Proceedings...

18th ANNUAL MEETING

January 9, 10, 1969

Bureau of Reclamation

Building 56, Denver Federal Center
PROCEEDINGS

EIGHTEENTH ANNUAL MEETING
FOUR-STATES IRRIGATION COUNCIL
January 9, and 10, 1969

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Denver Federal Center
Denver, Colorado 80225

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PRESIDENT'S MESSAGE

As we go from year to year operating and maintaining our individual irrigation systems, we meet new problems and greater challenges. I think the Four-States Irrigation Council offers a great opportunity to find at least some of the answers we are looking for. Many times we get so wrapped up in our own problems and confusion, we cannot see the forest for the trees.

This organization is made up of people who are charged with the responsibility of distributing one of our greatest natural resources. We must do this in a manner that will give our farmers an opportunity to produce the best crop possible at a cost somewhere in line with their economy. I know of no better way to broaden our knowledge than to get together in a meeting of this kind and exchange ideas.

We are very fortunate to have a place that offers so much—in personnel, facilities, and research—as the Denver Federal Center and the Bureau of Reclamation. I want to offer our thanks to each and every one of them.

I believe the North Poudre Irrigation Company has gained a great deal by our representatives attending the annual meetings and tours offered by the Four-States Irrigation Council. At this time, we are constructing a long-needed 7,100 acre-foot storage and operational reservoir that probably would not have been built for a long time to come, had we not attended these meetings. It was at one of these sessions we found out about the Small Watershed Act, P. L. '984, and how we could apply it to our own Project. It has also helped in selection of equipment and our maintenance program.

All Officers and Directors of the Four-States Council, Bud Dolven, Nat Tolman, Neil Schild, and other Bureau personnel met in Denver April 29, 1968 to make plans for this year's program and to select individuals to receive the 1968 Headgate Awards. With the able assistance given by Bureau personnel, we have been able to come up with this year's program.

The Four-States Council owes a debt of gratitude to Mr. Owen Dolven for his many hours of service to the Council in the last several years. As most of you know, "Bud" was transferred to Billings, Montana this past summer. We congratulate you, "Bud," in your new position.

I want to take this opportunity to thank all participants in the program, and Council Officers, for their cooperation this past year and especially to Mr. Neil Schild and Mr. Nat Tolman. Without their help, it would be nearly impossible to prepare a program of this kind.

We have an invitation from the State of Kansas for a summer tour in 1969. Let's all help to make it a success.
CONFERENCE REGISTRATION

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WESTERN LAND ROLLER CO., Box 668, Hastings, Nebraska
Left to right: James M. Ingles, Harlan Seaworth, B. P. Bellport, H. P. Dugan

Conference Registration

Speakers' View of Conference
The Eighteenth Annual Conference of the Four-States Irrigation Council was called to order by President Harlan Seaworth at 9:00 a.m. President Seaworth welcomed the conferees and reminded them of the objectives of the organization. He listed this year's contributing members, introduced this year's Officers, and urged audience participation throughout the meeting.

Opening Welcome
James M. Ingles, Director
Bureau of Reclamation, Region 7
Denver, Colorado

Again it is my pleasure to welcome you to Denver and the 18th Annual Meeting of the Four-States Irrigation Council. As expected, the Council has put together what appears to be an interesting and informative program. I am sure you will find the next two days very profitable.

Crop reports indicate that 1968 has been a good agricultural year in our four-state area. The yields of many crops were reported to be average or above. As usual the 1968 crop year was marked by extremes in weather conditions common to the Great Plains area. A late April freeze in the North Platte Valley damaged some of the early planted beets. Elsewhere scattered hailstorms throughout the growing season seriously damaged crops in localized areas.

Sugar beet yields in the North Platte area totaled the second highest production on record. The yields of pinto beans and potatoes were above average. Corn yields in all areas were average or above. Gross crop income in the four states is expected to be higher than last year.

Large amounts of irrigation water were used on all projects in Region 7 during the past growing season, but no serious water shortages were reported. The Webster Irrigation District in Kansas was pinched by water restrictions, yet crop yields there were good. The water supply outlook for the 1969 irrigation season is considered good to very good for the Colorado-Big Thompson, North Platte and Kansas River Projects Reservoirs--with the exception of Webster Reservoir.

The Bureau's construction program in Region 7 progressed satisfactorily during 1968, despite funding cuts for the Fryingpan-Arkansas Project. This project, now almost 30 percent complete, will eventually provide supplemental irrigation water for 280,000 acres of land in southeastern Colorado, and 20,500 acre-feet of water annually for municipal and industrial purposes. Two major features, Sugar Loaf Dam, near Leadville,
and Ruedi Dam, located on the Western Slope near Glenwood Springs, were completed in 1968 and the reservoirs are now storing water.

The South Fork and Chapman Tunnels of the Western Slope collection system also were completed in 1968. The 5.3-mile Divide Tunnel—the main tunnel piercing the Continental Divide—is scheduled to be holed through the latter part of April of this year.

In northcentral Kansas, Glen Elder Dam, the largest yet built by the Bureau in Kansas, was completed just last month. The lake ultimately will provide water to serve 21,000 acres of land. The Bureau is now making extensive studies for future authorization of irrigation facilities. Similar progress is being made in both Wyoming and Nebraska.

We are extremely proud of the irrigation developments that have been completed throughout the four-state area. We are also real pleased with the continuing fine work of your organization. Please feel free to call on me and my staff for whatever assistance you need in the future.

Your organization, now holding its 18th Annual Meeting, has had many men of vision and vigor expanding on the views of the men of vision and vigor before them.

Back in the 1800's irrigation first began in our area. The North Platte Project in the early 1900's was one of the Bureau's earliest endeavors.

Now I want to introduce one of today's men of vision and vigor, the man who furnishes the hall for this meeting—known not only in our four-state area, but indeed throughout the entire world. May I present the Chief Engineer of the Bureau of Reclamation—Mr. B. P. "Barney" Bellport.

Welcome to Bureau of Reclamation Engineering and Research Center
B. P. Bellport, Chief Engineer
Bureau of Reclamation
Denver, Colorado

I am pleased to again welcome all of you to the Bureau of Reclamation's Engineering and Research Center here in Denver. Unless I am mistaken, this is the sixth consecutive year I have had this pleasure.

From the news media, some of you may have the idea that the Office of Chief Engineer is concerned almost entirely with the planning, design, and construction of large dams and power generating plants. While we are involved in such prominent activities worldwide, we are also equally responsible for and involved in the design and construction of irrigation
carriage, distribution, and drainage systems. Because of this involvement and responsibility, we are also concerned with the operation and maintenance of these facilities.

We are most anxious to incorporate in our designs and construction the improvements which you in the business of operating project works find through experience are beneficial and economically warranted. We welcome, therefore, opportunities to participate in meetings such as this where ideas founded on actual experience are exchanged.

The practice of transferring the responsibility for operation and maintenance of irrigation systems to the water users' organizations after construction is completed makes it essential that the Bureau have a close working relationship with each of your organizations. It is my intent that lines of communication be constantly open between you and all offices of the Bureau of Reclamation.

Besides meetings such as this, there are established programs which we believe are mutually helpful and advantageous. One is the Review of Maintenance Program. Every three years representatives of Mr. Ingles' Office call on you and go over the condition of your structures and facilities. Every six years engineers from my office join in the examination of major structures on your projects. We hope you will participate in these reviews and talk freely with these engineers. Tell them how things work, what is wrong, and how you think they might be improved. This, also, is a good time for you to ask questions and discuss specific problems. Sometimes the individuals in the examining party can provide assistance on the spot. In other cases, it may be necessary to consider the problem more carefully. In that event, we will answer your question either in the Review of Maintenance report or in a special letter.

Another excellent opportunity is the Irrigation Operators' Workshop held in Denver each year. Some of you may have attended the most recent session last December. The Workshop offers operators an opportunity to discuss and exchange experiences under the guidance of knowledgeable instructors. These discussions afford both representatives of the water users and us an excellent chance to benefit from mutual knowledge and experience.

I do not want to infer, however, that we want to hear from you only on these specific occasions. Your timely constructive criticisms are needed if we are to progress. We want your suggestions for improvements, and we want to know if something fails or does not function properly. We are not thinskinned, and we realize the perfect system has not been built and is not likely to be ever without the full cooperation of those of you who are operating the projects.

I would also like to make it clear that our interests are not limited to the design and construction of new projects. We are equally interested in improvement of existing systems and willing to be of assistance in any way possible.
Nat Tolman
Panel Moderator

Dr. Norman Evans

Charles Rothermel
R. W. Hansen
Dean Schachterle
"Pollution Hazards in Fertilizer and Pesticides"

Norman A. Evans, Head
Agricultural Engineering Department
Colorado State University
Fort Collins, Colorado

As farm operators and irrigators, you and I are the food producers of this land. We are depended upon to feed the ever increasing numbers of hungry mouths, and each year there are fewer of us to do it. It is the same the world around—although not everywhere has productive capacity kept up with population numbers.

Our reliance upon the waters of our States is well understood. We also understand the interest of others in those same waters—domestic water, recreation, fish and wildlife and scenic beauty.

There are over 100 species of insects and mites considered to be major pests in agriculture. There are an equal number of weed pests, a large number of plant and animal pathogens and parasites and many vertebrate pests which hinder the production of food, affect the health of man or his animals or create such nuisance that they make life miserable. It is imperative we control these pests if we wish to sustain our food production. In addition, measures to increase productive capacity of each acre, such as fertilization, improved varieties and better water management are needed.

My subject focuses on one of the new problems facing you in the business of food production—that of pollution or degradation of water which may be a consequence of fertilizer and pesticide use in agriculture.

I read as many reports containing facts as I could find on this subject, and I want to summarize what I found and share with you the implications that I draw from the facts available to me.

The Role of Fertilizers

Rapidly expanding use of fertilizer (NPK) coupled with a national effort to prevent degradation of water supply has brought attention to the possibility that fertilizers in agriculture contributed to water pollution and directly or indirectly constitute a human health hazard as well as a hazard to aquatic biota.

In 1965 the American farmer used 46 pounds per cultivated acre compared to 163 pounds per acre in the Common Market of Europe. Harvested crops removed 16.6 million tons that year while fertilizer application supplied 10.5 million tons—a gross comparison indicating a fertilizer deficit rather than an excess. Table I compares amounts of fertilizer elements applied with the amount removed and indicates a deficit for nitrogen and potassium while approximately the same amount of phosphorus was removed.
as was applied. This picture, of course, does not accurately show that heavy fertilizer applications in local areas can result in local excesses which in turn can presumably get into the water supply and constitute a pollution hazard. Relatively little conclusive evidence has yet been assembled to improve this contention, yet most of us would accept the possibility.

With increasing costs of all inputs to agriculture (labor, fuel, machinery) fertilizer is assuming a greater attraction as the least costly input by which increased yields may be gained. We are yet far from using the amount of fertilizer current scientific knowledge would recommend.

The Sulfur Institute has estimated that if current recommendations on NPK were followed on the cultivated acreage, the application would amount to 120 pounds per acre. Even this is less than the 163 pounds reported in Common Market Europe.

Of the three primary elements, only N has significant mobility and hence potential for pollution. In field tests less than 10 percent of solid phosphate moved beyond one inch from the point of deposit. Liquid phosphoric acid moved only four inches (in calcareous soils). Solubility of phosphate is slight, in the first place, and it tends to form insoluble compounds with iron, aluminum and calcium very rapidly.

Potassium is soluble (relative to phosphate) but tends to absorb on clay minerals and become immobile. A cation exchange reaction is necessary if potassium is to become mobile and usually very little is found in water analyses.

Nitrogen is applied as (a) ammonium, NH₄ (b) nitrate, NO₃, or (c) urea, CO(NH₂)₂. Both ammonium and urea are converted to nitrate within the soil prior to uptake by plants, although some ammonium may be directly taken up by plants.

Nitrate ion is rapidly taken up by plants' roots. Most nitrate applied to soil is extracted within one month of application. But excessive nitrate can move out of the plant root zone into groundwater. For this reason over-use of the element can lead to pollution. Under wet conditions, nitrate will be transformed to nitrite ion and becomes of concern for public health because it can cause "blue babies" if ingested by infants.

A limited number of studies have been conducted for the purpose of tracing nitrate movement in the soil profile toward a water table. Stout studied a closed basin in California in which a good inventory of nitrogen applied was possible. He found nitrates reaching a water table at 40 feet were in lower concentration than that found in the irrigation water supply. He concluded that nitrates found in the groundwater came from decomposed vegetation over geologic time primarily, with possibly some currently derived from local sources such as septic tanks and municipal sewage.
He also found the type of subsoil was significant. Clays in the subsoil were found to trap and retain nitrate while a sandy profile permitted leaching of nitrate to the water table. He also found the sandy profile permitted nitrification of ammonium to occur at great depths.

Another nitrate study frequently cited is that of George Smith whose studies in Missouri indicated that nitrogen fertilizer is not an important source of nitrate accumulation in groundwater at the present time. Infiltration through feedlots was found to be a source of nitrate in groundwater and septic tank effluent was also found to be a major contributor. Both of these sources, of course, affect local areas. Another major source of nitrate found by Smith was geological materials which yield nitrites upon a solution.

A more recent study was reported by Stewart, Viets, and Hutchinson in which 129 sites in northeast Colorado were investigated to determine quantities of nitrate and other pollutants in transit through the soil to the water table. In that study water tables occurred from 10 to 65 feet beneath the soil surface. Most of the 621,000 cattle in Colorado feedlots (as of February 1, 1967) were located in this study area. Sites studied include feedlots, irrigated fields, dry land fields and native grassland. Figure 1 shows nitrate distribution to 20 feet found in these studies. The heaviest concentrations were associated with feedlot sites. Irrigated fields produced high concentrations of nitrate at the shallow depths, but very low concentrations beyond 5 feet. Cultivated dry land showed uniformly low concentrations through the 20-foot profiles. Native grassland and alfalfa showed negligible concentration and are not plotted on the Figure.

The authors estimated that considering the relative area in feedlots compared to irrigated fields, the amount of nitrate reaching groundwater in the study area was greatest from irrigated lands. Let me point out that the higher local concentrations associated with feedlots could be a hazard to farmstead water supplies.

Water samples from the water table collected during their study are illustrated in Table II which compares nitrate, nitrite, ammonium, and organic carbon. The feedlot contributes substantially greater amounts of both elements to the water table than does the irrigated field. None of the concentrations found approach limits presently considered toxic for human consumption.

Pesticides

In examining the role of pesticides in water pollution, one notices first the scarcity of factual data and case histories; and secondly, uncertainties in laboratory analytical results.

One consequence of both situations has been the impulse to "get the goods" on pesticides by collecting massive amounts of data.
Unfortunately, according to Bertram Sparr, "In the main, misinformation has arisen because of the demand for or the desire to produce numbers has been so great that scant attention has been paid to some of the requisites for valid analysis." He illustrates this by citing cases where plant and animal tissues which had been sealed long before the invention of chlorinated hydrocarbon insecticides have been analyzed and found to apparently contain those substances. Human tissues collected prior to the development of "DDT" were found to contain that substance and its derivitives in nearly every sample with the occasional occurrence of dieldrin in the analyses indicating aldrin, heptachlor, or BHC. All these impossible findings reflect the state of incertainty in methods of identifying minute quantities of many of the pesticides with which we are concerned. The explanation seems to be that other elements produce similar reactions leading to misinterpretation by the analyst. However, laboratory methods are constantly being improved, and the technique of using a "check" sample which is known to be unaffected by the pesticide for comparison purposes provides a way of checking the apparent result.

The first widespread public attention to pesticides as a pollution hazard was reported on a major fish kill in 1950 involving at least 15 streams in the Tennessee River Valley of Alabama. During the season, toxaphene, benzene hexachloride, DDT, and aldrin were used on cotton extensively in this area. Weather conditions during the season required unusually frequent treatments with pesticides resulting in higher-than-normal accumulations in the fields. Several heavy rains in August caused excessive runoff and presumably carried quantities of the pesticides into the streams along with quantities of the soil. In any case, fish kills were observed following each period of heavy storm runoff.

Nicholson, et al, reported a 6.5 year study on a 400-square mile cotton growing area drained by a single river system. About 16,000 acres of cotton in this area are treated with 59,000 to 86,000 pounds of insecticide annually, the most important being toxaphene, DDT, and benzene hexachloride. Nearly continuous sampling of water was done at the intake point of a domestic water supply at the lower end of the basin.

Toxaphene found in the water was in very small amounts (0.6 ppb) and unrelated to the amount used on the land. There was a correlation between benzene hexachloride in the water (up to 1 ppb), and the amount of that material used on the land. The present permissible concentration of toxaphene for public water supply is 5 ppb; that for BHC is 18 ppb. Interestingly, DDT was detected in only two out of seven years, although it accounted for 25 percent of the total insecticides applied annually. This observation was attributed to the strong affinity by DDT for organic matter in the soil. Many other studies have confirmed that DDT is firmly attached to soil particles and does most of its moving with the sediment eroded from land. It was found to be completely removed by routine water treatment processes.
Pesticide residues in irrigation waste water was thoroughly studied in 1961 and 1962 by Hinden where the occurrence of organochlorine pesticides in surface and groundwater was determined in several locations in the Columbia Basin Project in Washington. Bottom sediment from streams in the lake were also analyzed.

The amounts of pesticides present in water samples were all very low, the highest being endrin, at one location found at a level of 0.057 ppb. Concentrations in bottom sediment, while higher, were of a low order of magnitude, the highest being DDT at 144 ppb. These quantities were far below levels that would produce any toxic effects on fish or mammals.

The fate of pesticides, once they have entered waste waters, has been, and is now the subject of much speculation. Many herbicides disappear quite rapidly through absorption by aquatic plants, absorption on clay particles, chemical decomposition, and action of microorganisms. Organophosphorous pesticides, as a rule, appear to be relatively short-lived in water courses, although good data are lacking. There is evidence that some compounds—DDT, for example—may be absorbed by aquatic vegetation, only to be again released into the water when the plants die and decompose. Biological and chemical degradations of DDT are very slow, and there is a growing amount of evidence that it is passed from one food chain organism to another, thus enhancing its distribution throughout surface waters.

The seriousness of pesticide accumulation of danger to human beings and wildlife has not been established. There is considerable speculation that those of the pesticides which are fat-soluble will accumulate in the tissue of animals which feed upon aquatic vegetation and in time, accumulate in body tissues in sufficient quantity to be harmful. Carrying the food chain one step further, animal tissues thereby affected may be consumed by man and constitute an unexpected health hazard.

A significant warning on evaluating the health hazard of pesticides in domestic water was presented by Alice Ottoboni, a toxicologist with the California State Department of Public Health. According to her, if pesticides do enter a water system, it is not likely that they will occur singly but rather in groups, depending upon the pattern of pesticide use in the area. Some pesticides can act synergistically with others to produce an effect greater than the sum of the individual effects. Other pesticides can act antagonistically to reduce the total effect. The toxicity of pesticides can also be affected by the inorganic composition of water. Much less is known about synergism and antagonism than is known about toxicity of individual pesticides, yet these phenomena do exist and need to be considered when determining tolerable levels of pesticides in domestic water.

A second caution is that species vary greatly in their sensitivity to pesticides and they do not vary on the same relative scale. For example, chlorinated hydrocarbons are much more toxic to fish than are the organic phosphates, whereas for mammals the order is reversed. There is no one
indicator organism, uniformly more susceptible than all other species to all pesticides, that can serve as a monitor to tell us when our water supplies contain harmful levels of pesticides. Fish have been proposed for this purpose. They would serve us well for chlorinated hydrocarbons, but they would give us a dangerous sense of security in the case of organic phosphates. Some fish can withstand 2 mg. per liter of TEPP for as long as four days before death ensues, whereas infants provided drinking water in formulas made from water containing 2 mg. per liter of TEPP would suffer serious illness and perhaps fatality before fish monitors would tell us something was wrong with the water.

It is perhaps clear that however we approach the question of environmental poisoning hazards associated with pesticides and fertilizers, every thoughtful person will agree with the editor of the Denver Post who wrote on December 30 an editorial headed "Rachael Carson Was Right." Her early warning was pooh-poohed by many of us. She nevertheless did dramatically set in motion inquiry which by this time has given us cause to praise her foresight. Government regulations are stricter, manufacturers' label warnings are more specific, and many chemicals are no longer on the open market.

Scientific inquiry into the effect of most of the pesticides on all organisms making up the biosphere has been accelerated and expanded. A pesticide chemist at the University of Wisconsin has just recently discovered how DDT causes fatalities in wildlife by traveling through the nervous system to the nerve cells at the brain. There they block the passage of nerve impulses and literally cause a "nervous breakdown" and death. Unfortunately, DDT persists in nature for at least 10 years and is said to accumulate in fatty tissues, particularly in those species at the top of food chains—such as man and the bug-eating birds. It appears urgent that short-lived, nonaccumulative pesticides be developed to take the place of those which lend risk to the quality of our environment and indeed to human health.

At this point all the facts which we have tell us that pesticides and fertilizers carelessly used can be a hazard to the biological world around us and even to man himself. Exactly how much hazard exists with these materials properly handled, carefully used and residues fully monitored remains to be seen. Understanding the hazard and knowing what to do to minimize it is a long step toward preventing disaster as we have long since learned. It seems to me at this point we should move with some confidence forward in our applications of modern science including use of pesticides and fertilizer to food production keeping all the while a watchful eye upon the ecological hazards thereby created. Above all we should not have the producer of food on the one hand, and the ecologist, conservationist, or public health professional on the other hand each putting his head in the sand and refusing to acknowledge a middle ground.

It is impossible to conceive of world food production meeting population demands without the aid of both pesticides and fertilizer. With that premise there is only one course of action and that is to use these
materials intelligently. Hopefully, degradable and short-lived materials will continue to be found to replace those offering long-term hazards.

But much can be done through the simple expedient of wise and restrained use of these materials. For example, the State Department of Public Health of California and the irrigators of the State established the following safety precautions for the use of pesticides on irrigation projects:

1. No application of chemicals during rainy periods or periods when rain is threatened.

2. No spraying of chemicals if wind conditions would cause drift.

3. Provide means to detect drift of spray towards lakes or reservoirs.

4. No flying over reservoir surfaces with spray material in the plane.

5. No dumping of chemicals in a manner or location where they may be carried into a reservoir.

6. Dry up ditches flowing into any reservoir before application of chemicals.

7. Keep ditches leading into reservoirs dry for 24 hours after they have been sprayed.

8. Samples of water, stream sediments and plankton should be taken before and after application of chemicals.

9. A map of treated areas including applied rates with date of application should be recorded whenever chemicals are applied.

