

Hon. F. E. Warren,  
Cheyenne, Wyo.

April 3, 1902.

My dear Senator:

I have had latest United States mounted map sent to Fred, as requested by your telegram of first instant. Also, a copy of Commissioner Hermann's book on the Louisiana Purchase. Hermann was much flattered by the request for the book, and gave it very willingly indeed.

I saw Frank last night, and told him of my belief that Maxwell and Pinchot were using his minority report on the forestry transfer as a handle to influence the President against Judge VanDevanter, and against the Wyoming idea regarding irrigation, and probably using it with effect. Maxwell and Pinchot have taken every possible occasion to get Metcalf close to the President. This was shown in yesterday's conference between the President and the members of the House Irrigation Committee. The conference was requested by Mondell, and at his suggestion the President invited Maxwell and Pinchot to attend, inasmuch as they had been the strongest opponents here of the state control section of the irrigation bill. Frank said when the party went up to the White House they found Senator Dietrich there, and invited him to take part in the conference. Much to Frank's surprise, however, Metcalf turned up and joined the party in a manner indicating that he had been invited to attend. Frank was unable to find out, by indirect questioning, just how he came to be invited, but is of the opinion that Maxwell and Pinchot sent him word to come.

As indicated in my dispatch of to-day, Frank called on the

President this morning, and talked with him on the forest reserve transfer proposition. He told the President he believed in reciprocity, and reminded him that he had voted for Cuban reciprocity in the House. He said, also, that he wished to extend the idea into the consideration of the forestry matter; that he was opposed to the measure, but recognized the fact that others whose judgment he considered good, favored it. He knew the President desired the change, and wished to say that with filing his minority report, his opposition to the bill would cease; that he would probably vote against it, but would make no fight against it on the floor, and would do what he could to induce the others who had joined with him in the minority report to desist from opposing it. As he had spoken to Speaker Henderson and Representative Lacey, advising them that he intended to make a fight against the bill on the floor, he assured the President that he would go to both gentlemen, and tell them of his change of plan. He would also tell Mr. Pinchot that his opposition would not go beyond filing the report.

Frank says the President seemed wonderfully pleased, and told him he appreciated his action exceedingly. He said he thought it would be for the best interests of the west that the forests of the country be placed under one head, and transferred to the Agricultural Department. Frank said he was very profuse in his expressions of gratification, and then took up the irrigation bill, saying that he trusted the House Irrigation Committee would modify the state control section so that the measure could have the support of those who favored the general idea of irrigation, but were opposed to absolute state control. He intimated that he would favor such a bill, even though it should not meet the views and receive the indorsement of extremists.

The Washington Post printed a story this morning to the effect that Hitchcock has been asked to resign; that the request was made through another member of the Cabinet, but was made so delicately that it is supposed Hitchcock took it simply as a gentle hint, and not as a request. I send you the paper by this mail--and, on second thought, lest you might miss the paper, I enclose clipping containing the item.

Senator Cullom says he is very anxious to wait until your return before going into conference on the legislative appropriation bill. Unless the house conferees push for an early meeting, he will hold off on the conference until your return. If he has to go into conference, he will look after the amendment transferring the temporary roll clerks to the permanent service.

Mahon has not succeeded in securing conference on the omnibus bill as yet.

I learned yesterday, not for publication, that Hermann is to retire in June, and that the President has said Richards will succeed him.

Very sincerely,

(Enc.)

*J. A. Breckins*

Hon. William J. Deboe,

April 4, 1902.

United States Senate.

My Dear Sir: In the absence of Senator Warren, I beg to acknowledge receipt of your favor of April 3d, and to advise that the correspondence to which it refers was not enclosed therewith.

Very truly yours,

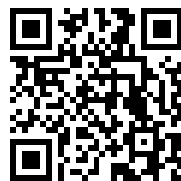
*J. A. Breckins*  
Secretary.

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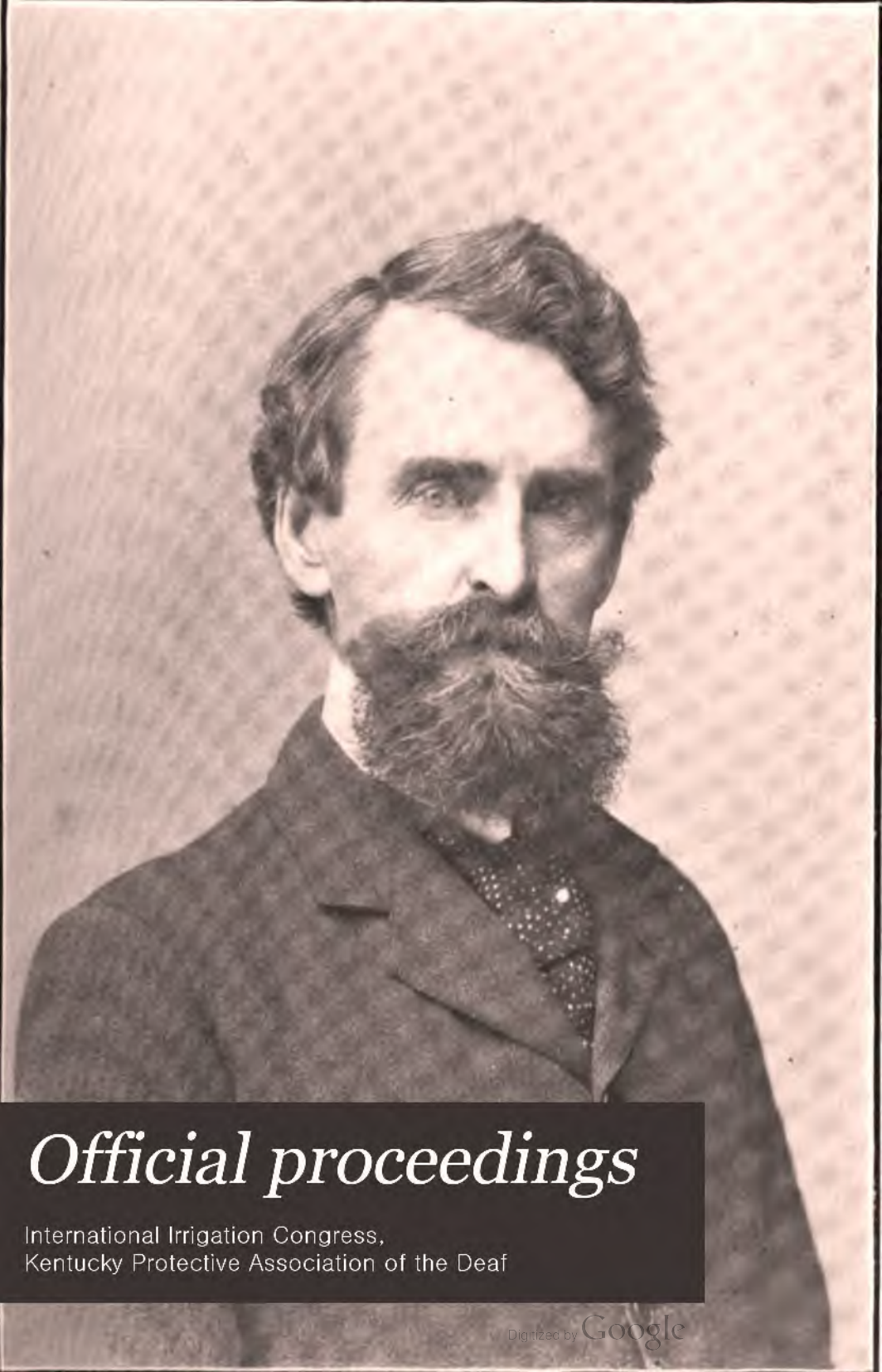
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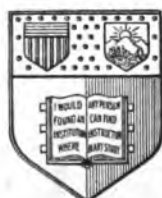




# *Official proceedings*

International Irrigation Congress,  
Kentucky Protective Association of the Deaf

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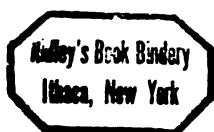
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THE OFFICIAL PROCEEDINGS  
OF THE  
TWELFTH  
NATIONAL IRRIGATION CONGRESS

HELD AT  
El Paso, Texas, Nov. 15-16-17-18, 1904

COMPILED AND EDITED  
BY  
GUY ELLIOTT MITCHELL,  
Chairman Press Bureau  
BY ORDER  
THE EXECUTIVE COMMITTEE

A. W. GIFFORD,  
Secretary

CHARLES B. BOOTHE,  
Chairman

*For Index see end of Volume.*

PUBLISHED BY  
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1905

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# CONSTITUTION

## OF

# The National Irrigation Congress

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### ARTICLE I.

The Congress shall meet at such time as shall be fixed by the Executive Committee, and at such place as shall be designated by the previous Congress.

### ARTICLE II.

The permanent officers of the Congress shall consist of a President, three Vice Presidents, a Secretary, and such assistants to the Secretary as the Executive Committee, consisting of one member from each State and Territory, who shall be selected by the delegation of their respective States and Territories, shall determine. The President shall be ex-officio member of the Executive Committee.

### ARTICLE III.

The Executive Committee shall select its own chairman and secretary and sub-committees.

The Executive Committee shall have charge of the interests of the Congress between its sessions, arrange the preliminaries for its meetings, and take such steps as they may deem proper to bring its recommendations to the attention of the Congress of the United States and urge their adoption.

The Executive Committee shall elect its Treasurer, who shall have charge of its funds, and no indebtedness shall be incurred unless the funds are on hand to meet it.

The Executive Committee shall divide the work of each Congress into three or more sections, each of which shall have a chairman, who shall be responsible for the carrying out of the work intrusted to that section, and through whom all correspondence pertaining to that section shall be carried on.

The necessary funds for defraying the expenses incurred by the Executive Committee shall be provided for as follows: First, from the local committee at the location where the succeeding Congress is designated to be held; second, from such other sources as the Executive Committee may find expedient.

### ARTICLE IV.

The length of each session shall be determined by the Executive Committee, and the election of officers shall take place at 11:00 a. m. of the last day of each session.

## ARTICLE V.

The Executive Committee shall require from the chairman of each section named in Article III, not less than two weeks previous to the date of meeting of each Congress, a list of speakers provided for that section, and a copy in duplicate of the papers to be presented in that section of the Congress, which correspondence from the chairman of each section shall be directed to the Secretary of the Executive Committee.

## ARTICLE VI.

The membership of the Congress shall be as follows: Fifteen delegates from each State and Territory, to be appointed by their respective Governors; five delegates from each town and city of the United States having a population of less than 25,000, to be appointed by its Mayor or chief executive; ten delegates from each city having a population of over 25,000, to be appointed by its Mayor; five delegates from each county, to be appointed by the chairman of the governing board; two delegates each from regularly organized irrigation, agricultural and horticultural societies, societies of engineers, agricultural colleges, and commercial bodies; each member of any state or territorial irrigation commission; also state commissioners of agriculture or horticulture; the chairman of each section and the permanent officers of the Congress; also the Governor of each State and Territory, and all members of the United States Senate and House of Representatives.

At the opening of each annual session, and from time to time during said session of the Congress, the Secretary shall report the names on the official register of delegates accredited to the Congress, and such report, when accepted and approved by the Congress, shall constitute the persons so reported members of said Congress.

## ARTICLE VII.

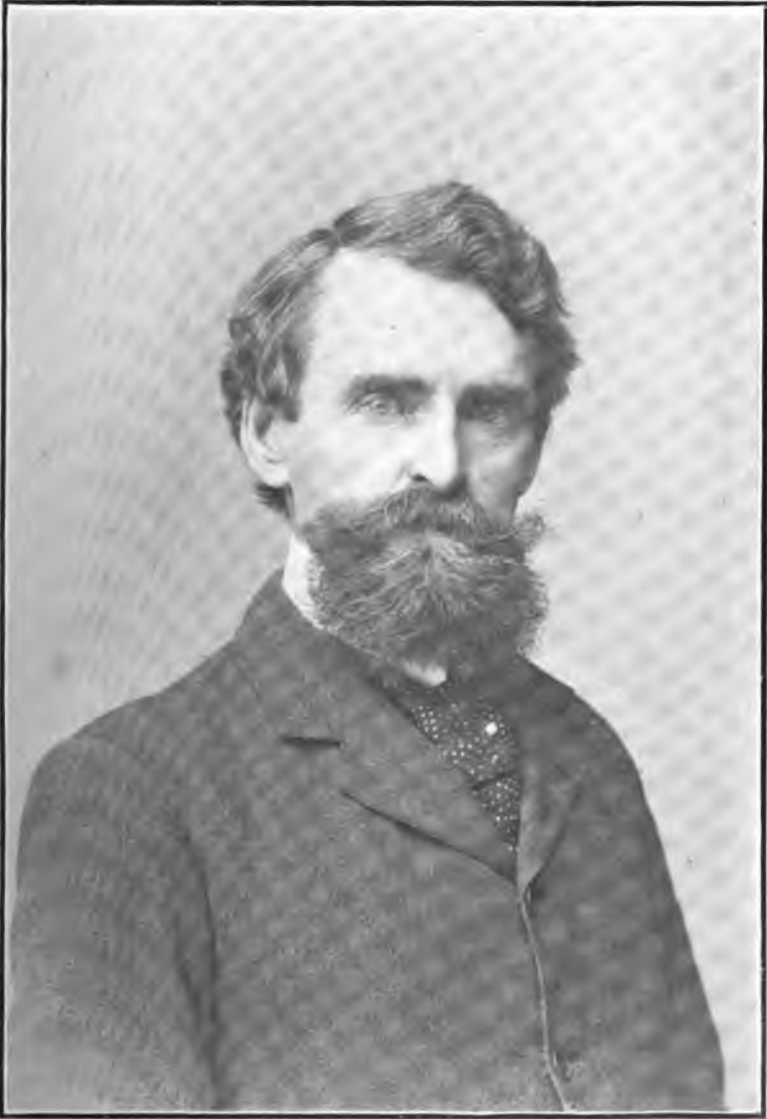
Each member of the Congress shall be entitled to one vote; *provided*, no State shall have more than twenty votes; and *provided*, when a State is represented by less than ten delegates, said delegates, if all present, may cast ten votes for said State; if some of the delegates of said States are absent, those remaining may cast their proportion of ten votes.

## ARTICLE VIII.

This Constitution may be amended by a two-thirds vote of the delegates of any Congress, under the provisions contained in Article VII.

## ARTICLE IX.

The Executive Committee shall have power to fill vacancies and shall make its own by-laws and rules of procedure.



HON. W. A. CLARK,  
U. S. SENATOR FROM MONTANA,  
President 12th National Irrigation Congress.





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# About El Paso, Texas.

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El Paso, Texas, is a city of 30,000 inhabitants, situated in the extreme western part of the State on the Rio Grande, which here separates Texas from Mexico and New Mexico.

El Paso commercially occupies a quique strategic position: there is no other city so large, so important, or so well supplied with natural and artificial advantages, within a radius of 600 miles in any direction. The nearest commercial cites of note are: on the east, San Antonio and Fort Worth; on the north, Denver and Kansas City; on the west, Los Angeles; on the south, the City of Mexico.

In the order of their importance as wealth producers for the population of El Paso and tributary territory, the principal occupations, resources, and assets of this community are: First, mining; second, trade; third, transportation; fourth, live stock; fifth, agriculture; sixth, manufacturing.

Agriculture is at present of comparatively little importance, but the possibilities of development in this industry are greater than in any other, as will be presently shown.

## MINING.

Mining dominates El Paso's trade development, industry and life. It is mining that, above all other considerations, makes the basis of El Paso's wealth and prosperity permanent and certain to increase in value.

El Paso is at the center of a vast mineral zone, whose development has as yet barely begun.

The mines in El Paso's circle of commercial influence produce annually \$150,000,000 in mineral wealth.

The custom smelters in El Paso's trade territory pay \$100,000,000 annually for the ores brought to them for reduction; much of this money naturally flows into El Paso's trade channels, directly or indirectly, and represents a constant influx of ready cash from the great purchasing and manufacturing markets of north and east and Europe, into the Great Southwest.

Ores come to the El Paso Smelter from as much as five or six hundred miles distant, and El Paso is the primary distributing point for mining machinery, hardware and supplies for a district larger than the State of Texas.

The distribution of mineral wealth about the city is interesting to note. North and northeast, the dominant product is coal; east, quicksilver is the best known product; southeast, iron controls; south, silver; southwest, gold; west and northwest, copper.

The coal deposits are the greatest west of the Mississippi river; the quicksilver mines are almost the only ones in the United States operated commercially; the iron deposits are among the most extensive on the conti-

ment; the silver district contains some of the world's greatest producers; the gold of northern Mexico is famous; the copper region, taken as a whole, is the greatest in the world.

### TRADE.

To the casual visitor in El Paso the most prominent feature of the city's life is the extraordinary commercial activity. El Paso, the city itself, is a city of trade. El Paso is always spoken of by visitors as the busiest city of its size in the United States.

El Paso's jobbing territory, the country actually covered by her traveling salesmen and dominated by El Paso commercially, extends over a region more than 500 miles in diameter.

The jobbing trade of this city is all the time increasing. El Paso has the advantage of cheap rates in, and fair rates out. This city being an important terminal point, with a number of competing lines stretching in every direction, we get the benefit of rates usually accorded only to towns with a much larger original traffic. Aside from the question of rates, there is the even more important consideration, in some classes of business, of quick delivery. This factor is particularly important in the mining industry.

Outside of El Paso's actual jobbing territory there is a zone where there are hundreds of mines and prospects dependent on the El Paso smelter to purchase and reduce their ores. The cash received by these miners from the El Paso smelter is largely spent in El Paso for supplies. The miners often visit the city and do their buying in person, thus adding to the city's retail trade. The same is true of the live stock interests.

El Paso's retail stores derive considerable advantage from the fact that there is no other city within 600 miles that carries such costly and complete stocks of goods as El Paso's stores carry.

This city, owing to its high altitude and wonderful climate, is gaining merited recognition as a summer resort as well as a winter resort. The travel through here is always large, and the retail trade benefits from it throughout the year.

### TRANSPORTATION.

The transportation interests of El Paso and the Great Southwest are of enormous importance, commercially.

Nine railroads have terminals in El Paso, six of which are great trunk lines. All the roads have numerous branches which are helping to develop the mining, stock, and agricultural country tributary to the city.

The freight movement on these El Paso lines is steady and perennial, being made up mainly of fuel, provisions, machinery and other staples always in demand, together with ores and other products of mining and live stock. Through traffic, both passenger and freight, is heavy all the year, and El Paso takes toll of it all.

The railroad pay rolls in El Paso form one of the most important sources of income, amounting to upwards of \$1,500,000 annually.

A \$280,000 union passenger depot to be used by all the roads is in course of construction.



## LIVE STOCK.

Large cattle ranches are found in all directions from El Paso, both in the United States and in Mexico, and the grazing industry is one of the most extensive and valuable resources of the city. Some of the lands hereabouts formerly occupied as cattle ranches have been or will be turned into farms, but stock growing will always be a leading industry in this part of the Great Southwest.

El Paso has all the necessary advantages for making one of the country's greatest cattle markets. Many wealthy stockmen make their homes, as well as their business headquarters, here. The El Paso union stock yards are connected with all the railroads, and last year took care of nearly 300,000 head of live stock. Much of the movement was from Mexico to Canada and the northern United States, but the greater part of the traffic was made up of stock moving from Texas and New Mexico ranges to California, Oregon and the feeding grounds of the Missouri valley.

## AGRICULTURE.

The Rio Grande valley, both above and below El Paso, has been cultivated since the first Spanish explorers entered the country, and no doubt the ancient Pueblos had prior to that utilized other portions of the valley besides the northern part where Coronado discovered them. The earliest Spanish chroniclers record the presence in the valley of domestic Indians, who farmed by means of irrigation dams and ditches, and well understood the extraordinary richness of the alluvial bottom lands.

It was not until the coming of the railroads and the large influx of new settlers some 20 years ago that Americans began to farm the valley on any considerable scale, or that modern methods began to be introduced. Now scores of pumping plants are at work in the valley watering thousands of acres of land.

The Mesilla and El Paso valleys are famous for their tree fruits, grapes, melons and early vegetables. Immense quantities of alfalfa are produced, but still not nearly enough to supply the home demand. This deficiency in product is true also of grain, garden truck, and some fruits, as well as poultry and fresh and canned food products generally.

Outside of El Paso there is a vast territory that would be be naturally supplied from this valley if the product of food stuffs were sufficient. It is safe to say that the valley does not now supply over ten per cent of this natural market. Yet in the valley from a point 50 miles north to a point 50 miles south of El Paso, there are 150,000 acres of cultivable land which ought to be and will eventually be brought into cultivation by modern methods of irrigation.

At the recent session of the National Irrigation Congress at El Paso, action was taken by representatives of New Mexico, Texas and Mexico that will, it is hoped, make it possible to commence soon the erection, under the provisions of the National Reclamation Act, of a vast dam or reservoir at a point 125 miles above El Paso on the Rio Grande, that will store water

sufficient to irrigate, even in the dryest years, 180,000 acres of valley land, including some 25,000 in Mexico which possess water rights on the stream.

Water users' associations have already been formed by the people of the valley, and all the interests are working hard for the early consummation of this great project. The plan involves the expenditure of \$7,200,000, which will impose a charge of \$40 per acre on the land to be irrigated. But the farmers welcome the opportunity, because at the end of ten years the payments of \$4 per acre per year will cease, and even that amount is much less than the cost of running a pumping plant, and not much more than has been paid to private canal companies for a service which failed more often than it supplied water.

There is no other opening in the United States for the farmer-irrigator so promising as this. Climate, soil, market, and all other conditions for successful farming and pleasant living are here unsurpassed. Under intensive farming 10 to 20 acres will support a family. It is plain that this Rio Grande valley would easily support 50,000 people engaged in tilling the soil.

Thus, while agriculture is not now among the most important local industries, its possibilities are greater than those of any other. There is room for more people in this industry without a chance of overcrowding than in any other branch of activity. There is a steady and increasing home market for the bulk of the product, and a demand impossible to satisfy, on the part of the northern and eastern markets, for our early fruits and vegetables.

### MANUFACTURING.

El Paso's manufacturing industries are largely devoted to supplying home demands. The most conspicuous exception, however, is also El Paso's most important single industry—smelting.

The principal El Paso smelter has a pay roll of \$60,000 a month, and maintains a community of 3500 people in an El Paso suburb. It reduces a ton of ore every minute in the year, running 24 hours a day and seven days a week.

One of the largest industrial enterprises is a dairy which is described by the world dealing directly with the consumer. This concern milks 350 to Secretary Wilson, of the Department of Agriculture, as the biggest dairy in 400 cows regularly, and delivers milk and cream to its own customers in iced sterilized bottles several times a day; it also does an extensive business in beef and dairy cattle and runs one of the most extensive alfalfa ranches in the valley. It has an important export and railroad trade.

Among the manufacturing concerns which ship goods out of the city are factories for the manufacture of office fixtures, blank books, boots and shoes, candy, carriages and wagons, brick, beer, cigars, clothing, Mexican curios, engines, boilers and mining machinery, ice, soap, lime, saddles and harness, trunks and valises, vinegar and cider.

As in agriculture, manufacturing in this locality has the vast advantage of enjoying a steady and always expanding home market, while the distances from which competing products must be brought mean heavy freight charges that would amount to a protective tariff for local industries. Steam coal is

not expensive and other forms of power are readily available. Fine water for boiler use can be had at no great outlay.

Labor conditions generally in El Paso are satisfactory to an extraordinary degree. El Paso has never had a strike of any consequence.

#### ADVANTAGES TO HOMEMAKERS.

El Paso is a city that quickly becomes home to the newcomer. It is supplied with every modern convenience and advantage. The public schools are kept at the highest standard, and a certificate from them admits without examination to many of the great universities. Every important religious denomination is represented among the churches. There are scores of lodges of all varieties. The social life of the city is cosmopolitan and elevated. There are all kinds of social and educational clubs for men and women, boys and girls. El Paso has a free public library, and plenty of facilities for amusement. There are three daily newspapers with the telegraphic news service of the Associated Press. Nearly every family possesses its own home. The climate is unequalled in the world for its invigorating and curative qualities, and for its perpetual sunshine under conditions of altitude, dryness, and continual breezes that prevent any relaxation of physical energy. The spirit of the people is intensely progressive, thoroughly western. Altogether there is no pleasanter place to be found than El Paso, in which to make one's home and do one's work.

For further information apply to the Secretary of the Chamber of Commerce, El Paso, Texas.



OFFICIAL PROCEEDINGS  
OF THE  
Twelfth National Irrigation Congress

FIRST GENERAL SESSION,  
Tuesday Morning, November 15, 1904.

The Congress was called to order in the large convention hall at 10:30 a. m. by Senator W. A. Clark, of Montana, President.

President Clark—Ladies and Gentlemen: This 12th National Irrigation Congress will now come to order, and I will take pleasure in introducing to you the Reverend H. W. Moore, who will pronounce the invocation.

**INVOCATION.**

Reverend Mr. Moore—Almighty God, our Heavenly Father, the earth and the fullness thereof, and they that dwell therein are the Lord's. Thy kingdom ruleth over all and ruleth forevermore. Conscious of our dependence upon Thee, our Heavenly Father, for all that makes for wise counsel and for good conduct, we look up to Thee this morning for Thine almighty aid and guidance during the deliberations of this great National Congress. We pray that Thy blessing may rest upon the officers and upon the members of this Congress; that Thou wilt give them sound judgment, and we pray Thee that unity and wisdom may characterize all the counsels of the different departments of this Congress. We pray that everything that shall be done shall be done for the common welfare of this great land in which we live.

We pray Thee that Thou wilt watch over those who are strangers; bless those who are yet to come to us. Let Thy blessing rest upon the homes left behind them and the interests with which they are identified. We pray for the President and those who are associated with him in authority. We pray, our Father in Heaven, for all these great commonwealths of ours; for this great land that we live in, for the economical, agricultural and educational pursuits, and we pray Thee that government may so be administered in this country that this land shall be a land filled with a people, happy, virtuous, prosperous and free.

We pray that peace and good-will may characterize all the governments of the earth, and Thy name be glorified, for Thine own sake.—AMEN.

Mr. Clark—We will now hear an address of welcome on behalf of this State. I take pleasure in introducing to you, Honorable W. R. Smith, member of Congress from the El Paso District.

**MR. SMITH'S WELCOMING ADDRESS.**

*Mr. President, Delegates to the National Irrigation Congress, Ladies and Gentlemen:*

In the name of the people of this great Commonwealth, always distinguished for their generous hospitality, I extend to you the "glad hand," and bid you welcome. All Texans to-day feel honored by your gracious presence here and their sense of pride has been quickened by the fact that you have come to partake of their hospitality while you labor to advance a cause which lies close to their hearts.

You have only entered our gates, and while you may be content to behold this beautiful and fertile valley which was the cradle of irrigation in this country, and may be satisfied with the pleasures afforded by this plucky little city, unique in the distinction of being the largest city of the largest Congressional district of the largest State of the greatest nation on earth, it is with pardonable pride that we ask you to look eastward over a distance of almost a thousand miles and behold the beauty and magnificence of a vast empire greater in territorial extent than Illinois, Ohio, New York, Pennsylvania and all the New England states combined and possessing a variety of soil and climate unsurpassed, if equaled, by any of her sister states.

We invite you to look upon her prosperous and happy population, which has increased from 820,000 in 1870 to more than three million in 1900, consisting of people from every state in the Union and from almost every country on the globe.

We invite you to look upon her white cotton fields, now producing one-fourth of the cotton crop of the world.

We invite you to look upon her vast herds of improved cattle as they roam over our illimitable prairies, adding to the world's supply of cattle more than twice as much as any other State in the Union, while at the same time taking the lead in the production of mules.

We invite you to visit our rice fields, where we are raising great quantities of rice, although we have just begun its cultivation.

We want to show you our immense crops of grain, fruits, vegetables, sugar cane and tobacco, and demonstrate to your satisfaction that the Census Department was not far wrong when it said that the value of our farm products of the year 1899 was two hundred and forty million dollars. It is more now.

We would like to have an opportunity to convince you that all the fabulous accounts you have read about our oil fields are true; that we produce enough oil in one day to run every locomotive in the the United States.

We would like to exhibit our coal, iron, marble, granite, copper, cinnabar and silver mines, which are all yet in their infancy, and point out immense sections rich in mineral resources yet undeveloped.

**THE GREATEST RAILROAD STATE.**

We have over eleven thousand miles of railway—more than any other State in the Union—running down to the sea and on which just freight rates are fixed and maintained by a commission chosen by our own people.

We want you to know also that Texas is not behind in her educational advantages. The assets of our permanent school fund amount to something like a hundred millions of dollars, and annually we are using the interest from this fund, together with a liberal tax, to educate our children from the kindergarten through a splendid university.

Our laws are as just and beneficent as any ever prescribed by a sovereign power and their strict enforcement is maintaining a security and social order among our people not surpassed anywhere.

But, my friends, we also take pride in looking to the future. Great as are our natural resources, great as are the products of our industries, and great as are our institutions, greater still are the possibilities of this Lone Star State.

#### TEXAS AN EMPIRE IN ITSELF.

I would ask you to contemplate the fact that her great area and natural resources are capable of easily supporting a population of a hundred million. I would ask you to contemplate the fact that she can produce more cotton than the whole world is producing to-day, and in addition she can raise enough feed stuff and beef to supply the world, while the value of the products of her diversified farms if fully developed would be beyond computation.

These are only a few of the things it is possible for her to do.

#### NEED OF IRRIGATION.

There is but one thing lacking, gentlemen, to complete the circle of her felicities, and that is the solution of her irrigation problem, and the development of her irrigation possibilities. She already has fifty thousand acres under irrigation, but this is not much more than a drop in the sea compared to what may be accomplished in this direction. As I said before, the irrigation problem lies close to our hearts. We cannot look to the national reclamation fund, as can some of our more fortunate sister States, but we must ourselves work out our own destiny so far as this question is concerned. We have already entered upon this great work with zeal and energy.

We consider ourselves most fortunate in having this great Congress meet with us at this time. While we shall enjoy you as guests we shall also greatly profit by your experience and counsel.

Gentlemen, we want you to feel at home, and we want your stay here to be in every way pleasant as well as profitable. I assure you that our welcome to-day measures up to the greatness of this great State, and is in full keeping with the generous character of her people. Whether you come from our sister States and Territories, or from the great Republic south of us, or from across the sea, we are happy to have you as our guests.

Mr. Clark—Next in order will be an address on behalf of the University of Texas by Dr. William B. Phillips, of Austin. I now have the pleasure of introducing to you Dr. Phillips.

**DR. PHILLIPS' WELCOME.**

*Mr. President, Delegates of the Irrigation Congress, Ladies and Gentlemen:*

I have the good fortune to hail from a city which numbers among its distinguished citizens a man of no mere local reputation. At one time, in a great National Congress, when acrimonious debate was rising every moment higher and still more high, it was by virtue of a single phrase that he poured a flood of oil upon the troubled sea, and attained more than a national reputation. So, in the language of John Webster Flannigan, of Austin, I ask: "What are we here for?" Not for office, not for any personal gain, but to set forth certain principles in which we believe and which are of economic importance to all of the country, from Oregon to the confines of Texas and from Maine to San Diego. It has been thought proper that a word of welcome should be spoken on behalf of the University of this State, because it stands at the pinnacle of the public school system, which system derives its support almost entirely from the public lands. You will remember, some few of us whose memory can go back to 1845 (I am not so fortunate myself), that when Texas came into the Union she reserved her public lands. Some years afterwards these lands were set aside as a sacred fund for the support of the common school system of this State. After that enabling act was passed, a portion of that land was also set apart for the support of the University as distinguished from the common schools, and for the support of asylums.

**GREAT LAND FUND FOR EDUCATION.**

That fund is now supposed to be worth somewhere between sixty-five and one hundred million dollars. It is all devoted—every cent of it, interest and principal—to the support of the common schools of this State.

At a time in its troubled history, when the fate of this State was trembling in the balance; when it had not yet made good its right to call itself an independent commonwealth; when the hearts of brave men fell fainting from despair, you will read among the earliest resolutions to this effect: "That the failure to provide for the education of the people is a just ground for revolution." That sentence may be said to be writ in blood upon the Constitution of Texas, and affixed thereto with a Bowie knife. Following along that general line the State has conserved for many years past this great fund, until to-day it promises to be the maintenance and support of generations still unborn.

The University is at the summit and pinnacle of this great fund, because it is at the head of the educational system here. There we are endeavoring to train men who, in the years to come, shall make two blades of grass grow where nothing grows now. It is into their hands as engineers and agriculturalists that we propose to devote the land that is now occupied by the ubiquitous jack-rabbit, by the vivacious but totally useless creature that we call a "prairie dog," which is now grown with lechuquilla, ojosen, tesejilla and palmilla.



We are endeavoring there to train the men who in after years are to settle this great problem of irrigation, so that when we meet in Ogden in 1993—as I see on the program—these men will be there. If there is any one thing that distinguishes a reclamation or mining engineer from the balance of humanity it is his foresight. He has provided a program for us to live up to till 1993, when we will then visit the City of Ogden, which by that time will have more than four hundred million inhabitants.

#### WATER THE ONE FACTOR MISSING.

In this country we need a good deal of water; we have the good society. You know there is said to be another place, a good long ways from Texas, where there is lacking both good society and water. Here we have the good society, but we would like to have a little more water.

It is easy enough for our friends to come from the great rivers of Oregon and Washington and California, and who have harnessed Niagara Falls, and made the Sioux pay tribute to civilization; who are taking out water from the Mississippi and Missouri and are harnessing the Platte and the Salt River, to say that irrigation is a simple matter.

You have merely to take out the water that is running in the bed of the stream and carry it where you will; but what can you do with a stream that has no water in it? What can you do with a country which has a very little rainfall, and that often postponed for several years? In this country here we are shut up to one single consideration when we depart from the Rio Grande and the Pecos, and that is "the reclamation of our arid lands by system of storage reservoirs in which rainfall is to be held."

#### DEMAND FOR NEW TYPE OF ENGINEER.

Now, we can very easily build a dam and find a great many excellent engineers whose business it is to build dams, but I think the man is still to be born who can fill that dam with water.

Back in the East there was a good old lady, a very pious old soul, who was asked to attend a prayer meeting to invoke the divine aid in behalf of a country which was suffering from drouth. When asked to attend this meeting she said: "No, I won't go to any meeting; the United States Government has turned that whole water business over to the weather bureau, and I had enough trouble with the United States a few years ago to last me the balance of my life."

I am greatly pleased, in behalf of the University, to welcome you one and all to this great State; how large it is all of us know, what its future is to be no one can predict; but we do know, now and here, that we have no latch strings on the outside of the door to offer you; we have taken the door off its hinges and thrown it away.

Mr. Clark—We will now listen to an address of welcome on behalf of the City of El Paso, by Captain T. J. Beall. I have the pleasure of introducing Captain Beall.

**WELCOME ADDRESS ON BEHALF OF CITY.**

BY CAPTAIN T. J. BEALL.

*Mr. President, Delegates to the National Irrigation Congress, Ladies and Gentlemen:*

It affords me very great pleasure, as the representative of the Honorable Mayor and Aldermen of our city council, to extend to the delegates of the National Irrigation Congress and the ladies accompanying them, a most cordial welcome to our city. In being honored in the performance of this duty, I am commissioned to say, that whatever resources we may have for your entertainment we freely lay them all at your feet, and bid you enjoy our hospitality to the fullest extent during your sojourn in our city. We fully realize that we have among us gentlemen whose presence we gladly welcome, who possess expert knowledge upon the subject of irrigation, the engineers who represent our government under the Reclamation Act of the 17th of June, 1902, which has for its beneficent object the development and extension of the great agricultural interests of the arid and semi-arid sections of our country. It is true that legislation, however beneficent it may be, does not embrace within its scope the imperial commonwealth of Texas, but extends only to the public lands embraced within the area of thirteen states and three territories of the United States. But notwithstanding our people are not the direct beneficiaries of the great work of reclaiming the public lands in which the national government is now engaged, our people feel an abiding interest in the cause of irrigation. "No pent up Utica contracts our powers" in respect to the grand work of carrying out a system of rendering fruitful desert and arid lands in a vast area of country, thus multiplying homes for the destitute, and giving employment to the people. In considering these great subjects, as patriotic citizens, we embrace within the horizon of our aspirations, the interests of the whole country, and we accord to our expert engineers who encourage us here by their presence, though not members of this Congress, a most sincere welcome. Our people sincerely trust that through the influence of this Congress there may be secured an amendment of the Reclamation Act, extending its benefits at least in part, to all the arid and semi-arid sections of our country.

**EL PASO DEPENDENT UPON IRRIGATION.**

The City of El Paso and the sections of country tributary to it are largely dependent for future growth and prosperity upon a broad and well-organized system of irrigation. We learn from the writings of the great Baron Von Humboldt, who explored this country in the year 1806, that when he saw the City of El Paso, which is now the city of Ciudad Juarez, the valley below was in a state of cultivation, producing fields of grain and wheat, and especially the wine grape, of finest quality, and other productions of fruit nature—apples, peaches, and pears in greatest abundance,—and speaking of its fertility and productiveness, he said, "this valley that I now look upon is as fertile and productive as the soil of Andalusia." Certainly, the City of

El Paso and its environs, having derived such benefit from the irrigable waters of the Rio Grande in the past, cannot but feel a deep interest in the great enterprise of irrigation, the primary object for which this Congress was organized. We believe it was largely through the unremitting labors of this Congress that the National Act of 1902 was passed, and that now in Wyoming, Colorado, Nevada, and other States, and the Territories of New Mexico and Arizona, our engineering corps are engaged in making surveys for storage reservoirs and canals, by which the waste and storm waters that have passed without use to the sea will be stored and applied to the arid lands of the West, and make to contribute to the support and development of individual and national life. It is a fact well taught in history, that in those countries where fruits ripen and fall into the mouths of the people, the earth yielding forth its supplies without any human effort, you always find the lowest types of humanity.

#### HIGHEST TYPES OF MANHOOD.

It is in those countries where human toil and skill must be exerted to make a living out of the ground that thorough manhood is developed, and it is here you will find the highest types of mankind, standing upon the highest plane of enlightenment and civilization. And all experience teaches us that water applied by irrigation, when and where it is needed to produce a crop, is more efficient in producing productiveness of soil than when lands are cultivated and simply dependent on the accidental fall of rain from the heavens. We have millions of acres of land—sterile and desert soil—in the Great West, which only lacks the magic touch of water to make it productive and fruitful in supplying the needs of man. As the poet says:

“So in the still air, the music lies unheard,  
In the rough marble beauty lies unseen;  
To make the music and the beauty, needs  
The master's touch, the sculptor's chisel keen.  
So when on parched and thirsty soil  
The irrigation falls like April showers,  
'Twill fructify the virgin earth  
And spread it o'er with fruits and flowers.”

In conclusion, I desire again in behalf of the City of El Paso, to tender you a sincere and heartfelt welcome.

Mr. Clark—The Hon. W. W. Turney, a prominent citizen of El Paso, will now welcome you as chairman of the local committee on arrangements. I have the honor to introduce to you Senator Turney.

**SENATOR TURNEY'S ADDRESS.**

*Mr. President, Delegates, Ladies and Gentlemen:*

It is with pardonable pride that we of El Paso have listened to what our Congressman, Mr. Smith, has said to you about the great State of Texas, all of which we and he are willing to assure you can be found to be the facts upon investigation, yet we of El Paso desire to say that, locally, we have not been able to enjoy all of the prosperity pictured by that eloquent gentleman. You must bear in mind that he lives four hundred miles to the east of us, that his district runs almost two hundred miles further east of us and that what might make him feel prosperous and happy would be very little advantage to the people of this great section.

While we are proud to be of Texas, many of us natives of Texas, and proud of her institutions and of her advancements and of her civilization, yet we feel that we have been called upon to do a work for ourselves which Texas can never do for us.

Having been a Republic, having gone into the Union under conditions different from those of any other State, her public lands are her own, and no Act of Congress can never affect them or benefit her in their improvements. We secure our support from much territory not a part of this great State. That territory is such as you are called upon by your action here this week to help benefit and help improve, and just to the extent that you will be successful in your work, to that extent El Paso will be benefited.

It was no unselfish act on our part which sent a delegation to Ogden to capture you. We care nothing about the benefits which we might secure by reason of your stopping at our hotels, visiting our places of amusement; that is of no importance. What we wanted was the result of your brains and your labor in order that you might tell us how we might benefit and improve this great country upon which our prosperity depends, and I want to say that when we received the news that this great Congress would meet here this week, it was the happiest moment in the lives of the citizens of El Paso, and to-day we have realized the fact that you have come and that you are here, and that we, people struggling for existence, as it were, will receive those benefits, not only for the present, but benefits that shall go down through all time, teaching people how they may find homes in these deserts, and teaching them how they may convert those deserts into villages, towns and cities. That is what we expect you to do, and what we know you will help us do.

**A WORK OF LOVE AND PLEASURE.**

Now, gentlemen, we want to say to you, that it has been our pleasure to incur the expense of building this hall; it has been our pleasure to provide some little entertainment for you; it has been our pleasure to set apart committee rooms in the court house and city halls, etc., for you, all of which we hope you will find convenient and ample. We expect you to use these. We expect you to call upon the committee whenever you feel that we may do you service in the promotion of your great work. You will find us ready at all times to comply with all your requests. We are here and you will easily

find us. We want to say in addition to this that you will find amusement easily when you are not at work. We have been charged that we shall not interfere in any way with the work of this Congress.

Your work must be done unmolested by festivities of any kind, but we want to say that these festivities, we hope, will take place at a time when it interferes with no important work of this Congress.

You will find over the river some amusements which perhaps very few of you are going to admit that you have seen, but I want to say to you they are amusements which all of our people have seen and say little about. Say nothing about it and go see them.

El Paso, gentlemen of this convention, is proud to be so closely situated to the great Republic of Mexico—to my mind the richest mineral producing country on the face of the globe, to my mind ruled over and governed by one of the greatest statesmen, soldiers and citizens known to this or any other age. One trouble of the people of the United States is they know so little about that great country and its resources and its government. It might be very interesting to you if we had time to tell you of some of its merits, some of its laws, and some of the beneficial conditions which exist there and nowhere else. You will find them out during the time you are here, and especially if you take advantage of the trip to the City of Mexico being arranged for this occasion. There you will have opportunity to study them and to know them as we know them.

#### NATIONAL AND PATRIOTIC.

El Paso, as I said to you, feels interested not only in Texas, but she feels interested in every part of the country which surrounds her. As you know, it is just a step to Juarez, which is in old Mexico; just a step to the line of New Mexico; we are here, as it were, on the very point of the great State of Texas, therefore when we speak for Texas and refer to Texas, we refer to New Mexico, Arizona and the north half of old Mexico, all of which you will find are similar in almost every respect. The people, it is true, are governed by different governors and rulers; at the same time their land conditions, their necessity for water such as you are trying to give us, are just the same, and will be benefited from your efforts just the same as will we. A great Governor of Texas once undertook to write a history. He had been a Supreme Judge, had been a District Judge; had been Governor, but he proved to be not very much of a historian. He went to describe a town, and he said "A town is the center of the surrounding country." El Paso, in that respect is a town. We are the only thing you will find for six hundred miles in any direction, and we expect to keep in the lead just as we are to-day; we expect that lead to be maintained more from the efforts of this Congress than anything that has ever happened or ever will happen to us."

Mr. Clark—In behalf of the Press, that omnipresent and essential factor in the world's progress, you will hear words of welcome from Mr. H. D. Slater, editor of the *El Paso Herald*, and of the El Paso Committee. I now have the pleasure of introducing Mr. Slater.

**WHAT MR. SLATER SAID.**

*Mr. President, Delegates, Ladies and Gentlemen:*

We have a saying in El Paso, "Live in the sun." It were an unkindness to detain you here to welcome you in formal fashion when you can see the welcome and breathe it in the very air, all about you, as you walk these streets.

El Paso claims commercial dominance over 1,000,000 square miles of territory, and we El Pasoans want you to feel that your welcome is as wide as the Great Southwest. Men and women of the Irrigation Congress, a million square miles of welcome come to you to-day from this platform.

Things have been said in few words before, in ways both concise and effective. It is related of the famous Dean Swift that on one occasion he was asked to come to a certain parish and make an appeal for funds for church extension work among the poor. On the day set for the appearance of the Dean, the church was crowded. Ascending the pulpit, Swift deliberately opened the big Bible and his sermon portfolio, and adjusted his glasses. Announcing his text, he read it twice, pausing for emphasis "He that giveth to the poor, lendeth to the Lord." Closing the book with a sweep, he removed his glasses, carefully polished them, and put them in their case. Then, straightening up, he delivered a sermon that for terseness and effectiveness has never been equaled. "My friends," said he, "if you like the security, down with the dust."

**BELIEVES IN THE CONSTITUTION.**

I am as much a stickler as anybody for the Constitution that our Joe Bailey discovered, but there is one serious contradiction in that immortal document. I cannot exercise the freedom of the press this morning by making a long talk without trespassing on the right of free speech that is guaranteed to the ninety speakers on your program. Being one of your hosts, I cheerfully concede the point.

So, in extending to the delegates to the 12th National Irrigation Congress the welcome of the press, I have only to say that the press of the United States is always ready to push a good thing along; and it is probably revealing no secrets if I tell you that, had it not been for the press, there would not have been any National Irrigation Congress or any national irrigation act in this generation.

**HOPE FOR THE EASTERN PRESS.**

Even in poor provincial New York, the editors whose ideas used to be limited by what they saw in the subway between flat and office door, are beginning to look upon the country west of the Ohio river as actually affiliated in some way with the American Republic and are giving space to articles about this El Paso Irrigation Congress almost as willingly as they describe the latest Paris modes in blankets for terriers. I note this to show how the press always leads public opinion in every community.

In the name of the fellows who never sleep, who fear nothing but failure, who confer fame and smash the wrong, who build cities and rule the nations, who cogitate before they irrigate, who agitate before you congregate, and who get it straight while you corusticate—the men of the American press—I welcome you to the metropolis of the Great Southwest.

Mr. Clark—This closes the addresses of welcome, and we will now have the pleasure of listening to some other responses, and the first one who will address you is a man who has been foremost and one of the ablest advocates and promoters of irrigation in the United States, the author of the Newlands' bill. I introduce to you the Honorable Francis G. Newlands, Senator from Nevada.

**SENATOR NEWLANDS' ADDRESS.**

*Mr. Chairman, and Delegates to the Irrigation Congress:*

Suddenly called as I am to respond to the addresses of welcome, I fear that my remarks will lack the felicity of thought and expression which the occasion demands. I must, however, express the warmth of feeling with which the delegates of this Congress, called from almost every State of the West, respond to the cordial and generous welcome accorded to us by the State of Texas and by the City of El Paso.

We have been interested in Texas. We have been interested in her history; we have been interested in her development. We recall the fact that Texas is the only Republic, which, by a single act, became a sovereign State of the great Union of States. We recall the fact that in the organic act which admitted her to the Union it was stipulated that if the people of Texas so demanded in the future, four great sovereign States should be carved out of this territory. And we also recall the fact that the pride of Texans in their State, its laws, its progress and its development, is so great that it would be regarded as an act of treason to-day if a Texan was to propose the division of this State to secure an increase of political power. During the recent campaign in the arid region I heard an eloquent Democratic orator comment upon domestic development as contrasted with foreign exploitations. He pointed out the vast area of territory within the boundaries of this country, the richness of its soil, the richness of its resources, the richness of its apparent and of its latent wealth, and he was urging that this great country should devote itself rather to internal improvement than to foreign adventure. And as illustrative of his subject he declared that the entire population of the United States could be concentrated within the boundaries of Texas and could there earn support. And then his face lit up with a smile, and he added, "I tremble to think in that event what the Democratic majority would be." I fear from present indications, that the party to which I belong, struck as it has been by a cyclone coming not from the East, or the West, or the North, or the South, but from all points of the compass combined, may have to resort to this method of securing dominance in the councils of the Nation. We may have to resort to the methods employed by Spain in Cuba; methods of the reconcentrado, by which we can force the entire population of the United States within the limits of Texas.

But it is gratifying to know that no process of violence or compulsion is required to increase the population of Texas. It is advancing rapidly and surely, and one of these days there will be a hundred millions of people in Texas, and in this great country of ours there will be between five hundred and a thousand millions. When we contemplate this fact, we can form some realization of the future greatness and power of this country—a power that will not have to be manifested by great standing armies, or by great fleets that float the sea, but will be evidenced by the energy, the courage and the advancement on their own soil of a great, a brave and a progressive people.



## TEXAS AND THE IRRIGATION LAW.

One of your speakers has alluded to the fact that thus far Texas has not been the beneficiary of the irrigation law, and he went so far as to assert that Texas would not be in the future. Notwithstanding the fact that Texas is not at present a beneficiary of the irrigation law, I wish to bear witness to the support and the aid and the encouragement given by Texas Representatives and Senators to this great movement. Their views were as broad as the State which they represent, and I trust that before long, Texas itself will be a beneficiary of this beneficent act. (Applause.)

I am now told that the reclamation service has in contemplation a project upon the Rio Grande, at Elephant Buttes, about one hundred miles from this place—the construction of a dam over two hundred feet high at a cost of seven million dollars embracing the irrigation of over two hundred thousand acres of land, now only partially productive and possibly not productive at all. The larger portion of that, it is true, is in New Mexico but it is immediately tributary to this State and the smaller portion is in the State of Texas itself. It is true that you have no public lands belonging to the United States in this State, but under that act it is intended to take care, not only of the lands that are now a part of the public domain, but also of the lands which have been actually settled and which lack a sufficient supply of water, and I don't see how, in principle, we can distinguish between the lands which were originally public lands of the entire Nation but are now in the hands of private owners who have settled upon them, and the lands of this State which were originally the property of the State and which now have gone into the hands of private owners.

It is a great national enterprise, intended to benefit the entire country, instituted under the constitution for the general welfare, and I don't see why in the future Texas should be excluded from its beneficent operation. In so far as I am concerned, I wish to say that I will gladly co-operate with Senators and Representatives of Texas in securing legislation in that direction.

## A NEW NATIONAL POLICY.

Now my friends, just a few words regarding this act. I think few people realize how far-reaching and comprehensive it is and how it opens up a new National policy of development. In the first place the Act itself is a most comprehensive one, as relating to the subject in hand. Instead of requiring the reclamation survey to come year after year to Congress with estimates asking authority for certain work and appropriation for its gradual completion, we have, first, a fund created from the sales of the public lands throughout thirteen States and three Territories and forever dedicated to the reclamation of the arid lands. That sum now amounts to nearly twenty seven million dollars. It is a revolving fund, for as the moneys are spent upon the construction of various projects, they are gradually returned by the settlers on the lands reclaimed in ten annual installments, and thus the moneys return to the fund. Under the operation of this act within the next twenty years at least one hundred and fifty million dollars worth of work will be accom-

plished; under this act, without further legislation the entire reclamation of the arid lands that are capable of reclamation can be accomplished.

The power is given to the Secretary of the Interior to investigate and determine what subjects are feasible and to enter without further authority upon immediate construction. No delays in construction by Congress, no delays in appropriation. The investigation can be immediately accomplished, and when the investigation is completed the work can be actually commenced; the one limitation upon the power of the Secretary of the Interior is that no contract shall be let unless the moneys for the contract are in the fund.

Thus no debts are contracted—no obligations are incurred. But the great Department of the Interior is charged with the responsibility of inaugurating these great enterprises. That work is entrusted to the geological survey—one of the scientific branches of the Interior Department, a survey that has grown up from a small beginning, composed of trained, educated, experienced men, who have become familiar with the entire country as to geology, topography, etc.—a body of men that are familiar with the face of the entire country, trained engineers, full of love of their profession, having high ideals, lifted above the prevailing commercialism which looks only to wealth as an ultimate goal, and thus this great survey has been employed in this work, and I ask that the sustaining power of the American people should be given to it; that it should be kept out of politics; that no legislation should be favored that will change its present constitution; that no administration shall be supported which will subject its appointment to political control.

If we maintain this policy, the reclamation service may be the germ of great public and governmental activity in the future in enterprises that have hitherto been regarded as belonging to the domain of private capital. Think how carefully this act has been guarded against monopoly. In this first place, as to the great public domain now in possession of the Government it guards against monopoly by providing that, as to lands reclaimed, no grant shall be made greater than one hundred and sixty acres. Thus the concentration of the lands reclaimed by the government in single ownership is avoided, and the great menace of land monopoly averted.

#### LANDS IN PRIVATE OWNERSHIP.

As to the lands now in private ownership and coming within the beneficial operation of this act, it is provided that no water rights can be granted to any proprietor of land within reach of an irrigation project for more than one hundred and sixty acres. He may have ten thousand, fifty thousand, a hundred thousand acres, but he can only secure a water right from the government for one hundred and sixty acres. But, you say, that is unjust to him and injurious to the country's development, that it condemns this entire area in single ownership to aridity. Not so. The fact that the waters from the irrigation project can be brought within the reach of this large holding raises its value. Purchasers of that holding in tracts of one hundred and sixty acres can secure water rights under this act. The large landed proprietor is benefited by having the water brought within reach. He has the opportunity of making sales of lands hitherto unsalable and a purchaser can unite the water

with the land by buying a water right from the government and thus dedicate the land to future productiveness. And so this act not only guards against monopoly in the future, but will gradually destroy existing monopoly and disintegrate these great holdings in the country without injury to any and with benefit to all.

#### TO PROMOTE THE GENERAL GOOD.

This gives an illustration of what the people can do when through their government they enter upon a great enterprise, no special privileges, equal rights to all, no monopoly, no concentration of wealth, the whole act tending to the distribution rather than to the concentration of wealth; and if this act can be faithfully and efficiently administered by the Interior Department, through the geological survey, we will have taken a step in the direction of solving a problem as to whether the people themselves can do things in the nature of enterprise. If this is successful we may find a practice inaugurated through this survey for the gradual building of government roads, not necessarily in competition with existing lines, or destructive of their values, but simply supplementing the present transportation system of the country, and absorbing the future growth of railroad construction in the interest of the people and not in the interest of concentrated wealth.

The attention of the American people has been called to a serious menace of the future of the Republic. During a century and a quarter of national life, this Republic, dedicated to the interest of democracy, has been developing into the greatest plutocracy that has existed in the history of the world. This has been accomplished largely through monopoly of production, and we now find that the men who have been monopolizing the production of the country are now engaged in securing the monopoly of the transportation of the country. Put these two sources of wealth under one control, and how can you hope for a fairly distributed wealth? If the great monopolies of the country are to control the transportation, if, by methods direct or indirect, they are to secure special privileges for themselves, secure rebates for themselves, accomplish discrimination against their antagonists, I ask you how long it will be before the entire wealth of the country will be in their hands? And if we can add to this the control of the finances of the country, I ask what limit there is to their power and their wealth?

I am no socialist; I am no communist; I believe that there will always be differences between men—natural differences—that the strong will always acquire more than the weak; that the intellectual will always accomplish more than the stupid; that the thrifty will always gain more than the thriftless. With these natural inequalities we must rest content, but we have a right to protest against artificial inequalities, created by the law or suffered under the law. It seems to me we have a new era opening to us of national activity that will demonstrate the ability of the people, through government, national, state and municipal, to accomplish great things for the benefit of all.

#### HONEST ADMINISTRATION OF PARAMOUNT IMPORTANCE.

To the Reclamation Service of the Geological Survey this great trust is given. Upon its conception of its high and noble duty, upon its faithful,

honest and efficient execution of its trust much will depend. Let us see to it that it enters upon and proceeds with its work unembarrassed by faction, by partizanship or by sectional jealousies.

I am told that the great State of Texas has model legislation upon these great questions relating to artificial inequalities. I am told that there is no State in the Union that is more free from monopolistic control; no State in the Union where the people have so much power in enacting their own laws, and it seems to me that it is particularly appropriate that, in this State, which furnishes the model for such legislation, we should meet and deliberate over these great problems of national legislation which appeal to all well-meaning men in the country, in behalf of the enactment and the administration of laws that will promote the welfare, the happiness and the prosperity of all.

Mr. Clark—Gentlemen of the Convention: We have a distinguished gentleman from the State of California, its Governor, the Honorable George C. Pardee, who will now address you.

**GOVERNOR PARDEE'S ADDRESS.**

*Mr. President, Ladies and Gentlemen of the Convention:*

I shall take but a short time and use but a very few words in expressing the obligation that the people representing the various States sending delegates to this convention must feel and do feel to the people of the greatest State in the Union for the hearty welcome which they have to-day extended to us. Such a welcome could come only from the great hearts of the people of the greatest State of this great Nation and it reminds us, from California, of the hearty welcome which the second greatest State of the Nation always gives to those who honor her with their presence on such occasions as this. Therefore it is with an especial pleasure that, representing the people of my State, I stand here to-day to express their gratification and the gratification of the Great West, the western part of this great Nation, for the hearty welcome which we are receiving here at your hands.

I notice that Maine, in the extreme Northeast of this Nation, sends her delegates here, and California we know is here, and Washington in the great Northwest, and Florida in the great Southeast also sent their delegates. The greatest State in all the Union we are meeting in, and Rhode Island—little Rhody—also has her delegates here. It seems that the people of the country realize the importance of such a meeting as this, realize the importance of the things that we are met here to-day to deliberate upon and pass resolutions concerning. It means that the great State of Texas will finally receive at the hands of this government, as has been pledged by the Senator from Nevada, such aid and such assistance as her greatness and wide extent of arid territory demands. It means that New Mexico and Arizona and Utah and California, and all the States and Territories to the north of us, here will receive that aid which will turn the vast area of deserts into a paradise.

My friends of Texas, I bring you greeting from California. I assure you of our hearty co-operation in all that we can do to make you equally participant with us in the great things which we are here to-day to deliberate upon, and which in due time will become yours with ours.

Mr. Clark—We have another live Governor here, from Idaho, who is also much interested in this question, and you will now be addressed by Governor John T. Morrison.

**GOVERNOR MORRISON'S ADDRESS.**

*Mr. President, Ladies and Gentlemen of the Convention :*

This is an unexpected pleasure upon a very important and happy occasion, and I wish in the first place to return my thanks to the Honorable Chairman for the courtesies shown for calling me up. I am not rising for the purpose of making an address upon this occasion. I stand up for the purpose of expressing on behalf of the people whom I represent and their delegates who are here, simply our high appreciation of the gracious words of welcome which have been spoken on behalf of the good people of El Paso and the State of Texas.

We feel that we are not entirely strangers to the people of El Paso. I remember, and I thought of it when Mr. Turney was speaking, how we were captured by the cohorts of El Paso, and I am here to say to you, ladies and gentlemen, that the terms of our capitulation have been entirely satisfactory. I am glad that we are in captivity to-day. The aims and purposes of this great convention, you will appreciate, I think, are of a great interest to us. You will appreciate it the more when I say to you that the great State of Idaho, with its eighty-six thousand square miles, is about 70 per cent arid, and of that territory not less than two million acres are susceptible of a high degree of cultivation, and will, by the beneficial application of water, produce a large product for the comforts and necessities of life; hence our interest in this great convention, and we shall meet with you and take part in your discussions, hoping to take back with us something that will be of interest and benefit to our people.

As I listened to the glowing words of praise uttered on behalf of the State of Texas, I appreciated more than ever the glory and grandeur of this magnificent Lone Star State, and somehow or other my thoughts drifted into illustration and I thought of this: Over there in the heart of that metropolis of the world, London, stands the great cathedral of St. Paul, renowned for its architecture, and beauty and symmetry of design, the pride of England, and the wonder of tourists. As you pass into the rotunda you will find upon a brass tablet in the wall, this legend: "Sacred to the memory of Sir Christopher Wren. If you would see his works, look around you." So, ladies and gentlemen, I thought when these gentlemen on behalf of Texas were speaking, if you would see their works, and their glory, look around you here in the beautiful little city of El Paso. Allow me simply to expand the thought; limit it not only to Texas, but extend it to the whole United States—what a glorious country we have! And how we, as citizens, are proud of its magnificent progress and its wonderful history! When you think of the fact that the great civilization which is built up here is the greatest and noblest the world has known, that settlements have spread across this great continent of ours until more than two hundred million acres of land have been transformed from wilderness and brought into the service of man; that the civilization has reached across the Rocky Mountains to the beautiful valleys and fertile mountain slopes of the Pacific drainage, your pride of country, my fellow-citizens, must leap to the front, and you cry out, "Great are the Ameri-

can people, magnificent in peace, triumphant in war." We have assembled here purely in the interest of irrigation. The civilization of which I have been speaking has established itself in the humid section of our country, and in the public the interest is largely centered there; but I stand here to-day to prophesy to you that the great civilization of the Mississippi valley will yet learn to irrigate, and that whole great valley will receive added benefits because of the science of irrigation which we are here to study.

#### THE COMING WEST.

Speak of the glory of Texas, of California and of the other States of our Union, marvelous as has been the development of the great Mississippi valley, I prophesy to you again that there will be a still more marvelous development of the Western slope of this country. The civilizations of the world have gathered around the Atlantic ocean, the wisdom of the ages has sat there. Even in its scenic wrecks may be read the history of the world to-day, and I say, fellow-citizens, that the great Pacific to the westward will yet become the great commercial ocean of the world, from which we will receive wonderful benefits. It is being written all over this country to-day that this progress is going forward. We are proud as American citizens to participate in it. Railroads will soon thread the passes of our mountains, the neck which connects the two Americas will be cut, and ships pass to and fro.

Let us then, fellow-citizens, while we glory in our individual sections, look beyond, and comprehend the whole country with its magnificent future and prospects.

Mr. Clark—I take pleasure in introducing to you Mr. C. W. Penrose, of Salt Lake City, Utah.

**MR. PENROSE'S ADDRESS.**

*Mr. Chairman, Fellow Delegates, Ladies and Gentlemen:*

I highly appreciate the honor conferred upon me this morning in adding a few words to those that have been delivered to you. I regret, however, very much that our Honorable Governor, Heber M. Wells, who was expected to be here, is not present to respond to the addresses of welcome extended to us to-day.

I find myself here to-day among prophets, like Saul of old—prophets who have pictured the future grandeur and glory of this great Republic, and of the future benefits to be derived from the systems of irrigation that have been introduced under the laws of our country. I believe all they have prophesied will really take place, and I say "Amen" to all their projects. Sometimes the prophets of old got a little mixed in their arithmetic, and I suppose that is the reason why these figures do not exactly correspond to-day.

But, ladies and gentlemen, the people of Utah fully appreciate the cordial welcome extended to them in common with all the delegates from the various States represented here to-day, and Utah herself, smiling with pride, reaches out her right hand to grasp the glad hand extended to her from the big State of Texas, big hearted Texas. Utah is a small State, but so far as matters which affect the future of this country are concerned, she takes an interest in everything relating thereto. We were told to-day that Texas was the cradle of irrigation. I thought when that sentiment was uttered that Utah brought forth the infant of irrigation; it was her first offense.

In the year 1847, when the pioneers first entered the valley of the Great Salt Lake, came down through the mountains, the party consisted of 140 persons; a small band had preceded them two days ahead. They were sent by that great pioneer of irrigation, as well as of other works of civilization in the mountains, Brigham Young. After they entered the valley they went down and cut the brush that the rest of the company might follow with ease; they had a plow along in one of the wagons, and, descending down on a level plain, they commenced to endeavor to plough the ground and plant some seeds. But they broke their plow because of the aridity of the soil, and they then looked around for something else with which to accomplish the work, and one of them remembered that Young told them that they should go to the northeast, and there they would find a stream of water. How he knew that I cannot say, only he was among the prophets. They found a small stream of water, as he had told them, and they turned the stream out upon the land, by which they were enabled to plow the first furrows in the soil of Utah. That was the beginning of the great irrigation system that is now used not only in Utah, but in other States.

**UTAH AN IRRIGATION OBJECT LESSON.**

Now, I will not take up your time relating the history of irrigation in Utah, but if you want to see an object lesson in irrigation, we invite you to come and see us. We will show you what has been done by co-operative ef-



fort, not by means of wealth, or by the organization of corporations taking up land and selling water to the people, but by the unity of efforts of the people themselves. The State of Utah is an irrigation State. We have projects on hand which, if carried out, will result in supplying the whole northern part of the State with water for irrigation under a system of distribution. By taking out the waters of the river and conducting them to the Utah Lake, a fresh water lake, by canals, then utilizing the waters of Bear Lake and Bear River, the two channels meeting together will not only increase the water supply for lands already occupied, but will bring into cultivation thousands upon thousands of acres of land not yet utilized. This is one of the projects we have in view, and we are very glad to know that we have the co-operation of the gentlemen of the government service, who have surveyed our lands and, I believe, pronounced the project practicable.

We expect much benefit through the National Irrigation Law, introduced by our eloquent friend, Mr. Newlands, and signed by the great man who has been indorsed by the people of the nation to be the head of the administrative government.

We thoroughly appreciate the favors that we enjoy from every source; we are grateful for Statehood; we are grateful that the people of the United States are beginning to understand us for what we are; that we are a part of this great Nation, though we are shut up in the mountains, and that we are now understood by our fellow-citizens in the East, and they are beginning to understand something about us. Some of our Texas friends came to see us in Ogden a year ago; we extended to them the glad hand, and now we are grateful for their reciprocal extension of that hand to us, and I say that the people of Utah are grateful for the words of welcome that have been spoken here to-day, and we extend an invitation to all our friends whenever they want to understand more concerning our resources, our capabilities, to come up and see us. We have no doors to leave open or latch-strings to leave out, but the way is perfectly clear. Come and see us; if you don't know much about us, ask our El Paso friends. I noted their energy and intelligence and their persistence in securing this Congress to meet in the city of El Paso, and I determined, if it was possible, that I would come here and see them again, and learn something about this great State of Texas, no longer the Lone Star State, but one of the great galaxy in the constellation of our country, where Utah also shines upon the same field. We are one with Texas and with all the States of the Union.

I hope that during the deliberations of this Congress nothing will be done in any selfish spirit. I desire to say that Utah has no particular axe to grind. If we have any information that will be of service to you, we shall be glad to impart it. We shall be glad to receive information from all our friends who are gathered here. We want to be one of them, and we want to learn all we can from them.

#### THE NEWLANDS LAW THE BEGINNING.

I indorse the remarks that have been made in regard to the progress of the nation. I understand that the Newlands Bill, as we call it in our State,

is not a finality. It may be added upon. The people of this country can amend it or add to it as circumstances suggest. We should have a fraternal spirit in regard to all the people of this country. I know that our friends in the East are not acquainted with the needs of the arid regions of the country, but we want to extend the benefits of the Irrigation Law as it may be amended to every State in the Union, whether it be strictly in the limits now defined or not, and I am certain that the predictions that have been uttered this morning concerning the progress and welfare of this great nation, the greatest nation that the sun ever shone upon, will be all fulfilled. And I want to say still further that I foresee the time when not only will beneficent irrigation laws be passed by the country for the benefit of the people in these States of the Union, not only will this all be fulfilled, but I believe that the destiny of this great nation is to carry liberty and light and civilization to every part of this globe.

I believe that thrones will totter and nations fall, but that the principles of Democracy and Republicanism will be carried to every nation and every clime, and the time will come when, through the power and influence of this country all mankind will be free. We have a motto among us in Utah which reads like this: "Freedom, peace and full salvation are the blessings guaranteed. Liberty to every nation, every tongue and every grade." And the day will come when this will be fulfilled, and you will find that Utah, though she may be smaller than some of her sisters in the States, will come to the front with all her majesty and power and strength and intelligence, for she possesses all these things, and render powerful aid in the accomplishment of the establishment of peace, liberty and happiness in all the world. I thank you for your attention.

Mr. Clark—The program of the morning session will close with an address by the Hon. E. L. Smith, of Oregon. It had been expected that the Hon. Gifford Pinchot, Chief Forester of the United States, would be present, but his train is late. I take pleasure in introducing Mr. Smith.

**MR. SMITH'S ADDRESS.**

*Mr. President and Gentlemen of the Irrigation Congress:*

The morning session has been prolonged so late, and there are so many subjects of vital importance to come before you, that I shall presume to keep you only for a brief moment.

For four successive days we traveled from the Columbia to the Rio del Norte, and many were the object lessons that impressed us in the country south of San Francisco. When we arrived at Southern California, we found a veritable Paradise. We saw the miracles that water had wrought there, for on every hand were fertile groves and fields.

As we continued our journey we came to the desert of the Colorado, and there was pointed out to us a railway constructed to bear away the harvest of that section of the country below the level of the ocean. We traversed the arid plains of Arizona, and there we saw great channels, great drainages, where the very wealth and life-blood of that section had evidently run off into waste. We were surprised at the great extent of the arid lands. The country seemed strange to us, but since we have been in this broad and beautiful city of El Paso, since we have listened to the addresses of welcome this morning, and partook of the generous hospitality of the people—a hospitality that I trust the commonwealth of Oregon will be able to reciprocate at no distant date—we feel that the hearts of the people of this great land beat warm and true, and that we are all alike, proud, happy, independent citizens of the same great and good government.

Mr. President, I thank you for the privilege of standing a moment before this great assemblage. It is an inspiration to look into the faces of the men who have come up from the South, and the West, and the East, and the North—have come to redeem the desert. May education go hand in hand with this work of reclamation, for it is the intelligence of the people that constitute their greatness in every country.

Gentlemen, in coming here I know that you have cast aside your political differences and your factional strifes in order that not a single note of discord may disturb the harmony of your labors, and I trust there will come up to you again and again, as it does to me this very moment, that grand old phrase, "how pleasant and how good it is for brethren to dwell together in unity."

Mr. Cobb—The Secretary is requested to announce that El Paso feels a special pride to-day and that this day will go down in her history as her proudest day. That she is not only proud of this hall erected by general and unselfish contributions; not only proud of the occasion, but she is proud of other and greater things, that even more than the pride that she takes in your presence is the pride in the good women of El Paso. Under the leadership of Mrs. Joseph Magoffin, a lady well known for her hospitality, the ladies of El Paso will entertain visiting ladies at the Sheldon hotel to-day from 3 to 5 o'clock. They will also present to the visitors, as well as to home people, a concert in this hall to-morrow evening. They have spared no pains to get the best musical talent, and with the melody of Mexican music will be blended the sweetness of American voices.

## Tuesday Afternoon Session, November 15, 1904.

The Congress was called to order by the President.

### **PRESIDENT CLARK'S ADDRESS.**

*Gentlemen of the National Irrigation Congress:*

In the presence of this great assemblage, and in the midst of such magnificent surroundings, the delegates of the 12th Irrigation Congress, gathered here from every section of the great West, as well as from some of the Eastern States, can not refrain from expressions of satisfaction, enthusiasm and delight as they enjoy the unstinted hospitality of the good people of this beautiful city of El Paso. I am also delighted to learn that we have several visiting delegations from different States of our sister republic, Mexico; a government at whose head stands one of the greatest and noblest rulers of modern times in the person and character of Porfirio Diaz. He has shown his interest and sympathy in this cause by permitting the attendance of the National Regimental Band, of world-wide celebrity, and has likewise honored us with an autograph letter, which will be read this afternoon, conveying touching and eloquent expressions of good wishes and regret at his inability to be present.

Every promise made in the competition for the location of this meeting by the delegates of the Lone Star State at Ogden has been fulfilled beyond expectation, and El Paso, in the entertainment of its guests, has set a pace which may be difficult to follow by aspirants for future similar honors. Our warmest congratulations are due alike to our hospitable hosts and honored guests for the assured brilliant success of this Congress, which overshadows all previous conventions. Moreover, when we consider the fact that Texas is not embraced in the area available to the benefits of the Reclamation Act, all enthusiasts in the great cause in which we are engaged must be sensibly touched by the deep interest and concern in the subject so ardently manifested by the people of this city. Irrigation, however, has been widely practiced in this part of Texas, where its advantages are understood and fully appreciated, and although there is no public domain in Texas belonging to the government, the law should be so amended that government aid may be extended in a manner adapted to the different conditions existing here, as in the other States.

### **GROWTH OF A MOVEMENT.**

The first efforts at organization for the advancement of irrigation, at Salt Lake City thirteen years ago, were eminently successful, and a movement was inaugurated which has produced happy results, beyond the fondest hopes of its founders. The most important of these is the Reclamation Act of 1902. I am delighted to see many of the pioneers of this great enterprise who participated in that meeting present here to-day. They come, no doubt, with many new ideas and broadened views, derived from study and experience, but imbued with an increased ardor and enthusiasm heightened by the inspira-

tion of present success and glowing prospects of the future. The consensus of opinion resulting from a wide discussion of the best methods for the promotion of the cause of irrigation in that first Congress was favorable to the cession, by the government, of the arid lands to the respective States and Territories in which they occur, thus leaving the problem of their reclamation to be worked out by State legislation. However, this position was subsequently abandoned as untenable, and the conclusion was reached that only under the strong arm and auspices of the federal government could a satisfactory solution be assured.

#### EASTERN OPPOSITION WAS ENCOUNTERED.

Efforts to secure favorable legislation in the National Congress were met by the most determined opposition from the East and Middle West, where a strong sentiment prevailed against allowing appropriations of public funds in the interest and for the exclusive benefit, as they narrowly claimed, of the western part of this country. After years of fruitless effort, when the cause seemed almost hopeless, the happy thought, like a gleam of light in the darkness, was developed that the proceeds of sales of public lands might be set apart and used for the purpose, and the result was the present Reclamation Act, the outcome of which will be a boon of countless blessings to the present and unborn generations beyond the power of the mind of man to grasp or conceive.

Detailed reports by the officials of the government assigned to this duty, showing the progress of reclamation work, will be submitted to this Congress, which will exhibit the information in a comprehensive manner. Likewise addresses will be delivered by Mr. Maxwell, Mr. Boothe and Mr. Smythe, who are also active members and officials of the National Irrigation Association, which organization has been a valuable auxiliary to this one, and others will contribute important information, so that every correlative topic will be ably covered, and therefore I will only briefly allude to some great features of the subject.

#### A SPLENDID INITIAL FUND.

The aggregate of funds available in the United States treasury under the provision of the act amounts to over \$23,000,000.

For convenience of administration, the reclamation service was placed under the supervision of the hydrographic branch of the Geological Survey, and a large staff of engineers selected on account of ability and experience in the various States and Territories was appointed, of which Mr. F. H. Newell was made chief. The present force comprises about 250 engineers. All reports are made to the Director of the Geological Survey, and through him to the Secretary of the Interior. The necessary preliminary work in the way of reconnaissance, measurement of flow of streams and surveys has been conducted over a wide range of country with intelligence, zeal, energy and technical skill that deserve the highest admiration and commendation for the eminent efficiency of the chief engineer and those working under his direction.

Active operations for the construction of dams and canals and other improvements are now going on in Arizona, Nevada and Idaho. For other

projects in California, Colorado, Wyoming and Montana available sites have been selected and adopted, estimates are being made, and contracts will be let in the near future. In all these cases sums have been set aside by the Interior Department, ranging from two and one-quarter million to three million dollars each, to carry on the work when the contracts shall have been completed.

