres now under cultivation may go idle. The state's underground water, which has been dropping steadily in some places as deep as 18 feet in the last 12 months.

CALIFORNIA PROBLEM

California, with a population of 13,500,000 which is expected to reach 23,000,000 by 1975, is working feverishly to bring in new supplies but is pumping

codons or vegetables in retirement last year finished a second barrel on its leg of the Colorado River aqueduct, but already is talking about a third.

Colorado, with water shortages in nearly every section of the state, gloomily watches the Colorado River quench the thirst of distant states while the state's high capital, Denver, will double to 1,800,000 in the next 10 years "but we're using every drop of water right now."

The city hopes to bolster its supplies via a 23-mile tunnel through the Rockies continuing to Nevada.

New Mexico is another state feeling the scorpion-like sting of water scarcity. Experts say the state's underground water table is dropping so fast in the eastern high plains that supplies

may be exhausted within 40 years.

Here, in brief, is a rundown on other shortage areas:

Connecticut—Farmers in the New Haven area have been pumping so much water from streams for irrigation that salt water is backing inland from Long Island Sound.

Illinois—41 cities reported shortages last year. Louisiana—Underground water levels have dropped as much as 200 feet in 20 years. State officials call the water situation grave despite the fact that the Mississippi River flows past New Orleans into the Gulf of Mexico at a rate of 300 billion gallons a day, enough to supply 2,000 gallons a day to every man, woman and child in the United States.

Missouri—The state now has more than 30,000 deep ponds here storing water. Officials say these have proved a godsend during dry spells.

Nevada—Over-pumping of wells has caused the booming Las Vegas area to sink two or three feet in the last dozen years.

New York—Critical water shortages are reported in the growing suburbs of three, up-

state cities, Syracuse, Buffalo and Rochester. New York City is spending millions to bring in new supplies.

OREGON HARD HIT

Oregon—Eastern irrigation districts report the worst short crop failure stemming from drought in the last 15 years.

The story of Little Monhegan Island, 20 miles off the coast of Maine, is a graphic illustration of what has happened to bring water shortages elsewhere in the country.

Residents of Monhegan (population 100) had to call on the Coast Guard this summer to fetch water from the mainland when 500 summer vacationists descended on the island colony.

Utah—Southern rangelands are dying of thirst. But in Salt Lake City, with runoff from six nearby canyons, water flows in the gutters to flush out dirt.

Wyoming—Water tables south of Cheyenne have dropped more than 100 feet in 12 years. Householders caught sprinkling lawns outside specified hours are fined \$100.

NO. DAKOTA HAS PLENTY

Contrary to the picture in many states, North Dakota re-

ports that its ground-water tables have risen "tremendously" as a result of abundant rains over the last decade. Officials say the state hasn't had a crop failure stemming from drought in the last 15 years.

Texas—State Sen. Dorsey Hardeman of San Angelo says water shortages have touched off a "battle for survival" throughout the Lone Star state.

Water-hungry Dallas plans to build a \$20,000,000 reservoir and transport water 45 miles from the Sabine River. San Antonio is "gravely concerned" about its future supply.

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