Using the above operating rules, one irrigation district carried out an aerial spray program with dieldrin with completely successful results while avoiding any measurable contamination of surface waters in the area. Chemical analysis could detect none of the chemical in water impoundments on the project, nor could an adverse affect on fish population be found during the three years following the treatment.

Above all, in facing ahead to the preservation of the biological environment which we so much need and enjoy, we face the fact of regulation, both voluntary and enforced. We should not get in the position where we become uncommunicative, leaving the solution of the problem to regulatory bodies such as the water pollution control agencies or the public health agencies. It seems best to resolve problems by open discussion during which solutions are sought that cause the least overall cost to the consuming public and taxpayer.
And perhaps above all, is the next generation of water users in your community being informed of the potential hazards. The old adage "If a little is good, more is better" does not apply when it comes to certain chemicals. An ounce of prevention is worth a pound of cure and a pound of cure can be awfully expensive for the next generation if we fail today to take a sensible approach to this potential problem.

Given good information and your leadership, we both know that today's water user will do his part to assure that the next generation has the natural resources to sustain life and a tolerable environment in which to live.

### Table I

U. S. Annual NPK Supplied or Removed, Tons (293 M Acres)

<table>
<thead>
<tr>
<th>Element</th>
<th>Applied</th>
<th>Removed</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>4.6 M</td>
<td>8.8 M</td>
<td>-4.2 M</td>
</tr>
<tr>
<td>P2O5</td>
<td>3.2</td>
<td>2.8</td>
<td>+0.4</td>
</tr>
<tr>
<td>K2O</td>
<td>2.7</td>
<td>5.0</td>
<td>-2.3</td>
</tr>
<tr>
<td>Total</td>
<td>10.5</td>
<td>16.6</td>
<td>-6.1</td>
</tr>
</tbody>
</table>

### Table II

Groundwater Samples Beneath Four Feedlots and Adjacent Irrigated Fields

<table>
<thead>
<tr>
<th>Water Table Depth</th>
<th>Nitrate PPM</th>
<th>Nitrite PPM</th>
<th>Ammonium PPM</th>
<th>Organic Carbon PPM</th>
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</thead>
<tbody>
<tr>
<td>Feedlot 30</td>
<td>8.6</td>
<td>0.09</td>
<td>5.1</td>
<td>130</td>
</tr>
<tr>
<td>Field 30</td>
<td>0.1</td>
<td>0.17</td>
<td></td>
<td>18</td>
</tr>
<tr>
<td>Feedlot 15</td>
<td>18</td>
<td>0.04</td>
<td>5.7</td>
<td>130</td>
</tr>
<tr>
<td>Field 10</td>
<td>31</td>
<td>0.09</td>
<td>0.1</td>
<td>12</td>
</tr>
<tr>
<td>Feedlot 12</td>
<td>21</td>
<td>5.7</td>
<td>5.8</td>
<td>90</td>
</tr>
<tr>
<td>Field 10</td>
<td>8.5</td>
<td></td>
<td></td>
<td>9</td>
</tr>
<tr>
<td>Feedlot 35</td>
<td>1.1</td>
<td>0.53</td>
<td>38</td>
<td>170</td>
</tr>
<tr>
<td>Field 35</td>
<td>18</td>
<td>0.06</td>
<td>0.04</td>
<td>26</td>
</tr>
</tbody>
</table>
I'm not here to sell you on recreation—nor am I here to be sold on irrigation—you've chosen your profession and I've chosen mine (Incidentally, I was born and raised on a farm and I am one of those who was forced into learning a new profession.)—I'm not here to tell you how to run your business, and I'm sure you won't attempt to tell me how to run mine. In fact, our two chosen professions have little or nothing in common. We both use one of God's products, however, in achieving economic gain and pursuit of happiness. We both know its value and I'm sure you feel as I do that in order to continue to reap the benefits, we both must be good stewards and guardians of this vital natural resource called water.

No water user can claim to be a good steward unless he is sufficiently informed and knowledgeable about the other uses of this resource. No water user can claim to be a good steward unless he is a good manager and uses proper management techniques.

What about negotiating easements for the use of a small part of your irrigation water during peak recreation use on your reservoir—just to stabilize the water levels for a few weeks out of the year?
And what about you as an irrigation district going into supplemental income producing business to provide recreation facilities so much in demand that warrant charging a reasonable fee for their use?

Individual initiative and private enterprise must continue to be the most important force in the development of outdoor recreation programs to meet this demand.

They must provide the many and varied opportunities for a vast number of people as well as the goods and services used by the people in their recreation activities.

The Wyoming Recreation Commission is convinced of one thing; that is, Wyoming's outdoor recreation program will fail if the development is dependent upon public funds alone. In the long run, private enterprise must carry the bulk of the commercial aspects of this sleeping recreation industrial giant. Our Commission must help. We as a state agency must provide the technical assistance and we as a state agency must provide reliable data so vital to the prospective investor. We as a state agency must appeal to the nonprofit groups and organizations to provide assistance and leadership in their communities so that proper planning efforts are realized and so that proper local financial programs are sound in management processes.

Private enterprise can play a major role in providing facilities. Overnight camping facilities could be a business venture, tying in all the services needed--from food to special buses equipped to handle wheelchairs and special devices for handicapped people.

In meeting outdoor recreation demands and in particular in preparing to meet the rising demand of the future, the first thought is for adequate space--open land, open water, open shoreline. But as every recreation seeker and every recreation administrator knows, certain types of man-made facilities will also be in great demand.

The problem of providing the necessary funds for these facilities, ranging from simple family camping sites to ski tows and multimillion dollar lodges, has been a major problem in the past. Shortage of capital for man-made facilities could, under some circumstances become a major bottleneck in meeting recreation's future needs.

Our Commission feels our responsibility is to not compete with private enterprises. We encourage private capital wherever the opportunity arises. We are gathering facts which will be useful to the private investor. Our first returns should be analyzed early this year. In any event, most Americans face the prospect of more leisure time in the future, and thus the challenge of using it for their own enrichment and development as individuals and citizens. This is precisely the contribution that outdoor recreation can make. For at its best, outdoor activity, whether undertaken lightly or with the serious intent of the perfectionist, is
essentially a "renewing" experience--a refreshing change from the workaday world. The use of leisure is important to the health of individuals in Cheyenne, in Denver, in Topeka, and in Scottsbluff, etc. The physical vigor of a society is as much a part of its strength as good education. The increasingly high rate of men rejected by the Army for physical reasons (my latest figure shows three out of every seven called) together with the obvious benefits of good health to individuals argue eloquently for the better physical fitness that many forms of outdoor recreation provide.

Outdoor recreation also has cultural values that are essential to the health of our society. It is a part of the educational process that strengthens men's minds as well as their bodies; that broadens their understanding of the laws of nature; that sharpens their appreciation of its manifold beauties; and that fortifies man's most precious possession--the spirit which gives life its meaning.

All in all, being in the outdoors is a good, wholesome, healthful use of leisure that can help create a better life. Our challenge--the irrigation districts throughout the land representing the private sector and the State Recreation Commission's representing the public sector must work together to assure all Americans permanent access to their outdoor heritage. Where best to start than here at home. We need your help--without it we cannot succeed.

Agriculture and recreation must work together to ward off "splash industrial explosions." Wyoming's crop farmers and recreation water users can help each other by pooling their resources to establish water impoundments beneficial to both uses.

By proper planning, every water impoundment can be so constructed so that it will retain a recreation pool. The recreation pool will assure recreation users an established level fluctuation variance so that recreation activities will not be hindered. The increased cost of raising the height of a dam would be financed by the recreation user. The purchase of the additional acre-feet of water to establish the recreation pool would be a one-time cost, both costs could be financed by a long-term revenue bond repayable through user fees charged the recreationists.

On the other hand, working agreements could be made with the irrigators to supply the annual evaporation losses, and in return the recreation pool could be tapped in drought years. What better assurances would the crop farmer need than to know that his spring plantings would still be harvested even during a drought year? In addition, all above-normal runoff would be stored to offset the annual evaporation losses.

Agriculture and recreation can be a very compatible combination. The cattle rancher can graze the same lands that are equally grazed by wildlife. Therefore, the hunter even though by law is hunting wildlife that
belongs to the people of the state, is still using the land that belongs to the rancher and in many cases lands that are leased by the rancher from the state and federal government.

The problems are quite obvious: respect for the private landowners' rights. This can be resolved in most cases by simply asking before entering, but in some cases, the recreation user should pay for the use of the habitat. Therefore, permanent easements beneficial to the rancher and the hunter would be a solution to many problems that have arisen with trespass upon or across private lands. The easements in most cases could include other recreation users such as rock hounds and fishermen.

Agriculture and recreation working together could then demand that industrial growth be orderly and that industry comply with the laws of nature and thereby create cooperation and coordination where all three concerns are a part of economic progress and success.

In support of the role agriculture plays in providing recreation areas and facilities is revealed in the following comments made by Mrs. Julia B. Hansen, Congressional Representative from Washington, when she reported on the House floor for the Appropriations Committee in 1968. She cautioned against assuming that recreation is a "frill" and she referred the House to hearings which listed the total National expenditure for recreation activities, which represents a primary source of income in many rural areas. She said, "In 1965, 11.6 percent of the gross National product was spent on recreation or was recreation-oriented and this activity accounts for about ten percent of National employment."

As pointed out by John Pearson in his Thesis: An Inventory and Analysis of Existing Outdoor Private Recreation Businesses by Enterprises and Activities in Wyoming - May 1968: "Private ownership of land in Wyoming accounts for 42.5 percent of Wyoming total land acres. Most of this land with the exception of that owned by commercial, industrial and residential could offer one or more recreational opportunities--only about 17 percent of the privately owned land in Wyoming is being used for outdoor recreational purposes," he said. Primarily, Mr. Pearson's Thesis relates the findings of a statewide effort by the State Agriculture Department, the Soil and Water Conservation Districts, the Agricultural Extension Service of the University of Wyoming, the Soil Conservation Service, the Wyoming Recreation Commission, the Division of Business and Economic Research of the College of Commerce and Industry, University of Wyoming, and many agricultural interests involving groups and individuals. All of these groups jointly conducted a comprehensive inventory of existing private outdoor recreation businesses by enterprise and activities. At the same time, potential enterprises were analyzed and recorded.

The major emphasis was placed on the number and capacities of each recreation enterprise relating to activities and demand and not to financial history or economic status. Those explored were divided into 12 categories:

In his conclusions, Mr. Pearson states: "Agriculture has declined greatly as a source of employment in Wyoming, while agriculture production has remained stable or increased. These unused agricultural lands have the potential to meet many of the recreation needs of an expanding population while opening up a new source of income to rural owners and operators. A merger of agriculture and recreation in the state would be exceedingly beneficial to both segments so that recreation businesses, if coordinated correctly, would augment traditional agricultural income sources."

"In short," Pearson continues, "the attitude of Wyoming's private citizen toward outdoor recreation, both as a businessman and a participant, will determine to a large extent the availability of recreation opportunities. Equally as significant, the quality of the recreation experience--whether at a public or private site--will depend heavily on the adequacy of private recreation areas and facilities."

In principle, recreation has for many years been considered a natural resource. The Taylor Grazing Act of 1934, a Federal law which created the multiple-use concept of public land, ordered that all land in the public domain be available to hunters and fishermen. In the past, however, the sporting use of land has often been the raggedy stepchild of grazing, lumber, oil and mining interests.

Today recreation is a "cash crop"--it has become big business in its own right. In 1968 billions of dollars were spent on outdoor recreation, including travel. Recreation can never have exclusive claim to multiple-use land unless the land is of great scenic importance or the recreation value is considered by the public to be greater than other monetary uses.

Wyoming has seen a tremendous growth in tourism with the greatest impact seen in areas offering various forms of outdoor recreation. The traffic counts, motel registers, and gas pumps give off a very accurate and concise evaluation of this new impact on the economy of Wyoming.

Without minimizing the economic impact of outdoor recreation, one should consider the great sociological impact that small recreation projects have had on our rural communities. We all tend to ignore that part of our society, yet must consider its accomplishments along with that of our urban areas.

Does it seem unreasonable to suggest that if we could afford to place thousands upon thousands of acres of our land in the soilbank for up to ten years, we cannot afford to provide incentives designed to preserve, protect, and develop the small percentage of our lands which are
tree-covered and which support a distinctive ecosystem of inestimable aesthetic and recreational value to the state? Is there not a glaring omission in our many Federal programs which completely ignores the rural states such as Wyoming? Is our commitment to natural beauty and outdoor recreation so narrowly circumscribed by our subjugation to economic and political expediency that we can take no effective measures to insure the future of our rural communities?

Most outdoor recreation takes place in or near water. Water-based recreation requires a high standard of water quality. At the same time that demands for water-based recreation have been vaulting upward the rate of increase in water pollution has been rapidly increasing. Rivers have become sewers in some parts of the country; lakes have become cesspools; and even stretches of seashore have become too filthy for recreation use.

Naturally, most recreationists feel that those who do the polluting should bear the cost of treatment and, just as naturally, the polluters believe that those who insist on pure water should bear the cost of providing it. A third alternative is to ask the general public to pick up the tab.

Perhaps we should ask ourselves a few questions like just what is pollution? Where does it come from and who are the polluters? We do know however that most pollution is usually the result of human activities, and it's everyone's problem.

Why we need water quality is self-evident—no matter what or who the water user is. As far as recreation is concerned, I believe the handwriting is on the wall. If we can't do anything else, we can look to the heavily populated east and learn from them. Do we want our western rivers and lakes to become as those have become in our populated east?

But it all takes money and cooperation! And a great deal of both is needed these days where inflationary costs and prices are eating away at profits and take-home pay.

You heard about the guy who framed his first dollar he made 30 years ago in a 10-cent frame? He found out just a few weeks ago that today the frame is worth a dollar and the dollar is worth 10 cents.

Secretary Udall was a great man as Secretary of the Interior and it's going to take some doing for anyone to follow his footsteps.

I would like to close with this story he told. He spoke of the marvels of man and the potential of our great country using a humorous yet true analogy: He told a story about an old farmer who was visiting a former neighbor who had struck oil. The neighbor had recreated the entire landscape on his ranch. He had moved mountains, built lakes, and literally created a new environment. The old farmer looked in bewilderment as his former neighbor gave him a tour of the ranch. When asked by the neighbor "What do you think?" he said, "I am thinking what God could do if he had money."
"Proper Feedlot Design to Control Pollution"

Ralph W. Hansen
Extension Agricultural Engineer
Colorado State University
Fort Collins, Colorado

The cattle feeding industry is currently experiencing waste disposal problems, comparable to the problems experienced by municipalities only a few years ago. As population centers grew in size and concentration, waste disposal systems became obsolete and inadequate. The problem had to be dealt with by sizable investments in the development and installation of new methods and equipment.

The beef cattle industry has undergone a dramatic change in the last five to ten years. The shift has been to large-size feeding operations located on relatively small areas. Heavy concentration of animals in feedlots has created serious problems in the control and management of the runoff and waste products. The small operations distributed over wide areas provided essentially a do-it-yourself waste disposal system with most of the manure products being returned to the land by the animals while under pasture or spread by the owners from relatively small feedlots.

Organic waste accumulates at an exceedingly rapid rate at high animal population densities and its disposal with proper control of the air and water pollution hazards is a matter of increasing concern to the feeder cattle industry. I do not have complete statistics on the number of cattle in feedlots; however, the figures for Colorado will, I believe, give an indication of the trend in feedlot operation in this area.

There were 637,000 head of cattle and calves in Colorado feedlots at the beginning of 1968. This was an increase of 5 percent over a year earlier. There were 94 feedlots with a capacity of 1,000 head or more on January 1, 1968, compared with 87 a year earlier. Thirty of these feedlots had a capacity of 5,000 head or more and held 333,000 head at the first of the year. Feedlots with capacities of 500 to 999 head numbered 99, compared with 106 a year earlier, and contained 52,000 head of cattle on feed. The smaller lots of less than 500 head capacity numbered 1,073 and contained 128,000 head of cattle on feed, compared with 130,000 head on January 1, 1967.

During 1967, there was an increase in total number of cattle in feedlots of approximately 6 percent over 1966, and in 1966 an increase of approximately 10 percent over 1965 was recorded.

To develop further the magnitude of the waste disposal problem from feedlots and the potential pollution problem, we need to look at the relationship between the quantity of manure produced and the physical characteristics of the feedlots. Engineers working with animal waste disposal have estimated that animal manure production in the United States amounts to over two billion tons per year--enough to cover a square mile to a depth of some 10 feet daily.
The most widely quoted values of daily production of feces and urine are 52 pounds per day and 20 pounds per day respectively, per 1,000 pound animal. The design of a feedlot generally allows for a concentration of about one animal per 150 to 200 square feet.

The term population equivalent is used extensively by sanitary engineers to equate animal manures to sewage. In a report to the National Institute of Health, Special Consultant John M. Henderson provided the following figures:

<table>
<thead>
<tr>
<th>Pop. Eq.</th>
<th>Man</th>
<th>Horses</th>
<th>Cows</th>
<th>Hogs</th>
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</thead>
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<tr>
<td></td>
<td>1</td>
<td>11.3</td>
<td>16.4</td>
<td>1.9</td>
</tr>
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</table>

These figures further emphasize the magnitude of waste disposal from feedlots of even a few thousand head of cattle.

It is obvious from the cattle concentration and manure production figures that only a few days of confinement are required before the surface of a lot is covered with manure. Normal practice dictates that lots be cleaned about every six months when cattle reach slaughter weight and are removed from the feedlot. Lots are essentially always covered with manure and it is evident that all precipitation that falls on the lot must either infiltrate, evaporate or run off into the adjoining waterways.

An understanding of the properties of farm animal waste is essential in the development of the methodology of manure management and disposal. The treatments that are commonly used for municipal sewage will not necessarily be successful with animal wastes. Sewage is water which contains some solid matter, while manure is essentially solid matter which contains water.

Properties of manure are commonly classified as physical, chemical and biological. The physical and chemical properties of animal wastes are known to be affected by the physiology of the animal, the feed ration and the environment. The size of the animal, as measured by its live weight, is perhaps the most important physiological parameter. The sex, breed and activity of the animal affect the manure properties to the extent that they partially determine the feed-conversion efficiency under a given environment. The digestibility of the feed ration, the protein and fiber content, and the nature of the other feed elements also affect the physical composition of the wastes. Temperature and humidity are the most important of the environmental factors.

The quality of the feed influences not only the amount the animal eats daily, which will be reflected in the quantity of manure produced, but
also the chemical composition of the waste. Proteins, which contain most of the nitrogen of the feed, vary in digestibility. Nitrogen in the undigested protein is excreted in the solid feces, where in the digested proteins it is absorbed and later excreted in the urine except for that part actually consumed in cell production in the animal. Potassium and phosphorus found in the feed are almost all excreted in the feces. Spilled feed is collected with the manure and represents undigested material, therefore manure will include all the ingredients of the feed from their original form to others in chemically simpler forms.

In some cases where antibiotics are administered to the animals, a sufficient portion may pass through the digestive tract to affect the biological characteristics of the manure. It is evident that waste accumulation and its chemical composition will vary considerably depending on ration, cattle and other variables.

Once the wastes are deposited, changes are going to begin to take place from natural causes. The changes will be influenced by conditions existing at any particular time. These conditions will be influenced by the slope of the lot, moisture content, rate of waste accumulation and numerous other factors. It is in this area that we can begin to exert some control through design and management practices.

There are many factors which affect the composition and quantity of runoff from feedlots. We will now try to determine the affect of some of the more important factors.

Two of the most important factors affecting the quantity and quality of runoff are the rate at which precipitation occurs and the prior moisture condition of the accumulated waste in the feedlot. Total quantity of precipitation is also obviously of prime importance in determining the total quantity of runoff.

A first impression would be that surfaced feedlots would have a higher runoff than unsurfaced lots. This is true immediately after cleaning; however, in view of the rapid accumulation of manure on the lot's surface, investigations have shown little difference in total runoff quantities from surfaced and unsurfaced lots. A feedlot will characteristically have a manure pack that is very well compacted by the cattle hoofs and with depressions on the surface which allow for considerable storage and a lag time between the start of the rainfall and the beginning of runoff. In the runoff investigations conducted at Colorado State University, it was observed that simulated rainfalls penetrated only the loose surface of the lot and the underlying material had little, if any, affect on the runoff.

A very important factor in the quality of the runoff is the moisture content of the manure at the time precipitation begins. If the accumulated organic mass on the feedlot area is dry and tightly compacted, it provides an impervious barrier where a high intensity rain resulting in
rapid runoff will remove large quantities of organic matter. While any runoff will contain a high concentration of dissolved organic pollutantcy, runoff from a high intensity rainfall may also contain a high concentration of suspended organic matter. It has also been noted that wastes resulting from the feeding of different rations have varying capacities for absorbing and retaining moisture. Generally, the high roughage rations have exhibited a higher capacity for absorbing and retaining moisture than the more concentrated rations.

Moisture contents and conditions prior to precipitation will affect the runoff quality in several ways. The pollution potential increases if accumulated organic waste is dehydrated as it is deposited, such as might be experienced during hot, dry summer weather. Under this condition, when precipitation occurs, the moisture reconstitutes the deposited material to nearly its freshly deposited condition and gives it an enormous potential for pollution. This can be explained by the fact that biological activity requires moisture and dehydration reduces the biological decay of the manure while it is stored in the lot. Generally, the moisture level is such that a composting process is in effect taking place while the manure is on the lot. Proper control of moisture will facilitate this process and aid in the waste disposal process.

The length of time the manure is exposed to moisture will greatly affect the quality of the runoff. A low intensity rain of long duration characteristically has a much higher pollution potential than an equal quantity in a higher intensity rain. Longer exposure to moisture allows dissolving of additional organic pollutants. This same affect on quality is reflected in the distance that runoff is allowed to drain over feedlot surfaces. The further it drains across the lot surface, the higher the pollution potential.

While it is obvious that steeper slopes will cause higher velocities of flow and greater erosion of accumulated organic mass on the feedlot areas, it does not have much effect on the initial storage capacity. The initial precipitation is stored in the depressions on the surface and until these depressions are filled and flow begins, the slope will not have much effect. From this point on, it will influence the erosion suspension capacity and time of contact.

The layout of a feedlot will have a substantial effect on the composition and quantity of runoff produced. Drainage from adjacent land area should be diverted around the feedlots, since if it is allowed to flow over the feedlot area, it will have much the same effect as the precipitation falling on the lot. Grading and shaping the lots to provide the most direct drainage into a drainage channel will minimize erosion and contact time with the manure materials with a consequent minimization of pollution of the runoff.