#### LAND WITHDRAWALS TO PREVENT SPECULATION.

In order to prevent private appropriation of land and water rights by speculators in the localities which seem to be applicable to the provisions of the law, the Department of the Interior has withdrawn from entry large areas of land in the several States and Territories, amounting to forty-three and one-half million acres, of which some three and one-half million acres have been found to be inapplicable, and have been restored to the public domain. The total amount of land available for irrigation has been variously estimated to be from fifty to sixty million acres, which, when made productive, will sustain a population of from twenty to twenty-five million people.

In undertaking to inaugurate this stupendous work, the engineers in charge were confronted with many difficulties. To begin with, all of the easily diverted waters had been appropriated by small farmers, who, by their own efforts, unaided by the capitalist or engineer, have brought millions of acres of land into a high state of cultivation, and by diligence and industry have established prosperous homes throughout the entire arid and semi-arid districts. These conditions, however, present no serious obstacles, but there are great numbers of vested rights acquired by individuals and corporations, many of them being of the intangible and invalid character, such as old unused rights of way for railroad companies, which lie in the way of proposed canal and reservoir sites. Seemingly anticipating the passage of the law, unscrupulous persons had made locations with the view to hinder and delay the progress of the work and extort money from the government. In all of these cases it is both tedious and expensive to adjust titles, although they may have no genuine merit. As the government can not proceed until all titles are properly vested in it, it is evident that rapid progress in every locality can not be expected. The work is being prosecuted in thirteen States and three Territories, and all possible projects are being examined. Some of them, which upon the surface seem easy and feasible, are found upon careful examination to be entirely impracticable, and their abandonment gives rise to disappointment and adverse criticism, which is entirely unjustifiable.

#### PASSED UPON BY HIGH ENGINEERING AUTHORITY.

Every project is passed upon by boards of consulting engineers before being submitted to the Secretary of the Interior for his approval. It is estimated that the work now adopted and under contemplation will absorb all of the funds now available and the probable receipts for several years to come. Numerous projects of secondary interest that have been examined can not be reached for a great many years to come, unless the government will come to the aid of the work with liberal appropriations. The reclamation fund will be

reimbursed for every dollar expended in the course of time, by the settler, who will pay the price of the land to which he acquires title and the cost of the improvements which will be assessed to him. No returns can be expected for some years to come, and under the ten-year installment plan the reimbursement will be very slow. After ten years the receipts will be very large, and they may be re-invested in new improvements. In the meantime the aid of the government should be invoked.

In connection with the problem of irrigation, and intimately associated therewith as an adjunct and auxiliary proposition, is the protection which the great forests afford to the sources of water supply and to the proposed catchment areas. Large tracts of forest lands have been withdrawn as reserves from entry under the land laws, by the government, and a Forestry Bureau has been created and placed under the able direction of Mr. Gifford Pinchot, who will favor this Congress with an elaborate report as to the conditions of that branch of the government service, and which will be replete with interest. In the proper administration of this department, several important questions should be considered.

#### NATURE'S STORAGE RESERVOIRS.

Conservation of water supply is the paramount feature. Where the heavy accumulations of snow on mountain ranges are protected by forests from exposure to the sun's rays in summer and gradually melt to feed the streams, their greatest utility is realized, while denudation of the forests results in torrential waste and consequent drouths.

Protection of timber from unnecessary depredations, having due regard for the legitimate demands of the domestic consumer, the farmer and the great mining industries, as well as the protection and encouragement of the young timber growth, demands the exercise of the greatest wisdom and diplomacy, in order that the great industrial pursuits of the people may not be unduly disturbed.

Another question that demands the most vigorous attention is the ravages of forest fires that destroy annually ten times more timber than is appropriated to meet the requirements of industry and domestic consumption. Large districts in Montana and Idaho, under my own observation, were swept by forest fires during the past summer and autumn, and all efforts to even retard their destructive work were powerless until the advent of the heavy autumn rains.

The government should take vigorous action to stop, if possible, this fearful destruction, which is of annual recurrence.

#### REPEAL OF BAD LAWS.

During the session of the last Congress a spirited discussion was maintained during an entire afternoon, and at times acrimonious in its character, on the question of the repeal of some of our land laws, and terminated in no definite conclusions as to the prevailing sentiment of the Congress, as a decision was evaded by the adoption of a meaningless resolution by way of compromise. The question will undoubtedly be revived in this Congress. I

feel constrained to reiterate my previously expressed opinion, that of our present land laws, the Desert Land Act and the commutation clause of the Homestead Act, have outlived their usefulness, and should be repealed in the interest of the actual settler and the small land owner. Any disinterested and unprejudiced person who is familiar with the conditions in Montana and other States, where all the water courses have passed into the control of large holders, thereby securing control of large tracts of adjacent lands, will, I believe, coincide with this theory.

The prosperity of a State is largely dependent upon small holdings of land, which insure its cultivation and consequently increased production and population. This feature has been wisely considered in the provisions of the Reclamation Act.

#### A COUNTRY-WIDE BENEFIT.

Sufficient has already been accomplished to arouse a national interest in the importance of irrigation. Whatever benefits one section of the Republic can not fail to benefit the whole country, and this scheme is not a sectional one, as the welfare of about one-half its entire area is involved, and the indirect contribution to the material prosperity of the other half is incalculable. The East must depend upon the West for its food supplies, and likewise for a market for its manufactured products. This is the kind of reciprocity that enriches the country, genuine American reciprocity. Why should the farmers of the Middle Western States fear competition from the far West while they produced this year little wheat for export, scarcely enough to supply home requirements, and when it has been found necessary to ship fifteen million bushels of wheat from the North Pacific coast to help supply the deficit. The area of wheat-producing territory has become inadequate to meet the requirements of our rapidly increasing population, and should there be a surplus, our Asiatic neighbors will hereafter furnish a market for all we can produce west of the Mississippi.

#### THE SOUTH SUPPORTS THE WEST.

The South will stand with us as allies in a common cause. Our flood waters withheld and stored, will save it millions of dollars annually in damages caused by overflow of the banks of the Mississippi river. The appropriations for river and harbor improvements deplete the United States treasury each year to the extent of many million dollars, and for whose benefit? Directly, largely the coast lines and commercial ports and cities of the East, where the money is expended; but we of the West, who contribute our share to these improvements, do not complain. With commendable pride in the advancement and glory of our entire country, we willingly concur in these expenditures. Why may we not expect from the East the exercise of equal generosity and equal patriotism in the building up of the great West? Let us point to the Louisiana Purchase Exposition, a magnificent triumph of the new century, that eclipses everything the world has ever seen, to emphasize the claims of the great semi-arid empire of the West, the chief factor and contributor to its success. There on the banks of the mighty Mississippi may



be seen "the greatest show on earth," which has brought into competition the highest exercise of inventive genius, artistic skill, technical science and intellectual prowess of all the nations of the earth, who are vying with each other for supremacy in the great march of civilization and empire.

#### GREAT INTERNAL EXPANSION.

In viewing this marvelous exemplification of the world's progress, we are constantly reminded that the Louisiana Purchase, a conquest of the Jeffersonian idea of expansion, which lies largely in the semi-arid region, is in all departments everywhere in evidence with the products of its fields, forests and mines of such surpassing excellence as to forcibly demonstrate its remarkable, although only partially developed, resources. Under the inspiration of this impressive display, we are forced to reflect and wonder what the future may reveal to the coming generation when the broad areas in the valleys and on the mountain slopes of this western empire, whose parched and arid soils are rich in all of the elements of fertility, now yearning for the magic embrace of water, which they woo but can not win without the guidance of the hands of man, shall have been reclaimed and transformed into green meadows, golden fields, and happy abodes. It is an enchanting picture to contemplate to all who have a thought of the future and wish to inaugurate a policy that will insure to their immediate posterity a priceless heritage.

Mr. Clark—Next in order of business will be the report of the Executive Committee, by Hon. Charles B. Boothe of Los Angeles, California.

Mr. Boothe—Mr. President and Members of the 12th National Irrigation Congress: Recognizing the value of time to a Congress like this the report of the Executive Committee has been made brief, but it is none the less necessary.

## **REPORT OF C. B. BOOTHE, CHAIRMAN EXECUTIVE COMMITTEE.**

*Mr. President and Members of the 12th National Congress, Gentlemen:*

Upon call of the Hon. Fred J. Keisel, Chairman of the Executive Committee of the 11th National Irrigation Congress, held at Ogden, Utah, September 14 to 18, 1903, the Executive Committee elected at that Congress met at the municipal chamber in the City Hall in Ogden, on Friday evening directly following the adjournment of the Congress.

The organization of the newly-elected Executive Committee was made with C. B. Boothe, of Los Angeles, Cal., as chairman, and H. B. Maxson, of Reno, Nev., as secretary. The appointment of assistant secretary was referred to the chairman and the secretary of the committee, and Mr. A. W. Gifford, of El Paso, was selected as assistant secretary.

In conformity with the instructions received from the Executive Committee at the above stated meeting, vacancies in the list of Honorary Vice Presidents and members of the Executive Committee have been filled in all the States with the exception of New Jersey, which State refused to respond to the requests for nominations.

The completed official roster will be found on the fore page of the proceedings.

A sub-committee on Constitution was appointed, with G. A. Richardson, of New Mexico, as chairman.

A communication having been received from Secretary H. B. Maxson, of Reno, Nev., that he was ill and unable to attend to the duties of secretary, Mr. A. W. Gifford, of El Paso, was appointed secretary. and Mr. Z. L. Cobb, of El Paso, first assistant secretary.

The instructions for the Executive Committee to put into effect the provisions contained in the fourth paragraph of Article 3, and Article 5 of the Constitution, relating to the division of the work of the Congress into sections, has been carried out, and it is to be hoped will prove as successful and satisfactory to all the delegates as the committee have anticipated.

The sections with their respective chairmen are as follows:

Forestry—Chairman, Mr. Gifford Pinchot, Chief Forester, U. S. A., Washington, D. C.

Production by Irrigation—Chairman Division A, Mr. I. D. O'Donnell, Billings, Mont. Chairman Division B, Dr. E. Benjamin Andrews, chancellor of the University of Nebraska, Lincoln, Neb. Chairman Division C, Mr. Herbert Myrick, of Springfield, Mass., editor of the American Agriculturist of New York, and the Orange Judd Farmer, of Chicago.

Engineering and Mechanics—Chairman, Mr. F. H. Newell, Chief Engineer of the U. S. Reclamation Service, Washington, D. C.

Climatology—Chairman, Mr. Willis L. Moore, Chief of the Weather Bureau, Washington, D. C. (At Mr. Moore's request Mr. H. E. Williams, Assistant Chief of the Weather Bureau, was made chairman.)

Rural Settlement—Chairman, Mr. Wm. E. Smythe, of San Diego.

Mr. Guy E. Mitchell, of Washington, D. C., was made chairman of the Press Committee.

Soon after the adjournment of the 11th Congress, advices were received from El Paso that a Committee of Arrangements had been selected there, with Hon. W. W. Turney as chairman, and A. W. Gifford as secretary, the other members being Mr. Alfred Courchesne, Mr. John W. Fisher, Mr. J. R. Harper, Mr. E. Kohlberg, Mr. Francisco Mallen and Mr. E. C. Pew, Sr. By agreement with that committee, November 15th to 18th was selected as the dates for the sessions of the Congress.

Early in September, under the provisions of the Constitution, was sent out the

#### OFFICIAL CALL.

The 12th National Irrigation Congress will be held at El Paso, Texas, November 15 to 18, inclusive, 1904.

All who are interested in conserving the great natural resources of the country—extending the habitable area—increasing the products of the land—insuring greater stability of prosperous conditions—making occupations upon the land attractive—the extension of internal trade and commerce, and a wider knowledge of a great economic movement which has for its ultimate object the upbuilding of an empire within the borders of a great nation, are invited to attend this Congress.

The organization of this Congress will be as follows:

The permanent officers of the Congress, including the chairmen of the sections.

Members of the United States Senate and House of Representatives.

Governors of States and Territories.

Embassadors, Ministers and other representatives of foreign nations and colonies.

Members of State and Territorial Irrigation Commissions.

Ten delegates, to be appointed by the Governor of each State and Territory.

Four delegates, to be appointed by the Mayor of each city of more than 25,000 population.

Two delegates, to be appointed by the Mayor of each city of less than 25,000 population.

Two delegates, each duly accredited by any Chamber of Commerce, Board of Trade, Commercial Club or other commercial body.

Two delegates, each duly accredited by any regularly organized irrigation, agricultural or horticultural society.

Two delegates, each duly accredited by any regularly organized Society of Engineers.

Two delegates, each duly accredited by any agricultural college, or college or university having a chair of hydraulic engineering, forestry, or other subject related to the general purpose of the Congress.

It is respectfully suggested that in the appointment of delegates, persons should be selected who are sincerely interested in and purpose attending the Congress, and that appointment be made as early as possible.

Please have full name and postoffice address of delegates mailed to Executive Chairman, 12th N. I. Congress, El Paso, Texas, that they may receive special information which will be mailed to each delegate not later than October 5, 1904.

The work of the Congress has been so greatly enlarged through the increased interest in matters pertaining to irrigation, that the Executive Committee have decided to systematize the work of the next Congress according to the provisions in Articles 3 and 5 of our Constitution; consequently the work of the 12th Congress has been divided into five sections, their titles and chairmen being shown on this letter-head.

Each section will be conducted by a chairman who will be recognized as an eminent authority in his line, which insures a thorough exposition of the respective subjects through the presentation of papers, addresses and discussion by the most eminent men interested in forestry, irrigation, climatology and their correlated subjects.

It is confidently predicted that the coming Congress will be more highly instructive and entertaining than any Congress which has preceded it.

El Paso, the western metropolis of the Lone Star State, and on the border line of Old Mexico, is making preparation for the largest Congress, in point of attendance, which we have ever held.

A general committee of its ablest citizens, supported by the unanimous sentiment of the city, is arranging a program, for the entertainment of the delegates, which would require too large a space to print in this call, but is so unique in character as to be interesting and enjoyable to all.

A comprehensive exhibit of the products of irrigation will be installed adjoining the great Convention Hall, especially constructed for this Congress.

Irrigation in various phases will be shown, which will include mechanics and electrical machinery and appliances.

Ample hotel accommodations can be assured to every delegate.

Special railroad rates have been made to apply from all parts of the United States to this Congress, the rates being the lowest ever made to any convention. Apply early to your nearest railroad agent, so as to insure the rates being made applicable from your section.

All newspapers and other publications are earnestly requested to give wide publicity to this official call, and to impress upon their readers the far-reaching importance of this Congress.

The Vice President and members of the Executive Committee from each State are urged to make the provisions of this call as widely known as possible, and insure the largest possible delegation from their respective States.

Every State in the Union is vitally and directly interested in the subjects to be discussed in the coming Congress.

In the various sections information will be dispensed regarding the increasing of production by irrigation in the Atlantic States as well as in the Pacific section; forestry problems in New England, and along the Appalachian Chain, as well as along the Rockies and Sierras; engineering applied to protect from the devastation by floods; drainage of the submerged areas; direct-

ing and conducting the water to its most beneficial use; climatology, with special reference to the service of the Weather Bureau throughout the United States, and rural settlement, with special reference to the disposition of "the surplus man."

THE EXECUTIVE COMMITTEE,

By C. B. BOOTHE, Chairman.

H. B. MAXSON, Secretary.

GENERAL COMMITTEE AT EL PASO,

By W. W. TURNEY, Chairman.

A. W. GIFFORD, Secretary.

Approved: W. A. CLARK,

President and Ex-Officio Member Executive Committee.

Most of the members of the Executive Committee have been active in their several States and it has resulted in bringing together a Congress, not only large in numbers, but representative in character, and generally, men of affairs in their respective sections.

The advance program which you have received indicates the excellent manner in which the chairmen of the various sections have arranged their work, and, being men of recognized authority in their various lines, of wide acquaintance with the subjects to be considered in their respective sections, it may be confidently anticipated by all that the addresses and papers which will be presented during the sessions will be of a most interesting and instructive character.

It is with great pleasure that acknowledgment is made to the Committee on Arrangements at El Paso for the generous and hearty support which they have given the National Executive Committee in every way which might contribute to the success of the Congress. No expense or labor has been spared for the comfort and entertainment of the delegates, and in making preparations for the holding of the Congress. Uninterrupted harmony has prevailed between the Executive Committee and the Committee of Arrangements at El Paso.

At this Congress, for the first time, the organization has been formulated upon the full and comprehensive lines laid out by our Constitution.

BROADENING OF THE MOVEMENT.

The growth of the national irrigation movement has brought it into intimate relation with many subjects not heretofore recognized as closely related with the main purposes and objects of our Congress.

The passage of the National Irrigation Act has revived interest in such important subjects as forestry and climatology. It has widened and extended our interest in the great fields of engineering and mechanics. Production by irrigation has received an impulse which, in the near future, will be felt from the Pacific to the Atlantic and from the Lakes to the Gulf, and all this thought, effort and action will be directed to the extension of settlement in old communities and the building up of new communities in a

vast desert, which but now, it is realized is filled with vast possibilities for the present and future generations of our people.

For many years each Irrigation Congress formulated new and untried policies, all of which have disappeared under the critical examination of men skilled in statesmanship and the consideration of great problems.

The 12th Congress convenes with a well-defined policy established by the Congress of the United States, and with its administration well in hand by the Executive Department of our Nation.

Matters for the consideration of *this* Congress are more largely that of the extension of the policy defined by the National Irrigation Act, and its best administration for the benefit of the people.

Through the information and facts brought together during the sessions of this Congress, and the conclusions reached after debate and discussion by the most able men in our country, the conclusions which may be arrived at will have great weight with the law-makers who represent us at the capital of the Nation.

The responsibility of each of us is great, that we shall not be swerved by any selfish purpose, nor that the resources which belong to the Nation shall be diverted from the people to whom they belong.

The foundations are being laid for an empire greater than has ever been known or dreamed of in the history of the world. We are the trustees for the present and future generations and they shall be the judge whether we have faithfully administered the trust. May we be guided by a zeal to do right, act wisely, and thus deserve the blessings of those who come after us.

Mr. Boothe—Mr. President, I have another report from the Executive Committee which I desire to present at this time, because it seems to be pertinent. The present Constitution provides for five members to be appointed by the Governors and one or two members by various organizations. We find, after two or three years' experience, it is necessary to appoint, to secure a satisfactory attendance, a good many more; for that reason the Executive Committee have decided to recommend the number that may be appointed by Governors and Mayors be considerably increased:

## **REPORT OF EXECUTIVE COMMITTEE ON THE SUGGESTED AMENDMENTS TO THE CONSTITUTION.**

*To the 12th National Irrigation Congress:*

At the close of the 11th National Irrigation Congress, a special committee on the revision of the Constitution made a report recommending that the matter be referred to the present Executive Committee and, after careful consideration, the chairman has been instructed to recommend to this Congress the adoption of the following amendments:

Whereas, No provision has been made in the Constitution for a Committee on Credentials, and the basis of representation being prescribed by the Constitution, the practice having been at several Congresses to adopt the official roster made up by the Secretary, it is recommended that an amendment to Article 2 in the Constitution be made as follows:

"The Executive Committee shall be convened by its chairman by 8 p. m. on the day preceding that on which the Congress convenes, and shall act as the Committee on Credentials and report at the opening of the Congress, and from time to time during its sessions, the names of those duly accredited as delegates."

Also an amendment to Article 4: "The President, the Chairman of the Executive Committee and the Secretary of the Congress shall constitute a Committee on Rules; and when approved by the Committee on Rules, the program submitted by the Executive Committee shall become the official program of the Congress."

Also amend Article 6 to read as follows: "The membership of this Congress shall be as follows: Fifteen delegates from each State and Territory to be appointed by their respective Governors; five delegates from each town and city of the United States having a population of less than 25,000; ten delegates from each city having a population of over 25,000; also five delegates from any county; two delegates each from any regularly organized irrigation, agricultural or horticultural society, Society of Engineers, agricultural colleges and commercial bodies; also the duly accredited representative of any foreign nation or colony; all members of the United States Senate and House of Representatives, and the Governor of each State and Territory; each member of any State or Territorial irrigation commission, and State Commissioner of Agriculture or Horticulture; the chairman of each section, and the permanent officers of the Congress."

Also amend Article 8 to read: "This Constitution may be amended by a two-thirds vote of the delegates of any Congress, under the provisions contained in Article 7."

Mr. Boothe—I move the adoption of the report of the Executive Committee.

Mr. Prince—Mr. President.

Mr. Clark—The delegate from New Mexico.

Mr. Prince—I suggest that the amendment to the Constitution be made a special order of some kind on some day after this. It is a very important

matter, this amendment to the Constitution. The report is a good one with regard to certain matters—I suppose good as far as it goes; but it is important for us to understand and consider it. I suggest to the chairman of the committee that this particular thing, as well as other matters of importance, should be made a special order for a specific time, so we can look into it and understand it when it comes up for action.

Mr. Clark—Does the gentleman from New Mexico make a motion to that effect?

Mr. Prince—I will make the motion. I have no preference with regard to time; I will be very glad to confer with Mr. Boothe in regard to that, if he desires to appoint any particular time. If there is no objection to it, I move that we take it up at 11 o'clock to-morrow morning.

Mr. Clark—There will not be another general session until Thursday evening. All that time will be taken up by the program.

Mr. Prince—It is no honor to this city that there is no general session until Thursday evening. I don't know why there should not be, because this body is its own master, and can hold a session whenever it chooses. But, if there is no general session until Thursday evening, I move we make this a special order for Thursday evening. It is certainly as important as anything can be to come before us.

The motion was seconded by a delegate from Oklahoma.

Mr. Clark—You hear the motion, gentlemen, that the report shall be made a special order for Thursday afternoon, at what time?

Mr. Prince—Whenever this general session is.

Mr. Boothe—There is no session in the afternoon; it is Thursday evening.

Mr. Clark—No session in the afternoon.

The motion was carried.

Mr. Clark—The portion of the report which relates to amendment to the Constitution will be made a special order for Thursday evening.

The remainder of the report was adopted.

Mr. Clark—The next order of business is the reading of letters and telegrams from distinguished absentees. The Secretary will now read letters and telegrams.

FROM THEODORE ROOSEVELT, PRESIDENT OF THE UNITED STATES OF AMERICA.

WHITE HOUSE, WASHINGTON.

C. B. BOOTHE, *Executive Chairman*:

My Dear Sir—I wish it were possible for me to accept your kind invitation to attend the National Irrigation Congress to be held at El Paso.

I need not state to you the deep interest I feel in the cause of national irrigation. Irrigation is in very fact one of the means for national expansion which is most effective.

Wishing you all success, I am,

Sincerely yours,  
THEODORE ROOSEVELT.



Mr. Boothe—I hold in my hand a personal communication from the President, delivered into the hands of this Congress by Mr. Pinchot, who has just arrived. If agreeable I will ask Mr. Pinchot to read this letter.

Mr. Pinchot—I was greatly honored by being made the bearer of a communication from the President to this 12th National Irrigation Congress, which doubtless would have come very much earlier were it not for the fact that we have had an election in the country.

FROM THEODORE ROOSEVELT, PRESIDENT OF THE UNITED STATES.

*To the National Irrigation Congress:*

It is a pleasure to send my greeting to you, both as President of the United States and as a man who has lived in the West and loves it, and is eager for its prosperity. Whatever any man or body of men may believe as to any question in political controversy, we may all unite in the great duty of internal improvement, the duty of making every foot of soil, every stream and every other resource of natural or human origin, contribute to the very utmost to the permanent prosperity of our country.

I congratulate you because you are no longer striving for what once seemed a distant hope; you are no longer engaged in a campaign of education for the passage of the Reclamation Act. On the contrary, your first great object is achieved. You have met to consider what has been and what is being done under that Act by the Reclamation Service, to consider means for giving it its largest and widest results, and to discuss the broad problems of irrigation method and practice.

It was through your efforts, and those of men like you, that the people of the United States as a Nation undertook to attack the desert, and to do away with it not only so far as there is water now for that purpose, but to the fullest extent for which water may be developed hereafter. Such an attack can be successful only when based on accurate knowledge. When the Reclamation Act was passed, the essential facts as to stream-flow had been ascertained in many parts of the United States, and the scientific basis for national reclamation, which otherwise it would have taken years to accumulate, was already in large part at hand. The fact that so much progress has already been made by the Reclamation Service is a striking example of the advantage of scientific investigation by the general government. It may be true that to the man whose interest is limited by immediate results, the admirable work of the Reclamation Service at times seems slow, but we are building for a great future, and it is far more important that the works built should be permanent and successful than that they should be completed in haste. There will be no unwise hurry, neither will there be any unnecessary delay. Most of the great problems of organization and methods have now been solved, and progress in construction and settlement is being made with increasing rapidity.

The passage of the Reclamation Law was a great step toward realizing the best use of all the public lands. For many of these lands their best use is to

produce water for irrigation. But always, and in every place, the best use of the public lands is their use by the man who has come to stay. There are, unfortunately, in every part of our country, a few men whose interests are purely temporary, who are eager to skim the cream and go. Instead of using the forests conservatively, they would, for example, abuse and destroy the natural reservoirs upon which national irrigation depends, to the permanent loss of every agency which makes for the true development and lasting greatness of the irrigable States. Such interests can not be allowed to control.

Now that your first great object has been accomplished in the passage of the Reclamation Law, you should make yourselves the guardians of the future, and the unrelenting and watchful enemies of every attempt to waste any of the great resources in forestry, grazing, and mineral wealth, the foundation stones of a newer and greater West. For irrigation, and every other interest which you represent, the period of exclusiveness is passed. The stock interest is no longer independent of the mining interest, nor either of them independent of the irrigator. A closer interweaving than ever before is at hand, among all the great interests of the whole country. One can not prosper without the others. So the future growth and greatness of the other Western interests will depend, in the first degree, upon the development of irrigation, and the development of irrigation will depend upon the protection and wise use of the existing forests and the creation of new ones, and the proper control of the grazing. Your work for the good of one interest is for the good of all.

The following letters were read:

FROM PRESIDENT DIAZ, OF THE REPUBLIC OF MEXICO.

MEXICO, October 21, 1904.

HON. WILLIAM ANDREWS CLARK, *President 12th National Irrigation Congress, New York:*

Dear Sir—I have received the courteous and esteemed invitation which you were kind enough to extend to me for the interesting meeting of the 12th National Irrigation Congress, which will be held from the 15th to the 18th of next November, in the progressive city of El Paso, Texas.

As much for the importance of the *transcendental* matters which will there be treated of, as to reciprocate the kind consideration with which you favor me, I would take sincere pleasure in attending, if my official duties would permit; but they are absolutely the only ones which deprive me of that great satisfaction, and I must content myself with being with you in spirit, though absent from your meeting, with sincere wishes that the most complete success may crown the intelligent and patriotic work of the illustrious Congress over which you preside, and which will undoubtedly influence powerfully the solution of the many problems relating to irrigation and the forest industry. The government thus understanding, the Department of *Fomento* and some of the governments of the States of this Republic will be duly represented in that assembly by their respective delegations.

I am, very truly yours,

(Signed) PORFIRIO DIAZ.

FROM VICE PRESIDENT CORRAL, OF THE REPUBLIC OF MEXICO.

HERMOSILLO, November 6, 1904.

MR. A. W. GIFFORD, *Secretary of the Committee, National Irrigation Congress, El Paso:*

Dear Sir—I reply to your esteemed letter, dated the 24th of last month, and thank you for the invitation which you sent to me to attend the National Irrigation Congress, which will be held in that city during the present month, and beg to advise that I am sorry not to be able to attend, notwithstanding my desire to do so. I am, with all consideration, sincerely yours,

(Signed) RAMON CORRAL.

FROM HON. PAUL MORTON, SECRETARY NAVY DEPARTMENT.

WASHINGTON, D. C.

My Dear Sir—I thank you for your letter of October 5th, inviting me to be present and address the National Irrigation Congress, to be held at El Paso, Texas, November 15-18, and regret sincerely that it is impossible for me to accept the invitation.

I have always been interested in everything that the National Irrigation Congress is trying to accomplish. I believe in saving the forests, storing the flood waters, reclaiming the deserts, and making homes out of the arid lands.

Very truly yours,

PAUL MORTON.

FROM HON. ETHAN ALLEN HITCHCOCK, SECRETARY OF THE INTERIOR.

WASHINGTON, D. C., Nov. 10, 1904.

Dear Sir—I desire to acknowledge the very courteous invitation extended to me by you to attend the 12th National Irrigation Congress at El Paso, November 15th to 18th, and to express my sincere regret that on account of the public business and the preparation of my annual report, which must be complete and ready to submit to the President before the preparation of his annual message, I can not be away from Washington at the time specified.

I am in hearty sympathy with the national irrigation movement and have taken great personal interest in promoting as rapidly as possible the reclamation of the irrigable lands and the carrying out of the manifest intention of Congress in this matter. While I can not be present personally, I will detail a representative of the department to attend the session of your Congress, which I trust will be of great benefit to the country.

FROM U. S. SENATOR THOS. R. BARD, OF CALIFORNIA, CHAIRMAN SENATE COMMITTEE ON IRRIGATION.

HUENEME, CALIF.

My Dear Sir—I thank you for, and fully appreciate the compliment extended by your letter of October 10th, in which you invite me to address the Irrigation Congress, to be held at El Paso, November 15-18.

At this time it is impossible for me to promise to attend the Irrigation Congress. My time is so wholly taken up with matters of an official nature, both current and in anticipation of legislation which may be proposed at the coming important session of Congress, that I fear I can not take the journey to El Paso. The session of the Irrigation Congress will come just at the time when I shall be in the midst of preparations for my departure for Washington.

Reciprocating sentiments of regard, I remain, etc.,

THOS. R. BARD.

FROM U. S. SENATOR PARIS GIBSON, OF MONTANA.

GREAT FALLS, MONT.

DEAR MR. BOOTHE—I have just received your letter of the 21st, and am very sorry to tell you that I shall be unable to attend the meeting at El Paso. I have not been well this summer, and although my condition is somewhat improved since last spring, yet I feel it my duty to avoid such a long journey as I would have to make from Great Falls to El Paso.

I fully realize the importance of this, the 12th National Irrigation Congress, and you can rest assured I would not fail to be present and lend what little influence I have for the preservation of our public lands, if I could do so.

Mr. Maxwell made a very effective campaign in this State and did much good for our cause. I hope he will be able next year to again visit Montana and talk to the people in all the important towns. It certainly would contribute very much to the enlightenment of the people on the subject of preserving the public domain for homemakers.

With kind regards, I remain,

Yours very truly,

PARIS GIBSON.

FROM COL. C. A. CARLISLE, HONORARY VICE PRESIDENT FOR INDIANA.

SOUTH BEND, IND., Nov. 8, 1904.

MY DEAR MR. BOOTHE—Your pleasant note of Nov. 2d reached me just as I was about leaving for a protracted eastern trip, and yet before I go, it is my desire that these few words of greeting and cordial good will shall be directed to you, and through you to the distinguished gentlemen who welcome you and to all the delegates assembled. My deep regret is that I cannot be with you in person, but it is my pleasure to notify you that we send you instead one of our distinguished associates, the Hon. E. M. Brannick, of Portland, Oregon, the vice president and general manager of the Studebaker's Northwest Company, and a gentleman in whose sagacious discernment you will find strength and wisdom.

I am mindful of the importance of such gatherings as you now have before you, through the like of which a higher and more perfect civilization, a more satisfying brotherhood of love, has come. It is but a short stretch of time and

imagination that we look back over the developments that have come through the hardest experiences of trials and tribulations since Thomas Jefferson (the great American expansionist), fired by determination to penetrate the mysteries of the unfathomed West, the great territory that now lies gracefully within the inner realm of the most enlightened civilization.

As we follow (now in history) the trails of those sturdy pioneers inspired by Jefferson to blaze a pathway across the continent, we see Lieutenant Zebulon Montgomery Pike, the first American to explore the upper Mississippi, the valley of Arkansas and to enter New Mexico, where the Spanish governor threw him into prison as a filibuster and revolutionist. But "Pike's Peak" will forever enchant the generations to come as it has those of to-day, and of the past, a glorious tribute to a brave man.

Jefferson sent his own private secretary, Merwether Lewis, and his associate and neighbor and boyhood friend, George Rogers Clark, across the trackless forests, the deserts, and the Rockies, to the Columbia River and down to the shrine of his determined aspirations, the Pacific; and the knowledge brought by those great patriots represented much, as the world had waited more than two hundred years for such a reliable report.

Next year, at Portland, the American people will applaud the memory of these men.

I congratulate the National Irrigation Congress, as I congratulate those in attendance, the city in which you meet, the State and all in authority, for men like those before you are the men who, through unselfishness have always been found upon the firing line—such as they are the force through which our glorious Nation evolved.

May God's blessing be with you and a most perfect peace prevail. With personal regards, believe me,

Sincerely,

C. A. CARLISLE.

FROM HON. ALEXANDER O. BRODIE, GOVERNOR OF ARIZONA.

PHOENIX, ARIZ.

MY DEAR MR. BOOTHE—I have yours of November 3d, extending to me a most cordial invitation to be present at the coming Congress at El Paso, and to deliver a short address upon any subject I might choose. It had been my intention to be present during this session of the Congress, not for the purpose of delivering an address, but for the purpose of taking part in the discussion of topics. I find, however, that I am to be disappointed, as within the last few days I have had word from Mrs. Brodie, who is at present ill in the East, that she is considerably worse, so I feel that the very moment I can be spared from the Territory, it is my duty to join her.

You understand, of course, that my heart is with you in your work, and that I am a well-wisher for the success of the National Irrigation Congress.

With kind regards, to yourself personally, and sincere regret over the fact that I shall be prevented from being with you, I am,

Yours sincerely,

ALEXANDER O. BRODIE.

## OTHER LETTERS.

Letters were also read from Secretary John Hay, Secretary Victor A. Metcalf, Secretary Wm. H. Taft, Secretary L. M. Shaw, former President Grover Cleveland, Land Commissioner W. A. Richards, Commander Frederick Booth-Tucker; Commissioner John J. Terrell, Texas State Land Office; Richard H. Edmonds, Editor Manufacturers' Record, Baltimore; Hon. Chas. Scott, President Inter-State Mississippi River Improvement and Land Association and member Executive Committee for Mississippi; Hon. C. F. Huehlin, member Executive Committee from Kentucky; Mr. Joe Mitchell Chapple, member Executive Committee from Massachusetts; Hon. W. A. Kelsey, member Executive Committee from New York; Hon. Samuel Hill, Seattle, Washington, and Hon. James L. Northrup, Mayor of Johnstown, N. Y.

Mr. Clark—These letters are all very gratifying as they indicate a widespread sentiment all over this land in the interest of irrigation. The letters will be filed and published in the Proceedings of the Congress.

The next in order will be an address by Mr. Gifford Pinchot, Chief Forester of the United States and Chairman of the Section of Forestry of this Congress. I have the honor to introduce to you Mr. Pinchot.

Mr. Pinchot—I will detain you but a very few minutes, because what I will say will be very briefly said.

### **ADDRESS OF CHAIRMAN PINCHOT.**

The National Reclamation Act, whose passage was directly due to the personal interest and effort of the President, is of a broader national character than many people in the East realized at the time. It will give to those portions of the country which it does not directly touch, far more than the effect of that general reflex action which the prosperity of any part of the United States must have upon every other. In this case there are specific reasons, and of these the greatest is this: That the development of the arid West through irrigation will be of unmeasured importance to the East by the creation of more and greater home markets, for it is by home markets first of all that our people prosper. The Reclamation Act is a national benefaction whose blessing falls first and most plentifully upon the West, but which does not fail to bless any portion of the Union.

One of the fundamental facts that nearly every man here knows to his own cost is that there is more irrigable land, in that prosperous country we used to know as the Great American Desert, than there is water to irrigate it. Water is the measure of the value of land, and it is water that the West needs. Every addition to the water supply will extend the irrigated area. When all the water now available has been put to use (and in many regions that time has either already arrived, or will not be long delayed), every deduction from the water supply will reduce the possible irrigable area. It is of the highest importance, therefore, not only to have a water supply but to keep it.

#### **FORESTS CONSERVE WATER SUPPLY.**

No argument is needed before this Congress to prove that forests conserve the water supply and vastly increase its usefulness for the purposes of irrigation. They do so by reducing evaporation, by regulating and sustaining the flow of streams, and by helping the snow water to get into the ground by seepage instead of into the air by evaporation. The forest is the first and most important factor in the water supply of the West except the water itself.

In the West the forest does not now occupy nearly all the area suited for its growth. Doubtless every man here is familiar with denuded slopes dotted with the charred remnants of forests which have been destroyed, and with great stretches of open land as to which there is no apparent reason why they should not be covered with trees. The fact is, the fire has driven the forest from vast areas upon which it should naturally flourish, and to which it may be restored by natural seeding or by extensive plantation. But it is not only the area of the forests which is reduced by fire. Very many forests are traversed by fire year after year and yet are not destroyed. But no forest can be burned without suffering in what is to you its most important function--its capacity to store the fallen rain.

#### **TO CREATE NEW RIVERS.**

The protection of the forest then protects the present supply of water. In many places continued and effective production will largely increase the steady flow of water in the streams, because many forests are now in poor condition.

But this is only half the story. If the forests now standing are valuable for water supply then new forests created on water sheds now denuded will also be valuable. Here lies the possibility of increasing the irrigable area by increasing the water supply.

We know already that forest plantations on the open plains of the Central West are taking on the character of natural forests, are reproducing themselves from seed, and are even extending their own boundaries. Forest planting in the irrigable mountain States is still too young to afford such examples, but the efforts of nature to again cover the denuded slopes furnish ample proof of what can be done.

The importance of all this lies in the fact that the extension of the forest on denuded water sheds will unquestionably be accompanied by an increase in the available water supply. I might cite case after case from older countries to sustain this contention, cases of springs restored and streams sustained by the renewal of the forest. We have begun planting too recently to prove it here, but unquestionably man after man in this audience could furnish proof of the converse proposition, that the destruction of the forest reduces the water supply. It stands to reason that if we restore the one we restore the other. Forest fires then not only restrict the forest area but they restrict the irrigable area as well.

#### TO COMBAT FOREST FIRES.

What is the remedy for this age-long attack on the irrigable West by forest fires? It is a triple one. First, extension of forest reserves over all mountain watersheds of streams used for irrigation; second, a national forest service to control the forest fires and destructive lumbering, which is often their cause and nearly always their confederate; and thirdly, tree planting on denuded areas in the forest reserves.

I hold with emphasis not only that it is the duty of the national government to extend the irrigable area by increasing the low water flow of streams through planting on denuded water sheds in the forest reserves, but I also believe firmly that we are about to undertake as a Nation more extensive forest plantations than have ever been made elsewhere. There is a definite need which can be met only with the protection of existing forests and the planting of new ones, and it is not to be doubted that we shall meet it.

Mr. Clark—I regret to say that Mr. I. D. O'Donnell, of Montana, one of the Section chairmen, has not been able to be present, although he has carried on a large correspondence and succeeded in including the presence of others here who will present papers under his section. We will now pass to an address by Mr. E. Benj. Andrews, the Chancellor of the University of Nebraska, Lincoln, Nebraska, and Chairman of the Section of Production by Irrigation. I have the pleasure of introducing to you Mr. Andrews.



**ADDRESS OF CHAIRMAN ANDREWS.**

*Mr. President, Ladies and Gentlemen of the Congress:*

The Congress meets under more auspicious circumstances than at any previous time. The cause it represents is better and better understood throughout the country. Prejudices against its work which were once very strong have been laid aside. It is matter for peculiar congratulation that the President of the United States himself appreciates the need of irrigation as a national policy and is willing to give to this great interest his support by official word and deed. The people of the East are to a great extent, and increasingly, relinquishing their attitude of hostility, caused by ignorance and misunderstanding.

A fact strongly tending to further and strengthen the cause of national irrigation is that certain technical objections to our scheme appear to have been surmounted, at least theoretically, to the satisfaction of experts. There was legitimate fear at first that comparatively little water could be stored at sufficiently high levels to enable it to flow over very vast areas in need of it. It was found, however, I believe, that the tracts reachable by proper irrigation works are indefinitely vast, much more so than one would at first suppose—sufficiently vast to make the utmost preparation for irrigating them well worth while.

It is more and more seen that the lifting of water from under the earth to pour it over fields can be made to pay in localities too high for cribbed water to reach, this form of irrigating being certain to supplement in an invaluable manner the river and reservoir work.

It is further observed that in nearly all localities, alkali, when present, can be drained away, so that with or without additional treatment the land will be rendered productive.

**NO LONGER A SECTIONAL ISSUE.**

The more intelligent newspapers and public no longer consider our work sectional, but look upon it in its true character as a national affair. I wish to dwell a little on this conviction and the ground for it. The making of ditches and reservoirs and the application of the reserved waters to the purpose of growing crops will certainly affect, in the first instance, special localities. But the instant these favored areas feel the touch of the living streams, produce grain and cattle and various other wealth, they will become purchasers of commodities of every kind produced in the manufacturing districts or for sale by importers, vastly enlarging the markets for all those engaged in producing or in selling. Not only will the total wealth of the country be swollen, but the profits of business will increase in every section of the land and in every department of industry.

Another consideration showing that our project is national and not sectional in its significance, lies in the fact that the vast population destined to be raised up through irrigation on the now arid and semi-arid portions of our beloved country, will be in the main perpetually agricultural, having the intelligence, the firm and vigorous physique and the intense patriotism usually

characterizing people living upon the land and deriving their support therefrom.

To say that the reclamation project before this Congress is of national importance does by any means express the entire truth. It is of consequence to all civilized mankind.

#### TO CREATE A FERTILE EMPIRE.

While all civilized races are increasing in number by leaps and bounds, the areas of the earth's surface which are naturally fertile are nearly all occupied, and a considerable proportion of them tilled to about the limit of their productive capacity. What is proposed is to add a fertile continent to the earth's productive area—not a continent far from the populations to be fed, but one situated right in the midst of these populations, making its food-products available without great expense to America, Europe and Asia. It is the greatest forward step now under consideration by civilized mankind.

#### EDUCATED MAN OVERCOMES NATURE.

What is the distinguishing mark that separates civilized men from savages? It is this: that, whereas the savage sits down humbly at Nature's feet and waits to take with gratitude whatever gifts of life she deigns to bestow, civilized man, on the contrary, dominates nature. Within large limits he commands her. If she does not obey to his liking, he takes her by the throat and forces her to do his bidding.

The American Indians made him their chief who could trail far, find rich hunting grounds, or corn and fruit lands, and conduct his people thither. We create hunting grounds and corn lands. We coerce Nature to grow cattle and corn to our liking in amount and in quality. If we don't like the breeds and varieties at first offered, we tell Nature to make better ones and she complies.

Hitherto, at one important point, that of moisture, nature has, over vast areas of our country, mocked at us. We wanted crops and grasses. Nature said "no, you cannot get them; you shall not have them. I withhold the moisture necessary to their growth."

Again, as at so many cries before, civilization is going to have it out with Nature, and Nature has got to yield. We may still have to yield to Nature so far the means of supplying the needed moisture is concerned, not compelling her to furnish it by means of clouds and rains, the usual method; but we are going to have the moisture all the same.

Mr. Clark—I will now introduce to you, Professor Thomas Shaw, of St. Paul, editor of "*The Farmer*," and one of the Chairmen of the Section of Production by Irrigation.

**ADDRESS OF CHAIRMAN SHAW.**

*Mr. President and Gentlemen of the Convention:*

I had not been very long in El Paso before the Chairman of the Executive Committee laid hands on me and requested me to take the place of the gentleman from Montana, who had been appointed chairman of this division. I had not been long in El Paso, as I have said, when the gentleman requested this of me, but I had been long enough to learn something of the courtesy that has been shown by the people of El Paso to the visitors at this time, and I made up my mind that I would try and do all I could to make this Convention a success, and that when I went back to St. Paul, I would take the opportunity which I am happy to say has been furnished me of telling one hundred thousand families of the States in the Northwest of the great courtesies shown me at El Paso by the visitors of this Convention. I am requested to speak in the place of Mr. O'Donnell, who was chairman of this branch of the work, and Mr. O'Donnell is not here, and as you can understand I did not know that I was expected to take his place until arriving here at noon to-day, therefore it will be unquestionably out of place for me to take up any considerable amount of the valuable time of you gentlemen in discussing this question. I would like to say to you, however, that I have heard former Congresses criticised, not so much because of what they did, but to some extent because of what they did not do.

**PRACTICAL FARM IRRIGATION PAPERS.**

They accomplished a great deal of valuable work, but there is one thing I think I am correct in saying they did not accomplish; they did not give the ranchmen something practical to take home with reference to his feature of the work and I have heard ranchmen criticise the Convention because of that fact. I think, Mr. Chairman, that I had the honor of submitting to the executive committee a year ago that that question would not be overlooked at this Congress, and the next day in conversation with yourself, I found to my great delight and satisfaction, that you had been thinking, doubtless before I had, in the same direction, and then and there it was decided to give the practical ranchman something that he could take home with him at the 12th Convention to be held at El Paso, therefore I will simply remind you of the meeting that is to take place to-morrow morning in connection with this department of the work. A gentleman from the State of Texas, Dr. Phillips, I believe from the University of Texas, will talk on the practical irrigation of the public domain in this State, and I do think, Mr. Chairman, that every citizen of Texas should be so interested in a subject of that kind, that every citizen of Texas who could possibly come to that meeting should be there to-morrow morning at nine o'clock to hear that address.

**GRASSES AND FORAGE.**

Then will follow an address by Professor W. J. Spillman, on the growing of grass and forage crops by irrigation. I do not know of any question that can interest the ranchman more than that—the question of growing grasses

and forage crops by irrigation. I do not know anything that would interest the man out on these ranches more than the best way in which he can sustain these grasses and crops, and I feel absolutely safe in saying this to you, that the party who is going to handle this subject, has the subject completely at his finger ends. How I came to know that so well, is that I have been tantalizing him for two years with all manner of questions on that very subject and I know from the nature of the answers he gave me, that he is going to tell you something well worth hearing. Then there will be an address on the question of irrigation by a gentleman, whose name I will not submit to you at present, for very good reasons, and there will be other addresses, so that I hope that all of those who are interested in the discussion of these practical questions will be on hand at Hall No. 1. I don't know where Hall No. 1 is, but you, gentlemen, will undoubtedly find it out. Remember, not half past nine, but nine o'clock to-morrow morning. I am told this is Hall No. 1.

I have just one thing more to say and then I am done. Dr. Andrews of the University of Nebraska, who spoke to you so eloquently this afternoon, I understand, has to go home before the meeting of this department, which will take place on Thursday. I was requested to preside at the meeting to-morrow morning by the Chairman of the Executive Committee, but I do think it would be unfair to you, and unfair to Doctor Andrews, who has to go away, that you should not have an opportunity to know what an able chairman he makes, and therefore Doctor Andrews will preside at that meeting and make it the success it should be.

Mr. Clark—Gentlemen of the Convention: It was intended to have Mr. George H. Maxwell, the Executive Chairman of the National Irrigation Association, conduct a section on the legal phases of the irrigation question, but it was found entirely impossible for him to undertake it. He is, however, present and is to address the Congress. The next in the order of business is an address by Mr. Frederick H. Newell, Chief Engineer of the Reclamation Service and Chairman of the Section on Engineering and Mechanics.

## ADDRESS OF CHAIRMAN NEWELL.

*Mr. President, Ladies and Gentlemen of the Convention:*

It gives me very great pleasure to meet you, and as the hour is late I will detain you only for a moment in speaking on the subject of engineering and mechanics of which section I have the honor to be the chairman. As my predecessor has said on the platform, each chairman of section will endeavor to make his particular section as interesting as possible and I will do all in my power to present to you an interesting program, and to see that the matter is pushed forward energetically and its most interesting features given.

### GREAT IRRIGATION WORKS OF AMERICA.

Engineering and mechanics as applied to irrigation is perhaps not a very attractive term to use, but in it lies the successful operation of the great irrigation works which exist now or are to exist in the future. Throughout the United States, or the Western part of it, all the irrigation engineering at present executed has been by individuals largely, and under directions of corporations, and the works already accomplished and the wonderful results testify to the work of engineers and mechanics in building the structures which now supply water to the needy crops. In our talk in this section it is hoped that we will be able to discuss the work already executed and more than that to talk about and discuss fully with you the large structures built and which are to be constructed under the terms of the Reclamation Law concerning which you have all heard about. If time permitted I should be very glad to take up State by State the work that is going on and which is projected in those States in the future, but that will be taken up I hope in the sections, and we will discuss from Arizona to Wyoming the work which is being done and which may be done in the future.

### A GREAT CONSTRUCTION FUND.

The reclamation fund you have all heard about. It amounts now, as has been said by our President, to twenty seven million dollars. It has been apportioned to the different States and Territories. The Secretary of the Interior has approved the construction of various works in nearly all of them, and concerning the execution of these we wish to meet with you and discuss fully what should be done in the future.

At this time I wish to ask particularly that each State delegation would attempt to make an appointment to meet with this section and to meet with the engineers of the reclamation service at some definite hour so that we may take up in each State and Territory the work which is desired and which is contemplated, in order that you may express your wishes and opinion concerning it. The engineers here have already met the delegation from Oklahoma and Oregon, and we have an appointment immediately upon adjournment to-night to meet with the joint Oregon and California delegation to discuss the Columbia project and other projects in which they are both interested, and I hope that time will permit for us to take this up in a very brief manner at least, and I wish the chairman of each delegation would arrange

definitely when he can meet that particular delegation and take up the features which are of interest to it. Now, without going into all the details which might be of interest, I will merely say that as engineers and as members of and all of us, and we must work together to put into effect this beneficent act ternal manner to get your co-operation and to work with you in the upbuilding of the West.

As has already been said, we are the guardians of the future, you and I and all of us, and we must work together to put into effect this beneficent act and see that the money is expended in the most economical manner to produce reclamation of the arid lands.

Mr. Clark—I will now introduce Mr. H. L. Williams, of Washington, D. C., Assistant Chief of the United States Weather Bureau, formerly called "Old Probability," and who is Chairman of the Section on Climatology. I have the pleasure of introducing Mr. Williams.

## ADDRESS OF CHAIRMAN WILLIAMS.

*Mr. Chairman, Delegates, Ladies and Gentlemen:*

The intimate relation that the subject of climatology bears to that of irrigation is self-evident, as the need of irrigation is due principally to aridity, which is a climatic factor.

The climate of any region is affected by such a variety of causes, both local and general, which operates so irregularly that a long and continuous series of observations, taken at short intervals of time and not far apart in space, is necessary to afford the data from which the true climate of a country or region may be established.

In the early history of the United States regular climatic observations were naturally few, being made only by those private individuals who from love of science were willing to devote the necessary time for this purpose. Systematic observations under President Jefferson's government supervision began to be made in 1817 by the Land Office Registers, and in 1818 by the Surgeon General's Office of the Army and surgeons of army posts. In 1844 the Hydrographic Office of the Navy began contributions to the work, and in 1847 the Smithsonian Institution entered the field by inaugurating a system of regularly recorded observations of the weather.

### CONSOLIDATING THE SERVICE.

Soon after the establishment of the meteorological branch of the Signal Service, now the Weather Bureau, in 1870, the meteorological work of the Smithsonian Institution was turned over to that organization, and by recent instructions of the President the meteorological duties of the Hydrographic Office are to be transferred to the Weather Bureau, so that the whole system of the officially recorded observations, with the exception of those conducted by the Surgeon General's Office, is or is to be under the control of that Bureau.

### A GREAT ORGANIZATION.

The Weather Bureau now maintains about 190 regular stations, where observations of pressure, temperature, precipitation, wind, humidity, clouds, and sunshine are made and recorded, and about 3500 other stations known as voluntary stations were, through the co-operation of public spirited private citizens, observations of temperature and precipitation are made and recorded, the instruments for the purpose being furnished by the government. Increasing interest as shown by requests for new stations constantly. Every State, and nearly every county in each State, is represented by these stations which occur in about 90 per cent of the counties at about 25-mile distances and the method of supervision is such as to insure uniformity and a very high degree of accuracy in the results. The Climate and Crop Service is divided into 45 local sections, each section, as a rule, covering a single State, and having for its center a regular observing station. These centers collect temperature and rainfall observations from more than 3,000 voluntary stations and publish these data in the form of monthly reports which are given a wide-

spread distribution. During the crop-growing season (from April to September, inclusive) each section also receives weekly mail reports from numerous correspondents (aggregating, for all sections, about 14,000) concerning the effects of the weather upon crops and farming operations, these reports being published in the form of weekly bulletins.

#### A WEEKLY BULLETIN.

During the same season the Central Office at Washington issues weekly a "National Climate and Crop Bulletin," containing a series of charts graphically illustrating current and normal conditions of temperature and rainfall for the entire country, a general summary of the weather, and brief reports on the condition of the crops for each State. There is issued at the Central Office every Tuesday during the winter a publication entitled "Snow and Ice Bulletin," which shows the area covered by snow, the depth of snow, and the thickness of ice in rivers, etc., as indicated by a large number of reports of observations made on the afternoon of the day preceding the issue of the bulletin. This publication is of especial value to those interested in the winter wheat crop, to ice dealers, and to the manufacturers of rubber goods and other articles, the sale of which is largely affected by the presence or absence of snow and ice. Throughout the cotton, corn, wheat, sugar, and rice producing sections designated centers receive telegraphic reports of rainfall and daily extremes of temperature for publication in bulletin form, each local center receiving the reports from all others.

#### VOLUNTARY OBSERVATIONS.

By the co-operation of several thousand voluntary observers, many of whom have maintained local records for long periods, the Weather Bureau endeavors to collect special local data and thus perfect the records that are needed for the study of the relation between climate and agriculture, forestry, and other industries. The results of these observations appear in detail in monthly and annual reports published at the respective section centers, and in the Monthly Weather Review.

As this method has been in operation for the past 25 years with a constantly increasing number of stations, it will be seen that with all the series of observations mentioned we already have a fair basis for the determination of the climatic conditions for nearly all parts of the country and the value of the data being accumulated increases with every year.

#### UTILIZED BY VARIOUS BUSINESS INTERESTS.

The value of the information acquired and the facts established by these observations, not only to irrigation interests as represented by this Congress, but to nearly all business enterprises and the welfare of the people generally, is manifest. Constructors of waterworks, bridges, culverts and sewers consult the rainfall records to ascertain the maximum water flow they will have to allow for. Architects of iron and steel structures and tall buildings study the records of maximum and minimum temperatures and wind velocity, in



order to estimate the contraction and expansion and amount of wind pressure their buildings must be prepared to withstand.

From the information as to climatic conditions made known through the reports, invalids and tourists are enabled to select the localities best suited to their health and pleasure, and manufacturers and agriculturists the regions best adapted for the carrying on of their particular industries.

#### TO FORECAST THE IRRIGATION SUPPLY.

By the recent extension of the system of snowfall observations throughout the mountain regions adjacent to the Great Plains, it has been made possible to forecast the probable flow in the rivers of the arid regions, a factor of great importance in irrigation. The records of the Bureau are of frequent use as evidence in courts of law for which purpose they have been decided competent by the Supreme Court of the United States.

It would be neither practicable nor desirable for the section of the Congress to which this subject is assigned to treat the topic of climatology in any exhaustive manner, and we have, therefore, chosen for the problems to be discussed such as have some special relation to the object of this meeting. While the topics are not all new the writers have brought out many new facts and ideas, and have endeavored to present them in such a manner as to make them of fresh interest.

I invite your attention to the program of the section, the meetings of which you are all cordially invited to attend.

Mr. Clark—We will now finish the program of the day by an address by Mr. William E. Smythe, Chairman of the Section on Rural Settlement.

**ADDRESS OF CHAIRMAN SMYTHE.**

*Ladies and Gentlemen:*

I had a lovely speech—how lovely you will never know, for I shall not attempt to impose it upon you at this late hour. I know this audience is in the condition of a worthy young man in California who was waiting on a charming young lady weighing about two hundred and fifty pounds. This young couple were engaged, and their parents had impressed upon them principles of economy, so they began economy in their days of courtship by occupying a single chair. John called one night and after Mary had sat in his lap about four hours, Mary turned to him saying, "John, are you tired?" And John looked up and smiled and said, "No, not now; I was two hours ago, but now I am only paralyzed."

So, in view of the paralysis of this audience, I shall not attempt to make a speech. I must, however, tell you a Thanksgiving story I picked up in Colorado the other day. It seems a Colorado boy was visiting a cousin in New England about Thanksgiving time, and the Colorado boy observed the very elaborate preparations being made for Thanksgiving. They had Thanksgiving in Colorado, but not on so grand a scale, and so this Colorado boy inquired of his New England cousin what was the object of it all. "Why," the New England boy said, "we thank God for the blessings of our crops." "But you don't thank God for your crops, do you?" asked the Colorado boy, and the New England boy answered, "Yes, of course we do, don't you?" "No," replied the Colorado boy, "we don't depend entirely on God for our crops; we irrigate."

Well, now, the remark was not a trivial one, it was not flippant, but was a profound one, for somebody has said, and most beautifully, "that God has never yet made a world." He has started several, including the one in which we dwell, but he depends upon man living in accordance with the laws of the universe to finish that world, and that thought applies especially to the conditions here in the arid region. It came to me with great force while I was listening to the address of Mr. Andrews, and by the way, as I listened to his expressions I was glad he had crossed the Missouri River, for he is every bit a Western man and has no business in New England.

**THE COLONIZATION PROBLEM.**

At this late hour I can only remind you of the section over which I have been called to preside—Rural Settlement. In other words, the Section of Colonization. All the efforts of this Congress lead to one great end, which is to make homes upon the land, and in our section on Rural Settlement we shall consider the history of colonization, the opportunities open to homemakers under the national works to be built, and we shall consider the methods of colonization. I don't want to be hoggish; not even piggish. If you want to hear of forestry or any of the other branches I hope you will hear them. I have the honor to preside over a section which excites human interest and I trust we will have a fair number of human beings to attend. Among the interesting things that we will discuss will be the history of colonization in

Utah. I have always been an admirer of the Mormons. The Mormons were the pioneers in that arid land. They have made fertile many of the valleys in the West. I sometimes like to shock my friends in the East by dwelling upon the wonderful success of the Mormons. I say to them, "My friends, you go forth by distributing tracts in illustration of the scripture; Mormons distribute tracts of land, not printed tracts." And then I say to them, "You offer people, if they will join your church, a halo; my Utah friends offer them three meals a day in this world and a halo in the next."

### TO GET A HOME.

Now, thanks to our beneficent irrigation policy, the day is coming when it is possible for a poor man to get a home upon the land without joining any particular church, and there are lessons which all can learn and particularly this Congress by attending our section on Rural Settlement and listening to the history of American colonization.

I wish I had more time. There is nothing in this world so truly uncomfortable as an undelivered speech. I have a few bad hours of indigestion ahead of me, but I want to close as I began by saying that I trust a fair representation of this Congress will spend Wednesday and part of Thursday with us while we discuss the past and glorious future of the American colonization among the mountains and valleys of the West. We were to meet at the Presbyterian church, and that fact reminds me of the following quotation from scripture: "Thus sayeth the Lord: make this valley full of ditches, for ye shall not see wind nor rain, yet this valley shall be full of water." That text once served me in good stead at the beginning of the irrigation movement in Montana. We had a great drouth that burnt up the State and meetings were being held at which the people prayed for rain. I began an address by saying that I thought the time had come to stop praying for rain and begin digging ditches, whereupon the minister expressed surprise and I crushed him with that text, and I am glad to say that he came up on the mourner's bench, a convert to irrigation.

Mr. Clark—The Chairman of Engineering and Mechanics Section desires to invite the representatives of the Republic of Mexico to be present at the meeting of their section and to present such papers as they will. They also invite these gentlemen to meet representatives of the United States Government at 5 p. m. on Wednesday at the City Hall for the purpose of becoming mutually acquainted.

Gentleman from Oklahoma—Allow me to make a motion. I move that when we do adjourn, as I understand this will be the last general meeting until Thursday, that we meet here in this hall from one o'clock to two to-morrow for a general meeting, so that all resolutions can be read before the Congress and referred to the Committee on Resolutions.

Mr. Clark—I understand the gentleman from Oklahoma that his motion is that we have a general meeting here to-morrow at one o'clock in this hall so that all resolutions can be read and referred to the Committee on Resolutions.

## Special Session, Wednesday Afternoon, November 16, 1904.

Executive Chairman Boothe—In the absence of the President and Vice Presidents, I will call the meeting to order. The offering of resolutions is the special order for this hour. Are there any resolutions to be offered ? (After several minutes' pause.) Vice President Hall is now here and will take charge of the meeting.

Mr. Hall—Gentlemen, I understand that you have met here by previous arrangement to hear and receive the presentation of resolutions. Resolutions are now in order.

Delegate from California—As there are few members present, I move we take a recess for ten minutes. Adopted.

Mr. Hall—The time for the recess having expired, please come to order. Delegates offering resolutions will kindly announce their name and the State or Territory which they represent.

Executive Chairman Boothe—While this is a meeting, the special order of which is the offering of resolutions, it might not be out of place for the Committee on Credentials to offer their report.

Mr. Hall—I do not think it will be out of order—reports of committees are always in order. If the Committee on Credentials are ready to report, they may do so.

Delegate from Oklahoma—This being a special meeting and for special purposes, I doubt whether the committee can report unless by permission.

Delegate from California—I make a motion that the special order be set aside for the Committee on Credentials to make their report.

Seconded.

Mr. Hall—There being no objections the Committee on Credentials will make their report.

Delegate Hays made report of Committee on Credentials, and on motion the report was accepted and the committee given further time.

Various resolutions were offered by Messrs. Pinchot, Florence, Fairweather and Stephens.

Gentleman from Colorado—Point of information: Does this session here exclude any further presentation of resolutions?

Mr. Hall—I can not say if it does or not.

Executive Chairman Boothe—Replying to that question, I will say that a special order will be made to-morrow evening at the beginning of the general session for the offering of resolutions.

Adjourned.

General Session, Thursday Evening, November 17, 1904.

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CHAIRMAN: L. W. SHURLIFF,  
First Vice President.

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Mr. Shurtliff—Gentlemen of the Congress, the first order of business is the presentation of resolutions.

Various resolutions were offered by Messrs. Holabird, Switzer, Linney, Pinchard and Palmer.

Mr. Twitchell of New Mexico moved that each State and Territory represented in this Congress name a Vice President and one member of the Executive Committee to be present at the opening of the session to-morrow morning.

Motion seconded.

The Chairman—Are you ready for the question? All in favor of the motion signify by saying aye. Carried.

Here a delegate from Idaho read the report of the Committee on Permanent Organization, which named the Vice President and member of the Executive Committee from various States and Territories.

Mr. Prince of New Mexico—I would like to know by what authority the Committee on Permanent Organization has taken upon themselves to name the Vice President and the member for the Executive Committee for each of the States represented here? It has never been done before. Each State has named its own choice.

Mr. Twitchell—I rise to point of order.

Mr. Prince of New Mexico—The Constitution requires the members of the Executive Committee shall be selected by the delegates of the various States. There is no other way. They are never reported by this Committee. This has never been done before.

Executive Chairman Boothe—They follow the same as was done by the 11th Irrigation Congress.

Mr. Prince—I have not the slightest objection to any name read, but I do insist that this is a precedent which should not be established. This Congress has always followed that rule, and that is that every State and Territory should name its own Vice President and one member of the Executive Committee. It is even put into the Constitution, which says that the Executive Committee shall be selected by the delegation from the respective States and Territories. Now it will appear, if this goes, on the minutes in this form as a report from this Committee, and that they were appointed by that Committee, and not by the specific States and Territories. I appeal first to the precedent that it has been enforced in this Congress that each and every Territory should name its own Vice President and its own member of the Executive Committee. I appeal to the Constitution which makes this obliga-

tory, as to the members of the Executive Committee, and I appeal, if there were no Constitution nor precedent, to that which we all know is the best rule in this case, that each State and each Territory should select its own representatives on the Executive Committee and its Vice Presidents.

Mr. Smythe—We have a magnificent program to carry out and I think it would be well for us to defer this discussion and proceed with the program, and I move that the report of the Committee be accepted, and the election of the Vice Presidents and members of the Executive Committee be let go until to-morrow.

Delegate from New Mexico—I move that each State and Territory be represented here to-morrow morning at 9:00 o'clock, and report to this convention its honorary Vice President and member of the Executive Committee.

Motion carried.

Mr. Clark—I will ask all of these gentlemen who have addresses to present to the meeting that they come forward and take a seat on the stage, so that we will know who is expected to deliver addresses. Next in order of addresses is a paper "The Progress of Irrigation in Egypt from Its Earliest Days Until the Present Time," by Mr. Bakhati. I now have the honor of presenting Mr. Bakhati of Egypt.\*

Mr. Clark—I think, gentlemen, I voice the sentiment of all when I say that we are under many obligations to Mr. Bakhati for coming here and giving us an account of irrigation on the Nile. I understand that Mr. Bakhati a few months ago could not be understood in English.

The Secretary read the following telegram:

"The President and Secretary of the National Irrigation Congress, El Paso, Texas: The National Association of Agricultural Implements and Vehicle Manufacturers, in convention assembled at Chattanooga, Tenn., unanimously and heartily send you greetings and wish you Godspeed in your progress."

Also a telegram from Mr. A. Kaplan, Louisiana Commissioner:

"President of the 12th National Irrigation Congress, El Paso, Texas: I regret my inability to be present at what I hope will be the biggest and most successful Congress ever held."

Delegate from Oklahoma—If I remember rightly, the Committee on Credentials have not made their final report, and before we vote for the election, that Committee should report so that each delegation will know how many they are entitled to before they vote. I would like to ask, Mr. President, then, how many votes each delegation has? As the Committee on Credentials has not made its final report, how are we going to decide who has a right to vote, and how many votes they are entitled to cast? I think it would be the unanimous consent to have the Committee make its final report so that we will know how to proceed.

Delegate from Texas—I would like to know how we are going to get together to vote. I don't know that the Texas delegation has had any meeting. There are sixty delegates from Texas in the house, and while our banner

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\* Mr. Bakhati's address is printed on page 129.

is over there, most of the delegates from this State have been very busy about other matters, and have not had time to get together. I think it would be well to declare a recess of a few moments so that the delegates can get under their respective banners and determine just how to cast their vote. In fact, I move a recess of five minutes that each delegation can get under its banner. Then we will get together and can caucus, and decide how we shall cast our ballots.

Delegate from Oklahoma—I amend that motion, to the effect that the Texas delegation be permitted to withdraw and decide which way they wish to vote. Amendment seconded and carried.

The Chairman—Texas delegation will be permitted to withdraw for the purpose indicated. To make things plain, I might say that if there are ten votes of any delegation present, they may cast ten votes, or a less number than ten will be allowed to cast their proportion of ten votes.

Delegate from Oregon—With the consent and at the request of the gentlemen from Idaho and the gentlemen from Oregon, I would ask that this conference to be held by the Texas delegation be held after the nominations have been made, and that will give them ample time in which to prepare their ballots.

Delegate from California—I would like to have the Constitution read as to States having more than ten delegates present. (That portion of the Constitution was then read by the Secretary.)

The Chairman—If a State has 15 delegates present, they would have 15 votes. The question has been asked by the gentleman, how are you going to know this evening how many votes each State can cast. The Committee on Credentials has made a partial report, and they intend to make a final report to-morrow, and I understand that about 70 more delegates came in since the partial report was made, and there is no one in this room who knows where the extra delegates are accredited to, that is, to what State. I should think that the Committee on Credentials should report first.

Mr. Smythe—Do I understand that if a State has but one delegate, and he is present, he can vote ten votes?

The Chairman—Yes.

Delegate from Oklahoma—I understand that the Chairman of the Committee on Credentials is now ready to report, and can read the report in a few minutes, and thus settle the matter.

Delegate from Illinois—Suppose that Illinois had two delegates; they would be entitled to cast ten votes. Supposing one of them was absent, how many?

The Chairman—If Illinois had one absent and one here, he could cast his proportion of ten.

The Chairman—The chair is of the opinion that the Committee on Credentials should report, and while it will amount to a suspension of the rules, if there is no objection the Committee will report. There being no objection, the Committee will now report.

## REPORT OF COMMITTEE ON CREDENTIALS.

The Credentials Committee reported that the Secretary's register showed the following named duly accredited delegates present.

## ARIZONA

D. M. Green, Solomonville.  
 Geo. W. Hance, Camp Verde.  
 Lyman Bridges, Tucson.  
 Henry Warren, Holbrook.  
 Frank P. Trott, Phoenix.  
 Dwight B. Heard, Phoenix.  
 H. W. Bishop, Solomonville.  
 J. E. Thompson, Bisbee.  
 W. W. Pace, Thatcher.  
 W. Y. Price, Florence.  
 Kendrick C. Babcock, Tucson.  
 Chas. D. Reppy, Florence.  
 F. C. Dolly, Casa Grande.  
 Edward N. Buck, Naco.  
 B. A. Fowler, Phoenix.  
 W. A. Wilson, Phoenix.  
 Frank H. Parker, Phoenix.  
 John P. Orme, Phoenix.  
 C. R. Hakes, Mesa.  
 R. A. Kirk, Douglas.  
 C. F. Joyce, Douglas.  
 E. R. Pirtle, Douglas.  
 J. M. Sparks, Douglas.

O. P. Bondeson, Yuma.  
 J. H. McClintock, Phoenix.  
 Andrew Kimball, Thatcher.  
 Phil C. Merrill, Pima.  
 Geo. Peck, Bryce.  
 C. S. Steward, Mesa.  
 J. A. Harrison, Nogales.  
 A. J. Davidson, Tucson.  
 H. B. Fletcher, Florence.  
 Geo. E. P. Smith, Tucson.  
 T. G. Norris, Prescott.  
 G. H. Murphy, Tucson.  
 L. H. Manning, Tucson.  
 Ed. L. Pomeroy, Mesa.  
 C. M. Burkhalter, Tucson.  
 Mose Drachman, Tucson.  
 W. T. Webb, Pima.  
 Mrs. W. T. Webb, Pima.  
 J. L. Waring, Mesa.  
 W. C. Ferris, Benson.  
 A. V. Grossetta, Tucson.  
 E. Randolph, Tucson.  
 Wm. G. McNulty, Phoenix.

## CALIFORNIA

C. B. Boothe, Los Angeles.  
 John Fairweather, Reedley.  
 C. W. Oberlein, San Francisco.  
 Scipio Craig, Redlands.  
 Mrs. Scipio Craig, Redlands.  
 Wm. E. Smythe, San Diego.  
 J. B. Lippincott, Los Angeles.  
 Ferd K. Rupe, Los Angeles.  
 Prof. A. G. McAdie, San Francisco.  
 P. T. Evans, Riverside.  
 David DeWitt Lawrence, Imperial.  
 T. P. Lukens, Pasadena.  
 Mrs. Helen Lukens-Jones, Pasadena.  
 W. F. Holt, Redlands.  
 C. S. Chesnut, San Francisco.  
 Fred C. Finkle, Los Angeles.  
 W. C. Mendenhall, Los Angeles.  
 Willis M. Slosson, Nordhoff.  
 J. R. Braun, Los Angeles.  
 E. T. Perkins, Los Angeles.  
 P. G. Lewis, Los Angeles.  
 E. G. Denniston, San Francisco.

A. R. Kanaga, San Francisco.  
 W. H. Holabird, Los Angeles.  
 Geo. C. Pardee, Sacramento.  
 Mrs. Geo. C. Pardee, Sacramento.  
 Leroy Holt, Imperial.  
 A. H. Heber, Imperial.  
 W. J. Doran, Los Angeles.  
 John Tuohy, Tulare.  
 Emmet Barber, Tulare.  
 Mrs. John Tuohy, Tulare.  
 A. F. Mack, Santa Ana.  
 W. A. Hawley, Santa Barbara.  
 N. W. Stowell, Los Angeles.  
 A. L. Sumption, Los Angeles.  
 C. M. Maze, Modesto.  
 Fred M. Smith, Los Angeles.  
 A. M. Shoemake, Modesto.  
 C. A. Dickinson, Ceres.  
 Capt. W. H. Auble, Los Angeles.  
 J. J. Underhill, Los Angeles.  
 Mrs. E. H. Underhill, Los Angeles.

## COLORADO.

Lute Wilcox, Denver.  
 J. S. J. Lallie, Denver.

A. J. McCune, Denver.  
 C. E. Wantland, Denver.



COLORADO—CONTINUED.

Joseph F. Thomas, Manassa.	H. E. Storrs, Denver.
A. Lincoln Fellows, Denver.	Chas. L. Michod, Colorado Springs.
E. B. Coggeshall, Denver.	Burroughs Edsall, Colorado Springs.
Arthur F. Francis, Cripple Creek.	

DISTRICT OF COLUMBIA.

Gifford Pinchot, Washington.	J. Garnett Holmes, Washington.
F. H. Newell, Washington.	N. H. Darton, Washington.
Edward B. Garriott, Washington.	Mrs. N. H. Darton, Washington.
Geo. H. Maxwell, Washington.	A. L. Dahl, Washington.
Guy E. Mitchell, Washington.	E. A. Sterling, Washington.
Morris Bien, Washington.	W. T. Swingle, Washington.
A. F. Potter, Washington.	H. E. Williams, Washington.
C. W. Dorsey, Washington.	

GEORGIA.

B. M. Hall, Atlanta.

IDAHO.

Jesse B. Hawley, Boise City.	J. T. Morrison, Boise City.
James H. Hawley, Boise City.	O. J. Turley, Boise City.
F. A. Sloane, Boise City.	G. H. O'Day, Mosco.
G. A. Latham, Boise City.	

ILLINOIS.

J. Lewis Draper, Chicago.	G. L. Hill, Champaign.
A. L. Klank, Danville.	Wm. H. Thompson, Chicago.
S. H. Watson, Mt. Vernon.	D. H. Anderson, Chicago.

INDIAN TERRITORY.

Herbert J. Evans, Muskogee.

KANSAS.

C. A. Schneider, Garden City.	D. W. Baline, Pratt.
Wm. H. Barnes, Topeka.	W. A. Harris, Limwood.

LOUISIANA.

W. J. Carter, New Orleans.	Henry F. Reymand (formerly of La.)
David Lemky, New Orleans.	El Paso, Texas.
C. J. Fuqua, Baton Rouge.	

MICHIGAN.

Mrs. W. K. Morley, Grand Rapids.	Thos. L. Hackett, Grand Rapids.
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MINNESOTA.

Col. V. W. Halstead, St. Paul.	J. Killoran, Duluth.
Thos. Shaw, St. Anthony Park.	A. M. Chisholm, Duluth.
John McAlpine, Duluth.	Geo. H. Crosby, Duluth.
Chas. L. Hyde, Duluth.	

MISSOURI.

M. Schulter, St. Louis.	Geo. E. Bowen, St. Louis.
Frank Anderson, St. Louis.	H. H. Wernse, St. Louis.
L. E. Archias, Sedalia.	T. R. Ballard, St. Louis.
L. H. Archias, Sedalia.	Levi Chubbuck, Skidder.

## MONTANA.

J. A. Switzer, Bridger.  
Herbert Strain, Great Falls.  
J. H. Anderson, Butte.  
W. A. Clark, Butte.  
A. B. Everett, Harlem.  
C. H. Campbell, Great Falls.

Wm. Roberts, Great Falls.  
T. M. Everett, Harlem.  
Samuel Dinsmore, Missoula.  
Austin North, Billings.  
S. R. Strain, Great Falls.