Until research and experience provide the opportunity for the evaluation of waste treatment systems, we can at this point only provide a guide to
systems that should provide for pollution control at reasonable cost. The extreme quantitative and qualitative variability of liquid runoff from cattle feedlots will require a treatment system different than the type used for treating municipal sewage water.

First of all, it should be pointed out that the most economical method of controlling pollution resulting from feedlot runoff is to minimize the quantity of runoff by preventing outside surface water from entering the feedlot. As pointed out previously, the drainage system should be designed to divert any drainage from adjacent land area around the feedlot, so that only drainage from the feedlot itself will have to be handled.

The lots should be graded to prevent overflows between lots and to provide the shortest route to a drainage channel. Good grading will also prevent the accumulation of standing water in the lots and provide the shortest exposure time of the manure to the water. As pointed out previously, the longer the manure is exposed to water, the more material is dissolved and the higher the pollution hazard.

The runoff water can be collected and disposed of by several different systems. The economics of installing a retention system will obviously be of extreme importance, and different situations will have different requirements.

Where the runoff can be disposed of directly on land without danger of contamination to water supplies, this will probably be the most economical and practical. In general, the only limitation is that the feedlot waste not be used on fresh fruit and vegetable crops which might carry the contamination over into the market product. This procedure will utilize the fertilizer value to help offset the cost of disposal. It may be that in the future, we will need to plan on using some land exclusively for waste disposal, applying the waste at a much higher rate than we normally do for a cropping system and utilizing a vegetative cover designed for the purpose of disposing of the liquid and solid waste rather than as a crop potential. A number of grasses and weeds have this characteristic. Changes in the usual cultural practice can also facilitate a higher concentration of disposal on a smaller land area than is normally practiced.

The water pollution control regulations of most states, as applied to feedlots, require the construction of collection and retention ponds wherever there is danger of contamination of water supplies. The retention ponds will undoubtedly take a number of forms, depending on the requirements of the individual situation. In some cases, they will be simply a temporary storage from which the runoff will be spread on adjoining land areas, probably as part of the irrigation requirements as discussed above. In other cases, a more extensive treatment system will be required.

Lagoons have been used with varying degrees of success for the treatment of biological degradable wastes for many years. While lagoons are
relatively inexpensive to build and operate, to provide adequate
treatment they require a fairly sizable land area.

Anaerobic lagoons are lagoons in which the concentration of organic
material is sufficiently high to support microbial population great
enough to completely de-oxygenate the water in the lagoon. The micro-
organisms in the lagoon break down the complex organic materials into
stable inorganic salts and gases. The process proceeds at relatively
slow rates and is accompanied by the emission of odoriferous gases such
as hydrogen sulfide. To reach a substantial stabilization of strong
waste materials such as feedlot runoff, a fairly long period of time
is required in the lagoon.

Anaerobic lagoons are ordinarily constructed fairly deep, so that they do
not occupy a very large surface area. Since they are deep and for relatively
long periods of storage, they do require sealing to prevent contamination
of underlying groundwater.

Aerobic lagoons are lagoons in which the loading of organic material is
slow enough to maintain some dissolved oxygen at all times in the water
in the lagoon. The first aerobic lagoons were designed to be relatively
shallow, usually about three feet, to allow sunshine to penetrate most of
the depth and expose a large surface area to maintain a dissolved oxygen
concentration throughout the depth of the lagoon. This practice required
large lagoon areas. More recently, the design has been modified to build
aerobic lagoons considerably deeper, load them heavier, and attempt to
maintain a concentration of dissolved oxygen by means of mechanical
aeration systems.

Even with lagooning systems, the runoff from any practical combination of
anaerobic and aerobic lagoons used for stabilizing feedlot runoff would
not be suitable for direct discharge into surface streams. They could
probably only serve as storage, a partial treatment system, and the
ultimate disposal would probably have to be by evaporation and spreading
on land.

There are other aspects of pollution that need to be considered together,
and as a part of, the control of feedlot runoff. The control of odors is
a critical problem we are just beginning to attack and analyze with the
ultimate objective of providing a control.

Insect control is necessarily a part of the feedlot waste management
disposal program. Flies can become not only a nuisance but a serious
problem in spreading disease.

We have much to learn about how to design and manage feedlot systems to
effectively control all forms of pollution. We have, however, recognized
the problem and research is being conducted throughout the country to
accumulate the knowledge we need to understand and control pollution
in a feasible way. It will require the attention of everyone concerned, continued research and probably a sizable investment in physical facilities to adequately control the potential pollution problem from feedlot wastes.

"Control of Aquatic Weeds by Semicontinuous Feeding Copper Sulfate into Irrigation Water"

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Are aquatic or water weeds and herbicides used to control them a water pollution problem? The answer to this question in many instances, particularly on irrigation systems, is "Yes." Therefore, as individuals, irrigation district officials, or a Government agency responsible for developing and using our water resources for irrigation of food crops, domestic use, or for industrial use, it is imperative that we understand this complex problem and approach it with knowledgeable foresight and vigor.

The word "pollute" and its synonym "contaminate" with regard to water is defined as follows: "To render water (otherwise satisfactory) unfit for a specified use." Such a specified use could be drinking and other potable uses, watering livestock and game animals, fishing, swimming, irrigation, or an industrial use. Pollution can be from many sources, including aquatic weeds, or from herbicides used to treat them or chemicals used to control landweeds on the ditchbanks.

There are about 150 different kinds of aquatic or water weeds that are pollutants in one or more situations. One of the most common aquatic pests is algae. Some microscopic plankton forms produce objectionable odors and tastes in drinking water. Other kinds are toxic to fish and others may cause "swimmer's itch." On irrigation systems a stringy, green-colored filamentous algae frequently forms a dense mat on the water surface of canals and laterals. These algae plug structures on gravity irrigation systems, sprinkler heads on sprinkler irrigation systems and farmers' siphon tubes. Some filamentous algae grow on concrete linings of canals and laterals and other control structures needed to operate an irrigation system, including measuring structures such as Parshall flumes, weirs, Sparling meters, etc.

In earth canals and laterals submerged weeds--rooted plants that grow mostly under water--are even more troublesome than the algae. Examples are pondweeds, elodeas, and watermilfoils. These weeds appear to be spreading rapidly in old and new irrigation systems throughout the four-state area.
Water weeds tend to grow vigorously and spread by the extra plant nutrients—particularly nitrogen and phosphorus—reaching our water supplies from the high levels of fertilizer used on agricultural land, runoff water from livestock feed yards, and from sewage effluent entering streams, lakes and other waterways. A survey made by the Bureau of Reclamation in 1960 shows the total annual water loss caused by aquatic weeds in the 17 Western States estimated at 1,966,068 acre-feet. This water loss caused from transpiration, increased evaporation and overflows of irrigation channels would have been sufficient to irrigate 330,000 to 780,000 acres of cropland, depending upon the length of the growing season, evaporation losses, and other factors. The total cost of losses caused by weeds for the 17 Western States was estimated at $5,739,164.

Many of our irrigation systems are now delivering water for a multitude of uses, such as irrigation of crops, water for livestock and wild game, domestic use for drinking, swimming and other recreational activities, and industrial use. Therefore, it is imperative that we select and use satisfactory control measures for the many water weeds that are invading these systems so they will not create additional pollution problems in our dwindling supply of clean water.

This brings us to the second aspect of the problem—herbicides used to control water weeds in irrigation systems. Our objective, of course, is to use herbicides as antipollutants; i.e., to remove or reduce pollution or obstruction problems caused by weeds.

Much progress has been made in the past few years in discovering and developing effective herbicides for controlling most of the water weeds that grow in and on water. However, several of these herbicides may produce adverse effects when used in irrigation water supplies, such as making them unfit for watering livestock and wild game, domestic use, and may kill fish. These adverse effects challenged our Research Staff in the Denver Research Center to find a herbicide which would control water weeds common to irrigation systems and would not make the water unfit for other uses.

After many successful laboratory experiments were completed, a field experiment was started in 1966 to determine whether daily applications of low concentrations of copper sulfate would be effective in controlling submersed aquatic water weeds and to study related factors pertinent to the development of this technique of aquatic weed control. These studies have been continued for a period of three years under the direction of Mr. Thomas R. Bartley, Head, Biological Investigations Section, Research Division, Bureau of Reclamation.

Copper sulfate has been safely used as an algicide since 1904, and is definitely an antipollutant in potable water, where the tolerance established by the U. S. Public Health Service is 1 part per million of copper (4 ppm copper sulfate in the pentahydrate form). In addition to being safe in potable water, most fish are not harmed at the concentration allowable in potable water. Trout are sensitive to 0.5 ppm but appear
to be unharmed at the concentrations used in recent Bureau of Reclamation field experiments. Copper sulfate treatment renders water unfit for certain industrial uses; therefore, all uses to be made of water should be thoroughly investigated before treatment is started in an irrigation system.

Since copper is essential to both plants and animals, this element is often dealt with as a nutrient rather than a toxicant. Studies now being made by the Bureau of Reclamation are to develop procedures for the use of copper sulfate to control submersed aquatic weeds and algae in irrigation canals, particularly where the water may be used for other than irrigation of crops, and to answer questions which are likely to arise as to the polluting effects some of the other aquatic weed herbicides may have on beneficial plant and animal life or industrial uses.

The first field experiment started in 1966 to control submersed aquatic weeds by daily applications of low concentrations of copper sulfate was conducted in an operating canal 11.8 miles long, known as the Farmers Ditch, located near Loveland, Colorado. It has an unlined earth bottom, except for a 1-mile concrete-lined section at the terminal portion. Ditch bottom width is about 12 feet for the first 6 miles and then it gradually decreases in size to a width of about 2 feet at the end. Normal operating capacity of the canal ranges from 20 to 30 cubic feet per second (cfs) of flow, and the water depth varies from 2 to 3 feet. Water moves slowly through the canal.

This canal has a long history of submersed aquatic weeds which have previously been controlled by mechanical means (usually a dragline). Aquatic weeds collected from the canal and identified during the experiment included sago pondweed, leafy pondweed, waterweed, horned pondweed and filamentous green algae. No algae were evident during treatment periods.

Copper sulfate crystals were introduced into the flowing irrigation water by using a commercially built, screw-type, volumetric dry feeder. The feeder has a 24-hour built-in timing device that permits an on or off position in any desired 15-minute time increment. By varying the size of the feed helix and adjustments in the double-reduction drive arrangement the quantity of material fed can be varied over a wide range.

The copper sulfate feeding rate, feeding time per 24 hours, and the general feeding schedule throughout the irrigation season were varied according to factors such as time of season, stage and extent of weed growth, and water discharged. A heavier feeding schedule was used generally in the early season and was tapered off as the weeds died and sloughed of the ditch-bottom. In 1966 there were 99 days of feeding time, with a total of 8,100 pounds of copper sulfate being fed into the canal; in 1967 there were 70 days of feeding time and 3,900 pounds of copper sulfate used; and in 1968 there were 114 days' feeding time, with a total of 5,900 pounds of copper sulfate being used. Above average rainfall during the early part of the
1967 irrigation season accounts for the rather low number of feeding
days reported for that year.

The following table shows the computed copper concentration in the canal
water on the basis of quantities of water being diverted into the canal
and copper sulfate dispensed at the upper end of the canal:

<table>
<thead>
<tr>
<th>Year</th>
<th>Average cfs of flow</th>
<th>Average pounds of copper sulfate fed/cfs/day</th>
<th>Average computed copper ion concentration, ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>1966</td>
<td>22.5</td>
<td>3.6</td>
<td>0.17</td>
</tr>
<tr>
<td>1967</td>
<td>23.0</td>
<td>2.4</td>
<td>0.11</td>
</tr>
<tr>
<td>1968</td>
<td>24.2</td>
<td>2.1</td>
<td>0.10</td>
</tr>
</tbody>
</table>

These figures represent the average for the three seasons.

Upon completion of the three-year study, it has been concluded and demon-
strated that daily applications of low concentrations of copper sulfate to
the head of an irrigation canal with water of relatively low alkalinity
were effective in controlling submersed aquatic weeds such as sago, leafy
and horned pondweed and elodea. Filamentous green algae were also readily
controlled with the low daily applications of copper sulfate. The quantity
of copper sulfate fed per unit of water diverted was reduced each season.
The decrease can be attributed to the reduction each year of roots, tubers,
visible seed, and other vegetative parts associated with reproduction of
pondweeds.

It was observed that aquatic weeds absorb copper readily from the water
and accumulate levels within the plant tissue over a four- to six-week
exposure that are toxic to the plants. Therefore, it is extremely import-
ent to start treatment early in the season so that the copper can become
effective before the water weeds interfere with delivery of water. It is
recommended that daily feeding of copper sulfate should begin when water
is first turned into a canal or as soon as aquatic weed growth is observed.
A general guideline for initiating a feeding schedule is three, two and one
pound of copper sulfate per cfs per day of flow for the first, second, and
third portions, respectively, of the feeding season. Signs of severe plant
injury would suggest the first reduction in feed rate and the sloughing out
of dead weed growth would indicate the time of the second reduction.

The alkalinity content of the water should be considered in any copper
sulfate treatment. Where the alkalinity is much greater than 100 ppm the
use of an agent such as citric acid should be considered to prevent copper
precipitation.

The purchase cost of the feeder and installation, cost of copper sulfate
required and labor to refill the hopper and adjust feed rates must be
considered in calculating the cost of controlling weeds by the technique.
The screw-type feeder is commercially available. Its cost installed is
less than $1,000 and it should give several years of good performance. Copper sulfate crystals presently cost from $20 to $24 per 100 pounds, depending on quantity desired and location of purchase. The results of the experiment indicate that it will require an average of 2 pounds of copper sulfate per cfs per day to maintain good control in a 10-mile reach of canal. Assuming that the feeding period is 100 days, then the estimated cost (using this method) is $0.20 to $0.25 per acre-foot of water treated. This estimated cost is for small canals in the range of 10 to 50 cfs of flow. Quantities of copper required per cfs in larger canals can probably be reduced, thus lowering the cost per acre-foot. Servicing and adjusting the feeder should not require more than one man-hour of labor per week.

Aquatic weed control using copper sulfate applied by this method will cost less in most instances than most mechanical methods being used for removal of troublesome weed growths. However, in most cases this method will cost more than some of the other aquatic herbicides, such as emulsified xylene now being used in some irrigation systems. By comparison, three applications of xylene would be required for control of aquatic weeds in the Farmer's Ditch which would cost about $0.12 to $0.15 per acre-foot. However, daily feeding of low concentrations of copper used as a preventative measure for inhibiting aquatic weed growth has advantages when consideration is given to nontarget organisms and the various uses to be made of treated water. Also, daily copper sulfate applications used for submersed aquatic weed control keep the irrigation system relatively free of unwanted vegetation during the entire operating season in comparison to floating pieces of aquatic weeds in untreated systems or those treated only periodically.

Another experiment started in May 1968 by Mr. Bartley to control algae in a lined canal by continuous low rate feeding of copper sulfate is now underway on the Charles Hansen Feeder Canal of the Colorado-Big Thompson Project. The object of this experiment is to determine the merits of a continuous feed of a very low concentration of copper sulfate as opposed to the slug-type treatment for algae control. This concrete-lined canal, 13.2 miles in length, is operated throughout the entire year to deliver water for irrigation purposes, domestic use, and power production.

Due to the frequent change in volume of water flow diverted into the canal, it was necessary to use an electric variable speed screw-type feeder and controls for automatically changing the feeding rate according to the change in water flow.

Records are being kept of the quantity of water being diverted into the canal and the pounds of copper sulfate fed into the water. During the period of June 26 to October 14 the computed copper concentration was 2.0 parts per billion (ppb). Costs for this treatment are now $0.05 for each 10 acre-feet of water being treated. The experiment so far has shown that continuous feeding of copper sulfate in low concentrations uses more copper sulfate than the previously used slug treatment. The experimental
technique, however, provided a more effective control of algae, reduced the labor requirement, and greatly reduced the maximum concentration of copper in the water, thus making it safe for all uses, including fish (trout).

Another field trial was initiated at the start of 1968 by the Ainsworth Irrigation District, Ainsworth, Nebraska, using semicontinuous feeding of low concentrations of copper sulfate into the irrigation water being transported by the Ainsworth Canal. This is a concrete-lined canal about 53 miles in length, which traverses the sandhills of Nebraska. Filamentous green algae had presented a serious operating problem the previous three years.

Because of the harder water, more copper sulfate had to be used than was used on the Charles Hansen Feeder Canal in Colorado. Excellent control was realized with a computed concentration of 30 parts per billion of copper during the feeding periods.

The one screw-type feeder located at the Ainsworth Canal outlet works of Merritt Dam controlled all algae growth in the first 48 miles of the canal. At this point a second feeder was installed. The estimated cost for controlling algae, using this method, was $0.05 per acre-foot of water being treated in the first 48 miles of the canal. This cost was much less than control methods that were being used in previous years and had proven ineffective in controlling algae growths.
I'd like to talk to you just a bit today about some of the problems that we know are going to be facing us with our water supply situation. If we don't start doing something about them very soon, we are going to be in a great deal of difficulty and we will lose the lead time that is absolutely essential to cope with the type of water problems that we see coming on us. We are going to have to get out of our horse and buggy vintage of water development and get into the space age. And the thing that's bringing this on so dramatically is the tremendous growth of population we are experiencing, and along with it, vastly greater needs for water.

Now, I hope you won't take my statistics too seriously because they are meant more or less as an illustration of the magnitude of the problem. I wouldn't swear these population projections are absolutely right. They only indicate that we have a sizable change coming in the western part of the United States where we live. The current population in our 17 western states is somewhere in the neighborhood of 16 or 17 million people. By the year 2020, we anticipate this is going to be 60 to 65 million.

The potential figures in land development, that a great many of you gentlemen are interested in, are still substantial. At the present time, we have under irrigation about 36 million acres and we easily have potentials that will irrigate almost 60 million. Now the water withdrawals that we are making are even more dramatic. This is water that is diverted or withdrawn from water resources, not the consumptive use of water. At present, we are withdrawing in the neighborhood of 150 million acre-feet annually. We project that withdrawals by the year 2020 for municipal, industrial and agricultural uses will grow to about 250 million acre-feet annually.

Our problem is where are we going to get this water. In most of our basins, we are very near to approaching complete control and potential shortages. The only basins of any significance, and by this I mean the larger basins, where there may be an ample or abundant supply, are the Columbia and the streams along the north coast of California. I hope that you will note that I didn't say any surpluses in the Columbia, but they do have water that would appear adequate to cope with some of their expansions. The basins like the Missouri River Basin, the Arkansas White and Red Rivers, Texas coastal streams, Rio Grande, Colorado, the Great Basin and the bulk of California are right up against a water problem or have one. Coupled with the shortage of water, we have water quality rearing its ugly head, and certainly, I think we know we have to cope with this problem. We've
got to find ways in which to keep our waters potable. Also, we are finding additional desires and requirements for water.

Now, I mentioned that I think that time is running out, and I think most of you gentlemen who are familiar with this kind of irrigation developments we've had in the past, recognize that it takes us a good deal of lead time and a lot of construction time to bring these projects into fruition. Ten or fifteen years is a mighty small time to get them into shape and producing. Now that we are beginning to talk and think about some of the larger augmentation schemes that we know will have to be entered into to keep pace with our demands, we're going to have to talk about lead times of 20 to 25 years. Coupled with this are the complex problems of determining how and what we are going to do, and raising costs. I think it's pretty important to expect a dramatic need for greater efficiency in water use. We just have to improve our efficiency because we can't afford not to. This is indeed a complex problem of management and cooperation. Certainly, the district or the body that has a good water right is not going to be as inspired to improve efficiency as one that is chronically short of water.

But I do think we have some encouraging things that are being accomplished. Here in the Bureau of Reclamation, through research we have been doing on use of water, we believe we are on the threshold of being able to work with the districts and the farmer in being able to efficiently predict when to put water on the crops so that we are not pouring water on a wet sponge. As a result, we believe that you will get better crop yields and will spend less on labor. There must be efforts made to consolidate ditches, line ditches, get rid of leaky reservoirs, control phreatophytes, and all the many things we might do to save a few drops of water.

But increasing efficiency is not going to be enough. We are going to have to explore and do something about controlling weather. Again, with research that we are strongly engaged in, we believe there are prospects of being able to increase snowpack on some of our higher watersheds. We have a big job ahead of us and we have much to learn.

Desalinization has been talked of, and we think that this has some very good potential for being able to make fresh water available, particularly along our coastal areas. It will be expensive water, but we are looking forward to improvements in the arts that will make the processes cheaper. Hopefully, these processes will enable us to produce enough extra heat that we can incorporate large thermal electric plants that will help to defray the cost.

By 1990, or thereabouts, the people that are experts in the field of nuclear power and energy are predicting that we will have what is known as a fast breeder-type reactor, one that is highly efficient and is almost like perpetual motion--one that will produce more feasible materials as a result of the process than are used to begin the cycle. Now, many people are involved and working on studies of augmenting our
water supplies. I think all of our states have perked up their ears and are looking into these possibilities. Many private agencies are also using their ingenuity and thinking of schemes.

Recently, the passage of the Colorado River Project Act by the Congress that authorized the Central Arizona Project and authorized five projects in the State of Colorado has clarified certain things in regard to water regulation in the Colorado River Basin. It also directs the Secretary of the Interior to make a study of the needs and water requirements of those states wholly or partially west of the Continental Divide. This means that the Secretary is charged with looking into the long-range water problems of our western states. This leaves out some of our friends in the Missouri River Basin and in the Texas Basin area, but it does cover quite a vast part of our United States. A progress report is to be made on the Secretary's findings by June 30, 1971, and a final reconnaissance report by June 30, 1977. It does have some strings attached on what we can do about augmentation studies. It states that no studies of imports to the Colorado River Basin can be made for a period of ten years except from Arizona, California, Colorado, New Mexico and those portions of Nevada, Utah and Wyoming within the Colorado River Basin. But it does get us started on some of the things that need to be studied in depth.

A brief outline of the Colorado River Project Act is as follows:

1. The Project Act issued to the Secretary is very broad.
2. Initial studies are to be reconnaissance in character.
3. The area of study comprises 11 western states, as I just described them to you.
4. Duplication of work of the Inter-Departmental River Basin Commissions and Regional Planning Commissions is to be avoided.
5. There will be broad coordination of studies of states, other Federal agencies, study commissions and the Western States Water Council.
6. The activity should be directed toward determining water supplies available and long-range water requirements.
7. Following the initiation of these studies, development of a plan to augment the Colorado River Project shall have high priority.
8. There is to be a ten-year moratorium on studies of imports into the Colorado River from natural river basins outside the Colorado River Basin states.
9. Progress reports to be submitted to the President, the National Water Commission, the Water Resources Council, and the Congress each two years beginning June 30, 1971 with the final report in 1977.
10. Investigation will not end with the reconnaissance report. This will be only the first phase to be followed by feasibility investigations.
11. Following the end of the ten-year moratorium, such studies as surface water imports from outside the Colorado River Basin states as justified will be undertaken.

The Bill goes a long way toward getting us off the ground.
Things are moving forward in many ways and I mentioned as one the current reconnaissance studies that the Bureau of Reclamation is making with the Corps of Engineers on diverting water that is surplus to the Mississippi River Basin to portions of New Mexico and Oklahoma.

Now, there have been many studies made of importing water from Canada. You've heard of many of them and just to reacquaint you with them, I will review them briefly.

Four plans for importing water from Canada have gained enough publicity to become known by name. These four are the North American Water and Power Alliance, known as NAWAPA; the Western States Water Augmentation Concept, which is a Lewis Smith scheme; the Central North American Water Project; and the Great Replenishment and Northern Development, called the Grand Canal Concept.

The NAWAPA scheme is a continental-wide proposal by Ralph Parsons of Parsons Company in Los Angeles. It would tap about 20 percent of the water from the Copper, Tanana, and Chitina Rivers in Alaska and the Yukon, Klondike, Steward and Pelly Rivers in the Yukon Territory of Canada, and Alaska. These waters would be diverted southward by a series of dams, reservoirs, pumping stations, canals, and tunnels. The heart of the system is a 500-mile long reservoir contained within the Rocky Mountain trench stretching into Montana. From the trench, 22 million acre-feet would be distributed to seven provinces and one territory of Canada, and 75 million acre-feet would be divided between 33 states of the West and Great Plains of the United States. Northern Mexico would receive 20 million acre-feet annually. A navigation canal from the trench to Lake Superior would deliver fresh water to stabilize and abate pollution in the Great Lakes with connecting links to Lake Winnipeg and Hudson Bay in northern Canada. An inland waterway connecting the Pacific and Atlantic Oceans would be created. The project cost is estimated at $100 billion with 48 percent spent in Canada, 47 percent in the United States, and 5 percent in Mexico. Annual sales of water and power and barge and ship tolls would increase the national income of Canada by approximately $9 billion and that of the United States about $30 billion. It is estimated that 10 years would be required for treaty negotiations and completion of designs, and 20 years for construction.

Now, the Smith scheme proposed by Lewis G. Smith is a little less grandios than the NAWAPA in that it is designed to supply supplemental water only to the 17 western states. The plan would tap the McKenzie River system of 40 million acre-feet annually. A series of dams, reservoirs, and pumping stations on the Liard, Piece and Frazer Rivers would be used to transfer the water to the United States-Canadian border. The plan calls for transfer from the border to Centennial Valley in Southern Montana by flowing down the Columbia River and reversing the flow of the Snake and Salmon Rivers or by reversing the flow of the upper Frazer River in the Rocky Mountain trench to Montana and constructing a conveyance system.
across the state. The latter method is favored because of objections to reversing the Snake and Salmon Rivers. The total lift on the Frazer route is in excess of 5,000 feet. From the 50 million acre-foot Centennial Valley Reservoir, branch take-offs to the Missouri, Colorado and Great Basins drainages are planned. The northwest would be served directly via the Columbia and Snake Rivers. A tunnel system paralleling the Continental Divide on the east would serve the Arkansas, Rio Grande and Texas Basin drainages. Cost is estimated at $75 billion and the collection and primary distribution system another $25 billion. Financing of the scheme, according to Mr. Smith, would be through development of oil shale reserves, sale of power from falling water, municipal, industrial and agricultural water sales.

The CNAWP scheme proposed by Dr. Tinney avoids use of the Rocky Mountain trench in the creation of large reservoirs. This scheme calls for diversion of water from the top four feet of Great Bear Lake and Great Slave Lake in the Northwest Territory, and by connecting some 50,000 square miles of lake surface with some 600 miles of canals and a lift of slightly over 200 feet. Water is proposed to be delivered to the United States as a salable commodity. Water delivered into the Missouri would be diverted from Fort Randall, transported 1,500 miles along the western edge of the Great Plains and down into the Rio Grande and Lower Colorado Rivers. Enough water is available to deliver 150 million acre-feet annually for use in the western United States. Dr. Tinney made no estimate of the cost of the facilities, but has been quoted that the costs would be about one-third of the $100 billion NAWAPA scheme.

The Grand Canal scheme is offered by T. W. Kerns of Gibb, Underwood and McClellan of Toronto, Canada. It promotes recycling water flowing into the James Bay, rather than diverting from the streams and headwater. Dikes would be built to prevent mixing of fresh and salt water. The scheme calls for continental water management making full utilization of the flowing streams for hydroelectric power and industrial development before delivering it to other uses. Water from James Bay would be pumped in a series of open-channel steps to the Great Lakes and there storage regulation would be achieved. Distribution would be made to the western United States and Canada by reversing the direction of the NAWAPA navigation canal between the Great Lakes and the Rocky Mountain trench. The system would provide an inland water linkage similar to that described in the NAWAPA proposal. Water supplies for the central United States would be drawn from the stabilized Great Lakes. Power for pumping would come largely from hydroelectric developments on the northern stream.

These are but a few that come to light. There are many more. Most all of them have been explored in a very cursory fashion. I think you should take the cost figures as being estimates, but not very exact estimates. I do think they indicate how very costly this water is going to be. When we talk about water costing $1.50 or $2.00 an acre-foot, the cost for some of these schemes is going to run in the $100 per acre-foot bracket. I am sure before you buy some of this kind of
water, you will be using what you have very efficiently. But it does point to the need for all of us to work together and to look toward our problems we are going to face, or at least that your children are going to have to face up to. I call upon the Four-States Irrigation Council as one of the groups who is interested in water in the west to keep abreast of these problems and to help all of us in the west and in the United States work toward solving them.
Thursday Afternoon

PROPOSED WATER LEGISLATION

Senator Maurice Kremer
Felix Sparks

Arno Windscheffel
Panel Moderator

Keith Krause
Floyd Bishop
"Water Legislation in Nebraska"

Senator Maurice Kremer
Nebraska Legislature
Lincoln, Nebraska

I am an irrigator and my legislative district at the present time includes approximately 425,000 acres of irrigated land, all of which has been developed from our groundwater. In my legislative district, which includes Hamilton, Merrick, Polk and part of Hall Counties, we have a total of approximately 6,000 irrigation wells and we installed about 200 more during 1968. As a consequence, our groundwater table is receding at a rate of up to one foot per year over a considerable area of my district. I recognize that the continued economic growth and prosperity of my legislative district will depend upon how well we can manage and sustain the yield of this great groundwater resource.

Even though I represent just the 34th legislative district, during the interim period between the 1967 and 1969 session of the Nebraska Legislature, I served as chairman of the Legislative Council Study Committee on Ground and Surface water. As a consequence, it was necessary for me to take a state-wide viewpoint of the water problems and programs of our state. A very brief resume of the physical situation as relates to our natural resources in Nebraska may be of value to you in orienting you as to the needs for some of the water planning programs and future legislation which we envision.

The climate in Nebraska is quite varied. The rainfall varies annually from 10 to 12 inches in western Nebraska to over 30 inches in the southeastern part of Nebraska. Basically, the western half of Nebraska is very similar to the climate and agricultural production of eastern Colorado and Wyoming. Irrigation is a must in most of this area if you are to satisfactorily and successfully raise cultivated crops. The eastern half of Nebraska has a climate and topography very similar to the states of Iowa and Illinois. In this area the principal natural resource problems are related to flood and erosion control, water quality and those problems related with a rapidly expanding urban population. But even in eastern Nebraska irrigation is becoming more and more important to the overall economy of the area. It is estimated that Nebraska has approximately 1.7 billion acre-feet of groundwater in storage. This is over 50 percent of the known groundwater reserve in the Missouri River Basin. Approximately 1.4 million acre-feet of water flow into Nebraska each year from the states of Colorado, Wyoming and South Dakota. During a normal year, we have about 7 million acre-feet of water leave our state, and there is an additional 26 million acre-feet which flow by the eastern boundaries of our state in the Missouri River. Generally speaking, the quality of all of our water is quite good. Obviously, our state has a substantial water supply which is available for development. The prudent development of this water supply is of major concern and interest to our Nebraska Legislature.
Because of Nebraska's available water supply and the related opportunity for development, much of our development to date has been in carrying out specific projects for a limited number of purposes. Up to the present time, very little thought has been given as to the inter-relationship of various programs and how the development of one particular project may adversely or complementary affect another area. Historically, we have attempted to fragment resource development into specific areas of programming. This is the reason that in Nebraska we have approximately 14 different types of special purpose natural resource districts that can sponsor natural resource programs. It has been estimated that we have approximately 500 special resource districts in Nebraska—many of these districts with the same authorities cover identical areas of operation.

Similarly, we have chosen to ignore the inter-relationship of our ground and surface water in Nebraska. We have done this through legislation whereby the responsibility for administering our surface water laws is vested in the Nebraska Department of Water Resources. The limited groundwater legislation in Nebraska calls for the formation of groundwater conservation districts which are in reality a local unit of government. In addition, we have fragmented our ground and surface water programs by assigning the responsibility for data collection for surface water in one agency, and groundwater in another agency. The water quality programs as relate to ground and surface water have been somewhat divided between two separate agencies. We are now beginning to realize that it will be necessary to consider both ground and surface water if we are to develop the maximum potential of our water resources. It will be necessary for administration and the management of our ground and surface water to be vested in the same local and state organizations.

Looking to the future, there is an outside factor that is going to have a very important influence upon the land and water development. This is the influence of the population shift from our rural to urban areas of our state. In the past, Nebraska has been considered to be a rural or agrarian state—this is rapidly changing. At the present time, 16 of the 49 Nebraska legislators in our Unicameral are from Lincoln and Omaha. We will have another reapportionment between now and the 1971 session. At this time, these two metropolitan areas will be allocated additional representation. I would predict that by 1980 the majority of people in Nebraska will reside within these two metropolitan areas. This means that the urban citizens of Lincoln and Omaha will be in the position to determine the laws that relate to the development of the natural resources of our state. Historically, the legislation and even the water planning in our state have been closely related to agriculture. The first water legislation in the 1890's related to irrigation. With this shift of population to urban areas, we can expect that there will be a shift in emphasis in certain natural resource programs. The same shift is being felt but even to a greater degree nationally. With this shift in population, we will note greater emphasis being based on such urban related programs as water quality, recreation, water supply, flood control and water transportation.
This shift in population and legislative control is a concern of all people who live in a rural area and receive their livelihood from the operations relating to land and water. Inevitably, those of us from rural areas, while we have major interests in the fields of irrigation, land treatment and flood control, must learn to cooperate and develop legislation which is of value not only to our own area but also to the entire state and nation. Personally, I feel that the rural people have a lot to gain by developing cooperative programs with their urban brethren. We cannot be selfish in our approach and we must recognize that the needs and requirements of our urban brethren will be met. Properly explained, I believe that the urban dweller can be cultivated and educated to the place where he will become an ardent supporter of those programs and projects which are required in our rural areas.

In Nebraska we are now beginning to see more and more conflicts developing between various water using groups and from proponents of various natural resource programs. As an example, we have a reclamation project in the central part of Nebraska which is presently being held up because downstream water interests are fearful that this project will have a detrimental effect resulting in a serious depletion of their water supply. In the design and development of future projects, we will have to be aware that if irrigation or rural oriented projects are to be legislatively palatable, they will have to fit into a state water plan which has been systematically and objectively developed which will meet as many of the future land and water requirements of a state as is humanly possible.

It was the need to objectively resolve future water conflicts in Nebraska and at the same time plan for the optimum development of our natural resources that led the Nebraska Legislature in 1965 to appropriate approximately $100,000 for the purpose of implementing a comprehensive water program in Nebraska. It was at this very same time and in recognition of the national need that the U.S. Congress in 1965 enacted the Water Resources Planning Act. This act established as national policy that we would have comprehensive planning and result in multi-purpose project development.

The Nebraska Legislature in 1967 unanimously adopted legislative resolution #5 calling for the Nebraska Soil and Water Conservation Commission to develop a state water plan. This resolution directed the Commission to analyze the soil and water resources of Nebraska and to prepare a comprehensive water related plan for the state. Such a framework plan is to be completed no later than June 30, 1971. This analysis, to be known as the State Water Plan, is to include an evaluation of the land and water resources of our state and to also include an examination of the legal, social and economic factors which are associated with resource development. The Commission was further directed to submit an interim report to the 1969 session of the Nebraska Legislature. Within the next few days, this interim report will be presented by the Nebraska Soil and Water Conservation Commission to the members of this session of the Nebraska Legislature.
am particularly interested in the state water planning program because I was chairman of one of the divisions in the Legislative Council Study Committee between the 1965 and 1967 sessions that specifically requested that this study be made. As chairman of the Legislative Council Study Committee between the 1967 and 1969 sessions, it has been my pleasure to cooperate with the Nebraska Soil and Water Conservation Commission in this program of study.

It is not my purpose during the discussion to go into the details of our state water planning program in Nebraska. Rather, I will relate my remarks to only those projects and programs which will require legislative action. The members of the Nebraska Legislature authorized this state natural resource planning program for the principal purpose of giving us needed information and guidance for future legislation. It is generally agreed in our legislative body that we will not consider major resource legislation until it has been studied as part of the State Water Plan and we as Legislators have the benefit of such a study.

For your information, the Legislative Council Study Committee on Ground and Surface Water has made three recommendations for the consideration of the 1969 session of the Nebraska Legislature. One of these is a housekeeping recommendation that relates to local financing and planning activities. The other two recommendations relate to the establishment of a natural resource data bank in Nebraska and for the reorganization of local natural resource districts. We recognize that if we are to have an outstanding water plan in Nebraska that it will have to be based upon the best information available. At the present time we have a considerable amount of basic data which have been collected by many local and state organizations and agencies in our state. An effort has not been made to compile these data at one location so that they can be processed and interpreted so that they will be in the most useful form for use in our comprehensive planning program. This data bank recommendation calls for existing agencies to continue to collect the data and process as they have done in the past. However, the administration of the data bank program will be through the Nebraska Soil and Water Conservation Commission who will collect the existing data from the various agencies and then supplement these data with information which they will require in their planning activity. Information will flow into the data bank from the various agencies and in turn all information from the data bank will be available to organizations within our state. This data bank program will also be in cooperation with various federal programs.

The third recommendation of the Legislative Council Study Committee calls for the reorganization of local natural resource agencies. As I indicated earlier in this presentation, we have approximately 500 special purpose resource districts in our state. It has been estimated that by the year 2000 we could very well have 1,000 such districts. I believe that you can well determine the problem of implementing a State Water Plan through such a myriad of overlapping and duplicating districts. Many of these districts are quite small. They have limited authorities in a few
specific areas. It is the opinion of many of us in our state that we need a broad-based natural resource district that can consider and sponsor all known programs of resource development. Legislation which is now being considered would call for the mandatory consolidation of soil and water conservation districts, watershed districts, watershed conservancy districts, watershed planning boards, and mosquito control districts into this multi-purpose district. Other districts such as drainage districts, irrigation districts, public power and irrigation districts, reclamation districts, and water supply districts would be given the option of evolving into a multi-purpose district if the necessary details for merger could be worked out and if the board directors of such districts were willing to so evolve. When, and if, this legislation is enacted, we will immediately reduce the number of natural resource districts in our state by at least 100. In addition, we will be assured that no additional natural districts will be organized in our state in the future. With this action by the Nebraska Legislature, we will be assured that in Nebraska we will have a local organization that can carry out the recommendations and projects envisioned through our state water planning program.

In addition to these three bills which have been recommended by the Legislative Council Study Committee, there is a possibility of some major legislation calling for the functional realignment of state natural resource agencies. Our Governor, the Honorable Norbert Tiemann, is giving the leadership in a study as to the desirability of some state reorganization in this field. He has commissioned the Dean of the Wyoming Law College, Mr. Frank Trelease, to make this study. It is my understanding that Dean Trelease’s recommendation will soon be made to the Governor and subsequently to the Nebraska Legislature. I feel that the members of the Nebraska Legislature will be very interested in any recommendation which will improve the effectiveness of state leadership in the natural resource field. At the present time, we have five state organizations that have relatively major responsibility in the field of natural resource development. The cooperation and coordination of these agencies has been quite good. The need for a state reorganization is not too evident at the present time; but as we look into the future and the complex programs which our state will be carrying out, many individuals see the need for the most effective and efficient organizational structure which is humanly possible to achieve in this field.

Looking to the 1971 and subsequent sessions of the Nebraska Legislature, I see four major legislative considerations which will have to be decided by the Nebraska Legislature. These are: preference of use, transbasin diversion, groundwater management and state financing of projects.

At the present time, the statutory and constitutional preference use for water in our state is (1) domestics; (2) agricultural; and (3) industrial. Preference for such uses as municipal, water quality, fish and wildlife are completely overlooked at the present time in our state. The manner of preference becomes important only during a period of shortage. We are
not sure in our state as to all the ramifications of our constitutional and statutorial preference provisions. We do recognize, however, that future municipal and industrial water requirements necessitate the study of this particular provision in our law. We are hopeful that through the development of projects as will be envisioned in our state water plan that we can basically meet most of the foreseeable future water requirements in our state.

The statutory law in Nebraska does not specifically prohibit transbasin diversion in Nebraska. However, there have been three supreme court decrees which have raised considerable question as to under what circumstances diversion may be allowed. We know right now in Nebraska that we have basins of deficit water supply. Hopefully our state water planning program will indicate areas of surplus from which water can be transported to areas of need. If we do have basins of surplus and basins of shortage in our state, I am confident that a prudent legislative body will enact the necessary legislation which will authorize and spell out provisions for transbasin diversion.

As I indicated earlier, we have approximately 1.7 billion acre-feet of groundwater in storage in our state. This vast groundwater resource offers the greatest opportunity we have for the economic growth and development of our state. At the present time, we have \( \frac{3}{4} \) million acres of land under irrigation in Nebraska of which \( \frac{2}{4} \) million acres have been developed from our groundwater resource. This past year we have put in over 3,000 irrigation wells. Because of this accelerated development, we now find considerable areas in our state where the groundwater table is receding. In essence we are mining our groundwater in these areas. I do not feel that mining of groundwater is necessarily bad. But we do need to have enough information to determine the consequences of such mining and the alternatives which are available through some system of management and regulation. We feel that conjunctive use of ground and surface waters will make it possible to balance our ground and surface supplies and utilize an area so that we can achieve maximum potential in our developments. I mentioned earlier that our ground and surface water regulation programs are split between the local and state levels of government. We cannot tolerate this splintering of responsibility when we know that these two waters must be regulated in a manner that recognizes their inter-relationship.

From all indications, in the future we cannot expect the federal government to finance 100 percent of the cost of construction of water resource projects which will be required by the 50 states of this nation. National financial commitments in such areas as international affairs, renovation of our metropolitan areas, welfare and education will hold the level of federal appropriation for resource development below that which many states, including Nebraska, will require if they are to develop a construction schedule which will afford our areas the maximum opportunity for economic growth through the development of the land water resources. At the present time in Nebraska the only money we have available for construction of water resource projects is approximately $300,000 to $500,000 annually which is made available to local sponsors of
watershed and flood control projects. This program of financing is a revolving type expenditure. As a consequence, the eventual capital outlet to our state will be much less than the level of appropriation. We have a constitutional prohibition in Nebraska which prohibits state indebtedness in most fields of activity. During the past general election, the people of our state did authorize the issuance of highway construction bonds. I believe that a similar type of constitutional referendum will have to be held authorizing the issuing of revenue bonds for the construction of water resource projects, such bonds to be repaid from revenue received from the sale or use of water. In addition to the revenue from the sale of water, there will need to be some direct state subsidy for resource development. This subsidy will be for such related programs as flood control, fish and wildlife, recreation, park development, water quality, and possibly others. We need to develop irrigation projects for our state. At present farm prices, I feel that landowners can afford to pay a maximum of $20 per acre-foot for water in Nebraska. Very conceivably the cost per acre-foot of some of our water development will far exceed this level. In this case, there will have to be a subsidy to assist in financing these projects because every citizen in our state will benefit directly or indirectly from this type of development.

Basically, the past sessions of the Nebraska Legislature have enacted natural resource legislation on which we can build good legislative programs in our state. However, most of the major legislation in this field will be coming in the 1971 and immediate subsequent sessions of the Nebraska Legislature. It is the intent of the Nebraska Legislature that all of this legislation will be based on objective and unbiased study resulting from our state water planning program. Hopefully, through proper communication and understanding on the part of the citizens of our state, our legislative body will enact the type of legislation, which will make it possible for the citizens of Nebraska to efficiently and effectively develop our two basic natural resources—soil and water.

"Proposed Water Legislation in Colorado"

Felix L. Sparks, Director
Colorado Water Conservation Board
Denver, Colorado

The history of water law in Colorado had its beginning in the territorial days. It was obvious to the early settlers that the riparian doctrine of water rights which was practiced in England would not be suitable for adoption in the arid western states. In 1872, four years before Colorado was admitted to the Union, the territorial courts laid the groundwork for the subsequent adoption for the doctrine of prior appropriation. When the Colorado Constitution was adopted in 1876 it contained two significant declarations on the use of water as follows: "The water of every natural stream, not heretofore appropriated, within the State of Colorado, is
declared to be the property of the public, and the same is dedicated to the use of the people of the state, subject to appropriation as hereinafter provided." The "hereinafter" proviso in part is as follows: "The right to divert the unappropriated waters of any natural stream to beneficial uses shall never be denied."

In light of the remarks which will follow, I wish to place special emphasis upon the words "natural stream" as used in the context of the constitution. Like virtually all constitutional mandates, statutory regulations must be adopted which implement the constitutional guidelines. This was done by the Colorado General Assembly and a procedure for establishing water rights pursuant to the constitution and a system for administering these water rights by public officials was adopted in statutory form.

However, two serious defects occurred in the adoption of statutory regulations which continue to plague us to this very day. One of these defects was the failure of the legislature to define the constitutional words "waters of a natural stream." The other serious defect was the failure of the legislature to adequately deal with the constitutional words "unappropriated waters." Hindsight is wonderful and I shall proceed to explain how these apparently unambiguous words in our constitution have caused us so much grief.