## NEBRASKA.

F. V. Meagley, Lexington.  
F. L. Temple, Lexington.  
H. C. McKibbin, Lexington.  
J. S. Thomas, Lexington.  
A. C. Banks, Lexington.  
T. H. Boyles, Lexington.

P. Maginnis, Kimball.  
T. L. Doherty, Loomis.  
J. E. Smith, Beatrice.  
W. H. Wright, Scotts Bluff.  
F. M. Sands, Scotts Bluff.  
L. P. White, Lexington.

## NEVADA.

Chas. Sparks, Reno.  
Francis G. Newlands, Reno.

A. E. Chandler, Carson City.  
J. M. Jones, Reno.

## NEW MEXICO.

Adin H. Whitmore, Las Vegas.  
M. W. Browne, Las Vegas.  
Chas. Ilfeld, Las Vegas.  
W. S. Gillian, Mesilla Park.  
G. W. Mossman, Earlsboro.  
S. G. Kilgore, Berino.  
A. H. Pearson, Hillsboro.  
Eugene Van Patten, Las Cruces.  
H. C. McLallen, Columbus.  
M. D. Gaylord, Nogales.  
J. A. Mahoney, Deming.  
E. H. Bickford, Lake Valley.  
W. T. McCreight, Albuquerque.  
A. L. Kendall, Cerillos.  
L. T. McLaughlin, Albuquerque.  
H. D. Bowman, Las Cruces.  
Guadalupe Ascarate, Las Cruces.  
Martin Lehman, Las Cruces.  
B. W. Randall, Lordsburg.  
F. G. Tracy, Carlsbad.  
H. C. Abbott, Springer.  
C. E. Linney, Santa Fe.  
Pearl Bailly, Chamberino.  
Oscar C. Snow, Mesilla Park.  
Mrs. C. E. Linney, Santa Fe.  
W. M. Reed, Roswell.  
J. S. Brown, Lordsburg.  
A. W. Wilson, Deming.  
Jay Turley, Santa Fe.

S. D. Swope, Deming.  
Geo. W. Prichard, Santa Fe.  
Wm. Palmer, Garfield.  
Herbert B. Holt, Las Cruces.  
A. M. Hove, Carlsbad.  
Edwin A. Chaffee, Las Cruces.  
Geo. H. Webster, Carlsbad.  
R. E. Twitchell, Las Vegas.  
J. D. Tinsley, Las Cruces.  
B. L. Rodey, Albuquerque.  
Theodore Ronault, Las Cruces.  
M. T. Brown, Las Cruces.  
R. S. Benson, Carlsbad.  
Herman Westheim, Dona Ana.  
W. N. Hager, Las Cruces.  
Henry Stoes, Las Cruces.  
W. C. Mead, Victoria.  
Jesus Ochoa, Anthony.  
Angel Alvarez, Anthony.  
R. J. Bolles, Carlsbad.  
Samuel I. Roberts, Carlsbad.  
C. H. McLennan, Carlsbad.  
B. L. Sullivan, Carlsbad.  
James G. McNary, Las Cruces.  
Jose R. Lucero, Las Cruces.  
Prof. Luther Foster, Las Cruces.  
W. Rogers, Chamberino.  
Nestor Armijo, Chamberino.  
Prof. J. J. Vernon, Mesilla Park.

## NEW YORK.

Truman G. Palmer, New York City.

## NORTH DAKOTA.

E. F. Chandler, University.

## OHIO

C. M. Cook, Toledo.

## OKLAHOMA.

W. T. Little, Perry.  
 Joseph B. Thoburn, Guthrie.  
 F. F. Ferguson, Union City.  
 E. J. Murphy, Arapaho.  
 J. M. Hayes, Mountain Park.  
 J. Campbell, Mountain Park.  
 W. L. Fullerton, Victory.  
 Dr. W. Woodward, Snyder.  
 Joseph McNeal, Guthrie.  
 J. M. Cassidy, Chandler.  
 Jared Sater, Sr., Kenton.  
 J. M. Potter, Kenton.  
 L. A. Wykoff, Kenton.  
 H. H. Champlin, Enid.  
 F. M. Cline, Woodward.  
 Mark Roberts, Mountain Park.  
 W. R. Baldwin, Cordell.  
 Geo. W. Seifert, Berlin.  
 Frank D. Northup, Oklahoma City.  
 C. G. Jones, Oklahoma City.

Sidney Clarke, Oklahoma City.  
 E. E. Brown, Oklahoma City.  
 Tesse C. Davis, Frederick.  
 Frank Lugert, Lugert.  
 Jno. S. Carmack, Snyder.  
 A. J. Hunter, Snyder.  
 S. J. Morris, Hooker.  
 C. W. Wolfington, Hooker.  
 Walter Naylor, Guyman.  
 G. H. Matthes, Lawton.  
 Miss Blanche Hinckley, Watonga.  
 Fwers White, McLoud.  
 S. B. Launs, Woodward.  
 E. W. Kinman, Guthrie.  
 A. R. McLennan, Lawton.  
 C. S. Meredith, Lawton.  
 C. B. Bellamy, Lawton.  
 W. M. Turner, Lawton.  
 P. H. Haner, Guthrie.  
 W. W. Wolfington, Beaver.

## OREGON.

C. W. Mallet, Ontario.  
 Miss Clara S. Carlisle, Portland.  
 Mrs. L. A. Carlisle, Portland.  
 H. C. Willis, Echo.  
 Tom Richardson, Portland.  
 Thos. G. Hailey, Pendleton.  
 E. L. Smith, Hood River.  
 A. H. Devers, Portland.  
 Steven A. Lowell, Pendleton.  
 A. K. Wilson, Portland.

E. M. Bramick, Portland.  
 J. N. Williamson, Priceville.  
 Gus Weber, Pendleton.  
 Frederick C. Harlow, Pendleton.  
 J. K. Reader, Ashland.  
 Mrs. A. F. Wood, Cottage Grove.  
 W. W. Sibrary, Portland.  
 J. M. Moore, Portland.  
 Mrs. J. M. Moore, Portland.

## TEXAS.

J. A. Smith, El Paso.  
 J. P. Casey, El Paso.  
 Prof. H. P. Attwater, Houston.  
 P. Theaux, Houston.  
 H. M. Holleman, Houston.  
 Judge W. A. Evans, Bonham.  
 C. E. Kellogg, Clint.  
 F. M. Walker, Galveston.  
 G. Waldo, El Paso.  
 A. N. Brown, El Paso.  
 A. Dulchery, El Paso.  
 J. D. Mason, El Paso.  
 V. R. Stiles, El Paso.  
 W. R. Brown, El Paso.  
 J. D. Morrison, El Paso.  
 C. R. Morehead, El Paso.  
 T. S. Foster, Sweetwater.  
 S. P. Weisiger, El Paso.  
 Adolph Hoffman, El Paso.

P. F. Edwards, El Paso.  
 Prof. Monta Beach, Houston.  
 W. B. Phillips, Austin.  
 J. A. Gillette, Marfa.  
 J. C. Bird, Alpine.  
 Morris P. Kirk, El Paso.  
 A. A. Ward, Beaumont.  
 W. L. Malcolmson, Marfa.  
 Henry Warren, Dallas.  
 J. A. Kemp, Wichita Falls.  
 Clell A. Thorpe, Pecos.  
 G. P. Lessing, El Paso.  
 J. A. Udden, Austin.  
 A. P. Coles, El Paso.  
 Aleck Meerscheidt, San Antonio.  
 Paul Stieren, San Antonio.  
 F. M. Edwards, San Antonio.  
 Jno. C. Beck, San Antonio.  
 G. Bedell Moore, San Antonio.

## TEXAS.—CONTINUED.

A. C. Wilmoth, Snyder.	G. M. Otis, Grand Falls.
Geo. E. Barstow, Barstow.	J. M. Ingle, Abilene.
Daniel J. Rogers, Barstow.	P. M. Millsbaugh, El Paso.
Geo. E. Briggs, Barstow.	Thos. H. Bomar, Grand Falls.
N. D. Lane, El Paso.	T. A. Thompson, Grand Falls.
John Kelley, San Saba.	Leonard Strable, Grand Falls.
Joe A. Williams, San Saba.	J. H. Stephens, Vernon.
John Hall, Lampasas Springs.	Z. L. Cobb, El Paso.
A. W. Gifford, El Paso.	J. J. Smith, Ysleta.
W. W. Turney, El Paso.	J. Stoney Percher, El Paso.
Alfred Courchesne, El Paso.	Felix Martinez, El Paso.
J. R. Harper, El Paso.	E. J. Hadlock, El Paso.
Francisco Mallen, El Paso.	J. R. Cunningham, Abilene.
John W. Fisher, El Paso.	Frank Johnson, Colorado.
E. Kohlberg, El Paso.	W. T. Lee, El Paso.
E. C. Pew, El Paso.	J. L. Rhead, El Paso.
W. Trickey, Pearsall.	B. F. Hammett, El Paso.
R. Woodward, Pearsall.	W. H. Winn, El Paso.
J. J. Mundy, El Paso.	A. Starr, Dallas.
C. O. Coffin, El Paso.	C. A. Greene, El Paso.
Prof. T. U. Taylor, Austin.	

## UTAH.

John Henry Smith, Salt Lake City.	Alex Brown, Randolph.
John Beck, Salt Lake City.	Thos. H. Means, Salt Lake City.
Miss Margaret Parks, Salt Lake City.	C. J. Humphries, Ogden.
Roger Farrer, Provo City.	O. B. Gilson, Ogden.
Jas. Meldrum, Provo City.	Chas. W. Penrose, Salt Lake City.
Fred J. Kiesel, Ogden.	Thos. Maloney, Ogden.
Miss W. R. Kiesel, Ogden.	Rufus Garner, Ogden.
L. W. Shurtliff, Ogden.	J. F. Pender, Ogden.
Dr. H. J. Faust, Salt Lake City.	Chas. F. Middleton, Ogden.
R. W. Young, Salt Lake City.	Jos. Carlson, Ogden.
Andrew Knudson, Provo City.	G. L. Hutchins, Ogden.
Oscar B. Young, Provo City.	John W. Wheelright, Ogden.

## WASHINGTON.

C. C. Hewitt, Spokane.	C. Eugene Bortle, Spokane.
Jno. F. Greene, Harrington.	H. B. Scudder, North Yakima.
A. W. Hadley, Spokane.	

## WISCONSIN.

Delbert Utter, Lake Beulah.	Chas. L. Slichter, Madison.
Thos. Barden, Ashland.	Gilbert Kleven, Mt. Horeb.
Martin Pattison, Superior.	A. H. Peacock, Lake Beulah.
Howard Thomas, Superior.	O. Greeley, Lake Beulah.
C. H. Callender, Black River Falls.	Chas. J. Maple, Milwaukee.
J. B. Stair, Lake Mills.	

## WYOMING.

O. Felker, Sheridan.

## MEXICO.

Gen. W. D. Snyman, Chihuahua.	Mariano Saminego, Juarez, Chih.
Guillermo Robert, Juarez, Chih.	Vicente Cordero, Juarez, Chih.
Inocente Ochoa, Juarez, Chih.	Rodolfo Chavez, Juarez, Chih.

## MEXICO.—CONTINUED.

Juan N. Fandoa, Chihuahua.	Anthony W. Ivins, Colonia Juarez.
C. A. Mathewson, Chihuahua.	Wm. C. McCellan, Colonia, Juarez.
J. P. Conduit, Tlilhualilo, Coah.	Chas. Whipple, Colonia Juarez.
B. F. Butler, Lerdo, Dgo.	Wm. G. Sears, Colonia Dublan.
C. C. Gonzales, Chihuahua.	Sam'l J. Robinson, Colonia Dublan.
R. Anderson, Chihuahua.	Lic. J. N. Amador, Ciuda Juarez.
Dr. W. C. Rowlings, Chihuahua.	Ing. P. Aguilar, Guanajuato.
Manuel M. Mendiola, Victoria, Tam.	Raphal de la Mora, Guadalajara, Jal.
Jose Duvallon, Victoria, Tam.	Ignacio Carranza, Mexico City.
Carlos Arguelles, Victoria, Tam.	Alberto Guajardo, Muzquiz, Coah.
Ignacio R. Montemayor, Jaumane, Tam.	Fred Eldridge, Casas Grandes.
A. E. Graham, La Cruz Sta., Tam.	J. M. Pryde, Casas Grandes.
Jose Martinez, Santa Engracia, Tam.	Jas. P. Dardon, Colonia Juarez.
Santiago M. Seguin, Monterey, N. L.	Benj. Echols, Oaxaca, Sonora.
Wentworth S. Conduit, Monterey, N. L.	Espiradion Provencio, Colonia Juarez.
A. B. Call, Colonia Dublan.	Don Romulo Escobar, Ciudad, Juarez.
Henry E. Bowman, Colonia Dublan.	Ambrosio Romo, Zacatecas.
D. C. Sutton, Sabinal, Chih.	Roberto Gayol, Mexico City.
Heleman Pratt, Colonia Dublan.	E. T. Turley, Colonia Juarez.
Sr. Jacobo Blanco, San Luis Potosi.	Maxwell A. Kilbert, Mexico City.
	Lic. Felipe Seijas, Juarez.
	O. C. Ellison, Hermosillo, Son.

## OTHER FOREIGN GOVERNMENTS.

M. K. H. Bakhati, Cairo, Egypt.

Delegates were appointed under the provisions of the official call by the following:.

## STATES.

California.	Missouri.
Colorado.	Montana.
Idaho.	Nebraska.
Illinois.	Nevada.
Iowa.	Oregon.
Kansas.	South Dakota.
Kentucky.	Texas.
Louisiana.	Utah.
Michigan.	Washington.
Minnesota.	Wisconsin.

## TERRITORIES.

Arizona.	New Mexico.
District of Columbia.	Oklahoma.
Indian Territory.	

## FOREIGN COUNTRIES.

Egypt.	Republic of Mexico.
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## COUNTIES.

Dona Ana County, Arizona.	Sierra County, New Mexico.
Graham County, Arizona.	El Paso County, Texas.
Pinal County, Arizona.	Ward County, Texas.
Yuma County, Arizona.	Rich County, Utah.
Grant County, New Mexico.	Weber County, Utah.
Las Cruces County, New Mexico.	Lincoln County, Washington.

## CITIES.

Birmingham, Alabama.	Kansas City, Missouri.
Bisbee, Arizona.	St. Joseph, Missouri.
Phoenix, Arizona.	Lexington, Nebraska.
Pima, Arizona.	Scotts Bluff, Nebraska.
Thatcher, Arizona.	Albuquerque, New Mexico.
Tucson, Arizona.	Deming, New Mexico.
Fresno, California.	Las Vegas, New Mexico.
Los Angeles, California.	Santa Fe, New Mexico.
Pasadena, California.	Springfield, Ohio.
Santa Barbara, California.	Piqua, Ohio.
San Francisco, California.	Portsmouth, Ohio.
Sacramento, California.	Lawton, Oklahoma.
Tulare, California.	North Bend, Oregon.
Colorado Springs, Colorado.	Pendleton, Oregon.
Cripple Creek, Colorado.	Austin, Texas.
Denver, Colorado.	Bonham, Texas.
Pueblo, Colorado.	El Paso, Texas.
Atlanta, Georgia.	Marfa, Texas.
Boise City, Idaho.	Wichita Falls, Texas.
Chicago, Illinois.	Ogden, Utah.
East St. Louis, Illinois.	Provo City, Utah.
Kansas City, Kansas.	Salt Lake City, Utah.
Henderson, Kentucky.	Spokane, Washington.
Lexington, Kentucky.	Walla Walla, Washington.

## UNIVERSITIES AND COLLEGES.

University of Arizona, Tucson.	University of North Dakota.
New Mexico College of Agriculture and Mechanical Arts.	University of Texas.

## COMMERCIAL ORGANIZATIONS, IRRIGATION ASSOCIATIONS, ETC.

Business Men's League of Decatur, Alabama.	Imperial Valley Chamber of Com- merce, Imperial, California.
San Pedro Valley Water Users' As- sociation, Benson, Arizona.	Imperial Water Company, Imperial, California.
Chamber of Commerce, Douglas, Ari- zona.	Board of Trade, Los Angeles, Cali- fornia.
Douglas Branch of Irrigation Asso- ciation, Douglas, Arizona.	E. Whittier Land & Water Co., Los Angeles, California.
Casa Grande Water Association, Florence, Arizona.	Jobbers' Association, Los Angeles, California.
Mesa Canal Company, Mesa, Arizona.	Chamber of Commerce, Los Angeles, California.
Board of Trade, Nogales, Arizona.	Modesto Irrigation District, Modesto, California.
Salt River Valley Water Users' Asso- ciation, Phoenix, Arizona.	Board of Trade, Redlands, California.
Association Civil Engineers, Tucson, Arizona.	Chamber of Commerce, Riverside, California.
Chamber of Commerce, Tucson, Ari- zona.	Chamber of Commerce, Sacramento, California.
Casa Grande Water Users' Associa- tion, Tucson, Arizona.	Merchants' Association of San Fran- cisco, California.
Board of Trade, Little Rock, Arkan- sas.	California State Board of Trade, San Francisco, California.
Chamber of Commerce, Brawley, California.	Westminster Farmers' Club, West- minster, California.
Water Consumers' Association, Ceres, California.	

COMMERCIAL ORGANIZATIONS, IRRIGATION ASSOCIATIONS, ETC.—CONTINUED.

- Chamber of Commerce, Denver, Colorado.
- Grand Rapids Board of Trade, Bloomington, Illinois.
- National Business Men's League, Chicago, Illinois.
- Arkansas Valley Land & Irrigation Company, Garden City, Kansas.
- Mercantile Club of Kansas City, Kansas.
- Mechanics & Lumbermen's Exchange, New Orleans, La.
- Board of Trade, Grand Rapids, Michigan.
- Business Men's Club, Sedalia, Missouri.
- Interstate Merchants' Association, St. Louis, Missouri.
- Merchants' Association, St. Louis, Missouri.
- Commercial Club, Duluth, Minnesota.
- Public Affairs Committee, Duluth, Minnesota.
- Rosebud Irrigation Company, Bridger, Montana.
- Business Men's Association, Great Falls, Montana.
- Chamber of Commerce, Reno, Nevada.
- Refugio Community Ditch Association, Anthony, New Mexico.
- Commercial Club, Albuquerque, New Mexico.
- Pecos Irrigation Company, Carlsbad, New Mexico.
- Carlsbad Commercial Club, Carlsbad, New Mexico.
- Pecos Water Users' Association, Carlsbad, New Mexico.
- Chamberino Community Ditch Association, Chamberino, New Mexico.
- Community Ditch Association, Dona Ana, New Mexico.
- Adelphi Club, Deming, New Mexico.
- Chamber of Commerce, Earls, New Mexico.
- Community Ditch Association, Hatch, New Mexico.
- Board of Trade, Las Cruces, New Mexico.
- Chamber of Commerce, Las Cruces, New Mexico.
- Mesilla Community Ditch Association, Mesilla, New Mexico.
- Horticultural Society, Mesilla, New Mexico.
- Community Ditch Association, Mesilla Park, New Mexico.
- Horticultural Society, Santa Fe, New Mexico.
- Board of Trade, Santa Fe, New Mexico.
- La Mesa Community Ditch Association, Victoria, New Mexico.
- Commercial Club, White Oaks, New Mexico.
- San Miguel Community Ditch Association.
- American Protective League, New York.
- Commercial Club, Beaver, Oklahoma.
- Commercial Club, Guthrie, Oklahoma.
- Commercial Club of Guymon, Oklahoma.
- Hooker Irrigation Society, Hooker, Oklahoma.
- Oregon Development League, Echo, Oregon.
- Commercial Club, Cottage Grove, Oregon.
- Morrow County Development League, Heppner, Oregon.
- Commercial Club, Irrigon, Oregon.
- McMinnville Development League, McMinnville, Oregon.
- Chamber of Commerce, Ontario, Oregon.
- Board of Trade, Portland, Oregon.
- Board of Trade, Austin, Texas.
- Chamber of Commerce, Beaumont, Texas.
- Barstow Irrigation Company, Barstow, Texas.
- S. W. Irrigation Association, El Paso, Texas.
- Franklin Irrigation Company, El Paso, Texas.
- Chamber of Commerce, El Paso, Texas.
- International Miners' Association, El Paso, Texas.
- Grand Falls Land & Irrigation Company, Grand Falls, Texas.
- Galveston Business League, Galveston, Texas.
- Houston Business Men's League, Houston, Texas.
- Texas Miners' Association, Marfa, Texas.
- Irrigation Company of San Saba, Texas.
- Board of Trade, San Saba, Texas.
- Business Men's Club, San Antonio, Texas.
- Huntsville Irrigation Association, Huntsville, Utah.

## COMMERCIAL ORGANIZATIONS, IRRIGATION ASSOCIATIONS, ETC.—CONTINUED.

Chamber of Commerce, Ogden, Utah.	Davis & Weber Canal Company, Utah.
Ogden Canal and Water Company, Ogden, Utah.	Chamber of Commerce, Spokane, Washington.
Weber Club of Ogden, Utah.	Business Men's Association, Sheridan, Wyoming.
Lynne Irrigation Company, Ogden, Utah.	Department of the Interior of Washington, D. C.
Provo Commercial Club, Provo, Utah.	Department of Agriculture of Washington, D. C.
Randolph & Sage Co., Irrigation Company, Randolph, Utah.	

## FOREIGN.

Dublin Industrial Society.	Colonization Company, Republic of Mexico.
Irrigation Projects Office, Egypt.	Agriculture and Horticultural Society, Republic of Mexico.
Board of Trade, Hermosillo, Republic of Mexico.	

The Chairman of Committee on Credentials reported that there were present 468 delegates.

Delegate from Oklahoma—I move that the report of the Committee on Credentials be received, and that the committee be discharged.

Motion carried.

The Chairman: We will now proceed for the location of the capital (laughter)—I was going to say this is a capital organization—for the location of our next meeting place. We will proceed to select the location for the next Congress. I have now the pleasure of introducing to you Mr. Hawley, of Idaho.

Mr. Hawley—Mr. President, ladies and gentlemen of the convention: I have been requested by my brother delegates of the Idaho delegation to present to you in behalf of Idaho a candidate for the honor of the next meeting of the Irrigation Congress. We, of Idaho, although we realize that we have not a State that is as great in area as California or as Texas, believe that we have one of sufficient importance to entitle our claims for this great honor to respectful consideration at the hands of this Congress. Idaho extends from British Columbia on the north to Utah and Nevada on the south; it extends from Oregon and Washington on the west to Montana and Wyoming on the east. It embraces within its area many diversified climates; many different sections which have different lines of business in which the inhabitants are engaged. We have in the north the greatest wheat-growing section in the United States, equaled only, but exceeded by none. Again in the central part of the State we have the mountains—the snow-capped mountains with their rock-ribbed sides, that seemingly hold promise in the near future to make us the equal of Colorado and Montana as a mining region. But more important than all, and comprising two-thirds of the entire State, is the southern part—the irrigated section. We have here a section that is singularly favored by nature. We are the only State of the arid region that has a sufficient supply of water for the irrigation of lands within our limits. A great tributary of the Columbia River runs through our borders from east to west, commencing at the Oregon line, making the most fertile valley in the universe. And this one valley is from 50 to 150 miles wide, and not only is the Snake River traversing this great section, but other rivers, not as



great, but almost so, flow there. And of all this land, with the exception of a comparatively small portion, is the richest land on God's footstool, all susceptible of irrigation, and all it needs is active aid in the way of reclamation to make it blossom and bloom like the rose. Situated at the head of one of these valleys—situated where the Boise River commences and where the great valley stretches, is located the capital city—Boise the Beautiful. Commencing as a mining camp, as a convenient center for the distribution of the supplies in the days of the '60s, it gradually grew to large proportions, and the people began to talk of building up the city, in making it a place in which families could live. And finally we ascertained that the soil which had been considered worthless, was, upon the application of water, capable of growing any vegetables, any fruits that could be grown in the temperate regions of this country. And borrowing from our neighbors in Utah to the south, we commenced an irrigation system in the State, which, from a small beginning, has grown until now it is the greatest in these United States. First, my fellow delegates, taking the property near the river, and the lowlands, then ascertaining that the higher lands were better, we commenced a system of canals which cover almost the entire valley in the vicinity of Boise. We have extended that canal system until 225,000 acres of the land of that little valley are under our canals and are being cultivated at the present time. We have a city that for beauty is unequaled in the West. We have a population of earnest and active men and women. We have endeavored in that far-away country to build up a community thoroughly American in principle, one that is bound to advance as irrigation advances, and there is no limit to the capacity of production of the ground upon which it stands and which is tributary to us. We have a population at the present time of about 20,000, but we are thoroughly prepared to entertain the next Irrigation Congress. We have every facility for doing justice to as great an assemblage as has convened in El Paso at the present time. We have a city to which we can refer with expressions of pride. We are an active community, a growing community. We have expended there during the last three months over \$300,000 upon our streets and our sidewalks; we do not owe a dollar of it, because we paid for it as we went. And other improvements are now in process of construction that will be finished by next September at least, costing \$700,000 more. We have in the vicinity of Boise the greatest irrigating enterprises that are now being projected in the United States. At Twin Falls, but a few hours' ride, there has been taken from the Snake River by means of dams and canals, a sufficient volume of water to irrigate 280,000 acres of land, and during the next season that water will be used upon these lands. A great community is growing up in that section which a year ago was given over to the jack rabbit and coyote.

We have at Minidoka, but a few hours' ride from Boise, a great government enterprise in course of construction. The contracts have been partially let, and over 180,000 acres of the finest land will be added to the agricultural resources of the State. We have a project which is already in process of survey, and will undoubtedly, during the next year, be carried to completion, involving the expenditure of \$6,000,000, which will conserve the waters of the great storms for use upon the lands that are not already covered. We have,

within a few hours' ride, in the regions of the Snake River, 500,000 acres of land irrigated in three months. We have great enterprises there—some in completion and some in process of construction. And I say to you, my fellow-delegates, if this is really an Irrigation Congress—if we want to improve our knowledge on facts involved therein, we should take this Congress to some place where irrigation is being practically carried on and where its workings can be studied.

I have the pleasure to name Boise for your favorable consideration. Although situated in the greatest of the irrigating States of the United States, never have we as yet been honored with a meeting of this Congress. We believe that if you will come to us and hold a session there you can learn much that will be of profit to you in the future. We believe if you will meet in our midst that it will be of benefit to yourselves.

We have come here from Idaho intending, by fair means if possible, to bring this convention to our own capital city. We have refused to enter into any combination. We have absolutely refused to entertain propositions that would in any way entangle the delegation from Idaho in the future. We present the name of our city upon its merits. We have not asked reciprocity from any one. We have not asked that some State shall favor us now because in the future we will give them our vote. We have not in any way compromised the future of the delegation from our State or from any other State. And I say to you that the rule that seems to have prevailed heretofore in this convention in certain States is one that should be absolutely foreign to the conduct of this convention.

It was only last night that in the lobby of the Sheldon Hotel I heard a gentleman from one of the greatest States say to a fellow-delegate from that State, "Take off one of those badges," and he had on the badge of the State of Colorado, and a badge reading "Boise, the Beautiful, for the next Session," and I spoke to him, and he says "it is understood that our delegation is going for Portland upon to-morrow's session." And I asked him why they were so doing, and he informed me that the reason was the fact that the Oregon delegation in the Mining Congress had seen to it that Denver was made the permanent city of that congress, and they proposed to reciprocate, and they were pledged to that effect, and I say to you, when delegations to this Congress, or to any congress, who come here for the interests of the arid section, so far forget their duty to the interest which they are supposed to represent, as to trade and traffic for the sake or benefit of their own locality, that they are traitors to their cause so far as the great interest of irrigation is concerned, and I am glad to say that that gentleman from Colorado retained that Boise badge upon his breast and refused to discard it because the Chamber of Commerce of Denver had entered into a trade by means of which the Colorado vote was to be cast against us.

I simply refer to this, not in a spirit of criticism towards these gentlemen, but I believe it is my duty to make these statements. I believe that this practice of swapping votes—that this practice of trading in regard to localities—is one upon which you should stamp the seal of your condemnation here and now, because it is unworthy of this great convention. We should meet wherever it is to the interest of the cause of irrigation to have the Congress go.

Now, my friends, what have you in opposition of Boise? As I understand it the only place, now, that is to present its claims against Boise for the next Congress is the city of Portland, in Oregon. Oregon is a great State, and Portland is a fine city. No one appreciates that more than the people of Idaho. But, my friends, Portland is the last place, in my humble judgment, to which an Irrigation Congress could go. What they want there is draining—not irrigation. Why, up in my country when we speak of an Oregonian, or one that lives west of the Cascade Mountains, we generally refer to him as a “web-foot,” because it is currently reported that a man that has lived in that section for a few years, on account of the humidity of the atmosphere, develops some of the characteristics of the duck family. Now, I am not stating this as a jeer against Portland. I am simply stating that which is a matter of current rumor. If they desire to disprove it, they can do so to this Congress.

Now, ladies and gentlemen, there is an eternal fitness in all things, and while I am not so hidebound as to deny to any State the privilege of meeting with us in an Irrigation Congress; while I would like to educate the people of the entire country up to the standard of irrigation, and impress upon them the need of building up a certain section of their own communities; while I believe that it is best to give space to every State and every Territory in this Congress for the sake of educating them up to the true standard, still I am not one of those who believe in taking this Congress away from the arid region to some place that does not need it. The papers that are read before us are for the purpose of instructing us as to the practical working of irrigation matters, that they may be thoroughly understood. Can you go to Portland and learn anything about irrigation? Is there anyone there that ever irrigates, unless they do it under a roof? I tell you, there is not an irrigating canal within 200 miles of the place, so what could you learn? My friends of Oregon have promised us a great deal. If they have not promised gum boots and rubber coats, I would advise you not to forget your own, for you will need them in Portland. Now, what claim has the State of Oregon, or at least that portion of the State of Oregon, upon this Congress? I ask you who are impressed with the importance of this question, and desire the success of the reclamation of the arid lands, what single, solitary valid reason you can present for taking this Congress to a location like that? What can you learn? How can you improve your knowledge in regard to this great subject? Can you do it by observation? Will you do it simply by hearing papers read? I tell you that you can only learn by the observation of actual reclamation and the working of great irrigation projects—not merely by listening to papers being read, for you can later read them yourself just as well.

Now, my fellow-delegates, it strikes me that if we are in earnest in this matter—and I believe this is a Congress of earnest men and earnest women—we will conceive that we have a great duty to perform—to assist in building up this great inland empire. I desire to appeal to you, as honest men and honest women coming here for this great purpose, whether or not a city like Boise, situated in the heart of the arid region, situated where you

can see practical irrigation carried on, where you can see the operation of the great enterprises that are already complete and those nearing completion, I ask you if this Congress can be taken from a locality of that kind, here in the arid region, and brought to the city of Portland, if the delegates that do that are doing their duty to the people that sent them here, and to the interests which they represent?

I would ask each and every one of you who are in doubt upon this subject, who have not absolutely made up your minds as to what way you will vote, I would ask you to call here upon this stand before this is determined such men as Professor Newell, the head of the Reclamation Department of the United States, and who is familiar with this great question in all of its details; I would ask you to bring such men as Mr. Fowler from Arizona, the father of the great Salt River section, who knows full well what Idaho is in this regard, and what the other arid States are. I would ask you to call Senator Newlands, who is versed in everything pertaining to this, and our retiring President here has a knowledge of the question in every particular. They might not like to take sides upon this question, but I believe that each and every one of them will rise in his place here and express his opinion regarding this great question, I believe that each and every one of them would tell you, ladies and gentlemen of the Congress, that it is your duty as delegates to see to it that this convention goes to Boise, instead of to rainy Portland.

But we are imformed, as I understand it, by our Portland friends, that there is another question to be considered. Away back in 1804 the President of the United States sent Lewis and Clark into that section of the contry, and they finally arrived on the Pacific Coast in 1905, and the city of Portland, in commemoration of that great undertaking, is about to start a great Exposition, and that the world is invited, and we believe that in taking the lead on this worthy matter, they are entitled to the commendation of the people of these United States. We, of Idaho, propose to help them to the utmost. We propose to assist them in every way in our power. But when they present as an argument to you that it is your duty to vote for the city of Portland because they are about to hold an exposition there, they are presenting a fallacious argument, and one which I believe you should not consider for one moment. Do you believe that this Irrigation Congress can be made a side-show to the Lewis and Clark Exposition and do us any good? Don't you know that if this Convention is taken to that place where the Exposition is being held that it will interfere most materially with the labors of the Convention? Have not these matters been before now attempted, and have they not always failed? Why here but a short time ago the Trans-Mississippi Congress was held in the city of St. Louis. I sent several delegates by virtue of my official position, and upon their return they informed me that it was a failure, simply for the reason that it was held in an exposition city, and they could not secure the attention of those who had gone there for that purpose. And the same way will it be in the city of Portland. You cannot, if attractions of this kind are going on, secure the attendance of the delegation. You cannot in Portland, no more than you could in St. Louis, prevent this exposition from interfering with the business of the

Congress. It is something that is impossible. But while we are not in favor of sending this Congress to the city of Portland, we are in favor of assisting that city in every way, and I want you all to remember that Boise is upon the road to Portland. I want you to remember that if you go to Boise, or stop at Boise for the Congress, that it will cost you no more than it would to go to Portland to see the Exposition and the Congress together, because, so far as your transportation is concerned, I am glad to be able to inform you that it is already provided for. To-day I had a message from Mr. Burley, the General Passenger Agent of the Oregon Short Line Railway, and he informs me in this telegram that in the event the Convention is taken to Boise City, that the privilege will be extended to all who desire to go to the Exposition and who have bought their tickets, to lie over in Boise as long as they shall desire, and their tickets will be good. So you will see that if it is the Exposition that you desire to see, and also if you desire to attend the Congress, you can see them both, and see that beautiful valley and inform yourselves regarding its great irrigation projects, and you can extend your visit to the city of Portland and take in the great show as well. I understand there has been considerable question regarding this matter. I understand that it is a question of transportation. This will settle it; the telegram is as follows:

"Hon. James A. Hawley: Referring to your telegram, stop-over privilege at Boise will be allowed on all tickets—and this arrangement should be the means of securing large attendance if the next meeting of the Convention is held in Boise City."

I assure you that so far as this question of transportation is concerned, it is one that we have met to the fullest extent.

Ladies and gentlemen, I have endeavored to present our city to you as fully as possible. I believe it is to the best interests of this Congress that it should go to Boise. If you choose to come and see us, if you choose to visit with us, we will meet you with a hearty welcome; we will extend the same measure of hospitality that the citizens of El Paso have extended to this Convention. We will ask you to come in force. We will ask you to bring your wives and children, and you had better, because if you ever come to Idaho and stay three days, I don't believe you will ever go back home.

We ask you to come there to study the irrigation problems which we are solving; we ask you to go home from that Congress and pattern after those efforts we have been making to build up a great city in Idaho, and I believe if you do come, I believe if you select Boise as the next meeting place of this Congress, you will do the interests of reclamation more good, you will work more benefit for the irrigation subject, than you could by selecting any other place.

The Chairman—I have the pleasure of introducing to you Hon. T. Lovell of Oregon.

Mr. Lovell—Mr. President, Delegates of the 12th National Irrigation Congress: I hold in my hand a telegram addressed to the President of this

Convention, from the Governor of the Commonwealth of Oregon. In language it is as follows:

"Hon. W. A. Clark, President: As executive of Oregon, and on behalf of her people, I extend a cordial invitation to the Irrigation Congress, a cordial reception and a pleasant time.

"GEORGE E. CHAMBERLAIN, Governor."

In the absence of the Governor of the Commonwealth from which I come, and in the name of her people, I bring to you a message and an invitation from the City of Roses, the Jewel of the Pacific Northwest, Portland. From Oregon, that magnificent State resting upon the Pacific, and stretching for 400 miles into the great American Desert. A city of magnificent possibilities and great resources; her mountains filled with mineral wealth, with more standing timber than any other State in the Union, situated in the zone of power, principal contributor to the reclamation fund of this nation; her agricultural features are great—a giant majestic sleeping—wanting only the influences which your organization represents, to spring forth into leadership in the battle for all that is best in the civilization in which we live—the happiness to the homes of men.

We present this invitation from various considerations. First, I appeal to that common justice which characterizes the American people, and appeal to you to send the next Convention to us, because the chronological history of this organization as displayed to you upon this banner indicates that as the standard of the life of man is measured, this Congress has lived almost a generation, and every important center throughout the great arid region has been represented, and now we ask you to come to an important section of the great inland empire of the North, the region from which I come.

It was my privilege in 1894 to stand upon the platform in the City of Denver, and appeal for this honor to come to the City of Spokane; we were defeated by Albuquerque, and we have waited a decade and now come again to ask justice for the State of Oregon. We do it now, confident of your response, because there comes at this time in the city of Portland an event commemorative of the greatest expedition which has ever been attempted, an expedition which emphasizes and forever will emphasize the grandeur and the wisdom of the administrative ability of Thomas Jefferson. That expedition of Lewis and Clark, which gave to this union 300,000 square miles of territory, out of which there has been carved three great States and portions of two others—Oregon, Washington, Idaho, Western Montana and Northwest Wyoming, came into the Union because of the wisdom of Jefferson and the ability of his engineers. Idaho, we are not engaged in any agreement or compact in voting—we recognize you as the daughter of Oregon—we are proud of you, wayward now though you be, we know you will come back to the arms of your mother, and send to the Convention in 1905 a magnificent delegation from your great commonwealth.

Not only that, but we appeal to you because we need the influence of a Convention like this. There is no State in this broad Union so utterly misunderstood as is the Commonwealth of Oregon. The great rainfall in her mountains and at the mouth of the great river of the North has impressed

the people of the nation with the idea that we are a humid State, but the fact is that there is an arid empire within her borders; three-fourths of all our territory is dependent upon irrigation for its higher development. An area extending all its breadth and two-thirds of its length, filled with valleys arid; two ranges of mountains cross the State, the Coast range and the Cascades, and all east of the Cascades and south of the Blue Mountains and west of the Coast Range are of the same character as Idaho, Utah and Colorado, and that State needs the influence and inspiration of this Congress; the magnificent valley at the mouth of which Portland stands, the finest valley which could be found in the whole Northwest, has its wet and dry seasons, and already the people residing there are becoming impressed with the necessity of irrigation. Bring your Convention there, and there will be brought to our people the very influences which are required to raise the State to the high standard in which she belongs in the sisterhood of States.

Come to us, and show to us as teachers what we shall do to people the great arid section of that State, and to make it fertile. Teach us how to marry the mountain waters to the soil, that the result may be the disappearance of the sand, and in its place fruits, flowers, grains and grasses, and when that time shall come we will support twenty millions of people, and in every valley we will plant the standards of civilization—the church, the school, the farm and the factory.

Portland, beautiful as a dream, queen upon two rivers, with the finest fresh water harbor in the Republic, with well appointed hotels, with 150,000 people, with theaters and halls in great abundance, with a lighting system and trolley system unsurpassed anywhere, at her doorway a stream leading out to the Columbia and then to the ocean, a city standing ready with the hospitality which has always characterized her, to give you the advantages which she at this time is glad to give because of the great fair which has come to her door. She realizes the purpose of this fair is to be representative of the distinctive industries of the great West, mining and irrigation. There is no intention to make it of such magnitude as that held at St. Louis. It will be compact, ideal in its character, well appointed and so comprehensive in its scope that you can come there with your families, grasp it all in two or three days and possibly then to devote your whole attention to the Congress. Portland is able at this time to offer advantages which never before have been offered. The great trans-continental railway companies, not only because of their interest in the exposition, but because of their desire to carry homeseekers to see the great plains of the Pacific Slope, have made a railway rate which never before has been equaled, and we are sure that you can come to us from Missouri River points at a very low rate—coming over one road and returning over another. Portland proposes that you shall see an object lesson in irrigation as fine as there is in the whole Republic. Her proposition to you to-day, through me, as her representative, although not a citizen of Portland, but of Northeastern Oregon, is to say that in order that you may have this object lesson and in addition may see some of the great beauties and resources which surround her, she will charter one of the river steamers and take the delegates of this Convention, with their wives, upon a journey over the Rhine of the West. She will show to you the

beauties of the great river of the North, the Columbia, and she will land you in a great valley whose fame is as wide as the Republic.

Now, my friends, a part of the purposes of this Congress is education; you want an object lesson, we are told, and in addition to that we want the inspiration of your work for the great Northwest. Now, in addition to that, one of the great educating influences of this day is travel, and would you like to see, as you approach the Pacific, the great grain fields, the magnificent cities and mining interests of Montana, the wheat fields of Washington, the wonderful beauties of Puget Sound? Then come to Portland over the Great Northern Road. Or would you prefer to gaze on the glories of Colorado; would you examine the wonderful and impressive civilization which has been stamped upon the valleys of Utah, a civilization to which I here and now, as the representative of my people, lay a laurel, because they have come more nearly than any other to a solution of the great agricultural problems of the age. In addition to Utah and Colorado would you see the glories of transformation of Southern Idaho, would you see the mining interests of Eastern Oregon, then come to us through the central railway lines, which reach through the Ogden gateway. Or would your preference be to traverse this commonwealth so grand and so hospitable, go across those wonderful territories which sustain a magnificent population and under the inspiring influence of irrigation are going to be a paradise; would you go through the Italy of America, through orange groves of California and look upon the magnificent city of San Francisco and feast your eyes upon their glories; then come to us over the Southern route.

Delegate from Montana—I wish to second the nomination of Portland for the next Irrigation Congress. I thought it was fully understood at the Congress at Ogden last year that Portland was to receive the Congress the coming year. In fact, I was surprised when I heard to-day that there was any competition at all. I feel that we should help this great exposition at Portland. We find that they are having a great deal of trouble in getting attractions to that portion of the country, and I think we should help them in that exposition.

Delegate from Nevada—I wish to second the motion nominating Idaho. It was my pleasure in 1900 to go to Idaho. I had with me over \$250,000 from New York, London and Edinburgh, and I visited that section of the beautiful Boise River. There is no place in all the great West where there is demonstrated such practical irrigation as there is in that beautiful valley. I merely say this to show you that you will see demonstrated as you go to Boise City some of the most beautiful farms that this great continent has, and you will see an irrigation system that you can see in no other State, and all kinds of fruits and vegetables are there to be seen. I merely second the motion, and I know that Boise will give you a hearty welcome.

Delegate from Utah—On behalf of a portion of the delegation from Utah I rise to second the proposition that the next Irrigation Congress shall be held in the beautiful city of Portland. I don't intend to take up the time of the Congress this evening in advocating the claims of Portland, as they have been so well presented by the gentlemen chosen to do so. I merely



arise to remove, if possible, the impression that has prevailed among a great many of my friends of Utah, and their relatives and friends and associates in other parts of the country, particularly in Arizona and New Mexico, in regard to a little misunderstanding that occurred at the late Mining Congress in Portland, when Utah lost what she desired, that is, that the Mining Congress be permanently located in Salt Lake. We did not quarrel with our Colorado friends because they got the Congress. We have no fault to find with Portland. A little misunderstanding arose, in which some very unpleasant reflections were cast upon Utah and its people, and a great many people were under the impression that this slur came from Oregon, and particularly from Portland. That impression has been removed. The conflict that arose was simply between two members of the Congress, and the sentiments expressed were not endorsed by the people of Portland, and certainly not by the people of Oregon. It is true that the gentleman who made these remarks was rewarded by some of those splendid roses about which we have heard, but other persons in the Congress were also favored by roses, and I wish to say that if the Irrigation Congress shall be held in Portland there will be no regrets. We have no grudge against Portland nor Oregon generally on account of that little dispute. I merely make this remark to remove the impression mentioned.

I understood at the Irrigation Congress held in Colorado Springs two years ago that in 1905 Portland should have the Congress.

Mr. Holabird of California: I wish to second the nomination of Portland. In connection therewith I might relate the following. Some time ago, while traveling, I saw sixty cars, with the exception of one car, that were great big steel cars loaded with coal. In the middle of that train there was one little car loaded with coal. Some fellow had taken a piece of chalk and written upon the small car: "Never mind, little car, don't you cry, you'll be a big one by-and-by." And I might say "Never mind, Boise, don't you cry, you'll get the Convention by-and-by."

I have had the unusual privilege of traveling a great deal through the West. I have recently visited the State of Oregon. I took a long wagon-trip of several hundred miles through the most wonderful country I was ever in—Eastern Oregon. It is capable of holding a larger population than a great many other States. You could put Idaho in the center of it and not find it. There are millions of acres of vacant government land there with no strings tied to it, that any human being, under the laws of our Land Department, can enter and make a home on. And I want to say it will be one of the most interesting object lessons of your life, and I don't think any man is fit to fill a public place in America unless he visits the commonwealth of which Portland is the capital. You have no idea of its vastness and its importance. There are 500,000 acres in the valley there that are most fertile, and you can irrigate every foot of it, and it will be done by-and-by. There is a large portion of that 500,000 acres waiting for homesteaders—for the young man to go there and make a home and bring a wife with him. Few of the people of the East have never seen the great rivers and the great steamers leaving Oregon, going to all parts of the earth, and you ought to see them—you are not half educated until you do see them. You won't see

them at Boise. I don't believe that many of you spent much time here in this city looking at irrigation work. I think you spent more time looking at the bull fights. With all the eloquence of our friend from Boise, I admire his pluck and his nerve, and I want to tell you that we have come to these conventions to listen to the lectures and learn something from the men, and I would rather listen to the lectures next year in some comfortable, magnificent building like this, and look around to enjoy something after you get out of the hall. I tell you, you will make no mistake if you go to Portland—and you will make a serious mistake if you don't.

The Chairman—If there are no further nominations, I declare the nominations closed, and the Secretary will call the roll of States, and after the roll is called, the chairman of each delegation will announce the vote which will be recorded, and the result given. There is no provision as to the unit rule in the Constitution of this Congress. So that unless each delegation should settle that question among themselves, the unit rule if not considered would not prevail. If they desire to adopt it, we will recognize it.

A delegate from Arizona—Before Arizona casts her vote she desires to explain: we have forty-six in our delegation, and we have thrashed out this proposition in order that we could reach an understanding. We have invited gentlemen from each of the delegations from the respective cities that have been spoken of to explain to us the proposition that we heard here to-night, and we have, in consequence of hearing both sides of the story, reached a ballot, and we now cast ten for each.

Ballot closed. Result: Portland, 203½; Boise City, 105½. The election of Portland was then made unanimous.

The Chairman—It has been thought proper that the following telegram be sent in answer to one received:

"National Association of Agricultural and Vehicle Mfrs., in convention assembled at Chattanooga, Tenn.: We reciprocate your friendly greeting and invite your co-operation in a movement which has become truly national in its scope and character.

W. A. CLARK,

President 12th National Irrigation Congress

Adjournment.

## General Session, Friday Morning, November 18, 1904.

Meeting called to order by Mr. John Hall.

Various resolutions were offered by Mr. Smith, of California, Mr. Taylor, Mr. Chafey, Mr. Hoffman and Mr. Prince.

Executive Chairman Boothe—I ask consent for the immediate consideration of the resolution just offered by Mr. Prince.

The Chairman—It is desired that the delegates here express our pleasure and gratification to our retiring President by a rising vote unanimously on this resolution. The resolution was unanimously carried.

Executive Chairman Boothe asked unanimous consent for the consideration of the report of the Executive Committee.

Mr. Prince—I would suggest an amendment regarding the doing away with the Committee on Credentials and also the Committee on Resolutions, mentioned in the report. This matter came before this very same Congress a few days ago when the motion was made in the usual form for the appointment of these committees, and the Congress then determined that it was desirable to have these Committees on Credentials, Resolutions and Permanent Organization. It seems but a small matter, but at the same time it has been the practice to have a Committee on Credentials, which has acted and, as the Chairman of last year stated on the floor, acted with a good deal of deliberation and a good deal of care as to various matters, and so far as I know has acted entirely satisfactorily. We have heard their report this year at the session two or three days ago, and, so far as I know, their plan of procedure, which is the usual plan, has met with no objection. It is, at any rate, a democratic system that a body, when it meets, shall have its own Committee on Credentials, who shall act on these matters. I only wish to call the attention of the members of the Congress to the fact that this would do away entirely with the Committee on Credentials.

Delegate from Arizona—I cannot see how the remarks from Mr. Prince apply to this case. Here is a body of men that have been elected by their own constituents, each State and Territory has named its own Executive Committee and is posted about the business, and when you come together in Portland or any other place your organization is complete on the start. I believe there is only one thing to do, and that is to adopt the resolution.

Mr. Hoffman of Texas—I am opposed to the amendment, for the reason that a body of this kind ought to be able to pass judgment upon its own constituents, because we are the judges, through the committee appointed by each State, to decide who are delegates and who are not. You place this power of deciding who are delegates into the hands of a few men who shall meet and they are likely to see that such delegates are recognized. I believe that a body of men like this ought to have the right to decide when it meets who are its constituted members, therefore I oppose the amendment.

Executive Chairman Boothe—There never has been, during the last few years that I have been at these Congresses, a single man who has come and put his name in who was not given a seat, and I have never seen a person that has offered the least objection to anybody sitting as a delegate. When

it comes to voting, the vote is by States, and each State decides for itself what its vote shall be. The matter of accrediting persons as delegates, putting them on the roster, has nothing whatever to do with the matter. At a matter of fact, this is a permanent organization made up of the officers and permanent members of the organization. So that really it is simply a matter to bring the names before the Convention at the opening of it. It does not affect the body or its right to vote.

Mr. Jones—This Executive Committee is composed of a member from each State, and they are to look up the credentials from the different States. I can see no objection to such an amendment as this. We have spent several days trying to find who are the Committee on Credentials.

Mr. Hays—There must always be an incentive for any movement, I fail to see the incentive in this case. For years all deliberative bodies are controlled by themselves, and why we should depart in this instance in this Convention I cannot see. The members of the Executive Committee that meets next year are selected by the delegates this year, and should not have control of the delegates next year to come. They may not be here. They may not be in Portland next year. I have talked with several members of the Executive Committee, and not one of them has assured me that he will be at the Portland Convention in 1905; no man knows, for no man has a right to say whether he will be alive one year from to-day, or at the next meeting, and I insist that it is only proper that every deliberative body should control the credentials of its own membership, and I am opposed to this resolution.

Executive Chairman Boothe—How many of the credentials that were filed in the office of the Secretary were examined by the Committee?

Mr. Hays—We have accepted the report of the Secretary, and looked over a part of the credentials. I am insisting on this proposition, that we are putting this Convention as controlling the next Convention, and that is what I am opposed to.

Mr. Young of Utah—It occurs to me that there is very little merit in the objections offered that the adoption of this proposition would deprive the next Congress of the exercise of its prerogatives. The fact would be unquestionable that the Executive Committee would merely as a committee report to the Congress. The fact of deciding as to delegates should be left to the Congress. In other words, the meeting would be held and perform its duties expeditiously and there would be no delay in our proceedings at the failure of the Credentials Committee to make a proper report. Therefore it seems to me that this proposition will tend to make the proceedings go along much quicker. I don't see why this Congress should not determine the proceedings of the next Congress. As a matter of fact, the Executive Committee will decide several matters.

Delegate from California—I have attended now four sessions of the Congress, and I have yet to see the day when a delegate presented any credentials and was ever rejected by the Congress, and I don't expect to ever see the day when any delegate from any source attends the National Irrigation Congress will be rejected. Now, in this Committee on Credentials this year there are twenty-four States represented. When they met there were ten States rep-

resented out of the twenty-four that were in session, and never at any time did the number exceed ten States. Now, I believe the amendment would be beneficial to the Congress, but a short amendment or a word or two more added to it, I believe, would fill the bill. I would suggest, "in case of any objection to the report of the Executive Committee on membership, it could be brought before the Convention and threshed out."

Mr. Hoffman of Texas—I move you as a substitute to this amendment that the Secretary of this Convention and not the Executive Committee be the receiver of all credentials, and that he report upon the morning of the meeting of the Convention.

Motion seconded.

Chairman—We will vote on the amendment. Amendment carried.

Amendment to Article 4, offered by Mr. Boothe.

Mr. Prince—I think that by putting this proposed amendment in the Constitution that the Congress is going to tie itself up entirely. If you will read it carefully, you will see it organizes a new committee which consists of a President, Chairman of the Executive Committee and the Secretary of the Congress, and, approved by the Committee on Rules, the program submitted by the Executive Committee shall become the official program of the Congress. Now, if that only means that this is a program which can be changed by action of the Congress from day to day as necessities require, why of course there is no harm in it. It is proper that somebody should outline something in advance in order that there may be a proper disposition of matters, and that they may be considered in due order, but by putting this in the Constitution it means that this official program of the Congress becomes a constitutional matter. I don't see any necessity for it at all if the former is the interpretation that is to be given. If it is to be of any special constitutional power it cannot be altered at will. It would be putting it above and beyond the power of the Convention when it chose to change the program.

Previous question moved. Carried.

Resolution offered as to Committee on Rules lost.

Amendment offered by Mr. Boothe as to number of delegates. Adopted.

Amendment to Article 8 by Mr. Boothe adopted.

Mr. Boothe—A duty tardily performed is better than not performed at all. This bouquet of flowers on the stage was picked from the Capitol grounds in Phoenix, Arizona, and sent here by the Governor as a compliment, and I was asked to mention that fact. I wish that some expression might be made by the delegates of this Congress in appreciation of the attention which has been given to us by the Governor of Arizona.

Delegate from California—I move that a vote of thanks be sent to Governor Brodie for this bouquet, which exemplifies the beauty of Arizona as well as the results of irrigation.

Bouquet acknowledged by rising vote.

Mr. Prince—I believe it is understood that the delegation from each State and each Territory name one Vice President and one member of the Executive

Committee, and that they do so this morning. I suggest that the Secretary call the roll of the States, in order that a response may be made.

Roll called and the names handed to Secretary.

Mr. Maxwell—Those of you who have attended these Congresses formerly note with a great deal of sympathy the absence at this time of Colonel Maxson, as Secretary of the Congress. I understand that Secretary Maxson is ill. I offer a resolution regarding him. Resolution adopted.

Chairman—The hour has arrived for the election of officers.

Delegate from Arizona—I would state that that part referring to the officers of this Congress was formally adopted last night; that part relating to the Vice Presidents and members of the Executive Committee was delayed until this morning, and has been completed, therefore inasmuch as the list of officers is undoubtedly in the possession of some one in the hall, it would seem to me unnecessary for the delay in sending for the report, and it would appear to me the proper method now would be the formal installation of the officers chosen. I have no doubt they are acceptable.

Executive Chairman Boothe—I move that the nominations sent in by the States and Territories for the offices of Vice Presidents and members of the Executive Committee be added to the report of the Committee on Permanent Organization, and that the committee be discharged.

Motion seconded. Carried.

#### REPORT OF COMMITTEE ON NOMINATIONS.

This committee, to whom is referred the matter of nominations of officers for the ensuing year, beg leave to report as follows:

For President, Hon. Geo. C. Pardee, of California.

For First Vice President, Hon. L. W. Shurtliff, of Utah.

For Second Vice President, Hon. J. H. Stephens, of Texas.

For Third Vice President, Hon. E. L. Smith, of Oregon.

We further recommend that the selection of Secretary be referred to the incoming Executive Committee.

We recommend that the Honorary Vice Presidents and members of the Executive Committee submitted by the delegations from each State in this Congress be adopted as a part of this report.

[NOTE.—The complete list of officers will be found on page 435 of these proceedings.]

Chairman Clark—The nomination of Governor Pardee is now before the Convention. Are you ready for the question? Unanimously carried.

Mr. Clark—Gentlemen of the Convention, I have the honor to introduce to you your distinguished next President of the Irrigation Congress, Hon. G. C. Pardee, of the great State of California.

Mr. Pardee—Gentlemen of the Congress, while I feel the greatest personal pleasure, and the greatest personal honor, for the distinction and the honor which you have to-day conferred on me, I feel, however, that it is done more as a distinction and an honor to the State which I am here to represent, than for any personal regard or for any personal distinction which may be given to me, and when I go back to my State I shall take back with

me the greetings of this Convention, transferred through me to the State which I am here to represent—as the Senator has said, the grand State of California. There is no doubt but that every State and every Territory of this Union is both grand and great, and with the exception of all the other States and Territories of this Union, I am here to declare that California is the greatest of them all.

What more can I say to you, ladies and gentlemen of the Congress? I am deeply impressed and deeply grateful for the honor which you have to-day conferred upon me, and I shall do all that lies in my power, with your help, which I hope you will cordially extend to me, to make the next session of this Congress approach somewhat at least to the benefits which we have derived from this, and I hope that your retiring President will not forget the duty which he owes to the Congress, the duty which he owes to the irrigation propaganda throughout the United States.

Mr. Clark—Gentlemen of the Irrigation Congress, before yielding this gavel to my very distinguished successor, I desire to express to you gentlemen, members of this Congress, as well as all preceding Congresses, who are present here to-day, my deep sensibility of obligation to the members of the several Congresses of which I have been an honored member, and particularly those of the preceding one and this one, over which I have had the very great honor to preside, for their co-operation, for their uniform courtesy and respectful consideration of their Chairman upon each and every occasion. And I also desire to state to you, my friends, that my work as Chairman of two Congresses engaged in this great movement has given me great pleasure. I have realized the honor that attaches to the position to which I was elevated, and I feel this, that it has been to me a labor of love. There is nothing in the world in connection with this great work, with which I have been identified for thirteen years from the day on which the first Congress was held in the City of the Saints in the beautiful Salt Lake Valley, that I would not do to promote its interests. I have felt an abiding and an untiring interest in every step of its progress, and particularly in the progress of the legislation, which at last has brought some measure of success in working out the solution of this great problem, which is so dear to all our hearts, and which means so much to the people of this great Western Empire.

I do not intend, in retiring from the high position which I have occupied, to relax one iota of the devotion and the love which I feel and enjoy in connection with this cause. I will try to be with you at Portland, and will do whatsoever lies in my power to aid you in your Congress there; and besides I want to see the magnificent exhibition which you will establish there on the banks of the beautiful Columbia—the grand Columbia River—commemorating that great event, the advent of Lewis and Clark at the mouth of that river in 1804, where they were sent by Thomas Jefferson to explore the great Northwestern country. And in the meantime, in pursuance of my duty as representative of my State in the upper branch of Congress, I intend to secure further legislation in aid of this cause, if it is possible, and if I can get the co-operation which I believe I will have from all the Western Senators and members of the House of Representatives.

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In my address I stated to you the other day that the fund accumulated now, amounting to about twenty-seven million dollars, will soon be absorbed in this great work. There have always been laid out projects, which, if carried to their completion, and which will be carried out by the able corps of Government engineers under the direction of Mr. Newell, will absorb at least two-thirds of this fund. I do not know what we are going to get in the way of additions to this fund, in the way of proceeds of public lands, as it varies from year to year. It may be more or it may be less; but whatever it may be, it cannot, in all probability exceed five or six millions of dollars. We must demonstrate to the Eastern people that the reclamation of the arid lands of the West is a national project, and worthy of the support of all the American people, and we must enlist their aid in its development. They are spending from fifty to a hundred million dollars every year on the rivers and harbors of the East and South, and when we make an appeal for a few million dollars for something in the West, they turn their backs upon us. Now I do not propose, so far as my influence and effort may extend, that they shall do this any longer, but that they shall come to our rescue and help build up this Western country, which means so much to them, as well as to us.

Thanking you, gentlemen, for your kind and courteous consideration, I now yield to my distinguished successor the gavel which I have attempted to use with impartiality and discretion, and certainly I have used it with great pleasure to myself.

Chairman Pardee—Gentlemen of the Congress, the next order of business is the election of First Vice President. The Committee recommended the election of Mr. Shurtliff, of Utah.

Delegate from Idaho—I move the report of the Committee be accepted and Mr. Shurtliff be elected. Motion seconded; carried.

Chairman—Next in order is the election of Second Vice President. Hon. J. H. Stevens, of Texas, is named by the Committee.

Mr. Taylor of Texas—I move that the report of the Committee, on Mr. Stevens, be adopted. Motion seconded; carried.

Chairman—Next recommendation of the Committee is Hon. E. L. Smith of Oregon to be your Third Vice President.

Mr. Hall—I move the election of Mr. Smith. Motion seconded; carried.

Mr. Smith—Ladies and Gentlemen, I thank you for your kind consideration. The place was unsought by me. While I am up here I wish to convey the thanks of the Oregon people for the very kind consideration shown in selecting Portland. I want to tell you that when you come there you will find that we are your own people; you will find a beautiful city, and I want you to get acquainted with some of those old pioneers and their children—those pioneers who traveled the deserts and forests over half a century ago to save that grand land from foreign supremacy. I have no promise to make to you, but Portland's hospitality will be commensurate with her ability.

The Chairman—Gentlemen, there appears to be no further business on the table of the Secretary, save the report of Committee on Resolutions. Is the Committee ready to report?



Mr. Smith of Utah—I desire to offer a resolution. That this Congress in every sense of the word endorse the exposition to be held at Portland, Oregon, and that the worthy work accomplished by Lewis and Clark shall be fully commended by us, and that in every way we will utilize our influence to make it a success. A hundred years have passed since the expedition of these men. We should use every effort within our reach to make this anniversary exposition a success in every sense of the word, and let us hope that the results may be all that our Portland friends expect. I make this resolution impromptu upon this occasion.

Delegate from Idaho—Idaho seconds that resolution. I desire to assure the rousing delegation that Idaho will only be second to Oregon itself in making this exposition a grand success.

The resolution was unanimously carried.

The Chairman—I take pleasure in introducing former Senator Harris of the State of Kansas, who bears a message from Kansas City to this Congress.

Mr. Harris—Mr. Chairman, ladies and gentlemen, I have no desire to detain you but for a moment. Last week I was called upon by the great commercial bodies of Kansas City to come here to El Paso and extend to you on their behalf a greeting and a message and an expression of their desire for your success and hope for your work in the future. That great State stands as a gate to the glorious and beautiful West. She is reaching out her arms to the great empire which we will see in time built up where there will be homes for American men, women and children. I agree most heartily, and I know that the sentiment of Kansas City coincides with the magnificent expression which has been uttered by the speaker who preceded me. Mr. Maxwell has been indefatigable in his work, and I am happy to bear witness to the efficiency of it. Kansas City feels that this great empire should be built to furnish homes for American men, homes upon American soil for American women, homes for American boys and girls. That is the kind of expansion we believe in back in our part of the country. Kansas City desires to say to you that whether your meetings are held in El Paso, whether they are held in Boise or whether they are held in Portland or any part of the country, she is in sympathy at all times with the work which you are furthering. She knows the kind of men who live in this great country, she knows what they have done; she has faith and hope in the future, which she will bring to pass. I thank you very heartily for the opportunity of presenting to you the best wishes of Kansas City for your success.

Mr. Kimball of Arizona—Gentlemen, I desire, in behalf of the delegation from Arizona, to call your attention to Arizona's display as you go out of the door, and say to you that, after the Convention exercises are over, we desire each member of the Congress to get an orange or lemon or one of the other of our fruits to take with you, showing to you that Arizona is at least six weeks ahead of California and other places in the raising of these products. I desire to say, also, that we want you to see the possibilities of our region, and to show what could be done by the conservation of the waters that are going to waste. We are raising at least five crops of alfalfa, and we are getting in the neighborhood of from eight to ten dollars a ton on the cars for it. We can raise two crops of peaches. I might relate a strange circum-

stance that happened this fall. In September a hailstorm stripped our apple trees of nearly all the fruit, and we thought spring had come again when the apple trees blossomed out once more, and we have another crop of apples on our apple trees. This is the spirit of the country; this is the spirit of the people—to keep on doing and trying again. And we do hope that the good people of this entire country will not forget those things that have been said by Mr. Maxwell, which are entirely true. I want to say to you that in the valley where I live—the Gila Valley, and I also have the honor of presiding over the people in the San Pedro Valley—that all that has been said is true, in regard to the waste of the water. I am told by the pioneers of the Gila Valley that twenty-five years ago the waters laid upon the ground in abundance, and the whole country was covered with wild grass. But now that is all destroyed.

Our rains come in the fall of the year, commencing in July and running through August and sometimes to September we have nearly all the rains that come during the entire year, and we cannot conserve the water and save it to use during the drouth. This last fall we were appalled to see the rains come as they did and wash the slopes and cut out the country; where formerly there was a little cattle trail are now rivers, some of them 100 feet wide, which have destroyed farms.

Twenty-five years ago five wagons, with a little party of emigrants, came in from Utah to reclaim the grand Arizona country and help make the mining industry possible. In connection with our labors, they assisted in making the great commonwealth there.

I desire to call your attention to these facts, and ask you to get some of the products of Arizona, and don't forget the great possibilities of that territory.

Mr. Smythe—I desire to say, for the information of this Congress, that Southern Texas is still in its infancy, but an irrigated farm there has raised seven crops of alfalfa in one season.

Governor Pardee of California—Come to California and get ten.

The Chairman—I desire to give notice that at the final adjournment of the Congress this afternoon the Executive Committee will meet on this platform immediately after the adjournment.

## General Session, Friday Afternoon, November 18, 1904.

The meeting was called at 2:00 o'clock by President Pardee.

Mr. Prince—Mr. President, I have an exceedingly gratifying, as well as important duty to perform. Most gratifying because it announces what I think is the most practical act in the history of this Congress, and the most gratifying of any duty which anyone has had to perform at this great gathering here in El Paso. I ask permission to make a very brief preliminary statement.

For a number of years there has existed a diversity of opinion—no, I rather may say a bitterness of action—between those living in the Rio Grande valley with regard to the irrigation improvements which seem necessary in order to utilize the water of that river. It was a three-cornered controversy—on the north, those living in the Territory of New Mexico; to the south and east of the river, those living in the State of Texas, and on the west of the river our brothers in the Republic of Mexico. Each had its own ideas, and each was sufficiently tenacious and sufficiently powerful to prevent action on the part of the other. Each, I am sorry to say, as time went by, became more and more antagonistic to the other, so that it seemed as if harmony of action was almost among the impossibilities. But a miracle has come; that which seemed to be impossible is not only possible, but is an assured and accomplished fact. Harmony and unity of action have succeeded in the place where before was contention and bitterness. There have been frequent assurances during the course of the existence of this Congress, among all of those from all parts of the Rio Grande valley, north and central and south, and this has resulted in the adoption of a resolution which has been very aptly called "a most happy solution of a vexed question." This agreement was so perfect, that yesterday afternoon, at a meeting in this room, a resolution was adopted unanimously, by all who were present, asking that some course of action should prevail, and that the officers of the Reclamation Service should go on and do the great work which they had found it was possible to do. And since that time, in another conference, this statement, with an addendum explanatory to some extent, has been signed. I hold here the original; it has been signed by five representing New Mexico, five representing Texas and five representing the Republic of Mexico. The resolution which was adopted yesterday read: "That we heartily approve the valuable work of the Reclamation Service under the Department of the Interior of Washington, whose officers of the Rio Grande have been in New Mexico and elsewhere, and we heartily endorse and approve the proposal of building the Elephant Butte dam as a happy solution of a vexed question that has embarrassed the parties interested, providing that an equitable distribution of the waters of the Rio Grande with due regard to the rights of New Mexico, Texas and Mexico."

"EL PASO, TEXAS, NOV. 18, 1904.

"The undersigned Mexican delegates to the Irrigation Congress, have had no time to make a comparison of the two projects to store the waters of the Rio Grande, the International dam project and the Elephant Butte dam

project, but assume, for actual purposes, that the data given by Mr. Hall in his report read yesterday at convention hall in regard to flow, sediment, evaporation, distances to bed rock, etc., are correct and that it is thoroughly practicable to bring to the site of the old Mexican dam, above El Paso, the water necessary for the areas that were previously irrigated, and that said quantity of water will be given to Mexico, without cost, at that point, surveys to be made by the engineers of the United States Reclamation Service to determine the number of acres upon the Mexican side of the Rio Grande which can be so irrigated, said surveys to be subject to the approval of the Mexican government.

"Under those considerations, the Mexican delegation endorses the Elephant Butte dam project, as explained by Mr. Hall, said endorsement to be subjected to the approval of the Mexican government, as the delegates have no instructions whatever, as stated yesterday at convention hall by the delegate from Tlaxcala, Sr. Carranza.

"JACOBO BLANCO,

"ROBERTO GAYOL,

"JOSE DUVALLO,

"YGNACIO CARRANZA,

"RAFAEL DELA MORA.

"We, the undersigned committee, representing the American side of the Rio Grande valley, heartily and unanimously endorse the above statement and presentations, made by the honorable delegation representing the Mexican republic, and through them, the Mexican side of the Rio Grande valley, subject to the approval of the United States government.

"FELIX MARTINEZ,

"A. P. COLES,

"Z. T. WHITE,

"A. COURCHESNE,

"J. A. SMITH,

"OSCAR C. SNOW,

"H. B. HOLT,

"WM. PALMER, JR.,

"R. E. TWITCHELL,

"MARTIN LOHMAN."

This document, which has been signed to-day, is, in addition to that, explanatory of it to some extent, giving it greater force and efficiency, and is signed by five representatives from the Republic of Mexico, by five from Texas and five from New Mexico, who have been appointed a committee of conference on that subject. Mr. President, this is a matter of most hearty congratulation to all who live in this section of the United States. The Rio Grande is the great river, as its name implies, of this section of the United States and of Mexico. It has vast valleys on its sides, and at certain periods of the year it brings down great volumes of water which, as matters are now, are entirely lost, which, if conserved, would add to the agricultural resources of the United States and Mexico, and now that all obstacles are removed, now that all have agreed to accept the dictum of the authorities on the subject at Washington, and to work harmoniously in order that they may be

brought to a practical conclusion, it is, as I say, a matter of great congratulation to all of us. It is, in another sense, a matter of great congratulation to this Congress. Sometimes we are asked "why do you hold these gatherings, what do you achieve? What have you to show of the practical in the way of results for the expense and the trouble and the time and the exertion that is employed in the carrying on of these Congresses." And I say that if nothing else has been done at this National Irrigation Congress now being held in the city of El Paso, if every other moment of its time had been absolutely wasted and was soon to be forgotten, that this, which I have now the pleasure of announcing, is enough in the way of practical results to have justified the holding of this Congress, even if the expense and the trouble had been ten times what it was.

I am directed by the delegates and representatives of the Rio Grande country, in its whole extent, the three territorial divisions to which I have alluded, to ask of this Congress the endorsement of the harmonious wish to which they have all agreed, by the passage of this resolution:

"Resolved, that we heartily approve the valuable work of the Reclamation Service under the Department of the Interior at Washington, and its officers in the Rio Grande Division in New Mexico and elsewhere, and we heartily endorse and approve the proposal of building the Elephant Butte dam as a happy solution of a vexed question that has heretofore embarrassed the parties interested, providing that an equitable distribution of the waters, with due regard to the rights of New Mexico, Texas and the Republic of Mexico."

I move the suspension of the rules, that this may be received for immediate action by the Congress,

Delegate from California—I second the motion made by Mr. Prince. This is a question of great importance, and I think should be acted on at once.

Chairman—You have heard the motion, that the rules be suspended and that the Convention act immediately on this question. Are you ready for the question. Motion carried.

Resolution of Mr. Prince was adopted.

Mr. Prince—We sincerely thank the Congress for this action.

Mr. Fairweather of California—Gentlemen, I have been requested by a few members of the Congress to give a little explanation of the workings of the irrigation law of California; if it is compatible with the views of the Congress, I am willing to do so.

Chairman—Please take the platform, Mr. Fairweather.

Mr. Fairweather—Mr. President, ladies and gentlemen of the Convention; during the discussions in the various departments of this Congress it has been alluded to in some of them that if the various sections in the arid states and territories had some similar law as the State of California, it might do much good, and help them by helping themselves to get relief earlier than they will from the general government. Now, it has been generally heralded abroad that the Wright Law of California was a humbug and a fraud, and everything else that was bad. We in California, who know the beneficial effect of that law, brand that statement as a bare and bald face lie. Our law provides when a number of people in a division or neighborhood, for instance, the people interested get up a petition under the law, and apply to the Board

of Supervisors for them to endorse that, and then they elect five or three Directors. When that is done all those within the District begin to work. Now, the Biddeford Law makes it obligatory to have a majority of the land owners, or those having title in the district, to sign the petition first. When this is done, then we go on with the workings the same as you do in a school district. We are a quasi-public corporation. The property in the district pays no taxes, because it is for the benefit of the public, and the land is enhanced in value and pays the taxes in that way to the State. We have our own officers. We elect directors; the law gives permission to elect three or five. We elect our directors, we elect our assessors, our tax collector, we levy our own taxes. It does not go through the county office in any way, manner or form. We bond our district. We have \$490,000 of bonds out on our district at five per cent. They are twenty and forty year bonds; to-day the bond owners prefer the long term bond. I don't know of any bond in our district that is on the public market, and certainly there is not any bond that can be bought in that district below par.

Now, in levying our assessment for water, we levy a tax on land exactly as you assess for anything else. If I have a 20-acre vineyard or orchard or alfalfa field, and my neighbor has a 20 or 40 or 60-acre piece beside me that is growing wheat or not growing anything at all, if it is the same class of land, his land is assessed at the same price per acre for irrigation as my vineyard or my orchard. We make no discrepancy in that, and we have had very few instances where any individual kicked, for the reason that the more improvements made in going along, they add to the value of the land. Of course we are favorably located on the river, and have been working under that law now for thirteen years, and you cannot come into our district to-day and find five people to say a word against the Irrigation Law.

Under the Constitution of the State of California it allows every man—every legal voter—in the district to cast a vote. Some of your State constitutions limit the voters to property owners, and I believe it would be a good thing to allow only the actual owners of land to vote. The law says all property shall be assessed at its true value, but that is not always done, at least not in our district. The improvements are ordinarily assessed—that is, buildings. We don't call trees and vines and alfalfa improvements. For instance, if a man has got forty acres of land and a good house on it, costing \$1300 or \$1500, his house will be assessed at \$250. If he has a barn, it will be assessed at \$150. The secondary improvements on the land are not assessed very high, and do not increase the tax rate very much. The tax in our district amounts to about thirty-seven or forty cents per acre per annum, and two-thirds of the tax that is levied in our district to-day is for paying interest on our indebtedness. When that is paid off, the running expenses of our district will amount to about \$10,000 or \$12,000 a year, and it won't cost twenty cents per acre per annum.

We don't divide our waters—we have no locks on the gates. The law provides that every individual is entitled to his pro rata of water. He can even exchange it if he will. We seldom hear of anyone suffering from the use of too much water on his land; that is a trouble experienced in nearly every irrigated section of the world—using too much water.

I have given you in as few words as possible the workings of the State Irrigation Law, and I thank you. If any gentleman wishes to ask a question, I will try to answer him.

Chairman—Gentlemen, I declare a recess for ten minutes.

Meeting re-called at 2:40 p. m.

Chairman—I want to announce that each speaker will now be limited to five minutes, unless granted otherwise by the Congress. The long-lost Committee on Resolutions is here. They report that they will be ready in a few moments.

#### REPORT OF COMMITTEE ON RESOLUTIONS.

Mr. Penrose of Utah, Chairman of the Committee on Resolutions—Ladies and gentlemen; I would apologize for this late appearance if I thought that the Committee had anything to apologize for. I wish to say we have been in session for a long time, and I beg to report the following:

The report of the Committee on Resolutions was read. (Report as made was adopted with the slight amendment offered by Mr. Finkel of California. Resolutions are found on page 125.)