In the early days of statehood there appeared to be an abundance of water and there was no great amount of litigation concerning water rights. However, at about the turn of the century most of the dependable surface water supply in the more populous areas of the state had been appropriated. Each new appropriation therefore, for the most part, was in conflict with some older appropriation. Litigation became more frequent and accelerated with the passage of time.

It was inevitable that the courts would be called upon to define the terms "waters of a natural stream" since the legislature had failed to do so. There are three circumstances which come to mind immediately in considering the definition of the waters of a natural stream; namely, is underground water a part of a natural stream, are floodwaters which originate in normally dry watercourses waters of a natural stream, and are springs waters of a natural stream?

All of these circumstances were actually presented to our courts fairly early in the history of the state. In each case the courts decided that if the waters in question would reach a natural watercourse or were in a natural watercourse, they were in fact waters of a natural stream. About the only legislative guidance on this point, however, was the law which states that the owner of the lands upon which a spring arises may use the waters of that spring. The Supreme Court held that this law was unconstitutional if the waters of the spring would reach a natural watercourse and had been appropriated by others.
Historically, the people of Colorado have been preoccupied with diverting waters available from the surface. The adjudication statutes, in fact, mention only the adjudication of waters of natural streams. In what category, therefore, does water pumped from a well fall in? This question has never been clearly answered to this day. To confuse the issue further, some courts have adjudicated underground waters on the theory that they are in fact waters of a natural stream. Other courts, however, have held that for adjudication purposes, water produced from wells are not waters of a natural stream. This is the situation in which we find ourselves today.

I wish now to examine the other serious statutory defect which has to do with the definition of the words "unappropriated waters." Under our adjudication system we grant water rights regardless of whether or not there is any unappropriated water. Our theory is that it doesn't make any difference how much water is appropriated since state water officials are available to protect senior appropriators. The result is that decrees have been awarded which exceed by many times the available supply of a given stream. Our system is actually based on an after-the-fact examination of a decree, rather than a before-the-fact examination. Most of our neighboring states in their early days perceived the pitfalls of the Colorado system and adopted a permit system for the appropriation of water, a system which requires a before the-fact-examination of the availability of the water.

During the past 20 years here in Colorado there has been a virtual explosion in the use of groundwater for irrigation purposes. Caught in an ever-increasing economic squeeze, the farmers of today must get close to maximum production from their lands. Water is an essential ingredient in achieving such production. The great yearly fluctuations of the surface water supply made it inevitable that the groundwater supply would be brought into production as a supplemental source. The actual fact is that the water resources of this state cannot be properly utilized without extensive groundwater use. In some parts of the state there is no other source of supply. Even in river valleys extensive pumping of groundwater is necessary. Paramount to all considerations, however, must come the recognition that ground and surface waters constitute a common supply.

In recent years millions of dollars have been expended on the construction of wells without any color of right or title, except for the vacuum which exists in our state water laws. Groundwater uses must be recognized and protected consistent with constitutional mandates. This is the formidable problem which faces Colorado today. The problem has no simple solution. We now have approximately 30,000 wells in the state which have no adjudicated water rights. Under our existing laws, if these wells are now adjudicated, they will be junior to all of the surface decrees which have previously been entered by the courts. One of the major questions presented is whether anything would be accomplished in the Arkansas Valley, for example, by giving wells decrees which will generally have a priority date later than 1950, when for the greater part of the irrigation season virtually all decrees with dates after 1900 are ordered to cease diversions.
We are faced on one hand with the necessity for preserving the appropriation doctrine as expressed in our constitution, and on the other hand with recognizing the necessity of preserving an agricultural economy which is based to a large extent upon a combination of surface and groundwater diversions. The agency which I represent feels there is a solution, although it will be most difficult to accomplish.

We propose, in essence, that the existing wells, insofar as possible, be recognized as alternate sources of supply for existing surface decrees. For example, let us assume that decree No. 1 on the Arkansas River has a right to divert 50 cfs during the irrigation season. Let us further assume that the owners of decree No. 1 have already supplemented this decree by the pumping of groundwater. We think that the only practical solution is to recognize the groundwater usage as part of the original decree, but to prescribe, however, an annual quantitative limitation on the combined surface and groundwater diversions. We propose that this system be adopted to all decrees in order of their original priorities as long as the water supply lasts. Obviously the water supply would not permit every decree to be supplemented in this manner. As a practical matter there are hundreds of junior decrees which are worthless anyway.

At the present time there is no substantial agreement as to how the integration of groundwater with surface water decrees should occur. Our state legislature is making a determined effort to solve the problem, and I am confident that it will do so. Whatever legislation is adopted will not be satisfactory to everyone concerned. But then, what legislation is?

"Existing and Proposed Water Legislation in Kansas"

Keith S. Krause, Executive Director
Kansas Water Resources Board
Topeka, Kansas

(Note: Mr. Krause was ill and unable to attend. Mr. Windscheffel read Mr. Krause's paper.)

The introductory paragraphs of "The Kansas Law of Water Rights" by Wells Hutchins, R. Y. Smrha, and Robert L. Smith succinctly sum up Kansas' State water policy. Kansas was admitted to the Union by an Act of Congress January 29, 1861. The State water policy of Kansas has been made by the Legislature and the courts. The Constitution is silent in regard to water. The policy of the State with reference to the right to appropriate water was initiated by the Legislature in 1886. It was not completely implemented, however, until enactment of the 1945 Statute together with favorable construction by the Supreme Court and amendments made by the Legislature in 1957. The Legislature of Kansas provided in 1945 that "All water within the State of Kansas is hereby dedicated to the use of the people of the State subject to the control and regulation of the State in the manner herein prescribed." A Kansas
Supreme Court, after quoting the aforesaid section stated that "This is the heart of the Statute, the rest of treats of detail and procedure. It forms the basis for a different approach to the solution of questions concerning water rights than we have had in some of our opinions. Heretofore we have approached the questions largely on the basis of individual interest alone, under this declaration and other provisions of the Act we now approach them on the basis of the interest of the people of the State without losing sight of the beneficial use of the individual is making or has the right to make of the water."

While the Constitution of Kansas makes no mention of the development of water in the State, it did in its original form contain a prohibition against works of "internal improvements." The drafters of the Kansas Constitution, observing the financial difficulties that other states had become involved in as a result of the construction of canals and other works of improvement resolved to avoid similar happenings in Kansas. This prohibition not only extended to water resources development but to highways and other public improvements. The first breakthrough came in 1928 when the Constitution was amended to permit the State to carry out a highway construction program. Then in November of 1958, the Constitution was further amended to permit the State to participate in works of construction and development relating to its water resources.

A rather long series of water legislation beginning in 1866 now constitutes the body of law governing water resources development within Kansas.

I will not explore these individual pieces of legislation except to say that they contain the main provisions enacted for the acquisition, administration, and control of water rights and water resources development in the State. I should like to call to your attention two pieces of legislation of special significance to the development of irrigation practices in the State of Kansas. The first pertains to the establishment of irrigation districts for the purpose of utilizing surface waters (K.S.A. 42-357 through 42-388). The second is a very new act having been enacted in the 1968 session of the Kansas Legislature and is known as the Groundwater Management Districts Act (82A-1001).

The establishment of irrigation districts under K.S.A. 42-357 has been utilized in the State to form five districts as an adjunct to the development of irrigation under the Reclamation Act and encompasses approximately 75,000 acres in these districts. The enabling legislation contains the necessary conditions for establishment, operation and maintenance.

The Groundwater Management District Act would permit a group of groundwater irrigators to form into a body for the purpose of conservation of the groundwater resources since this Act is new. I will describe it in a little more detail. The "District" means a grouping of water users within an area of land which is overlying an aquifer having sufficient productive capacity to yield useful quantities of water for irrigation purposes. The "Water
User" means a person holding the water right or permit to appropriate or withdraw groundwater for the purpose other than domestic. An "Aquifer" means any geological formation capable of yielding water in sufficient quantities and of such quality that it can be extracted for beneficial purposes. The Districts have been provided powers to collect and disseminate data, and provide technical information. A district can promulgate and administer policies relating to the conservation and management of groundwater which are not inconsistent with the other provisions of the State policy. They can adopt rules and regulations after such have been approved by the Chief Engineer of the Division of Water Resources of the State Board of Agriculture. A district can employ professional services, purchase property, acquire water rights, purchase and sell water, and construct, maintain, and equip facilities for doing so. A district can contract with individuals and Government agencies, including the Federal Government. A district can establish research, development, and demonstration projects.

No districts have yet been formed. The law became effective July 1, 1968. We do expect that in the course of the next couple of years one or more districts will be formed. The objective of the law was to put into the hands of the irrigators themselves certain amounts of responsibility and tools for implementing a program of water conservation, research and eventually a financial program for sustaining the economy of the districts either through better water use efficiency or importation of water. The Act itself provides that an assessment up to ten cents for each acre-foot of water withdrawn may be made by the districts to finance their local program. The law's shortcoming may be its lack of provision for the establishment of groundwater management districts in areas not yet developed.

I should like to turn now to the administrative practice in connection with irrigation and water rights. The Division of Water Resources of the State Board of Agriculture has the responsibility for the administration of the water rights legislation. Mr. Robert V. Smrha is Chief Engineer of the Division of Water Resources. From this point on I am going to quote rather liberally from a paper Bob prepared discussing the Water Appropriation Act of 1945 and its applicability to irrigation. The Water Appropriation Act of 1945 first established the general principle that all waters within the State of Kansas are dedicated to the use of the people of the State subject to the control and regulation of the State as prescribed by the Act. Mr. Smrha states, and I quote, "Other basic principles of the Water Appropriation Act provide that subject to vested rights all waters within the State may be appropriated for beneficial use and that as between persons with the appropriation rights the first in time is the first in right. The priority of an appropriation right dates from the time of the filing of an application in the Office of the Chief Engineer.

"The perfecting of an appropriation right involves six steps taken over a period of time extending from two to ten or more years. The procedure is initiated by the filing of an application in the Office of Chief Engineer of the Division of Water Resources. Upon review and when in proper order
the application is approved and a permit is issued authorizing the proposed
diversion and use of water. There follows then a period of time within
which the applicant constructs or installs the necessary works or equipment
and applies the water to the authorized beneficial use. When this has been
done the applicant notifies the Chief Engineer of the completion of the work
and submits proof as to his use of water. In due course of time this is
verified by the field inspection. If it is found that the water is being
used in accordance with the terms of the permit, a certificate of appropri-
ation is issued for such quantities of water within the limits authorized
by the permit as has been put to beneficial use during any calendar year.
The certificate constitutes evidence of a perfected water right and must
be recorded with the Registrar of Deeds of the county in which the point
of diversion is located.

"In order that water users may be served more expeditiously and have ready
access to official action, four field offices under the direction of the
Kansas State Board of Agriculture have been established in the State as
provided by the law. These offices are located in Topeka, Stafford,
Stockton, and Garden City. The work at each of these offices is directed
by a water commissioner. They are responsible to the Chief Engineer and
act as his representatives in administering the law and performance of
other duties assigned to them. Enforcement of the law is obtained when
necessary through the Office of the Attorney General, who is authorized
to bring action in the name of the State to enjoin the unlawful appropri-
ators' diversion, use, and waste or loss of waters of the State. Since
all vested rights were established under some common law rule they can be
enforced and administered against each other only upon being adjudicated
by court decree or pursuant to rules and regulations. The mechanics of
enforcing other water rights involves a procedure of several steps. It
can be applied in the case of a vested right versus an appropriated right
or as between a senior appropriation right versus a junior appropriation
right. In such instances, the procedure is initiated by the making of a
written complaint by the parties seeking to have his water right enforced.
His complaint is investigated and he is given a written report of the water
supply situation. If there is no basis for further action by the Division
of Water Resources, the complainant then must make a written request to
secure the water to satisfy his right. Other water users who have been
found to be involved in the matter then are given written legal notice
of the extent to which their use may be modified in order to satisfy the
prior right. Further investigation is made to determine that there is
compliance with the notice. Over a period of years a number of situations
have been brought to this point and there has been compliance. In the
event of noncompliance, the law provides one remaining step. The Attorney
General is authorized to bring suit to enjoin the unlawful appropriation,
diversion and use of waters of the State. It appears that one of the most
difficult problems in administration of the Water Appropriation Act will be
in the application of the rule of priority of right to the distribution of
groundwater, particularly in those areas where there is a substantial quantity
of water in storage but where the rate of recharge is very low. Unless the
rule of priority of right is applied to groundwater in some manner such water rights will exist for all practical purposes under the common law rule.

"A large part of the groundwater occurs in the western part of the State. Here in many places the water is generally at a considerable depth below the surface and except for limited areas the rate of recharge is very low. There are large quantities of water in groundwater storage. Any extensive development of this valuable resource can result only in its depletion, but at the same time it is of value only to the extent that it is developed and used for beneficial purposes. Such development should be orderly and should be based on the policy which is understood by and is acceptable to the people in the area who are directly affected."

Many of us have felt that the mining of groundwater and support of the major portion of irrigation in Kansas could lead to an economic crisis if some provision were not made to increase water use efficiency through research and educational means, import or by other means maintain an equivalent economy of the affected area. The establishment of the underground water management districts will be a step in the direction of setting up on part of a system for doing this.

I believe most of us in the planning and administrative practice fields feel that our present approach does not completely resolve the problem of getting the most out of our water resources or of sustaining a State and regional economy where it is based on a depleting resource. We foresee some very difficult policy decisions if we undertake any form of water use curtailment except under emergency conditions.

We have not yet come to grips with the problems of administering water used "for supplemental irrigation." I define supplemental irrigation as that form of irrigation where water is applied on relatively infrequent occasions, largely in crop support where the major reliance is placed on natural precipitation. The administrative and financial procedures supporting irrigation in arid or semi-arid regions simply do not apply under such circumstances.

Under other problems facing the irrigator in Kansas and also those responsible for the administration of water within the State is that of controlling the pollution of the underground and surface waters in such a manner that such pollution will not interfere with irrigation practices. Salt water intrusion into our groundwater and surface waters from natural and from man-made sources is appearing at more and more frequent intervals throughout the State and is giving us a great deal of concern. We believe that as our groundwater tables decline, the intrusion of salt water into the fresh-water aquifers is increasing, a great many wells, both water and soil wells, have been drilled through the fresh water aquifers into lower geological formations, these may be leaking salt water into the fresh-water aquifers from below. The principal problem is finding such sources of pollution and plugging them, both of which are very difficult tasks to accomplish.
This has been a rather brief resume of the existing and potential legislative requirements of the irrigator in Kansas. I believe I am safe in saying that we have taken the early and necessary steps to protect the irrigator. We recognize that we do have problems and we have initiated efforts to solve those problems. We hope that our timing is good enough so that we can avoid some of the crises which we know can happen.

"Proposed Water Legislation in Wyoming"

Floyd A. Bishop
Wyoming State Engineer
Cheyenne, Wyoming

The Wyoming State Legislature convenes January 14, 1969, and will be in session through February 22, 1969. I anticipate that a number of bills will be introduced during this session which relate to water in one way or another. Among the proposals which will probably be considered at this legislative session are the following:

1. State Paid Water Commissioners - This is essentially the same bill which was introduced in the 39th Legislature. Legislation of this nature has been recommended by the State Engineer and the State Board of Control for many years. Although this modification in the handling of Water Commissioner payment and appointment would involve a significant increase in the cost of water administration to the State of Wyoming, there would be a corresponding decrease in the cost to the counties. This particular legislative recommendation is fundamental in a much needed and long overdue program to upgrade water administration. The proposed law would provide for Water Commissioners to be appointed by the State Engineer, upon recommendation by the Water Division Superintendent, and that all Water Commissioners would be paid by the State of Wyoming. The rate of pay would be fixed by the State Personnel Commission, and should be flexible enough to permit each individual to be paid a salary in conformity with his responsibility, ability, experience, and the results he accomplishes. I think we do a reasonably good job of administering water in most instances under the present system. However, we are occasionally confronted with situations where counties refuse to budget money for the payment of Water Commissioners, or they refuse to approve the appointment of Water Commissioners, which of course can make it impossible to administer water in a particular county. The proposed legislation would resolve questions of this nature, as well as upgrading the quality of water administration generally.

2. Use of Water for Highway Construction Purposes - Under the existing law, there is a provision for the temporary use of water under existing water rights for highway construction purposes. This law has been utilized in the construction of highways in wide areas of the State. The present law provides that any water user who might be affected by the use of water for highway construction purposes can demand and accomplish a shutdown of the
highway use of water, regardless of whether the affected water user is prior in time to the water right being utilized for highway construction purposes or not. The present law should be amended by striking the provision that junior appropriators can shut off the highway use of water.

3. **Temporary Use of Water for Other Uses** - Under existing statutes, there is no legal authority for the temporary use of water for any purpose other than for highway construction. We have suggested a bill similar in nature to the existing statute providing for temporary use of water for highway construction purposes. There is an obvious need for some statutory provision whereby water can be used for purposes such as drilling of test wells, drilling of mining exploratory holes, railway construction purposes, and other uses of a temporary nature which do not justify acquisition of a permanent water right. Passage of such legislation would head off the possibility of serious problems arising in the future as a result of the lack of statutory provisions for such uses of water.

4. **Groundwater** - This bill is a proposed amendment of the existing groundwater statutes. At the present time, stock water and domestic wells are not required to be registered and are given a superior right to all other uses. In view of the growing development of groundwater use in Wyoming, it appears that all wells should be registered. In those situations where two domestic wells are interfering with each other, some provision should be made for a regulation on the basis of priority. Complete development of a groundwater aquifer will inevitably involve the need for regulation of use among the various users, and a record of the location, depth, amount of water uses, purpose of use, and other information on all wells is necessary in order to effectuate a proper regulation. In addition, a reasonable limitation on the amount of water which can be used from any individual well for stock and domestic purposes is needed. This particular bill is designed to accomplish the above-mentioned purposes.

5. **Hearing Procedures** - Under existing procedures certain types of petitions to the State Board of Control require that a public hearing be held by the Water Division Superintendent. Included in this category are petitions for (1) amendment in land descriptions under adjudicated water rights; (2) change in water usage to a preferred use; and (3) change of location of water rights from an area inundated by a reservoir, to a new location. When petitions of this nature are submitted, the Board of Control refers them to the proper Water Division Superintendent for public hearing, and then after the hearing has been held, once again considers the petition for final action. This bill would amend the law to permit the Division Superintendent to proceed with public advertising immediately upon receipt of such a petition, and if no protests are received after a reasonable period of time, then the Board of Control could take final action on the petition without holding a public hearing. This would streamline the procedure and save time and expense for both the petitioner and the Board of Control.
6. **Right of Entry** - In past years some water users have questioned the right of a water commissioner or other water administrative official to enter upon private property for the purpose of shutting off illegal diversions of water, and other duties connected with fulfillment of their responsibilities. This bill would clarify the right of entry upon private property by water administrative officials in the performance of their official duties.

7. **Fees** - There has been no significant modification in the fee structure connected with water right applications and petitions for many years. In view of the increased cost in the processing of these documents, a major increase in the entire fee structure is justified. The proposed bill would accomplish such a revision of fees.

At present the filing fee required for submission of any water right application is $2.00 regardless of the amount of water to be used. The proposed fee schedule would be a sliding scale starting at $5.00 for minimal amounts of water and graduated up to $100.00 for 15 cfs and over, or for a reservoir of 7,500 acre-feet capacity and over.

On applications for irrigation, whether original supply or supplemental supply, the quantity will be assumed to be 1.0 cfs for each 70 acres of land to be irrigated. If an application is for more than one type of use, an additional fee of $5.00 for each additional use will be necessary.

For underground water applications, a fee of $5.00 will accompany each application for the use of groundwater (including stock or domestic wells). Additional fees must accompany the statement of completion when submitted which will be based upon the amount of water appropriated and actually being withdrawn from the ground, as determined under the schedule of fees.

An additional fee shall be collected by the State Board of Control at the time of filing of any petition, to be determined by the Board, which shall be sufficient to cover the cost of preparing and recording a certified copy of any order of the Board concerning the petition, provided that any such fees not needed shall be returned to the petitioner.

8. **Advertising Procedures on Water Right Applications** - Wyoming law at the present time provides that the State Engineer shall consider all applications for water right and either approve or deny each of them. There is no requirement that applications should be advertised nor that other appropriators should be given an opportunity to protest the granting of a water right application prior to its approval by the State Engineer. Prior to final adjudication of a water right by the Board of Control, public notice is required and other appropriators have the opportunity to protest. However, at this point in time the ditch or reservoir application has been approved, the facilities have been constructed, and the water has been applied to the beneficial use proposed. It seems apparent that a protest submitted prior to the approval of the application would be much more effective than one
submitted after the fact. Legislation to implement this procedural change is expected.

9. **State Financing of Major Water Projects** - The difficulties connected with authorization and financing of federal projects in recent years and particularly the long delays between the inception of a project and its realization, have convinced us in Wyoming that a new approach is needed if we are to continue the pattern of development and use of our water resources. We are currently involved in a study of existing procedures for state financing of multi-million dollar projects with an eye toward modification of the statutes if necessary to provide the best possible vehicle for such financing. Probably the most practical approach to this problem is a combination of state and federal financing. It appears that both federal and state legislation may be necessary to accomplish this objective. These proposals are still in the preliminary study stages, but it is likely that this concept will be considered during the upcoming legislative session in Wyoming, and in the 91st Congress as well.

10. **State-Federal Water Rights** - The question involving state versus federal control of water resources has been a source of growing concern to the states for many years. The long-term trend toward federal domination in the control of water resources is clearly evident to those of us involved in water administration at the state level. Court decisions in recent years have accelerated this trend to an alarming degree. The need for clarification of the relationship of the United States and the individual states in the control and jurisdiction of water resources is more urgent today than ever before. Unnecessary delays in western development could result from a failure of the Congress to enact legislation which will provide this much-needed clarification. Major projects requiring the investment of large sums of money will be difficult to finance when there is a serious cloud hovering over the rights to the use of water.

Because of several decisions of various courts, and assertions made by the Justice Department in what they feel to be protection of federal property rights, some federal agencies are now contending that when lands were reserved for various purposes, that reservation, even though it did not mention water, included sufficient water to effectuate those purposes. Although water rights established under state law with priorities previous to the reservations or withdrawals are generally respected, the contention is made that increased usage of water may be made under the reservation theory, so long as it will effectuate the original purpose of the reservation. The further contention is made that such expanded use of water may be made in derogation of use under valid rights established according to state law after the reservation, even though those rights may have been in existence for a half century or longer.

The inception of the state-federal jurisdictional problem in water resources goes back many years in history. There is no apparent need to recite this historical information, other than to state that efforts to pass clarifying
legislation in the Congress to remedy this problem have been carried on unsuccessfully for more than ten years. The threat continues to grow with the passage of time, and it appears to be urgent that such legislation should be passed by the next session of the Congress. It is extremely disturbing to note the policies of administrators of the various agencies and bureaus of the United States Government, who are consistently asserting the supremacy of the United States of America over the states in the control and administration of water. The U. S. Forest Service has already implemented a modification in their policies in the acquisition of water rights, under which they do not recognize the authority of any state to issue a right to the use of water on a forest reservation. Other federal agencies are showing signs of adopting policies along these same lines. I personally feel strongly that legislation to correct this problem is of the utmost importance.

FOUR-STATES IRRIGATION COUNCIL ANNUAL BANQUET

Musical Entertainment
Denver Barbershop Quartet
"The Footnotes"

Banquet Speaker
C. Wheeler Barnes
"Dig Your Well Before You Are Thirsty"
Presentation of Headgate Awards
President Harlan Seaworth
Silver Glade Ballroom - Cosmopolitan Hotel

In every organization, whether it be business, irrigation, public service, there is somebody that always stands out and takes the leadership. The Four-States Council the last seven years decided to recognize someone from each state who has taken this leadership and done something with it. To such men, the Four-States Irrigation Council proudly presents its HEADGATE AWARD.

State of Colorado Award

The first gentleman I will introduce is from Colorado. Mr. Kyle F. Bryning is "Mr. Irrigator of Colorado." He is not only a successful manager of the largest irrigation system in Colorado for 25 years, but he and his lovely wife, Thelma, are also outstanding community leaders in their home community of Monte Vista. Since 1944, Mr. Bryning has been Superintendent of the Rio Grande Canal Company which serves 115,000 acres of excellent irrigated land in southwest Colorado. A graduate engineer from Colorado State University in 1927, Mr. Bryning has successfully operated the Rio Grande Canal Company system and greatly improved this system over this period of management. In community activities, Mr. Bryning served as a member of the school district in Monte Vista for 16 years receiving the Distinguished Service Award from the Colorado School Board Association for his services. He has been President, Vice President and Secretary to the Four-States Irrigation Council and a local leader holding positions of trust and honor in the Kiwanis Club, Masonic Lodge and Eastern Star organizations. Kyle and his wife, Thelma have been residents of Monte Vista since 1939. They have three children, Gerald, Janet and Robert, all married and successful in their own communities. I want to present to you Mr. Kyle Bryning.

Mr. and Mrs. Kyle F. Bryning

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Mr. Bryning's Response

Thank you very much, President Harlan, ladies and gentlemen. I do want to thank the Four-States Irrigation Council for this award and also for its recognition of the San Luis Valley as a part of the State of Colorado. We do have trouble along that line at times. We live in a rather isolated part of the State where the elevation of the cultivated land is between 7,500 and 8,000 feet. The growing season is 80 to 90 days. The annual precipitation is seven inches and the average temperature is 43 degrees. You won't consider this a hot climate, but then you have to consider the people in the San Luis Valley and they really are "something else." The farmers and ranchers are independent, aggressive and inductive. I am proud to be associated with these people and also with the Four-States Irrigation Council. Thank you very much.

State of Kansas Award

Now, we move to the State of Kansas. Jack R. Nicholson of Ellis, Kansas, is one of the "new school" of conservationists. Expansion of irrigation in Kansas is a recent development in the State's economy and Mr. Nicholson is a reclamation and conservation leader in this "new horizon" future for the State. Mr. Nicholson's activities cover a large range of interests. He is a successful businessman, President of the leading bank in Ellis, and owner and joint operator of an irrigated farm in the Cedar Bluff Irrigation Project. For a period of many years, he has been a State-wide leader in soil and water conservation. He has been President, Vice President, Secretary, and Director of Kansas Reclamation Association, and has actively supported the U.S. Army Corps of Engineers in their flood control program in Kansas. Mr. Nicholson is a graduate of the University of Kansas, and he and his wife have two lovely daughters and two grandchildren who are expected to be the next generation of conservation in Kansas. Mr. Nicholson had a wedding to attend and he wasn't able to come here this evening, so we have Mr. Clayton Flood to receive this award for him. Mr. Flood, I am very happy to present this plaque to you for Mr. Nicholson.
Mr. Flood's Response

Thank you, President Seaworth, and ladies and gentlemen. I am most happy to accept this award this evening for Jack R. Nicholson of Ellis, Kansas. Not only is Mr. Nicholson highly honored to receive this award, but the State of Kansas is honored. A little bit of sidelight—Mr. Nicholson happens to be a country-kissing cousin of mine. We are approximately the same age, grew up together as children, and I think I should give you a little more of the background of Mr. Nicholson, and particularly some family heritage in the Nicholson family. His Uncle, the late Ralph Nicholson, was one of the early leaders in Kansas in soil and water conservation and one of the first promoters of our Cedar Bluff Irrigation District in Kansas. We can't claim a big acreage; we're only 6,800 acres, but to our part of Kansas, it is a tremendous economic boom. Without the work of Ralph Nicholson, and later his Nephew, Jack Nicholson, I can assure you we would not have had our Irrigation District. I know that those of you who have worked many, many years in trying to promote an irrigation district know that they don't happen overnight. Someone has to promote them, someone has to do the spade work, and in our irrigation district, it was largely the work of Ralph Nicholson and Jack R. Nicholson. I am happy to accept this award. Thank you.

State of Nebraska Award

Now, we go to the State of Nebraska. Mr. Donald L. Thompson. Mr. Thompson, a native of Nebraska, was born in McCook, reared and educated in Red Willow County. Don Thompson is known far and wide across the State of Nebraska as a successful farmer and purebred livestock breeder. His reputation, however, is as a State personality and has been given more attention than his success as a livestock breeder. Mr. Thompson served five years in Nebraska Unicameral Legislature and was elected Speaker in 1961. He has been President of the Nebraska Fair Managers Association, a member of the State Board of Agriculture, a member of the State Soil and Water Commission, as well as serving in positions of responsibility with the Hospital Advisory Board at McCook, and on the State Health Planning Committee. He was one of the original officers of the Frenchman-Cambridge Irrigation District, and as President, has effectively carried forward the program of the Republican Valley Conservation Association in the development of flood control and irrigation in southwest Nebraska. Mr. and Mrs. Thompson have one daughter, Mrs. Gary Angus of McCook. I present to you Mr. Donald L. Thompson.
Mr. and Mrs. Donald L. Thompson

Mr. Thompson's Response

Thank you, Mr. President, ladies and gentlemen. I accept this plaque on behalf of the many people who have worked so hard in my endeavor. I also want to welcome you to pay a visit to the Republican Valley, to the "Great Lakes" of southwest Nebraska made possible through the efforts and the initiative of the local people along with the help of the State agencies and the Federal agencies. We've enjoyed their cooperation. It's been a pleasure to me to take part in this work and I certainly am happy to be presented this plaque tonight. I want to thank you very much, all of you.

State of Wyoming Award

Now, last but not least, Mr. Marlin Kurtz of Wyoming. The capsule description of Mr. Kurtz' life might be put into one word--service. Throughout his career after graduation from the University as a teacher, coach, supervisor of education, in community activities, in war relocation, as a Red Cross and recreation worker in New Guinea, an Executive Director of Chamber of Commerce and into his business life--service has been a magic word for Marlin T. Kurtz. Mr. Kurtz served the State of Wyoming as a representative for seven years and was Speaker in 1963-1965 Legislature. While in public office, he sponsored and promoted Wyoming Underground Water Law and legislation to provide industrial water in Fontenelle Reservoir. For many years, he has been active in Wyoming Water Development Association, and was President for several years. He is now Wyoming Director on the Board of Directors of the National Reclamation Association. The people of Wyoming have recognized his outstanding service to the State by granting him an Honorary Doctor of Law Degree conferred by the University of Wyoming in 1963. I present Mr. Marlin T. Kurtz.
Mr. and Mrs. Marlin T. Kurtz

Mr. Kurtz' Response

Thank you, Mr. President, distinguished guests, ladies and gentlemen. I accept this award in all humility. As I sat there and listened to this recital of some of the things I have done, I had the reaction that golly, that sounds like an old man that has done a few of those things, and I just want to show you that at this date, I'm only 39 and holding. Then again, I had the thought, as I told somebody else this evening, that I'm reminded of the time back, actually in 1909, when my folks moved from Missouri to Buffalo, Wyoming. For some reason or other, they brought me along, and I grew up there in Buffalo and out west of town there is beautiful Clear Creek Canyon, and I tell the people up around Buffalo now that I got in there early enough to help dig Clear Creek Canyon. Some of them are looking at me in recent years as I tell that story as though they about halfway believe me. Well, a few years have passed, but I do want it understood, by accepting this award, I don't want to be put on the shelf. There is still work to be done. I am sure that you and I are of the same opinion that we can do much in getting this work done if we don't care who gets the credit. With one thought in this space age, I would like to say that I think we all need to go into orbit and stay there while we are working on our water problem here in the west; and Nationally, I think that we need to join forces. I am sure that many of you, as I have, came from the field of agriculture where we are thinking of water for irrigation but I think we have to come to understand the other whole problem. We have to see the need for the conservation and use of water in municipal and industrial use, for recreation, and so on. I think for just what it's worth instead of going to the various legislative bodies, State and Federal, and fighting among ourselves, so to speak, before those legislative bodies
that we need to get together in our various associations, interstate, intra-
state, regionally and nationally, and solve these problems. Hammer out the
answers in our own associations, then go to our legislative bodies and there
will be much done toward obtaining successful solutions to help us with our
water problems. Thank you again for this award. I will cherish it always.
Thank you.

Four-States Honorary Ditch Rider Award

We have one other award that I want to present. In every organization, in
every endeavor, there is an unsung hero who performs his task with such out-
ward ease that he seldom gets notice or given credit. This is a common trait
among irrigationists. We sometimes brag on our new cars, on how good our
new car is, but we frequently overlook the garage mechanic that keeps it
tuned up and running smoothly. Region 7 had such a tune-up man until he
was discovered by the Billings, Montana office last June. He was and is
a man of ability, diplomacy, perseverance, and most of you have worked with
him. You know him as Bud Dolven, now Supervisor of Irrigation, Region 6,
Billings, Montana. As Chief of Irrigation Operations here in Region 7,
Dolven, for six years, was powerful in staging the annual meetings of the
Four-States Irrigation Council. He served your Council Officers as their
trusted efficient planner and expeditor and became the contact man between
the Council Board and the membership. In irrigation farming, he most nearly
represents an efficient, dedicated ditch rider, the make-it-go man. We all
relly upon him. It is my pleasure at this time to honor Bud with our coveted
Four-States Honorary Ditch Rider Award. Bud, would you come forward. Bud
I think this is a well-earned award and I'm real proud to present it to you.

Mr. O.A. (Bud) Dolven

Thank you, very much. I had a speech prepared for tomorrow, but not for
tonight. I'm really surprised and I'm sure you all know that I'm very
happy. Thank you very much.
Friday, January 10

"O&M - Cost Cutting"

Dean Groshong - Panel Moderator

O. A. Dolven

R. J. Willson

Leo Olson

Earl Phipps
My assignment is to discuss operation and maintenance trends, so I looked up the meaning of the word "trend." Trend, according to the dictionary, means an "inclination in a certain direction." After studying records and reports, I came to the conclusion that irrigation operation and maintenance programs do show slight inclination in certain directions—some good and some bad. We are aware of the problems and discuss solutions intelligently, but are very slow to initiate or adopt new procedures and techniques.

In reviewing O&M records in Billings, Montana, I came across a conference program dated February 20, 1915. On that date, a group of O&M supervisors met in Great Falls, Montana, and discussed the following topics:

1. Reduction of O&M costs
2. Seepage — methods of prevention and control
3. Construction and operations of drains
4. Keeping canal banks free from weeds
5. Relations of project officials with water users
6. Disposition of old equipment and surplus work animals
7. Wood vs. concrete in replacing wooden irrigation structures.

Fifty-four years and many meetings later, we are still talking about many of these same problems. We no longer worry about the disposal of old work animals or debate the merits of wood vs. concrete, but we have introduced many new topics or problems, such as:

1. Water pollution
2. Automation
3. Replacing open laterals with buried pipelines
4. Aquatic weeds
5. Water rights and water measurements.

If irrigation operation and maintenance is to keep pace with the technical advancement on the farm and in industry, we have to join the computer age and take advantage of new technology and modern equipment. I don’t expect you to install remote-control equipment to operate the systems or to buy helicopters to patrol the project, but there are some changes that will have to be made. Let’s discuss a few trends.

Trend No. 1 — During the past 12 years, O&M costs have increased 22 percent. During the same period construction costs have increased approximately 80 percent. This means that a project which collected $3.00 per acre in 1956 is collecting $3.65 in 1968. The additional 65-cent-per-acre increase on
a 50,000-acre project would bring to the district $32,500. A 50,000-acre project would normally employ about 25 people. The increase would allow the district to raise their salaries approximately $100 per year, or $1,300 over the 12-year period. In many cases, a good share of this increased revenue has been used to provide fringe benefits for the employees such as retirement, hospitalization, sick and annual leave, and insurance. Equipment and material costs have risen considerably the past 12 years. If salaries have taken most of the revenue from increased assessments, managers must be doing the job more efficiently or deferring some of the maintenance. Let's hope the maintenance isn't deferred.

The constantly rising curve of O&M costs should make it clear that any inclination to defer needed maintenance or replacement can rarely be a bargain. In fact, any undue backlog of maintenance can almost guarantee an unnecessary increase in the costs of such work.

Trend No. 2 - Managers and directors worry about the new water pollution laws, yet few districts have initiated action programs designed to reduce pollution. Actually, the water pollution laws may be a blessing in disguise. We may be forced to follow better water management practices both on the farms and on the irrigation systems. Good water management reduces water pollution, drainage requirements, saves water, and increases crop production.

Antipollution measures--like charity--should begin at home. Unless you start now to put an end to dumping of any raw sewage into your distribution or drainage system, you run the risk of having some State Health Officer doing the job for you.

Trend No. 3 - The value of water is increasing rapidly. Municipal and industrial water requirements have been increasing gradually for many years. Recently, several major energy companies have purchased large quantities of water. Efficient processes have been developed to convert rather low-grade coal into gasoline or natural gas. These companies are willing to pay approximately $10 per acre-foot and pump the water from reservoirs.

The fiercely competitive market for water is going to challenge not only any diversion over that of beneficial use, but perhaps the very basis of our water right on the grounds of some so-called higher use. Men in high places in the Southwest, for example, are today publicly advocating the reallocation of irrigation water supplies to low water-use industries with more income-generating possibilities. Others see the need for some water-using crops disappearing altogether as our technology advances. The substitution of synthetic fibers for cotton is a case in point. All these "straws in the wind" point to the need for not only improving our efficiency in the use of irrigation water, but for putting any apparent surplus to beneficial use.
Trend No. 4 - Districts in Regions 6 and 7 are installing automatic controls on a few structures. The use of telemetering equipment has increased mostly on Government-operated projects. Remote-control equipment is becoming less expensive but not being installed on many projects. I'm sure considerable saving and better operation could be accomplished on most projects through some automation.

Let's "debug" this word "automation" right now. It is not some "far-out," highly technical experimental work understood only by college professors or graduate engineers. As Ben Prichard pointed out from this same podium at last year's meeting, many of these automatic controls and devices can be fabricated and installed by your own work forces; and justification for such expenditures can usually be obtained from savings in operator's time, improved service, and system safety.

Trend No. 5 - The Bureau is being pressured to build buried-pipe laterals in place of open ditches on new projects. Many of the directors and managers on the older projects are considering replacing the smaller open laterals with pipelines.

Up in Region 6, The Garland Division of the Shoshone Project is blazing some new trails in that direction. Satisfied that they can no longer afford the high operating costs of an obsolete system, they have surveyed their system, developed plans for a $6 million modernization program, and, as soon as funds are available under the R&B program, will be replacing many miles of their open-ditch distributaries in closed pipe.

Trend No. 6 - Land and aquatic weed problems are becoming more complex and expensive to handle.

The prevention of pollution to crops, livestock, and surface water is becoming so demanding that major advances in our technology may be required if we are to afford the cost of the war on weeds.

Trend No. 7 - System water losses on projects throughout the West have increased the past ten years. Even though many miles of canals and laterals have been lined, operational waste must be increasing.

There's no doubt that O&M managers and directors are facing a greater challenge than at any time during the history of irrigation in the West. The headlong rush of technological advances in our day and age waits for no man. Either we prepare ourselves to keep abreast of these new developments, or we bow to obsolescence and retirement. There are no tolerances for ignorance, indecision, or halfway measures. The day when we can be permitted a 50 percent farm efficiency factor in the use of irrigation water, and a 30 to 40 percent loss in our transmission system is fast drawing to a close. The competitive demands for the available water supply will not tolerate such waste. If we are going to continue to enjoy our water right on the basis of beneficial use, we will have to adopt the sophisticated designs and practices that will eliminate such waste and improve our
overall efficiency. Some of you are already far down the road in making this transition, I know—but you and I have got to find the ways and means of making full use of it. The question is “how?”—and here are some suggestions:

1. No computerized, pushbutton system will ever replace the human element in our operations. The increasing complexities of irrigation system management will call for managers of a high degree of competency, dedication, and vision. If you can't hire them, you create them through the process of training such as is made available by this meeting and other "in-service training" courses.

2. You help your individual water user toward the realization that the old concept that water is free—that only dams and canals and ditchriders cost money—is no longer valid. Water is the most precious commodity in our lives, and unless we face up to the cost of treating it as such, we may well lose our right to use it.

3. Getting your own house in order, you join hands with your water-using neighbor both up and downstream, to insure that the resource by which we all exist shall remain of a quality that permits our society to prosper and to grow.

"System Improvements"

R. J. Willson, Maintenance Engineer
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A highlight in the summary of a recent Bureau of Reclamation budget estimate submittal states in part, "An adequate supply of water of suitable quality equitably and efficiently managed is essential to meet all reasonable requirements of the United States population. By the year 2000, 60 percent of the Nation's total water resources will require manipulation to meet the gross water demands and 51 percent will need quality control." Improvement of water manipulation practices is a topic that is receiving considerable attention nationwide and, as it might apply to an irrigation system, is my topic today.

Manipulation of water is your business. Attention to improvements is necessary in any organization that wishes to stay in business, and such an appraisal is your responsibility to the farmers served from your irrigation system.

There are numerous improvements that can be made to existing irrigation systems that may pay dividends in terms of lower O&M costs, reduced use of water, and better land utilization. Suggested are road improvements, bridge and flume replacements using long-life materials or substitute
structures, waste water reservoirs, use of pipe and linings in carriage and lateral systems, and the installation of automation and remote controls on storage, diversion, and carriage facilities. There undoubtedly are other cost-saving improvements that might be mentioned.

Determining which improvements are likely to be of most benefit on a particular project is difficult. Cost, unfortunately, is usually the determining factor and this can be complicated. We can generally arrive at an acceptable estimate of the construction cost, but O&M costs are more difficult to come by.

Even without data to prove it, we know that some system improvements are bound to save O&M costs. In previous meetings of this Council, some of these improvements have been discussed. In last year's meeting, during a panel discussion on the subject of modernizing irrigation systems, you learned of efforts being made to conserve water, the objectives of good water management, and the benefits that can be derived from automation and remote control of system facilities. You also heard of some of the work being done to rehabilitate and better several irrigation systems. All of these topics are a part of the story toward lower O&M costs, savings of water, and better land utilization over the "long haul."

Modernization, improvement, rehabilitation, and betterment will cost money. Financial help can be obtained from private sources or from the Federal Government. Or, you can take a slower approach to the same thing by outlining the program and accomplishing it a bit at a time over a longer period with increased O&M charges. Some districts are doing this in the latter way with excellent results.

One of the improvements that can be essential to the betterment of most irrigation systems is the improvement of access and operating roads. Good roads cut vehicle operation and maintenance costs, travel time of operation and maintenance personnel, and generally contribute to less costly maintenance procedures. Better roads also can provide for the use of more mobile equipment and the need for less equipment because of the better mobility. Less costly maintenance also is possible with the operating roads at or near a uniform level with relation to the canal water surface and at an elevation not too far above this surface. Generally, designs now provide for berm roads at a maximum of not more than six feet above normal water surface.

Modern wheel-mounted equipment also requires wider road widths. We now design for a minimum width of 12 feet unless there are unusual conditions to be met. On our larger canals, berm widths of 20 feet or more are being specified to accommodate modern equipment. On some canals, particularly in urban and populated areas, we find that paved roadways can be justified. Roadway improvements usually can be accomplished over the years as time permits.
While discussing roads, we should also mention that there are savings to be realized in maintenance costs over the long-haul in the rehabilitation and replacement of bridges. Many are using steel or precast and prestressed concrete elements in the replacement of wooden bridges or portions of these bridges that are more susceptible to deterioration. Precast concrete piers, bents and wingwalls, and prestressed girders and deck members can be obtained from many fabricators. The steel beam and floor frames from obsolete railroad cars also have been used by some as bridge beams.

Others are substituting pipe crossings for bridges, particularly on smaller canals, laterals, and drainage channels. Bureau designs now generally call for concrete or steel structures, with precast and prestressed concrete being utilized in many instances.

Flumes, as you know, were widely used at the time of construction of many older irrigation systems. They have and will continue to serve a useful purpose on many projects. However, under several rehabilitation and betterment programs, deteriorating wooden and some steel flume structures are being replaced with inverted siphons or by placement of canals and laterals on contour and on compacted earth fills.

Weed control in general, but particularly the control of aquatics, is reported by many irrigation project operators to be the most costly of all maintenance activities. There seems to be little doubt that our problems will be compounded and consequently even more costly in the future with increased automation, pumping, and especially sprinkler irrigation. This will be particularly true if we are forced to greatly restrict the use of chemicals.

Weed control is mentioned in passing today, not because we have revolutionary new means of control to present to you, but to report that in a cooperative program with the Federal Water Pollution Control Administration we are going to increase our efforts in a three-year study to determine the amount of herbicide residues remaining in the canal waters treated with chemicals. We will be measuring the chemical compounds in parts per billion or less and collecting data which will be useful in obtaining registration of certain herbicides for use on irrigation systems. A field sampling program will be undertaken this spring. This will begin on the Columbia Basin Project in the State of Washington, and later be expanded to other projects, to obtain additional information. We may be calling on some of you for cooperation.