Governor of Idaho—Mr. Chairman, I move as an amendment to the report of the Committee that that portion of the resolutions referring to the repeal of the Stone and Timber Act and the Desert Land Act be taken from the resolutions. Motion seconded.

Delegate from Idaho—I wish to say a few words explaining my position, and I think the position of a great many others here, with reference to this matter. While I am in accord with many of the suggestions in that portion of the resolution which we seek to eliminate, I do not believe that the time has arrived when we can safely act upon the matter; I believe it is one that should be more fully considered and should be referred to the next annual session of this Congress. We are, Mr. President, in need of funds at the present time. The main want of the people in the arid regions at the present time is money to be placed in the reclamation fund in order that the great projects may be carried on, and others that have been suggested may be made possible. Mr. President, if I recollect right, there are some ten millions of dollars that have been placed in that fund by the sale of the public lands in the year 1903, and seven and a half millions by the sale of land under the Stone and Timber Act and under the Desert Land Act. Can we safely take such action as would possibly induce Congress at this time, acting upon our suggestion, to eliminate that source of revenue, and put us back possibly in a position where we could not depend upon more than three or four million dollars a year in this fund? I say that it is a serious question that confronts us. The report of the Committee itself, in the very next resolution, says that it is necessary, in the opinion of the Committee—and with that opinion I believe we all agree—that a greater fund be raised, and we ask in the next resolution that the Congress appropriate moneys in the nature of a loan to this reclamation fund, to be repaid. I ask, Mr. President, how it will be possible to secure that money from the Congress of the United States unless we provide some means by which it can be repaid, and it is a serious ques-

tion in my mind whether the adoption of this resolution, if favorably acted upon by the Congress of the United States, will not so impair our revenues as to render it impossible for us to obtain this money which we are now seeking in addition to that amount which we acquire from the sale of lands? You will find, Mr. President, that the Congress of the United States, in dealing with us, will want to know how the money loaned will be repaid.

Mr. Newlands—Mr. President and delegates of the Irrigation Congress, the gentleman from Idaho objects to this proposed action, not because he objects to the reform which we have in view, but because our action will tend to prevent sums of money from going into the reclamation fund, which, under existing law would go there; and he asks whether we can imperil the great work of national irrigation now advancing so rapidly by interfering with the increase of this fund through the proceeds of land sales. Now the proceeds of land sales come largely, I am told, from timber lands, and we find that the timber lands of the country are, under existing laws, going into the hands of great combinations and syndicates which hold them for future speculation and profit, so whilst we are rigidly guarding in the Reclamation Act against land monopoly in the future by providing that as to the lands reclaimed they can be acquired only in small tracts sufficient to support a family, we are adhering to a policy which is concentrating the timber lands of the country in private hands, and is gradually strengthening the very monopoly against which the Reclamation Act is intended to guard; so I say that if the fund were in danger, even if not a single dollar in the future was to be added to this fund from this source, I would favor legislation to stop this concentration of land in private ownership. But that danger is not to be apprehended. Under this very resolution it is provided and recommended that Congress should concurrently with the repeal of the Stone and Timber Act, provide for the sale of stumpage upon these timber lands, and provide that the proceeds of such sales shall go into the reclamation fund. I firmly believe that more money will be secured from the sale of stumpage than will be secured from the sale of the lands themselves. After we have sold the timber that is now upon these lands, we will either plant new forests or we will retain the lands for agricultural purposes, and then this land can be held, like the old arid domain, in trust by the country for home seekers, in small tracts sufficient to support a family. Thus if we retain the land and sell the timber we will get more for the reclamation fund than under the present system, and we will still hold the lands under the policy of this Irrigation Congress for future home seekers.

But we will assume that it is true that, temporarily, the proceeds from the sale of stumpage will not be as large as the proceeds from the sale of the timber lands themselves. We have already in that fund nearly twenty-seven million dollars, and that Act has been in operation for two years, and only about three million in all, I believe, has been expended. Under the Act the fund is a revolving fund. When twenty-four million dollars now in the fund are expended, the work does not end; that twenty-four million dollars returns to the fund through the annual payment of the settlers on the land, and you can readily see that if the fund only amounts to twenty-seven millions of dollars, that fund in the next twenty years, by the aid of



this revolving process, will accomplish at least one hundred and fifty million dollars worth of work; so that even without an increase in the present fund we could accomplish the work, though not so rapidly, perhaps, as desired.

Now in addition to the legislation which we suggest regarding these lands, we have urged a Government loan to the Reclamation Fund so that if the Reclamation Service, after a full survey of all the projects in contemplation, find that this fund is not sufficient to meet the existing demand, they can so report; they can state how much is required—five or ten or fifteen or twenty million dollars—and we can go before Congress with the recommendation of the Reclamation Service and urge Congress to appropriate a loan to the Reclamation Fund, to be used in this work, to be expended in reclaiming arid lands; the cost of each project to go back to the fund by annual payments of the settlers and thus the Government will be reimbursed and the great work accomplished without the loss of a single dollar to the Treasury.

Now I ask whether we are in earnest in all these Irrigation Congresses in demanding that a stop should be put to land monopoly? If we have been in earnest, we have an opportunity now to demonstrate it. My friends, we have not realized yet in this country the perils of land monopoly. Why? Because we have more land than we have people to occupy it; because, though we have a population of eighty million people, we have in this country land equal to the demands of five hundred millions of people and we will yet arrive at that population, and when we approximate that point we will experience the evils of the concentration of land in private ownership. It has been the cause of more social disorder, and of more serious and bloody revolutions than any other cause in the history of the world. It was the cause of the long revolt of Ireland against English misrule; it was the cause of the French Revolution; prior to the French Revolution one-third of the entire land of France was in the hands of the church, one-third in the hands of the nobility, and one-third in the hands of the people at large. And it was this system of concentration of ownership of the lands in the church and in the nobility which led to that revolution—the bloodiest in history—and we have as a result of that revolution, in which the greatest excesses were committed, the present system of peasant proprietorship in France, which has given peace to the people and a stability to the government of that people that has never been enjoyed before.

In the Philippine Islands, the protest of the Philippine people was not so much against the tyranny of Spain as it was against the monopoly of the best lands by the Friars. Their revolution against Spain, which we aided, resulting finally in the expulsion of Spain from the Philippines, had its source in this monopoly of land upheld by the Spanish government—and you will find that in our South American and Central American States—the gradual increase of land holdings of the church led to disorder which ended in revolution against Spanish domination, and the absolute spoliation of the church of its property.

Now, we want to avoid disorder and revolutions here, not so much because it is a present danger as because it is a future danger, a danger to the peace and prosperity of the Republic. It seems to me that we have an opportunity now, without loss to this fund, to shape these laws so as to prevent the con-

centration of lands in private ownership, and to see to it, so far as the public domain is concerned, that the prevailing system of combination and monopoly, so oppressive to the people, shall not prevail.

Chairman—Are there any further remarks, gentlemen?

Delegate from Oregon—How is the sale of stumpage going to prevent the monopoly of land, I would like to ask?

Mr. Newlands—If the government simply sells the timber on the land instead of the land, the government retains the land, and there is no monopoly. It is a monopoly of the entire people instead of a particular combination.

Delegate from Oregon—I would like to know what length of time is contemplated for the cutting off of these lands?

Mr. Newlands—That will be a matter for the administration to determine.

Mr. McAlpine of Minnesota—I wish to say a word, Mr. Chairman. The gentleman who just spoke stated that the repeal of the Acts in question would prevent a monopoly. An individual citizen of this country can go into the woods and take up the different stones, but he don't say a word against the monopoly that furnishes millions of acres of the public timber in the State of Idaho.

Mr. Newlands—Will you allow me to interrupt you? It is true that I made a reference to that, but the resolution asks the repeal of all laws permitting the issue of scrip.

Mr. McAlpine—Let that be amended first. Don't take the right of the citizens of this country from the public domain that belongs to them. This country has prospered since the Constitution of the United States was first inaugurated, and is prospering to-day. The land belongs to the people and not to the combinations. That is what I say, the combination wants to take the public domain out of the market. Then they care little for the land laws when they use them as long as they want. The Northern Pacific Railroad got \$50,000,000 worth of public domain to build 2000 miles of railroad from Duluth to the Pacific Coast. If they sold that land for \$5 an acre, they would have put \$150,000,000 in the treasury of the Northern Pacific Railroad. Now, if the public land is taken out of the market, those lands will increase in value about three-fourths. A citizen can go and take up 160 acres at \$2.50 an acre—\$400 for 160 acres of land, and if he sells it for \$5 an acre he will have a gain of \$400. Which is best, to put the money in the treasury of a combination or a citizen. For the year ending June 30, 1903, the Government received \$4,537,000 from timber and stone. That would take 10,500 citizens of this country to enter these lands. They paid the Government \$2.50 per acre for that. Supposing they sold that for \$5 per acre. There was 10,500 citizens made \$2.50 an acre on it. Which was the most benefit—distributing it among 10,500 citizens of this country, or putting it into the treasury of those railroads or combinations. Which is most beneficial? The combination is behind this scheme and has been for five or six years and more. Which will they do? The government received \$2,850,000 for the sale of the homestead land. For the desert land there was 1,425,000 acres. They received \$256,000. For the sale of these three acts of the Government which belongs to the people, the Government receives \$7,644,419.

That was set aside generally from the Northern States and other States for the sole benefit of the irrigation in the arid land States. The fund is for that purpose. It does not cause any hardship on any branch of the Government of this country to cut off that. That will take the fund away from the desert land districts. That is what is before the Convention. We have to have combinations. There are men in this country who built railroads and never got one dollar from the Government. The Great Northern Railroad was built from Duluth to the Pacific Coast—2000 miles—by James J. Hill, one of the greatest men of the United States, who has done more to open up the country than any other man. The second man to Hill, that builds railroads without going to the Government for aid is our retiring President, W. A. Clark. He is building a railroad from Utah to Los Angeles. He don't want to rob the people of their lands. It is a combination, gentlemen, we are now confronting, and I defy any man to object to one word I have said. The trouble is with the combination; the sale of the stumpage is referred to by my honorable friend, Mr. Newlands, and I ask him the question which is the best, to put the money into the combination or give it to the people. He don't answer me. There are always men that will support combinations of every kind. Some of them can be bought; some of our judges can be bought and sold to support combinations, but, gentlemen, they can't all be. I will refer you to one little matter in the State of Minnesota that was seventeen years in the Department of the Interior, before four sections of the Interior and four Commissioners. There were two little attorneys in Duluth who took the matter I refer to up, without fear or reward, and brought it to the courts of the State of Minnesota and it went to the Supreme Court in less than fifteen months, and the Supreme Court made a special order and canceled the patent. There are plenty of men in this country that can be bought and sold if the question is put right before them. I will say that this one of the most far-reaching schemes that ever went before the people of this country.

Mr. Finkel, of California—In the interest of this Convention, and the California delegation, I wish to state that hereafter if any one speaks longer than five minutes, we want to also.

I wish to say just a few words on this question. There is no real apparent difference between our friends Senator Newlands and Mr. McAlpine. Mr. McAlpine thinks that we are liable to affect the fund. I don't think that this legislation would have that effect. It would not have that effect for this season, that the stumpage off this timber land will be sold. The administration of a new law would fix the price of stumpage at such a figure that it would not enable these corporations to increase the price. In the second place, the work for which we are striving here to prevent the monopoly of land would be hindered by amending this resolution, for the simple reason that we are now accumulating funds and expending them for the purpose of distributing lands among people under the National Irrigation Law, thus introducing a new supply of lands. The new supply of land has the effect of depressing the value of all the holdings held by railroad corporations. I think this is a sufficient answer to the question. What I say is this: that every law which tends to build up a monopoly in this country should be repealed.

I just simply want to make one amendment to this resolution not on this point.

Mr. King from Oregon—Gentlemen of the Convention, one year ago when I attended the Irrigation Congress at Ogden, I made up my mind to keep still except on the Resolution Committee, but after listening to the discussion of my esteemed friend from Minnesota in the Resolution Committee this morning for three-quarters of an hour, I cannot resist the temptation to say a few words upon this question. I am not disposed to question the motives of anyone who differs with me. I regret that I have to take sides and oppose my good friend, and while I do so, I do not question his motives. One year ago when I appeared on the Resolution Committee I was undecided about this question. I listened to the discussion of this one question at least seven or eight hours, and after listening to their discussion of this question, I was convinced that the timber land laws and other laws of this country should be repealed. The scrip question was referred to, and they said if we could offer some substitute for the desert land law, it would be upheld. We found to-day when this matter came up that amendments were made and we found that still our timber friends opposed it and said if we could repeal the scrip law and stop the further issuance of scrip we could accomplish just as much. We have brought in a resolution recommending the repeal of all acts permitting lien sections or issuance of scrip and notwithstanding we have added that, we find our friends still opposing, and I want to tell you they are going to continue to oppose it just as long as we attempt to repeal the laws. I believe it is not a question as to whether this man or that is going to profit; it is a question as to what is the best for the majority of the people. I do not question the motives of the gentleman opposing this, if he has an interest in such a question, for that interest might blind his judgment. We have resolutions here which tend to the preservation of the forests, and we should pass them. The proposition is to preserve the forests. After you sell the timber lands, give the Government a chance to own this land and replenish these forests. It makes no difference if people may have millions or billions of scrip. Do you propose, by continuing the present land laws, to continue to permit the land grabbing? If we have one wrong it is not necessary for us to continue another wrong, and what difference does it make if some man does profit when we realize that to continue the present system will continue to encourage the land grabbing of this country. In the country not wholly arid we find that much has been reserved to be taken only under the Homestead Act, and under the laws of the National Irrigation Act they must reside upon that land for five years before they can acquire title.

The Chairman—Your time is up.

Mr. Keisel—I move that the time for the gentleman from Oregon to speak be extended five minutes more. Motion seconded. Lost.

Mr. Smythe of California—The gentleman from Minnesota says there is a combination behind the demand for the repeal of these laws, and he is right—there is a combination—a combination of truth, of patriotism and of civic pride. In that combination are included the ablest and most distinguished men in the Republic. The men who have taken part in the admin-

istration of Grover Cleveland, of Harrison, the administration of William McKinley and the administration of Theodore Roosevelt. I do not impugn the motives of those who disagree with us. There are plenty of honest men who think these laws should not be repealed. I do not say that all those who oppose the repeal of these laws are land thieves, but I do say that all the land thieves oppose the repeal of these laws. The gentleman from Idaho says that the time has not come for this legislation. When will it come? After the last acre is gone—is that when the time will come? Some time ago this Congress considered this question and demanded the repeal of these laws, and now, thank God, the question has come up to the Irrigation Congress of this year, and many of the loyal citizens of this country are on the side of the repeal. What we propose to do is not a radical innovation. It is simply a logical step in our policy. They tell us what we propose to do is merely destructive. They said we wanted to sweep away the laws upon our statute books and put nothing in their place. We now propose a substitute for everything which we would displace. But we do not insist that so far as agricultural lands are concerned, no man and no woman can acquire title to another acre save they show their good faith as home-makers by living there five years.

We have land for the man or the woman who wants to make a home. We have no land for the man or the woman who wants merely to engage in speculation. We will encourage those who wish to farm the land. We propose to sit down on those who wish to speculate.

We received a message from the President of the United States in which he referred to us as the guardians of the future. This morning by a rising vote we declared that we would be the faithful guardians of the future. My friends of the West—men and women of this Irrigation Congress—we are fighting a serious battle. We have no right to consider such a suggestion as the gentleman from Minnesota made about someone who made \$200 by taking up some timber land and selling it. Those are not the people for whom we are guarding the future. We are considering the future, and in order to do that we must preserve for the home-maker the lands for farming, and as to the timber, we must get all the money we can out of it. The gentleman from Idaho says we would decrease the income. We will increase the income five or ten times from that source. We are now getting \$2.50 per acre for lands that are worth far more.

Mr. Young of Utah—I believe, Mr. President, that the President of the United States has called on the gentlemen in the Department of Lands to make an investigation to know where he is at. He has been accused of being the tool of monopolies of the United States, and I don't believe it. I am a Democrat, and I voted for him because I don't believe it. Now, when these men that he has asked to make reports make their reports I believe they will tell him to leave the present land laws alone. I have lived in a community—raised from a boy—when men came to the head of the department of the Latter Day Saints, my father, Brigham Young; some came with lies, others came with soft soap and he always had to weigh what men told him for fear they would give him the suds. Theodore is in the same fix. He has asked these good men to take care of his part of it. We are going

to hear from Theodore Roosevelt in his message to the United States, but I wanted you to hear from me too. I am here, an old man, 58 years old. I am too old to fight—never had enough wisdom to fight—but I am glad to speak a word on this question.

Previous question moved.

Chairman—Before putting the question on the previous question, I wish to state that Senator Clark has requested permission to address the Congress on this matter.

Senator Clark—Mr. Chairman and gentlemen of this Convention; I think, from the allusion that I made in my opening address, that you all know where I stand upon this question of the repeal of some of our land laws. I stand for the people that are desiring to make homes in this country and not for the land baron. I know something about this scrip business. I bought a few years ago a piece of land scrip for the purpose of locating a saw-mill on the timber land, and I found that the reservation where the scrip had been taken from had been restored to the public domain, and I was entitled to that original part of the public domain represented by this scrip. When I sent down there to find out what kind of a country it was, I found the ground barren. I think this is one of the greatest frauds of this age to allow the railroads to get scrip and sell it to the people and thereby defraud them. The homestead commutation clause gives room again for further fraud. You know very well that more than half of the homesteads in that country are commuted in fourteen months, as they are allowed by law, and how can a man who wants to avail himself of a homestead land law, and goes and moves upon it and tries to build up a farm there—how can he, from the proceeds of that barren land, acquire sufficient funds in fourteen months to pay for the land unless he is aided by somebody. And there is always somebody around to put up the money. I know a number of instances of it myself, where men have moved to land apparently in good faith to make a home there, and in fourteen months the land would be commuted and the men had the money to pay for it, and moved off somewhere else, perhaps to take up new homesteads. It is a source of fraud that should be corrected by the repeal of this act—this commutation clause.

So far as the Desert Land Act is concerned, it has enabled the grasping men of this country to acquire large domains where they get thousands of thousands of acres in one body by reason of this act, and scarcely ever work them. You can go to the State of Montana, where I live, and start in at the Yellowstone River, and attempt to cross the country to the Missouri River, about one hundred and fifty miles, and you will find that where there should be hundreds of homes and prosperous villages, where there should be towns and cities, you will find scarcely a house; instead of these you will run up against wire fences. That broad district is owned by a few men. Hence I appear before you making an earnest appeal in behalf of the actual home settler, the man who goes upon a piece of public land in good faith to make a home, where he can rear his children, and thereby contribute to his own happiness, and the prosperity of the community and State in which he lives.—Great applause.

Chairman—The gentleman from New Mexico has moved the previous question, which was seconded in various directions. Shall the previous question now be put?

Mr. Prince—I wish to ask whether the question on which the previous question is asked is simply to strike out this one or three sections applying to the desert act and timber act?

Chairman—Shall the previous question be put? If there be no objection, the Secretary will call the roll of States. All those who vote aye on the question now before the house will vote to strike out from the report of the Committee this recommendation for the repeal of these three certain things. Those who vote no will vote to keep in the report of the Committee its recommendation for the repeal of those three certain things.

Roll call by States.

Chairman—The noes have it—63 ayes and 205 noes.

Mr. Finkel—I desire to move an amendment to that portion of the resolutions regarding a loan of the Government; I wish to put in the words “non-interest bearing” before the word “loan.” I do not think we should incur any interest-bearing debt. Congress may not understand this, hence these words regarding interest should be put in. Motion seconded; carried.

Mr. Prince—I move as an amendment a substitute for the three sections with regard to the acts that have just been voted upon, the following:

“Whereas, The Timber and Stone Act, the Desert Land Law and the commutation clause of the Homestead Act have in some instances in their administration been found to result in speculation and monopoly;

“Resolved, That we request the Congress of the United States to make such modifications in said laws as will save the remaining public lands for actual settlers who will found homes and live upon said lands.”

Congress, by its action a very few months ago, has shown, Mr. President, that it desires to take some action on the subject. It has refused to strike out the action that was proposed by the committee, which shows distinctly that it does desire some action. I submit the action which was taken last year which was very prudent and careful and judicious, and I think it is not desirable that this Congress, in the passage of any of its resolutions, should continually change its views and its standing on certain questions from year to year. It is a great deal better to re-affirm what we have done, once it is shown to be absolutely right. This was passed last year after a very long and searching discussion in which the best minds of the Congress of the United States expressed themselves. They are not here, these gentlemen, this year because they thought this matter was settled at once and forever by this Congress. Senator Teller is not here. Mr. Mondell is not here—not here because they thought this matter had been settled. That is the reason they are not here. In the first place let us re-affirm what we did then, which is in opposition to everything that is wrong in these acts and in favor of everything that is right.

Mr. Clark—I want to refer to the action of the Congress at Ogden last year. A great many members here present were there and recollect that the contention went on and a discussion was had which was, in many points,

very acrimonious in its character, and aroused some intense feeling, and I believe, and so did the others believe, that if the Convention had been allowed to vote upon the main proposition it would have voted as they did upon this amendment—would have voted in favor of repealing these laws; but the men who were there sent by the corporations of this country, like a distinguished man from San Francisco, and several others, and the representative from Wyoming was there, and when they found that those resolutions were going to be carried by that Convention and they were afraid of the result of the vote, they trumped up the compromise proposition which does not mean anything; which was simply a makeshift and is really not a recommendation to Congress at all, and thereby we stultified ourselves by allowing the resolution to go through. But the people were tired. It was late in the Convention and they got tired with discussion, and believing that it might work out some good for the cause, they let it go through, and the men to whom the delegate from New Mexico refers are not here to-day, but they turned up in Congress. I don't know what Mr. Mondell said in the House of Representatives because I was not there, but I know that his colleague, Senator Warren, and Hansbrough from North Dakota made long arguments in the Senate chamber, opposed to this measure, and endeavored to defeat it there, so I believe these men were resting quietly, perhaps believing that this Congress will take up some such meaningless, worthless proposition, and for that reason they did not come.

I am opposed to tampering idly with this question. Let us go squarely on the proposition. Say we want these land laws repealed or not repealed; let us act manly about it and not try to put up a compromise that will be discreditable to us and have no weight in Congress.

The amendment was lost.

Motion to accept the report was carried.

Mr. Hawley of Idaho offered a resolution thanking the people of El Paso for their courtesy and hospitality which was unanimously adopted.

Chairman—I have a request from the delegate from the State of Sonora, Mexico, who wishes to be allowed a few moments for a greeting from that commonwealth. I introduce to you Mr. Ellison, of Sonora.

Mr. Ellison—Ladies and gentlemen, I have to say that I am only here as a substitute for a much more distinguished man. This man sends his regards. I exceedingly regret that such an unqualified person as myself is here in this position. It is my exceedingly great pleasure to be able to say that the very distinguished statement of your retiring President regarding us has been very impressively confirmed. I shall be brief and only consume a few moments. I hold in my hand by the courtesy of a Senator of the United States, a most wonderful instrument—the treaty of the Gadsden Purchase, which was consummated by Franklin Pearce and Mr. Gadsden; under that treaty and by that treaty we are indebted for the rich soil upon which we stand; by that treaty the State of Sonora lost thousands of miles which belonged to us. This treaty is dated at Mexico, June 30, 1853. It is signed by Mexico and the United States, passed the Senate, and is an exceedingly interesting document. It is out of the question to read it, but no more interesting document could be submitted to an audience. It concerns the entire



border. Sonora should have been here with a delegation of 100. This territory of Sonora is intimately and closely associated with Arizona, with California and Texas, and we are interested in whatever concerns you.

I invite you to come and see us—drop over the border and see our good people and receive a most hearty welcome.

Mr. Fairweather of California—I think the press of El Paso has done nobly during this Convention by publishing very full reports. I move a vote of thanks of this Convention to the press of El Paso.

Motion carried unanimously.

Mr. Smythe of California—Mr. President, ladies and gentlemen, the closing hour of this Congress is at hand, and I have just been called upon to return the thanks of our delegates to those to whom we are so deeply indebted for the opportunities and the pleasures and successes of this event.

El Paso in 1904 will go down into the history of irrigation as one of the greatest conventions, perhaps, all things considered, the most fruitful of all the conventions which have been held in the interest of this movement, and for this result our thanks are due to the big-hearted people of Texas and especially of the city of El Paso.

Many individuals in this community have devoted months of time to preparations for this event. Among them I will mention the Hon. W. W. Turney, Chairman of the General Committee of Arrangements. I must refer to the indefatigable labors of Secretary Gifford, who has been a host to each and every one of us. Also to Mr. Cobb, the Reading Secretary. A resolution of thanks to the press is one that is well deserved. I think that never in the history of this movement has a convention been more generously treated than by the press of El Paso. To my mind it is a happy thought, because it is a true one, that for every one hundred dollars El Paso and Texas have expended upon this 12th National Irrigation Congress, Texas and El Paso and New Mexico and Old Mexico will receive a million dollars in return. I believe the years of the early future will bear out that most fully, and I want to say a few words of tribute to the very efficient and self-sacrificing and indefatigable Executive Chairman of the National Irrigation Congress. No Congress has ever had a greater Executive Chairman than Mr. C. B. Boothe, of California.

The Convention has already paid its impressive tribute to Senator Clark, who during the past two years has been our presiding officer; who has been one of the inspiring influences of this movement, and as I have listened to his speeches I have felt like telling him, "You are the noblest Roman of them all." I sought the platform this morning at the time of the election of our new President, hoping that I should have an opportunity to place his name in nomination, but the quick adoption of the report gave me no opportunity to do that. As my name was considered for the same place, it seemed the fitting thing that I should say a word to the Congress regarding him. Now, the election of Governor Pardee as President of the 13th National Irrigation Congress is not merely a personal compliment. It is not merely a compliment to a grand commonwealth. It is an action which is significant of a new era of statesmanship in California, and I hope in many Western States. It seems strange, my friends, but until this man went into the Executive Man-

sion, we could not get a governor to mention irrigation in his message to the legislature. Governor Pardee gave it prominence in his first message. And not until he came were we able to interest a governor to the extent of securing his attendance upon a National Irrigation Congress. When we have an oasis of a governor coming in a desert of disappointment, we are glad to have you join us in giving more power to his elbow. And now, again and again and again I want to say to Texas and to El Paso, "Well done, and thank you forever."

Mr. Boothe—I desire to add one word to that statement by Mr. Smythe. The ladies who have attended this Congress have been most generously and kindly entertained here by the ladies of El Paso, and a committee headed by Mrs. Magoffin. We never have received more attention, if as much, at any place. A magnificent ball will occur to-night, at which the ladies are going to entertain, and I have been told that the husbands have been instructed to stand aside and give the boys a chance. I desire to have recorded an expression of thanks by a rising vote to the ladies of El Paso for their kindness to the delegates of this Congress. Rising vote.

Mr. Cobb, of El Paso—Mr. President, ladies and gentlemen; a few moments ago Senator Turney, that worthy citizen who has done so much for El Paso in regard to this Irrigation Congress as well as other matters, requested that I respond in a few words for him. It was after we had looked for that knightly cavalier of Texas—that eloquent orator of El Paso—Captain Beall, whom you have heard speak, and in his absence I have been requested to say to you that El Paso has been moved by your appreciation. El Paso opened her doors wide to you. El Paso gave you that welcome which comes from the bottom of her heart. But El Paso's heart is moved more now than ever before in her history by the generous expressions of appreciation from you, our friends. And in speaking for our proud city, I would not claim that we are not proud of her—I would not be worthy of El Paso if I did not proclaim her before the world as the bright jewel which gives lustre to the Lone Star of Texas. I would not be worthy of her if I did not tell you that she is the grandest, the best city in all America. The way that she has treated you is the way that she treats every man that comes to her border. You don't have to come to us as delegates. You don't have to come to us with authority or title. El Paso is great in heart and noble in spirit. We welcome every visitor, high or humble. It is the greatest town in all America, and I speak for her that spirit which has made her great. No man has come to El Paso who has done his duty but what has won. No man has struggled in her markets, in her work, no man has worked with her, but what he has risen to the pinnacle of success. I proclaim to you that we are glad to have had you as guests, and we know if you would stay with us you would be glad and proud to call yourselves El Pasoans.

There are many in this community who came here in poverty. I remember but a few years ago when I wore a pair of pants in this town which had to be hidden by an overcoat. I remember that that pair of pants is replaced by two pairs of trousers. Come to El Paso whenever you can, and you will always receive a welcome. Come to us after the Elephant Butte dam is built; come to us when that valley is fertile and irrigated. It is fertile

now, but come when water is put upon it, and you will see a valley that is grand, you will see a sight that is colossal; you will see railroads running into the Empire City of the Southwest every three minutes.

If you appreciate what has been done for you, go away from El Paso and speak praises of her. Go away and speak of her as we speak of her. We are proud of her. We are proud that she is so good, so noble; and I tell you when America sees the progress that she will make; when Mexico has opened her resources as will be done; when our friends in New Mexico and Arizona contribute still more to their proud metropolis, El Paso; when all this is achieved in the course of the next few years, I tell you that all America will join in the sentiment that El Paso is the brightest jewel of an international diadem.

Mr. Holabird—Three cheers for El Paso.

Chairman—Three cheers for El Paso, Cobb and the patched pair of pants.

Mr. Boothe—I desire to give notice to the newly-elected members of the Executive Committee, that the Committee will meet here on this stage immediately after adjournment this afternoon, to organize.

Chairman—Is there anything further to come before this session of the Congress?

Motion to adjourn *sine die*.

Chairman—Before dropping the gavel, I wish to express for my State, if you will permit me to say, the greatest State, our great appreciation of the work which you have done here at this Congress, and also of the honor which you have conferred upon my State by electing its Governor your President for the ensuing year. Gentlemen, the convention stands adjourned.



# RESOLUTIONS

ADOPTED BY THE

Twelfth National Irrigation Congress,

November 18, 1904.

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Our thanks are due to and are hereby heartily tendered to Honorable W. A. Clark for his manifold and valuable services as President of this Congress during two successive terms.

It is the opinion of the National Irrigation Congress that the National Irrigation Law should be so extended by Congress as to include the State of Texas within its provisions, in so far as to permit the Secretary of the Interior to direct engineers of the United States Reclamation Service to examine and report upon feasible irrigation projects, and, when approved according to the terms of the said law, to superintend their construction, to the end that Texas may have the benefit of the same service that is now extended to the other arid sections.

The full text of the National Reclamation Act should be printed in the official proceedings of this Congress, and all the proceedings of the present Congress should be published in book form and indexed; such published report should include the Constitution and By-Laws of the 12th Annual Session.

## FOREST PLANTING.

The appropriation of funds for forest planting on denuded water sheds in the forest reserves is essential to the progress of irrigation, and we strongly urge upon Congress legislation to that end during the coming session with the view of increasing the volume of streams still flowing and restoring those which have disappeared.

We express the fullest confidence in the honesty, ability and capacity of the officials of the Reclamation, Forestry and Weather services, and commend their impartial and non-partisan administration, and our hearty thanks are hereby tendered to the officials of the Interior Department and of the Department of Agriculture, who have so ably contributed to the success of this meeting.

We heartily commend the work of the Weather Bureau in the preparation of the Climatological Dictionary now in progress, and we bespeak for this publication the widest possible publicity.

#### LAND LAW RESOLUTIONS.

It is the sense of this Congress that the remaining public domain should be sacredly preserved to all the people of the United States and should be rigidly reserved for the benefit of actual homeseekers who will live upon the land and in good faith cultivate the soil. We recognize that much has been accomplished to this end; that under the provisions of the National Irrigation Law forty million acres of agricultural lands have been withdrawn from entry except under that act, and from the operation of laws which permit the absorption of public lands for private speculation, and that eighty million acres of timber lands have been withdrawn from entry in order to protect the water sheds, thereby increasing the source of water supply and conserving the public good.

#### REPEAL OF LAND LAWS.

In further pursuance of this wisely established policy of preserving the public domain in the interest of the entire people we urge the repeal of the Timber and Stone Act, of the Desert Land Law, and of the commutation clause of the Homestead Act.

#### NEW TIMBER LAW.

As a substitute for the Timber and Stone Act we favor the adoption of a bill passed by the upper branch of Congress at the last session, repealing the said act and providing for the sale of stumpage and for the application of the proceeds thereof to the reclamation fund.

#### ARID LAND HOMESTEAD LAW.

As a substitute for the Desert Land Law and the commutation clause of the Homestead Law we recommend an arid homestead law which shall limit the entry of any one individual to one hundred and sixty acres, which shall permit a reasonable intervening period for reclamation before requiring continuous residence; provided, however, that after reclamation the occupant shall be required to live on the land five years before securing title, as settlers are required to do under the National Irrigation Law.

#### REPEAL OF SCRIP LAWS.

We also recommend the repeal of all acts permitting the selection of lieu lands, including any and all laws authorizing the issuance of any kind of land scrip, and recommend legislation for the valuation and purchase by the government, if necessary, of all lands in private ownership within the limits of forest reserves.

#### TO AUGMENT THE IRRIGATION CONSTRUCTION FUND.

We fully recognize that the funds now available are inadequate to the realization of the national irrigation policy upon a scale commensurate with

the opportunities of the West and the needs of the nation, and we favor a non-interest bearing loan by the government to the Reclamation fund, to be used in the construction of projects approved by the Secretary of the Interior and to be repaid by the owners of lands benefited, in accordance with the provisions of the present law.

#### LOCAL CO-OPERATION WITH THE GOVERNMENT IRRIGATION WORK.

But we would not have the West depend alone upon national aid in the development of its resources, and we urge the several Western States and Territories to adopt legislation providing for the formation of irrigation districts which shall be able to raise funds by the sale of bonds, said districts to be organized only upon approval by the Secretary of the Interior, who shall employ the engineers of the Reclamation service in the construction of district irrigation works. By this means the Reclamation fund will be supplemented to the extent of millions of dollars by every State and Territory, while the benefits of national administration will be vastly extended. We commend this subject to the earliest attention of the legislatures of our Western States and Territories.

#### TO ENCOURAGE SUGAR BEET PRODUCTION.

It is the sense of this Congress that the irrigated lands of the arid and semi-arid West are demonstrated to be admirably adapted to the production of beet-sugar, and therefore we favor such national legislation as will tend to encourage that industry on such lands.

#### CONSOLIDATION OF FORESTRY WORK.

We repeat and emphasize the resolutions of previous Congresses in favor of the consolidation of all government forest work in the Department of Agriculture owing to the peculiar fitness of that department for the work, and urge the immediate passage of the bill for this purpose now before Congress.

We indorse the policy of the government in the construction of a ship canal along the west shore of the Sabine Lake, in Southeast Texas, with the view of opening to navigation the Sabine and Neches Rivers, which in addition to opening the inland fresh water harbors nearest Kansas City and St. Louis has aided in conserving the fresh water supply of these streams for rice irrigation, and we urge that similar work be extended to other localities throughout the nation, where practicable.

#### INVITATION TO MEXICAN DELEGATES.

The presence of distinguished delegates from our sister Republic of Mexico has strengthened the bond of friendship between the two nations, as well as enlarged our scientific and general knowledge of this continent, and in appreciation of the cordial treatment of this Congress while we were on Mexican soil by the officials of the State of Chihuahua and delegates to this Congress from the Republic of Mexico, we cordially invite the Republic of

Mexico to send a delegation of her citizens to the National Congress to be held in Portland, Oregon, in 1905.

#### MESSAGE TO A FORMER SECRETARY.

This Congress extends to Colonel H. B. Maxson, whose long and zealous service as Secretary of the Congress has so closely identified him with the organization, its sincere regrets that illness should have prevented his attendance at this session and its cordial appreciation and recognition of his services as an officer of this Congress during the years he has served as its Secretary, and expresses its hope for a speedy recovery of his health.

This Congress as a whole and each and every of its members individually feel under lasting obligations to the people of El Paso for the warm welcome extended and the uniform courtesy and kindly treatment received during our stay. And we assure the people of this city that the recollections of our visit will be a life long pleasure.



# General Addresses.

## IRRIGATION IN EGYPT.

M. K. H. BAKHATI, Engineer of Irrigation Projects Office, Cairo, Egypt.

When you consider that Egypt is the mother of civilization you at once conclude that its irrigation is likewise the mother of the irrigating systems of the world.

I will divide the irrigation age into three epochs:

1. Irrigation as it existed up to seventy years ago.
2. Irrigation from the time of the Khedives up to the year 1880.
3. Irrigation as it has been understood from the year 1880 up to the present time.

*First*—Irrigation as it existed up to seventy years ago embraces a period of time extending from the reign of the Pharaohs, ancient kings of Egypt who lived four thousand years ago, up to the time of Mohamed Aly Pasha, the first Khedive of Egypt.

Irrigation was caused by the overflow of the Nile, which is the only river of Egypt; the earth would be inundated by the rising of the flood, and the remainder of the year it would be deprived of water, for there were no means of raising the low water, which flowed continually in the bed of the Nile, except by some inadequate method. The land in those days was at the mercy of the overflow. If it was good and sufficient, fine harvests were produced; if the water was low there was great scarcity of crops.

## GREAT ANNUAL INUNDATIONS.

The whole land was covered with water and there remained only a few elevated portions which were chosen for habitation, forming isolated villages, and barks passed from one to the other as boats circulate between the different isles of the Antilles, and as is Cuba to-day, so was then Memphis, the capital of Egypt.

I do not condemn the systems of the ancient Egyptians, for they produced some very great results in raising the water by machines that modern science has declared war against and has set aside as belonging to the past.

The ancient Egyptians utilized Lake Moris as a reservoir to reduce the immense overflow of the Nile, and now we wish to imitate them by using this lake as a reservoir for irrigation purposes. But in examining the different strata of earth we fear infiltration, for we have on one side low lands, well cultivated and well cared for, where the level changes from eighty feet above the sea to one hundred and forty feet below.

It is not only infiltration that we have to consider, but the advantage arising from our expenditure.

*Second*—The first stone in the second epoch of irrigation in Egypt was laid by Mohamed Aly Pasha, the first Khedive of Egypt, in 1833, by the construction of the dam in the Nile at the point where the river divides, forming within its two branches the delta, bounded on the third side by the Mediterranean Sea.

#### CONTINUED THE WORK OF THE PHARAOHS.

Mohamed Aly pitched his tent outside his residence and he remained near the great work, not wishing to leave it until it was entirely finished. He made in one year the concrete, the floor and the piers as far as the spandrel of the arches, and the second year he finished the work that Nature had called for ever since the Pharaohs changed the course of the Nile from the Sahara to the Mediterranean Sea.

With the building of this dam, Egypt entered another epoch, which is the epoch in which the true irrigation of our country commences.

Mohamed Aly constructed the dykes of the Nile, excavated the canals and built the waste gates, or regulators, for leveling the water, and by this means he was able to save the fertile land of Egypt from the annual inundation of the Nile. Since that time our minds have been centered on improving our irrigation system, and on supplying the essentials that were lacking for its completion.

In his time Ismail Pasha excavated many of the canals, of which the Ibrahimieh Canal, which is two hundred miles long, demonstrates and displays the talent of the engineers who had in charge the carrying out of the plan of this large canal, and to provide irrigation for two hundred and fifty thousand acres of land at all times of the year.

Other portions of the land which can not be supplied with water from the canals are irrigated by the rising of the Nile. The lands are divided into basins and receive water through the canals from a distance suitable for the perfect irrigation of each basin.

We commence to drain these basins into the Nile when the water from the overflow begins to abate. The lands which are subjected to this system of irrigation are planted but once a year. However, the peasants dig wells in the summer, in which the infiltrated water accumulates, and with this they are able to irrigate their land and reap a harvest of corn before the Nile overflows its banks.

#### SOIL DRAINAGE TO OVERCOME ALKALI.

*Third*—The third epoch of Egyptian irrigation is that of to-day and embraces the last twenty-four years.

It is well understood that for a land whose level surface is not exaggerated it is necessary to drain off the water which circulates in the different subterranean strata and which spoils the soil by alkaline substances which are found dissolved in it. We carry off this by means of drains. This was the first step towards placing the Egyptian soil adjacent to the Nile among the most fertile and productive soils of the world.

We excavated many drains and changed some canals in order to do away with the use of machines for raising the water of the canals and to change the irrigation system into irrigation by gravity.

We built our dam at Assuan, 530 miles above Cairo, and stored in it a quantity of water amounting to 1,300,000,000 cubic meters, or 39,000,000,000 cubic feet, or 10,000,000 acre-feet. The great work was finished two years ago by an English contractor under a contract with a heavy bond, and we began to change the system of basin irrigation into our modern system of irrigation by canals, and utilized the water stored up above in our reservoir.

We built our dam on a grand scale, fulfilling the different technical requirements with reference to foundation and stability, and escaping the deposit of silt or sediment, which is greatly to be feared in the construction of reservoirs. We examined the different strata of the valley in which the reservoir is located and judged that we would lose nothing by infiltration. The reservoir is underlaid with granite, and granite is the material used in its construction; and it can not be denied that the dam of Assuan is the largest and strongest of all dams in the world.

We undertook to change the basin system extending over 432,000 acres, and up to the present time we have completed the work on 198,450 acres.

Three and one-half per cent of the land used in excavating our canals and drains was occupied, and the owners of the land will be reimbursed by the government.

The government assesses an additional tax of \$2.00 an acre, and the peasant, on the other hand, should be able to produce five harvests every two years.

#### A GOOD INVESTMENT.

The government has expended \$525,000 on the reclamation of 55,000 acres and realized at the end of the first year thereafter \$111,200, or 21 per cent. In this way the government can realize its expenditure within five years, and the peasant can cultivate cotton and sugar cane, the primary sources of the wealth of Egypt.

The citizens of our country have water furnished to them by the government free of all charge. The land taxed by the government at \$7 per acre produces three crops per year. Ordinarily the proprietor rents his land for a period of two years. The peasant can produce five different plants every two years, namely, cotton, clover, beans and maize of two varieties. He can realize from the cotton \$140, two crops of maize \$40, clover \$15 and beans \$30.

The revenue amounts in two years to \$225 per acre, and he must pay rental of \$70 to the proprietor of the land. I do not exaggerate when I say that a peasant in Egypt who has an acre and a half of land produces from his land cotton to the value of \$280. He pays to the government a tax of but \$7.50 per year.

This is not all. We raise also all kinds of vegetables and fruits, of which the date with its twenty different varieties assures a large income from its production.

### GREAT INCREASE IN LAND VALUES.

Having spoken of the productiveness of Egypt, I must not fail to speak of the price of land in our country. The price has doubled in the last three years. Formerly we paid from \$100 to \$250 per acre, but now it is impossible to purchase at the former price, and the lowest price at which land can be bought is \$250 per acre.

When you consider that the value of the land in Egypt, comprising 7,000,000 acres, has increased in value \$1,050,000,000 and more, then you can clearly judge of the actual increase of agriculture in Egypt.

And with our government well financed and with sums of money reserved for irrigation purposes, I do not hesitate to say that we wish to drain our lakes, which are situated near the sea, and we can gain by our work an added area of 1,500,000 acres.

It is true that we would lose the major portion of the silt from the overflow of the Nile in the sea, but it would be deposited on the new lands that we would gain in driving back the waves of the Mediterranean to the north.

### DEVELOPMENT OF THE SOUDAN.

In Soudan, which comprises 7,000,000 acres, and which is an Anglo-Egyptian possession, we have done nothing, but all thoughts are directed to it, and all ideas are well developed for the construction of reservoirs, and with our water from the Nile and our labor we will make of Soudan another Egypt.

You will understand from all that has been said that irrigation in Egypt is expressed in these three words, "Irrigation by gravity." We are building our regulators, we are measuring our canals and drains in a manner to suit our climate, and we say to the water, which is at our mercy, "Go, water the land. You need not be raised by machines; we have commanded you to rise by our regulators."

### THE VOLUME OF THE NILE.

As nearly as I can remember the silt which is found in the water of the Nile for the three months of the overflow amounts to 48,000,000 cubic meters, or 1,440,000,000 cubic feet, and with this quantity there could be constructed two dykes in the Nile from Cairo in Egypt to Kartoum in Soudan, of which the dimensions would be seven feet wide at the top, seven feet high, and the slope of the two sides would be one to one.

There could be made from this amount forty-two pyramids, each fourteen times the size of the three pyramids of Egypt. The discharge of the Nile when the water is low is 1,200,000,000 cubic feet per day and the average discharge of its overflow is 12,000,000,000 cubic feet, and the greatest overflow has reached 30,000,000,000 cubic feet. Considering that the discharge of the Nile changes every two months and that its maximum discharge is 12,000,000,000 cubic feet, and the minimum is 1,200,000,000, and that the amount of discharge after the first two months of the inundation diminishes to 3,000,000,000, we have the capacity of our Nile in one year, which is 1,458,000,000,000 cubic feet, which would cover the State of Texas, its mountains and its cities to a depth of six inches at least, if not an entire foot, or it would fill 729

reservoirs of the size of the Elephant Butte at the lowest calculation.

In conclusion, I wish to thank you for the kind reception I have met with in the United States, and I thank the engineers who have kindly given me all necessary information concerning their methods of irrigation, and I beg you to accept my congratulations for the fine systems that you have established for irrigating your land.

And I wish to thank the honorable chairman of this Irrigation Congress for the invitation so kindly extended to me in behalf of Egypt.

And allow me to express my great admiration for the American nation, and to say as my last word *not* "Good-by," but "Au revoir."

**RURAL SETTLEMENTS.**

COMMANDER BOOTH-TUCKER, of the Salvation Army.

It is with pleasure that I accept your executive officers' invitation to submit for your consideration a paper on the all-important subject of "Rural Settlements."

The fact that this plank has now been formally added to your national platform, that you have given to it so much prominence in your deliberations, and that so many expert students on the subject will be gathered together to mature definite plans, is a source of lively gratification to me. By thus bringing the question of national colonization prominently before the people and placing your imprimatur upon its importance you have demonstrated the practical character of this Congress.

It seems to me that the alliance thus formed between the kindred subjects of irrigation, forestry and colonization is of the most vital importance in order to assure the success of each. Of them it may be said as of the Swiss cantons, "United we stand—divided we fall." Not only are they naturally correlated, but I venture to say that each adds both to the dignity and feasibility of the other. Let it not be supposed, therefore, for a moment that in embodying "Rural Settlements" in this your magna charta of national requirements the progress of the kindred cause of irrigation will be impeded, but accelerated.

You will remember the old parable of the pond, the ice and the snow. Winter came, the pond was frozen over, and the ice said proudly to the pond, "I don't belong to you." A little later the snow fell and covered the ice, saying to it, "I don't belong to you." But the sun shone and the snow melted and said to the ice, "You are my brother," and the ice melted and said to the pond, "You are my brother." Gentlemen, under the genial auspices of this conference I venture to say that the snow and ice have already melted, and pond, ice and snow are saying to each other, "We are brothers!"

There are many important signs of the times which demonstrate that the nations of the world are waking up to the extreme gravity and importance of these subjects. The so-called policy of "masterly inactivity," which is in reality no policy at all, but that of the shiftless lazy nation, which invites calamity by failing to provide for the evil day, is being abandoned in favor of carefully organized plans based on scientific principles and often attaining mammoth proportions.

**PROFIT OF GOVERNMENT WORKS IN INDIA.**

India we are told has expended something like \$125,000,000 on its colossal irrigation enterprises, combining with it a systematic plan of rural settlements and colonization, which has in the last nine years resulted in placing 800,000 persons on part of its once arid and abandoned lands. The fact that the government has not only been able to meet all interest payments and carrying charges, but to make a clear annual profit of three and one-half million dollars, surely speaks for itself and requires no comment.

Second, perhaps, in this remarkable march of the nations should be placed the great advances which, thanks to the energetic action of this Congress, have taken place in arid America.

While last, but not least upon the list, is the remarkable action of New Zealand in its expenditure of some twenty million dollars under its Advances to Settlers Act. Here the possibilities that lie before systematic colonization have been demonstrated in an altogether remarkable manner, as will be seen from the copies of the act and the official reports upon its operation which I have taken pleasure in submitting to your delegates for their consideration.

The fact that the State of Oregon has invested some four million dollars of its school funds in advances to the farmers of that State at 6 per cent, and this without incurring, as I understand, any losses, seems to me to further demonstrate the safety and wisdom of a policy which shall extend to our rural districts and would-be bona fide settlers a system of credit, without which our commerce and trade would languish and be compelled to yield the palm to the other nations of the world.

#### FARM COLONIES IN THE UNITED STATES.

Our own Salvation Army farm colonies bear out the same deductions. Crippled as we have been by lack of capital we have nevertheless been able to establish three farm colonies with a total acreage of 3000 acres and a population of 530 souls. With a total expenditure of about \$300,000 the repayments have amounted to about \$50,000. On our California colony a thirty-acre tract was recently sold at the rate of \$155 per acre, while one of our Colorado farms has just changed hands at \$115 per acre, and the owner says that he would not sell it for \$200 per acre.

On our townsite in Colorado lots have been selling at an average of \$200 per lot, or \$3200 per acre, while the business turnover for the year amounts to about \$200,000.

A working people's sanitarium for consumptives has been established under the supervision of an expert physician, where for popular prices good treatment and excellent climatic advantages can be obtained within the limits of any working man's capacity. It is hoped that ultimately the sanitarium will constitute a home market for the colony, while the colony will provide light work and outdoor employment for the patients.

Gentlemen, it seems to me that the experimental stage has been passed, and the time has come for action on an extended scale.

#### TO ENACT A COLONIZATION LAW.

By following the lines which have been laid down by the most successful workers in this field it seems to me we shall minimize the risks of failure. What these lines should be I have indicated in the draft of a colonization bill, which was prepared after the last session of your Congress by some eminent lawyers. That draft was submitted to the late Senator Hanna and met with his approval, and was to have been introduced by him. After his death the late Senator Hoar took charge of the bill, and it was referred to the committee on public lands. Copies of that bill have been submitted to the dele-

gates of this Congress for such action as they may deem to be desirable. You will see that it follows in a general way the New Zealand act, with such modifications and adaptations as appear necessary or desirable. In brief it proposes:

1. The formation of a colonization bureau with a commissioner in charge under the Secretary of the Interior.
2. The collection and distribution of information regarding lands suitable for colonization, so that the would-be settler can get reliable data.
3. Loans of \$500 to \$1500 in cash, live stock or materials to enable poor but worthy families to make homes for themselves upon the public lands.
4. The issue of bonds to the extent of \$30,000,000 for the purpose of providing the advances to the settlers, not more than \$5,000,000 to be issued in any one year, thus enabling Congress to put a stop to the expenditure should the plans not answer.

I have no doubt that upon this outline you, gentlemen, will be able vastly to improve. I trust that in some form or other that bill may receive your endorsement, and that the "ipse dixit" of this Congress, which carries so much weight in the counsels of our nation, may go forth with no uncertain sound in favor of the organization and establishment of rural settlements on a national basis.

I thank you for this opportunity of expressing my opinion on this vitally important subject. It has been with a profound sense of my own insufficiency and with no particle of desire to dogmatise that I have written. But I feel that I must not transgress the limits of your patience lest you should be tempted to follow the example of the cannibal tribe in Africa, who when asked by the parent society in America what had become of their missionary who had mysteriously disappeared, replied, "He gave us so much advice that we ate him!" Lest the editorial scissors of your Executive Committee should deal similarly with this article, I would conclude with one little incident.

There is in a Salvation Army home for convalescent workers a pet dog which seems to have wonderfully imbibed the spirit of its leaders in that when its meal is served it will not touch the food till a bevy of neighboring sparrows have joined in the feast. Gentlemen, millions of human beings, our fellow-citizens, are watching this Congress. In making it possible for them as honest home-owners and genuine homesteaders to partake in your great irrigation banquet by means of a properly organized system of rural settlements it appears to me that you will secure the approval of your conscience, the admiration and support of all good men of every party, and the co-operation and blessing of the Almighty.



## **THE WATER SYSTEM OF PASADENA.**

HELEN LUKENS JONES, Pasadena, California.

The system employed in obtaining water for use in the city of Pasadena, California, is an estimable one, in that it practically demonstrates what it is possible to accomplish in a locality where there exists no surface stream flow.

Pasadena, in a way a celebrity, since her pictures and praises have been tossed like confetti far and wide, needs but brief introduction. During the fall and winter, when winds and snows and floods and cold make the East bristle with discomforts, Pasadena becomes the Mecca of the tourist. Vast is the contrast between her disposition and appearance and that of frigid Eastern cities. She is circled, entwined, entangled in flower gardens. Her houses peek merrily from behind veils of roses and jasmine. She is always laughing and good natured. She has a soul—a soul of sunlight and gladness. Association with her—life in her genial atmosphere—is ever a delight. Like a bright-eyed bird she snuggles in a nest formed by encompassing hills and mountains, a nest known as the San Gabriel valley.

### **THE WATER SOURCES.**

To the north, within three miles of the city, loom the rugged flanks of the Sierra Madre Mountains. It is the grouping of underground water currents from this water shed that constitutes Pasadena's water supply. In no single instance is there a visible stream-flow. Of the 601 miner's inches developed for use in the city, every drop comes from underground filter beds, most of which are located in the Arroyo Seco, near Devil's Gate, under the old river channel and its adjoining mesa, all within three miles of the city. Because of this complete underground system Pasadena's water has been declared by experts to be equal if not superior to that of any other city in California.

At present, to use an expression explanatory, the city is divided into three parts, namely, east, west and north, and the water system is controlled by three companies, which are managed on a basis profitable to stockholders as well as satisfactory to consumers. The city is negotiating for municipal ownership, believing the advantages will be greatly increased by combining the three divisions into one system under one management. The city has abundant capital for such undertaking, and under municipal ownership the facilities for more extensive water development would be exhilarated.

The area supplied by the system is twelve square miles and the consumers number 20,000. In all there are ten wells, ranging from 150 to 700 feet in depth. Six of these are bored wells, worked by means of compressed air pumps. The other four are dug wells with steam pumps. There are five reservoirs for storing water, with a united capacity of 85,000,000 gallons. Floors and sides of these reservoirs are cemented and they are tightly roofed. This condition, and the fact that all water is carried in closed iron pipes, excludes all notion of impurities, and the water when it reaches the consumer is

as crisp and sparkling and crystal clear as when it left its home in the underground gravel. Not only does the covering method permit purity, but it prevents evaporation and waste, a most important and necessary precaution in regions where water is limited and difficult to acquire.

#### ECONOMY IN WATER USING.

Seven years ago the water companies of Pasadena found it absolutely necessary to initiate a meter system to prevent misuse and waste of water by consumers. If a man must pay for every inch of water he uses he is vastly more cautious in regard to the amount than if given unlimited freedom. The new scheme worked admirably, in fact very shortly after its inauguration the storage supply increased notably and remained uniform, where previously it had fluctuated in a fashion alarming for the good of the community. Four thousand meters, aggregating approximately \$60,000, have been installed. Ninety per cent of these are known as five-eighths meters. The remaining ten per cent are larger. A number of consumers are still without meters, but in time all will be supplied.

According to the last annual report the cost of operating the entire system, including the mechanism of the three companies, was \$45,700. The receipts amounted to \$86,799, showing a net profit of \$41,099. The most extensive developing paraphernalia is located at and near Devil's Gate, a jagged pair of rock crags that picturesquely dig their toes into the bottom of Arroyo Ceco, northwest of Pasadena. Here is an \$11,000 water plant, also an underground tunnel 4500 feet in length. This tunnel runs to a submerged dam founded on the bedrock, where it received the underground flow of water arrested by the dam. The depth of the tunnel below the surface averages 160 feet. In this tunnel wells have been sunk from which is attained purest water from deep subterranean strata by use of compressed air pumps. The plant used at this point consists of 100 horse-power high-pressure water-tube boiler, Leyner compound steam engine and two-stage air compressor, air receiver 36 inches by 8 feet, exhaust steam condenser and the necessary boiler feed-pumps. This machine has a pumping capacity of 1800 gallons per minute. Oil is used for fuel, thirteen barrels of which are consumed every twenty-four hours. By using a condenser not more than three per cent of the water is wasted, showing that the method is one of economy. The mouth of this tunnel is closed and cemented and a gate used to release the water required. From the plant the water enters a 22-inch pipe, and by means of gravity is distributed in the various reservoirs and thence to the consumers.

To further illustrate the economic methods of Pasadena it may be well to mention the fact that under municipal management a remarkable sewerage system has been inaugurated, whereby all sewerage is utilized for irrigating a 460-acre farm owned by the city. The produce from this farm, including walnuts, grain, corn, pumpkins, alfalfa and stock nets the city a luxurious sum.

**“UNITED WE STAND.”**

C. EUGENE BORTLE, Secretary The Inland Empire Association,  
Spokane, Washington.

Irrigation is really in its earliest stage of infancy in this country; when we stop to review in our own minds the expensive and oftentimes profitless undertakings in other lines we marvel at the shortsightedness of those individuals who have tramped over countless wastes of arid lands to eventually sink their fortunes in an uncertain project which held out anticipations of sudden riches. Where these same expenditures might have been devoted towards a far better purpose in turning these arid lands into veritable gardens of productfulness.

We have only to look back a few years and see the Yakima Valley one sage brush desert, occupied only by roving bands of Indians and the howling coyote; her sparse growth of bunch grass providing grazing through the winter months to a few thousand sheep. Little was ever known of its true value to the agriculturist and horticulturist until surveyors had gone over the valley and discovered how feasible it was to irrigate large portions of the lands lying in the valley and along the lower benches of the hills. To-day after years of ceaseless work the Yakima Valley is a veritable Garden of Eden, as famous as the renowned valley of the Nile. Its fruits and other products rank among the finest in the world. Her products shipped to Oriental ports alone are no small part of the immense quantities that are shipped from all of the Pacific States combined and her products shipped all of the way to the Atlantic coast have been the means of advertising the whole State of Washington.

The wealthy ranchers throughout the Yakima valley have reaped their riches from the narrow confines of small irrigated tracts of land which would prove in the Eastern States, where they are compelled to depend on the provisions of nature's rainfall for moisture, a starvation income.

The banking institutions of the city of North Yakima are carrying the largest amount of deposits of any other city of like population in the West. These deposits are placed there, not by the commercial interests of the city, but by those same tillers of small acreage tracts.

Wenatchee, which sets nestled along the shores of the great Columbia River, is another instance of what can be accomplished by irrigation. The altitude of a little over 700 feet above sea level will not permit of a sufficient amount of rainfall to be of any benefit to the lands for agricultural purposes, and as the topography of the country is such as to make irrigation feasible and the canals easy to construct, much has been accomplished in the past few years to transform the Wenatchee valley into a marvel of productiveness. Some of the most prolific yields of fruits are raised in this valley, whose soil is composed of volcanic ash and the vegetable wash from the hills which has accumulated for ages past, forming an inexhaustible quality of soil. With the application of water from their ideal irrigation system this is truly a great lesson to take from irrigation.

### NATURAL STORAGE RESERVOIRS.

Eight small lakes situated on the edge of irrigable lands in the Spokane valley forms a natural reservoir for the storage of waters and supplying 60,000 acres of land in this valley, thereby forming a means of support to at least 30,000 people. So successful has been this undertaking that the people have required better transportation facilities for their produce, and as a result electric lines have been constructed, running through the thickly populated sections of the irrigated district. Telephone lines have been run which lead to all long distance points; the mail is delivered daily to the doors of the residents and they are provided with as many conveniences as if their homes were situated in the city of Spokane.

To live nearer the soil is in most popular favor at this time, and people are beginning to see the great benefits to be derived from a residence on a ten or twenty-acre tract where the boys are given the opportunity to get the out-of-door environment which the close confines of the city does not allow. They are here given the space to make men of themselves and learn the true value of out door farm life, which can be carried on to-day without any privations to hinder as in years gone by, when our closest neighbor lived a mile away and a doctor could not have been reached in case of an emergency without a ride over rough country roads of twelve or fifteen miles.

To inform a new arrival from the East that some of the irrigated lands were producing from \$200 per acre upwards to even \$500 would immediately arouse that man's skepticism, but they are nevertheless true facts and can furthermore be proven by a visit to almost any one of the irrigated districts of the State of Washington.

These are only instances of what has been accomplished in our own vicinity and what can eventually be realized throughout the now arid portions of our great State. As one gazes over the map our eyes wander to the great bend of the Columbia River, known as the "Big Bend Country." Three million five hundred thousand acres of this vast domain are irrigable, and 1,000,000 acres can be irrigated at a probable cost of \$30,000,000; a large sum to be sure, but when we take into consideration that many times this amount of money is being sunk at the bottoms of our eastern harbors and along the waterways where but only a few individual vessel-owners are reaping the benefits therefrom we at once turn over in our own minds the immense evolution to be wrought if the same amounts of moneys were being devoted towards arid wastes of our great inland West.

### SMALL ACREAGES UNDER IRRIGATION.

It has been demonstrated that from ten to forty acres of land under irrigation in this country is bound to occupy a man with assistance of others to handle and do justice thereby; stop a moment and figure how families would profit and prosper on 1,000,000 acres of irrigated land.

Then a few figures would evidence the fact that they would require the output of great manufacturing industries, and think what an army of employees it would necessarily demand the services of.

With the millions of acres of irrigable lands lying out in the parched and bleaching sun only waiting the application of moisture to have them give forth profits to the needy and industrious, we wonder how this change of conditions can be brought about.

It would be a useless waste of time for one man to attempt the change, or for even a number of men, but with the combined efforts of thousands of men throughout the United States, men who represent the wealth of the largest commercial enterprises and who have come to realize the fact that the needs of the country demand available government domain be utilized to provide for the masses who are compelled to seek their residence and occupation at their different trades in the congested cities, they are ready to give every aid and attention towards remedying the present condition. With the ending of the fiscal year June 30, 1901, there went into effect one of the most broad-minded and humane laws in the history of our nation. The provisions of this reclamation law we are most of us familiar with, yet it stands open to-day awaiting with her accumulating millions the proper legislation to have granted to ourselves a sufficient amount with which to carry out such projects as the government has found feasible for irrigation in the Northwest.

At the irrigation convention held in Spokane October 5th, many important matters were discussed, among which were means suggested whereby more interest could be brought to bear among the people who are to realize the direct results of contemplated projects to be carried out by the government. Among the many prominent speakers on this occasion was George H. Maxwell, the Executive Chairman of the National Irrigation Association. During Mr. Maxwell's address he stated that "the money for developing the water courses of the West so they can be made to water the countless acres of arid land must come from Congress. If you would get any appropriations from Congress you must unite your forces and reach the Congressmen through their constituents.

The national association is not a channel to get the Reclamation Service to do this or do that. It has nothing whatever or will it have anything to do with the engineering of the work. But when the Secretary of the Interior shall name any irrigation project as feasible and should be carried out, we are for it, whether it be in the Arizona desert, in the great plains of Montana or in the Big Bend country. It is then our job begins and we at once start out to get money from Congress.

#### TO INTEREST THE EAST.

We go to our Eastern connections and then we will get the money. We have the International Harvester Company, the International Implement Company, the National Board of Trade, the National Manufacturers' Association, and all of the great manufacturing bodies of the East behind us that employ hundreds of thousands of men and turn out hundreds of millions of dollars worth of manufactured articles every year. What makes markets for them is good for the constituents of their Congressman, and applies the leverage.

You want to develop the State of Washington, and they want it developed. You want an organization in this State that will combine every interest in the State. If you go to work, every irrigation system that can be built will be built as fast as you can place settlers upon the land. It is up to you.

Mr. Maxwell's visit gained a great amount of interest in the National Irrigation Association, and had the effect of organizing the Northwest Section of the National Irrigation Association, embracing all of the State of Washington and the northern part of the State of Idaho.

The objects of the Northwest Section is to co-operate in the work of the national association to bring about effective laws towards benefiting our own local sections of arid lands which the government surveys have proven to be feasible.

The great amount of interest already manifested in the work warrants the belief in the minds of its officers that the Northwest Section will have at least 1500 members one year hence.

**EARLIEST ATTEMPTS IN MODERN IRRIGATION.****A REMINISCENCE.**

BISHOP WM. C. McCLELLAN, Colonia Jaurez, Chihuahua, Mexico.

Writers and speakers frequently give to Utah the credit for being the pioneer in the great irrigation movement, and this credit no doubt is largely deserved, but in my mind there is no question but that the irrigation microbe was carried to Utah from the valley of the Rio Grande.

The writer was a volunteer in the United States service in 1846, under the command of Colonel P. St. George Cook. We had been ordered to California, and in October of the year mentioned we found ourselves at Santa Fe, which place we left on the 21st of October and continued our march down the Rio Grande valley. At a point a short distance above where Rincon now stands the writer, with forty-nine others, most of whom were invalids, was detached and sent back under command of Lieut. W. W. Willis to Pueblo, Colorado, where other detachments had been sent for the winter.

On this return trip we took our slow and tedious march for the second time along the winding banks of the Rio Grande, and were thus given excellent opportunities for observing the Mexican people, and especially their style of farming, not only on the river, but in the smaller valleys toward the Taos Mountains. The irrigation idea was a new one to us, and we were not a little surprised and interested in noting the miles and miles of canals that had been constructed and the many acres, otherwise barren, that had been made productive by this system.

**EARLY NATIVE CANALS.**

We found canals along almost the entire route from Santa Fe to Socorro, some of them of great length, and in places very heavy work had been done in making deep cuts, or in building earthen aqueducts of considerable height and length. And how all this labor was done and all these results achieved with the tools then in possession of the natives was an unanswerable question with us all then, and indeed remains so with me to the present day.

While irrigation was not going on when we were there, owing to the lateness of the season, we could plainly see how it was done, in fact the manner of preparing the ground with bordering ridges and of flooding it, etc., was very much the same as that still in practice in the neighboring State of Chihuahua. From these irrigated fields were produced wheat, corn, chili, melons, pumpkins, grapes and some inferior apples and peaches.

In May, 1847, the detachments that had been wintering at Pueblo took up their line of march toward the West by way of old Fort Laramie, where we struck the trail of the Mormon pioneers, and followed it until the 27th of July, when we came upon the first body of Mormon pioneers encamped on the ground where Salt Lake City now stands. They had arrived there three days before.

Here was an ideal place for putting into practice the A, B, C's of irrigation, as the waters of City Creek canyon could easily be made to run east, south or west; and before the end of July these waters had been diverted from their channel and were moistening the parched soil on the south and west; and

there and then, I believe we may say, was launched a movement that has since been the salvation of Utah and surrounding States, and must eventually prove the redemption of all the mighty West.

And let me now take the liberty of correcting a statement that appeared in an El Paso paper a few days since, to the effect that much of the responsibility and consequently the credit for the early irrigation successes in Utah rested with me. Candor compels me to say that I took no part whatever during the first few years, for as a young man I was so disheartened with the forbidding sunflower and sage-brush desert that I did not think it worth an effort at reclamation, and my greatest desire was to get away from the scene of desolation that surrounded us. This I succeeded in doing about the 16th of August, when I left Salt Lake Valley determined never to return.

But there were those whose judgment was better than mine; those who saw into the future with a clearer light than I did. They determined to remain, and with the running streams as their allies to conquer the desert and wrest from it the necessities of life, and with the push that even then characterized the Americans, and under the direction of the astute mind and leadership of Brigham Young, they were victorious.

#### METHODS BORROWED FROM THE RIO GRANDE.

While personally I did not assist in this work then begun, I have no doubt that others of our party who remained were invaluable helps, and possibly leaders in this work, as a result of the ideas they had borrowed from the Mexicans along the Rio Grande.

After three years spent in Iowa I became converted to the doctrine of irrigation, and securing an outfit I returned to Utah. And there I found land that three years before had been covered with black crickets now producing fine crops of potatoes, etc., and many canals had been built, most of them small and easy of construction. My faith in the cause of irrigation was strengthened and I began learning about it, and working for it. Soon after I took an active part in an irrigation scheme that furnished homes for about 100 families, and since then, in one way or another, I have had more or less to do with problems of arid soils and irrigation, and I must say that in a degree I sense the feeling of honest pride that comes to men who have battled with the desert and with the drouth and subdued them through their own necessities and for the benefit of their fellowmen.

In traveling along the Rio Grande a few years since I was led to reflect upon the great changes in conditions. Where the water was waist deep in 1846, and that was said to be a dry season, I could have crossed dry shod at the same place and same season of the year fifty-four years later. No doubt we all understand how much of this change has been brought about by using the waters of the tributaries for irrigation purposes, thus helping to dry the river.

It is devoutly to be hoped that the contemplated schemes for the storage of waste waters in this region may be crowned with complete success, and it seems to me but right to express the wish that your neighbors across the Mexican boundary line may be, on some terms, permitted to share in the benefits thus obtained, as in the past they have no doubt been sufferers.



# Engineering and Mechanics Section.

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CHAIRMAN: FREDERICK H. NEWELL,

Chief Engineer U. S. Reclamation Service.

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## Wednesday Morning Session, November 16, 1904.

The meeting was called to order at 9:00 a. m., November 16th, by Chairman Newell. Upon his request, Mr. H. N. Savage acted as secretary. There was a brief discussion as to the purpose of the conference and concerning the program of the proceedings.

Mr. Newell—We will listen to a paper by Mr. Savage on "Reclamation Work in the State of Washington."

Mr. Savage—Mr. Chairman, Ladies and Gentlemen: My paper was prepared since coming here, because after arriving I found that I had been scheduled for a paper on irrigation in Utah and that Mr. Doremus, State Engineer, had also been put down for one on the same subject, and I decided to shift to Washington. I have selected the Palouse Project as the subject for a little talk, because it is one of the latest investigated and developed and is up for final consideration at this time.

### **RECLAMATION IN THE STATE OF WASHINGTON.**

H. N. SAVAGE, Supervising Engineer.

It has been the policy of the Reclamation Service during the field season of 1904, to concentrate its work as far as practicable upon one principal project in each State, with a view to bring it to the point of construction with as little delay as possible. The preliminary surveys and investigations are carefully prepared, and from them plans are developed, comprehending the projects in their entirety, for the consideration of the consulting and supervising engineers.

In Washington attention this season has been given chiefly to the southeastern part of the State, where the engineers have located apparently a feasible project, known as the Palouse project. This scheme contemplates the irrigation of 100,000 acres of land lying between the Snake and Columbia Rivers in Franklin County, which are sufficiently low to be reached by a gravity canal diverting water from Palouse River. It is proposed to divert the water by a low dam near Hooper Station, and convey it by means of a canal about six miles long through the divide and into Washtucna Coulee. The proposed cut involves an excavation of about 600,000 cubic yards of gravel and small boulders. An alternative plan consists of building a dam 140 feet

high across the Palouse River, constructing it of the material taken out of the cut through the divide between that river and Washtucna Coulee. This would require the removal of a few miles of the Oregon Railroad & Navigation Co. track and the acquisition of the area to be overflowed by the spillway. By increasing the height of the dam a few feet, sufficient storage could be obtained to regulate the flood run-off of Palouse River.

Washtucna Coulee, a part of which it is proposed to utilize for storage purposes, is a narrow basin extending from the Palouse river valley to within one mile of Connell. That portion of the Coulee extending from the rim of Connell 15 miles east to Silver Lake, is the proposed reservoir site.

#### INCIDENTAL POWER DEVELOPMENT.

From the cut through the divide into the coulee it is proposed to construct the canal on a minimum grade for a distance of 7,800 feet to the town of Washtucna, where two drops aggregating 83 feet can be used for developing power. It is estimated that the minimum flow of Palouse River during the irrigation season, with the storage available in Rock Lake, would be 350 cubic feet per second, which would develop 2,500 horse power. From Washtucna for about 10 miles the coulee is comparatively flat, but for the remaining distance to Washtucna Lake, about  $1\frac{1}{2}$  miles, there is a drop of 78 feet where over 2,000 additional horse power can be developed when desired.

At the west end of this coulee it is proposed to excavate a channel through the divide into Esquatzel Coulee, building a dam at the summit of the divide, which will give an available storage of 210,000 acre-feet. By increasing the height of the dam 43 feet, a storage capacity of 255,000 acre-feet could be obtained.

South of Connell lies Esquatzell Coulee, down which it is proposed to construct the main distribution canal from the storage reservoir to the irrigable lands. The Northern Pacific Railroad now occupies this basin and the Oregon Railroad & Navigation Co. Washtucna branch extends through the entire length of Washtucna Coulee.

#### NOW A BROOK; AGAIN A TORRENT.

The Palouse River varies in volume from  $17\frac{1}{2}$  to 15,000 second feet, and has a drainage basin of 2,200 square miles, most of which is uncultivated. On Rock Creek, one of the principal branches of the Palouse River, is a natural lake nine miles long, which can be converted into a storage reservoir with a capacity of 75,000 acre-feet, by the construction of a dam 37 feet high across the outlet. The total discharge from the lake during the season 1903-04 was 91,300 acre-feet. The discharge of Palouse River during the season 1901-02, the lowest run-off year recorded, was 341,000 acre-feet. During 1903-04 the discharge was 637,000 acre-feet. It is estimated that 100,000 acres can be irrigated by gravity under the Palouse project, assuming the duty of water to be 3 acre-feet per acre per annum. Along the line of canal from Washtucna reservoir down Esquatzel Coulee, there is a considerable fall which can be utilized for pumping water to additional lands lying between 600 and 750-foot contours, if required.

The estimated cost per acre for developing this project is from \$35 to \$40, and the scheme is considered desirable at those figures.

Mr. H. A. Storrs—I would like to ask if the railroad companies have agreed to move their track at their own expense?

Mr. Savage—They have not. In response to our inquiry, they have stated that they would bear such expense in moving their tracks as the traffic expected to result from this development warranted. Negotiations have been carried on for some time, and the indications are that the companies will do what is fair in the matter.

Mr. Storrs—What is the expense involved?

Mr. Savage—About \$200,000. I might add that the conditions prevailing in this project for power development seem to be worthy of very special notice. Throughout Washington there are a number of electric railways being projected. A number are already in operation and are proving to be very profitable. Many small towns are putting in electric plants and there will be a demand for the power which can be developed from this project as soon as everything is settled. The power will have to be transmitted but a very short distance, and these small towns will grow rapidly. The junction of the two rivers which are navigable insures also a big development in municipal manufacturing enterprises.

Mr. Storrs—Will this power be available at all seasons?

Mr. Savage—Throughout the year. At least 4,500 horse power will be available constantly the year round.

Mr. Newell—The next paper is by Mr. G. H. Matthes, who has had charge of the work in Oklahoma. A great deal of his attention has been diverted from the strictly reclamation work by the instructions of the Secretary of the Interior. I might say that in Oklahoma a fund has been created in three counties, amounting to about \$700,000, by the sale of lands, and that this fund is to be expended by these counties in certain structures, jails, court houses, bridges, school houses, etc., and that work has been put under the charge of Mr. Matthes, so that he has not been able individually to give as much of his time to the reclamation work as we had hoped; nevertheless, he has had excellent assistants and has not neglected the study of the Territory.

[Mr. Matthes presented a paper on "Investigations in Oklahoma"; it is here omitted as it is printed in the Third Annual Report of the United States Reclamation Service.]