Much is being done on many irrigation systems toward automation and remote control in the management of water. Automation and remote control can accomplish three objectives: (1) Reduced operating costs, (2) provide for more efficient use of water, and (3) provide better service to the water user. This latter can be done by better matching of water orders and its delivery and delivery of the requested amount of water without unsteady or fluctuating flows. This also can be accomplished with less
operational waste; can provide for rapid transfer of water from one part of a system to another; and, of course, provide means for general, as well as more precise control.

In the more sophisticated systems, control may be accomplished by "a little black box" or a knowledgeable "watermaster" who can see from continuously and instantaneously reported data the status of water in the system. By whatever method used, on many presently constructed systems, a combination of conventional, remote, and automatic operation can result in dramatic benefits.

"Little Man" devices, such as those on display here and explained to you last year, may be all that are required, or these devices can be further instrumented to provide for remote overriding of the automatic controls. On one of our newer projects desirable instrumentation for automation and remote control was estimated to cost $75,000 to $80,000. However, by instrumenting the reservoir outlet and canal headworks gates only at this time at a cost of about $25,000, it was possible to eliminate the need for a damtender and housing for him in a remote area. As funds become available, other sensing and control features are planned to accomplish the overall objective. Initial installations always should be made with an ultimate plan in mind.

The "Little Man" has been successful in solving the problem of maintaining constant water levels on the upstream side of individual check structures. This involved "UPSTREAM CONTROL." The basic action of "UPSTREAM CONTROL" is to transfer the effects of mismatches downstream by changing the downstream discharge. Operating under this concept, provision must be made somewhere downstream to accommodate the positive and negative discharges. This can be accomplished by an equilizing reservoir; however, without a reservoir, water must sometimes be wasted.

A further refinement that is now under study is automatic "DOWNSTREAM CONTROL." The basic action of "DOWNSTREAM CONTROL" is to transfer the effects of the mismatches upstream by changing the upstream discharge.

In "DOWNSTREAM CONTROL" water is transferred downstream from its source to its point of use in response to an increase in demand and only when the demand occurs. The reverse effect takes place when the demand is decreased. The system can be made to respond rapidly and takes corrective action immediately to abrupt and unscheduled changes in turnout diversion. This action reduces the necessity to spill water and minimizes the occurrences of shortages in the lower reaches.

A discussion of system improvements would not be complete without some mention of canal lining and of the increasing interest in the conversion of many distribution systems from open laterals to pipe. So far as linings are concerned, I am sure you are familiar with the advantages and disadvantages of the several types of linings that have been developed over
the years. You probably also are aware of the new Bureau policy of requiring pipe or linings in all new canals and laterals unless there is adequate justification for not doing so. We would consider substitution of pipe at least equal to or better than a lining in most instances.

Possibly another factor to be considered should be the rapidly expanding use of sprinkler irrigation and needed improvements through lining or installation of pipe to reduce silt, weeds, and other foreign materials that might interfere with operation of sprinklers. There has been a 76 percent increase in the use of sprinklers nationwide since 1960, with a tremendous increase of 136 percent in the 17 Western States.

You may be interested in the studies now being made on five major types of pipe in our laboratories and in the field. One is a new pipe, known as reinforced plastic mortar (RPM) and represents a potential major technological and economic advance for irrigated agriculture in this country through practical application of a space age development. RPM pipe is a composite structure consisting of a polyester plastic resin and sand mortar which is reinforced with layers of continuous glass fiber filaments wound to provide strength in both circumferential and longitudinal directions. The special properties of these products are high strength, light weight, and flexibility. After preliminary testing, the Bureau devised field tests to yield data from actual field service on a range of environments including freeze-thaw conditions.

Theoretical behavior of flexible steel type, having diameters of up to 30 inches, is being tested by applying pressures to it in a soil load box in the laboratory. Protective coatings and linings for this product are also being investigated as a continuing research program.

Sulfate resistance tests and soil burial tests are underway on a third kind of pipe. This is a small diameter, corrugated, perforated polyethylene drain type. Further development of filter theory and mechanized construction practices indicate the possibility of tremendous rewards in the field of plastic pipe for drainage. Liaison is being maintained with other agencies involved.

Specifications for reinforced concrete pressure pipe are being updated. These revisions are the result of tests, analyses, Reclamation's experiences, and recommendations of industry.

The possibility of extending the size limits of the other major pipe—that made of asbestos-cement materials—used on Reclamation projects is being investigated.
"Cutting Machine Costs"

Leo V. Olson
Irrigation Manager
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Pueblo, Colorado

Cutting machine costs is a good subject which we can really wind up on. If we knew what to do and how to do it, and how far to pursue a cost-cutting method, we could possibly reach that high point of efficiency that we are all striving for. Many approaches can be used today to reduce machine costs. All of these are basic and are not new to the business of water delivery. Many methods and ideas are being used and are sound. These, to be effective, must be re-examined periodically and probably there is no one method or one application that will fit the many districts represented here today.

To lead off, we can consider the operation and maintenance of equipment. In this, we think of types of oils and lubricants, inspection of the equipment and its daily job applications. The use of these, we know, will prevent unnecessary down time. Down time caused by mechanical failure can generally be attributed to the lack of a daily check on the equipment.

Down time can be thought of in three categories:

1. Repair costs covering labor and equipment parts—whether you do your own work or have it done by someone else.

2. Equipment failure due to the lack of preventive maintenance and which contributes to additional costs with resulting poor production. Generally, when a piece of key equipment is frequently down, other pieces are immediately affected.

3. The overall picture of the O&M dollar to the people of your district and the directors, who in good faith have invested their hard-earned money. These people expect and should get a fair return on their investment, as well as its productive use by management.

We believe that one key to the problem of equipment down time is the operator, who must not only like his work but must also be aware of the amount of dollars invested in the equipment. It is also imperative that he knows and understands that his efforts are a part of the overall teamwork; that his link must be as strong as the rest of the chain. Today, this man is becoming very important, simply because the man you want and need does not exist as he did in the past. We believe that the training of the operator is one area to which we should be giving a great deal of attention.

Still thinking in terms of preventive down time, is there a proper follow-up system on what the operator is doing, when he is doing it, how he is
doing it? Again, it can be said that equipment production is no better than the ability and initiative of the operator. They must be in balance. Is the foreman or superintendent responsible for getting the job done, or is the operator?

Should we, at this point, think about the endless hours of practice, which, after all, is really what training is? Your operator can be an all-around professional operator only through your efforts to provide the necessary training. Then, is there a proper follow up on his performance?

Before we go on, I would like to prod the management in charge of purchasing equipment, the foremen, superintendents and, last, the very important board of directors. We are still talking about cutting costs here. If the top people do not have time to think of equipment and operating costs and the welfare of the operator, then how are you going to attract the type of machine operator you need? From the top down, director to manager, to superintendent, to foreman, don't stop thinking when you read the accomplishments of your district for the month or year. It's not only cubic yards or buried pipeline which counts--it's also the cost of operation and what can be done to decrease it.

There is another important cost aspect that should be carefully investigated, especially in the light of today's spiraling wages. We should look at the number of temporary and permanent employees now on the payroll. In this area, it will take much more effort and sound soul-searching to see how or where an improvement can be made.

Generally, the number of employees required on a given water system has been decreasing, especially over the last 20 years. We all know that the horse and cart and the ditch rider have disappeared but it has been a slow evolving process that took care of itself as the years rolled by. Times and conditions are changing rapidly. There is the immediate burden of having to change basic concepts in operational methods. We could shrug this problem off and call it the "things-are-going-too-fast" gap or the "we-have-been-doing.pretty-good-so-far" gap. We might just as well face it--conditions are changing and will continue to change in the future. Of these changes, we will mostly feel the lack of trained and willing water-oriented employees and, above all, the related pressure putting the squeeze on the power of the O&M dollar.

Another topic to touch on is equipment now owned. Generally, we have reached a point where equipment that was on the market and purchased ten years ago still governs our maintenance practices. Today, we have available light and heavy equipment, fixed and mobile, rubber or track mounted. When it comes to water monitoring, there is a wide range of telemetering and remote control equipment. It is much better to receive by radio or read on a wall chart the 24-hour conditions at a given station than to rely on the all-too-common method today of a canal patrolman giving a brief glance of probably less than a minute as he passes by, while that
part of the canal goes unattended for approximately 23 hours. In line with this thinking, the astronauts stake their lives on mechanical processes and have proved their dependability in the space program.

With this picture in mind, and assuming that our operators and supervisors are adequate, the next major step will be to initiate a study of possible changes in presently owned equipment, such as track to rubber or possibly changing to larger equipment to increase productivity.

For example, the D-7 dozer weighing 18 to 20 tons and over-width, is a standard piece of equipment in our districts. This type of equipment has weight and power and is a good machine until you have to move it to another ditch site. Then you need a low boy and tractor. Let's take a hard look at this equipment and determine the actual needed horsepower and size. Consider the purchase of the D6C type CAT, which has greater power, performance and maneuverability than the D-7. More important is the weight factor of the D-6 dozer, which is around 15 to 16 tons. That dozer can be transported on a dual tandem-wheel, tilt-deck, tow-type trailer. The maintenance on this trailer is minimal compared to maintenance of the tractor and low boy unit. With the tilt trailer, a tow unit is needed, and here, again, is where a big change, dollar-wise, can be realized.

The 2-ton or 3-5 cubic yard truck has been standard as an all-around unit. By purchasing the 10-12 cubic yard tandem-drive, you can, for the same money and with one operator, perform the same job which previously required two drivers with the lighter units. The 12 cubic yard tandem-drive dump truck can replace the tractor unit pulling the low boy which has normally been a costly and unproductive unit on the job. Here is where our equipment goes up in size and cost but can still reduce operational costs because of reduction in manpower and in the number of units.

To go further, the crane or dragline is a necessary unit in a district's general equipment needs. The standard size is limited by weight and cost. For example, the Northwest 25 type, costing $50,000, versus a more expensive mobile 25-30 ton crane on rubber which does not require a transporting unit. Again, your benefits will be realized over a period of time. If it is necessary to continue maintaining the track type crane due to special problems within a district, consider leasing or renting this equipment from a local trucking firm or contractor. While on the subject of draglines and cranes and thinking of the heavy investment of $50,000, one should consider the methods of prolonging the life of such an investment. In the past, this type of machine has been used in the loading or moving of fill material. The per hour cost of a diesel front-end loader of \( \frac{1}{2} \) to 2 cubic yard capacity with the operator is about one-half the operational cost of the crane. These front-end loaders are rapidly becoming the jack-of-all-trades in equipment. It is surprising what different field activities an O&M crew can do with this machine. Again, being equal to or superior in some job capabilities, these front-end loaders require about one-half the original investment of the dragline.
Now to crew transportation. How many times have too many trucks and pickups made the trip to and from headquarters with miles of unproductive wear and tear on the individual units? Two vehicles, the foreman's pickup and a crew cab truck will provide transportation for eight men plus needed fuel and tools for the day. They are comfortable and economical to operate. The crew cab has been widely adapted by railroad maintenance crews and telephone crews.

There are many more steps that can be taken to adapt specialized equipment to a district's needs but you should start with some good planning; the rest comes with time.

In summary, select and, above all, continue the supervisor's and operator's training beyond their initial starting point. Specialize your equipment actually needed. Avoid the rut of past performance and keep equipment and personnel needs flexible. Check investment dollars and interest costs before purchasing.

It's going to be difficult to provide the needed maintenance and improvements to a canal system and live with inflation and higher operation and maintenance costs. Still, it's a challenge to all of us and I wish you the best of luck toward your goals.

"Management's Approach to Rising O&M Costs"

E. F. Phipps, Assistant Manager
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I appreciate this opportunity to talk to you about a subject that is dear to my heart, irrigation O&M, even if it is an unpopular side of the subject—rising costs.

Rising O&M costs is an ever-present problem that we all face. We need to take a good hard look at it now and then to see where we stand. As long as this inflation spiral continues we can expect prices and wages to continue their annual increase at a rate of three to six percent, or more. These increases arise as a result of factors over which you and I, as irrigation operators, have no control, so what can we do about it. Trying to find an answer to this puts us in a real bind.

We are not alone in this, the people we work for, the irrigation farmers, the men who must cough up the money we spend, are in a bind, too. The individual farmer's costs are going up every year but the prices he receives for his product have not kept up. He is caught in a cost-price squeeze that is threatening his very survival as an agricultural producer.

You and I perform an essential service for him—one that he cannot do without. We handle the distribution of his water supply, we operate and
maintain his irrigation system; we manage the resource that is most essential to his success as an irrigator.

He will, and should, look with a critical eye at how well we do that job. He will be looking for any sign of wasteful, inefficient, or unnecessary expenditures that we might make or propose to make. He is a shrewd businessman and manager himself. He has had to be to stay in business. As such, he will know whether or not we are doing the job we should be doing. He will know whether or not we are doing everything possible to reduce the effect of rising costs.

What, then, can the management of an irrigation system do about rising O&M costs?

As I see it, there are four main categories of O&M costs in which it is possible to minimize or reduce the effect of rising prices and wages.

The first and most important of these, I think, is personal services. Since our business is primarily one of service—the performance of a service for our water users—a high percentage of our annual costs are, quite naturally, for salaries and wages. In the case of our District, about 60 percent of our direct O&M cost each year is for salaries and wages; and, about 50 percent of our total District operating expense, as an average, is for salaries and wages. Obviously, anything that can be done in this category of costs to stretch the dollar will have an important effect on total O&M costs.

The performance of a service requires people and these people require an adequate wage, if you expect to keep them. When a good employee quits to take a higher paying job somewhere else, you have lost money. You have lost your investment in that employee. You have increased costs.

We figure it takes at least a year to break in or train a new man on our O&M crew. During this time we are investing in him, not only his salary or wages but, also, the time and effort of his supervisors who must train him—time that could be used elsewhere. We have, also, set up and started funding some of the so-called "fringe benefits" that are accepted and essential parts of employee compensation these days. All of this is lost and must be repeated, if the man quits. This is wasteful and should be avoided, if possible.

The only way to avoid this is to "meet the competition." We must not only meet the competition in compensation—salaries plus fringe benefits—but, also, the competition for employee loyalty and pride in his work.

Fortunately in our District we have programs designed to meet both of these areas of competition. Our District has a Board of Directors and Manager who have established carefully, considered policies in these two areas.
One of these is a management recommended system, adopted as policy by the Board, which utilizes an objective system for annual salary adjustments. We use a salary and wage survey conducted annually by another agency which compares salaries and wages being paid by industry and government for job classifications comparable to our own. The employees are shown the results of this survey and can see where they stand in relation to the competitive job market. This satisfies them that they are paid an adequate wage. They also know from this that if their salary is equal to or slightly larger than the market, their own performance is good. If, on the other hand, an individual's salary is very much less than the market, he knows there is room for improvement in his own performance.

This leads to the other area where the competition must be met--employee pride in his work and loyalty to his organization. In addition to--and sometimes even more important than adequate pay for his work--each employee needs to know, or at least likes to feel, that what he is doing is important; he wants to know that his efforts are recognized and appreciated; he likes to be complimented for good or outstanding work he has done; and conversely, he wants to know where he has failed or needs to improve his performance.

Meeting these needs and desires is the best way I know to maintain high employee pride in his work, loyalty to his organization, and enthusiasm for efficient performance. The result of all of this is maximum efficiency of service by the whole staff. This gets more work done, gets it done better, and at the least possible cost for personal services.

Our District tries to meet this area of competition by communication--personal communication. This is a policy of management--not one dictated by or established by the Board of Directors. The Board is aware of and approves this policy, but the Board leaves personnel relations almost entirely up to the Manager.

This policy of personal communication must work all the way up and down the line, if it is to be effective. It begins with selection and hiring. We try to spend enough time with each prospective employee or applicant to be sure we want him and he wants the job. We try to learn all we can about him, not just his technical qualifications. What are his outside interests, hobbies, and recreational habits? How curious is he? What kind of questions does he ask? If his only interest is how much pay and other benefits he gets, we don't want him. How does he think? You can learn a lot about a person by his comments and questions when he is relaxed and thinks you are just visiting and not conducting an interview.

We try to spend at least a half-day with any prospect that looks promising. We give him a short tour of our system; show him the kind of work he will be doing; let him meet the other employees; and later get their reactions to him. By this time we know him pretty well and can judge more accurately whether he really wants the job we have for him. We know equally well whether or not he is the man we want for that job.
Once hired, the new man is, of course, instructed and trained immediately by his supervisor in his specific duties. He then joins the other employees in a continuing program of education and participation; or, as I called it earlier, personal communication.

We feel that every employee should know, or at least have the opportunity to learn, about every facet of the organization's operations, not just his own part in it. If he knows, at least generally, what the functions and problems of the other departments in the organization are, he can see his own part in the total picture with more clarity and understanding. He will know his job is essential to the success of the whole ball of wax. He will be proud of his part in it. This will make him a better, happier, harder working, and more efficient employee. Other things being equal, he will be loyal and permanent, too.

We try to accomplish this role of continuing education by more or less regularly scheduled bull sessions or staff conferences. Sometimes these sessions include the whole staff, or just the O&M crew; or the supervisors; or, at times, the administrative staff.

We also encourage, but do not necessarily require, attendance and participation in outside activities that are related to District work. These activities include such things as this Council meeting; the Chief Engineer's O&M workshop, Colorado Water Congress meetings; various field trips and tours; weed control meetings; and equipment O&M demonstrations or training sessions conducted by dealers and manufacturers. We give our field men an opportunity to attend, on a rotational basis, one or two Board meetings each year. This permits the individual employees and Board members a chance to meet and get to know one another.

All of this helps keep the employee's interest and enthusiasm high. It keeps him highly motivated to do his best. It makes the O&M dollar spent for personal services produce its maximum. This, of course, is the pay off. This is where the effect of rising O&M costs for salaries and wages can be minimized.

The next category of O&M costs I want to discuss is equipment selection and maintenance. This, too, is an important area for holding down costs. It doesn't help to have highly qualified and efficient people if you don't give them the tools with which to work.

The best truck driver or dozer operator in the world can't move much dirt if all you give him to work with is a wheelbarrow; the best ditch rider can't handle many miles of canal if all you give him is a horse, the best bookkeeper can't keep many records if the only tool he has is a pencil.

The kinds and amounts of equipment needed varies tremendously from one organization to another. For this reason, I won't go into detail about our equipment but, rather, just give you some of the principles we try to follow. Some of these principles we had to learn the hard way.
First, select and acquire equipment adequately sized to do the job and do it efficiently. When we first started O&M on our canals, one of the first pieces of equipment we bought was a little A.C. Model D motor grader. We thought we were saving money by not buying a bigger machine but we didn't. It was fine for light grading but not for much else. We couldn't even keep up with our road maintenance work with it; it wasn't heavy enough to cut diversion ditches or build new roads; and it wasn't rugged enough to take the pounding from the half-buried rocks we encounter on some of our roads. After a few years of frustration, several expensive repairs, and a broken frame, we traded it off for a bigger machine.

And here we learned another lesson the hard way. Used equipment is rarely a bargain. We traded the Model D for a used Cat Model 12. This machine was big enough to do our job and the dealer we bought it from said it had been completely reconditioned. He backed this up with a one-year or 300-hour guarantee. To make a long story short, within two or three months after the guarantee was up, we discovered the thing needed about $3,000 worth of repairs to put it into dependable operating condition.

The third principle I want to stress is--keep your equipment in shape--preventive maintenance. Keep it ready to go. This principle we did not have to learn the hard way. This one we have always tried to practice consistently.

The fourth and last principle I want to mention is trade at the optimum time. Use your equipment until you have gotten the least costly work out of it, then trade it off before it needs major repairs. If you have earned a reputation for good equipment maintenance, you can usually get exceptionally good trade in allowance for it. We traded two 3-year old pickups for two new ones not long ago for a difference of $750.00 each. That amounts to a depreciation of only $250 per year. This helps on equipment costs.

The third category of O&M costs I want to talk about is maintenance of the irrigation facilities. I can't over-emphasize this one. Here is where the greatest saving in dollars can occur. Savings here will hedge other rising costs where the dollar increases are beyond our control.

I am referring, of course, to the principle of preventive maintenance. It costs much less to prevent a major repair job than it does to fix it. A truck-load of riprap at the first sign of erosion near a structure may save a hundred loads later. It might even save the structure. An hour's work cleaning a plugged diversion ditch could save some concrete lining or prevent a washout. A few dollars worth of brush killer could save hundreds of dollars for tree removal later. Stopping bank erosion with gravel blanket or riprap costs much less than the major repair and right-of-way purchase that would be required later. There are many examples of this.
Doing a preventive maintenance job is almost automatically taken care of if you have taken care of the first two categories of O&M costs I've talked about--good people with good tools.

There are some specific techniques for doing this job, however, that are worth mentioning. Train your people to be observant. When they are operating canals, have them look for signs of deterioration of any kind--erosion, increased seepage, plugged diversion ditches, etc. Be sure they report what they see so that something can be done about it. Make the necessary repairs as soon as possible. It does no good to know about a condition if nothing is done about it.

At the close of each irrigation season, make a careful, detailed inspection of all facilities. Make a record of what you see. Even if no repairs are needed this year, three or five years from now that record will help you determine the rate of deterioration and permit advance planning for repair.

Use the information you gathered from the inspection to plan and budget for the coming year's maintenance program. A well-planned program, both immediate and long-range, is easy to sell to a good Board of Directors.

Analyze your costs on all major repair or improvement work. Keep detailed cost-analysis records. These will be useful in the future in preparing realistic cost estimates for similar work.

If you practice preventive maintenance consistently, your long-range costs will be held to a minimum. If not, your future costs will be compounded. You will find that you have more work to do each year and, if inflation continues, the unit costs will be higher.

The fourth and final category of O&M costs in which it is possible to hedge rising prices is in improvement work. Carefully chosen improvements built today will pay dividends in cost saving and improved efficiency for many years to come. An automatic water level control gate, for example, is a wise investment if it will improve delivery of water and eliminate two or three hours a day of time waiting for a change in flow to level off. In 30 or 40 years the time saving alone could repay the cost of the gate several times. There are many examples I could list--automatic controls or telemetering to save travel; control gates in lieu of stop logs at check structures to save time, or maybe a rupture; cattle guards to save opening gates; handrails and safety cables to save a life; additional access roads to facilitate maintenance work... You can probably think of many similar improvements that could be used on your own system.

An important principle to remember here is to use the brains you have on your crew. Encourage suggestions. The man doing the work will frequently think of a way to improve something that wouldn't occur to anyone else. Use his idea, if it is good, and give him credit for it. If you do, he will bust-a-gut to come up with an even better idea. I can best illustrate
this maybe by quoting from a report made by the Bureau of Reclamation following an inspection of our system. "The District has made many improvements throughout the system and has installed some very ingenious devices to solve local problems. It is obvious that the District Manager encourages the O&M people on his staff to suggest, and later implement, ideas which will improve system operation."

In conclusion, let me reemphasize some of the main points I've covered. Most important--get and keep good people; give them the tools to do the job; practice preventive maintenance--keep ahead; and, finally, improvements--make your irrigation system and your people even more efficient, if you can.

And remember this--we can't rest on our laurels. The best answer today may not be the best one for tomorrow. We can't assume that we're doing everything possible to hold down costs. We must keep our primary goal always in mind--maximum long-range service to our water users.

One thing for sure, if you and I fail to do the job, our water users will find someone else who will do it.
Providing your board members with the working tools of an effective director.
"The Future of Irrigated Agriculture in Southwest Kansas"
Herbert Hobble, Jr., Secretary
Southwest Kansas Irrigation Association
Liberal, Kansas

It is indeed a distinct honor to be asked to address this distinguished group of individuals who are gathered here today in the interest of irrigated farming.

Your program states that I will speak on the subject of "The Future of Irrigated Agriculture in Southwest Kansas." May I take the liberty of changing the subject a little in order that what I may have to say will apply to each of you and to the farmers of your area just in case you are interested in what I have to offer and along the lines I suggest.

However, I wish to caution you that my remarks are based upon my knowledge and experience of farming conditions, both dry land and irrigation in southwest Kansas. You realize I am not familiar with farm conditions in Colorado, Wyoming, Nebraska and that portion of my state outside my own area. This may give rise to questions in your mind as to statements I will make based on my limited knowledge of the four-state area.

I think it is necessary for us to accept the fact that the present farming operations are not a success, in that they are far from satisfactory when the year is over and the so-called "net profits" are figured. You are all too well acquainted with the low prices for the products the farmers have to sell and the high prices he pays for what he has to purchase to operate the farm. In my area, in the 1950's, wheat was $2.50 a bushel and a good tractor could be purchased for $4,000. Today, it is $1.25 wheat and the same tractor is $8,000. In the last ten years on the National average, farm labor has gone up 37 percent, vehicles 19 percent and machinery 38 percent. I have no figures on taxes but heaven knows they are on the increase. In Kansas alone, in the last ten years taxes have increased almost 100 percent on farm operations. All of these increases are during a period of decreased income for farm products. If anyone in the room can show me how a farmer can make money with this kind of prices, both selling and purchasing, coupled with increased overhead costs, then it is time for me to sit down and listen to what the speaker has to say.

In July of 1968, an article appeared in one of our farm publications as to the future of farm programs in Congress and, believe me, it was a dreary picture, for out of the 435 Congressmen, less than 40 are from districts where one-fifth or more of the district is farm population. In other words, the urban or city congressman is sitting in the driver's seat when it comes to legislation. Less than one-third of the House Agriculture Committee will be from farm districts. The prevailing attitude in Congress, according to the editorial writer, is to do away with all present farm programs and to tie the farm program into the welfare program on the basis that it is not a farm problem any more, that it is a poverty
problem, and that the only farmers that are actually in need of any help are the low-income farmers, the farmers of marginal land. Irrespective of your political beliefs, we have today a Congress made up of a majority of city congressmen and they have it within their power to make the change as they so desire. The problem now arises that if they do make the change, then what is your future?

I have, on different occasions, made the statement to farmers of my area that if they are interested in a greater income from their farms, it is not necessary to seek more Government payments and it is not necessary, generally speaking, to buy more land to farm. The first thing they must do is sit down and take a general inventory of themselves to determine just what the individual farmers want out of their farming business; do they want greater income or are they truly satisfied with what they have. If it is the latter, don't worry about the former, but if he is interested in the former, that of greater income, then it is time to begin some long-range investigation and planning. The result may wind up with an individual program of his own, or a joint program with some of his neighbors. Regardless of which way it turns out, individual or joint program, he will find a more productive use of his own land.

The main purpose of these remarks is to discuss the problems that will arise with those that are interested in greater incomes.

Those that write in the field of agriculture and particularly agriculture economics have said for several years that this farm area is a sleeping giant and is on the threshold of gigantic economic growth. With the highly capable human resources and the abundant natural resources present, the potential for development staggers the imagination.

The first thing you must recognize, although we do not care to admit it, is that agriculture as you know it today is the sickest business in the United States. The farmers realize the least profits for their merchandise of all industries in the United States. The real profits made on their products are made by the processor and the merchandiser. The farmer's number one job is to make a change of some nature in that picture in order that when the ultimate proceeds are divided, he will get a greater share than he is now receiving. Either he must receive a share of the processing or the market proceeds. In southwest Kansas, feedlots have increased the demand for processed alfalfa and as a result, investigations are being made in several areas by groups of farmers for the building of alfalfa mills to handle the local demands of the feedlots and many farmers are cooperatively building feedlots, not only for the profits that can be made from the feeding of cattle but to obtain a better price for grain sorghums and silage that they can raise. This same principal can be applied to many, many farm products and if the farmer is to expect a greater profit for his farm products, this same principle must be applied to his farm operation. The ultimate decision on this matter of profits will be made by the farmer when other factors herein presented are fully examined.
The second thing I think you should realize is that you are not a farmer in a sense that you simply farm land and dispose of your products on the open market, but you should consider yourself and be considered by your neighbor as a businessman and a farm manager. The time has arrived when you must think, when you must plan, when you must organize, and when you must decide. The following statement I make is not intended with any sarcasm on my part but you must realize that you possess a mechanism more wonderful than all the Appolos that the United States will ever build, more complicated than you can ever imagine, the limits of its abilities are unknown, yet it weighs less than a pound and scientists tell us it is, in comparison to other things you possess, used very little—I refer to your brain. You are the only one that is going to decide what to do and how you are going to do it. You are the only one that will decide just how far you are going with your farm operation, you are the only one that is ultimately interested in your farm operation. It is going to call upon you to do some real thinking as to the future and the future of your operation. Do you want to remain as you are or do you want to advance along with all other industries and keep up in this speedy world and make your farm operation a part of this fast growing empire that you enjoy in America? Are you going to be satisfied to simply sell your crop at the local elevator or are you going to be—a part of a planned, well-organized industry in which you may participate individually or jointly that is going to put your farm products directly on the market all over the world such as Rome, London, Copenhagen, Manila and Cairo. We have recently read of farm products from Arizona and California such as tomatoes, grapes and strawberries that are flown directly to European markets and there is certainly no reason why you cannot do the same. These, in substance, are the kind of questions that you have to answer and that is why I say that you alone are the only one that is going to make these decisions after you have given careful consideration of all phases of the program, both good and bad.

This word "manager" is the key to all your future success. If you have or can develop good managerial ability, your success is insured. Management is the key to all industry. Our largest corporations have management in every phase of their operation and the same principles that apply to their business can apply and does apply to your farm operations. Management of all industry acknowledges that the four functions of management are (1) planning, (2) organization, (3) controlling and (4) directing.

Planning—not on what your farm will produce in 1969 but planning in 1969 what you will produce in 1973, 1974 or 1975.

Organization—putting together the necessary capital and labor to produce those crops at the least possible cost even though it demands junking your present ideas as to the use of capital and labor. This matter of lowering operating costs, in many cases, is far more important than the price received. It also calls for decisions as to matters pertaining to whether or not land should be purchased or leased and whether or not machinery should be owned or leased.
Controlling--as applied to your farm, suggests the controlling of prices either through the use of the future market as to livestock or grain or in the case of special crops, the contracting of certain special crops at specified prices.

Directing--under management of all phases of your program and bringing into your organization the necessary specialists that will be needed to make your operation more efficient. At this point, money management comes under this particular function. It may be that your banker needs to be educated as to your operation, your ability as a manager, and your future planning. If you prove yourself to your banker, your battle is more than 50 percent won because your banker is a necessary part of your operation.

Under this general heading of management, I have found that many farmers do not take advantage of the services of an accountant. No business in America which is a success operates without an accountant and if you don't have one, I suggest you get one as soon as possible in order that you may actually see what is your most profitable enterprise and be able to determine what farm operations you have that might need to be discarded because of the fact that they are not making you a profit. Don't be fooled; I have seen many farmers who believed that a particular operation was a profit-making one, only to find out that the profit was less than zero when the operation was over and all entries were made in the books. I know many farmers in my area that have found by proper bookkeeping, that it is by far more profitable to raise wheat for pasture only than to harvest the grain. After all, it is more important to have a good profit from pasturing the wheat than it is to enjoy seeing the golden grain go to market and wind up with no profit.

Speaking of accountants and their importance to you and your operation, there is a term with which you will become more familiar in years to come that is used a great deal in banking circles today and that is the term "cash flow." A chart is prepared for a 12-month period showing your estimated income by months and your anticipated cash outlay by months which will reveal the high-income months and the high-cash outlay months in order that you may properly arrange your financing to meet the cash outlay months and arrange to have proper credit to take care of the same, if necessary. This is only one phase of this management program that you will face but again I say, this is your accountant's problem; however, you certainly need to be acquainted with it, for satisfactory evidence to your banker that you are familiar with the term "cash flow" and its purpose will further satisfy your banker that you are a well-qualified farm manager.

I am a little reluctant to suggest to you a matter that I think is terribly important to you, but one that I believe is very necessary for your success. It is said that the most independent man in the world is a farmer, and if this be so, then I believe it is time for you to get over your independence and enter into the spirit of cooperation with your fellow businessman,
order to accomplish something that is practically impossible for you to do alone. After the accomplishment has been achieved, if you desire to again take up your independence, that will be your business, but I seriously doubt if you will.

The accomplishment that I speak of is the third suggestion I have to make to you. Let me say in the beginning of this suggestion that there is nothing you could possibly use in connection with your farm operation that you cannot buy, perhaps individually no, but collectively, yes. Today, there is available to you the most modern techniques of research the world has ever known. Research and marketing are becoming "household" words in all industry. Industry today cannot succeed without first spending vast sums for preliminary research and marketing investigation. The same thing that applies to industry applies to farming and the sooner you realize this fact and put it to use, the quicker you will realize your ultimate goal. I am not and I do not intend to belittle your State Agricultural College, your experiment stations, or any other agricultural aids of your state, but I am simply stating a fact based on things I actually know in my years with the Southwest Kansas Irrigation Association.

The work of our agricultural colleges and experimental stations are very important to each area, but it seems to me that they do not go far enough in their work. I noticed in the January issue of "Farm Journal" an editorial that the result of a survey made by the Extension Service of its own service, 38 percent of its present service is to help improve farm production; that 6 percent of the present service is on "marketing, processing and distribution" and that by 1975 that will be stepped up to 80 percent of its service. Of course there are other areas wherein the Extension Service would work primarily in education of farmers, public service, work with the low-income farmers and with the youth of the rural areas and urban slum areas, but I wish to point out that the main effort will be in the area of "marketing, processing and distribution."

To return to the matter of research and marketing, to state it in simple language, it is a matter of discovering the need for crops that can be raised on your farm and the proper way to market the same or it may be a problem of marketing in a different manner the crops you are now raising. Marketing and research call for the assistance of specialists in those particular fields. You are not expected to be qualified in these fields yourself but as I said a moment ago, these services can be purchased.

I well realize that research and market investigations cost money but it is not money thrown down the drain so to speak, it is experimental money as far as you are concerned. I presume I am correct when I say to you that you have spent money on your farm that did not bring you a profit; therefore, if you are interested in research and marketing, think of it as an investment in the possible success of your farm.
The result of this research and marketing could easily result in new crops or a livestock program on your farm. It could result in agribusiness being established in your area such as processing plants, feedlots, packing plants and it could result in bringing to your entire area a new concept of the field of agriculture.

You must remember there is an old adage in the irrigation business that the real money made in irrigation farming is not raising crops that can be raised under dry-land conditions in your area so if the result of the research is that you will be raising new crops under proper management with all new techniques available to you, this sleeping giant that I spoke of a little while ago will awake and 10 or 15 years from now, you will wonder how you farmed as you did in 1969.

I am well aware there are many problems involved but I am from an area where mother nature has dealt us some tough blows, drought, hail, and only this year, the green bugs practically ruined our grain sorghums. But we are not giving up, we are going ahead. We are working in the field of research and marketing and I am sure that the next 10 years will bring changes to southwest Kansas that many of us today do not at this time recognize. In the field of farm machinery, you are well aware that computerized farming is just around the corner when you will sit in your pickup at the edge of your field and punch a button on a panel board and watch your field cultivated, planted and harvested without a human being operating any of the machinery. This is hard to realize and it may be more difficult to accept but the farm manager that is willing to accept new ideas and programs as they are presented to him is the manager that is going to succeed.

It is a matter of your being converted to new methods, new practices, new principles and new concepts. If industry keeps up with everything new that is offered, so must the farmer. If you farm today the way you farmed yesterday, you are headed for trouble tomorrow.

Mr. Seaworth introduced the film "The Miracle of the Missouri." The film was produced by the United States Bureau of Reclamation.

FRIDAY NOON LUNCHEON

"Agriculture's Future Farmers"

John Reid, President
Colorado Chapter, Future Farmers of America
Ordway, Colorado

It is certainly my pleasure to be here representing the Colorado Association, Future Farmers of America. I have a keen interest in irrigation just as you gentlemen do, for I farm 160 acres of land,
irrigated with wells. My Dad and I put up prairie hay, subirrigated by
creek water.

We as Future Farmers believe that there is a future in agriculture for
farm oriented boys. However, I stress the word AGRICULTURE. It is true
that production agriculture is a declining business, with each production
farmer feeding more people every year. But we also see an outstanding
future for many of us in the field of agribusiness.

Forty percent of America's work force is engaged in ag-related businesses,
which includes production, processing, marketing, distribution and pack-
aging foods. Add to that the manufacture of machines and supplies to keep
these businesses going. We can see a definite shortage of man power in
these areas. For every college graduate in the field of agriculture,
there are three jobs to be filled.

Farming is no longer the "40-acres-and-a-mule" which followed the frontier.
Today, agriculture is an industry and must be recognized as such, not only
by the farmers themselves, but by government planners and other basic
industries. Physically, there is little difference between agriculture
and such industries as steel, oil and automobiles. All have their roots
in the soil and the products they turn out come from the soil.

With technology advancing as it has, the farmer has given up the pitch-
fork in favor of the office. The good farmer today is not the one who
can build a square stack but rather the one who can plan and then accom-
plish. Buying, selling and other management decisions based on facts and
records will be most profitable. There is still plenty of muscle work left
on the farm--but the 1969 farmer is best paid for his brainwork and managerial
ability.

As producers of food, our efficiency can be matched by no other industry.
The farm, just like other business, must be able to expand--increasing
efficiency per man-hour. With the current cost-price squeeze, efficiency
becomes doubly important and diversification is a must. Yes, farming is
truly becoming the most important and the most efficient business this
nation has ever seen.

The Future Farmers' part in the future of this business is best exemplified
by the FFA creed:

I believe in the future of farming, with a faith born not of words but of
deeds--achievement won by present and past generations of agriculturists:
in the promise of better days through better ways, even as the better things
we now enjoy have come to us from the struggles of former years.

I believe that to live and work on a good farm, or be engaged in other
agricultural pursuit, is pleasant as well as challenging; for I know the
joys and discomforts of farm life and hold an inborn fondness for those
associations which, even in the hours of discouragement, I cannot deny.

I believe in leadership from ourselves and respect from others. I believe in my own ability to work efficiently and think clearly with such knowledge and skills as I can secure, and in the ability of progressive agriculturists to serve our own and the public interest in producing and marketing the product of our toil.

I believe in less dependence on begging and more power in bargaining; in the life abundant and enough honest wealth to help make it so—for others as well as myself; in less need for charity and more of it when needed; in being happy myself and playing square with those whose happiness depends upon me.

I believe that rural America can and will hold true to the best traditions of our national life and that I can exert an influence in my home and community that will stand solid for my part in that inspiring task.

We Future Farmers find that cooperation plays an important role in our future. As the number of farmers continues to decline there must be added cooperation between the agribusinessman and the farmer. Only 5.4 percent of the United States population is presently engaged in farming, making this occupation a definite minority; but add to this the many, many phases of agribusiness, and approximately 40 percent of the nation's people are engaged in agricultural occupations.

It is important that we direct this cooperation in one specific area—public relations. There is a growing frustration throughout most of agriculture about our poor public relations and our dwindling political power. These worries grow as the number of farm voters gets smaller, and as agriculture assumes more of the characteristics of big business.

We all say we have got to quit wringing our hands and talking to ourselves. We must find a way to talk to millions of consumers and voters in this country. We talk about agriculture or agribusiness as though it were a big, well-defined, single unified industry. It is not. Agriculture is a hodgepodge of thousands of different activities and interests, many unrelated and some directly opposed to each other. What has an Oregon cranberry grower in common with a Colorado cattle feeder? For example, a Delmarva broiler competes for a place in your stomach with an Iowa hog. A fertilizer manufacturer is a strong member of the agribusiness industry and yet, how much enthusiasm does he get from a corn grower on the subject of boosting the fertilizer prices?

When you come right down to it, the only thing we have in common is a public relations problem and that we must solve together.
As you gentlemen well know, water has become a precious commodity, in demand by all, especially in this part of our nation. We must compete with industry, recreation and the urban community for the use of water.

Advancements in the field of irrigation, just as in any field of agriculture never cease to amaze me. We have witnessed an unbelievable era in agriculture but the most fantastic is yet to come.

In the past, the hiring of an irrigator was considered common cost in an irrigated farming area. Today, gated pipe, cement ditches and automatic gates have made irrigation nothing more than a chore. A chore which the self-propelled sprinkler has almost eliminated.

The future will show us irrigation practices yet unheard of. Farmers will see many more new labor-saving ideas, thus creating more agribusinesses. In this unseen future will be the real need for outstanding leadership.

Leadership is another area that we can already see as a necessity for the future. Farmers and agribusinessmen must be leaders, able to try new ideas and to make them work.

You in the irrigation world use good leadership to see new sources of water for use on the farmland. Your leaders must be able to discover ways of conserving water and reusing it time and again. Leaders in irrigation must be able to cooperate with the other businesses in this vast world of agriculture. This cooperation must lead to the ability to get our story across to the public in such a way as to make them see how it will benefit them too.

I am sure that irrigation will continue to play an important role in feeding a hungry world. You will develop new ideas to make irrigation even more beneficial and productive.

A poem from the files of my Grandfather, the late Judge John G. Reid, contains a great deal of food for thought.

THEY

THEY ought to help the farmer and buy the ranchman hay. THEY ought to lower taxes, but who, my friend, are they? THEY ought to raise the pensions and help the debtors pay. THEY ought to trim the budget, but who, indeed, are they? We've got to have a bonus or something else that's free. But high surprise awaits us--to find that 'they' are WE!
Outgoing, Left to Right:
Glen Graf, Director, Kansas
Robert Myers, Director, Colorado
Charles Preuit, Vice President
Harian Seaworth, President
Jim Ingles, Director-at-Large
Jim Pringle, Secretary-Treasurer
Don Long, Director, Nebraska
L. E. Whitman, Director, Wyoming

Incoming, Left to Right:
Jim Pringle, Vice President
Glen Graf, Secretary-Treasurer
Charles Preuit, President
Jim Ingles, Director-at-Large
L. E. Whitman, Director-at-Large
Frank Milenski, Director, Colorado
Jim Wanamaker, Director, Kansas
Robert Colson, Director, Nebraska
Annual Business Meeting

Four-States Irrigation Council

The meeting was called to order by President Harlan Seaworth in the cafeteria, Building 67, Denver Federal Center, on January 10, 1969.

The minutes of previous meetings of the Directors and Officers were read and approved.

Financial Report

Cash on Hand - 1/26/68

Receipts:
- Membership Dues: $985.00
- Conference Registration: $1,267.00

Total Cash and Receipts: $3,228.73

Disbursements:
- 1968 Proceedings: $367.36
- 1968 - Stationery: $13.25
- 1969 - Stationery: $14.75
- Supplies and Postage: $31.74
- Plaques and Badges: $113.00
- Transportation - Ladies' Tour: $60.00
- Conference Expense: $1,217.35

Total Disbursements: $1,817.45

Total Cash in Bank - 2/1/69: $1,411.28

The report from the nominating committee for new Officers and Directors was as follows:

Directors:
- Colorado - Frank Milenski - La Junta
- Kansas - James Wanamaker - Ellis
- Nebraska - Robert Colson - Gering
- Wyoming - L. E. Whitman - Torrington
- Director-at-Large - James M. Ingles - Denver

Officers:
- President - Charles Preuit - Wheatland, Wyoming
- Vice President - Jim Pringle - Scottsbluff, Nebraska
- Secretary-Treasurer - Glen Graf - Long Island, Kansas

The report was accepted and there were no nominations from the floor. It was moved and seconded to cast a unanimous ballot for the above officers and directors. Motion carried. There being no further business, President Seaworth adjourned the meeting.
Thursday morning, January 9, some of the ladies whose husbands were attending the Four-States meeting assembled at the Cosmopolitan Hotel at 10:00 a.m. The 23 ladies in attendance boarded a chartered bus for a tour of several points of interest in the City.

The first stop was at the U. S. Mint. Here, they saw large coils of metal being chemically cleaned for the coin blanking machines. The coils were then fed into these machines and the blanks were collected in large hoppers. From this operation, the blanks were fed into the stamping machines from which bright, new, shiny coins were ejected into a hopper and inspected for flaws. The finished coins were then taken to the weighing and bagging room. Here, they were automatically counted into bags and taken to the vault.

The second stop was at Jonas Brothers Furs. The ladies began the tour in the taxidermy section. Here, they were shown how animal hides were prepared for mounting and mounted over precast forms of the animals. They next visited the fur coat section. Here, the steps for making mink coats were explained. First, the fine mink pelts were cut into narrow strips and sewn together. When enough pelt strips had been sewn together, they were then made into a coat. They also inspected the hides of other various breeds of animals that were in the process of being made into coats. The ladies had an opportunity to try on various styles of expensive fur coats.

The group stopped at Andy's Smorgasbord Restaurant for lunch and a fashion show.

The group then visited Sanders Carpets and Draperies. The various types of carpet materials and products used in the making of fine carpets were explained to the group. The ladies were amazed at the wide use of indoor and outdoor carpeting.

The last stop was at Charles J. Eisen's Decorative Furniture Showroom. Mr. Eisen remarked about the quality of the furniture that his firm produced. The Company wholesales furniture, but he explained that if prospective buyers wanted to inspect his firm's furniture, they could do so at the showroom. If they found furniture they wished to purchase, they could then give the stock numbers to their own furniture dealers for ordering.

The group returned to the Cosmopolitan Hotel at approximately 3:00 p.m.