Mr. Newell—You have before you the paper of Mr. Matthes on conditions in Oklahoma. It illustrates one of the unfortunate conditions that we occasionally run up against, that is, when our first investigations show that a project seems feasible and looks good, but later investigations develop the fact that it is very difficult of execution. It is intended to put into Oklahoma immediately the best reconnaissance men the service has developed during the last few years, to make a continued and thorough study of the Territory for other opportunities. We will continue to keep at this thing until we do build something in Oklahoma. It is possible that a modification of the first ideas of the Otter Creek project and the North Fork project may be

reached which will make these projects appear in a better light, but it is fair to state that our first conclusions are disappointing.

A delegate from Oklahoma—I would like to say that taking the government reports of the rainfall in the region investigated you will find the rainfall very short. Another thing I would like you to investigate is the underflow of Otter Creek. There is an underflow of the North Fork where I investigated 150 feet across and about 2 feet deep. The underflow of Otter Creek is 156 feet across and about 5 feet in depth. It runs back almost to Granite Mountain. The underflow of that creek is much larger than the overflow. I think the underflow would counteract the loss by evaporation.

Mr. Newell—The matter of underflow is always very interesting. I have made a computation. If we estimate it at 156 feet wide, 5 feet deep, and moving at the rate of 10 feet per day, we get less one-tenth of a second foot with a  $\frac{1}{4}$ -inch pipe. We are apt to get very big notions of an underflow because we fail to bear in mind the fact that it is moving so very slowly. We must not attach much weight to an underflow.

A delegate from Oklahoma—I would like to ask if it would not be practicable to give us a beginning with the North Fork, give us a reservoir there and then if it proves practicable, extend the works to include Otter Creek.

Mr. Newell—That is an excellent suggestion and one which, since I have been in Oklahoma, I have been thinking of seriously. We started in with Otter Creek as our leading or initial point. The proposition now is to put some more good and experienced men in there and tell them to simply start out with that as their starting point, and see if they cannot discover a feasible site there, or if not, an alternative. We are going to hammer on this line until we get something that will stand the scrutiny of the men who will have to pass upon it ultimately.

A delegate from Oklahoma—What would be the cost per acre of putting in these works?

Mr. Matthes—The cost per acre as computed from the original project was \$13.20. It is now very certain that it will be greater. If we have to cut down the size of the reservoir, we will have to increase the estimated cost per acre.

A delegate from Oklahoma—Was the cost to irrigate included in your estimate per acre, or was it simply the cost of construction?

Mr. Matthes—The computation was made on the basis of the cost of the complete works, including lands, damages, etc. The cost of maintaining the works and conveying the water to the lands was not included.

Mr. Newell—That amount of \$13.20 I think is too low. Of course, when you take into consideration the bringing of the land under subjection, the price will have to be raised. In these computations it has been the tendency of the engineers to raise the estimated cost. For instance, the people of Las Vegas will be down here to try to convince us that \$57 per acre is not too much to pay, but they will have a pretty hard task to convince us that it is not too high for them to pay, and in Oklahoma I think it will be necessary to raise the amount very materially.

Mr. Mendenhall has made considerable investigations in this matter of underflow in California, and I will ask him to give us in general the results of

his conclusions, those which are most interesting to us. The underground supply, of course, compared with that on the surface is always very, very small. It is hard to form a comparison between the two. If I remember right, an ordinary irrigated farm of 80 acres will require almost as much water as a city of ten thousand population. About the same comparison might be made between the waters underground and the waters on the surface.

This study which Mr. Mendenhall has been making of the underground waters of California is typical of other parts of the United States and gives us the result of a very thorough and careful examination of conditions which have been puzzling the people there for many years.

The engineers of the Reclamation Service and Geological Survey have been carrying on two distinct, yet very closely related lines of work. This work of Mr. Mendenhall's is not under the Reclamation Act, but comes under the related work. Mr. Mendenhall is what is known for convenience sake, the Division of Hydrology.

I will state for your information that the work of the Geological Survey in its relation to irrigation and reclamation is divided into a number of divisions. There is the work of the men who are measuring the streams in all parts of the United States; there is the work of the men who are studying the wells and underground waters, and there is the work of the men also who are studying the quality of the waters and its relation to irrigation, such as ascertaining the alkaline contents of the water and its possible effect upon the crops; yet all of this work comes right down to the question of the industrial development of the whole United States. Here in Texas we have been studying the flow of the rivers, the opportunities for development, the quality of the water, the underground conditions, and all such matters that will lead to a larger and better use of the resources of the State. Under the Reclamation Act we can not expect to go into actual developments in the work in Texas, but we can study the conditions, and the suggestion has already been made by Senator Newlands and others that it may be proper to allow the expenditure of a portion of the funds in Texas, especially in connection with the Rio Grande, and this is a point on which I think the people of the State may appropriately express their wishes and desires.

Mr. W. C. Mendenhall—I might say, as a preface, that in Southern California we are studying the conditions in a community, which, although not an old one, is densely settled and one in which our resources have been highly developed. Our object is to determine whether the underground waters may be further developed so the people themselves may know how much more land they can reclaim in safety.

## **THE UNDERGROUND WATERS OF SOUTHERN CALIFORNIA.**

W. C. MENDENHALL, Geologist, U. S. Geological Survey

The greatest population and the highest cultural interests in Southern California are concentrated within a wide diversified valley that extends inland 80 miles from the Pacific Coast at Santa Monica, and is effectually screened from the Mohave and Colorado Deserts by the San Gabriel and San Bernardino Mountain Ranges. These high groups protect the land on their Pacific slope from the climatic extremes of the deserts, and at the same time wring from the ocean winds the moisture with which they are laden, and which in the form of perennial streams, makes possible the high state of cultivation that has given some of the adjacent agricultural lands values of from \$500 to \$2,000 per acre. Yet the rainfall is low—from 10 to 20 inches in the valleys—and this, and its concentration within a few months of the year, are conditions which demand irrigation to insure crops even of grain and hay, and make it imperative for the much more valuable citrus lands, walnut groves and gardens.

The practice of irrigation was begun early in the century by the Missions, before a general settlement of the country by the Mexicans or the Americans. Short and simple ditches, which usually took their water from the Cienegas, the perpetual springs, and served a small acreage about the ranch houses, sufficed for the simple agricultural needs of this pastoral period. The construction of permanent works of a better character began before the Civil War, and was most actively carried out during the seventies and eighties. The famous Riverside Colony was founded in 1870, its existence depending entirely upon the successful construction of a large canal, which carried the flowing waters of the San Bernardino Basin to a strip of desert mesa north of the Santa Ana River. By the construction of other canals built about this period, the mountain waters as they came down the canyons to the margin of the low-lying tillable lands, were gradually diverted, and the acreage under cultivation extended. Such flourishing colonies as Anaheim, Pasadena, Pomona, Ontario, Cucamonga, Highlands and Santa Ana owe their foundation to the diversion of these surface waters.

### **THE WASTE OF THE FLOODS.**

By 1880 the available flowing waters had been generally diverted and utilized, and the limit seemed to have been reached to the amount of land reclaimable from this important source, but the stimulus of the very high values reached by the California citrus lands, and the comparatively small acreage under cultivation as compared with that reclaimable if water were available, combined to induce a most thorough examination of all possible sources. After the appropriation of the normal stream flow, there remained two additional possibilities sufficiently inviting to enlist the attention of capital and skilled service. Because of the high gradients of the California river beds, and the steep slopes of the mountains where the greater part of the rainfall

occurs, as well as because of the fact that a large part of the annual precipitation falls during heavy storms of moderate duration, there has always been a heavy loss of water through run-off during floods. If this could be saved by impounding reservoirs, a great gain would be affected. But the generally constricted character of the San Bernardino and San Gabriel mountain canyons has been unfavorable to the construction of reservoirs. Actually but two important projects have been completed; the Bear Valley dam, whose stored waters have added the flourishing Redlands colony to the reclaimed areas; and the Hemet dam, less favorably situated as regards rainfall, and less successful therefore in the matter of acreage redeemed. Another project, the Arrowhead, is under way after years of patient observation of rainfall and run-off, hence eventually there will be a further addition to the waters conserved in this way.

The second attractive possibility for the development of additional water lay in the development of the great underground reservoirs. It had been found in the sixties and early seventies that the boring of wells in certain moist land areas was followed by flowing water, and when the surface supplies had all been appropriated, engineers turned their attention to these lands and to the storage sites as the two remaining sources which promised most in the way of increasing the available supply.

### THREE THOUSAND ARTESIAN WELLS.

The Gage canal system, completed in 1886, has depended from the first almost entirely upon underground waters, and its 7500 acres of splendid citrus lands are an example of what may be done with them. Since this experiment the development of underground waters in Southern California has continued, until now there are nearly 3000 artesian wells and about 1600 pumping plants representing a capital of about \$3,500,000 and a combined production of at least 400 to 500 second feet continuous flow.

This development, although under way for thirty years, was given a great forward impulse by the series of dry years which began a decade ago. The previous ten years had been years of abundant rainfall, the precipitation being well above the average, although this vital fact was not generally recognized by water users. As a consequence the acreage brought under cultivation during those years exceeded the amount which the ditches depending upon surface streams could serve when the dryer period came on. The most important and valuable of California crops are perennial plants, citrus and deciduous fruits and walnuts which can be rapidly adjusted to fluctuations in the water supply. A grove which does not come into profitable bearing until five years after planting, represents by that time considerable capital. If the water fails it for a season, that capital is lost. Hence great energy has been displayed in the development of water as the surface supplies have dwindled under the influence of the drought. There are few important irrigating systems whose supply has not been augmented during the ten years past by the boring of wells whose flowing or pumped water is used to make up the deficiency in stream flow. And in addition much independent irrigation has been undertaken whose supply is well water entirely.

A large part of this is new land, not under cultivation previous to the beginning of irrigation from wells; a smaller proportion was moist land cultivable without irrigation before the dry period, and retained in the cultivated class since only by the installation of wells. The reclamation of lands in this way has been most extensive, naturally in the artesian areas, and in those other low-lying lands bordering the artesian basins, where water could be obtained near the surface and at but slight cost by pumping, but it has been practiced in a more limited way where higher, warmer and more valuable lands have enabled the horticulturist to lift water to greater heights, and to pay the resulting higher charges.

### UNDERGROUND WATERS THE SAVIOR OF SOUTHERN CALIFORNIA.

It has been fortunate indeed for Southern California that she has had large bodies of subterranean waters to draw upon. This fact has enabled her to come safely through so trying and generally fatal a combination of circumstances as a decade of heavy rainfall, and consequent exaggeration of her most fundamental asset, accompanying such a rapid industrial development as to constitute a boom of the first order. The reaction from such a combination is usually utter stagnation. The worst fault of our Western American business character is its cheerful, careless optimism. We will believe any tales however false, that flatters our community pride and promises fortune; we will have nothing of any facts, however absolute, that set a limit to our resources. Here in the Southwest we might well parody the well-worn motto of the court of Louis XV, and say, "After us the drought." But Southern California has not as yet lost any extensive areas of her reclaimed lands, although the deficiency of rainfall at Los Angeles for the past eleven years has aggregated twenty-six per cent of the average, and during that time, and at present she has been steadily increasing her acreage.

The geologic relations which have made this condition possible may be briefly outlined. The valley of Southern California is not a normal stream valley, carved by stream action and adjusted in width, depth and alignment to the volume and course of the stream. It owes its character entirely to other agencies, those agencies being crustal movements. This diversified low land may be best described as a series of deep, irregular crustal troughs, parallel to each other and to the Pacific shore line, plunging to the northwest and abutting in this direction against the granitic San Gabriel range. At the foot of this range the ridges separating the troughs are lowest, and a practically continuous valley extends from Santa Monica to San Bernardino. Farther south the separating ridges rise higher, and the valley is broken by mountain chains and groups. As these troughs and their separating ridges have formed by geologic processes, the previously existing rivers have maintained their way across them from the higher mountains where they rise, to the sea, and in maintaining these courses have cut canyons in the ridges and have filled the troughs with the sands, gravels and clays that are due to their erosive action. The result is a series of deep bedrock valleys filled with alluvium, across which the rivers flow. These conditions give rise to cer-



tain peculiarities in the habits of the rivers, peculiarities which it happens adapt them in a wonderful way to man's needs as an irrigationist.

### BECOMES A LOST RIVER.

The Santa Ana River is the most important of these Southern California streams, has the largest drainage basin, the longest course and exhibits these beneficent peculiarities in the great perfection. It will therefore be briefly traced as an example of the type. It rises in the higher San Bernardino Mountains where rainfall is abundant, and has attained a volume of from 25 to 50 second feet when it reaches the first of the filled geologic troughs at the mouth of its upper canyon. Here it promptly sinks in the coarse debris and percolates slowly below the surface, protected perfectly from evaporation and contamination until it reaches the lowest point in the rim of this depression. This rim forces it to the surface, and it flows across it as a living stream, the waters which escape diversion sinking again in the gravel filling of the second trough. After a short subterranean course it is forced out again by the impervious rock at Riverside Narrows, and continues to flow over the surface through the Santa Ana Mountains until beyond these it reaches the inner edge of the greatest of the troughs, the Coastal Plain, in which it sinks. Below Santa Ana it rises once more in a series of strong scattered springs and escapes to the sea.

This hide and seek habit is characteristic of the rivers of this valley, and is as ideal an adaptation to the needs of the arid land horticulturist as though definitely planned by man for his own benefit. The lower rims of the rock folds force the water to the surface at very convenient intervals for diversion, and meanwhile not only is the water in its underground passage saved from loss by evaporation, but the irregular spasmodic supply at the canyon mouths is converted into a uniform flow which is unaffected by individual storms and responds but slowly to prolonged wet or dry periods. These basins are, therefore, not only storage reservoirs, but are most effective regulators as well, and go far to bring about that most important desideratum in irrigation practice, uniformity of supply. An additional important economic factor is introduced by the presence of artesian conditions along the lower margin of each of these storage basins.

The material with which the rock basins are filled is alluvium, river deposited sediment. Each stream issuing from its mountain canyon carries with it the products of its erosional activity there. Debouching upon the plain, its velocity is checked and the heavier fragments are dropped. At the lower margin of any particular basin, where the velocity of flow is least, the finest materials are laid down as clay sheets. These have the original slope of the stream bed and are limited in their extent upstream. In this direction they gradually become coarser until they are no longer impervious. The waters entering the valley at the canyon mouths and percolating seaward below the surface through the more porous strata are entrapped beneath these sloping clay blankets, where, under the weight of the waters behind them, they accumulate pressure. Then when the impervious clay cap above them is pierced they flow.

## AN ARTESIAN BASIN OF 250 SQUARE MILES.

These cheap artesian waters are well distributed in Southern California, and have been important elements in its development. The original area of the lands under which they were found was about 375 square miles, but it has suffered a shrinkage of 33 per cent during the last fifteen years and now measures only about 250 square miles.

Since these artesian basins are unlike the normal synclinal folds in porous rock which have come to be regarded as the type, so they have special characteristics which bear directly upon their usefulness.

In the first place, being in wholly unconsolidated and generally coarse material, they have a high transmission capacity. So freely does the water flow through them that individual ten-inch wells have in a few cases yielded six or eight second feet of water. Such wells do not fail because the water supplied at the head of the alluvial fan can not reach the boring, as has been the case in the Denver basin, for example. On the other hand, flowing so freely they draw down the supply at a very rapid rate, but can be restored if closed for a time, while a new supply is allowed to accumulate.

The fact that the water bearing strata lie approximately parallel to the surface, and that the highest are very near it, facilitates development to such an extent that ranchers in many instances have found it more economical to sink a well for each ten acre lot than to distribute from a single central well. This condition encourages the multiplication of wells and the draughts upon the artesian supply.

It is these great rock basins, with their filling of saturated alluvial wash which constitute the important underground reservoirs that have not only tided the region over a long period of low rainfall, but have actually made possible constant additions during the dry period to the reclaimed lands. These great natural reservoirs more than compensate for the lack of sites for effective artificial storage. Their actual capacity is to be expressed in cubic miles rather than in smaller units. The San Bernardino basin has been explored by the auger for over 1000 feet, and is roughly estimated to attain a maximum depth of 3000 or 4000 feet. The alluvial filling about Pomona and Chino, and that east of Pasadena, above the Paso de Bartolo, is known to extend below sealevel. The great Coastal Plain basin has been explored for 1300 feet, and its depth, were it known, would probably be found to run well up into the thousands. With a surface area of 775 square miles and on the basis of 30 per cent of voids, a very impressive but utterly valueless estimate might be made of the amount of water stored in it.

Now while, as I have stated, the underground reservoirs have proven of incalculable value to Southern California during the decade just passed, and have not only carried the country through this period, in spite of the fact that the greater part of its earlier development was carried out during and upon the basis of a decade of excessive rainfall, but have actually permitted a continual increase of acreage under irrigation, it is not to be expected that this result has been attained without affecting the water level in the reservoirs.

## UTILIZING ALL THE WATER.

Water levels have, in fact, declined notably, artesian areas have shrunk, and pressures in wells still flowing have decreased markedly. The thing which causes most surprise is that these shrinkages have not been more violent. The underground supplies have been attacked in front and rear. The summer, and a part of the winter flow of the mountain streams is diverted at the canyon mouths and used for irrigation, where formerly all of it sank into the gravels and joined the underground supply. A few storage reservoirs have been built which hold a part of the winter flood waters that are now and always have been the chief source from which the ground waters are replenished. Thus not only has the supply been less during the past decade because of drouth, but it has been further curtailed because of diversion and storage. In addition to this indirect attack, the great number of artesian wells and pumping plants which have been put in have directly attacked the quantity of stored waters. It is estimated that of the 225,000 acres under irrigation in the valley of Southern California at present, two-thirds are dependent upon developed underground waters, about 400 to 500 second feet of which are used while the surface streams supply but 200 or 250 second feet. These relations are not fixed, there being a large acreage which is irrigated with surface water when this is abundant, but with well water when the streams are low. But the irrigation from developed water alone is increasing, while that from streams is at a standstill, or is shrinking, the flow of certain important streams which are due to rising ground waters having diminished during recent years.

The shrinkage in artesian areas is brought out graphically by the accompanying map, upon which fourteen areas are shown in which flowing water is or has been found. These combined artesian areas originally amounted to 375 square miles; they now cover about 250 square miles, a loss of 33 per cent, most of which has taken place within ten years. One great water company, whose supply of 40 second feet was originally all artesian, except about six second feet, now pumps at least 75 per cent of the total. The water levels in wells in important water-bearing lands tell the same story. Maximum declines of 60 or 70 feet within the past four years are of record. Declines of 25 or 30 feet are not at all rare.

These of course are the phenomena to be expected during a period of drouth. The critical point with the California irrigationist who is dependent upon underground waters, is to determine how much of it is due to the dry period and how much to development. Obviously this is a difficult point. The amount of water returned to the gravels each year is scarcely capable of direct estimate, at least with the data now available. The greater part is contributed of course during the winter floods, but the measurements of these are difficult, and but few attempts have been made to estimate them.

Observations upon the fluctuations of the ground water level are perhaps of more value. A system of such observations has been begun by the survey, but it will have to be continued for a considerable period before its results furnish a safe basis for conclusions. At present we have only two or three

sets of observations within the valley which extend far enough back to be valuable. Fortunately for our thesis, their evidence is harmonious. I have selected for discussion the profile of the water level in a well near Anaheim, on the inner edge of the Coastal Plain. Pumping plants are numerous in this vicinity and are being rapidly increased in number, so that the phenomena exhibited by this profile may be accepted as typical of those neighborhoods where most pumping is being done. For direct comparison with it a rainfall chart has been prepared in which the departures from the average are shown for each year, since it is with the relation of each year's rainfall to the normal that we are especially concerned.

It will be noticed that from the time when the observations began in 1898, the declines were continuous and regular throughout the dry period, which was interrupted during the winter of 1900-1901 by an excess of rainfall. During this winter the water level raised two feet, but the gain was more than lost before the beginning of the next rainy season. The decline then continued, although irregularly, until the winter of 1902-1903, another year of excess in precipitation. Here again the profile shows a rise, but again it was more than lost before the end of the year. Since that time the decline has been rapid.

#### FACING A SERIOUS PROBLEM.

The significant thing about this profile—and such other measurements as we have exhibit the same phenomena—is that years in which the rainfall has exceeded the average have failed to stop the decline, although they have checked its rate. With present developments then the decline will continue, rapidly through years of deficiency, less rapidly through years of average rainfall, slowly through years of slight excess, and will cease only with an amount of excess greater than any that we have had in a decade. This is a sufficiently serious showing to call for a halt in the development of underground waters. It does not necessarily mean loss of land now reclaimed, because it is recognized that the proportion of water available for the restoration of the underground supplies, increases at a rapidly accelerating rate as the rainfall itself increases, that is, where a precipitation of fifteen inches may add little to the underground supplies, with a fall of twenty inches, nearly all of the last five may prove effective for this purpose, and a precipitation of twenty-five inches, well distributed throughout a long wet winter, may restore the continuous declines of half a dozen years of deficiency.

But the evidence is quite sufficient to show that it is time to stop increasing indiscriminately the number of wells for reclamation of virgin lands. There is grave danger that the splendid subterranean reservoirs which have carried communities through the past decade without distress, and have responded so fully to every demand made upon them, may be overestimated. Such supplies are everywhere peculiarly liable to over-valuation for several reasons. Among them is the fact that if the total quantity of stored water be estimated, the figures are so great that thoughtless users immediately conclude that such supplies are inexhaustible. They forget that actually it is only a very small part, often no doubt only one or two per cent of this great amount, which is, or with present methods, can become available. Again,

the fact that these great bodies of gravel are efficient regulators of the supply through rainfall, responding but slowly to periods of drought or periods of excessive precipitation and showing but slowly the effects of over-use, leads many to suppose them wholly independent of those controlling factors, and so encourages them in their campaign of over-development. As a matter of fact, close, careful and continual observations should be made of fluctuation in ground water levels, as development proceeds, and these when compared with rainfall measurements, will give a safe, scientific basis for the regulation of the acreage irrigated from ground waters.

Meanwhile, development must proceed with extreme caution, for obviously nothing worse can happen to a community than to be forced to abandon lands which have been reclaimed at a great expenditure of time and capital.

Mr. Newell—Mr. Mendenhall has given us briefly the result of years' of very careful work. He has called attention to a serious condition which exists in that locality, where a field possessing ideal conditions may have its underground waters drawn upon by so many wells as to imperil the value of the entire area. The striking thing to me is the rapid decline in the area of these artesian fields. A fact we should emphasize to the people of California and others interested in that there is a limit to the artesian and underground waters, and without alarming them, we should suggest that they should exercise wise and prudent forethought, and if necessary, enact State laws to guard against over-development and total destruction of the field by putting down too many wells, and thereby kill the goose that lays the golden egg.

Mr. Fred C. Finkle, of Los Angeles—Having devoted about 18 years to practice as a hydraulic engineer in Southern California, I am thoroughly familiar myself with these conditions, and what applies to Southern California applies to a great extent to other portions of California also. Within the last few years it has become generally recognized among engineers that these artesian springs, as well as other basins that are not artesian, have been drawn upon to a greater extent than they can sustain. For many years it has been that the man who had the longest pump rod would deprive others of their share of the water, but now the Supreme Court has changed the aspect of the law so that no longer can a man go in irrespective of the rights of others and draw out the underground waters so as to destroy the old supply; yet it will require a great deal of time to restore the normal conditions.

#### GRAVEL BEDS HOLD THE WATER.

An interesting thing which we will observe by the topographic map exhibited by Mr. Mendenhall is that in all of these basins and between them and the mountains are large beds of gravel, sand washes from the various streams. The supply of these basins comes from the floods which come from the foothills and fill the lower levels. The floods carry enormous amounts of silt, which is caught by these gravel beds, thereby preventing the percolation of the water through them and thereby preventing the full benefit from

accruing which would otherwise come from these artesian belts and storage basins.

I am not so optimistic myself as some of the people of my section of the country, but I do believe if the people will listen to reason and cease their developments—the courts will probably enjoin some of the recent developments—that in a reasonable time all of these basins can be restored practically to their normal level, but this can not be accomplished without the assistance of the courts. As to the value of these basins, Mr. Mendenhall has dwelt almost entirely on their value as water supply for irrigating lands. They possess another great value, that of sub-irrigating the lands overlying them. When the water stands within a few feet of the surface, as it does in these artesian basins, the underground water feeds the alfalfa and other products in that section; so these waters in their original state serve two purposes, they first sub-irrigate the products and then furnish waters for irrigating other lands in the foothills and arid districts of the State.

Mr. Newell—Gentlemen, the next paper on the program is by Prof. E. F. Chandler, State Engineer of North Dakota.

## **SPRING FLOOD MEASUREMENTS IN NORTH DAKOTA.**

E. F. CHANDLER, State Engineer.

It is not my intention to treat a topic so broad and so long as one might infer from the title printed in the program ("River Floods and Water Supply of North Dakota"), but merely one special phase that may force itself on the attention of those making stream measurements in as northern a latitude as North Dakota, a topic, however, concerning which I have not happened to see anything published.

This is the casual relation existing between the early spring floods—or rather, the first high water of the spring—and the ice which then, after holding the river all winter in a grasp of iron, is melting, breaking up, and floating down.

It is a characteristic of North Dakota streams that quite frequently there are two well-marked high-water stages during the season, the first, early or late in April, the result of the melting of the snow, may be almost certainly expected. Then, there being no mountains to hold heavy snow banks through the spring and no forests to delay the run-off, the water promptly slides off the prairies into the rivers and, even where the fall is as slight as in many of these prairie streams, it has soon run by and is gone. Afterward comes the second rise, the "June rise" as it is termed, which can not be predicted with certainty, but which usually occurs, following the rains, in late spring or early summer.

It is the April rise that is likely to give the highest water. If irrigation is in view, this early flood, though not needed for immediate use, must be stored for later use and is the most assured source of supply. Thence measurements of its quantity are made.

Perplexity not infrequently follows in the mind of the hydrographer because of a serious and sometimes apparently causeless discrepancy that may be found between these measurements and those at later season high stages. I believe that the rule may be safely laid down that, on prairie streams of as sluggish a nature as these, when the ice first breaks up and goes down, the height of the water on the river gage for several days, or for a week or two, must be assumed as due not entirely to the quantity of water being discharged, but in part to the ice; for this seems to have a tendency as it catches on the banks and increases the friction to retard the speed and raise the water more or less, even when it is running freely down the river without forming any visible jam or barrier.

### **STREAM GAGES NOT ALWAYS ACCURATE.**

If a rating-table, based on later season measurements, is to be applied in the computation from the gage-height record of the season's run-off, it is necessary to reduce the gage-heights or deduct a very considerable per cent from the assumed discharge during the first portion of the flood following the spring break-up. Unless an unusual number of discharge measurements have been made at that season (which may be hardly convenient for an engineer who has charge of a number of gaging stations on different streams, all

of which are apt to have this brief spring rise at nearly the same time) one has not sufficient data to obtain a comprehensive idea of the precise amount of this correction each day for every stream, and it is largely a question of judgment, an estimate. Yet such an estimate must necessarily be made, for the records for those few days may denote the highest water of the whole season, hence be of proportionate importance. This past spring the floods were somewhat unusual, it is true; but there was scarcely a stream in the region but had at least a third of its total run-off for the year within a single month in the early spring, and in some cases four-fifths of the total run-off passed in less than a month.

A few illustrations may be of interest.

On the Pembina River, a small stream of eighty feet width, a spring measurement made while the channel was covered across with lodged or floating ice cakes at some points, although clear and open at the point of measurement, gave at a 12-foot depth of water a discharge 20 per cent less than the rating table, equivalent to subtracting  $2\frac{1}{4}$  feet from the gage height. This rating table, by the way, checked perfectly with a still higher measurement a week later.

On the Red River, at Grand Forks, a spring measurement made while occasional ice-floes were still running down the stream and lodging against the shore gave a discharge of 21,000 second feet instead of 27,000 second feet expected from the gage-reading, a discrepancy on a total depth of 36 feet equivalent to a difference of  $4\frac{3}{4}$  feet.

A measurement under similar circumstances eighty miles further up the same stream, at Fargo, a few days later, produced a 30 per cent discrepancy, indicating that out of a total depth of 13 feet the ice had raised the water  $2\frac{1}{2}$  feet.

At the same time on the Cheyenne River, near Fargo, a discrepancy of 22 per cent, equivalent to  $3\frac{1}{2}$  feet out of the 16 feet depth of water was found; but this was not unexpected, for the ice-floes were lodged across the channel a short distance below.

On the Red Lake River, at Crookston, Minn., a measurement made when the ice seemed to be all gone except narrow strips fringing the bank, and when considerable inspection discovered no gorge or barrier below, gave only 6000 second feet discharge instead of the 10,400 expected (an expected figure confirmed by still higher-stage measurements the following week), equivalent to  $5\frac{1}{4}$  feet fall from the 16 feet depth. An autumn low-water measurement at the same place, made with the temperature falling toward zero, and a driving snow storm covering the river with a layer of snow-sludge and shell-ice sliding along the surface, gave results 25 per cent too small, equivalent to a difference of nearly one-half foot on the  $3\frac{1}{2}$  feet depth. I suspect, however, that anchor ice was forming on the bottom of the channel a little further down, diminishing the cross-section somewhat.

#### SLIGHT FALL OF STREAMS.

All these streams have only a gentle fall, meandering through level valleys whose general descent is about one foot per mile, or less than two feet



at most, and in the clay and silt of this level prairie they have eroded comparatively narrow channels of from twenty to fifty feet depth. With a maximum velocity of not more than three or four feet per second under any circumstances, and of one and a half feet to two and a half feet per second in all the cases mentioned above, the current does not often drive the ice-floes together with force enough to cause any conspicuous ice jams where the ice is gorged together into a huge dam. But the influence of whatever barriers there may be extends a proportionately greater distance up the stream to retard the flow and raise the gage-height. And, furthermore, if I interpret the data right, the mere presence of the jostling ice cakes in the stream, when they form so considerable a portion of its volume as the three-foot and four-foot ice-floes and bergs of North Dakota may do, by making one layer of the stream so to speak more viscous, retards the flow and raises the water disproportionately.

Mr. Newell—The paper by Mr. Chandler, dealing with ice conditions, is one which some of us can not appreciate very much, especially in the southern part of the country. The ice proposition, however, is one with which the engineers have to deal and is very important. In all of our structures in the North we must take the ice situation into consideration, such as its volume, duration periods, its thrust, ability to overturn structures, etc.

Mr. Storrs—There is one important feature, which applies to the western portion of North Dakota at least, and which differentiates the conditions Prof. Chandler refers to. In the western part of the State we have many small streams which, during the flood season, come down the coulees and wash in considerable volume. An examination of these small streams shows that it would be exceedingly valuable to conserve their waters by storage and thus obviate the necessity of pumping. The waters can ordinarily be stored above the upper benches and can, therefore, supply water to the lower areas which can now be developed only by pumping. Even if the amount of water that can be stored is small and variable, it is very valuable, because it will save pumping to the higher level, which is extremely expensive. In seasons whenever there happens to be an abundance of water it may be unnecessary to pump to these higher tracts at all. In that respect it is distinctly different from the conditions in Oklahoma, where there is only a variable supply from the streams, there being no reservoir such as we have in North Dakota, where we have the Missouri River to draw on and a pumping plant at hand to make up any deficiency in the run-off in the small streams.

#### DEVELOP SMALL RESOURCES.

Mr. Newell—The matter is very important to the people in North Dakota. There the matter of reclamation is a problem of developing smaller resources. We hope to be able to develop a method of pumping which will be applicable to that State and others in a similar condition. The fall of the ground is not sufficient to take the water by gravity ditches out of the Missouri River.

Mr. Storrs—It is barely possible that there may be some such favorable localities but I have not run across any yet. The hills—you can hardly call

them mountains—in that State do not conserve the snowfall to any extent. The streams are small and the run-off from most of them is limited. It is possible that if a favorable reservoir site could be found some power could be found to draw the water from the reservoir, but that would be quite unreliable, and I should think, in any case, would only supplement to a small extent the pumping by means of a steam plant. Steam plants are especially inviting in that State because of the abundance of a cheap grade of coal, called lignite, making it quite economical to do the pumping by means of using coal for fuel.

Mr. Newell—That illustrates the condition of the Reclamation Service, where we do not have one thing we have another. It so happens that in North Dakota we have large quantities of this lignite, and tests are now being made in St. Louis of the efficiency of the coal from North Dakota and other parts of the country and the best way to utilize it for pumping in irrigation. They are testing it by direct fire, steam boiler, by putting it in a gas producer and testing it also by making briquettes of it, which can be handled commercially, but the tests so far indicate that the gas producer may be the way in which we can best use it and put it into effect. This is one of the innumerable ways in which the engineer and business man must overcome the effects of natural conditions.

#### EXPERIMENTS WITH COMPRESSED AIR.

A Delegate—Have they ever tried the compressed air system?

Mr. Newell—Not that I know of.

A Delegate—I will state that where I live they have just put in a compressed air plant and are making quite a success of it. They say they can lift the water by compressed air in large plants more cheaply than they can by pumping. This plant is run with oil as fuel. We purchase oil at the wells at about 15 cents per barrel, or a cost of about 50 cents per barrel at the plant, which makes it a very cheap fuel. At present they are demonstrating what can be done with compressed air. I think that in large plants it would be by far the cheaper method of lifting the water. It is much cheaper to have one large plant than to have numerous small plants, because one large compressed air plant can be utilized to lift water from a great many wells. This plant when completed is to cost \$16,000, and the parties have entered into a contract with the owners of the land whereby the latter are to purchase enough water to irrigate 13,000 acres of land at a cost in construction of the plant \$16,000, and about 40 to 60 cents per acre for each irrigation. It seems to me that whereas in Oklahoma or the Dakotas, or other places where they have to irrigate by pumping, that it is important to look into this matter to ascertain if they can not produce the water more cheaply by means of compressed air plants than by the construction of these large irrigation works and reservoirs, where the water can be obtained at a depth of say less than 150 feet. I do not know what the area is in North Dakota that they have irrigated, but it seems to me that under the conditions it would be very expensive for them to irrigate from wells by pumping.

Mr. Finkle—Is it a system of direct lift?

Delegate—Yes, sir.

Mr. Finkle—If so, I would state that that system has been used by us in Southern California for a great many years and it is now being used where the wells are scattered over a wide territory. I have made some very careful tests of that system and I have found it to be very inefficient in the matter of fuel. Air compressors do not usually have an efficiency in a warm climate of more than 50 per cent. Then again the free air discharged into the well loses a good deal of its force, so about the best results I ever obtained was about 30 per cent, and in many cases only got as much as 20 per cent of our actual power, so we do not look upon that system with a great deal of favor in that country. Mostly all of the pumping plants there now are either gasoline engines or electric motors, the electricity being obtained from the water powers in the mountains.

Mr. Newell—It is understood that Mr. Fred C. Finkle will favor us with a discussion of the subject of "The Most Economic Type of Hydraulic Power."

## THE MOST ECONOMIC TYPE OF HYDRAULIC POWER.

Mr. Finkle—I was not advised that I should speak before this gathering until last evening, so that I have not prepared any paper, and whatever I will have to say to you this morning will be in the nature of rambling remarks.

In Southern California we are dependent more on the underground waters than upon any other source. The streams are limited in their flow during the irrigating season, and reservoir sites are very scarce, and with few exceptions we do not expect much from that direction in future. We are blessed in another way. Although we lack reservoir sites we have a precipitous fall in all of these canyons, which can be utilized for the development of electric power. I am satisfied that some of our rivers have falls as great as 350 feet to the mile. While the streams are small, we sometimes obtain considerable horsepower from them. I may mention one stream on which I constructed a power plant for the Edison Electric Company of Los Angeles, known as Milk Creek, where 24 second feet of water flows in average years. We have constructed a power plant on it by means of less than seven miles of conduit, which gives us about 4000 horsepower available. The fall at the station being nearly 2000 feet, which registers about 840 pounds to the square inch at the nozzles. These plants are used for irrigation, light and street railway operation.

### POWER CONDUITS.

One of the most important questions we engineers have had to meet is the proper design and proper materials for constructing power conduits. In early days our power conduits were constructed mostly of cheap materials, generally wooden flumes which were hung on the sides of the mountain, and every storm that came up they would be broken or damaged by rolling boulders or land slides above them, so the engineering profession has been compelled to give a good deal of study and investigation to the matter of designing something permanent. You can realize the utter importance of having an uninterrupted service in a power plant. It is not only necessary where you are furnishing power to light cities, and run electric railways, but also where you are pumping water for domestic use and irrigation. These disasters to the

early and crude power plants were very bad and caused the whole matter to be looked upon with suspicion and investors were not eager to put their money in the securities of these power plants. From my own experience I have come to the conclusion that there are two available methods, but before I outline these to you I wish to state briefly the conditions usually encountered in building conduits, referring particularly to California. The waters in California are all diverted at the base of the mountain ranges and distributed over the bench lands, so that power plants in the valleys practically do not exist. We have only one power plant in the valleys, and that is on Mill Creek, known as Mill Creek No. 1, which diverts the water at the mouth of the canyon and carries it two miles. All of the other structures are in the mountains, where you have to contend with vertical bluffs and steep sides of the mountains, scantily covered with vegetation, and when the heavy rains occur in the winter, landslides come down these mountains and almost any kind of structure exposed on the surface would be very undesirable.

#### MODE OF CONSTRUCTION.

The mode of construction which I have now practically decided upon is a concrete and cement pipe. We make this pipe in two-foot sections by mixing the ordinary gravel and sand which we find in the waters and screen through a coarse screen with one part of Portland cement. The pipe is laid in trenches dug to a depth sufficient so the pipe will be below the influence of land slides and to prevent it from being broken by rolling stones coming down the mountain. In some places we find it impossible to excavate these trenches on account of the vertical bluffs and in those cases we construct a tunnel. These pipes are laid on a uniform grade and the grade is usually determined by the velocity that is safe to give the water in your pipe, as it is not advisable to make the velocity greater than 5 feet per second, as to make it greater would have a tendency to wear the pipe. The joints are made by means of a cement collar put on the outside, made half of sand and half cement and covering the entire circle of the pipe. This collar is put on by men wearing rubber gloves, who press it down carefully. Inside of the pipe we plaster the joint with cement and this makes it a perfect joint. We now have three power plants which have been constructed in this manner and they have proven an excellent success, having had no interruptions in the service of any of them. One of them has been in use six years and that is a thing that never has occurred when flumes or other surface structures were used. In Southern California we have developed all of our smaller water powers and have had to go farther north. The Kern River is now the principal source from which new developments are being made.

#### POWER DEVELOPMENT BY TUNNELS.

The Edison Development Company is developing a plant on the Kern River. It will develop an enormous amount of land and give us 28,000 to 35,000 horse power in Los Angeles. This quantity of water is so great that a conduit of the nature I described would not be possible. A conduit 48 inches in diameter I have never found to be successful. For this particular purpose

we are driving a tunnel 9 feet wide and 9 feet high in the rough. When lined with concrete inside it will be 8 feet wide with a water carrying cross section of 7 feet in depth, the upper part being arched over in a circular form to sustain the formation. We find that by the use of this tunnel, we shorten the line which would be occupied by a flume from about 14 miles to  $8\frac{1}{2}$  miles. Although the tunnel will cost more than a flume, it will be a perpetual thing when constructed. A tunnel of this character if driven through the rock will be a thing which for all practical purposes we may say will endure forever, while a flume under the very best conditions is only good for 15 or 20 years. Besides, the other objection which I mentioned, namely, interruption to the service, is a vital matter. Companies which built flumes in the early days have abandoned them and built tunnels. There was one company at Bakersfield which originally built a flume and had so many interruptions that within three or four years after the flume was built they drove a tunnel. For a large flow of water the tunnel is the most economical form of power conduit. The problems an engineer must meet are cross section and grade to be adopted for each particular grade. As to the grade to give such a tunnel, what governs me almost entirely is the velocity which the concrete work inside such a tunnel would stand. My reason for concreting these tunnels is that in this way you can save considerable on the first cost of the work and you reduce the co-efficiency of roughness. My method of concreting is to use 4 parts of crushed rock and three parts of sand to one part of cement and lining and covering the bottom with three to four inches, plastering the whole surface with a mixture of 1 to 2 sand and cement, applying, say,  $\frac{1}{4}$  of an inch to give a smooth surface and prevent percolation through the cement. By means of this construction the co-efficiency has been reduced as low as .01 and in other cases it has been as high as .012. If the work is very poorly done it might run to .013, but I have never had a case of that kind in my experience. Of course the first investment in a power plant is made greater by means of this class of work.

#### TUNNELS VS. FLUMES.

In California where timber is quite abundant a flume can often be constructed very cheaply, but by figuring the cost of maintenance of such a plant, the loss to the company by interruption to its service and consequent loss of reputation, etc., and cost of renewals, which are very great on all timber structures, I find that the figures I have prepared show that although higher at first the other system is cheaper in the end. I deem this subject one of considerable interest to the Reclamation Service for unquestionably will they meet with problems of this nature, and what I have said in regard to the economy of a power company of course applies fully to the Reclamation Service wherever the plant is for power purposes, and where it is not for power purposes it applies to a considerable degree. Of course many of us in our first practice as irrigation engineers had to do more or less timber work in the arid part of the United States. The companies often allowed us only a certain amount of money to do the work and many of the land schemes were dependent upon the revenue derived from the sale of lands,

and the habit grew up among the hydraulic engineers of the West of doing a great deal of timber work. The results have not been very satisfactory. Many of the systems are in such a condition that they have to be re-constructed or give very inefficient service in the future. In irrigation it is possible to forego the use of the water for a short time when a break occurs in the canal or conduit, but it is not possible in the case of power; and I might state that the development of power is what first called our attention to the necessity for doing permanent work, and this necessity is now coming to be recognized by engineers engaged in reclamation work. I am pleased to see that the Reclamation Service is planning to do good and permanent work. Not being connected with the Reclamation Service in any way, I know very little about their plans except what they see fit to give out from time to time. I know that it is not advisable to advertise their plans at all times as there are speculators in the country who are always willing to take advantage of the government as well as the people.

#### ELECTRICAL POWER DEVELOPMENT.

I would state that in Southern California at the present moment as near as I can remember there is something like 3000 horse power (electrical) developed from water, used for lifting water for irrigation and that is all done in a valley which is about 100 miles in length and an average width of not over 20 miles. There is a good deal more power than that employed but it comes from gasoline engines, which are used to a great extent, the electrical companies not being able to supply the demand. A good many of these gasoline engines will be replaced in the near future when some of the larger electric power plants are completed. On the Kern River, which is within 40 miles of Los Angeles, it is possible to develop 70,000 to 80,000 horse power, which will be available for use in that vicinity. This power will not, of course, be used for pumping water to any very great extent, because we have practically reached, if not overreached, the limits to which water can be pumped at the present time, and there are many other uses to which it can be applied, such as electric light plants, and the electric railway systems, which are becoming very numerous, joining all the small cities and towns in a perfect net-work. We have just passed through a period of dry years and that fact taken in connection with the excessive development has caused a depletion of the underground supply of water, and the curtailing of some of these excessive developments. We have hopes, however, that with the return of wet years in that section all the water that is needed for irrigation can be obtained, ultimately, in Southern California.

Mr. Newell—The matter Mr. Finkle has brought up is interesting to all engineers. The matter of permanent construction is one that must appeal to all of us. Construction up to the present time has been of a temporary character. The work of the reclamation engineers is largely in the line of good and permanent work. We have been experimenting on the construction of large cement pipes. We have been experimenting on the construction of pipes larger than 48 inches. We have been endeavoring to ascertain the practicability of constructing this pipe 6 feet in diameter, especially for pres-

sure conduits to take the place of flumes so that we would not be compelled to use the wooden box trough or the wooden pipe, which has been used very successfully and largely in the West.

#### PUBLISHING ENGINEERING DETAILS.

Mr. Finkle has referred incidentally to the fact that the plans of the Reclamation Service were not widely known, and I think it only proper to state that in all matters of engineering detail we desire to have the widest possible dissemination and discussion, but in matters of advice to the Secretary of the Interior, our instructions are very positive and direct, that we are employed to work for him and no one else and our advice is to be given to him and not the public. I have noticed occasional squibs in the papers to the effect that they cannot find out anything. That is really a compliment to us. If anyone wants any information if he will write to the Secretary he will probably get it. In all matters of engineering that we can we want to take the public into our confidence and get suggestions from them.

#### TUNNEL DISCUSSION.

The subject of tunnels is an extremely interesting one to us, particularly in connection with such tunnels as we are building in Nevada and especially on the Gunnison and in the Montrose Valley. In the latter, under the direction of Mr. Fellows plans have been made for a tunnel 30,000 feet in length and 12 feet in the clear, lined throughout in order to increase the velocity to a point of safety. I think the velocity figured on is 10 or 12 feet per second. The work on that project has now advanced to a point where the bids have been received, and I think you may be interested to know that the bids have ranged from \$2,600,000 to \$1,000,000, and all made by men who are experienced in the work. The contract has been let and is now ready for signature.

Mr. Fellows--I have been particularly interested in what Mr. Finkle has said. I am not prepared to discuss the very able remarks he has made, but I have been asked to deliver a paper later in regard to tunnel estimates, in which I propose to cover some of the points he raised, particularly in reference to decreasing the size of the tunnel and the increasing of the velocity through lining. In referring to the tunnel which Mr. Newell has described, we have been criticised by some of our principal citizens who have said that the Reclamation Service was going so far as to propose to line this immensely long tunnel so as to make a pretty job of it, make it look nice and give it a pretty finish. It has been asserted by some of our citizens that we could reduce the cost of the tunnel one-half by leaving off the lining. As a matter of fact, as Mr. Finkle has stated, the result of adding the lining is exactly the opposite. In the tunnel we have used .012 as our co-efficient of friction, thinking that to be on the safe side. In the unlined section constructed by the aid of machine drills we have used roughly .030, and it is my recollection that the discharge of the tunnel without lining would have been about 485 cubic feet per second and with the addition of the lining the same size tunnel

decreased in size by the amount of lining would have a discharge of 1300 second feet, thus considerably more than doubling the capacity of the tunnel by the addition of lining with an increased cost of about 25 per cent. This illustrates the necessity for concrete lining, which reduces the cost and is advantageous in every way. We find that in certain portions of the tunnel it will not be necessary to line the upper side of the tunnel by placing an arch in it, and in that section the lining is to be left out, but wherever the lining or support is necessary for the maintenance of the tunnel the lining will be included.



## Wednesday Afternoon, November 16, 1904.

Chairman Newell—Regarding Mr. Bien's paper on the proposed State irrigation code, I might explain in advance that when the Reclamation Act was passed there was a great deal said in the papers on the necessity of reforming the State laws in accordance, and in the winter of 1902-3 we had many inquiries from every State and Territory asking advice as to what changes should be made in the State and Territory laws so as to conform with the Reclamation Law.

Our invariable answer was that we did not advise any changes whatever at present or until we knew more of the practical workings of the law. We have now had 2½ years' experience with the irrigation law and are better qualified to say in what way the State and Territorial laws might be improved with reference to that experience.

The States of Oregon and Washington appointed commissions to consider a State irrigation code and at their invitation Mr. Bien and myself met these commissions in joint session at Pendleton, Oregon, and Walla Walla, Washington, and at their suggestion and request Mr. Bien drew up a code to serve as a starting point for laws that may be beneficial. Copies of this code have been sent out to persons everywhere who indicated that they were interested in the matter. With this brief statement as to why we are interested in the matter, I take pleasure in introducing Mr. Morris Bien.

### **PROPOSED STATE CODE OF WATER LAWS.**

MORRIS BIEN, United States Reclamation Service.

The simplest form of regulation of the use of water is best exemplified by the present laws of the State of California. These declare the principles of priority and beneficial use and provide that claims to the use of water shall be recorded in the form of a notice of appropriation and shall be perfected by application to a beneficial use.

The form and theory of these laws was developed by several of the States, which followed in general the California laws and elaborated upon the methods established in that State.

### **DECREES OF WATER IN EXCESS OF SUPPLY.**

The operation of these laws places no restraint upon appropriations of water. The courts in passing upon the claims of the appropriators, having scant information concerning the amount of water available for use, with no guide to the quantities which should be applied in the cultivation of crops, and confronted with the excessive claims of the parties, have often adjudicated rights to the use of water many times in excess of the amount carried by the stream.

The knowledge obtained during recent years concerning the discharge of streams and the use of water have caused such decrees to become exceptional in present practice. Nevertheless the need for a more careful regulation of the appropriation and use of water has been apparent for many years.

### MODERN STATE WATER LAWS.

In 1890 the State of Wyoming enacted a code of water laws providing for a thorough supervision of the utilization of the water supply of the State through a State Engineer and State Board of Control who adjudicate rights to the use of water in the first instance, and Division Superintendents and water masters, who have immediate charge of the distribution of the water in the various water divisions.

Nebraska subsequently adopted a code of water laws substantially the same in principle as those of Wyoming.

Idaho, Utah and Nevada in 1903 at the last session of their legislatures adopted codes of water laws based upon those of Wyoming with, however, a number of important modifications dictated by the experience of Wyoming and the development of irrigation practice.

### OREGON AND WASHINGTON IRRIGATION COMMISSIONS.

At the sessions of the legislatures of Oregon and Washington, in 1903, the governors were directed to appoint commissions to prepare and submit draft of a code of irrigation law.

At the joint session of the two commissions with the Chief Engineer and other members of the Reclamation Service held last August, the fundamental principles of a modern irrigation code were discussed. There was also some consideration of the provisions which should be incorporated in such a code to facilitate the operations of the Federal Government in carrying on the work of constructing the irrigation systems contemplated by the Act of Congress approved June 17, 1902 (32 Stat. 388), known as the Reclamation Act.

As the conditions in the two States were similar it was deemed advisable for the two commissions to work in harmony and to prepare codes which should be as nearly identical as the conditions would permit, in the hope that by co-operation the commissions would be able to submit to the respective legislatures a code which should be an expression of the most advanced development of irrigation law.

### PREPARATION OF DRAFT OF STATE CODE.

At the conclusion of the joint session of the two commissions, I was requested to prepare a draft of a code of water laws to form a basis of discussion by the commissions. The draft was prepared in a few weeks and widely distributed among those interested, for comment and criticism.

A number of valuable comments and suggestions have been received, enabling me to formulate amendments which a subsequent careful study of the draft had shown to be advisable, besides suggesting important changes and improvements.

I desire particularly to express my obligations in this matter to Messrs. F. I. Dunbar, Secretary of State of Oregon; A. E. Chandler, State Engineer of Nevada; Clarence T. Johnston, State Engineer of Wyoming; L. G. Carpenter, State Engineer of Colorado; D. W. Ross, Engineer in charge of the work of the Reclamation Service in Idaho, and T. A. Noble, Engineer in charge of the work of the Reclamation Service in Washington.

### PROVISIONS NEEDED IN STATE CODE.

A State code of water laws should provide for the appropriation, adjudication and apportionment of the waters of the State, and divides itself naturally into four branches.

First—A declaration of the fundamental principles upon which the right to use water shall be based.

Second—The adjudication of rights to the use of water claimed under the previous laws, thus determining the unappropriated public waters.

Third—The regulation, control and determination of the rights to water to be subsequently acquired.

Fourth—The regulation and control of the distribution of the water, rights to the use of which have been established.

### PROPOSED CODE FOR OREGON AND WASHINGTON.

In discussing these branches of the subject the important features of procedure in the proposed code for Oregon and Washington will be described.

Under the first heading the fundamental principles are few and well established; namely, that all the waters within the limits of the State belong to the public and are subject to appropriation for beneficial use, except from sources of supply which are navigable; that the beneficial use of water shall be the basis, the measure and the limit of the right; that the use of water is a public use, and private parties may exercise the right of eminent domain for the acquisition thereof; and that water used for irrigation shall be appurtenant to the land on which it is used.

### ADJUDICATION OF RIGHTS.

Under the second heading, providing for the adjudication of rights claimed under prior laws, it is now generally conceded that the final adjudication must be by the courts. The codes of the different States contemplate various forms of procedure. In the code proposed for Oregon and Washington, a State Engineer, appointed for six years by the Governor, subject to confirmation by the Senate, is to make a complete hydrographic survey of a stream system, obtaining all the data necessary to determine the amount of water available and the rights of the parties entitled to the use of it. This material is turned over to the Attorney General of the State, who is required to enter suit promptly for the determination of the rights of all parties and to prosecute the same diligently to a conclusion. In all suits for the determination of the right to the use of the waters of any stream system, all who claim the right to use such waters shall be made parties. In all suits involving the determination of water rights, the Attorney General is required to intervene on behalf of the State, if in the opinion of the State Engineer the public interest requires it.

### PROCEDURE FOR APPROPRIATION OF WATER.

The third subject, namely, that of the regulation, control and determination of rights to the use of water to be acquired, is placed in the hands of the

State Engineer. The procedure proposed is substantially the same as that adopted in the other States having a modern irrigation code with some differences of detail.

The principal feature to be noticed is that before any work looking to the construction of an irrigation system is commenced, and after the State Engineer has passed upon the form and substance of the application, the intention to appropriate the water shall be published in a newspaper circulated in the community. After such publication the State Engineer will approve the application if no valid objection is presented.

#### LICENSE TO APPROPRIATE WATER.

When the construction is completed, the works are to be inspected and approved by the State Engineer, who will then determine their capacity, which will limit the amount of the appropriation. Afterwards, when the water is applied to a beneficial use, the State Engineer makes a further inspection, whereupon he issues a license for the appropriation of the amount of water which has been applied to a beneficial use. A time limit is fixed for completion of construction and for beneficial use.

#### DISTRIBUTION OF WATER—WATER COMMISSIONERS.

For the distribution of the water, which comes under the fourth branch, the States are divided by the law into four Water Divisions by drainage areas, each under the supervision of a Water Commissioner appointed by the Supreme Court of the State. Their functions being the distribution of water under judicial decree or appropriation, they may be regarded as, in a sense, officers of the Court. The four Water Commissioners with the State Engineer constitute a Board of Water Commissioners, of which the latter is president. The Water Commissioners each serve six years, their terms being so arranged that a new one is appointed every two years. This board has general supervision over the waters of the State.

#### DISTRIBUTION OF WATER—WATER MASTERS.

The actual work of distributing the waters of those entitled to use them is done by water masters appointed by the Water Commissioners with the approval of the State Engineer. Each water master has charge of a water district set apart by the State Engineer as found necessary from time to time. The operations of the water master are under the supervision of the Water Commissioner, and their acts are subject to appeal to the State Engineer.

The cost of the water distribution is borne by the water users. The general expenses of the State Engineer and the Water Commissioners are paid by the State. The greater part, if not all, of this expense will be returned to the State Treasury by the fees collected by the State Engineer and by the repayment of the cost of hydrographic surveys by the parties to the suits for adjudication.

## RELATIONS TO RECLAMATION SERVICE.

Special reference should also be made to the features of the draft relating to the work under the Federal Reclamation Act.

In order that the State may obtain the full benefit of this work and prevent serious interference with, and perhaps the entire abandonment of the projects to be investigated, it is provided that the water supply for such projects shall be reserved from general appropriation until the investigations of the Reclamation Service shall determine the precise amount required for the project, the remainder being then released from such reservation.

It is also provided that State lands coming under such projects shall be disposed of in harmony with the plans for the disposition of the lands of the United States, and that lands required for the Reclamation project, for irrigation works shall be transferred to the United States without charge.

In all sales of State lands hereafter, the conveyance is to reserve right-of-way for ditches or canals constructed by authority of the United States.

## DUTY OF STATE.

The theory of these provisions is that the State regulates the appropriation of the water, exercising this power and holding the land in trust for the public, and when the interests of the public are so directly involved as in these large irrigation projects, and when, further, there is no element of individual speculation or profit in the construction of the works, which are for the purpose of establishing the maximum number of homes on the land, it is the duty of every State to which the Reclamation Act is applicable, to assist with every resource under its control.

## MISCELLANEOUS PROVISIONS.

It will be of interest to review several of the other provisions of the draft.

Units of measurement are established; the cubic foot per second for the flow of water and the acre foot for volume. The miner's inch is fixed as one-fiftieth of a cubic foot per second, unless a different ratio has been agreed upon by contract, or established by actual measurement or use.

The amount of water which may be appropriated for irrigation is limited to one cubic foot per second for 70 acres, or its equivalent.

## WATER FOREVER APPURTENANT TO LAND.

While it is conceded that water used for irrigation must be appurtenant to the land, the fact must be recognized that conditions may arise to make it impracticable or uneconomical to continue to irrigate a particular tract. Provision is made so that the use of water may be severed from the land, after application to the State Engineer, due publication of notice of such intention and approval by the State Engineer. Similar provision is made for a change in the nature of the use to which the water is applied, or in the place of diversion, storage, or use.

## SEEPAGE WATER.

The subject of seepage water is one that has given much trouble, and provision is made for the appropriation thereof in the same manner as other

waters, with the requirement that the appropriator must pay reasonable charges for storage or carriage to the owners of the irrigation works from which it comes, provided that the seepage can be traced to such works beyond reasonable doubt.

All decisions of the State Engineer or Water Commissioners affecting a substantial right are subject to appeal to the courts.

#### MODERN CODE FOR OREGON AND WASHINGTON.

The Commissions of the States of Oregon and Washington in working upon this subject, have before them an opportunity to make a definite advance in the development of irrigation law, and the character of the men comprising them justifies the hope that they will prepare a creditable work and assist in making the State laws of the arid region an exposition of the high development which is found to be the invariable accompaniment of the irrigation community.

It will be impossible, of course, to consider every section of the code. Many of those present have seen the code and have examined it. What I wish to do is to call your attention to the main points embodied in this draft and also to a few amendments which have been made and to some important changes that have been suggested by those who have had an opportunity to examine it.

The keynote of the entire draft is contained in the first section, which I will read as amended:

"Section 1. Waters of the State Public Waters.—All the waters within the limits of the State from all sources of water supply belong to the public, and except as to navigable waters, are subject to appropriation for beneficial use."

The next section proclaims the fundamental principle of the irrigation law that the beneficial use of water is the basis, the measure and the limit of the right.

#### STATE ENGINEER.

It then takes up the establishment of the office of State Engineer, giving his duties and requirements of his office. One point that has been questioned in this connection is the requirement that the State Engineer shall not engage in private practice. The code provides that the State Engineer shall receive a salary of \$3000 per annum and shall not engage in private practice.

Question—What is the objection to that?

Mr. Bien—Of course a first-class engineer will make more than that, and the idea of some is that the State may get a better man by allowing him to engage in private practice that would not interfere with his duties. It appears to me, however, that the State will get better service from a man who devotes his entire time to the State's business.

Mr. Fellows, of Colorado—What you have said is probably true. It is difficult to put the salary higher than \$3000 and yet it would be hard to secure the best talent for that amount. For that reason it may be well to pay the State Engineer the salary mentioned and allow him to engage in private

practice, but I do not think he could do that without compromising himself in many ways. Things would come up that he would have to pass upon as a State Engineer and in which he might be interested privately. I do not see how it would be possible to successfully permit the State Engineer to engage in private practice. This is simply a suggestion.

Mr. Finkle, of California—While it would be undesirable to have the State Engineer engage in private practice for fear that he might be tempted to favor private parties, I think that the salary might be raised to about \$5000, which would enable the State to secure a man of reasonably good ability to take the office. I should think that would be nearer right than \$3000.

Mr. Bien—This code was drawn with a view to the conditions in Oregon and Washington, and while I think that the State will need better talent when it begins an irrigation system than at a later period, yet I think it will be difficult to get most legislatures to make the salary \$5000. In States like California, for instance, there would be little trouble on that point, and the legislature would doubtless make the salary \$5000, or more.

Senator F. G. Newlands, of Nevada—What salary is paid in Utah?

Mr. Bien—I think it is \$3000.

Mr. Finkle—What is the rule in Utah and Idaho?

Mr. Bien—They do not engage in private work.

Mr. Chandler, of Nevada—Speaking from the standpoint of the engineers: In legislating for any other position it is seldom, if ever, provided that the occupant of the office shall not engage in private business, and I hardly see why a man engaged in public business should not be allowed to engage in private business. Of course if he does not perform his public duties properly and satisfactorily, it is the duty of the Governor to remove him. I think it would be casting a reflection upon the office of State Engineer to make any such requirement. We do not put it in when district attorneys are appointed or when men are appointed to other State or municipal offices. I can see considerable advantage in eliminating the requirement. The only State irrigation code having that particular clause is that of Nevada. It is not mentioned in any other code and in no other position perhaps do men do more effective work than is done by the engineers in other States. Mr. Johnson, State Engineer of Wyoming, works not only a good many hours of the day but a good many in the night. Engineers must be honest and capable men in their line of work. If they are that kind of men they will necessarily fulfill the duties of their office. If they are not, the sooner they engage in private work the better for the State.

Mr. Newell—The subject under discussion is one of great interest to all of us, and I would like, for the sake of argument, to take the other side from my friend, Mr. Chandler. I think the moral effect of that clause is good because it will tend to raise and keep the salary of the State Engineer higher. If he is put in office and notice served upon the people that that man is not going to do private work, they will then give him a fair salary. There is too much tendency to say, "Give him \$2000 and he will make enough on the outside to pay him." That is just what we want to avoid. My experi-

ence leads me to the conclusion that a public official, especially in engineering work, should not do private work and that his energies should be required, both by law and custom, to be devoted exclusively to the business of his office. I fully believe that a second-class man who devotes all his time to the subject is a great deal better than a first-class man who gives some of his time to private affairs. By putting it in the form of a law that he has no outside interests I believe it would result in his getting a better salary and in protecting him from the influences that might affect his office.

### JUDICIAL FUNCTIONS OF STATE ENGINEERS.

Senator Newlands—The State Engineer is often called upon to discharge almost judicial functions. In many of the States he is a member of the Board of Control. Mr. Chandler in our State has discharged his duties most acceptably to the entire State. He is now inquiring into the Carson River matter, which involves the determination of priority of right and amount of water to which each claimant is entitled. Of course his determination is not final. He simply makes up a list of water rights and gives his views as to the prior rights, but his moral position would be very much affected if it were known that he were employed by any of the private interests in irrigation work, construction work, running lines or ditches, or any work of that kind. It would be regarded as an indirect method of controlling his judgment. In all of these States men who have vested rights and claims, which are often very much in excess of the water which they actually use, are in a state of great apprehension as to the determination of these questions by any board or party. In the State of Nevada it has been almost impossible to amicably adjust or pass upon any question of water rights. The people would prefer to fight the decisions rather than submit the matter to any tribunal except the courts. Now, as long as the people in these States are in a sensitive condition, it seems to me of the highest importance that the law should guarantee them that the State Engineer is absolutely impartial and unbiased and free from interests of every kind. As to salary, I think that is a matter to be determined by the financial condition of the various States. In some States all salaries are exceedingly low. The compensation, I imagine, should be adjusted according to the prevailing standards and according to the area of the State. It is very important that the State Engineer should not engage in private practice.

### HYDROGRAPHIC SURVEYS.

Mr. Bien—The first definite step to be taken under the law is the adjudication of existing water rights. It is provided that the State Engineer shall make a hydrographic survey of the stream systems and obtain the data necessary to establish the rights of parties interested. This information when obtained is to be furnished to the Attorney General of the State, who is required within sixty days to enter suit for the adjudication of these rights, bringing in all persons who are interested in the same source of water supply.

It is also provided that in all suits between parties all those interested in the water supply in controversy shall be brought into the suit, and further, that in any case in which, in the opinion of the State Engineer the interests of the



State are affected, the Attorney General is required to represent the State in the litigation. The costs of these suits are divided between the private parties interested in proportion to the water rights adjudicated, and similarly, the court is authorized to order a hydrographic survey of the stream system when considering rights on that stream and this cost is assessed against the parties.

It may be that in some States it would be better to have the State bear the entire cost of these adjudications. There are a great many reasons why the State should, but I think the controlling principle will be the State Treasury.

#### WATER RIGHTS—METHOD OF OBTAINING.

The next step in the matter of water rights is in making application for the water. This code follows largely the precedents established in Wyoming, Utah and Nevada and requires application to be made to the State Engineer in such form as he may provide.

When the application has been made in proper form notice is published in the district where the water is to be used, stating the nature and amount of the proposed water right, thus allowing all parties whose rights may be affected, to present to the State Engineer at a certain time any objections they may have to the approval of this right. It is the duty of the State Engineer to decide whether there is unappropriated water available for this right. If there is, he approves the application, and it then becomes a permit to appropriate water and after that the applicant may begin his construction.

The law requires that the work shall be completed within 5 years from the date of the permit, and at or before that time the State Engineer is required to inspect the works and determine their capacity. This capacity will limit the amount of water which can be appropriated under this permit. Within three years after that time it is required that the water shall be applied to a beneficial use, and then another inspection is made in order to determine the amount of land that has been furnished with water and upon that inspection the State Engineer issues a license to appropriate water to that extent.

The right is then fixed, and if there are no other applicants—as there probably would not be, because all parties interested having had an opportunity to object—the right to appropriate this water will probably be unmolested throughout the life of the application, which, of course, is as long as the water is used for beneficial purposes.

The code provides that any decision of the State Engineer which affects substantial rights shall be appealable to the courts.

#### STATE WATER DIVISIONS.

There is a provision also for the division of the State into water divisions, and after considerable discussion it was thought that four water divisions wherever it was possible would be the best, because the four Water Commissioners selected in these divisions, together with the State Engineer form the Board of Water Commissioners, which is equivalent to the Board of Control in other States. The Water Commissioners appoint Water Masters to have charge of the distribution of water in each water district. The water

districts are determined by the State Engineer. The Water Masters are appointed by the Water Commissioners, subject to the approval of the State Engineer. The idea is that the State Engineer should have control as far as possible of the entire machinery relating to the appropriation and diversion of waters. The Water Masters are the officers with whom the appropriator comes in contact, and in case of a disagreement the appropriator may appeal to the Water Commissioners and from them to the State Engineer, whereupon the State Engineer is required to fix a time when he will hear and determine the questions involved.

#### SALARIES—HOW PAID.

The State Engineer and Water Commissioners are paid by the State. It is believed that the fees of the office of the State Engineer and the repayment by parties to suits of the cost of hydrographic surveys will return to the State a large proportion, if not all, of the appropriation. The work of the Water Masters is paid for by the appropriators. The Water Master renders his account, approved by the Water Commissioner, and in that account is required to state the amounts chargeable to each ditch or appropriator. The county pays this account and assesses and collects it in the same way as it collects taxes.

#### MISCELLANEOUS PROVISIONS.

That is, in general, the system outlined in this code. The remainder relates to a number of important miscellaneous provisions. The first is the establishment of units of measure, the cubic foot per second for the flow of water and the acre-foot for the volume of water. It provides also for a ratio between the miner's inch and the cubic foot per second. It is, of course, understood by engineers that the miner's inch, as measured by the crude methods generally in use, may vary almost indefinitely. I think that the ordinary methods of measurement practiced in various parts of the country will cause the miner's inch to vary  $1/30$  to  $1/60$  of a cubic foot per second. Where it is not otherwise provided the miner's inch shall be considered as  $1/50$  of an inch per cubic foot. In California there has been legislation making it  $1/50$ , and that is an advantage because it is easier to compute. The range is so great that we are just as likely to be at an average at  $1/50$  as at  $1/40$ .

Mr. Finkle—We are very much confused about the matter in California. We did have it  $1/50$  before March 23, 1901, when the legislature passed another act providing for a standard miner's inch of  $1/40$ .

Mr. Bien—When an appropriator of water fails to use the water beneficial there must be some means of determining when his rights shall cease and after which abandonment will be presumed.

It is also provided that in making adjudications or in issuing permits to appropriate water the amount allowed shall not be in excess of one cubic foot per second for 70 acres or the equivalent. That is the rate that has been most generally adopted in the States.

### WATER APPURTENANT TO LAND.

The water being appurtenant to land for irrigation purposes, we often find conditions when it is not possible to use the water on the land beneficially for various reasons. Under these conditions it would be a waste of valuable property to require this water to be continually applied to this land or be abandoned. By application to the State Engineer, the publication of notice, and the subsequent approval of the State Engineer the water may be transferred to other land. It is desirable that the transfer shall be made only after the fullest investigation, and it is believed that the procedure outlined will give an opportunity for investigation and examination that will prevent any injustice. A similar procedure is provided for a change in the place of use or method or nature of use of any water which has been appropriated.

### APPROPRIATING SEEPAGE WATER.

The question of seepage water has given a great deal of trouble. The code provides that the seepage water shall be subject to appropriation in the same way as other water, through an application to the State Engineer, but that the party desiring to appropriate this water must pay a reasonable charge to the person owning the irrigation works to which the water can be traced without a reasonable doubt. The permit to appropriate this water is not given until the State Engineer is satisfied that the proper arrangements have been made.

### CO-OPERATION WITH RECLAMATION SERVICE.

The next point is the relation between the State and the Reclamation Service in the operations required by the Federal Statutes. It is, of course, understood that for a great many reasons the work of the government must necessarily be slower than that of private parties, and also that the government is ready to spend whatever sums may be required for the most advantageous development of the water supply it should have ample opportunity to investigate the water supply and surrounding conditions without interference by speculators who are continually taking advantage of this proposed work. For that reason it is impossible for the government to say just how much water is necessary for any particular enterprise it would undertake. The State itself being vitally interested, and whatever control it has over these waters is for the benefit of the public, so it was deemed proper that the State should reserve the water necessary for the Reclamation Service for general appropriation until the amount needed could be definitely determined, after which the surplus would be open for general appropriation.

The State is able in other ways to assist in the operation of the Reclamation Service. First, by providing that all public lands belonging to the State shall be sold with the reservation of a right-of-way for canals, etc. constructed by the United States. The United States has done that with its own lands sold since 1888. It has also provided that a right-of-way over any lands of the State shall be granted to the United States in connection with its reclamation operations.

## SALE OF STATE LANDS UNDER RECLAMATION PROJECTS.

Any lands belonging to the State which are within the limits of withdrawals for reclamation projects shall be sold in harmony with the system pursued by the Federal Government, the idea is that individuals should not be permitted to buy this land in enormous quantities. The Federal Reclamation Act prohibits the sale of water rights for more than 160 acres to any one person. If parties are allowed to take State land in unlimited quantities the government will have considerable difficulty in adjusting their claims to the Federal law when work is undertaken.

That is a review of the important points of this draft, and if there are any questions to be asked regarding it, or any points for discussion, I would like to hear them.

## DISCUSSION.

Mr. William E. Smythe, of California—How does that law differ from the Wyoming law?

Mr. Bien—The main difference is that the Wyoming law constitutes the Board of Control a judicial tribunal. This code leaves it to the courts; the State Engineer collects the data and the Attorney General brings the suit.

Delegate—Is the State Engineer appointed by the Governor?

Mr. Bien—Yes, sir; and the Board of Control is formed by electing one member from each of the four districts.

Delegate—Does this code recognize the private ownership of the water apart from the land?

Mr. Bien—No, sir.

Delegate—Does it make any provision for regulating the rights of companies supplying water?

Mr. Bien—It provides that no appropriator can have a right for more water than he can use. Any surplus water shall be held in trust by the water company for those who may have an opportunity to use it.

Delegate—In Mexico all interstate streams are absolutely controlled by the Federal Government; the State governments have nothing to say. I think this is one of the greatest sources of difficulty in the United States. It is one of the difficulties we have to contend with in Texas.

Mr. Bien—That question is not touched upon in this code. Under our Constitution it is a question for the courts to decide. I think any action which the States may take will not affect the matter. It may complicate it, but it cannot affect the ultimate conclusion. The question is now before the Supreme Court of the United States in an action between Kansas and Colorado. What the relation of the States may be to interstate streams is a judicial matter as conditions now exist. It is hoped that the Supreme Court in passing upon that case will make a definite settlement of the matter.

Mr. Finkle—There are two points which I would like to mention. The first is as to the time of the completion of the works and also the time of beginning work. We had some difficulties in California on the latter point by reason of the forest reserves. The government would not permit an appropriator to go into the forest reserve and go to work until permission was ob-

tained from the Secretary of the Interior. As the law of California formerly stood there was no provision touching the matter, so we had an act passed through the legislature two years ago which corrected the difficulty and which provides that surveys for the proposed work must begin, if within a forest reserve, within sixty days after permit is granted and that actual work of construction must begin within sixty days after permission is obtained from the Secretary of the Interior. That brings me up to the other point. You provide five years as the time for building the works complete?

Mr. Bien—The State Engineer is authorized to make an extension of three years for physical causes.

Mr. Finkle—I was going to suggest that it would appear unreasonable to allow small works that much time, and that it would perhaps be proper to make the limit in proportion to the cost of the works, say one year for every \$100,000 invested.

It has also occurred to me that the matter of appropriation should be definitely stated. As I understand the law there is no right to appropriate except on public lands of the United States. I judge it must be the law everywhere, because the whole theory of appropriation is based on the act of Congress passed in July, 1866.

#### VARYING DUTY OF WATER.

Delegate—In making a limit in the allowances of water, do the reclamation engineers take into consideration the immense difference in the requirements of different parts of the country? For instance, in California it will not take very much. At the experimental station in Arizona several years ago the bulletin reported 6 feet practically for crops of alfalfa. Our experience here is almost parallel and we know it positively because we have to pump the water. Different crops require different amounts of water. Corn, for instance, requires about two feet. In making an estimate of how a dam, for instance, can cover 180,000 acres of land, how much is allowed for each acre per annum? Our evaporation here is 80 inches and our rainfall 8, practically nothing.

Mr. Bien—The allowance of water in each project is carefully estimated according to the local conditions, according to the best data that can be obtained and according to the peculiar conditions of each case.

Mr. Newell—As Mr. Bien has stated, in every project we study the local conditions in that particular area. Mr. Means, the soil expert, studies the method of use and the proper means of developing it, the kind of products for which it is best suited, etc. One man may plant one kind of a crop and one another and we cannot anticipate what that will be, but we make an allowance to cover all the probable conditions and include it in our estimate, whether it is one, two or six feet. Of course when a country is developed and when we have 50,000 or 100,000 acres under irrigation, we all know that conditions will change greatly and that less water will be required. In our preliminary estimates, we will presume, for instance, that a dam will hold two million acre feet of water and that that will probably supply 180,000 acres of land, but a lot of that land one year will not require as much as the other

part and in determining the average we must take the experience of engineers of past generations.

Mr. Savage—I think we all realize the importance of the discussion. Mr. McCune of Colorado is here and we would like to hear from him.

#### FORMER STATE ENGINEER DISCUSSES QUESTION.

Mr. McCune, of Colorado—I think Mr. Newell has covered the point with regard to the state engineers, still I am satisfied that it would be difficult to get that salary arranged, at the same time it might be difficult to get the best talent for the salary suggested, so the man taking the office must have some public spirit, be something of a martyr, so to speak, for I do not see how he can engage in private practice and do the office justice. In regard to the use of water, we have many problems coming up and it is difficult to decide all of them. They have to be worked out as we go along. The duty of water and the question of abandonment are problems that are giving us a great deal of trouble. As to the question of abandonment, I think the time might be fixed at five years. In the matter of the completion of the works, in one case it might require five years, in another three, and in other cases it might be necessary to give more time. It is a difficult matter to fix and I don't see how it can be worked out except as we go along.

Mr. Savage—We have present some of the members of the various commissions in Oregon and Washington, and I would like to hear from some of them.

#### VITAL POINTS IN CODE.

Mr. Hailey, of Oregon—It seems to me that the vital point in this bill is some law by which we can determine the rights of the appropriator and the limit of the appropriations; some law, for instance, whereby all appropriations are recorded in one place and so that over-appropriations can not be made. I was reading an address this morning delivered by a lawyer in California, and he cited statistics showing how in three or four of their drainage basins they had appropriated under the present California law enough water by their written appropriations to irrigate all of the irrigable lands west of the Mississippi River and north of Texas. I do not know how that would apply in Louisiana. We might extend California all over the western country by soaking it so that it would swell up as rice does in Louisiana. It is just that kind of expansion we want to stop. We want a man to have what he is entitled to. We want to adopt some feature which will have a tendency to do away with litigation. You gentlemen, who live in States where they have the most laws governing water rights, know that this is where they have the most litigation and instead of the water users being rich it is the water lawyers who are getting rich. If a man is going to spend all his substance in trying to build up a home in lawsuits, he will not have any home to live in when he gets through. I approve of the provision which makes the state engineer a disinterested party. He should be nothing but a state officer and have no other private interests. If a man can work for Uncle Sam and exclude his private interests he can do just as much for Texas, Oregon, California or any of the States as another. If he is working that way with no private interests he will be disinterested just like our Su-

preme Court judges and he will try to arrive at the truth in all things and in so doing avoid a great deal of litigation and he will perform his duty not only as an experienced man, but also he will do it with a technical education.

#### ABSURD COURT DECREES.

The article I referred to cited an instance where a court on the testimony of the farmers in the community gave to one man twenty feet of water when his ditch would not carry over eight. If they had had the advice of an expert engineer the court would not have done that. I think if we had these two fundamental principles in our laws, one defining the right to take water and the other cared for through the State Engineer, we would have the essential requisites of a good law. No law as drafted in the first instance will cover the whole ground. If it would, there would be no occasion whatever for a meeting of this Irrigation Congress. If the National Irrigation Act, which is one of the most complete laws ever drawn, were self-acting, you would never call this Congress together, but we are pushing that same thing all the time and that is what we will have to do to improve on this law. Washington expects to do the same thing. The code was drafted at our request simply because both States are situated almost identically as to water rights. The eastern portion of our State has some arid land and the western portion has plenty of water, sometimes a little too much, and we asked Mr. Bien and Mr. Newell to draft with their experience what they deemed to be the main feature of a law, and so far as I have heard from Washington and our own people, they are highly pleased with this code.

Mr. Savage—We have with us one of the irrigators up in that country who likely will have to work under that law, and we would like to hear from him—Mr. Mallett, of Vale.

Mr. C. W. Mallett, of Oregon—The gentlemen from Wyoming, from Louisiana and others, together with Mr. Hailey, have nearly destroyed my case. I have got to invent something new or keep still.

As to paying the State Engineer, I heartily agree with the majority opinion in regard to that matter. It frequently occurs that I call to my aid my neighbor, or my neighbor calls me to his aid in performing work, and I am sure that if I were in his employ he would certainly raise my wages after a time if I would give my whole time and attention to his benefit. I know if I call on my neighbor for assistance, I would rather raise his wages if he would give me his whole time and benefit of his knowledge. I feel the same way about the State Engineer. We want his whole time and impartial services.

As to the amount of water necessary to irrigate a given tract of land, or in other words, as to the duty of water, it is a question of utmost importance from the standpoint of an irrigator to determine how much water is necessary to set aside. It may be 2 acre feet, 3, 4, 5 or 6. The aridity of the climate, the soil and kind of crops produced all have a modifying influence on the amount of water absolutely necessary. In eastern Oregon the best that can be done is to flood the field to a depth of six inches at each irrigation. In the beginning of the reclamation work it would require three

or four irrigations during a season, and ordinarily there would be necessary nearly an acre-foot at each irrigation.

Mr. Hammond, of New Mexico—I notice that it has been stated that the basis of estimating the service of water is one second foot for 70 acres of land. I take it that that is the amount that is needed under the most adverse conditions. Is it to be understood that it is not conceived that there is any land or conditions which would under any circumstances require more than one second foot per 70 acres of land? I do not know what the maximum would be in New Mexico, for in that territory the service of water varies greatly.

Mr. Bien—One second foot for every 70 acres of land is, according to all general practice, ample for practically all conditions. It is suggested as the maximum. In a great many cases the amount allowed would be less.

#### READJUDICATION NECESSARY.

Mr. Switzer, of Montana—In the State of Montana all adjudications up to this time have allowed one second foot of water to 40 acres of land, which is very wasteful. Is there any provision made in this code whereby old water rights may be adjudicated in the light of more modern knowledge?

Mr. Bien—I think the courts would have to attend to that. I think that it is possible when the courts have had considerable experience in irrigation litigation they may review these old decisions and decide that such an amount of water is a waste, and that a party could not acquire title to water that is wasted. The principles which are developed by experience would open an opportunity possibly in the future for the courts to review such decisions, but the law can not change the decisions where a right is involved.

Delegate from Fresno County, California—In Fresno County, California, we go on the basis of one foot of water for 160 acres. I do not think there is one in a hundred that gets that much. I am satisfied that in our State we have done too much irrigating and have used too much water. In my orchard I have irrigated only once each year during the last four years and I find the results very satisfactory. I made up my mind to irrigate in that way and my neighbors said, "Your trees will die." I said, "Then let them die."

#### WASTEFUL METHODS OF IRRIGATION.

Delegate—Is there any provision made by which those who use too much water can be prevented from using more than they actually need? If there is not, there should be such a provision. In Tulare County, in the San Joaquin Valley, California, we have men who use water to the injury of their land. They have water-logged their land until they can not raise crops and they still use water. They use so much water for fear if they do not each year they will lose the right to use the amount of water they claim for appropriation, and by that method they have prevented others from having water who actually need it.

We have streams in California—the Tule River is one of them—where the sand is from four to twelve feet deep and the under-flow in the summer time becomes enormous. We can dig down in the sand and find water two feet below the surface of the sand and that flow of water will perhaps be twelve



feet deep, but no one can get the use of that water because we have no submerged dams and these parties who claim the prior rights will take out all of the water they can get, when others further down the stream are suffering for water.

As to the amount of water that we require, on an average one acre foot is sufficient, although there are many fields that do not require any water at all. I have a small vineyard that has not been irrigated in six years and produces better than others that are irrigated every year. In sections of the country near the rivers, where the early appropriators have used so much water they have drawn the alkali to the surface and now can not produce anything but salt grass, and very little of that, whereas twenty years ago they produced pretty good crops. There should be some provision in the law regulating these conditions, and there is no State in the arid region which needs this law more than California. In my seventeen years' residence there I have seen the need of such a law. I have seen the owners of riparian rights claiming the water when they could not use it, to the detriment of those who could use it to great advantage. I have seen others who wanted to use the water at times of the year when they did not really need it. A great many of them have not tried to educate themselves along the line of beneficial use. The matter of the use of water is one along the line of which the people have to be educated. There are many sections near Fresno where they have not used any water for several years, and they would be glad if the ditches were taken out, because they are an injury to the land and the crops they grow there and they will have to begin to drain very soon. Some of them have already commenced to drain. It seems to me that the regulations regarding the water being used beneficially should be very strict.

Mr. Bien—The fundamental principle of the entire law is beneficial use, and this is a matter of education, and the courts must prevent waste. There is also a provision that in the distribution of the waters by the water master they shall be so distributed as to prevent waste.

In regard to the duty of water, the idea was to provide for a maximum amount. The local conditions and a great many other things will change this amount, and it is really one of the most important duties of the State Engineer to gradually raise the duty of water by means of his adjudication and passing on these appropriations, and when he has established the proper sentiment, there is no doubt but what the courts will follow and ultimately waste will be cut out in that way.

#### PAID SENTRYMEN GUARD WATER.

Mr. W. E. Smythe, of California—There is no section in the West so greatly in need of an intelligent and enlightened irrigation law as the State of California. It is true that we have had more water in the court houses than we could put on the land. We have had almost a civil war in trying to divide private waters. On the Tule River I have seen erected on the headgate of the canal a sentry box like State penitentiaries have, and I have seen in the balance sheet of that company for its annual expenses an item of \$1500 for guards, guns and ammunition. That is the kind of barbarism we have had in place of the civilization we talk about in California, and yet in

spite of these conditions it has been impossible to bring about any reform. The only remedy is more water. The people can not see any remedy in more law unless you accompany the proposed legal reforms with means of supplying more water for the irrigation of their lands.

It seems to me that Mr. Bien has produced a composite photograph of the water laws and has utilized the strong features, avoiding the weak, and I think that something like that can be adopted in most of the States, but in California it will not be adopted unless accompanied by means of providing more water. Of course the ideal system of irrigation would be a national system under the present law, if a sufficient amount of money were available for the purpose, but it seems to me that the amount of money now available is sufficient only for an experimental policy. We have not anything like money enough to meet the needs of the arid region. We have \$27,000,000 now in the reclamation fund.

#### POTENTIAL GREATNESS OF COLORADO RIVER.

We could use every dollar now in the reclamation fund upon one single river of California, or, rather, it belongs to five States, one territory and a foreign country, that is the Rio Colorado. According to the estimates of Mr. A. P. Davis by the application of that money we would make homes for a new population of 1,500,000 in Southern California and Arizona, but that \$27,000,000 must be divided between sixteen States and Territories. The present fund represents the accumulation of more than seven years of the receipts of the land office, which amount now to about \$500,000 a year. Under the present wise law the expenditure may be concentrated for a time in one locality, but every ten years it must be equalized between the States and Territories coming under the Reclamation Act. \$500,000 a year for this western country is a mere bagatelle. I would like to suggest a method of supplementing that fund. You have heard of the district irrigation law, commonly known as the "Wright" law, although most of our people have become impressed with the idea that it is the "wrong" law. The law seems right to me, as it joins inalienably the right of land and water. It undertook to furnish us water at a little cost, but the difficulty was that it fell down on its administrative side. It put into the hands of communities of farmers matters which they did not understand how to handle, and of the forty-seven districts formed I think perhaps only four or five may be said to be successful. The rest had failed for various reasons, but the cause of their failure can be summed up in the phrase, "Lack of supervision." The trouble is not with the fundamental character of the law; the trouble is in carrying it out. They traded their bonds, which represented mortgages on their homes, for water rights which existed only in the imagination of promoters. They were wrecked by their district and other officers mostly. Large sums were expended in works that never were completed and are now going to decay. My suggestion is, let us amend the district irrigation law in California and let other Western States adopt such a law, but let it be provided before a district can be formed that the Secretary of the Interior, acting through the United States Reclamation Service, shall investigate and approve that project as plausible in its engineering, economic and financial features.

### NATIONAL SUPERVISION OF LOCAL DISTRICTS.

If we had had such a provision for national supervision, not a single district in California would have been a failure. The government would have investigated these projects and proved most of them as being unpalatable, and the people then would not have voted the bonds and the banks would not have bought them. On the other hand, if the Reclamation Service had recommended it, the people would have gladly voted these bonds. I would like to have it provided that not only shall the Reclamation Service investigate and report on the districts, but that the engineers of the service shall also be charged with the actual work of construction. If you build these canals, our farmers can operate them successfully, but they are not fitted to pass upon the feasibility of these projects. In other words, I propose a method by which California can supplement the reclamation fund available for expenditure by from fifty to one hundred million dollars. We can safely say that for every dollar we get out of the national treasury we will put four dollars into the irrigation work. The money can be paid by the lands that are to be irrigated. We will have to pay 4 or 5 per cent interest on our district bonds, but I believe it is the feasible method. The National Irrigation Act is extremely elastic and under it the Secretary of the Interior can do almost anything, and he would be able doubtless to make the investigations at the expense of the reclamation fund, but the large element of cost would be represented by the proceeds of district bond sales placed at the disposal of the Reclamation Service and expended under their direction.

Now, if you will go before the people of California and say two things, first—we propose more law, and second—more water, then I believe we will get the law, but as long as it presents itself in the aspect of a destructive measure, a measure to bring everybody into court and prompt litigation, I believe there is no probability of its being adopted in our State.

As to this matter of the duty of water, the duty of water varies with the conditions, climate, soil and crops, also the customs and even the traditions of the country affect the amount of water that is applied to the land.

### WATER AND LAND INSEPARABLE.

I believe that in a few years we will have no such thing as a private work of irrigation, that is, a work of irrigation owned apart from the land. We are going to establish the principle that the man who owns the water shall also own the land and the air. Unless we adopt that principle we can not have true, economic freedom in this country, and I am sure that this irrigation movement is not going to stop short of that point. I believe that we are going to see, as is already the case in the Salt River Valley, a natural merger of all the irrigation works in a watershed, into one comprehensive system. The nation will be able to let us have the money necessary for the works at the head of the streams and we must devise for ourselves a method of providing the moneys necessary for building the works of distribution and the great pumping works and drainage systems—for drainage is the handmaid of irrigation, and nothing is more certain that if you put the water on the land you must get the water off. We are going forward in the evolution of

our irrigation systems until we have one splendid, magnificent, comprehensive system of works. When we reach that point it will be possible for every watershed to settle for itself the question of the duty of water. If they want one cubic foot per acre per second, they can settle it on that basis, and if they want six times as much on the Rio Grande, they can also arrange it satisfactorily. It is free water and the water should be used in its natural watershed. We want to bring the thing down to a matter of home rule. We want the aid of the nation in constructing these works, but when constructed we want them to be administered by the little democracy living in these little watersheds. People use various quantities of water, not only because their crops differ, but also because the soil differs. You can often throw a stone from one kind of soil to another, and then, people differ as to the amount of water that is required. When you have it merged into one single system, you can provide a certain minimum amount of water for which a party will be charged. Everybody should pay for the insurance they get from an irrigation canal, and in addition let them use what they think they need and let them pay for it. On that basis you can adjust it with actual equality. I want to say that if there ever was a body of men fit to lay the foundation of a great civilization, we have them in the Reclamation Service as organized to-day. Let the States help this work hand in hand, and be sure that when you ask for more law that you give them more water at the same time.

#### GOVERNMENT AID TO DISTRICTS.

Mr. Newell—Mr. Smythe has a touch of genius in his suggestions. It gives us some relief as to how we are going to construct many of these works, especially where private land is involved. On the spur of the moment it strikes me that the suggestion is worth all the trouble that Mr. Smythe has taken to come here. If under a State law districts can be formed, we have enough money in the fund, and probably always will have, to make the necessary investigations and bring the projects to a point where actual contracts can be let. That is feasible, for we are able to call upon the district, the men interested under the State law, to vote the bonds necessary to pay for the contract. These bonds would simply bear interest from the time the money was needed to pay for the construction. It would then enable this work to progress on what seems to me admirable lines, because the men who must pay for the works ultimately could on security of their own property advance the money as needed at a low rate of interest, as it is to be assumed that while the credit of the United States might not be behind these bonds, yet I believe it would be so considered in financial circles and it would give these bonds a standing in the market which an irrigation bond has not now.

Mr. Emmett Barbour, of California—In our county we have formed a district, and on the basis of about \$7 per acre have secured all the water we need. The bonds are paid up and it costs us \$1 per acre for the first irrigation and about 50 cents per acre for the second irrigation. I think we are now in as good standing as any district in the State.

Mr. W. A. Ward, of Texas—In the irrigation company I am interested in, we wanted more money to extend our plant and we issued bonds, and although we made over 50 per cent profit last year, there is no profit for the bonds.

Mr. Fairweather, of California—We have 138,000 acres of land. Our bonded indebtedness is \$492,000. The water tax in our district does not exceed 45 cents per acre per annum. Two-thirds of our water tax to-day is paying interest at 5 per cent on those bonds. When these bonds are paid off by the next generation and the district is clear of debt, the water tax on our district land will not exceed 15 cents per acre.

Mr. Newell—Gentlemen, I notice that Governor Ahumada, of Jalisco, and staff, escorted by the Executive Committee, has just entered the room, and we will take a recess for five minutes to extend him our greetings. (The Governor addressed the convention in Spanish, which translated, is as follows:)

#### GOVERNOR AHUMADA'S ADDRESS.

Governor Ahumada, of Jalisco, Mexico—I desire to thank you for the invitation which you have extended me to be present amongst you, and to say to you that I regret very much my inability to address you in English. I am pleased to see such a large assemblage of delegates, and I trust that your efforts for the reclamation of the arid lands as well as the storage of our flood waters will meet with success. I am here as Governor of Jalisco to assure you that you will have the co-operation of my State and the entire Republic of Mexico, as I realize your efforts are conducive to the benefit of the joint countries. I desire to especially thank the Executive Committee for sending me the invitation to attend the Congress.

It has been twenty-five years since I first lived among you. For the past twenty-five years I have had the pleasure of living among Americans and Mexicans on the frontier, during which time I have observed the good feeling which has existed between the two people, and the relations between them have been cemented more and more closely each year. It is gratifying to appear before you as a friend of the American people.

Although my duties have called me away from the office of Governor of Chihuahua to assume the governorship of the State of Jalisco, I note with pleasure that the feeling of friendship which exists on the frontier has extended also to the State of Jalisco. The people here are not only interested in your deliberations, but the people down there are also interested in what you are doing, and I can say to you unconditionally, that we will co-operate with you in any of your undertakings that we are able to assist you in.

In conclusion, I desire to say that I trust that your deliberations may prove beneficial alike to both countries, especially in your deliberations regarding the reclamation and irrigation of the arid lands. I trust that you may be able to get at the matter as easily as possible, and that will be by taking the easiest way.

Mr. Newell—We will now be favored with a description of the Klamath Project in Oregon and California, by Mr. J. B. Lippincott.

Mr. Lippincott introduced an elaborate map of the Klamath Project and explained it in detail, accompanying his address.

**THE KLAMATH PROJECT—STATUS OF INVESTIGATION,  
1904.**

J. B. LIPPINCOTT, Supervising Engineer U. S. Reclamation Service,  
Los Angeles, California.

The basin of the Klamath River was visited by Mr. John T. Whistler, Engineer U. S. Geological Survey, in October, 1903, and reported upon under date of November 2, 1903. Mr. H. E. Green, Engineer U. S. Geological Survey, also visited this basin in October, 1903, and reported thereon in a communication entitled, "Report of Reconnaissance of the Country Lying on Either Side of the Boundary Line Between California and Oregon in the Klamath and Ashland Atlas Sheets of Oregon, and the Shasta and Modoc Lava Beds Atlas Sheets of California." These reports were preliminary and were considered sufficient justification for a further investigation of this section during the present summer.

In the latter part of June, 1904, Mr. J. B. Lippincott, Supervising Engineer, made an extended trip through a portion of the basin of Klamath River and Lost River Basin with Mr. T. H. Humphreys, Assistant Engineer. No extensive surveys had been made at that time, Mr. Humphreys having spent his time in acquainting himself with the general situation. The basin of Sprague River, which lies largely in the Klamath Indian Reservation, has not yet been explored, but it is stated currently that there are large areas of excellent land in this reservation that may be reclaimed. This report is therefore based very largely upon general information received from Mr. T. H. Humphreys and upon a personal reconnaissance of J. B. Lippincott, Supervising Engineer, aided by the topographic maps of the Geological Survey. The data based upon the surveys now being made is not now available.

Permanent gaging stations are being established by Mr. Humphreys at Keno, on the Klamath River, at the Horse Fly reservoir site on Miller Creek, at the Clear Lake reservoir site on Lost River, a gage rod and evaporating pan in Tule Lake, near Merrill, and a gage rod in Klamath Lake, near Klamath Falls. The record will be maintained of the flow of Link or Klamath River at Klamath Falls, Mr. Whistler's gaging station on Lost River, in Langell's Valley, will be abandoned, also the gaging station in Lost River at Olene.

**GENERAL LOCATION.**

The principal streams of the Klamath basin are Williamson River, Sprague River and Lost River. The drainage is quite singular. Lost River at present does not flow into Klamath River, but into Tule Lake, which has no outlet. The general situation is in Klamath County, Oregon, and in Modoc and Siskiyou Counties, California. The State line to a singular extent divides this basin between the two commonwealths. For instance, the Clear Lake reservoir site lies in California, but the water impounded therein can best be used in Oregon. The Horse Fly reservoir site is situated in Oregon, and this water can best be used in Oregon. A diversion conduit from the Upper Klamath Lake will serve lands both in Oregon and California. The

falls of the Klamath River are in both California and Oregon, and this power can best be used for the pumping of water onto lands in California. Klamath River is navigable in a portion of its course and is so used commercially. Upper and Lower Klamath Lakes are commercially navigable and are cut in half by the State line. Tule Lake is navigable but only to a slight extent so used, and is cut by the State line. We therefore have an interstate situation, both as to water supply, power and irrigable lands.

This immediate region has no railroad, the nearest station being Pokegama, from which a stage drive of some 30 or 40 miles is made to Keno and from that point the Klamath River is navigated by means of a gasoline boat to Klamath Falls, which is the county seat of Klamath County. Two railroads are now being projected into this region, one from Pokegama and the other coming in from California and known as the Weed road. Both these railroads are built primarily for lumbering purposes.

### THE KLAMATH RIVER.

Sprague River and Williamson River are the two principal tributaries of the Klamath. Williamson River is fed by some very large springs, the water supply apparently coming in large part from the country around Crater Lake. Sprague River drains the region northeasterly from Klamath Lake.

These streams flow into Klamath Lake, which covers 67,220 acres. If the marginal swamp lands are included it becomes 94,000 acres. The river is therefore regulated by this large area of lake and swamp. From the Upper Klamath Lake the stream falls abruptly about 56 feet and is called Link River. At Keno the lower rapids of the Klamath River begin. This Link River also supplies the Lower Klamath Lake, which covers 29,400 acres with water and 88,300 acres of water and marginal swamp. The lower lake acts as an additional regulator and the fluctuation in river height at Keno probably does not vary over two or three feet.

On October 25, 1903, Klamath River was measured at Klamathon by Mr. H. E. Green at its low water stage, and the volume discharged was 2000 second feet. It was stated at the time that the river was lower than at any previous time for twelve years. The low water flow of Link River in 1904 was 1773 second feet. The Upper Klamath Lake may be used as a storage reservoir if desirable. An examination of the map which accompanies this report will indicate at a glance the extent to which this stream is interstate.

The elevation of Klamath River near the Southern Pacific crossing at Klamathon, according to the topographic sheets of the Geological Survey, is less than 2200 feet. The elevation of the River at Keno is 4086 feet, as determined by levels run from Klamathon, which indicated a fall of about 1900 feet in a distance of 40 miles. Near the mouth of Falls Creek there is a drop in the river of 400 feet in two miles, as indicated by the topographic map on the Shasta quadrangle. With a low water flow of 2000 second feet, this 400-foot drop would develop 91,000 theoretical horse-power. Beginning at a point about six miles below Keno in a distance of 10 miles the map indicates a drop in the river of 800 feet. This would be sufficient to produce 181,000 theoretical horsepower with a flow of 2000 second feet. From

this it will be seen that the opportunities for power development on the river are very great, and it will be shown later that there is the possibility of using this power for irrigating arid lands.

It appears to be feasible to make an excavation near Keno in the channel of the river at the head of the rapids, where the river drops 60 feet in a short distance, by means of which the water can be drawn off of the marshes surrounding Lower Klamath Lake, as well as from the Lower Klamath Lake itself. This difference in elevation probably could be made sufficient so that the flood waters of Lost River which are not impounded in the reservoir sites on Lost River could be turned into the Klamath River and away from Tule or Rhett Lake. The advantage of such a proceeding will be treated of later.

### LOST RIVER.

Lost River is an interstate stream, which flows to a material extent through Clear Lake. Horse Fly reservoir site, on Miller Creek, tributary to Lost River, has a drainage area above it roughly estimated at 200 square miles. Its elevation is 4792 feet. The basin is fairly well timbered and apparently has a fair rainfall and winter stream flow. The reservoir basin is very flat and swampy and it is estimated that the area of the valley is about 3500 acres, and that a dam of 50 feet high would give a capacity of 100,000 acre feet. The river flows through a narrow canyon of basaltic rock at the dam site. The land under this reservoir site is largely public and has been withdrawn for a reservoir. The site is of very substantial importance.

Clear Lake reservoir site is situated on the southern branch of Lost River, and above Clear Lake the stream above the lake is known as Willow Creek. The drainage area of Willow Creek, as obtained from the topographic sheets, above Clear Lake dam site, is 577 square miles. The area of this lake as shown on the topographic sheet is  $12\frac{1}{2}$  square miles, or 8000 acres. It is estimated that a dam that is 40 feet high at dam site below the lake would probably hold half a million acre feet and this estimate is here endorsed. The dam site is in a canyon of volcanic rock. Apparently there are excellent spill-way opportunities and probably the dam could be best constructed of earth and loose rock. There is a very pronounced public opinion to the effect that the principal supply for Lost River comes down Willow Creek. The grades into Clear Lake are very singular. Willow Creek in flood discharge overflows into Clear Lake, but at the same time a large portion of this water passes down Lost River. When the creek falls Clear Lake begins draining into Lost River and discharges through its in-take channel. The area of Clear Lake, according to land office surveys, is 9200 acres. The area of adjacent swamps, according to survey, is 15,000 acres. The drainage basin above the lake is covered by a sparse growth of pine trees. The elevation of the lake is 4533 feet, according to the contour maps. The rise of the lake during the past winter would indicate an in-flow of about 150,000 acre feet additional to the discharge of Lost River, which was continuous during the in-flow period.

Lost River discharges into Tule Lake, the area of which is 90,000 acres. During the past winter the lake had a net rise of seven feet, indicating an



in-flow of 830,000 acre feet. The past winter, however, was one of unusual rainfall. The evaporation in this region is believed to be about  $3\frac{1}{2}$  feet. As this lake maintains an area of about 90,000 acres, this would indicate a mean annual net flow of Lost River of 315,000 acre feet. This agrees with a statement as to the usual annual rise of Tule Lake. There is the opportunity, both at Clear Lake and Horse Fly Valley to hold over water from wet to dry years. It would seem reasonable to expect that 200,000 acre feet annually might be obtained from these two reservoir sites. The water from these reservoir sites would naturally be used on Langell Valley, which contains about 12,000 acres of irrigable land; Poe Valley containing 10,000 acres; Swan Valley, 30,000 acres; Alkali Valley, 20,000 acres, or 72,000 acres in all, in valleys lying under these two reservoir sites and above Klamath River. These areas are gross and only roughly approximate and probably will be increased by a detailed investigation. It would seem reasonable, however, to consider that these two reservoir sites can irrigate all the underlying agricultural lands in the valleys named. There is practically no public land in Poe Valley, some public land in Langell Valley, and quite a large amount of public land in Alkali and Swan Lake Valleys.

As previously stated, the flood waters not impounded in Horse Fly and Clear Lake reservoirs could be diverted into Klamath River and away from Tule Lake.

#### BUTTE VALLEY.

Butte Valley is in California, adjacent to the northern line of the State and in Siskiyou County. It is roughly estimated that this region contains over 100,000 acres of agricultural lands, and that there are some 10,000 or 15,000 acres of government land in the southern limits of the valley. The elevation is about 4200 feet, between 150 and 200 feet above the level of Lower Klamath Lake. Butte Creek and Antelope Creek flow into this valley. The mid-summer water supply, however, is quite small and is used for irrigation. There would be an abundant water supply for pumping from Lower Klamath Lake, and a great abundance of power obtainable from Klamath River for lifting this water into Butte Valley. The question as to whether it is commercially feasible to do this is not yet estimated upon, but the withdrawals of public land along the Klamath River for the purpose of generating power pending this investigation are believed to be justified.

#### TULE LAKE.

Tule, or Rhett Lake has an area of 90,000 acres. The lake is supplied from the in-flow of Lost River. Tradition states that in years past the lake has been almost dry and that teams have crossed over very considerable portions of this area, and that sage brush stumps are found in the lake. If Lost River water can be mostly impounded in reservoirs and the surplus diverted into Klamath River by lowering the outlet of the river at Keno, and by throwing a levee across Lost River, there practically will be no other supply into Rhett Lake, and with an annual evaporation of  $3\frac{1}{2}$  feet, it is believed that the lake would rapidly shrink in area and uncover a large area of land. It is a fresh water lake. This lake is interstate and navigable, but only slightly

so used. The margin of the lake is meandered by the land office. If the lands that are uncovered are public lands that could be disposed of under the Reclamation Act, they could be very easily irrigated by means of a diversion canal, either from the Klamath River or from Lower Klamath Lake. This is a subject that will require legal opinion. Tule Lake is an interstate navigable lake and could only be drained by Congressional permission.

#### LOWER KLAMATH LAKE.

Lower Klamath Lake has a water surface of 29,400 acres and a swamp and water surface of 88,300 acres. If the outlet from the lake at Keno can be lowered, as previously suggested, the greater portion of this swamp land can certainly be drained and probably a large portion of the lake bed itself. This lake is interstate and navigable, and used commercially for navigation. It is a duplicate of the Tule Lake situation, and if these lands can be drained they can be readily irrigated from the Klamath River. The swamp lands are all in private ownership, title having been conveyed by the State.

The areas of the beds of these two lakes that might be uncovered, as suggested, of course are not definitely known as yet and is being determined by survey, but it would seem within reasonable limits to say that there might be from 50,000 to 75,000 acres of public lands so reclaimed.

#### KLAMATH INDIAN RESERVATION.

Klamath Indian Reservation has not yet been investigated, but it is reported that there are large areas of irrigable lands therein and this will be made a subject of future study. Particular attention is called to the fact that the State of Oregon has a claim pending in court for the swamp lands shown as the Klamath marsh on the Klamath quadrangle, which lands are in the Indian Reservation.

#### EXISTING CANALS.

A canal has been constructed from Lower Klamath Lake near the State line, for the irrigation of the north shore of Tule Lake. This is the largest canal in the district. The manager of this canal is Mr. Adams, postoffice address, Merrill. I have talked with Mr. Adams and other owners of the canal, and they state that all they wish is water for their lands, and that they will be pleased to have the government enter this field and to turn over their canal systems to them.

Another canal diverting water near Klamath Falls carries between 600 and 1000 inches of water. This ditch irrigates the lands between Klamath Falls and Lost River. The ditch was constructed some years ago, has passed through bankruptcy and is now irrigating some 5000 or 6000 acres of land. There are one or two small irrigation ditches in Poe and Langell Valleys.

About January, 1904, the Klamath Canal Company was organized for the purpose of constructing a canal from the Upper Klamath Lake towards Tule Lake. This would parallel the largest existing canals in this region, being some 10 or 15 feet higher in elevation. This Klamath Canal Company is being managed by an engineer of the name of W. K. Brown. They have

entered into contracts to furnish water to land owners southeasterly from Klamath Falls and along the existing canals. They are proposing to furnish this water for \$10 an acre, with \$1.00 per acre annual rental. Their water contracts are severe. At present this corporation is constructing a tunnel 4x7 feet in section out of the Upper Klamath Lake, the intention being to widen this tunnel to such dimensions as may be required by the contracts that are ultimately entered into. They have purchased some land and succeeded in signing up for water for about 20,000 acres of land. Their field of operation, as previously stated, is situated between Klamath Falls and Tule Lake, covering an area of some 60,000 acres. This canal company at present is very active along promotion lines, and is working quite a force of men on the tunnel in question. They began work on their canals about the first of August. They express very great dissatisfaction and regret over the fact that the Reclamation Service is making investigations in this section, as it will interfere with their program, and have endeavored to have orders issued to suspend the surveys. The principal men of this region, outside of this corporation, are of the opinion that public irrigation works are desirable. Numerous petitions to this effect have been presented to the service. The Reclamation Service will not proceed unless the people of the region desire it. The withdrawals made were for the purpose of giving the Reclamation Service an opportunity of investigating the country sufficiently to determine whether there was any occasion for the construction of public works here. These withdrawals were considered necessary, as the Klamath Canal Company were filing on streams and endeavoring to file on the Horse Fly and Clear Lake reservoirs, which filings, if perfected, might prevent the federal government, or, for that matter, any other irrigation enterprise, from doing business in this region.

It would hardly seem reasonable that the Reclamation Service should stand aside for a corporation that was not irrigating an acre of land, and that did not have a mile of ditch or canal constructed, and leave to this corporation the reclamation of over 300,000 acres of land lying in three counties and two States, the source of water supply being both interstate and navigable.

#### LAND WITHDRAWALS.

It was deemed advisable to withdraw, at least temporarily, all public lands in the Clear Lake and Horse Fly reservoir sites, and the public lands along Klamath River for power, and also to withdraw such townships as contain public irrigable lands. An examination was made of abstract records in Klamath County, Oregon, and only such townships withdrawn as contain public land.

If the beds of these navigable lakes are public lands, as is believed to be the case, it will probably be possible to reclaim 100,000 acres of public land in addition to over 150,000 acres of private land under this project.

## SUMMARY.

The following is a very rough estimate of the gross irrigable areas:

*Irrigable from Clear Lake and Horse Fly Reservoirs.*

Langell Valley.....	12,000 acres
Poe Valley.....	10,000 acres
Swan Valley.....	30,000 acres
Alkali Valley.....	20,000 acres— 72,000 acres

*Irrigable from Klamath River.*

Between Klamath and Merrill.....	60,000 acres
From Merrill to Carrs.....	10,000 acres
Bed of Tule Lake.....	50,000 acres
Bed of Lower Klamath Lake.....	20,000 acres—140,000 acres
Butte Valley, irrigable by pumping.....	100,000 acres

Total .....312,000 acres

The water supply is believed to be adequate for this irrigation.

## RECOMMENDATION.

It is recommended that pending these investigations and reports, the segregation previously made should be maintained and that no further rights of way, particularly to reservoir sites, should during that time be granted to any applicants of this region. Surveys should be vigorously made to determine the vital facts upon which final judgment must be rendered by the Secretary of the Interior.

Mr. Newell—This brings up matters of policy and matters in which citizens of both Oregon and California are interested. I therefore suggest that we give the matter full consideration while it is before us, as it is one of the very big questions the Congress will have to consider.

Mr. A. King Wilson, of Oregon—From the explanation we have heard it appears that the only question before us is how we can assist in promoting this project, and I have to offer a resolution in order that we may have some written record. The resolution is as follows:

“Whereas, unusual opportunities exist for the reclamation of large areas in both the States of California and Oregon in the basin of the Klamath River, and

“Whereas, the public interest and sentiment of the citizens and land owners of said section is desirous of having these works built in an extended and comprehensive way by the U. S. Reclamation Service and not partly constructed by water selling corporations; and

“Whereas, the irrigable lands and their water supply are divided by the Oregon and California State lines; and

“Whereas, the engineers of the Reclamation Service are now making investigations of the extent and cost of said reclamation, including the drain-

age of large interstate lakes, which work may call for special legislation from both Congress and State Legislatures.

*"Therefore be it Resolved*, by the California and Oregon delegations to the National Irrigation Congress, in joint session assembled, that the Secretary of the Interior is hereby respectfully requested to diligently prosecute said surveys, and if the said Klamath Project proves feasible to build the same as an interstate enterprise; and

*"Be it further Resolved*, that the representatives in both Congressional and State Legislative bodies be and hereby are respectfully requested to lend their aid and assistance to the Reclamation Service in passing such acts as may be found requisite."

Mr. Fairweather, of California—We have heard something of this subject before. Of course the California people read and know something about what the press and people are doing in the State, and at the meeting of our California delegation yesterday morning we undertook to discuss a few subjects and I introduced a resolution, but I am instructed by the California delegation to say that they decided that with all the powers they have now, or will have in future they will stand by the Reclamation Service in everything it has done in the past or may do in the future. We have that confidence in the government men who are now doing the work that we wish them to know that California will stand at the back of the Reclamation Service, and we do second with all our powers the resolution now before the house.

Mr. Newell—The motion is before the section on the adoption of the resolution. It has been moved and seconded. What is your pleasure?

Mr. Finkle—I am heartily in favor of this resolution and the reclamation work, but it seems to me that we ought to adopt this resolution here and not present it to the general convention. It seems that it only concerns California and Oregon and the reclamation people, and if we adopt it here unanimously that lends it all the force possible and puts us on record before our respective legislatures and the legislative branch of the government of the United States.

Mr. Newell—All in favor of the resolution, signify it by saying "aye." The resolution is adopted.

Delegate—I move that the resolution as adopted and the action of this joint session be reported to the chairman of the Irrigation Congress tomorrow night and let them pass on it and adopt it. It is only a question of adding to it all the force we can get, and if the National Irrigation Congress will endorse it—it is an interstate proposition—it seems to me it will give it more strength, because when we do that we will be getting some of the men who are in Congress of the United States to endorse by their action what we as mere representatives of our respective States are endorsing.

Mr. Finkle—If we do that it opens the door for everybody to come in with resolutions recommending all kinds of enterprises to the Reclamation Service, and if they adopt one of them they will have to adopt all. We all have faith in the reclamation engineers and know they are people who are able to pass upon a project, and I don't think we ought to have the Congress pass upon it.

This is a project in which two States, Oregon and California, are interested. This is our excuse for this joint meeting to recommend it to the Service. The Reclamation Service through their representative who has spoken endorses this project if the people of Oregon and California can come together on it, and we have shown that we can come together on it, but we should not take it to the Congress simply for the precedent it would establish.

Mr. A. H. Devers, of Oregon—There is such a committee and all resolutions that may come before the Congress are first presented to the committee. I presume that that committee is competent to take care of and pass upon all resolutions. I believe it is necessary to give this resolution all the force that it is possible to give it. If the Resolutions Committee of the Irrigation Congress thinks it worthy to be presented to the Congress, let them do so and give it all the prestige they can. I move that the resolution be presented to the Committee on Resolutions of the National Irrigation Congress.

Motion is seconded.

Mr. Fairweather—Oregon and California have agreed on one proposition. We have adopted this resolution, and we have thus done all that we can do in this Congress. We have agreed in this resolution to do all in our power to aid the Reclamation Service and do what we can with our State legislatures. There was a resolution introduced this afternoon before the Congress of a like nature as this, affecting a part of our State—I don't care to mention it—but the California delegation feels strongly that the resolution now already passed by us is entirely sufficient and we hope that the Oregon delegation will withdraw their objections and allow this division of the Congress to pass this resolution and not carry it any further.

Delegate from Oregon—I will withdraw my motion and say that California with her gold and Oregon with her grain will stand by this resolution and the Reclamation Service until that scheme is carried through.

Mr. Newell—The paper by Mr. Lippincott has been presented and discussed, and I understand that all objections to the resolutions as passed has been withdrawn.

I will say that the Reclamation Service is pushing its work forward as rapidly as possible and hopes to soon have all the necessary data upon which to proceed. If it is thought wise by our friends in Oregon and California to assist us their support will be a great aid to us. The matter of public policy is one in which we need your support. We are the servants of the people. We must get the facts and you must do the work based on a knowledge of those facts.

Thursday Morning, November 17, 1904.

Chairman Newell—The session will now be in order. You will first have the pleasure of listening to an address by Mr. H. A. Storrs.

### **IRRIGATION DEVELOPMENT IN NORTH DAKOTA.**

H. A. STORRS, Electrical Engineer, U. S. Reclamation Service, In Charge  
Irrigation Work in North Dakota.

Surveys and examinations of the entire arid or semi-arid portion of North Dakota have been pushed systematically and energetically by the Reclamation Service to discover a locality where the natural conditions offer a fighting chance of working out a feasible irrigation project. But the topographic features of the State are distinctly unfavorable to the storage and diversion of water from its streams, and while its neighboring State in the West offers a dozen possible projects, many of them evidently feasible, North Dakota seems to possess few, if any, possibilities of large irrigation projects.

The Missouri river affords an abundance of water, but the irrigable lands along its banks exist either in small tracts at low elevations, or in extensive plains at high elevations above the river. The lower lands are not sufficient in extent at any location to warrant the enormous expense involved in damming and diverting the waters of the Missouri. The higher lands could be reached only by dams of great length and height or by large canals several hundred miles long. Neither of these methods is considered feasible, in view of the unfavorable topographic features presented and the enormous expense involved.

The smaller streams are flat in slope, variable in flow, devoid of favorable reservoir sites and hemmed in by high banks of earth, all of which conditions are unfavorable to storage or diversion of irrigating water.

### **PLANS FOR PUMPING.**

This season, however, it was determined to ascertain whether it would be feasible to pump water from the Missouri River for irrigating the inviting bench lands which extend for many miles along its banks. The Reclamation Service has been unwilling to resort to this method of securing irrigating water, on account of its presumed high cost, if any cheaper or simpler method could be discovered. The feasibility of any pumping project is not assured until it is demonstrated that the value of the lands and crops will warrant the necessary expenditure for pumping machinery, canal system and annual operating expenses. These expenditures must be borne by those who receive the benefits of the irrigating water, since every dollar expended by the government for such purposes must, soon or late, be returned to the Reclamation Fund. For this reason it is really the people concerned in any such project who, by agreeing to co-operate with the government, decide that the project shall be considered feasible.

The engineer can determine the natural conditions, the cost of irrigation

works and their maintenance and operation, and can present figures showing the cost per acre for irrigating a proposed tract of land. It then rests with the land owners to decide whether they will agree to pay what is required to install and operate the proposed irrigation works.

#### IRRIGATION EDUCATION NECESSARY.

The people of North Dakota have much to learn regarding the value of irrigation. Almost no irrigation has been attempted thus far, and the majority of farmers have had no opportunity to see what has been accomplished in other States. Undoubtedly when the facts are presented to and understood by the people, they will be as ready to accept the conditions and secure the benefits resulting from reclamation projects as have been the farmers in Montana and other western States.

As a result of preliminary investigations not yet completed, the Reclamation Service will soon present to land owners in the vicinity of Bismarck, in Buford-Trenton and possibly some other localities, the proposition to erect pumping plants at these places, provided the people will agree to pay the costs of obtaining water in this way.

#### WILL BE UP TO THE PEOPLE.

These costs promise to be but little if any higher than for many of the projects in other States, where an annual charge of three to four dollars per acre is required during the first ten years. This amount pays for the irrigation works in ten annual installments, in accordance with the terms of the Reclamation Act, and also pays the cost of operating expenses during the first ten years. During subsequent years the annual charge covers only maintenance and operating expenses.

In projects involving steam pumping plants, the operating expenses will probably be greater than on gravity systems. These operating expenses, however, will be proportional to the amount of water actually pumped. Consequently in years of heavy rainfall the operating expenses will be small. The pumping plants are really a reserve, to be called upon to supply the deficiencies of rainfall and run-off. By storing all the flood-waters of small streams within the area covered by the project, the run-off may materially lessen the quantity of water which has to be pumped.

#### CHEAP IRRIGATION.

In general it may be stated that the pumping works and canal systems for the two projects examined would be paid for in ten annual payments not exceeding two dollars per acre each. The maintenance charges would amount to about one dollar per acre and would be practically constant whether much or little irrigating water was used. The operating expenses would, however, vary according to the amount of water actually used and would amount to little or nothing during years of abundant rainfall. During dry years when as much as two acre-feet per acre might be used, the total for maintenance and operation would approximate two dollars per acre. The pumping plants will have the capacity to deliver two acre-feet per acre for the



entire tract during an irrigating season 100 days in length. This amount is probably the maximum that will be required if economy is exercised in the use of water.

### TWO OBJECT LESSONS.

The Buford-Trenton project includes about 18,000 acres and the Bismarck project about 15,000 acres. The latter may be considerably extended after the surveys are completed and the results studied. Possibly it will be thought advisable to erect a central power station convenient to the coal supply and transmit the power electrically to the pumping plants, thus saving transportation of coal to pumping plants located at a distance from the railroads. The land owners along the Missouri, and possibly other rivers in the State, will soon have an opportunity to signify their desires regarding the construction of national irrigation works within the confines of the State.

Mr. Newell—Gentlemen, the subject which Mr. Storrs has just presented is a very attractive one, particularly to all parts of the arid region. If it will be found practicable to pump water for irrigation at a price comparable with that furnished by gravity canals, the limit to which we can extend the development of the West becomes a very broad one. The most notable advance in the last twelve months has been in the conception and the use of the gas producer and the gas engine for pumping plants, by which we cut out the old steam engines, and instead of utilizing the coal for the purpose of making steam in the boiler, and then furnishing the steam to a steam engine, and this engine furnishing the power to operate the pumps, we burn the coal in a gas producer; the gas thus obtained is used at once in the gas engine and there applied directly for the production of the necessary power for raising the water. The problem which Mr. Storrs has been dealing with, that of pumping water from the Missouri River in particular, is one that is applicable all over the West. We have before us a number of engineers who have had more or less experience in pumping, and I believe this opens out one of the widest vistas of development which has yet been presented. I see before me Mr. Finkle, and will ask him for a few remarks.

### PUMPING IN SOUTHERN CALIFORNIA.

Mr. Finkle—Mr. Chairman and Fellow Delegates: I have certainly been very well entertained by the able address which Mr. Storrs has just delivered; he has presented the subject in such a comprehensive manner as to leave but little more to be said by anyone. In Southern and Central California we have resorted to a very great extent to the pumping of water for irrigation. The pioneer portion of the State in this respect is Southern California, notably the counties of Los Angeles, San Bernardino, Riverside and Orange. I have not at hand the figures to give you the exact results of these operations, but in a general way I may state that there is approximately about three thousand electric horse-power applied to pumping plants in this region of California, in addition to which there are numerous individual plants operated by steam or gasoline. The success of these operations has been attended by a very rapid extension of the work all over the water producing sections

of the southern end of the State of California, and at the present time no one doubts the profits which are derived from such operations. The only element of uncertainty is the supply of water which is available for such extensive operations. Yesterday, in this section Mr. Mendenhall dwelt upon this subject at length, and I had the honor of making a few remarks upon the matter, pointing out how the danger could be averted to some extent by curtailing the use of the water in all necessary operations as far as practicable and adding to the stores of water in nature's own reservoirs. There are many sections of the arid regions not so vitally interested in this as California. I wish to state that pumping in California is yet in its infancy, and I desire to mention one or two notable examples. The Kaweah River, which flows through the county of Tulare, has upon it two power plants, and a great portion of the power derived from these plants is now applied to the pumping of water in the vicinity of Visalia, Tulare, Exeter, Porterville and other settlements. Some of these settlements are orange growing districts and produce the earliest fruit in the State of California, which does not, to any extent, come into competition with the later fruit of Southern California. Fields of alfalfa and other crops are produced in this same manner. Also, near the city of Fresno there has been constructed an electric power plant on the north fork of the San Joaquin River, which is also supplying power for similar purposes. The capacity of this plant is so limited, however, that enormous projects are in contemplation on the Kings River by the Kings River Power Company. We will be able to develop, on the Kings River, approximately one hundred thousand horse-power, a portion of which will be devoted to the pumping of water for irrigation purposes in the great San Joaquin valley.

#### NOTE OF WARNING TO ENGINEERS AND PROMOTERS.

In closing my remarks I desire to say a few things in the way of precaution to the engineer and promoter relative to the development of irrigation by pumping. In the first place, of course, an inspection is necessary of the ground waters which are to be applied for the purposes of irrigation in the different localities in the arid regions of the United States. These ground waters are sometimes impregnated with salts, which if applied to the land would cause the destruction of the crops. It is therefore necessary to make a careful chemical analysis of the water to be applied in any locality before any extensive enterprise is entered into. In the San Joaquin valley we have found localities where the ground waters would be unfit for irrigation, but the greater part of that valley is underlaid with waters suitable for such purposes. In Southern California we have no difficulty of that character as the waters are all very nearly free from salts, the only mineral which is carried to any extent being calcium carbonate, which, in moderate quantities is harmless. The salts of sodium are the ones which we dread the most, particularly sodium carbonate or black alkali. This subject cannot be discussed in detail to-day, but I desire to state in this connection that the Reclamation branch of the United States service has in its employ experts who are entirely competent to deal with this stage of the question, and the cities

in the arid West in the localities where the government is doing test work need have no fear that this feature will not be carefully looked after. Also, there is another feature equally as important. From the address made by Mr. Storrs we see that this feature has received its careful attention; of course this being the foundation of success or failure, it can in no case be overlooked. The question of the crop which can be grown by irrigation, the prices at which this crop can be sold, and the cost of production on the one hand and the cost of supplying the water on the other must be carefully determined by qualified experts; when this is determined the scheme may be safely recommended if it is found to be feasible. In this regard we again have the assistance of the able engineering corps which is combined with the Reclamation Service of the United States, men selected for their special fitness in these lines of work, who have devoted a life-time, almost, to those questions, and by the work so far accomplished show that they are devoting their energies to determine which schemes of reclamation are feasible. Now, we need not think that the reclamation of arid lands will stop when all the schemes which are to-day considered feasible have been developed. The history of every old nation shows us that as a country grows, as population increases the demand for production increases, and with these demands for production enterprises which would not be commercial in ages past become profitable. Therefore, I expect to see that the reclamation of arid lands in the United States will continue for centuries. I expect as the population increases the cost of production will diminish from natural causes. In this manner, enterprises where it is now considered impracticable to pump water for irrigation, will become entirely feasible, and it is hard for any one living in the present day in this country, unless he has visited the older sections of Europe to realize the extent of the possibilities to which this may be extended.

There are many others here who have ideas upon this subject, and as this is a gathering where the ideas of the many may be an estimate of the whole, I desire to thank you for your attention.

Mr. Newell—Gentlemen, in the remarks that Mr. Finkle has made he has touched on two very important considerations, the first is the quality of water from underground pumping plants, and that, as he has stated, is being studied quite thoroughly--by two different divisions of the work. The other point that Mr. Finkle has made is the economic, and there is where we must give a great deal of thought and attention. That question is not to get water on the ground or cultivate it, but the question is, will it pay in a given soil and climate to cultivate the ground intensively; what are the crops and markets which will enable men to succeed under the conditions? There is a subject which opens up a wide range of discussion, whether, in a given locality a project is feasible from the human side.

We have with us as guests and friends and associates in this work several of the engineers from the Republic of Mexico. We appreciate their presence; they have been very kind to come here, and one of them, Mr. Robert Galor, Commissioner of Public Works of the City of Mexico, has consented to appear and say something of his work, although he is very apologetic as re-

gards his ability to speak in English before a public audience, yet I trust he will at least come forth and present himself to the audience. I take pleasure in introducing Mr. Galor.

#### DRAINING THE MEXICO BASIN.

Mr. Galor—Mr. Chairman, Ladies and Gentlemen: I was invited by Mr. Newell to say a few words about my work in Mexico. It will give me pleasure to do so. The City of Mexico is situated in the bottom of a basin which has no outlet to the sea, and it is about seven thousand feet above the level of the sea. Since the times of the Aztecs the city was flooded a good many times with very heavy water. The Indians began the work of the drainage of the valley, but did not succeed. The Spaniards came afterwards and met with some measure of success, but their works were not sufficient to drain the valley. Afterwards the Government of the Republic of Mexico started several times to do this work in order to save the city from the floods. In 1886 our government started the work and pushed it with great vigor until it was finished about eight years ago. The works consist of a canal thirty miles long and at the end seventy feet deep and twenty feet wide. After the canal there is a tunnel six miles long and three feet in diameter. As soon as these works were completed we were able to build the sewers of the city. A lake was formed from storing the rain water of the valley. The drainage works are large enough to include the waters of the lake as well as the soil water of the city. We started the construction of the drainage and for that purpose I was put in charge as chief engineer of the construction of the sewers. I came to this country and had the pleasure of meeting several of your ablest engineers, who gave me very good ideas, which I used in making the plans for the sewerage of the city.

In 1896 we started the construction of these sewers and they are now finished. The system of sewers that we use is a combined system. I was particularly interested in giving a good system of flushing, and I think we succeeded, because we can flush our sewers every day in five hours and thirty-seven minutes with only twenty men. All this water and the refuse water off the houses goes to the main drainage canal, and through the tunnel. A company was formed in order to use this water for developing electric power and use the water for irrigation. As the tunnel is constructed on a steep grade, they erected three power plants in which they generated electric power, and they sent this power to Pachuca, which is one of the largest mining places in the Republic of Mexico. This city is lighted by power generated with this refuse water of the City of Mexico, and a great number of mining places receive power from this source. As soon as the water leaves the power plants it goes to irrigate a large portion of very dry land, where formerly they could not get crops one year out of five. Now they get crops every year because they irrigate all these lands with very rich water, the refuse water of the city. I think this is one of the most complete and best schemes for the use of water, as we take it from the upper lakes that are on the southern side of the City of Mexico and use it on the dry lands. At the same time we have a complete system for the drainage of the city.

Mr. Newell—We have to thank Mr. Galor for his kindness and for the very interesting facts he has put so concisely before us.

For the benefit of those in the back of the audience, or room, I will say that Mr. Galor is chief engineer of the sewerage system of the City of Mexico. He has devised and constructed a system of drainage or sewers for that city, discharging through a tunnel and power is developed from the use of that water, and the power transmitted and used for electric lighting and pumping, after which the water is turned out on the dry lands and used in irrigation, producing good crops, and the seepage or return waters go back into the streams in a naturally filtered and purified condition by their use in irrigation. It is an ideal system and I hope that the description which Mr. Galor has given out may be translated and published in our proceedings, at least in the proceedings which will go to the engineers. We will learn a great many lessons I think from the practical experience which Mr. Galor has had.

As the next paper on the program I will call upon Prof. Thomas Taylor, Professor of Civil Engineering at the University of Texas, who has been co-operating with us in Texas in the study of the water supply and development of the water resources of the State for irrigation and power. For the information of our Texas friends who have the idea that because the reclamation fund is not applicable in Texas, we are not working in Texas, I think it is only fair to say that the Geological Survey has been spending a considerable amount of money in Texas for many years; is systematically studying this State as it is all parts of the United States, preparing the topography and maps of Texas; is studying its geology; studying its water, and studying the opportunities of development, and if opportunities offer we will co-operate in every way in utilizing the waters for the irrigation of land whether in Texas or in any other part of the country. Professor Taylor will speak to us briefly on his investigations of power for pumping water for the irrigation of rice.

Mr. Taylor—Mr. Chairman: Before I commence I wish to precede my talk with this motion: I move a vote of thanks to Mr. Galor for coming so far and having the courage to address us in our own language.

Mr. Holabird—I take pleasure in arising to second the motion, not only to extend our thanks to the individual, but to the Sister Republic for sending him and giving us the knowledge of this treble use of the water.

Motion carried unanimously.

Mr. Newell—The management has requested that I give notice that the Rural Settlement section is holding a session on the second floor of the Court House. It has been feared that perhaps some one has wandered in here thinking he was in the Rural Settlement section, and if so we will warn them that this is not the proper place. I will do all in my power to give Mr. Smythe an audience, and ask every one to go over and listen to them if he so desires. We want to be fair in this matter and give the other section a chance.

**POWER FOR PUMPING WATER FOR RICE IRRIGATION.**

PROFESSOR THOMAS TAYLOR, of Austin, Texas.

*Mr. Chairman and Gentlemen of the Convention:*

This paper could well have come as a discussion of Mr. Storrs paper, because it is on a similar subject. It is not a new topic at all; it is a continuation of the general subject of pumping water for irrigation purposes. The statement was made day before yesterday that in Texas there were fifty thousand acres under irrigation. The gentleman stated only one-sixth of the truth. There are over fifty thousand acres irrigated for general crops. There are two hundred and twenty-five thousand acres of rice irrigated in Texas, making in all nearly three hundred thousand acres, or as some estimate three hundred and twenty-five thousand acres under actual irrigation in Texas not under ditch. The majority, or nearly all, or I might say ninety-five per cent of the rice irrigation is done by pumping, strictly. There is only one that I could call a ditch or canal plant in Texas, which derives its water from tapping a stream by a dam, which is located at Del Rio. There is only one plant in Texas that develops its power by water, that is at Cuero. The ninety-five per cent then in Texas is from pumping direct; ninety per cent of this is from the use of the centrifugal pump. Now as to this, as I said, it is a continuation of the paper by Mr. Storrs—almost right in line with it. I believe I got the statement right, that it required two acre-feet generally as an average there to irrigate the crop. If I understand, that statement was that each season you had to cover the land with about two feet of water.

**RICE GROWING IN TEXAS.**

In rice cultivation we have to put on more, because rice is a marshy crop; it is used to growing in a swamp. Now, instead of taking the rice to the swamp, or taking the mountain to Mahomet, we went and got Mahomet and brought him to the mountain. Now, instead of taking the rice down on the coast and growing it in the marshes and bayous, we simply brought the marsh up on the table land by pumping. We put a dam around the land to be cultivated and we pump on the inside of that and that makes our marsh there; this is briefly rice irrigation. Now, rice irrigation you know—just briefly I will take up the Japan method; I have read this paper but will repeat just a few words of it. A few facts were given; the Japan farm has an average size of about a quarter of an acre. This room is about the size of a Japan farm, of which there are nine million in Japan, or about 3,000,000 acres. Those of you who have been used to planting tobacco know that you have to put your seed out in a seed-bed before you start. They put theirs in a seed-bed and then go out onto the farm and plant it out by hand, putting about two hundred thousand stalks on one acre, and every one put down by hand. Now, you can imagine the condition of a man's back when he gets through with an acre. Notwithstanding that, Japan produces to-day eleven times more rice than the whole United States. In addition to this there are three Japan colonies in Texas to-day on our rice farms; at Del Rio; at Webster; at Garwood. and I can say, as I said yesterday, they are displaying the same energy in

rice irrigation in Texas that they are now displaying in scaling the walls of Port Arthur. Now, instead of putting two feet per acre on their ground in Texas and in Louisiana, which is the Carolina method, we have got to put about three feet on unless it rains, and this is an uncertainty. We have got to put three feet of water on the ground. We start and sow the rice like we do wheat. We plow the land like we do for wheat; then we sow it with a drill exactly like we do barley. The only difference is this: it is laid off in farms where the difference in level is about six inches; they are dyked in and the water is pumped on these after the rice is up a few inches, and it stands there for about ninety days. Every particle of rice should be covered at the roots from two to six to eight inches, and it ought to stand there for sixty to ninety days; this is the modern method. Mr. Storrs spoke of the number of plants and said that pumping was in its infancy. Well it is in its infancy in Texas and Louisiana, but I must say it is a pretty robust infant.

### SIZE OF PUMPS.

Now, as to the size of these pumps: last summer I walked through the suction pipes of one of these pumps. I stood in one and the upper part of it was two feet above my head. That gives you just a faint conception of what we are doing, and that very large engines are required to do this work. There are five hundred, in round numbers, well plants in Texas irrigating rice by using the small centrifugal pumps. I made a tabulation last night and this morning of the number of big canal systems. There are in operation to-day in Texas, or were this last summer, exactly forty-one, irrigating from 500 to 16,000 acres per system. Now, on each acre per each minute that you irrigate you ought to put seven and a half to nine gallons of water. In Texas we estimate gallons per minute; we have to keep to that language or the people will not understand us. On every acre every minute you have got to put about seven and a half to nine gallons; say seven and a half gallons; that means for ninety days just three feet that you have got to put on there. Now I make no excuse for the technical part of this because that is what this section is. If we let  $X$  represent the number of acres to be irrigated and  $Y$  the lift in feet, there are two factors, and only two in rice irrigation, as there are only two in all irrigation plants. The first is, how much do you want to irrigate, that is in pumping plants; the second is, how high have you got to lift the water; of course these are the fundamental factors. When you know these two an engineer can tell you how much power you have got to put behind the machine to drive it. Now, the theoretic horse-power or the actual horse-power in operation: If you multiply the number of acres you want to irrigate by the lift in feet, and divide that by 440, you will get the number of horse-powers that you have got to have for pumping. Roughly speaking, then, if you multiply the number of acres you want to irrigate by the lift in feet and divide by five hundred, you have a still more conservative estimate.

Now if a man is going into this business he should always make the manufacturer guarantee the goods. I know a lawyer down in Texas that almost had his license taken away; he was over the average. He went to buy a horse and

the professional horse-trader told him a long tale about the horse; the lawyer took it all down and says, "Come across the hall," and then said "will you please swear to that." He stepped back. "No, sir, I may be a Texas horse-trader, but I won't swear to that; I am too old a bird for that." But you can do this, and the reputable makers of large centrifugal pumps as well as small ones will guarantee them, and they go from one inch to sixty inches in diameter—they will guarantee them, but never go into it unless they do guarantee them.

#### COST OF PUMPING.

Now, as to the cost, it is found in Texas you can get water from the big canal systems at two bags of rice per acre, about three hundred and sixty pounds; in average figures then that will mean five or six dollars per acre per season. You can get the water for that or pump it yourself, and on the small well plants they actually irrigate for less than that. A well plant where it has got a lift of not over twenty feet will uniformly produce better results than the big pump canal systems. Now, that is roughly the substance of the investigation of the amount of power necessary for the irrigation of rice in Texas and in Louisiana. Why do I say in Texas and Louisiana? Because in the old Atlantic States they are still using what we call the Carolina method. Briefly, then, what is the modern method? It is simply to produce a marsh on the highlands by pumping the water up there, and there is but one gravity plant in Texas, one water power plant in Texas, and all the rest are power plants, pure and simple.

Mr. Newell—It is very impressive to learn what has been done in Texas in pumping, the enormous development which has taken place there quietly with the assistance of the engineers and other persons interested. The lessons given by Professor Taylor of the excellent results accomplished should encourage us all to consider pumping as one of the great developments of the future. The cost, I expect, will show up larger than that of gravity canals, but we must recollect that the gravity canals built by private enterprises all over the country have taken the cream of things. You cannot go along and repeat and take out ditches now as you did ten or twenty years ago, and so pumping plants come now into direct comparison with the later ditches, which we must build at larger expense. In this connection it may be of interest to some of us to know that in a telegram just received I find it stated that at St. Louis, at the coal testing plant, in what is known as the mining gulch, near the mineral building, we have just completed a most successful run on North Dakota lignite in gas producing.

#### DAKOTA LIGNITE AS A GAS PRODUCER.

That is quite significant because of the fact, which will be appreciated by our North Dakota friends, that the North Dakota lignite has been considered hardly worthy of taking into account in the development of the country, but it is found that in this experimental plant that by utilizing that lignite as a gas producer we get results which are superior to that of bituminous coal. We hardly appreciate it until we understand that in that State hundreds of



thousands of acres are underlaid with this lignite, which has been considered very inferior to bituminous coal. If this is true it means an enormously increased value to that whole State and its industries.

Professor Taylor—I omitted one thing, that is the advantage of pumping from surface wells as over canal systems. We have in Texas an irrigation law, so-called, and law they say is a science, but if our irrigation law is a science, why, it is one of a rather peculiar brand. Now we have in the courts a term known as the Texas rule. That Texas rule is that the latest decision of the Supreme Court in regard to the upper and lower proprietor, the present Chief Justice decided this, almost word for word: That if the water could be used, that if irrigation was necessary for agriculture in the locality where the contest occurred, the upper proprietor could take all of the water out of the stream and not leave sufficient for the lower proprietor for the same purposes. He can force him to leave enough for domestic purposes, but not enough for irrigation purposes. The well proprietor has the advantage; he is away off from a lake, away off from any stream; he has a farm of one hundred and sixty acres, digs his well, and for twelve hundred dollars can put down a good pumping plant, irrigate only thirty-five acres of rice, spend nine hundred and seventy dollars in doing it, take in only one crop and clear twenty-three hundred dollars on thirty-five acres. Now, we are not all doing that; that is one of the best, but I am only going to give you the best; we will do our own washing at home—not here. I always advise a man to put in a well plant, why? Because injunctions cease from troubling him, and irrigation laws are forever at rest on the well plant farm.

Mr. Newell—The Texas rule has the advantage of simplicity, for the fellow first up the stream can get all the water; just think what it would do for us in other parts of the arid region. Now we have left five minutes before the stated order of the day, and the only thing I have on the program is an address by Mr. Holabird on errors to be avoided in the management of irrigation systems. If Mr. Holabird will speak to us for five minutes we will ask him to do so on the errors to be avoided in the management of irrigation systems.

#### ERRORS TO BE AVOIDED.

Mr. Holabird—Mr. Chairman, Ladies and Gentlemen: This is a little bit of a surprise. I really have not very much time to even think about it, as I think Mr. Newell will concede that. My observations, having some experience in the management of irrigation enterprises and in observing the working of irrigation enterprises, lead me to form some conclusions, and I believe they are reasonably correct. First, a given amount of water in one—I will not name the enterprise; it is a great irrigation enterprise, possessing a great deal of natural merit, both in the land and climate—the company allotted to the land altogether a quantity of water. The land not all being farmed or occupied, each water user was allowed to use all the water he wanted. Instead of accumulating his water, which we will say was thirty miners' inches, and using it at stated periods by a schedule, he was allowed to use two or three hundred miner's inches all the time. Finally financial disasters overtook this large corporation and they were in very great trouble. It was necessary

to repair the ditches; it was necessary to sell more land in order that the income from water rentals might be sufficient to maintain the ditches and keep the company alive. It was ascertained that there was no surplus water, because the few water users on these vast areas were using from two to ten times as much water as they were entitled to, and when I suggested taking it away they threatened to mob me; so you will see it is dangerous. In the first place it teaches the farmer a very bad practice, of making him believe that he has a prescriptive right to water that he never can own and should not be allowed to use to his detriment, because my observation is that there is more damage to crops by the abuse of water than from the lack of water; you will find that universal throughout the West without exception. When you talk about water—large quantities of water to a given quantity of land, why, the orange growers of California who produce twenty-eight thousand car-loads of fruit per annum, would think themselves wonderfully supplied with water if they had one California miner's inch to ten acres. The other danger is in not having a schedule, and that will end my brief talk. I believe that all distribution—I am speaking now from the point of the manager and not of the engineer—of water should be distributed under a schedule. I do not think it is wise; it will not work out well to let Mr. Jones telephone in to the water man and say "I want some water to-morrow for my north forty." I believe it is best to make your schedule, and tell Mr. Jones and Mr. Smith the very day and the very hour and the very minute this water shall be turned on, and when it shall be turned off. This is very important indeed.

#### WASTEFUL METHODS OF IRRIGATION.

One of the most beautiful valleys in California, and I regret they are not represented here so far as I know, is Owens Lake Valley, in Eastern California; it is one of the gems of the western continent. In the early days they took the water falling from the high Sierras and appropriated it, as we call it. There are scores of little farms in there using two and three hundred miner's inches of water. They irrigate when they want it and when they do not want it the water goes to form lakes; the result is they are filling the valley full of lakes or ponds. That shows the folly of giving a farmer more water than he actually needs and letting him have it to go to waste and ruin the country and ruin his own crops.

Mr. Newell—The time has arrived for the special order of business, which is of peculiar interest and importance to the citizens of this beautiful city, and the inhabitants of the neighboring country on both sides of the line.

I wish now while I think of it to announce that at 12:00 o'clock the committee of organization is to meet here in this hall.

#### THE RIO GRANDE.

The subject which has been assigned for 10:30 is that of the Rio Grande, the wonderful river which flows—sometimes—by your city; the river that rises in the State of Colorado is of great importance to the southern part of that State, flows through New Mexico, is the fount of life of the greater part of that territory, forms the State boundary between Texas and New Mexico

for a little distance, and then for many miles forms the international boundary between the State of Texas and the Republic of Mexico. The use of its waters is, of course, of prime importance—of vital importance—to the citizens of the State of Colorado, Territory of New Mexico, State of Texas, and last, but not least, the Republic of Mexico. You are all familiar—those of you who are interested in the subject—with much of the past history of this river, and the discussions which have gone on concerning its use. I think it is not necessary to mention, and in fact from the view-point of the engineer we wipe aside all of the past, and simply consider, and have the right as engineers simply to consider what are the best conditions of the river and what are the best uses of its waters irrespective of all territorial or social or human interests. Starting out, therefore, with this consideration solely, as to the river itself, what would be its ideal use without reference to State, county, or territorial lines; then, with that starting point, which is as far as the engineers will go, we simply say, here are the facts. Now, it is for your consideration as citizens, as statesmen, to say what shall be done with the river, but it is for us to inform you, as clearly and impartially as possible, what we consider are the physical facts which must be taken into account in any of the problems, and the best use of the waters of the stream. There are before us in the audience, representatives from New Mexico, from Texas and from Mexico. There are members of Congress and others who must give the last word to this matter, and we wish, in presenting this as engineers, to confine ourselves strictly to the engineering features, and let you draw your own inferences and reach your own conclusions without any intimation one way or the other, as far as we can, as to what we consider to be the best solution, other than that which is based on the facts.

The Secretary of the Interior, who has charge of the expenditure of the reclamation fund, has authorized, among other investigations in the West, a study of the Rio Grande in the same way that he has authorized the study of the Colorado and the Arkansas and the Platte and all the other great streams in the West, and we will report to him the facts, which we find, with such recommendations as may seem desirable. He has gone still further, I think, in official publications and intimated that both the Secretary of the Interior and the Secretary of State hope to see, through the expenditure of the reclamation fund, some solution possibly, about the question confronting us on the Rio Grande. The passage of that law, creating the funds which are available for construction put an entirely new basis upon the consideration of the Rio Grande, and many of us who may have formed opinions in the past, must of necessity recast them on the basis of the facts which have been carefully considered and brought out and given during the past season. These are engineering facts simply, they are based upon careful measurements made by Mr. W. W. Follett, who has devoted practically his life to the study of the Rio Grande, and worked up by him in connection with Mr. Hall, our supervising engineer for the Rio Grande district.

I now have the pleasure of introducing Mr. B. M. Hall, who will speak to you briefly on the subject of his studies of the Rio Grande. Many of the most important matters to be considered by Mr. Hall can only be made

comprehensive by diagrams, and it will take a little time to display these. These are diagrams which can only be understood by careful personal examination; they are not of a nature to be displayed largely in a hall. I might say that this paper was prepared originally to be read at a small session of the engineers, where we could get together in a small body and see the diagrams, and we had no expectation of the popular interest in the matter until, we may say, this morning, when it seems that a large number of people wished to hear the reports and calculations of the engineers. Therefore the diagram which was prepared for our own personal and direct inspection may not be wholly intelligible, and we will ask those interested to see Mr. Hall later so that they may see them. We also have a large number of drawings, which can be inspected at any time, here or in Mr. Hall's office a short distance away.

## **PAST AND PRESENT PLANS FOR IRRIGATION OF THE RIO GRANDE VALLEY.**

B. M. HALL, Supervising Engineer U. S. Reclamation Service.

The Rio Grande rises in the State of Colorado, and flows south through the entire length of the Territory of New Mexico to the north boundary of Texas, near the town of Anthony. From this point "The Pass," about four miles above El Paso, Texas, it forms the boundary between New Mexico and Texas. At "The Pass" it becomes the boundary line between the United States and Mexico, and continues as such for about 1300 miles to the Gulf of Mexico.

So far as its history is known it has always been a torrential or storm-water stream, subject at times to great floods, and at other times to periods of minimum flow when its bed was dry, or carried an insignificant amount of water along certain parts of its course.

Above El Paso it has a length of about 900 miles, and a drainage area of about 38,000 square miles. In this section its ordinary flow, or what is known as its permanent water, comes almost entirely from a comparatively small area in Colorado and upper New Mexico, where there is a heavy snowfall in the mountains.

The country through which it flows is very fertile, but the rainfall is so meager and so erratic that it is an arid desert, and no crops can be raised without artificial irrigation.

### **EARLY IRRIGATION IN RIO GRANDE VALLEY.**

Before the middle of the sixteenth century the Spaniards entered the valley of the Rio Grande in New Mexico, and there found the Pueblo Indians living in towns, cultivating the land, and bringing water onto it by irrigating ditches, many of which are still in use to this day. A Spanish colony was established at Chamita, New Mexico, in 1598, and at Santa Fe in 1605. The latter colony existed until 1680, when they were driven out by the Pueblo Indians. Spanish supremacy was again established in 1692. From that time to near the middle of the nineteenth century the Rio Grande Valley in New Mexico was under the dominion of Spain and Mexico, and was settled up by Spaniards and Mexicans, who irrigated and cultivated the lands. In the excellent report made by Mr. W. W. Follett in 1896 to the International Boundary Commission, he says: "While quite a large native population has come into the Rio Grande drainage in New Mexico since the construction of railroads in 1880, it is confined principally to the towns, and to-day fully 90 per cent of the irrigating in this section is done by Mexicans and Indians." In the same report Mr. Follett says: "The El Paso Valley was occupied by Spaniards over three hundred years ago. In the year 1600 El Paso del Norte (now called Juarez) was an important town, and records are in existence over two hundred and eighty years old which refer to the Acequia Madre of El Paso del Norte as being in use." In speaking of his investigations in El Paso Valley, Mr. Follett says: "From all I could learn, I should judge that in former years some 40,000 acres of land were tilled in this valley, more than half of which was on the Mexican side of the river."

## SCARCITY OF WATER.

During recent years there has been a great scarcity of water in the Rio Grande, in New Mexico and in the El Paso Valley of Texas and Mexico. The deficiency of flow at El Paso brought about a complaint from the Republic of Mexico. The question by a protocol, dated May 6, 1896, was referred to the International Boundary Commission for a full investigation and a report upon the following points:

1—The amount of water of the Rio Grande taken by irrigation canals in the United States of America.

2—The average amount of water in said river, year by year, before the construction of said irrigation canals, and since said construction.

3—The best and most feasible mode of so regulating the use of the waters of said river as to secure to each country concerned, and to its inhabitants, their legal and equitable rights and interests in said waters.

On November 25, 1896, this Commission, composed of Col. Anson Mills for the United States, and Señor Don F. Javier Osorno for the Republic of Mexico, having before them the full and complete report of Mr. W. W. Follett, United States Engineer for the Commission, reported as follows:

1—The increase in the acreage irrigated from the Rio Grande in the State of Colorado from the year 1880 to the year 1896 was 197,000 acres. The increase of acreage irrigated in New Mexico during the same years was 3000 acres, making a total of 200,000 acres.

2—The flow of the river at El Paso has been decreased about 200,000 acre feet of water per annum by the taking of water for irrigation by canals constructed in the United States of America; the great mass of these waters consisting of flood waters utterly unavailable for irrigation without large reservoirs.

3—As "the best and most feasible mode of regulating the use of water, and securing to each country and its inhabitants their legal and equitable rights in said waters," the Commission recommended that the United States government should buy all necessary land, pay all damages, and construct at its own expense an international dam at "The Pass," about four miles above El Paso; submerge 25,565 acres of good land in the United States with water; extend the Mexican boundary upstream to the dam site, giving Mexico 98 acres additional territory in order that one end of the dam may be on Mexican soil; deed one-half of the dam, the reservoir and the water supply to the Republic of Mexico, and in some way prevent the construction of any large reservoirs on the Rio Grande in the Territory of New Mexico.

The Commission estimated the cost of this project at \$2,317,113.36.

As above mentioned, Mr. Follett estimates that about 40,000 acres of land had prior rights under the old canals in El Paso Valley, and was deprived of irrigation by the act of American citizens on the head waters; and that something more than one half of this 40,000 acres lay on the Mexican side of the river. As the restoring of these ancient water rights is the primary object of the proposed expenditure of \$2,317,113.36, the cost of the project would be \$57.92 per acre. However, it will be shown further along in this paper that the proposed reservoir could be made to irrigate 55,000 acres

in El Paso Valley, which would put the cost per acre at \$42.12, provided the estimate of the Commission is a correct one. There is every reason for believing this estimate too low, but aside from the monetary cost per acre for the land to be irrigated, there is another item of cost to be considered. The reservoir would cover 25,565 acres of good valley land with mud and water, and would cause marshes to form in the low flat valley at the head of the lake amounting to perhaps 15,000 acres additional, making a total destruction of about 40,000 acres of land in Mesilla Valley, which is just as near to El Paso, and just as valuable as any of the land that would be irrigated.

#### WOULD HAVE LEFT NEW MEXICO OUT.

While the published report of the Commission and its engineers plainly sets forth the fact that increased irrigation in Colorado caused shortage of water in Mexico, Texas and New Mexico, their recommendations not only leave New Mexico out of all the benefits to be derived from a project inaugurated for the purpose of making up this shortage, but give part of her territory to Mexico; cover up another part of it by the proposed reservoir, and distinctly ask that the government shall prevent the construction of any other large reservoir on the Rio Grande in the territory of New Mexico. The only reasonable explanation of these extraordinary recommendations lies in the probable fact that the Commission had no alternative plan for consideration, and thought that the plan recommended was the only possible plan that could be adopted for restoring the water to which Mexico laid claim by virtue of ancient prior use. Indeed they were confronted at the time with the prospect of an Elephant Butte dam in New Mexico, not under government management, but to be constructed, owned and operated by a stock company of private capitalists, whose plans contemplated the construction of a comparatively low dam, without sufficient storage capacity for irrigating a large area above and having a surplus for Mexico. At that time the United States government had no Reclamation Service. Now that conditions have completely changed, and there is an alternative plan which claims to be able to accomplish just as much for Mexico, and a great deal more for the United States, it becomes necessary to compare these two plans, and choose between them.

The alternative plan, suggested by the U. S. Reclamation Service, is to build a storage dam opposite Engle, New Mexico, across the Rio Grande at a point about a quarter of a mile below the site selected by the old Elephant Butte Company, and a third of a mile below the Elephant Butte, which is a conical mountain peak rising abruptly from the river bank to a height of about 500 feet. At this site it is proposed to build a dam that will form a reservoir 175 feet deep at its lower end, and 40 miles long, with a storage capacity of two million acre feet, that will impound enough water to furnish 600,000 acre feet per annum, and irrigate one hundred and eighty thousand acres of land, distributed as follows:

110,000 acres in New Mexico.

20,000 acres in Texas above El Paso.

50,000 acres in El Paso Valley below El Paso.

(11)

With the above brief statement of the U. S. Reclamation Service project we will proceed to compare it with the International Boundary Commission project, in a spirit of fairness, and with the object of arriving at the best solution of the question before us.

In considering these projects, or any other plan of water storage on the Rio Grande, it is well to keep in mind the following facts:

1st—While the floods on the river are enormous, they do not come with any regularity, and the total flow in some years is less than one-tenth of the total flow in other years.

2d—Any reservoir constructed on the river will stop all the silt that comes down the river in suspension. Hence a small reservoir will accumulate as many acre feet of mud per year as a large one until it is filled with mud.

3d—All of the water that comes down the river is needed for irrigation. We can not afford to waste any of it.

These three conditions make it imperative that the reservoir should be as large as possible, and as deep as possible; having a capacity for carrying a supply of water over from year to year to equalize the yearly inequalities, a surplus capacity for mud accumulations, and a surface for evaporation that is as small as possible in comparison with the quantity of water in storage.

Mr. Newell—The next short discussion or presentation of facts on this subject will be by Professor Schlichter. He has made a very careful and thorough study of the question of the underflow in and about this city. This investigation was made for the purpose of setting at rest the questions which come up at all times as to how large a quantity and the quality of the water which is believed to be moving beneath the surface of the ground in the apparently dry river channel. Professor Schlichter has during the past few years developed and put to practical use very ingenious devices for measuring the rate of movement of water under ground, and he has been able to demonstrate the fact, which we before suspected, that the waters are moving underground in these apparently dry river channels, but that they are moving very slowly in many places. The quantity is restricted and the quality varies very much from that of pure water. Professor Schlichter has made these investigations for the purpose of furnishing material for comparison, and will give us briefly the results of his examination.

#### RIO GRANDE VALLEY UNDERFLOW.

Professor Schlichter—Ladies and Gentlemen: I had the very great pleasure this summer of co-operating with Mr. Hall in one or two of the secondary problems connected with his very difficult investigations upon the Rio Grande project. I will report in a very few words upon the investigation of the underflow in the pass above the city. The point selected for this investigation was the exact line of the proposed international dam. Accepting the Mexican borings at this point as correct the greatest depth to bed rock here at this point is eighty-six feet, and the total width of the sands at the level of the channel of the river is less than four hundred feet. The first point that we investigated was the determination of the slope of the water through the



pass. We found by running the levels that the average slope of the water at this point in the river was considerably less than four feet to the mile, being no greater than three and six-tenths feet to the mile. This first part of the investigation was very discouraging, for we expected to find a very large flow of water through the gravels, as the flow of water through gravels is controlled by the head under which it flows, as well as the flow of water through pipes or through streams themselves. We began the investigations by making borings to various depths, and we found that at this point the sands were very uniform. There was an absence of boulders and of broken rocks; finding only occasionally layers of silt. The sand might be described as a large-sized cement sand or planter sand, quite free from silt except in occasional layers. The layers of silt increased as depth was penetrated until they became quite numerous at greater depths. The velocity of the ground waters through this pass was found to be exceedingly moderate, as might have been anticipated from the slight slope which the water possessed. The velocity in no case exceeded three feet in twenty-four hours, the lowest being a little more than two and a half feet in twenty-four hours, and I should say it is slightly less.

#### SALINITY OF UNDERFLOW.

But one surprising feature that developed in these investigations was the increasing saltiness of the water as the depth penetrated increased. The amount of common salt in the water at ten feet is about one hundred parts in one hundred thousand, but this continued to increase with every foot of depth, but quite slowly, and at a depth of between thirty-five and forty feet the amount of common salt took a sudden jump and increased enormously, so that at a depth of sixty feet the amount of common salt in the water was found to be about two per cent, or two pounds of common salt to one hundred pounds of water. Not only did the common salt increase, but the alkalies and other salts in the water showed an even greater tendency to increase. These, at a depth of between thirty-five and forty feet suddenly increased and seemed to increase almost indefinitely, until at a depth of fifty feet the total salts in the water were found to be just short of five per cent, or about one pound of salts to three gallons of water, which is considerably stronger—not quite twice as strong as the water of the ocean. An estimate can be made from the cross section of the gorge as to the amount of underflow, the amount of water that passes through the gorge. Before passing to that I will say that it is of course very difficult to measure the rate of movement of these very strong waters, but at a depth of forty-two feet the apparatus worked very well, and we waited many days in our tests, and we found that at that depth the motion of the water had ceased altogether, which corresponds, of course, with the sudden change of the character of the water, where the water was found to suddenly increase and the amount of salts dissolved in it, that was the place where the motion of the water ceased altogether. So, taking the cross section of the gorge, and assuming that I am mistaken in regard to the lack of movement of the water at great depths, the total amount of water flowing through the gorge is less than one and one-half second feet, or taking the area in which we know the water moves, and

accepting as a fact the area in which we know it does not, the total amount of water flowing through the gorge is one and one-tenth second feet, barely sufficient to irrigate, I suppose, from sixty to seventy acres of land.

#### SOURCE OF SUPPLY MESILLA WELLS.

I will not take up your time with any further matters except one point I observed in the Mesilla Valley, near Mesilla Park and Las Cruces, where we succeeded in measuring the amount of water lost by the river and contributed to the gravels. As the results of the investigation at that point, I think we have established that the source of the water that is used by the pumping plants is the river itself; that the origin of the ground waters, or the supply of ground waters which are used by the pumping plant, is the water contributed by the river itself or lost by the river. A number of test wells were put in places and observations were made upon these about every week by Professor Tinsley of the Agricultural College, who extended the observations through the time of the heavy floods. We found that before the flood, or during the very low stage of the river, the river was contributing a very small amount of water to the gravels, but at the time of the flood and silt that is deposited on the bottom of the channel is scoured out by the heavy flood, and during that period the river loses for each mile of its channel seven and one-half second feet of water; that is the maximum contribution of the river during the floods for each mile of its channel it loses seven and one-half second feet. For the entire five weeks of these observations the loss of the river to the gravels was an average of a continuous flow of three second feet for each mile of the river.

These cover, I think, sufficient points that directly bear upon the proposed dams and storage reservoirs.

Question asked of Mr. Schlacter—For the benefit of myself as well as others more deeply interested in this matter, Mr. Hall in his table there shows that the overflow in the Elephant Butte dam will be nothing. Now, the first question that I want to ask is this: If there will be no overflow in the Elephant Butte dam, naturally the Elephant Butte dam would catch and retain all of the water, and I therefore want to ask, the first question, would there then be any river at El Paso?

Mr. Schlacter—It seems to me that that question is not directed exactly at the right person. I understand that the water is to be allowed to flow down the channel of the river, and that the diversion dams will take it out, although this is a question that does not belong to me.

Question—Well, that question probably does not pertain to your discussion, the next question that I want to ask probably will; and that is, if there is no overflow from the Elephant Butte dam, and we obtain the water for our pumping plants from the river, will not these pumping plants exhaust the water below and the pumping plants cease to exist?

Mr. Schlacter—Very likely that would be the case. If the source of supply is cut off and you continue to pump, there must be a depletion of the stored waters, which occurs at the present time during every irrigation season. Water levels are very greatly lowered by pumping plants.

Question—As I understand it, you propose to bring that water down the river channel, is that true, Mr. Hall?

Mr. Hall—The water that you get now in the river, that is underneath the river bed and in the valley lands comes from the rains on the high lands and from floods down the river, and from the water that is flowing in the river at certain periods. The under gravel gets saturated. We estimate that when we get in that storage dam, that instead of injuring that condition we will better it. You will still get all of the rainfall that comes below the dam; of course you will have the floods originated below the dam—they will not be disastrous floods—but you will at all times have a wet river bed and considerable water flowing in it, while at present you have a river bed that is dry for five months—and longer this year—and I suppose the conditions ought to be better because of the percolation from the river bed more or less and there is always a flow from the rain-fall on the mesa.

Mr. J. L. Rhead—I just want to mention a fact, that I believe one point has been lost sight of, that is the fact that the water stored in the Elephant Butte reservoir would be distributed over the lands of the valley, and the pumping plants would be thereby benefitted in place of being injured. In place of being fed by the water of the river they will be fed by the distribution of the water over the lands.

Question—I should like to ask a question, Mr. Hall. Your table shows that the flow at the upper location—at Elephant Butte, is greatly in excess of the flow of the river at this lower point. Professor Schlichter's discussion gave us to understand that the sub flow at any point in the river was very small comparatively. I should like to ask as a matter of information what becomes of the water which flows at the upper point, and not at the lower, if it does not become sub flow?

Mr. Hall—We have not followed that up; we expect to find that out; all we know is that it was true.

Mr. Hoffmann—You will probably have to "go below" to find it out, Mr. Hall?

Question by Congressman Stevens, of Texas—I started to ask Mr. Hall this question: I believe you reported that fifty thousand acres shall be irrigated below the city of El Paso. You do not state whether they shall be equally divided between the State of Texas and Territory of New Mexico, or make any recommendation.

Mr. Hall—I thought it was best for us as engineers to leave that to you, gentlemen.

Mr. Stevens—As a rule of law, as well as common sense, the party getting up a document—a legislative body or court—should construe it and not leave it to other parties who do not know what their intention is.

Mr. Hall—I made a calculation in the paper which I did not have time to read. The opinion that I had upon the question was that it would be better for the State Department and the Congress of the United States to settle that question. We have troubles enough of our own.

Mr. Stevens—I desire to ask another question: I find a statement, Mr. Hall, in your report, to the effect that the Water Boundary Commission pro-

vided, in a bill I presume, or in a report, that no reservoir should be built at any point in New Mexico.

Mr. Hall—That was given the preference in their recommendation. They did, however, give an alternative, which I did not mention. It was their expressed desire that no dam be allowed to be made on the river above, but if that could not be prevented, then they give an alternative.

Question—The language in the report that I desire to draw your attention to is this: In the first part, speaking of the Water Boundary Commission, you say that they distinctly ask that the Government prevent the construction of any other large reservoir on the Rio Grande in the Territory of New Mexico. Now the bill, which was formulated by that committee, and that satisfied both the United States and Mexico, and was recommended by this Commission, which you seem to in some measure criticise, is this: it is a bill to provide for the equitable distribution of the water of the Rio Grande between the United States of America and the Republic of Mexico. The second object is for the purpose of building an international dam and reservoir on the said river at El Paso, Texas. Now, the misconception, as I understand it, is this: You stated it was the object and purpose of this Commission to prevent the building of any other dams above here in New Mexico? The bill states this distinctly, the first section of the bill. "Be it enacted by the Senate and Congress of the United States of America that nothing of the Acts of March 3d, 1891, shall be so construed as to authorize an appropriation and storage of the waters of the Rio Grande in the Territory of New Mexico, to which others have right by prior appropriation." Now that has been left out in the calculations in the newspaper statements and in the criticisms of myself and other men who have advocated the building of this international dam from the beginning, and my object in arising here is to defend ourselves against the statements published in New Mexico and advocated in Congress. We have never asked or sought to prevent the building of dams in New Mexico, and all we ask now is, that the water that has heretofore been appropriated by this valley and Mexico shall be continued to be appropriated by us.

Mr. Hall—I will state that I made no criticism upon Congress nor any bill that has been introduced in Congress. I simply wished to show by that statement the recommendation of that Commission, and I quoted the language of that recommendation as to their preference. They stated that the Government should be asked to prohibit the building of any dam in New Mexico if possible, but if they could not do it, to do something else.

Delegate from California—It seems to me that Mr. Hall has answered in his paper the question raised by Mr. Stevens to a great extent by saying that the building of one large reservoir would be much better than the building of small ones, several, one above the other, owing to the silt question.

Hon. B. S. Rodey, Congressman from New Mexico—On behalf of New Mexico I desire to state now, that notwithstanding this report and this agreement, that the remaining portion of New Mexico does not waive any of its rights in reference to building dams, nor any of its claims to have dams built up at a later date. Myself and Brother Stevens have for the past six years fought this out in Congress and I hope it is to be settled here to-day.

Mr. Stevens—I am glad to know that Mr. Rodey has the common sense to recognize the fact that we do not want all the water of the river in the international dam, but that we are willing to divide with New Mexico, but that we do want the water that we have had the right to appropriate heretofore. (Applause).

Mr. Rodey—We have been scared to death for about ten years by Brother Stevens. I believe the whole matter can be settled now, but we never have given up our rights to the waters that fall in our dishpan. We are good citizens and are liberal, but we don't give up the waters we need.

## Thursday Afternoon, November 17, 1904.

The meeting was called to order at 1:30 p. m., Chairman Newell presiding.

Mr. Newell—Our program calls for a paper by Mr. Thomas H. Means, Engineer of the Reclamation Service, on "The Necessity of Draining Irrigated Lands."

Mr. Means—I have not attempted to prepare a paper on this subject, but have gotten together a few ideas on the necessity of draining from the standpoint of the growing plant in the hopes that some discussion would be provoked and bring out a great many more thoughts, perhaps, than I could by a more lengthy paper.

Most of the agricultural plants which we use now are the result of thousands of years of selection and development. They are almost without exception plants that are adapted to growing in moist soils, but not wet soils or in standing water. A few of our plants, as rice, are adapted to growing in water, but we can say that generally our agricultural plants cannot grow in standing water. The roots of these plants require two things for their proper development. The first and foremost is water; the second is air, and if we exclude either of these from the roots they will not develop as they should. Most of us do not consider that air is essential to the growth of the roots of plants, but you might almost as well cover a plant to its top with water as to cover the roots entirely with water and exclude the air from them. We have aside from the roots, a number of friendly bacteria in the soil and all of them require moisture and air for their proper development. One of the most useful families of plants, the legumes, have a faculty of obtaining from the atmosphere through the activity of bacteria, the nitrogen necessary for their development, and leave nitrogen in the soil. This nitrogen is obtained through the myriads of nitrogen bacteria in the soil, and these bacteria can not exist there in the absence of moisture and air and perform their proper functions. Where air is excluded and moisture is in excess a different set of bacteria or denitrifying organisms seem to flourish and undo the good accomplished and turn loose their nitrogen. So for the benefit of the plants themselves as well as the bacteria we must have both air and water. However, every drop of excess moisture in undrained soil is damaging to the plants growing in the soil. Undrained soil not only prevents the proper growth of the roots, but is usually cold from the fact that there is a greater evaporation on the surface. The cold soil naturally prevents the development of the roots and the development of plants from the roots.

We also have certain chemical changes which take place in undrained soil. In the arid country the development of alkali takes place. This sometimes occurs in the soil as a result of decomposition, but I have known a great many instances where it has developed from the fact that the soil was not drained. You will notice in districts where black alkali occurs around the edge of the plants there will be a black ring of sodium carbonate, resulting from the undrained condition of the soil. In the eastern regions sour soils develop in undrained fields. The same thing is also seen in the West, though western

soils usually contain a large excess of carbonate of lime, which has a tendency to prevent the formation of acid.

### IMPORTANCE OF DRAINAGE.

The most important feature in connection with undrained soils in the West is the development of alkali. We have in all of the soils and rocks a certain amount of soluble matter, either present as such or forming by the processes of rock decomposition. This accumulates at the point where the water evaporates and leaves all the alkali there at the surface where it can do the most harm. The development of alkali is a most serious problem confronting the irrigation farmer because it prevents crop growth. Drainage, applied either artificially or existing naturally, prevents these conditions from occurring or if they exist, greatly aids in reclamation by removal of the alkali. We know it is possible by drainage to reclaim alkali lands and to improve the soil and allow the friendly bacteria to develop and grow, and that it is possible by this means to obtain the nitrogen from the atmosphere which is useful to the crops that produce it and the following crops.

Drainage also prevents the formation of black alkali. There have been seen some marked cases of this, where the simple drainage of the land has prevented, or, as one might say, neutralized the black alkali, and the last but not least effect is that drainage warms the soil. These are some of the points we want to consider from an agricultural standpoint. They appeal to the engineer because he is trying to irrigate lands for the use of the agriculturalist. A great many points I might bring up, but I think they can better be brought up by some discussion.

Mr. Newell—The remarks of Mr. Means are now before you on the necessity of draining irrigated lands. That matter which Mr. Means has discussed briefly and so well is one of the most important in the work of the irrigation engineer, that is, to provide drainage or consider the necessity for drainage at the same time he considers the necessity for irrigation. We have all seen the ruin and blasted hopes due to the lack of provision for drainage and the destruction by alkali closing up the pores of the soil. There are a number present who probably know something about that, and I would like to hear from Professor Forbes, who has done such good work in Arizona.

### THE DATE PALM A WATER FEEDER.

Prof. Forbes, of Arizona—I might cite an exception to Mr. Means' rule that all soils must be drained, of which he has given one exception—the case of rice. I will give another. I have just returned from a trip into Lower California, where I went largely for the purpose of hunting up a plantation of date palms I had heard of down there. Among other conditions I have found in that oasis, I found great numbers of date palms, thousands of them ranging up to 200 years in age, growing in a water-logged soil and bearing fruit. My companion and I dug some 18 wells from one end of the water-logged strip to the other, ranging in depth from two to ten feet, and found that water came all the way from one foot to within two inches of the surface of the soil, and in that sub-aqueous strata we found the ground matted with date

palm roots. That is interesting as it shows that water-logged soils have their uses and their utilities. It is possible that in regions like the Colorado River where there will probably be undrained lagoons for many years their utilization may be brought about.

Mr. Newell—That is an exceedingly interesting matter, as in some parts of the country it will be practically impossible to drain lands because of the fact that they are beneath the general level of the water. The whole subject of drainage is one that is impressing itself upon us more and more. The Reclamation Act provides for the control of water to reclaim the land, but we have rather read into the law that it includes drainage, which is involved in the reclamation of a great deal of the better land we have to deal with.

Mr. Barbour, of California—For two years I was employed to construct canals and lay off lands for irrigation. The lands were laid off first from the main canal by running contour checks, starting from the main canal and running contours, dropping down from each check from 3/31 to 4/10 from one to the other. After the checking had been done, we put in a system of irrigating ditches from the main canal, and between the irrigating ditches we had drainage ditches, which we carried down to sloughs or else made other ditches to carry off the surplus water and take it back into the main canal again lower down, and in that way we drained off a great deal of land where there were spots of both black and white alkali. There were spots there which at first would not grow vegetation but in two or three years it produced in abundance grain and alfalfa.

#### AN INTERESTING EXPERIMENT.

In talking with Mr. Miller one day he gave an instance of an experiment he had made. On the San Joaquin River he had about ten thousand acres of alkali land that would produce nothing. He had heard of the government's experiments in draining the alkali out. He built a large canal through the center of the tract and on either side of the canal was a slough. He built irrigation ditches from that canal in both directions. He carried these ditches out a certain distance so that they would not come quite to the slough and then built drainage ditches between the irrigating ditches to carry the water off to the slough. He irrigated the land and as soon as it was dry enough plowed it up, let it lay about two months, irrigated again and plowed it up again. He then let it lay until the next spring, when he irrigated again and plowed it up again. He let it lay again for about two months and repeated the process. The third season he put in wheat on the alkali land and got the largest crop that he ever raised anywhere. The fourth year he put it into barley and the fifth year into alfalfa, and said that it was the best alfalfa that he had on any of his ranches. Now this was land that would not grow any kind of vegetation. It was perfectly waste. Not only that, but he reclaimed about 3000 acres of that lake bed by running this alkali into the sand of the lake bed. As a matter of fact he reclaimed about thirteen thousand acres of land by that experiment. He said he got his first idea of reclaiming this land from reading of Government experiments.



Mr. Newell—We have a paper, as the next number on the program, by Mr. Fellows, on "Estimate on Tunnel Work."

Mr. Fellows—I wish to state that what I have to say with regard to estimates on tunnel work will be limited to irrigation work only, as that class of tunnel work would necessarily be considered by itself to a certain extent. At the same time, the rules applicable to one form of tunnel must necessarily apply to the others also. What I have written must be considered as general as well as relating more particularly to the irrigation work.

## ESTIMATES ON TUNNELING IN IRRIGATION PROJECTS.

A. L. FELLOWS, District Engineer U. S. Reclamation Service.

I first became intimately concerned with tunnel construction about eighteen years ago, in connection with an irrigation project in Southwestern Colorado. In this project, the lands to be reclaimed were separated from the river which was expected to furnish water for their irrigation, by a divide rising to an elevation of several hundred feet above the river bed. The tunnel forming part of the irrigation system as constructed, was 5400 feet in length, with a cross section of 7x9 feet. My connection with this project was that of Assistant Engineer, and there I learned principally what *not* to do.

As is common with corporate enterprises, the amount of money available was decidedly limited, and it was generally considered that money that could be saved in surveying was economy for the project. As a matter of fact, in this particular case I have estimated that three-fourths of the actual cost of the project would have been saved by careful and thorough engineering.

The tunnel was constructed of considerably greater length than was necessary and was left unlined, in spite of the protest of the Assistant Engineer, on the theory that it was more economical to give it a heavy grade and to leave the tunnel unprotected, than to construct lining that might serve as protection.

### RESULT OF FALSE ECONOMY.

This tunnel may today serve as a typical, horrible example. The roof has caved in until there are, in places, rooms of from 16 to 30 feet in height. The finer material has been washed out to some extent, but the bulk of the material broken down from the roof is left as a menace to the maintenance of the tunnel and an impediment to the flow of the water. It would cost more to-day to put this tunnel in good repair than to construct a new one. I cite these conditions simply as instances of things to be avoided in tunneling, or, in fact, any other kind of engineering work.

My attention was first drawn to the Uncompahgre Valley Project, of which the Gunnison Tunnel is an integral party, by its similarity to the project which I have just instanced, and in its examination every effort was made to avoid the mistake that had been made in the first project.

The importance of thorough surveying, with reference to any class of engineering, cannot be over-estimated, and this importance is particularly well illustrated in the survey of the Gunnison Tunnel Project which I am now discussing. As a matter of fact, mistakes did creep into the early part of the work, and had the project been constructed as at first contemplated and as the earlier surveys seemed to indicate was the proper method, it would have been done at an increased cost of several hundred thousand dollars. In my opinion it is safe to say that surveys amounting, at the outside, to not over \$8,000 in cost effected a saving of not less than \$200,000 in construction. This refers to the construction of the tunnel alone, and not in any way to the increased efficiency of the project as a whole, with reference to which it is estimated that the cost has also been lessened by at least another \$100,000, and perhaps by twice that sum, through the change.

## FACTORS CONSIDERED.

The best location for a tunnel having been decided upon in a general way, the details must be worked out with the greatest of care. The amount of water to be carried, the amount of fall available, the best alignment for the tunnel, from both topographic and geological standpoints, the cross section, co-efficients of friction and velocity of flow, are all to be determined as exactly as possible.

The alignment may depend upon a variety of both topographic and geologic conditions. The shortest line may be the best, but it may also be affected by the character of the formation to such an extent that a longer line through better formation may be preferable. It is true that one cannot tell what conditions he may meet with in a long tunnel, but, with reasonable care, the probabilities may be ascertained and many uncertainties done away with, at least within reasonable limits.

At first thought, it would seem that the natural location for a tunnel was always where the line was the shortest, but the very causes which have made such a location the shortest line may also be of such a character as to prevent easy construction and possibly provide contingencies which will very materially increase the cost of construction. A saddle between hills often owes its existence to the fact that the erosion which has taken place has been caused by the softness of the rocks at that particular point, or possibly to the fact that there is a fissure at this location which has rendered erosion easy, but tunneling difficult.

The grade to be given the tunnel, as is the case in the grading of canals, syphons, etc., will depend upon the conditions. If there is sufficient flow available, the tunnel should be given enough grade to carry the amount of water desired at the maximum velocity that will not erode the tunnel lining, this being, of course, for the purpose of decreasing the cross section to as great an extent as possible.

The co-efficients of friction depend upon the surface of the tunnel, and will range from 0.010 to 0.012 for smooth concrete, up to 0.030 to 0.035 for the ordinary rough rock walls in machine-bored tunnels.

The velocity is dependent upon the grade which can be given. In my plans, I have assumed that the lining can withstand a velocity of approximately 12½ feet per second, without injury. This high velocity would not be possible if it were expected that the water to be conveyed through the tunnel would carry a great amount of silt, but, in the project which I am now considering, the amount of silt carried is usually inconsiderable.

Assuming that the location of the tunnel has been made with the necessary care, we are ready to make an estimate of the cost of construction. In the course of my investigations with regard to this subject, I have compiled considerable data concerning the cost of construction of tunnels in different localities, much of which, however, I regret to state I am unable to incorporate in this paper, as it was given to me confidentially and is, therefore, not to be disclosed. It is sufficient to say, in this connection, that the cost per cubic yard of material to be removed may vary from a very small sum, amounting

to perhaps not more than \$2, up to almost any figure. My suggestions with regard to estimates can be, therefore, only general, the details necessarily being worked out separately for each individual project.

### MAKING ESTIMATES.

The kind of estimate to be made will depend very largely upon the stage of investigations. For example, in the earlier stages, when general knowledge only as to cost of construction is desired, it is quite common to accept figures concerning cost shown by actual construction under as nearly similar conditions as possible in the region in which the project is located. This estimate may be based either upon the cubic yard or linear foot. I have found no very clearly defined idea as to the proper cost per cubic yard in making estimates. Some authorities state that \$5 per cubic yard in long tunnels is the time-honored basis for estimate; others state that \$6 is more nearly correct; and still other figures are given by other authorities.

Probably the more usual practice is to determine as nearly as possible the cost of similar structures in the vicinity; for example, in the preliminary investigation with reference to the Gunnison Tunnel, I found that tunnels of about the same size and in conditions apparently more unfavorable than those surrounding the construction of the Gunnison Tunnel, had cost, for excavation alone, from \$20 to \$30 per linear foot. In the two tunnels most nearly like the proposed Gunnison Tunnel, of which I have knowledge, the proprietors, who had done the construction work themselves, without the intervention of contractors, informed me that while the excavation had cost them somewhat more than \$20 per linear foot, they were certain that under as favorable conditions as they knew to exist with reference to the proposed Gunnison Tunnel, \$20 per linear foot would be ample. Later investigations have demonstrated to my satisfaction that these estimates were not too high, but in general, those made in this way can be considered as approximate only.

As investigations proceed more nearly to completion and final estimates, before letting contracts, are desired, it becomes necessary to consider the probable cost much more in detail, and then the only proper way of making an estimate, in my opinion, is on the basis of a contractor's bid. Plans must be drawn, showing the different varieties of cross section to be used, with the amount of lining necessary for different degrees of hardness of the geologic formation, and the probabilities with reference to the finding of water in great or small amounts, must be determined. In the specifications for the Gunnison Tunnel, an effort was made to do away with all uncertainties, so far as the water to be encountered was concerned, by incorporating proposals with reference to the amount of water to be pumped, thus putting the burden directly upon the government, and not upon the contractor and thence indirectly to the government.

### DETAILS TO BE WORKED OUT.

The first details to be worked out with care are those relating to the furnishing of power for construction. A water power, if available, may often be preferred to power derived from the use of coal or oil, unless these are extremely low in cost. This subject has been most ably treated by Mr. H. A.

Storrs in his valuable paper, and need not be gone into at this time. I desire to say, however, that in general I am sure that the Government would save money by constructing the power plant itself, instead of leaving this for the contractor to do. It would lose nothing thereby, as the cost of establishing a power plant is well known among contractors, and they would almost invariably allow for the cost of such a plant, with probably some additional allowance, if they were satisfied that sufficient power would be furnished.

In the matter of the establishment of a water power plant, a number of instances which have come under my observation have led me to believe that the saving to the contracting party may be several times the cost of the power plant; in other words, the contracting party is practically losing nothing and may have considerable to gain by itself establishing the power plant. In making the estimate, the cost of depreciation upon the plant must, as has been shown by Mr. Storrs, depend upon whether the plant will be entirely used in the construction of this individual project, or whether there will be considerable salvage. In most cases there should be a salvage of from one-half to one-third of the original cost of a new plant. This has an important bearing upon the estimates, as the cost of the plant is a very considerable proportion of the entire cost of construction. Estimates with reference to the cost of a power plant may generally be determined with reasonable accuracy through the aid of the engineering supply companies, which are always glad to furnish preliminary estimates.

#### THE LABOR PROBLEM.

The next item to be considered in detail, is that of labor, and here, too, conditions will vary widely in different localities. It is usual for contractors, in making their estimates, to determine the cost of operation per day as the first step, the amounts paid for labor being different in different localities. In estimates for a 12x12 tunnel which I have in my possession, I find the following items in computing the cost of excavations at one heading for one day, the number of employees varying with the number of shifts:

Compressor engineers.....	2 to 3.
Compressor firemen.....	2 to 3.
General foreman.....	1.
Shift foremen.....	2 to 3.
Time-keeper .....	1 or 2.
Machinist .....	1 or 2.
Blacksmiths .....	2 to 3.
Drillers .....	8 to 12.
Helpers .....	8 to 12.
Muckers .....	14 to 21.
Trackmen .....	2 to 3.
Dump men.....	2 to 3.
Light men.....	2 to 3.
Nippers .....	2 to 3.
Stable men.....	2 to 3.
Pump men.....	2 to 3.

4-horse teams.....	1 or 2.
2-horse teams.....	1 or 2.
Locomotive engineers.....	4 to 6.
Brakemen .....	4 to 6.

To these are to be added the cost, varying in the different localities, as before stated, for fuel, water, power, oil, repairs, carbons, depreciation of plant, insurance on men, pumping water, bond and incidentals not otherwise accounted for, the last item amounting usually to about 10 per cent. of the total cost.

The estimates made by the contractors will probably not vary very widely, generally, as to cost per day. The crucial question is as to the amount of work that can be done in one day. For example, in two bids in my possession, the contractor who made the higher estimate of cost per day, has assumed that he could do not to exceed 12 feet of work at each heading per day; while the other makes his estimate on the assumption that he can complete, on an average, 18 feet per day in each heading, this decreasing the cost per linear foot in the second case very considerably.

#### LINING.

The lining will naturally depend upon many different conditions. In some localities where material for making brick is at hand, it may be thought best to line the tunnel with brick. In others, where construction is intended to be temporary only, the lining may be of timber, with a board surface to facilitate the flow of the water. In the project under consideration, it was decided that concrete should be used, and in making the estimates with this end in view, the following items were taken into account, the cost of a cubic yard of material in place being computed: Labor, crushing stone or transportation of gravel, or both, as the case may be, sand, forms, placing forms, cleaning bottom of tunnel, drayage, cement sheds and depreciation on equipment. To the sum of these items should be added also the cost of cement, although where, as in this case, the cement is furnished by the United States Government, its cost will not be included in the contractor's estimate.

#### TIMBER.

The amount of lumber used per linear foot may be easily computed and is to be added where timbering is necessary.

The summing up of the various items enumerated above, reduced, according to the best judgment of the engineer, into cost per linear foot for different classes of work, will give his estimate of the actual cost of construction. Where it is expected that bids will be asked, however, a profit to the contractor must be added. Few contractors will estimate on less than 20 per cent. profit, and ordinarily 25 per cent. will be accepted as a reasonable basis.

It is not expected that in a general discussion upon such a subject as this, it would be possible to cover all conditions that may arise. Only general rules can be laid down and all details must be worked out separately for each individual project. Where the plan outlined above is followed, however, it will, in general, give a close approximate idea of what should reasonably be

expected as bids by contractors. The engineer must use his best judgment in making these estimates and endeavor to cover all details. Difficulties of an accidental nature that may arise should not be included, excepting in the insurance and contingencies as above provided for. The contractor may perhaps make an additional allowance for unforeseen emergencies, but the fact is generally recognized that although a contractor may possibly make his estimates on the worst possible conditions, the contracting party may do the work himself and thus avoid the extreme conditions on which the contractor's basis is estimated.

In conclusion, I desire to deprecate a too common tendency to over-estimate. It appears to me to be as much of an error to over-estimate as it is to under-estimate cost, and while reasonable allowance for contingencies should be made, it is not, in my opinion, good engineering to make an additional allowance after the allowance for contingencies has once been made. I have known of instances where estimates had to pass through several different hands and each individual felt it incumbent upon him, even after expressing himself as satisfied with the details, to add some lump sum for unexpected emergencies "so as to be on the safe side." I appreciate the fact that engineers are often criticised for under-estimating, and I deprecate this fault as fully as any one can, but the point which I desire to make is that after the engineer has stated what, in his opinion, is the proper estimate, that amount should be adhered to and neither added to nor subtracted from, unless some good reason for the change is shown.





# Forestry Section.

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CHAIRMAN: GIFFORD PINCHOT,

Chief Forester Bureau of Forestry U. S. Department of Agriculture.

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The first paper presented was by Prof. George L. Clothier.

## **FOREST PLANTING AND FARM MANAGEMENT IN THE MIDDLE WEST.**

GEORGE L. CLOTHIER, Assistant Forest Inspector U. S. Bureau of Forestry.

Since the first settlement of the treeless prairies of the Middle West, forest planting has been practiced by the farmers of the region with more or less success. In no other part of our country has tree planting been so universal, because climatic conditions have forced farmers to plant for protection. Not only has the tree planting idea taken hold of farmers, but every city in the region that takes any pride in its appearance has planted shade trees in such abundance that towns located on a bald prairie thirty years ago now seem to be buried in a forest.

Although forest planting has been popular in the prairies, it is very seldom that one finds a farm forest plantation that was wisely conceived or that was planned with reference to the benefits which the remainder of the farm might receive from its presence. Throughout this region, the best development of the country requires that the soil moisture be conserved during the long summer drought which is a recognized feature of the climate. It is a well known law of physics that air in motion has a very much greater power of evaporation than still air. Anything that will retard the movement of the air currents near the surface of the ground will reduce the rate of evaporation from the soil in proportion to the retarding effect. For this reason windbreaks have a powerful influence in reducing evaporation and consequently in the conservation of the soil moisture. Forest trees make the most efficient windbreaks, because of their height and flexible yielding character which causes them to act as a cushion to lift the air currents and keep them at a considerable distance above the ground.

Professor F. H. King, found by experiment that a windbreak reduced the evaporation for a distance in front of it equivalent to more than 16 times its height. Twenty feet from the hedge on the protected side, the evaporation was only 60 per cent as great as three hundred feet away where the influence of the windbreak was not felt.

### LOCATION OF THE FOREST PLANTATION.

No prairie farm is complete without its forest plantation, but since a forest is the most permanent thing that can be planted on a farm its location should be chosen with great care. The forest should be so placed as not to interfere with the convenient division of the farm into fields. Where the windbreak effect is the most important advantage sought, it will generally be found advisable so to distribute the forest plantations in belts on the borders of the fields as to afford protection to the whole farm. A good plan is to plant strips five rods wide on the windward side of the farm, as for instance, on the South and West, and single lines of trees every 30 rods apart, crossing the farm as nearly as possible at right angles to the path of the destructive winds. The single lines of trees will serve as boundaries to the permanent fields and may be used as living fence posts upon which to fasten wire fencing.

Good farm management requires that the farming be conducted in accordance with a system of crop rotation. A scientific crop rotation is dependent upon the number and size of the fields in the farm to which it applies. The permanent subdivision of the farm into fields, where windbreaks are essential, is determined by the forest planting, hence the inauguration of any scientific system of crop rotation on a prairie farm should be preceded by a planting plan definitely locating the forest plantations.

### UTILITY OF FOREST.

Forests are useful to man in two distinct ways, namely, the direct and the indirect. The direct usefulness of a forest is dependent upon the production of useful articles, such as lumber, poles, ties, fuel, tan-bark, nuts, turpentine, resin, etc. The direct effect of forest growth is the one usually seen and appreciated first by man. The indirect value of forests depends upon their power to modify climate, conserve the soil moisture, protect from disagreeable and destructive winds, prevent soil erosion, and to beautify the land, making it more desirable as a home for the human race. The people who settled in the great prairies of the Middle West were the first citizens of our country to discover that forest trees may have an indirect value that far outweighs their direct value. It took the conditions of treeless Nebraska to bring about the observance of Arbor Day. The drouths in Southern California are rapidly teaching the people of that region the value of forest as sources of water supply for irrigation.

### PLANTING STILL NEEDED.

Even in the States of Kansas and Nebraska where forest planting has been extremely popular, the planted area in comparison with the total area of the country is but an insignificant fraction, being but a little over one-third of one per cent, or one acre in two hundred and seventy-five.

The origin of all hot winds in the prairie States is local, and they can be controlled by local devices if all the people of a region will co-operate for this purpose. The remedy is tree planting in sufficient quantity that the green leaves will keep the air cool. No one ever experienced a hot wind blowing from the green foliage of a forest.

The destructive drouth of 1901 shows the need of more trees in the Middle West. In 1901 the hot winds began to blow early in June in the prairies of Texas, having originated on the stubble fields of the early harvested grain crops. As they increased in intensity they killed the corn and dried up the prairie grasses, thus forming conditions for increasing the radiation and consequently increasing the heat of the air. The belt of country devastated gradually extended northeastward, the hot winds following in the wake of the wheat harvest, until the first of August, when the wind was so hot in the James River valley in central South Dakota that the green corn was dried up in 48 hours so that it would burn like dead prairie grass. Of course the precipitation during this period was light, but after the conditions of dead vegetation were once established it would have taken a soaking rain every two or three days to have prevented hot winds. While the corn was drying up, the leaves of the few trees which the region contains were still green. As one neared the forests of the Ozark Mountains and the fringes of timber along the streams in eastern Kansas, eastern Nebraska, Iowa and Missouri, the destruction to crops was much less than in the prairies farther west although the drouth in parts of Missouri that season was even more intense than in the plains of Texas and Kansas.

#### FAST DIRECT VALUE OF PLANTED FORESTS.

Not only is forest planting at the basis of farm management in the prairie States because of the indirect effects of forest trees, but the importance of forest products to this treeless region is so great that planting for the growth of timber is highly practicable. The fence problem has been only temporarily solved by the use of the make-shift barbed wire fence. In Kansas there is no doubt but that barbed wire fences have killed and injured enough stock during the past 25 years to pay for replacing of the barbed wire with smooth woven wire. The difficulty with a woven wire fence, however, is that to be a permanent effective fence it must be supported by two or three times as many posts as is necessary with barbed wire. The scarcity of timber in the region has prevented farmers from replacing their old barbarous barbed wire by more modern woven wire. Catalpa fence posts may be profitably grown by planting on good land in many parts of the Middle West.

The production of a cheap grade of lumber from planted trees is also practicable. The cottonwood on sandy river bottom land will grow large enough for a saw log in 20 years. Cases are on record where planted cottonwood trees have been lumbered when 15 years old. While the cottonwood does not make good finishing lumber, it does make excellent dimension stuff and is well adapted for the structural timbers of barns, elevators, grist mills, etc. The Carolina poplar, a horticultural variety of the common cottonwood, promises to be a much more valuable timber tree than the wild form. The rapid depletion of our native forests will soon make general planting for timber supplies necessary.

#### FOREST PLANTING MEANS BETTER FARMING.

Forest planting on the farms in the prairie States will determine in a large measure whether the farm is to be managed intensively or extensively.

Intensive management is only possible where the production of a wide range of crops is possible. This diversification of agriculture is accomplished most successfully where forest protection modifies climatic extremes. Intensive farm management requires that the land be divided into fields of comparatively small dimensions. There is no better border for a field in the prairie States than three or four rows of planted trees. As the farm management becomes more and more intensive the land will be subdivided into smaller and smaller fields from time to time. Increase of forest belts should go hand in hand with this process.

### FOREST PLANTING AND THE FARMSTEAD.

The portion of a farm containing the buildings, orchards, barn-yard and garden is called a farmstead. Forest planting is of great benefit to a farmstead, particularly in a treeless country. Throughout the Middle Western States, successful fruit culture demands that windbreaks be planted on the south and west sides of the orchard. The comfort of the rural home demands also that a windbreak be planted on the north side of the farmstead to protect it from winter storms. It is thus evident that the farmstead should be protected by forest belts on three sides, namely, the north, the west and the south.

### WHAT TO PLANT.

In the discussion of the subject of forest planting, one of the first topics that interests the prospective planter is what to plant. The unreserved recommendation of any one species is liable to cause harm, because local conditions of soil, moisture supply and climate may make the planting of a species very valuable for one locality, a very hazardous undertaking in another locality. Whenever we meet a man who professes to have a tree that is good in all situations, we may put it down at once that that man is a fraud. In the region to which this discussion applies we hear a great deal said in favor of the hardy catalpa. This species is an excellent tree to plant in river valleys at moderate altitudes where an abundant moisture supply is within reach of its roots. It is absolutely worthless except with irrigation throughout the semi-arid plains. It will not endure the winters of Minnesota and the two Dakotas. Its optimum region for planting may be said to embrace the river valleys of the eastern half of Kansas, the eastern third of Nebraska, the southern half of Iowa, the northern two-thirds of Missouri, the southern half of Illinois, and the southern third of Indiana.

Another excellent tree for planting in the Middle West that may be given good soil to thrive is the black walnut. Its optimum region extends from the Appalachian Mountains to central Kansas, and from southern Minnesota to Texas. It will grow on much poorer soil than the catalpa, and is a much longer lived and hardier tree.

The tree that has been planted most widely in this region is the common cottonwood. When planted along river banks it makes the best growth of any species and if we leave out the question of the production of fence posts, it is probably the most profitable. It is peculiarly well adapted to land which overflows.

Two other species that have been planted very extensively in the region are box elder and silver maple. These trees are both about as poor species for planting as could have been selected. They neither make fence posts nor good fuel, and as for lumber they are not worth considering. The only reason they have been planted so extensively is that they grow from seed as easily as weeds and consequently are profitable to nurserymen.

The white elm and hackberry are two species very similar in habit of growth and very hardy. They will grow throughout the Middle West although their rate of growth on very poor land will be slow. These species deserve to be planted very much more extensively in the future than they have been in the past.

The Osage orange and Russian mulberry thrive throughout the southern half of the region. They will not stand the cold of Minnesota and Dakota winters. The chief value of the Osage orange and mulberry is for hedges and windbreaks. Their timber also makes excellent fence posts.

The black locust has been planted very extensively in the southern half of the region and, if it is not attacked by borers, it is likely to prove profitable because of the great durability of its timber. The honey locust is a much hardier tree and wherever planted south of South Dakota it has proven a success.

One of the hardiest species for prairie planting from the Canada line to Texas is the green ash. It is rather slow in its growth but very persistent. In the northern half of the Middle West its timber is prized very highly by farmers for fence posts.

Farmers have paid little attention to the conifers in this region. Since the evergreens grow with very much less moisture than is required by deciduous species, it seems that the conifers ought to be especially well adapted to the semi-arid plains. In the planting that the Bureau of Forestry is undertaking on the Nebraska sand hills no other species except conifers are being tried. The western yellow pine from the Rocky Mountains and the jack pine from the Great Lake region are the chief species now being tested.

#### WILL IT PAY TO PLANT?

The first question that is likely to be raised when a farmer is urged to plant forest trees is, will it pay? A few instances where it has paid are the following:

At Howe, in southeastern Nebraska, is a grove of hardy catalpa 25 years old, 2.4 acres in extent, that has produced a total value in fence posts and poles of \$890.60, or \$371 per acre, averaging \$14.84 per acre per annum, not reckoning compound interest. During nearly half the time since the grove was established the ground has been used for grazing and the thinnings from the plantation have afforded considerable wood for domestic uses on the farm. Another catalpa grove owned by Mr. C. D. Robinson of Pawnee, Nebraska, of 12 acres in area, produced when 13 years old, fence posts to the value of \$190 per acre, or \$14.61 worth per acre per annum.

Four years ago a gentleman near Tekamah, Nebraska, cut 30 planted cottonwood trees 31 or 32 years old from a row in his fence line which yielded

20,000 board feet of lumber. He was offered \$16 per thousand for the lumber, but refused to sell it, preferring to use it in building a residence and barn. It cost him \$5.50 per thousand board feet to convert the trees into lumber, leaving a net value of \$210, or \$7 per tree for the cottonwoods.

Mr. Kilvert—On the point mentioned in regard to windbreaks, Mr. Clothier, you suggest single rows of trees down through the fields?

Mr. Clothier—Yes, sir.

Mr. Kilvert—In Mexico our fields are laid off into 25 acre lots, and 32 fields make a plantation, and 10 plantations make a ranch. They are planted with cottonwood, and the oldest cottonwoods are about 18 inches through, so on the timber side you can increase your figures, if you are talking about Mexico. The land which lies near the ditch will naturally be surest to produce better plants. Our rows run both east and west and north and south, so that for three months the sun is practically overhead, and a certain space is shadowed by the tree for about eight hours. Just as far as that eight hours shadow travels there is pretty near a bare place.

Mr. Clothier—I am aware of that, but if you grow alfalfa, you can grow almost as much as if the shade was not there, can you not?

Mr. Kilvert—I presume so. I just wanted to bring this point up and see if it was a local condition.

Mr. Clothier—It is a general condition.

Mr. Stewart—Such trees as the gentleman from Mexico spoke of grow much faster in our country. They will grow one-third more in the same length of time. They are an advantage to the alfalfa, and save us the trouble of keeping the weeds out of the ditch, and also in shoveling the mud out of the ditches. We used to cut all of the little cottonwood out, but now we are watching them and keeping them in the ditch to keep it from washing out.

Mr. Eberlein—In the country around Hay City the timber is honey locust. Would conditions be the same as in the country you speak of, and can these plans be carried out in Kansas?

Mr. Clothier—I know of one place, 75 miles north of Hay City, where 30 trees were cut that were from 30 to 32 years old and they produced 20,000 board feet of lumber, having a total net worth of \$210, or \$7 per tree. They grew in a fence line and did not take up any land, and also acted as a wind-break at the same time. The cordwood was not counted in this estimate.

## **FOREST PLANTING IN THE SAN GABRIEL FOREST RESERVE.**

T. P. LUKENS, U. S. Bureau of Forestry, Pasadena, Cal.

That portion of Southern California susceptible of a high state of cultivation, has a southwest frontage of over 200 miles on the Pacific Ocean. Running nearly parallel with the coast from northwest to southeast are the Sierra Madre Mountains, all but extending to the ocean at the northwest extremity, the space between mountain and ocean gradually widening towards the south.

This mountain range has been made into reserves for the conservation of water, in all close to 4,000,000 acres. There are about 1,000,000 acres more of mountainous area from which more or less water is derived. It has long been understood that the mountains and forest-covered areas are alone to be depended upon for irrigation water in arid and semi-arid regions. Many species of trees suited to arid conditions grow there.

### **FIRE DESTRUCTION.**

From the earliest history until very recently the destruction by fire and unwise methods of lumbering and stock-grazing have seriously impaired the conserving power of our mountains, while now only 20 per cent of our mountain area is covered with trees which are growing along streams and on the medium zone above 3000 feet elevation, while 80 per cent of the area is covered with chaparral.

There are no other mountains on our coast so precipitous as ours, consequently nowhere is it of so great importance to maintain a forest growth for the conservation of water and to prevent erosion.

With our long rainless season, often eight consecutive months, all growth on the mountains becomes very dry, and fires have wrought great damage. Forests have been supplanted with chaparral, and in time over much of the area chaparral is supplanted with a light growth of herbacious plants, with little root power. As a result, many perennial streams that formerly flowed to the sea have ceased flowing entirely except in form of floods immediately after storms.

### **WATER SUPPLY AFFECTED BY FIRES.**

Southern California has a population of 384,000 and an assessed valuation of \$324,000,000. There could hardly be any limit to our growth in population and wealth if our water supply could be increased, to accomplish which would require first for temporary relief the building of storage reservoirs. But for a permanent water supply, measures must be adopted to arrest the devastation of our watersheds by fire, and to plant over the denuded areas.

Once Persia was the most fertile land of Asia, well watered and richly wooded. Once the Sahara was the granary of Africa and of Europe. To-day they are barren sands, brought about by the irrational use of the forests. The fearful famines in India are traceable to a large extent directly to forest

destruction, and many other parts of the world, once rich in growing crops, have become desolate, barren regions from the destruction of the forests.

A few years ago the United States Geological Survey selected a watershed in the State of Washington, and one in Arizona, each covering an area of 142 square miles, their purpose being to ascertain comparative value of forested and non-forested areas in the regulating of stream flow. The area in Washington, Cedar Creek, was completely forested, and the annual precipitation was from 93 to 150 inches. The maximum run-off from Cedar Creek was 6321 cubic feet per second, while the maximum run-off from Queen Creek in Arizona, with a precipitation of but 15 inches annually, was 9000 cubic feet per second.

#### ENCOURAGING RESULTS OF EXPERIMENT.

In a careful study of the behavior of the stream-flow on several small catchment areas in the San Bernardino Mountains it has been found that the effect of the forest in decreasing surface flow on small catchment basins is enormous, as shown in the following tables, where three well-timbered areas are compared with a non-timbered one:

##### *Precipitation and run-off during December 1899.*

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percent- age of precipitation.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Per cent.</i>
0.70	Forested .....	19+	36—	3
1.05	Forested .....	19+	73+	6
1.47	Forested .....	19+	70—	6
.53	Non-forested .....	13—	312+	40

At the beginning of the rainy season, in early December, the soil on all four of these basins was very dry as a result of the long dry season. The accumulation of litter, duff, humus and soil on the forest-covered catchment areas absorbed 95 per cent of the unusually large precipitation. On the non-forested area only 60 per cent of the precipitation was absorbed, although the rainfall was much less.

##### *Rainfall and run-off during January, February and March, 1900.*

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percent- age of precipitation.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Per cent.</i>
0.70	Forested ... ..	24	452+	35
1.05	Forested .....	24	428+	33
1.47	Forested .....	24	557+	43
.53	Non-forested .....	16	828+	95

The most striking feature of this table as compared with the previous one is the uniformly large run-off as compared with the rainfall. This clearly



shows the enormous amount of water taken up by a dry soil, either forested or non-forested, as compared with one already nearly filled to saturation. During the three months here noted, on the forested basins about three-eighths of the rainfall appeared in the run-off, while on the non-forested area nineteen-twentieths appeared in the run-off.

*Rapidity of decrease in run-off after the close of the rainy season.*

Area of catchment basin.	Condition as to cover.	Precipitation.	April run-off per square mile.	May run-off per square mile.	June run-off per square mile.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Acre-feet.</i>	<i>Acre-feet.</i>
0.70	Forested .....	1.6	153—	66—	25—
1.05	Forested .....	1.6	146—	70+	30—
1.47	Forested .....	1.6	166+	74+	30+
.53	Non-forested .....	1	56+	2—	0

The above tables clearly show the importance of forests in sustaining the flow of mountain streams. The three forested catchment areas, which during December experienced a run-off of but 5 per cent of the heavy precipitation for that month, and which during January, February and March of the following year had a run-off of approximately 37 per cent of the total precipitation, experienced a well-sustained stream flow three months after the close of the rainy season. The non-forested catchment area, which during December experienced a run-off of 40 per cent of the rainfall, and which during the three following months had a run-off of 95 per cent of the precipitation, experienced a run-off in April (per square mile) of less than one-third of that from the forested catchment areas, and in June the flow from the non-forested area had ceased altogether.

#### EFFORTS TO REFOREST THE MOUNTAINS.

With all these facts clearly established, showing the incalculable benefit of trees on our mountains, a determined effort is being made to re-clothe them, and for several years experiments have been carried on to determine the most economical and practical plan to pursue. As a preliminary to planting is the preparation of the areas so as to exclude fires, or at least to reduce the danger to the minimum. That can be done by clearing the ridges of brush, so as to confine the fire to narrow limits.

The experiments carried on thus far have been under the most unfavorable climatic conditions. Southern California has just passed through a series of very dry years, during which time natural reproduction has been precluded, not only of trees in the forested areas, but of chaparral as well.

Seeds were planted in the open ground, some without preparation, but in most cases beds were prepared by digging a space a foot or more across and a foot deep, on which a number of seeds were planted. The plan promised well, but the long season—ten months—without rain, left but few trees. Our experiments with transplanting trees promised to be the better plan. We are growing in nursery and at two years old will plant on the mountains with confidence of success.

## KINDS OF TREES TO PLANT.

To determine on the species of trees to plant has necessitated a careful study of nature's plan, with which we keep in as close touch as possible. Coniferous trees form the base, of which by far the greater number will be used, planting them in their indigenous zones, and as far as possible in soil and conditions of their choosing. Along water courses we are succeeding in growing ash and walnut trees. Seeds of indigenous conifers "and of a few species of exotics in an experimental way" are grown under lath houses, and at the end of the first year's growth transplanted in the open ground to harden, and at two or three years old are to be planted on the mountains.

Our nursery is located in the mountains at a medium altitude that the propagation may be more certain and the trees having been grown in the same character of soil they are to be finally planted in are more certain to succeed. Where the tree is to be planted a small space is loosened with a mattock, in which the tree is planted and mulched. The planting must be done during the rainy season, which is between November and April, that the trees may become anchored before dry weather sets in.

## HOW WILL IT PAY?

As I have said before, the assessed valuation of property in Southern California is \$324,000,000. If we were to say it would cost \$22,000,000 to completely restore tree growth on our mountains and properly care for them and prevent fires for fifty years, it would without consideration be declared impossible on account of expense, but when it is looked at from a business standpoint it is clearly a good investment; an annual levy of 13 cents on \$100, or a total of less than 7 per cent of present assessed valuation of property in Southern California over a period of fifty years.

The British government is carrying on tree planting on the watersheds in India to prevent erosion, filling their reservoirs with silt. There, labor is 10 cents per day, while here it is \$2.00.

The same applies to Japan, where dirt is carried in baskets in which to plant the tree, on areas where once was a luxuriant growth of trees, but now barren rocky slopes, brought about by sheep, goats and fire.

It is the natural and proper thing for the U. S. government to take the lead in this work, to make the investigations along scientific lines, establish working plans and supervise the work, which they are doing well, but where so much is needed as in Southern California, the people directly benefited, yes, whose very existence depends upon the work, must raise money to carry it on if it is to be accomplished.

For equitable climate, richness of soil, and scenic beauty Southern California is unsurpassed. The only thing that can limit the growth in wealth and population is the supply of water, without which but little can be accomplished.

**THE RELATION OF FOREST COVER TO STREAM FLOW.**

J. B. LIPPINCOTT, Supervising Engineer U. S. Geological Survey.

The relation of rainfall to run-off is very uncertain, depending upon the nature of the storms, whether gentle showers or violent rains, the steepness of the drainage basin and its covering, and whether the precipitation is snow or rain. It has been found that in the districts where the forest cover is small the output of the basin occurs in violent floods of short duration. Because these floods are violent, and of large volume, and owing to the fact that the soil of the drainage basins is not held together by a network of roots extensive erosions occur in these barren basins and the stream carries much silt in suspension. Where the basin is covered by forest, the mat of twigs and leaves which covers the ground is an absorbent sponge, retaining in itself large quantities of water and preventing evaporation from the underlying soil. This permits of a holding back of the floods and the gradual draining off of the water, thus largely accomplishing the purpose of regulating reservoirs.

A striking example of the output of a barren, treeless drainage basin is shown in the following table of discharge for the year 1896 for Queen Creek, taken from the Eighteenth Annual Report of the Geological Survey, Part IV—Hydrography. It represents a typical year's output:

*Estimated monthly discharge of Queen Creek at Whitlow's, Arizona. Drainage area, 143 square miles.*

Month, 1896.	Discharge in Second-feet.		
	Max.	Min.	Mean.
January .....	2	2.0	2.0
February .....	2	2.0	2.0
March .....	2	2.0	2.0
April .....	2	1.0	1.5
May .....	1	1.0	1.0
June .....	1	1.0	1.0
July .....	9,000	0.0	121.6
August .....	1,433	0.6	13.1
September .....	3,428	0.5	17.1
October .....	1,188	0.5	13.3
November .....	80	0.6	1.3
December .....	207	0.6	2.0
	9,000	.0	15

In contrast with Queen Creek in Arizona a table is given showing the discharge of Cedar Creek, Washington, for the year 1897.

*Estimated monthly discharge of Cedar Creek near Seattle, Washington.  
Drainage area, 143 square miles.*

Month, 1897.	Discharge in Second-feet.		
	Max.	Min.	Mean.
January .....	2,812	815	1,430
February .....	2,415	823	1,303
March .....	1,366	723	901
April .....	2,752	790	1,599
May .....	2,143	939	1,562
June .....	1,410	780	1,060
July .....	2,284	572	1,135
August .....	561	342	427
September .....	418	311	350
October .....	433	294	339
November .....	3,155	323	1,318
December .....	3,601	674	1,639
Total .....	3,601	294	1,089

The amount of solid matter carried by a stream is a very serious problem in connection with the construction of storage reservoirs thereon. The most astonishing stories are told of volumes of sediment carried by the rivers of Southern Arizona from their barren drainage basins. It is said that when these floods first appear, discharge off of ranges that have been traveled by the large herds of cattle in quest of grass, the soil which has been exposed to the direct action of the sun, being exceedingly light and dry, is washed off in quantities that are enormous. In order to determine the amount of silt in the Gila River at The Buttes, which stream has a similar basin and regimen to that of Queen Creek, the Geological Survey has made observations by taking samples of the water daily, and permitting the mud to settle, measuring it wet and then determining its dry weight. The average amount of silt for the twelve months' observation was 10 per cent by volume wet, and the amount of solids 2 per cent. No other stream in the United States is known to carry such a high per cent of sediment. This is in striking contrast with the clear streams of our northern forested basins. The water supply used for domestic purposes from Cedar Creek, Washington, does not require filtering or settlement.

The serious nature of this silt problem can readily be appreciated by those who have studied the storage of water for irrigation. It is probably the gravest of all the engineering problems related thereto. Forestry should assist greatly in removing difficulties of this nature.

Mr. James W. Toumey, Collaborator Bureau of Forestry in the Agricultural Department, has selected certain small and adjoining drainage basins in the San Bernardino Mountains in a portion of the catchment area proposed to be utilized by the Arrow Head Reservoir Company. Throughout this area this corporation for a term of years has been making exhaustive hydrographic studies of the available water supply. It is proposed to divert the water flowing from a number of these small mountain basins which are situ-

ated on the northerly slope of the San Bernardino range by means of gravity canals and tunnels to the southern side of the range and into the San Bernardino Valley. This Arrow Head Reservoir Company has placed its hydrographic data at the disposal of the Bureau of Forestry, which organization made a forest study in connection therewith. The data that is presented by Mr. Toumey is perhaps the most precise and definite information on the subject of related stream flow to forest cover that we have so far been favored with in the West. His conclusions, while they were to be expected, are gratifying in their definiteness. We can do no better than to quote from Mr. Toumey in extenso:

"Because rainfall is most abundant where forests grow, many believe that forests exert an important influence on the amount of precipitation. A more reasonable inference, however, is that *rainfall is the great factor in controlling the distribution and density of forests.*

"Precipitation occurs whenever the air is suddenly cooled below the dew-point. The most effective cause of this is the expansion of air on ascending. This upward movement is caused very largely by cyclonic storms. Whether forests have any appreciable effect in cooling the air to below the dew-point is uncertain. From the known effect of forests on the temperature and relative humidity of the air, it is reasonable to infer that they may have some effect, at least to a small degree, and consequently that they have some influence in increasing precipitation. The present evidence, however, derived from many series of observations conducted in Europe and elsewhere, is so conflicting that a definite answer to this question, having the stamp of scientific accuracy, is not possible.

"In a careful study of the behavior of the stream flow on several small catchment areas in the San Bernardino Mountains it has been found that the effect of the forest in decreasing surface flow on small catchment basins is enormous, as shown in the following tables, where three well-timbered areas are compared with a non-timbered one:

*Precipitation and run-off during December, 1899.*

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percentage of precipitation.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Per cent.</i>
0.70	Forested .....	19+	36—	3
1.05	Forested .....	19+	73+	6
1.47	Forested .....	19+	70—	6
.53	Non-forested .....	13—	312+	40

"This is the stream discharge during a month of unusually heavy precipitation.

"At the beginning of the rainy season, in early December, the soil on all four of these basins was very dry as a result of the long dry season. The accumulation of litter, duff, humus and soil on the forest-covered catchment areas absorbed 95 per cent of the unusually large precipitation. On the non-

forested area only 60 per cent of the precipitation was absorbed, although the rainfall was much less.

*Rainfall and run-off during January, February and March, 1900.*

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in per cent. of precipitation.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Per cent.</i>
0.70	Forested .....	24	452+	35
1.05	Forested .....	24	428+	33
1.47	Forested .....	24	557+	43
.53	Non-forested .....	16	828+	95

"The most striking feature of this table as compared with the previous one is the uniformly large run-off as compared with the rainfall. This clearly shows the enormous amount of water taken up by a dry soil, either forested or non-forested, as compared with one already nearly filled to saturation. During the three months here noted on the forested basins about three-eighths of the rainfall appeared in the run-off.

*Rapidity of Decrease in run-off after the close of the rainy season.*

Area of catchment basin.	Condition as to cover.	Precipitation.	April run-off per square mile.	May run-off per square mile.	June run-off per square mile.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Acre-feet.</i>	<i>Acre-feet.</i>
0.70	Forested .....	1.6	153—	66—	25—
1.05	Forested .....	1.6	146—	70+	30—
1.47	Forested .....	1.6	166+	74+	30+
.53	Non-forested .....	1	56+	2—	0

"The above table clearly shows the importance of forests in sustaining the flow of mountain streams. The three forested catchment areas, which during December experienced a run-off of but 5 per cent of the heavy precipitation for that month and which during January, February and March of the following year had a run-off of approximately 37 per cent of the total precipitation, experienced a well-sustained stream flow three months after the close of the rainy season. The non-forested catchment area, which during December experienced a run-off of 40 per cent of the rainfall, and which during the three following months had a run-off of 95 per cent of the precipitation, experienced a run-off in April (per square mile) of less than one-third of that from the forested catchment areas, and in June the flow from the non-forested area had ceased altogether.

*Annual rainfall and run-off on forested and non-forested catchment areas in the San Bernardino Mountains, California.*

Area of catchment basin.	Condition as to cover.	Precipitation.	Run-off per square mile.	Run-off in percent- age of pre- cipitation.
<i>Sq. Miles.</i>		<i>Inches.</i>	<i>Acre-feet.</i>	<i>Per cent.</i>
0.70	Forested.....	46	731	28
1.05	Forested.....	46	756	30
1.47	Forested.....	46	904	36
.53	Non-forested.....	33	1,192	69

"In conclusion, it may be said that although the forest may have, on the whole, but little appreciable effect in increasing the rainfall and the annual run-off, its economic importance in regulating the flow of streams is beyond computation. The great indirect value of the forest is the effect which it has in preventing wind and water erosion, thus allowing the soil on hills and mountains to remain where it is formed, and in other ways providing an adequate absorbing medium at the sources of the water courses of the country. It is the amount of water that passes into the soil, not the amount of rainfall, that makes a region garden or desert."

It will be observed in the table last above that the total annual run-off of a treeless basin is 38 per cent greater than from an afforested one. The deduction, therefore, would appear that provided storage reservoirs were used to conserve the floods that this would permit of the greatest economy in the water supply. It must be remembered, however, that flood water so held is subject to evaporation from broad water surfaces. It would be impossible to make an exact general statement as to the extent of this loss, but it seldom is lower than 20 per cent of the total amount stored and often reaches 40 and 50 per cent, depending on numerous local conditions. Therefore, provided the floods from a treeless basin are retained in storage reservoirs and from the water so impounded is deducted probable evaporation losses, we will have a net annual result from such a condition which would more closely resemble the total annual output from the timbered basin. It must be remembered that even in forested basins floods occur, and while the tree is a regulator of the stream, it does not necessarily obviate the uses of the storage reservoir. On the other hand it may be said that the forest is the protecting friend of the storage reservoir, each supplementing the benefits of the other.

#### SACRAMENTO FLOODS.

The drainage basin of the Sacramento River includes the greater part of Northern California. It has been occupied by Anglo-Saxon settlers for the last fifty years. During the first portion of the American occupation of this State, sea-going vessels are reported to have proceeded up stream as far as the present city of Sacramento. The tidal range of the river was observed also at this point. Placer mining was the first industry. This work consisted in washing the oriferous gravels found along the western foothills of

the Sierra Nevadas. The resulting debris was discharged into the streams and has, to a very material extent, filled their channels, so that to-day the head of tidal water is many miles below Sacramento, near the upper end of Grand Island, and only flat bottom river steamboats are able to ascend the Sacramento River as far as the city of that name. This stream condition has been still further aggravated by the destruction of extensive areas of forest, both by fire, lumbering and sheep grazing. Yet the lumber industry is but in its infancy in this section, and plans are being perfected to cut down great areas of virgin forest. Extensive forest reserves have been provisionally set aside, covering most of the remaining timbered portions of the basin. These contemplated reserves have been greeted with a storm of public protest from central and northern California that has been hard to allay. In February, 1904, northern California was visited by heavy rain storms. While the precipitation was great, it was by no means the heaviest rain which has occurred in this section, and it was one that could reasonably be expected to be exceeded in violence in the future. However, with the combined conditions of reduced forest cover and filled river channels, a flood condition was produced in the Sacramento Valley last February which has no known equal in the previous history of the State. Eight hundred thousand acres of valley lands were submerged and the damages are estimated to have reached into the millions. All this is in spite of the fact that over twenty million dollars had been expended in the construction of levees to prevent these overflow conditions. A great State convention was called in San Francisco to consider the disaster that threatened the commonwealth. Eminent engineers have been brought to California from the lower Mississippi basin and elsewhere in the East to study this great overflow problem. Organizations have been perfected to urge, if not demand, both from the State and from the Nation, relief from impending disaster. It is contemplated that a comprehensive levee system must be constructed the entire length of the valley at enormous expense.

It may be stated that while there is no definite scientific information that forests increase rainfall, yet we have certain striking instances presented where the rainfall is greater on adjacent forested areas than on those that are denuded. At least in the arid regions it may be stated that the total annual output from a deforested drainage basin is greater than from a timbered area, but that the regimen of the stream is distinctly to the disadvantage of all who are interested in the use of the watered resources of the country, whether he be navigator, irrigator or water power investor. From the denuded area the floods are greater and the drouth is more intense. To remedy this condition one naturally turns to the storage reservoir for relief, yet even in this extremity one is confronted with adverse conditions. The violent flood from the bare basin rushing through the mountains carries with it eroded sediment, which it deposits in the first pool of still water that it encounters. The result is the reduction of the storage capacity of the reservoir along its course. Forests are the natural and greatest storage reservoirs and regulators of water supply. On few streams do we find reservoir capacities even approximating the total annual output of the drainage basins above them. Accepting the facts as outlined above, the great importance of preserving the forests, particularly in



the semi-arid regions of our country, is most manifest. In Southern California, Arizona, and New Mexico particularly, we are so closely bordering on a condition of desert that when the forest is once destroyed the difficulty of reproducing it renders the task well nigh hopeless. We should therefore all join with the Bureau of Forestry in its effort to save the forests and store the flood.

Question—Have you any figures in this connection bearing on the evaporation of storage reservoirs which reduces this difference?

Mr. Lippincott—This is dependent on a deep or shallow river, but it is a very ordinary occurrence for 25 or 50 per cent of the water in the storage to be slowed off, and I think as a general statement you might say you should consider a loss of 20 per cent. That is dependent on the time of year and water. Now, in Colorado the storage water is all held from February, but in Arizona it is held from the two different seasons of rain; but generally speaking you lose about 20 per cent of storage water by evaporation.

Mr. Kilvert—Your article will be a great deal of use to me in Mexico, and I wish you would put in a paragraph covering what you have just said.

Mr. Hurd—Would not the loss in storage depend on the size of the reservoir. If you had a reservoir say covering an area of 100 feet, the loss would not be so great as a smaller one?

Mr. Lippincott—No, sir; it would not.

Mr. Clothier—Is it not possible that storage water running down into the ground, and which is not taken up by the usual wells, would increase the per cent of loss?

Mr. Lippincott—We have been studying the question a good deal, and the volume of water passing through we find to be practically small in every instance. I do not believe it would figure into a very great volume.

Gen. Snyman—Don't you think the different climates and soils have a good deal to do with this water?

Mr. Lippincott—Yes, sir.

Gen. Snyman—I know it was always a great question in our country to look for black ground, which is called in this country "alkali," which is more water tight. I have known places where water has been stored where there has not been rain for eighteen months. Now I am only speaking of reservoirs catching rain waters where you have no rivers.

W. T. Swingle—Do you not think the winds, their course and temperature, effect the evaporation?

Mr. Lippincott—Yes, sir. The Weather Bureau has some valuable information on this point.

Mr. Sterling—I should like to ask if any silt measurements are being made?

Mr. Lippincott—No, sir.

## **GRAZING ON THE FOREST RESERVES AND ITS RELATION TO WATER FLOW.**

ALBERT F. POTTER, Forest Inspector, U. S. Bureau of Forestry.

In the establishment of forest reserves throughout the West, it often happens that the areas included form an important part of the summer ranges used for live stock pasture, and consequently no one is more directly interested in the policy adopted for the administration of the reserves than the stockmen. The government recognizes the fact that the forage resources of the reserves are of great economic value, and that the only method by which this product can be utilized is in pasturing live stock.

The exclusion of cattle, horses, and sheep from their customary summer range would in many cases cause disaster to the live stock interest, as it would mean not only the loss of the summer grazing, but oftentimes also loss of the use of the winter range, which on account of lack of water can only be used during the winter season and is directly dependent upon the summer range and useless without it. Also in many sections the sale of hay and farm products depends almost entirely upon live stock which are pastured in the mountains during the summer, and the loss of the summer range would seriously affect the market for local farm products. So that aside from the other interests dependent upon the forest reserves the regulation of grazing is directly important to the stock man.

### **POLICY OF THE GOVERNMENT.**

It is the policy of the government to make the reserves useful and to allow every privilege consistent with their proper care. In the first establishment of reserves, grazing was very closely restricted, and sheep entirely excluded from all reserves except those in Oregon and Washington.

After investigation, however, it was found that in many other localities the range was well adapted for sheep grazing and the people largely dependent upon this industry, and that total exclusion was unnecessary, but what was really needed in most cases was such regulation of grazing as would prevent injury to the forest and insure a proper use of the range.

In the creation of new reserves in many cases the full number of stock, both cattle and sheep, which were then ranging there, have been allowed permits during the first season, and afterwards if it was found that the range was overstocked, the number has been gradually reduced until a limit was reached which would allow as full utilization of the forage as possible without serious injury to other interests.

The government has tried to be fair in the allotment of grazing permits and grant them to those who appear best entitled to them, favoring the actual resident and home-builder, but also giving consideration to non-resident ranch-owners and others who have been customarily using the range.

### **DOES GRAZING AFFECT RUN-OFF?**

The relation of grazing to water flow pertains most directly to surface run-off, and is a question upon which many different opinions exist. That

grazing does have an effect upon the stream flow appears to be a well-established fact, because wherever the undergrowth, forage plants and grasses have been destroyed by excessive grazing, the result has been a change in the flow of the streams to a more rapid and torrential run-off, while on watersheds where grazing has been judiciously managed, and the natural forest and forage conditions preserved, the stream flow has continued regular and normal.

The injury from grazing is mostly due to tramping and the destruction of vegetation which would check the flow of water, keep the ground in a more pervious condition and prevent its erosion. Where the watershed is in a natural condition, the rain and melting snow is rapidly absorbed, and by underground seepage keeps up the steady flow of springs and streams.

Investigation of the ranges has shown that damage caused by live stock is usually due either to overstocking, grazing too early in the season, or the manner in which stock has been handled.

Under the free range system of the West there was at first very little restriction as to the number of stock any one had the privilege of pasturing, and owing to the opportunity offered to engage in the business of stock raising, and to the alluring chance of money-making which it apparently offered, the ranges of many sections became overcrowded and soon commenced to decline in their pasturing capacity.

#### CAUSES OF DAMAGE BY GRAZING.

Serious controversy arose over the use of the range between cattle and sheep owners, and also between different owners of the same class of stock. No one thought of reducing the number of his stock, but each stockman exerted himself to keep the other fellow off of what he claimed as his range. In this struggle for supremacy little consideration was given to the future utility of the range itself.

This was about the condition which existed on some of the summer ranges which were included within the forest reserves. They had been overcrowded with live stock, in some sections with sheep and goats and others with cattle and horses, until the excessive use of the range had resulted in injury to the young growing forests and destruction of the forage plants and grasses to a greater or less degree, and also in tramping the earth in a way which greatly increased its erosion and reduced the capacity of the watersheds in absorbing and storing the rain and snow which fell upon them.

The damage by sheep grazing was found to be largely due to the manner in which they were handled. In places where the sheep had been camped on the same bed ground for a long time, perhaps a month or more in the same place, the grass and forage would be completely eaten out for a mile or so around and many of the young trees nibbled by the hungry stock. Damage by this system of handling is usually entirely unnecessary, and is detrimental to the best use of the forage as well as injurious to the forest. The forest reserve regulations require that sheep must not be bedded in the same place for more than six nights in succession.

One of the greatest evils in the destruction of forage is that of putting stock on the range too early in the season while the feed is yet immature.

Lack of range control is usually responsible for this condition. If the number of stock to be driven to the mountains for summer pasture is in excess of the number there is sufficient pasture for, there is often some particular section of the range which one stockman desires to secure ahead of his competitors, and in the struggle to get there first the stock are driven along as fast as possible, and destroy as much feed by tramping as they consume in feeding. In some sections this competition for range continues during the entire season, and of course results in great destruction of forage as well as damage to the forest and water supply.

#### IMPROVEMENT UNDER GOVERNMENT CONTROL.

Immediately upon a range coming under government control in a forest reserve, the damage from this cause is checked and a better use of the forage results. The total number of each class of stock to be allowed permits to graze upon the reserve is decided upon, the dates on which the stock will be allowed to enter and on which the grazing season will close are designated; the ranges are divided in the manner which appears most practicable, and for the best interests of all, either into individual ranges, districts to be used jointly by the owners of a certain number of cattle and sheep, or districts to be used exclusively by the owners of either class of stock. Sometimes it happens that the conditions are such that it is necessary to exclude all stock from limited areas for a period, but usually all that is necessary is a reasonable restriction on the enforcement of proper regulations.

Under this system of management each stockman who is granted a permit, knows just what portion of the range he will be allowed to use, how many stock he can pasture and when he can drive them in, and furthermore, he knows that on arriving there he will not find the range already occupied by someone else, consequently there is no need for any haste in driving and the stock are grazed along in a way that little damage is done.

#### PRACTICAL RESULTS OF REGULATION.

It has been found in some cases that ranges which apparently were greatly overstocked have shown a marked improvement in condition by the application of the grazing regulations without any reduction in the number of stock, showing clearly that the damage has been caused largely by the manner in which the stock was handled.

Cattle prefer to graze in the meadows and parks rather than in the timber, and consequently when a summer range is heavily stocked with cattle the greatest damage usually appears to be in tramping out the grass in the meadows and on the neighboring slopes. Every effort should be made to prevent the concentration of the cattle. As many watering places as possible should be provided. Where the springs and seeps are liable to be injured by traveling, they should be fenced and the water piped out into troughs. In salting stock the salt should be placed in many different localities, and a short distance away from the water.

## GRAZING REGULATIONS NOT UNPOPULAR.

Since the regulations regarding grazing have been modified and a more liberal policy towards the livestock interest adopted, much of the opposition to forest reserves has been removed. In many of the reserves grazing has been under control for a sufficient length of time to practically demonstrate the advantages of this system of range management, both in the improvement of the forage and the regulation of the flow of streams, and stockmen who had first opposed the reserves, realizing the benefits to be derived from control of the ranges, are among the most earnest supporters of the reserves.

The stockman has learned from experience that forest reserve protection of the summer range means an improvement in the condition of his stock and an increase in the profits of his business. During the past season when stock in many range sections suffered severely on account of lack of feed and water, those who were fortunate enough to have pasturing privileges in the forest reserves were able to get their stock fat while many of the outside stock remained thin in flesh, the result being that the stock pastured on the forest reserve were in better demand and sold for more money than those from the outside ranges.

As the policy of the government becomes better understood and the benefits to be derived from judicious management of the grazing land is shown by practical demonstration, the opposition of the stockmen to the creation of forest reserves will be entirely removed and they will co-operate with the government in the proper regulation of grazing and the permanent improvement of the ranges.

Question—I would like to ask you now, if the grazing of cattle and sheep would not assist in extinguishing fires in the mountains and ranges, and would it not add to the advantages of the forest that stock be taken in there in the prevention of fires? Fires start from various causes—the burning of brush, and sometimes from lightning striking the grass. There is a great deal of trouble about that, but I think if the range was allowed to be grazed off to a certain extent it would be an advantage in keeping down fires.

Mr. Potter—Yes, sir.

Question—There is another point—the permit to use the range by the government. Do you not think it would be better if there was a rental charge for it, a lease for a limited number of years—don't you think it would be an advantage to both the range and stock owners?

Mr. Potter—I think along that line where arrangements are pretty well settled, the greatest advantage would be to extend the term of five years' lease, and in that way the stockmen would feel encouraged in trying to improve its condition. But the government tries to manage the stock reserve just the same where the stockmen do not pay, and a great many of them feel that there ought to be a government charge and they try to devise the best regulations possible. I think one of the things which is needed most along that line, where the question of range right is pretty well settled, is to make a lease term of five years.

Question—Well, to give a five or ten years' lease, don't you think it would be fair to the government and stockholder for the stockholder to pay a rental; would it not make him take more interest in it?

Mr. Potter—Yes, sir; it might.

Mr. Stewart—In speaking about the driving of cattle and sheep from one range to another, I want to state to you how we are situated. The sheep graze in the summer time on the Monkhill Mountains and in the winter time down on the desert; there is a travel of 100 miles between the two ranges. Now, our idea is that they scatter in going from one range to the other, and in some cases they scatter all over the country near Salt River, where we are building a dam. This country is practically bare. Now, if they were passing about five miles in a trail, they would simply ruin that strip. The cattle are not as much of a damage as the sheep are.

Mr. Potter—I think you are right in that practical section, but generally speaking it is better to let the sheep scatter out. Now if the forest reserve was to be extended over that section of the country, the trail would be extended.

Mr. Stewart—There have been trails, such as you speak of, through the Black Mesa surveys made by sheep, and some of them are transient sheep, coming through some of them from a very great distance, and they have already established a trail. If this were extended, that system of trail would be extended down there and sheep would be confined to a different trail. I would say that under our government administration they would not allow a general travel by sheep or cattle. They started in allowing 300,000 in a reserve, but they cut them down, and I think the number mentioned would be allowed in case this was extended—they might allow a certain number to commence on.

Mr. Potter—Can the government have any control over these sheep after they pass off of the reserve?

Mr. Stewart—No, sir. I am in favor of the lease law—I have been in the cattle business about fifteen years and had a good deal of experience, and I should think that the term of lease years should not be less than ten.

Mr. Potter—I think that would be fair.

Mr. Stewart—Now, the cattlemen are an advantage to the lease land, because every time a fire breaks out they all go out and help fight it with all their men. I think they are an advantage. The cattlemen will be of great help to keep fires down, and they do not hurt the pines at all, as the pine burs seem more liable to catch on the side of the hill where the cattle tramp. I knew that this work was being done, but did not know that it had gone on so far, and if there is anything I can do, or the cattlemen can do, we would be glad to help you in any way we can.

Mr. Pinchot's two resolutions were next offered and, upon motion duly seconded, adopted by the Section.

Adjourned until 2:00 p. m., November 16, 1904.

## THE RELATION OF FOREST RESERVES TO THE MINING INDUSTRY.

MAJ. F. A. FENN, Forest Superintendent Forest Reserves in Idaho,  
Lewiston, Idaho.

Ever since mining first became an important industry in the United States the government has dealt with it in the most liberal manner. The steadfast policy has been to stimulate the prospecting of the country and encourage the development of its mineral resources. Whatever tends to retard the progress of the miners' work contravenes that policy, anything calculated to advance his interests accords with it.

Congress in the enactment of the law authorizing the setting apart of portions of the public domain as forest reserves consistently adhered to its course respecting mining when it provided in that Act as follows:

"It is not the purpose or intent of these provisions, or of the act providing for such reservations, to authorize the inclusion therein of lands more valuable for the mineral therein \* \* \* than for forest purposes."

And further, "Nor shall anything herein prohibit any person from entering upon such forest reservations for all proper and lawful purposes, including that of prospecting, locating and developing the mineral resources thereof. *Provided*, that such persons comply with the rules and regulations covering such forest reservations."

And further still, "And any mineral lands in any forest reservation which have been or which may be shown to be such, and subject to entry under the existing mining laws of the United States and the rules and regulations applying thereto, shall continue to be subject to such location and entry, notwithstanding any provisions herein contained."

While the Act contains the above quoted provisions, it also outlines a plan for the preservation of the forests within the reserves and gives to the Secretary of the Interior power to elaborate the system and make it effective, by authorizing him to "make such rules and regulations and establish such service as will insure the objects of such reservations, namely, to regulate their occupancy and use and to preserve the forests thereon from destruction."

Realizing the vital importance of the mining industry to the national prosperity and at the same time appreciating the necessity of protecting the forests for the benefit of the people, the lawmakers devised a scheme of forest protection that enables forest reserves to be maintained and the mining industry to be carried on simultaneously in the same territory, not only without conflict or friction but in such manner that scientific forestry may be applied in fullest measure while the best interests of the miner are subserved and promoted.

Strange as it may seem, after knowing the provisions of the law cited above, the establishment of a forest reserve in a mining region often excites grave apprehension in the minds of the residents of the locality. Fearing dire results from the presence of the reserve, with the administration of which they are unfamiliar, and the effects of which they have not studied, mine owners are frequently aroused to strenuous opposition and seek in every way

to escape from imaginary ills. What they would avoid they find in the end to be a boon. An apt illustration is found in the history of the Black Hills forest reserve, one of the earliest to be set aside. The great Homestake mine is within the limits of that reservation, and when the reserve was created the Homestake people were panicstricken. They thought the innovation would at once close their mine, and they believed its continuance would result in the practical destruction of their property. They sought to have the reserve abolished. The government was firm, however, and insisted on conferring its benefits. The experience of years has shown the Homestake owners their error. Now they appreciate the reserve system and are working hand in hand with forest officers in all that concerns the reserve. Not only so, they have adopted reserve methods in the management of their own extensive timber holdings. Now they regret that the reserve was not created before their mine was discovered.

The forest reserve system contemplates the accomplishment of a two-fold object in the preservation of the forests; first, to keep them in the state of highest continued production for the benefit of the people locally dependent upon them for a supply of timber products; and, second, to conserve the water supply and maintain an equable flow in the streams. These two chief purposes are admirably suited to meet the needs of the two great branches of the mining industry, lode mining and placer mining. The principal natural products required by the lode miner is timber, while the placer miner is powerless to carry on his operations without water.

Man is ever extravagant with whatever nature bestows, and miners in the use of timber, if unrestrained, demonstrate the rule. Their business makes them creatures of the present. They rarely consider the ultimate good of the community when they are cutting timber; they regard only the satisfaction of their own immediate needs in their quest for wealth. Commonly in the mountainous mineral districts there is naturally a goodly supply of timber, but the discovery of mines leads quickly to the reckless destruction of this and to the heedless impairment of the forest growth. No thought is given to the future. Wasteful, careless methods of cutting prevail and vast accumulations of tops, limbs and other refuse soon encumber the cut over tracts. Fires now get in and what may have escaped the chopper fall a prey to the flames. Were the fire confined to the areas cut over, the damage would not be so great, but, unopposed, it does great damage. Thus are destroyed quantities of timber compared with which the amount consumed is insignificant. The fire is the great and real destroyer, but man is responsible for the conditions which make the destruction possible.

Worse yet is the damage done by the incendiary, who in order to clear a brushy hillside or remove thick timber in a canyon sets fire to the country to facilitate prospecting work. Thousands of acres of most valuable timber have been burned in this way to the inestimable damage of the mining industry. The anxious seeker for a mine lets selfishness blind him to the best interests of the community. He destroys the supply of timber upon which, very likely, hinges the question whether or not his mine may be profitably worked.



In the vicinity of almost every mining camp the naked hillsides testify to the destruction wrought in the early days. Where formerly the mountains were covered with forests they are now denuded. Favored spots may be seen whereon a limited number of seedlings and saplings proves nature's effort to restore normal conditions, but many years must elapse ere her object can be attained even with all the care and assistance forest reserve methods may render. In the meantime the mines nearby must, at great cost, draw upon distant sources of supply for such timber as is necessary to their continued operation.

Everyone familiar with placer work in any long established camp has heard the general complaint. "The climate must be changing, for water gets scarcer and scarcer every year." Streams which formerly furnished ample water for the working of extensive properties during the full open season a few years ago are now without a sufficient flow for more than a few weeks' run in the claims. The true reason for the changed situation is not far to seek. The mountain slopes once forested tell the tale of repeated fires and the consequent reduced water-storing capacity.

These deplorable conditions prove the importance of preserving the forests if mining is to continue to hold its place among our industrial pursuits.

Whenever it is the purpose to run a tunnel or sink a shaft for development, or to extend the workings of a property in extracting ore, it is known beforehand that timber will be needed for such underground work; if the construction of a mill is contemplated, the first thing to look for is suitable material; if a steam power plant is to be operated, above all fuel must be provided. This timber question in all such matters is fundamental and should, it would seem, receive primary consideration. The prudent manager of a mine in a forest reserve would, therefore, make provision for timber at the very beginning of his preparations for any such proposed undertaking, by submitting proper application for the amount which he estimates will be required to serve his ends.

Miners are more prone to be careless in the use of timber than most other people and consequently from them come the bitterest criticisms when they are first brought in contact with the regulations. The explanation is simple. For fifty years the miners of the West have followed the suggestions of their will; they have cut and slashed the forests unrestrained. Unfamiliar with the new order of things, they look upon the country as their own by right of discovery and exploration. When once he appreciates what the innovation is intended to accomplish he promptly adapts his affairs to the new regime.

The honest miner who in good faith is developing or working his property encounters no real difficulty when he confronts the forest reserve law and regulations; but it is the stake locator and the person who seeks fraudulently to secure a body of timber under a pretended mining location that meet with obstacles. What mine owner when looking for timber in the vicinity of his claim has not found the best and most accessible supply covered by invalid locations made by some unscrupulous person for no other purpose than to "hold up" the legitimate miner and compel him to purchase a worthless claim in order to secure timber to which he thinks he is entitled?

While reserve officers are protecting the forests from damage by fire and from spoliation they are at the same time vigilant to guard the government against fraud and in the illegitimate location, occupancy and use of pretended claims by persons who from selfish motives attempt to evade the law relative to the acquisition of title to mineral land. The prospector or miner receives every assistance and encouragement from forest officers; they facilitate his operations.

Where a forest reserve is established in a mining locality, so soon as the reserve law and regulations are fairly understood, opposition on the part of the law-abiding element of the population ceases.

The prospector and miner have nothing to fear from a forest reserve. It is established for the advancement of their interests together with the promotion of the general welfare. Examined comprehensively the relation of forest reserves to the mining industry appears so intimate, the success of the one so directly interwoven with the continued prosperity of the other, that the possibility of real antagonism between them cannot be entertained. The forest reserve system has come as a public benefactor of the mining industry and there is every incentive for miners to give it their loyal support. Forest officers in the administration of reserves will labor for the common good and reciprocally miners, as active and efficient friends, may co-operate in the achievement of the objects alike beneficial to themselves and conducive to the public weal.

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## **INFLUENCE OF TREE PLANTING UPON THE DUTY OF WATER IN IRRIGATION.**

F. H. KING, University of Wisconsin.

In the effort to discover and establish underlying principles of agricultural science and to direct agricultural practice along lines which shall be in harmony with them, thus leading more directly and certainly to higher economic returns, we stand generally in need of an increasing body of accurately determined fundamental facts; and it is very much to be hoped that it will be more and more recognized that the development of these fields falls properly within the purposes of Government aid and work. An adequate discussion of the broad problem of how to secure the maximum duty of water in agriculture is not at present possible on account of lack of a sufficient body of well established facts; and this is especially true of that phase of the problem relating to the influence of tree planting upon the duty of water. The body of accurately determined facts regarding the influence of windbreaks of any type upon the wind movement close to the surface and especially upon the rate of evaporation from foliage, soil, and water surfaces, is extremely small and yet such knowledge is necessary to a proper treatment on the subject. Some general facts and tendencies have been ascertained which are helpful for a preliminary consideration of this subject.

### **INFLUENCE OF WINDBREAKS UPON VEGETATION.**

There is no doubt but that under certain critical conditions windbreaks do exert a very measurable influence upon vegetation. In the spring of 1894,\* during May and June, an opportunity was afforded to make a somewhat critical study of this subject under field conditions. There is in Wisconsin an area of some 10,000 square miles of light sandy soil or sandy loam and, upon the lighter and more sandy portions of these soils, crops are occasionally very seriously damaged by the drying effect of the wind; and the fertility of the soil is much reduced by the drifting which occurs at such times. At the time in question there had been a heavy fall of rain on the 5th and 6th of May, but on the 7th it was clear and cold with a strong wind blowing from the northwest. During this and the following day, notwithstanding the rain, the soils on many fields about Plainfield and Almond, Wis., had been badly drifted. On the morning of the 8th the drifting had gone so far, on many fields, that at both places, the loose sand with which oats had been covered, whether with seeder or with drill, had been driven from the fields to such an extent as to leave the kernels entirely exposed and the plants lying flat upon the ground, hanging by the roots and whipping in the wind. On the fields where the whipping had not been so severe and where oats stood three inches high, the oats had been cured like hay close to the ground and even the leaves of dock sorrel were blackened and so dry as to crumble in the hand. Very many of the blades of oats, through wilting, had broken over close to the ground, presenting an appearance which suggested to the farmers that they

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\*Bulletin 42, Wisconsin Agricultural Experiment Station.

had been cut by the sand. It was at once evident, to the most casual observer of the fields at this time, that wherever a field lay to the leeward of any sort of shelter the destructive effects of the wind were either not apparent or else they had not been nearly so severe.

About three weeks after the first serious injuries had occurred a careful study was made of many fields and the results are recorded in detail in the bulletin to which reference has been made. Some of the observations made at this time are cited here in illustration of the decisive evidence regarding the influence of windbreaks upon vegetation. A north and south road two rods wide fenced with wire along which were scattering trees 10 to 18 feet high, together with a scanty growth of hazel, had a field of oats lying to the east which was greatly damaged, but a strip two rods wide, next to the road, appeared wholly uninjured. A field of oats lying to the east of a field of timothy in which there was a strong growth of dock sorrel, had a strip of oats 200 feet wide next to the grass where the stand was good while on the eastern half, 30 rods wide, the plants were entirely destroyed. Another oat field having grass on the north and west sides, and bordered by a rail fence, showed a strip of uninjured grain 100 feet wide next to the two fences and fully 200 feet wide in the northwest corner of the field in the lee of the two fences. In another oat field fully five-eighths of it had been so thoroughly destroyed by the wind that it was harrowed and fitted for potatoes, but a strip along a rail fence on the south side, 150 feet wide, had been allowed to remain on account of the better stand, and on this area, as was usual generally, the number of plants increased as the fence was approached. To the west of this same field there was another of timothy and adjacent to this there was a strip of oats 200 feet wide where the stand of plants was markedly better than farther away; and the same fact was observed in an adjacent field lying to the east of a closely fed pasture free from trees and shrubs. In another field 120 rods long from north to south and 80 rods wide, seeded to oats and clover, the effect of the surroundings upon the crops is indicated in figure 1 where it will be seen that at a certain distance from the conditions which have influenced the temperature, humidity and velocity of the wind the oats had been very much injured and the clover had been entirely killed out.

In figure 2 the southeastern field is 80 rods long and 30 rods wide. Here it will be seen the oats were good along the road in the lee of the two fences 40 per cent gone further away and entirely destroyed on the eastern half. Further north the field of oats adjacent to the field of grass and with woods to the north and in the distance to the west, had a good stand of plants, being seriously injured only at the south end where the wind came through between the two pieces of woods along the course indicated by the arrow. Similarly, in figure 3, the influence of shelters are clearly and sharply brought out by the condition of the crops observed and there recorded. The southern field in this figure was 60 rods from east to west and 30 rods wide. It will be seen that the half of the field stretching out into the path of the free wind coming through the gap between the two pieces of woods, as indicated by the arrow, had lost all of the crop while the stand increased toward the woods on the west and was good at a distance of 10 to 20 rods from them.

The piece of oats lying on the south side of the scantily wooded pasture was in excellent condition and although only 15 rods wide a very appreciable difference could be seen in the stand of clover, to which the field had been seeded, on the margin most distant from the pasture. Even fields of corn stubble having fields of oats to their leeward were observed, in three instances, to have exerted very marked effects upon the stand of grain and in one of these fields, on one portion of the protecting corn stubble, there was a strong growth of dock sorrel. To the leeward of this part of the field the oats had been much less injured, suggesting that the effect of the humidity of the air passing across this may have been enough altered to render the wind current appreciably less destructive. Observations like these appear to place beyond doubt that, under certain conditions, at least, windbreaks do exert a very measurable effect upon the vegetation of cultivated fields.

On three other oat fields which had been seeded to clover and which were bordered on the west with fields of grass, the number of clover plants upon unit areas which had survived the effect of the wind was determined at different distances from and to the leeward of the fields of grass. The counts were made in series along east and west lines at right angles to the margins of the grass fields and the results are given in the following table.

*Table showing the decrease in the number of young clover plants per unit area with increase of distance to the leeward of the margin of grass land.*

*Field No. 1.*

Distance from Margin of Grass, Feet.	No. of Plants, Series 1.	No. of Plants, Series 2.	No. of Plants, Series 3.	No. of Plants, Total.
50	187	209	187	574
200	120	139	131	390
400	88	75	68	231

*Field No. 2.*

100	77	73	99	249
200	55	109	113	277
400	43	78	72	193
600	67	66	56	189
800	54	54	30	138
1000	27	11	10	48

*Field No. 3.*

50	377	382	371	1130
400	166	209	225	600
700	203	180	160	543

These three sets of data appear to leave little room to doubt that in some manner, the grass fields to the windward of the fields seeded to clover did exert an influence which materially affected the stand of clover on them. In what manner this effect may have resulted will be referred to later.

# INFLUENCE OF WOODS UPON THE RATE OF EVAPORATION TO THE LEEWARD.

At the time of the observations just described others were made to measure the rate of evaporation at different distances to the leeward of woods, using a form of Piche evaporimeter rendered more sensitive by increasing the diameter of the evaporating surface to 5.9 inches, thus giving an effective area of 27.06 square inches, deducting the area of the water reservoir, the latter being graduated to .1 c. c. The instrument as placed in the field is represented in figure 4.

With a series of six of these instruments set up in a line at right angles to the margin of a black oak grove having a mean height of 12 to 15 feet, the rate of evaporation which occurred simultaneously between 11:30 a. m. and 12:30 p. m. was measured, with the results given in the next table.

*Evaporation at one foot above the surface at different distances to the leeward of a grove of black oak in a field of sandy soil recently planted to corn.*

Distance from Woods, Feet.	Evaporation in One Hour, C. C.
20	11.0
40	11.1
60	11.3
80	11.2
100	11.9
120	12.9

These results show that until a distance greater than 100 feet is reached but little difference in the rate of evaporation was found. At 120 feet the evaporation was 17 per cent greater at 20 feet. Three of the instruments were next set up at 20, 40, 60 and at 280, 300 and 320 feet from the same grove and in the same field. During one hour the amounts of evaporation were as given in the next table.

*Evaporation at one foot above the surface at 20, 40, 60, and at 280, 300 and 320 feet to the leeward of a black oak grove in a field of sandy soil recently planted to corn.*

Distance from Woods, Feet.	Evaporation in One Hour, C. C.	Distance from Woods, Feet.	Evaporation in One Hour, C. C.
20	11.5	280	14.5
40	11.6	300	14.2
60	11.9	320	14.7
Average. .40	11.66	300	14.4

From this table it is seen that the rate of evaporation was 23.4 per cent. greater at 300 feet than at 40 feet, basing the computation upon the averages.

In another locality the evaporimeters were set up at distances ranging from 20 to 500 feet to the leeward of a piece of black oak woods where they had an average height ranging between 15 and 25 feet and were thicker on the

ground. The results secured during an hour of sunshine in the middle of the day are given in the table which follows:

*Evaporation one foot above the surface of ground in a field of oats at different distances to the leeward of a black oak grove of trees 15 to 25 feet high.*

Distance from Woods, Feet.	Evaporation in One Hour, C. C.
20	11.1
100	14.3
200	15.7
300	18.5
500	18.3

In this series the evaporation appears to have become constant at about 300 feet from the woods and was some 66 per cent greater than at 20 feet distant.

The effect of a scanty hedgerow was also measured. This was composed of a strip of bluegrass 16 feet wide in which there were scattering black and burr oak from 6 to 8 and occasionally 12 feet high. The hedge had open gaps in it and the nearest evaporimeter was set up in the lee of a clump of six trees spanning a length of 40 feet, there being a gap of nearly equal length on either side. To the windward of this hedge there was a naked field of 80 rods wide recently plowed and being planted to potatoes, and the instruments hung above the field of oats where the plants were about 4 inches high. The next table gives the results obtained.

*Evaporation one foot above the surface of a field of oats at different distances to the leeward of a scanty hedgerow.*

Distance from Hedgerow, Feet.	Evaporation in One Hour, C. C.
20	10.3
150	12.5
300	13.4

In this case the evaporation at 300 feet from the hedgerow was 30 per cent. greater than at 20 feet and 7.2 per cent. greater than at 150 feet, and the results make it clear that even scanty hedgerows exert a measureable influence upon the rate of evaporation at considerable distances to the leeward.

#### INFLUENCE OF A CLOVER FIELD UPON THE RATE OF EVAPORATION TO THE LEEWARD.

Adjacent to the naked field behind the hedgerow just considered, there was a field of clover 360 feet wide along the margin of the oats and extending 780 feet back from it, across which the wind passed in its course from the north. At the same time the last observations were made a similar series was taken to the leeward of the clover, the results being these given in the following table:

*Evaporation one foot above the surface of an oat field at different distances to the leeward of a field of clover.*

Distance from Clover Field, Feet.	Evaporation in One Hour, C. C.
20	9.3
150	12.1
300	13.0

These results indicate that at 300 feet to the leeward of the clover the rate of evaporation exceeded that at 20 feet 39 per cent and that at 150 feet 7.4 per cent. Comparing the evaporation from the two adjacent areas where, as stated, the evaporimeters were similarly and simultaneously exposed, it is seen that the air coming across the long stretch of naked ground and then passing through the hedgerow, caused measurably more evaporation than did the current which had traversed the field of clover; and these results appear to be in complete accord with the observations cited regarding the stands of grain and clover to the leeward of woods, hedgerows, grass fields and shelters of other kinds.

**INFLUENCE OF WOODS AND GRASS FIELDS UPON THE HUMIDITY OF THE AIR TO THE LEEWARD OF THEM.**

At the same time that the several sets of observations were taken and at the same places, others were also made with wet and dry bulb thermometers of the Henry J. Green make, reading to tenth of a degree C. The results obtained are given in the following table, each value being a mean of 10 readings, which were made in regular rotation, passing from station to station of each series during the interval of exposure of the evaporimeters:

*Relative humidity of air three feet above the surface at different distances to the leeward of woods, hedgerow, clover field and naked soil.*

*Grove No. 1.*

Distance to the Leeward, Feet.	Mean Dry Bulb Readings, Degrees F.	Mean Wet Bulb Readings, Degrees F.	Mean Relative Humidity, Per Cent.
30	65.32	49.46	27.0
300	63.80	47.35	24.0

*Grove No. 2.*

20	75.04	58.35	34.6
100	73.13	56.39	33.0
200	72.03	55.83	34.2
300	71.47	55.13	32.8
400	73.63	55.63	29.6
500	73.31	55.94	30.8

*On leeward margin of clover field.*

0	52.48	43.97	48.0
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*On leeward margin of naked field.*

0	53.24	43.57	44.0
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The four series of observations, although too limited to serve as the basis of general conclusions, are, in a general way, quite in accord with the records of evaporation which have been cited and also in harmony with the very pronounced observed protection afforded to oats and clover to the leeward of the various shelter conditions which have been cited. To my own mind, however, the surprise lies in finding such profound differences in crop conditions associated with the observed differences in meteorological and surface conditions. It should be borne in mind, however, in considering these relations, that the meteorological observations were not made at the time the destructive work was going on, hence what differences then existed are not known. The relations which have been observed and pointed out are clearly vital to the reclamation problems of the arid and semi-arid West and merit full investigation, especially from the standpoint of field conditions.

The very marked influence which has been observed upon the stand of both oats and clover under the conditions cited is undoubtedly, in large measure, due to the character of the soil and to the stage of growth of the crops, the wind coming at a time when the root system of the plants was yet scantily developed and very close to the surface; but the measurable differences in the stand of clover, at such long distances from the conditions which have evidently produced them, leaves little reason to doubt that crops are sensitive to such differences of temperature, humidity and velocity of the air near the surface as must result from the conditions whose types have been here considered. There can be no doubt that rows of trees along canals and about reservoirs must very materially reduce the loss of water through evaporation from their surfaces, and such observations as have been cited make it hopeful that their influence upon the loss of moisture from adjacent fields and their effects upon crops themselves may be of much greater importance, especially in plains regions, but only fuller investigations can make certain the true relations.

#### WIDTH OF THE ZONE INFLUENCED BY WINDBREAKS.

Newell,\* in speaking of the influence of windbreaks on plains, states that: "It is estimated that every foot of height of compact trees protects a rod of ground; hence a Lombardy poplar windbreak of an average height of 60 feet, properly set out, has a beneficial influence extending practically 1000 feet to the leeward." In the cases which have been cited the rate of evaporation and the humidity of the air were measurably affected at distances having the same or perhaps a little higher order of value; but when the effect upon the crops themselves is taken as an index the influence clearly has a wider range, there being in the case of the fields seeded to clover so strong a contrast as 183 to 48 between the distances of 800 and 1000 feet to the leeward of a grass field, where it appears that the influence must have been exerted in some manner other than by directly modifying either the wind velocity or the humidity of the air. It appears possible that broad, continuous naked fields of dry soil or sand on clear days may have a peculiar effect upon air currents sweeping across them. The dry soil or sand itself

\* Irrigation by F. H. Newell, page 370.

under such conditions, becomes heated and tends to expand the air lying in contact with it, making it relatively lighter than the much cooler and more rapidly moving currents above, and it may be that when these conditions are established the warm air is displaced by the heavier, cooler and more rapidly moving air from above. Such a current from above, aside from its higher velocity, would be likely to exert a peculiarly parching influence as its temperature rises after coming in contact with the soil. Grass covered surfaces and damp soil could not be expected to have this effect in so marked a degree and the result may be that during windy times the air moves across damp surfaces and fields of grass in a less turbulent manner and, as a consequence, maintains a higher humidity which reduces the parching effect. If, however, the turbulency of the air currents at the surface of the ground increases their parching effect it may be asked whether windbreaks on plains may not augment the turbulency of the currents and thus while exerting a protecting influence over a certain distance to the leeward of them, they might not lower the duty of water in the district as a whole and have a prejudicial effect upon average crop yields. Indeed it appears quite possible that if the windbreaks were placed too far apart such an effect might be the result, but hardly otherwise. But even if windbreaks do exert in general a beneficial effect and tend to increase the duty of water, exact observations are yet too limited to indicate whether the magnitude of such influence would be sufficiently great to make their establishment an economic investment, much less to permit an estimate to be made of what returns might be expected from such an investment; but the problem is capable and worthy of solution.

#### RATE OF EVAPORATION FROM WATER SURFACES.

There is already a considerable body of data accumulated in this country which indicate the magnitude of the rate of evaporation from water surfaces. A portion of this data has been obtained by measuring the loss of water from tanks floating in reservoirs or canals, but most of them show the loss from tanks 3 feet square or in diameter and 3 feet deep set in the ground so that the rim is within twelve inches or less of the general surface. The mean evaporation during the growing season, April 1st to October 31st, as indicated by the records of nineteen stations located within the rectangle 103 and 121° of longitude and 32 and 43° of latitude, is .21 inches per day; 21.149 inches per 100 days and 47.358 inches for the 214 days in the period under consideration. The minimum evaporation at any station indicated in the records was .14795 per day; 14.795 inches per 100 days, 31.66 inches for the seven months; while the maximum—not including two at Wheatland, Wyoming, which appear to be exceptional—was .273 inches; 27.295 inches per 100 days and 58.41 inches or close to 5 feet for the seven months, at Logan, Utah. East of the Mississippi we have access to records from but five stations in the rectangle 71 to 90° longitude and 39° 30' and 44° 30' latitude, and the mean evaporation has been .145 inches per day; 14.533 per 100 days and 31.1 inches for the seven months. The records obtained at Boston, Mass., and Rochester, N. Y., are from floating tanks and the mean evaporation was at the rate of 12.09 and 11.448 inches per 100 days respectively.

In the absence of fuller data it is perhaps permissible to assume that the ratio of evaporation at 20 feet and 300 feet from the woods, as observed with the Piche evaporimeters, is the same as would have been found from water surfaces had they been similarly placed. The mean of the three sets of observations with the evaporimeters indicate that the evaporation at 300 feet was 40.73 per cent greater than at 20 feet. If we consider the probable saving of water by windbreaks, it appears likely that, except in the cases where the trees exclude the sun from canals or reservoirs, the 40 per cent represents the maximum saving which could be expected from windbreaks. With an evaporation of 47.358 inches, given as the mean above, the maximum probable saving would be 18.94 inches of water from a canal or reservoir.

#### EVAPORATION OF WATER FROM CONTINUOUSLY MOIST SOIL.

During the summer of 1903 a soil evaporimeter having an evaporating surface of 11.7 square feet was maintained at each of four stations, Goldsboro, N. C., Upper Marlboro, Md., Lancaster, Pa., and Janesville, Wis. The soil surface was kept continuously capillarily saturated by maintaining a water level in the soil at about 12 inches below the surface from which an autographic record was secured in each case. The mean evaporation, per 100 days, at the several stations, was found to be 21.2, 19.2, 15.3, and 18.0 inches at the four stations respectively, given in the order above, or an average of 18.43 inches per 100 days and of 39.43 inches for April 1st to October 31st. If the mean evaporation from similarly moist soil surfaces in the arid regions holds the same relation to that in the humid region as is indicated by the relative rates of evaporation from water surfaces in the arid and humid regions the total evaporation from a constantly moist soil would average 60.04 inches instead of 39.43, the mean found at the four stations east of the Mississippi during the growing season, computed to 214 days. If five feet is the mean rate of evaporation from continuously moist soil in the West the maximum saving through windbreaks would be, according to the observations cited, some 40 per cent of the total, or 24 inches. It is, of course, never true that the surfaces of fields are maintained continuously as moist as was the case under which the rate of evaporation has been determined. It is true, however, that during the time water is being applied in irrigation and for some considerable time thereafter, the rate of evaporation will exceed that which has been recorded from the surfaces kept capillarily saturated from a water level one foot below; and irrigators recognize the fact of rapid evaporation during the hot portion of the day through the notably less distance water will travel under a given head, before sinking into the ground, than is the case at night and when it is cool.

#### COMBINED EVAPORATION FROM SOIL AND CROP.

At each of the places where the soil evaporimeters were maintained and at the same time, an entirely similar one filled with the same soil matured 10 stalks of maize. The water level in these evaporimeters, however, was maintained at 3 to 3.5 feet below the surface instead of at 1 foot and an auto-

graphic record of the evaporation was obtained. The time between planting and harvesting averaged 120 days and, during this time, the mean total evaporation amounted to 24.15 inches, or a rate of 20.13 inches per 100 days and a total of 43.08 computed to 214 days. On these evaporimeters the mean yield of dry matter per acre was 13,881 pounds, 10,000 being a large field yield. This observed mean rate of evaporation is, therefore, likely to be some higher than for ordinary field yields under the same climatic conditions, and the indications are that the evaporations from the field surface under crop may not be quite as large as has been found from the continuously wet soil surface. It may appear impossible that such a relation as this can exist, but the probability of it being true is made clearer when it is understood how great is the reduction in the rate of evaporation from soil surfaces when a thin layer at the top is allowed to become dry and especially if it is loose and in the condition of an earth mulch. The surface of the soil in the plant evaporimeters was maintained in the condition of a good earth mulch three inches deep, and the effectiveness of earth mulches is clearly brought out by the results given in the following table where the mean amount of evaporation from firm and mulched surfaces of six soil types are given:

*Evaporation from six soil types during 28 days with surfaces firm and under three-inch earth mulches, computed to 214 days—seven months.*

Soil Types.	Surface Firm.	Surface a 3-inch Mulch.	Difference.
	Inches.	Inches.	
Sandhill .....	14.37	1.57	12.80
Selma silt loam.....	22.13	5.92	16.21
Pocoson .....	25.64	7.11	18.53
Norfolk Sandy Soil.....	31.87	5.89	25.98
Goldsboro compact sandy loam.....	40.85	6.73	34.12
Norfolk fine sandy loam.....	49.79	8.70	41.09

These observations were made at Goldsboro, N. C., in June and July and they show that there is a very great protection against evaporation afforded by 3-inch earth mulches; also, that there is a large variation in the loss of water from different soil types under like conditions through surface evaporation. As the data of this table were obtained during a comparatively dry period, and when the temperature was high, the rates and differences are perhaps as large as are likely to occur, on the average, in the irrigated districts of the West, under such conditions.

In another series of observations made under what must have been conditions closely similar to those of arid climates, columns of capillary saturated soil 10 feet long were maintained under a continuous draught and without moistening the surfaces, during 314 days where the temperature ranged between 60 and 90 degrees F. The loss of water which occurred was only determined percentagely, but from the weights of the soils per cubic foot the total evaporation, computed to 214 days, must have been very close to the amounts given in the next table:

*Evaporation from ten feet in depth of two soil types under arid conditions continuously during 314 days—amounts computed to 214 days.*

Soil Types.	Surface Firm,	Surface under	Difference.
	Inches.	3-inch Mulch, Inches.	Inches.
Sandy loam.....	2.85	2.49	.36
Heavy clay loam.....	6.55	4.65	1.90

From these observations, and those given in the last table, it is clear that whenever the surface of a field is protected by a layer of dry soil, whether this is firm or loose, the evaporation will be relatively small but less from the loose than from the firm surface.

It is probable that the losses of water by evaporation from fields in the irrigated districts of the western United States ranges all the way between 1.57 inches and 50 inches from April 1st to October 31st. If this is the case the maximum conservation of soil moisture, through windbreaks, is likely to be found to lie somewhere between 40 per cent of 1.57 inches and of 50 inches or between .63 inches and 20 inches for the period April 1st to October 31st.

The windbreaks themselves, of course, transpire not inconsiderable amounts of water, but when they are planted about reservoirs and along canals, laterals and head ditches, they may draw largely upon water that would otherwise be lost through percolation or seepage; moreover, the land which such windbreaks would occupy is often, in part at least, necessarily waste land unless used in this manner. But if it shall be found practicable to make the windbreaks by using fruit and nut-bearing trees so that an annual income will be realized from them even though it must be small, the promise of a good investment along this line becomes much better.

**RELATION OF FORESTRY TO IRRIGATION.**

FREDERICK H. NEWELL, Chief Engineer Reclamation Service, U. S. Geological Survey.

*Mr. Chairman and Gentlemen of the Committee:*

I want to express to you gentlemen the fact that we, from an irrigation standpoint, appreciate heartily the work which you are doing, and want to keep together, as this is a great movement for the natural resources of the country. The principal thing now for us to do is to convince the public and thinking men that in forestry lies a large portion of the wealth of the country. We are getting beyond the time of mere enthusiasm, or, "Woodman, spare the tree" idea—we are getting down to where the tree is looked upon as a useful thing both as lumber and as wood. Yet we have to come and convince them that we want the trees—we want them to grow, we want them to use. We want the forests on the mountains, not because they are pretty, but because they are useful, and year by year we can see the demand for them growing.

I wish to say I appreciate the opportunity of coming to meet you and to say a word, and that we are heartily in sympathy with this move, and want to be as useful to you as you are to us.

## **HOMESTEAD LEASEHOLDS AND GRAZING RANGE ADMINISTRATION IN THE WEST.**

R. H. FORBES, Director Agricultural Experiment Station, Tucson, Arizona.

The problem confronting the range interests of the West at the present time is, on the basis of adequate knowledge of the public range, to devise land laws which shall enable a maximum population to support itself in a pastoral country; and to make these laws so flexible as to apply to all grades, both best and poorest, of grazing lands, harmonize all kinds of stock interests thereon, and provide for the often unexpected development, through irrigation, of agricultural lands within formerly purely grazing districts.

### **UNSATISFACTORY REMEDIES PROPOSED.**

Practically the only proposals thus far made to remedy existing conditions are to lease the public lands in blocks at stated rents, or to issue permits to individuals to run stated numbers of animals upon specified portions of the public range.

The unsatisfactory nature of these proposals is attested, in part, by their repeated rejection by one or another faction of those concerned, and for reasons quite evident when the merits of the measures are considered. Lease or fence laws permitting the control of large bodies of land on the basis of competitive bids are usually favored by the wealthier stock raisers who would be at an advantage under such laws, and are earnestly opposed by the small men who would be exterminated through their operation. Horizontal lease laws have been proposed providing for the leasing of all grazing lands at the same rate per acre of rental. When it is considered that different grazing districts may easily require all the way from 3 to 60 acres to support a single cow, the unjust discrimination against the more desert ranges of a horizontal rate-per-acre lease law is too evident to require discussion.

The leasing idea, nevertheless, has a good foundation in the fact that it recognizes that in order to place the grazing industries on a stable basis, *stockmen, like farmers, must have control of the land upon which they operate.*

The permit system has many advocates—possibly largely for the reason that this method has been put into practice on forest and Indian reserves and its results are known to those who would expect to take advantage of it. The permit system, however, is practically no better than free range with a tax added to the stockman's expenses and a more or less unsuccessful attempt on the part of the government to regulate the number of animals in a specified district.

### **AUSTRALIAN EXPERIENCE AND RESULTS.**

Australia, which is and always has been, more a pastoral than an agricultural region, for the last 75 years has been making and remodeling her laws relating to the disposal of Crown lands to settlers. As they now stand the land laws of various of the Australian states present the following sensible features: First, grazing lands are divided according to their capacity to

carry stock into as many as four classes and settlers are permitted to occupy smaller or greater allotments of territory according to its quality. Second, these lands are occupied under long tenure leases, with renewal privileges, which give practically permanent control to the stockmen. In addition to the motive thus created to improve their leaseholds, they are also usually required by law to fence and otherwise improve their holdings. Third, the classification of lands and their allotment to settlers is done by a Board of Commissioners acting for the government with a view to correct judgment and equitable division of the public lands.

The operation of these laws with reference to the development of pastoral industry is stated to be highly satisfactory. Vast areas of semi-desert lands, divided into comparatively small holdings, are legally occupied for long terms by stockmen who, prompted both by law and their own best interests, improve their holdings. Thus it is that in Australia an immense pastoral country has been fenced, substantial improvements are installed, provision is made against famine in dry years, animal pests are exterminated, poisonous plants are eradicated and an era of improvement has apparently been inaugurated *directly due to the recognition of the fact that the Anglo-Saxon must have proprietary interest in land if he is to be expected to improve its condition.*

In unhappy contrast to the upbuilding of pastoral Australia is the reverse process everywhere evident in our own Western States. The spoliation which has resulted, inevitably, from the lack of laws having for their object a saving administration of the range country, has resulted in a gradual but sure decline of its carrying capacity. In some districts, especially where, under stress of overgrazing, the soil is easily eroded by rainfall, this damage can never be repaired; in others, restriction of grazing, reseeding, and other remedial measures may effect a large measure of restoration.

#### PRINCIPLES ON WHICH SOUND GRAZING LAND LAWS MUST REST.

Successful grazing range laws must of necessity rest upon two kinds of knowledge—knowledge of the range itself—the forages that it bears, their habits of growth and reproduction, their food value for animals, the classification of grazing country into different grades, and the carrying capacity and endurance of these different kinds of range.

The second sort of knowledge required is that derived from legislative experience in dealing with purely grazing lands elsewhere.

*Australian experience, considered together with the traditions of our own land laws points to the practicability in the United States of the stockman's homestead or long term leasehold in pastoral districts. The homestead idea, long-tried and well approved in this country, is, briefly, that a settler shall be granted enough territory to afford him a living—enough and no more.*

#### THE MEANING OF THE HOMESTEAD.

As applied to the Mississippi Valley a homestead meant 160 acres of land, this area being found in the average instance sufficient for a farming family.



But when the tide of immigration pushed west of the 100th meridian into the semi-arid regions it was found either that 160 acres with water was worth a great deal more, or that 160 acres without water was worth vastly less than that same area back in the Mississippi Valley.

*Why should we not apportion grazing ranges so as to grant a sufficient acreage for a sufficient time to afford the small stockman the necessary territory to support the herd whose increase shall give him a living income, and protecting him in his tenure for a sufficient length of time to create an incentive for the maintenance and improvement of his range?*

In Australia, from 1,280 to 40,000 acres of grazing lands, according to quality are thus leased, at rates proportionate to value, for terms of from fourteen to forty-two years. Many benefits are experienced under these provisions. Sheep and cattle wars are rendered impossible since each interest is confined to its own territory. Co-operative arrangements are entered into extensively where co-operation permits of more economical management of large adjoining leaseholds. Grazing leaseholds are operated in connection with cultivated farms; and humane methods of handling stock are rendered possible.

#### OBJECTIONS TO BE ANSWERED.

It is objected by some that long tenure leases will close those public lands now thought to be purely grazing lands to future agricultural development; that such development is now occurring in sections formerly thought to be unreclaimable, and likely to continue indefinitely and to an unexpected extent. There is no more reason why the grazing leasehold should stand in the way of the agricultural homesteader than that it should stand in the way of the prospecting miner. The right-of-way and the opportunity to make good are, apparently, just as possible to farmers, as to miners in a parallel situation under the well-tried mining laws of our western country. With suitable provision, as in Australia, for allowing the pastoral leaseholder preferential homestead rights on his leasehold, no hardship is implied, but the way is parallel for an easy transition from grazing to agricultural pursuits in regions capable of higher development.

Again, recurring to the subject of permits, it is thought by some that the solution of the range question lies in the extension of the permit system—that all public lands should be apportioned to grazing interests by permit, until taken up by homestead. This idea, with all deference to those who are working on that basis, may be questioned, both in practice and its adoption to Anglo-Saxon human nature. In the first place, to carry it out on the enormous grazing domains of the West implies the creation of a numerous official body over whose work it would be impossible, in the nature of the case to exercise close control. The abuse of the permit system by stockmen who can easily take advantage of their official overseers is stated to be frequent. The permit system, giving stockmen tenure of their range from year to year only, puts the industry on a less permanent basis even than under the free range regime, and, in addition, adds a tax to the already severe conditions under which, in this day of decline, stockmen are laboring.

Yet again; the stockman, no more than the farmer, wishes to be officially regulated in the technical management of his business. Give him his territory, define his rights, make scientific knowledge and advice available to him—but give him the *management* of his own business.

Still again; to those who imagine that the interests of the farmer are jeopardized by those of the grazing leaseholder, let attention be called to opposing facts. The irrigation farmer is virtually interested in the condition of his watershed. An improved condition of grassy watersheds confers a great and direct benefit upon irrigation farmers; and this improvement will be brought about by the proper protection of the stockman upon his grazing range.

As to the feasibility of range improvement it is only necessary to point to the results already obtained on the experimental grazing range reserve south of Tucson, Arizona.

This reserve, containing 49 square miles of diversified lands, was selected and fenced under the co-operative arrangement between the United States Department of Agriculture and the Arizona Experiment Station. Practically a desert when it was fenced two years ago, protection from the ravages of stock for that time has resulted in a remarkable restoration of forage grasses.

There can be little doubt that the scientific and economic basis on which range administration must rest is capable of adequate development. It only remains to devise and put into operation a suitable system of tenure whereby the natural wealth of our grazing regions may be developed and utilized by our people.

Mr. Potter—Have you sowed grass seed extensively in that reserve?

Prof. Forbes—No, sir; however, nature seems to be grassing that point rapidly.

Mr. Potter—It comes up without being seeded?

Prof. Forbes—Yes, sir. If it is just given a chance it will produce a fair crop. There are patches of grass coming in all over that reserve, so I do not doubt that in the course of ten years it will be grassed, even in its most barren portions.

Mr. Walter T. Swingle—I would like to ask Mr. Forbes if this fenced range would not keep it from spreading with good grasses?

Prof. Forbes—They tell me that the Black Droma is slowly dropping out. Dr. Griffith, I think it was, said that the grasses were spreading out most rapidly, and washes and waters have probably carried seed. On the other hand it is a fact that worthless weeds have obtained a hold in that country and have come to stay.

That country has a soil particularly subject to rain, and when once a valley is cut down into a deep gulley, the whole is forever to be changed.

## **FIRE PROTECTION IN THE SANTA BARBARA FOREST RESERVE.**

COL. WILLIS M. SLOSSON, Forest Supervisor Eastern Division Santa Barbara Forest Reserve, Nordhoff, California.

The Santa Barbara Forest Reserve contains approximately 1,800,000 acres, in Santa Barbara, Ventura and Los Angeles counties, State of California, and is divided into two divisions, the eastern and western. As forest supervisor I have charge of the eastern division, which contains about 1,100,000 acres, lying in Ventura and Los Angeles counties.

There is considerable pine, cedar and fir timber in the mountains along the north side of this reserve, but the reserve is mainly covered with brush. Nearly the entire eastern division is the watershed of the Santa Clara River, which flows from east to west and empties into the Pacific Ocean a few miles southeast of Ventura.

The purport of this paper is to give the present plan of fire protection, and what is needed to improve it.

The Santa Barbara Forest Reserve is mainly a brush-covered reserve and most people think brush is a useless cover, but the settlers of Ventura and Los Angeles counties know the value of it on this reserve, the eastern division of which is the watershed of the Santa Clara and Ventura Rivers. In the Santa Clara River valley \$1,000,000.00 worth of lima beans were raised this year, and the farmers who irrigated their land raised on an average double the number of sacks per acre in comparison with those who did not irrigate. At one place where the bean-fields of two different ranches joined the farmer who irrigated raised twenty sacks per acre, while the farmer who did not irrigate got only eight sacks per acre, and as the beans are worth at least \$3.00 per sack the irrigation was worth twelve sacks or \$36.00 per acre to the man who irrigated his land. The same can be said of the sugar-beet industry of that valley, one of the largest beet-sugar factories in the country being located at Oxnard, near the center of the valley. The refined sugar turned out of this factory this year is 400,000 sacks of 100 pounds each. One orchard of English walnuts contains four hundred acres, and the English walnuts raised in the valley are valued at \$350,000.00 this year. The Lemonaria ranch, near Santa Paula, is the largest lemon orchard in the country. But if this valley is to continue in its prosperity and produce good crops it must be irrigated and the cause which makes the splendid crops grow must be protected. As the watershed is the Santa Barbara Forest Reserve, then the cover that best conserves the water-flow is the cover to be protected. On this reserve it is brush and the denser the brush, the better the water is conserved.

### **VALUE OF BRUSH COVER.**

A good test of the value of brush as a cover for conserving water has been shown in the Ojai Valley the past year. In October, 1903, the canyon in that valley, where the San Antonio Water Company obtained the water for their water for irrigation, was burned over and they did not get one-half the flow

of water this season that they did during the season of 1903, though the rainfall each season was about equal.

The government in its management of forest reserves allows sixteen rangers for the eastern division of this reserve in the summer or dry season, and eight for the winter or wet season. In the summer season each ranger is assigned a certain district to patrol, and is instructed to be courteous to all, but firm in the enforcement of the rules and regulations. He notifies the hunters and campers to be careful with their camp-fires, and keeps fire-warning notices posted at all the camping places. He is also instructed to ascertain the cause of every smoke that he sees in his district or adjoining districts. If the ranger cannot handle the fire alone he is allowed to get outside help, for which twenty cents per hour is paid. The second class ranger in whose district the fire is located takes charge of the work, provided the supervisor does not get there.

### MUSCULAR AND NERVY RANGERS WANTED.

The main feature of our plan of protection is to have rangers who have good judgment, muscle and nerve. The ranger should keep "level-headed" and have judgment to know how and when to take every advantage of a fire. He should have nerve and muscle to face the fiercest fire when called upon and jump in and fight it, even though it singes his hair. Men who can and will do that kind of work often win the fight.

In fighting brush fires in the mountains we have found that an attack on both flanks is necessary. Therefore we are cutting trails or fire-breaks along the tops of the main ridges between canyons and along the different ranges. These trails or fire-breaks allow the rangers and men fighting fires to confine the fire usually to one canyon, as they have an open pathway on each side of the fire where they can keep along with it until the top of the range is reached; or until night comes and the draught is down the canyon, when they may be able to close in and head off the fire in the canyon. In the low places along the ridge, at the heads of some little canyons are the places that usually try the ranger's nerve. The brush is usually thicker and the fire comes up pretty lively, and if it crosses the trail it will burn along the side of the next canyon and slowly down into it. Therefore at these places hard work is called for, and the fire-break is cut wider. A patrol is established around the burned district and kept up until all danger is past.

### ORGANIZED FIRE FIGHTERS.

Shovels and axes are the principal tools used and each ranger has to carry them, so that he will be ready when fire is discovered. At times it seems impossible to make any headway against a brush fire, and starting back-fires is resorted to, but this kind of work is a kind of double-acting proposition and is usually dangerous. Therefore we rely principally upon the flank work along the ridges, and are cutting trails and fire-breaks as fast as possible to perfect that plan of work.

We have two cabins where tools and supplies can be stored and rangers camp. This saves packing the tools and supplies at time of fire. Drinking

water is very necessary for men working, but in some places it is hard to get, therefore each man is supplied with lemons as a substitute.

Some may think twenty cents per hour for extra men too much, as we pay at that rate from the time they start until the fire is out or under control so the rangers can handle it. But when they replace the clothes and shoes that get burned, torn and destroyed, the balance is not an extra compensation for forty-eight, sixty or eighty hours' work. I do not believe in hiring too many extra men, but get good workers if possible, and men that will go ahead and not have to be told every move to make. Neither am I in favor of depending upon a volunteer force, unless the volunteer is personally interested, for the reason that too many bosses show up in a volunteer force.

What is needed to improve the plan is: rangers enough to complete the trails and fire-breaks as now planned, and more cabins where tools and supplies can be stored, thereby saving time in packing them long distances at time of fire. Arrangements should be made so that the extra men hired to work at fires do not have to wait from thirty to sixty days to get their pay. It would be a great benefit if a telephone line could be built to several places overlooking the reserve. But the greatest benefit would be to have the State enact a law governing the careless burning of brush by owners and settlers in and along the borders of forest reserves or other places useful as watersheds. A majority of the fires and those doing the most damage to watersheds start from the careless burning of brush, weeds and stubble on private holdings.

There may be other and better plans of handling brush fires, but during the past six years we have been more successful where we had trails, fire-breaks or an open pathway along the adjoining ridges, where we could work on the flanks of the fire. With the thermometer registering from 100 to 110 degrees in the shade, but little can be done to stop the headway of a fire until night; then possibly success may come in an effort to head it off.

More cabins should be built and located in places where the surrounding territory is accessible. At the cabins rangers can camp, an extra supply of tools should be kept stored in these cabins by the government. Many other improvements might be made that would be pleasant, but whatever else is done, trails and fire-breaks must be made, so that rangers can get around a brush-covered reserve, if it is to be protected as a watershed.

Mr. Walter T. Swingle—I would like to ask if you could get any assistance from stockmen renting range, in putting out fires?

Col. Slosson—I will say that in forest reserves permits have to be granted to stockmen, and in the application it provides that they shall aid in their locality. There are more cattle grazed in the Santa Barbara reserve than all the rest of the reserves in Southern California. One reason why I ask that stock enough be allowed is so that each year the grass that grows in the canyons may be fed off, because it dries up in dry seasons, and if there is a body of that scattered over the ground the fire gets a quicker and better start. We are not always in a position to get the wet sacks and it gets a headway so we can not stop it. Therefore, I believe it is better to get enough

stock, but not overstock it. I think they are making more money and grazing districts are kept in better condition if not overstocked.

Question—Would it not be well to leave it to a supervisor to name the amount of stock necessary to eat off this grass?

• Col. Slosson—That would depend a great deal on the honesty of the supervisor. The supervisor is allowed to issue a permit to settlers. He is the man on the ground and understands the position, and if he is honest there will be no damage. I think the stockmen should be compelled to fence springs around the mountains and put in troughs and pipe the water out to the stock.

## **CONDITION AND ADMINISTRATION OF THE GILA RIVER FOREST RESERVE, NEW MEXICO.**

R. C. McCLURE, Forest Supervisor Gila River Forest Reserve,  
Silver City, N. M.

This national forest reserve was created March 2, 1899, and comprises an area of 2,327,040 acres, is located in the southwestern portion of the Territory, in the counties of Grant, Sierra and Socorro. It was formerly divided into eastern and western divisions, and under the management of two Forest Supervisors, but is now one reserve and under the management of one supervisor, assisted by a number of forest rangers, with headquarters fixed at Silver City, the most accessible point of location for the accommodation of citizens having business relations with his office, accessible to daily mail and affording telegraphic communication with the central office at Washington, D. C.

Included within its area are five distinct mountain ranges, the Black, Diablo, Mogollon, Tulerosa and San Francisco, all spurs of the Rockies, and in these mountain ranges the Mimbres, the Gila and San Francisco Rivers and their tributaries have their source, and in the continuous flow of these rivers a large per cent of the population of both Arizona and New Mexico are interested. I have it from a forest inspector familiar with the various reserves of the United States, that the Gila is one of the best timbered reserves in the Middle West, has upon its areas sufficient timber to comfortably house and home twice the population of the Territory in which it is located and leave young timber and seed-bearing trees sufficient upon its area as to reproduce itself in the next fifty years.

This reserve has a resident population of about 1500, due to the fact that prior to its creation agricultural lands lying in the narrow valleys of the rivers and their tributaries heretofore mentioned had been entered and most of them passed to patent before the date of the creation of the reserve. Citizens of the reserve are generally satisfied with conditions, and, in fact, most of them would protest against any proposed elimination.

In the foothills of the Mogollon mountain range, to the west, is located a large group of valuable mining claims, properties pregnant with richest ores, and representing millions of capital, located in the west center of the reserve and about ninety miles north of Silver City, their nearest railroad shipping point. This important industry, perhaps the leading industry in the Territories of Arizona and New Mexico, it is the province of the national government to foster.

### **PREHISTORIC RUINS.**

The Gila River Forest Reserve abounds in ruined pueblos, prehistoric mounds and cliff dwellings. The best known cliff dwelling is located on the west fork of the Gila River. The main cliff is about 600 feet in length, has a perpendicular face averaging 150 feet in height, showing various phases of aboriginal engineering and architectural skill of numberless "human martins" that carried on their backs up steep cliffs every stone and every bit of mortar used

in building cozy little rooms in this ponderous edifice, and the skill here displayed stamps them as a most extraordinary little people. We judge of their size by the presence of tiny little doorways leading from one compartment to another, and from the size of the rooms in which they lived. These ruins, what is left of them, it is made a part of the duty of forest officers to protect from further vandalism, that they may be left undisturbed and together, so that the scientist ambitious for the solution of the interesting and mystifying problems of American ethnology and archæology may have the benefit of any knowledge to be gained by a study of these relics, and this exhibition of engineering and architectural skill of this little people which ages ago so proudly held their own in isolation and solitude.

In the southwest corner of this reserve are about two hundred thousand acres of lands that have practically no timber upon them. They are neither forest lands, mineral lands or agricultural lands. The only classification that may be given is that they are high mesa grazing lands, not susceptible of irrigation and possibly never will be.

#### GAME LAWS ENFORCED BY FOREST OFFICERS.

The headwaters of the streams heretofore mentioned are full of fish and in the deeper recesses of the forest may be found bear, mountain lion, wild turkey and deer, the latter of which are increasing in number, due to enforcement of Territorial game laws by forest officers. The reserve abounds in numerous hot springs, waters from some of which issue from the ground at boiling point, best known of which is called Gila River hot springs, by some called Hill's hot springs, best known for the reason that these springs are located upon patented lands, have been improved for the use of the public by putting in of bath tubs and the building of a kind of way-side inn, where the people who frequent these may get hotel accommodations, and bathe in these waters, which are said to contain medicinal properties.

Administration is a most important question, not only in the Gila reserve, but in every other forest reserve of the United States. The service is being improved with each passing year and the standard of proficiency is being raised and men already in the service are acquiring larger experience and a better understanding of what is expected and what is contemplated. We have commenced the doing of permanent work, such as the building of permanent trails, construction of rangers' cabins centrally located, cutting of fire-breaks, etc. The efficiency of the men is being brought to a higher standard, and promises for the future greater protection and more satisfactory administration.

Stock grazing in New Mexico is one of the leading industries and the national government in its efforts to foster it has provided for limited grazing in its forest reserves, and this year admitted to graze in the Gila River Forest Reserve 150,000 head of sheep and 55,000 head of cattle and horses.

#### STOCK GRAZING IN RESERVE.

For the accommodation of this number of stock the reserve has been divided into nineteen grazing districts, this division into grazing districts



made necessary for the more equitable and systematic apportionment of grazing areas and distribution of the maximum number of stock allowed to graze according to the grazing capacity of the several districts and to better enable forest officers to prevent over-grazing. This division of the reserve also enables us more equitably to divide the range between cattle and sheep, which, it is claimed, do not thrive well on the same area. For this reason sheep are assigned to certain districts and cattle to others. When patented ranches of cattle owners fall within sheep allotted districts we assign to such cattle owner home range in the vicinity of his ranch or farm, from which sheep are excluded. Sheep were admitted to graze from April 1st to August 1st, and cattle, as a rule, the year round.

I believe that all grazing in forest reserves is, more or less, detrimental, yet danger from forest fires would be very much augmented by a failure to permit sufficient grazing to consume the grass that would otherwise grow up and become a tangled mass. Once on fire in this arid region during the summer months great loss would result, so that the risk in this particular outweighs the little damage that is done the reserve by restricted grazing. This distribution of sheep and cattle has not given entire satisfaction to either the cattlemen or the sheepmen, but it is the most equitable of which the supervisor is capable and its abandonment will work injury to one or the other of these industries and ultimately result in exclusion of either sheep or cattle.

The taking down of unlawful enclosure was perhaps the most delicate task yet assigned forest officers. But fences down, the stockmen have found that it is possible, by leasing a school section here and there, to get along fairly well without these vast areas of unlawful enclosures, and they never questioned the justice of the order.

Forest rangers, in addition to wearing a badge of authority, have voluntarily adopted a uniform of gray color with green stripes, and the good effect makes it commendable and bespeaks a personal pride on the part of the field force.

The justice and the wisdom of setting apart this vast expanse of well-timbered areas is no longer questioned by thinking people, who concede that the right of the individual ceases where the right of the public begins. A healthy public sentiment favorable to national forest reserves, wisely administered, now exists among the people.

## **FOREST PLANTING A REQUISITE TO SUCCESSFUL IRRIGATION IN NORTHERN MEXICO.**

MAXWELL ALEXANDER KILVERT, General Manager Tihualito Agricultural Company, 28 Ortega, Mexico City.

What makes up Northern Mexico politically comprises three sections of distinct physiographic character. There is the coastal plain on the east, which includes the State of Tamaulipas and part of Nuevo Leon. The climatic conditions existing there resemble those of the Texas littoral, modified by the high ranges of the Eastern Sierra Madre. On the west are the ranges of the Western Sierra Madre, and the much narrower Pacific coast plains. It is the central table land which presents the serious problems indicated by the title. This district forms an irregular quadrangle, of which the south side nearly coincides with the Tropic of Cancer, from the 100th to the 104th meridian west of Greenwich, and the north side lies along the frontier from 29 to 32 degrees north, and between the 101st and 106th meridian.

This district is an elevated plateau, with a height of some 6000 feet above the sea along its southern border, falling off toward the north, and more especially towards its northwestern corner, where it is only slightly over 700 feet. There is a pronounced depression in the western edge about one-third of the distance from its southern to northern limits, in the neighborhood of Torreon, and just where the most extensive irrigation operations in Mexico are being carried on. The altitude here is about 3500 feet, and from this point the plateau falls off, in fan shape, toward the north and east to its low point at Eagle Pass, rising, however, along its western side to about 4600 feet at Chihuahua, and dropping about 900 again from there to El Paso.

This table land is very much broken by clumps and ranges of hills and low mountains, rising from 200 to 300 to perhaps 1500 feet above the surrounding plain. These ranges run in a general northerly and southerly direction, and some of them are unbroken for many miles by passes feasible for wagon roads.

The prevailing formation is limestone. These elevations are totally bare of forest. Short of forested hills, they show every stage of chaparral covering, of mesquite and other large shrubs of sparse grass covering, of rocky, cactus and ixtle-like covered areas down to the bare soil-stripped rock. The plain itself presents many phases. In the northwest part are large areas of fair to poor grass-covered range, and from the south to the northeast every condition, from good chaparral to the apparently hopeless stony desert stretches, with nothing except various forms of the cactus making a struggle for existence. Vast areas, however, are composed of the most fertile alluvial deposit, the result of thousands of years of disintegration, washing down, blowing off, and settling. These plain areas need only the stimulating touch of water to equal in fertility the most bountiful districts of the world. The depth of the alluvial deposit in many places is very great. Experiments made recently in well-digging in the principal irrigated districts have shown over 200 feet of alluvial deposit, of strata of humus, sand, light clay and some gravelly strata.

### AN ARID SECTION.

The amount of rainfall throughout this district is still largely a matter of conjecture. It is, however, quite safe to say that by far the greater part of the area falls within the limits of the distinctly arid belt, only the part referred to as the range country reaching the semi-arid class. Observations taken at a point near Torreon, between the 22d of March and the 22d of October, of the year 1904, a period which includes more than the so-called "rainy" months, show a rainfall of 5.02 inches, and this is undoubtedly a relatively wet season.

The only hope for the reclamation and productiveness of this territory lies in irrigation, and for the most part, in works on an extensive scale.

The water which is available for this purpose to-day is the run-off from rains in the mountains. It is that precipitated on the more considerable ranges that must be dealt with. Except in the northwestern and extreme northern part of the area, the water courses are quite dry during most of the winter and early spring months. In summer and autumn they fill from the hill rains, and when not otherwise diverted, carry the water down through the plain, most of them forming small ponds and lakes. There are very few of these which receive enough water to prevent drying up during the dry season.

Of the few of this class, the principal one no longer exists, all the water of the stream which fed it being now utilized for irrigation. This stream is the Nazas, and the land which its waters now irrigate are known as the Laguna district, and comprise the area formerly covered by the lakes formed by its flood waters, and much more in addition. What has been done by the Laguna represents the most extensive and systematic attempt yet made in Mexico in the line of irrigation. There are probably some 300,000 acres under ditch, and the service requires close to 3000 miles of main and distributing ditches and perhaps more. The holdings are very large, half a dozen or so owners probably holding a large fraction of the cultivated area, and with one exception having few or no lessees. Cotton is the main commercial crop. If the water supply were regular and permanent, conditions would be ideal, the dryness, sunshine and heat of the climate being insurance against serious insect depredations, except in abnormal years. But the flow of the Nazas River, like that of all the others, depends on the rains in the nearer mountains and the eastern ranges. The beginning of the summer flow ranges anywhere from the first of July to the middle or last of August. This irregularity of flow renders a crop, which would otherwise be much more dependable than most, almost as uncertain as under "sky farming."

### TO CONSTRUCT IMPOUNDING RESERVOIRS.

Anything which would so regulate the flow of this stream that the big floods were checked, and if possible, to such an extent that the run-off was carried entirely through the year instead of ending at any time from January to April, as now, would be worth a very large expenditure. The government is proposing to achieve this end by the construction of impounding

reservoirs, and now have engineers investigating the feasibility of a project for damming a canyon not far above the upper canal intake dams. If the manifold difficulties of handling flood waters which are exceedingly heavily charged with silt, are overcome, the regulation of the flow by a reservoir system would doubtless be an improvement on dependence upon the unbridled vagaries of the present stream. But the hills of by far the greater part of its catchment basin have been stripped clean of trees, and as the foothills immediately surrounding the plain are reached, they are bare of everything but ixtle, cactus and the hardier shrubs. There is still much more rainfall on them, however, than on the immediately adjacent plain, as judged by inspection, for no measurements have been taken in the hills. It may be impossible to reforest the scattered hills in the plain, but further back into the range a foothold can be secured and the mountains reforested, and miles by miles the desert can be driven back, and the excessive flood waters checked. It is quite certain that this area was once forested.

The Nazas has been used as an illustration because its use has been so fully developed. The total volume of water discharged from 1st of July, 1902, to the 30th of June, 1903, according to the government expert, was in round figures 787,000,000 c. m., or say approximately 650,000 acre-feet, of the total amount for any year, probably nearly two-thirds would be delivered in about four months. This proportion applies in a still more marked degree to most of the other water courses emptying into the district under discussion. The great fluctuations of the rivers, both those emptying into the temporary lakes of the plain, and those running into the Rio Grande or its tributaries, all present the same difficulties in handling as does the Nazas, and from the same cause.

#### THE FORESTRY IDEA UNDEVELOPED.

As yet practically nothing has been done in Mexico in the way of preserving the existing forests, to say nothing of reforesting. The only law of general application on the subject is one forbidding the cutting of wood or timber within ten miles of the bank of a stream. This is intended to preserve the banks from erosion and caving, but it is not generally enforced. New lumbering companies are constantly forming, and rapid inroads are being made on the standing timber. The main ranges of the Sierras, hitherto immune for lack of transportation facilities, are now being attacked. Within five or ten years damage will have been done which it will take more than a generation to repair. The government is turning its attention to the subject, but the lumbermen are moving much faster than the government. All the work that could be handled in reforestation, and in the expenses of maintenance for considerable forest reserves, would not require more than a fraction of the amount lost in this year alone by the Central Railway and the Laguna planters on account of the irregular flow of two streams only.

For successful irrigation in Northern Mexico, for the uninterrupted maintenance of its means of communication, for the preservation of its climate, and for the conservation of the timber necessary for its industries, a comprehensive system of forest preservation and extension by tree planting is necessary in Mexico, and necessary to-day.

## TREE AND PLAIN.

### *Discussion of the Problem of Aforesting the Great Plains.*

WM. T. LITTLE, Editor "Oklahoma," Perry, Okla.

There are forests where there are rains, not rains where there are forests, yet, being to a certain extent correlative, one must perceptibly induce the other. There, maximum altitude suggests minimum moisture. Great land expanse remote from large water surface induces hot air of low moisture content. The 36 degree parallels are high pressure areas, so from there air is forced down and out, establishing them as dry belts, one of rainfall's prerequisites being an ascending current. Intervening with north and south wind, the Rockies mitigate this ill, yet their removal 100 miles westward would make forests of the prairies, prairies of the plains and plains of the almost desert.

The less of annual precipitation the greater per cent of crop season rainfall. The 20-inch rain belt has, approximately, four-fifths of its supply during crop season, while one-half in summer and one-half in winter is common ratio for the more humid States. Four-fifths of 20 is 16, and one-half of 36, very common for portions of Wisconsin, Michigan, Illinois, Indiana, Ohio and New York, is 18, giving a growing period advantage of but two inches.

Increased evaporation and decreased air humidity partially offset this advantage. This first is susceptible of relief by frequent cultivation. In this way is evaporation limited to foliage, and the humidity of air equalized and supplemented, the loose soil receiving more water. And here lies the secret of growing trees on plains. As east and west determine precipitation, so north and south determine evaporation. At its minimum point, the 20-inch rain belt of Texas has two and one-half times the evaporation of that same belt in Minnesota. In addition to heat, this is partially accounted for by greater prevalence of wind. It would be reasonably fair to say the average annual evaporation of the total country considered would be something like 45 inches, or two and one-fourth times its entire precipitation. Mr. Kellogg gives its middle district, a part of Kansas, as 54 inches of evaporation and 20 inches of rain.

### THE FABLE OF INCREASED RAINFALL.

Honest ignorance has led agents to publish tables of the plain's increased rainfall, which but retards remedy. Sun radiation is excessive on sand surface and barren soil. A tree's north will remain moist with dew much longer than the south and sprout more twigs. Corn to the north of prairie ponds will the longer survive hot winds. In malaria countries you will find Indian camps between wind and creek. Black clothes take up many degrees more of heat than do white ones. The government's experiments as to effect of wind velocity on evaporation, from water surface, also establishes the principle as applying proportionately to soil surface. In this connection it should be well to know that fourteen miles per hour is an average wind velocity for portions of the plains, increasing that by 50 per cent for weeks at a time and occasionally doubling even that. From the former surface a 25-mile per hour wind takes up from six to nine times as much water as would evaporate dur-

ing perfect calm. The average western Kansas wind increases the calm's evaporation by five fold. So four-fifths of that soil's water is lost, and much of the precipitation becomes flood water. These things both emphasize our necessities and suggest possibilities. At Lawrence, where artificial timber has been planting for half a century, Prof. Snow records the period of from 1888 to 1893 as having eight per cent less wind velocity per hour than the period of from 1873 to 1888.

On heat's control and wind's defeat,  
So many things are pending.  
That what we hold within our power,  
Appears to have no ending.

There is suggestion that reforestation has perceptibly re-established normal precipitation and surface wind velocity in certain Old World districts. Some few official recordings support the old settler conviction of Pennsylvania's denuded areas being subject to increased wind velocity and constancy. Generation yet extant recalls "the wind-swept prairies of Illinois," an expression so gradually thrown into disuse by silviculture as to make unnoticeable its departure

The 20-inch rain belt, meaning semi-aridity, crosses the extreme southern point of Texas and the northwestern corner of Minnesota, three times bending to the West in obedience to east and west streams approaching with co-operative effect, the Wichita mountains possibly once aiding results. Upon entering the zone of earth rotation winds, water courses lost effect, however, possibly because of their north and south direction.

Artificial timber diverts cloudburst flood water into earth percolation that later evaporates through foliage, equitably supplementing atmospheric moisture. Increasing topographical sameness, by giving air more freedom of motion, accentuates disadvantages of a constantly increasing altitude. This can be neutralized by trees that would, in effect, create hills of wind-reducing capacity. Besides being reduced in amount, precipitation concentrates for fewer and more violent efforts. Possibly incapable of serious increase, ravine dams would prevent much of its return to the ocean, and trees so delay progress as to establish perennial springs, replenish water courses and possibly so evaporate as to tempt overhanging rain clouds. The plain's misfortune arises less from absence of moisture in her higher atmospheres than from the absence of vertical moist currents.

Tropic trade winds come up from southeast of Florida and, turned north by land banks of New Mexico, pass up the Mississippi valley. Once in that more northern zone, where elevated winds incline toward the earth's rotation, they mingle with a colder current and condense for an eastern journey that brings rain immediately upon coming in contact with an upward current of sufficient moisture and particle content. The dryer and more level is surface, the less likely is a vertical current, as there are fewer temperatures to induce mingling of strata.

## TREES WOULD KILL THE WINDS.

Were the country in question one compact forest, these wind-swept plains were perfect calm, and just so near as the first condition is approached, to that degree will the second be attained. King's test showed that during a light wind, evaporation from water surface 200 feet from an oak grove wind-break was 41 per cent greater than at its base, 300 feet being about the limit of benefit. The higher the protection and the more intense the velocity, the greater the ratio of protection. In a general way it is said these distances and heights are as sixteen to one, so a 30-foot east and west board windbreak, every 480 feet from Gulf to British domain, could not but be a solving. Dr. Saunders once found this 16 feet extended to 80. Replaced by trees, some wind would escape through foliage, and their rounded tops would make applicable that rule of spheres effecting but one-half the resistance presented by square flat surfaces whose square equalized the sphere's diameter squared. Dovetailing into the vital questions of precipitation, surface evaporation, soil water, pond construction and artificial tree windbreak becomes the alpha and omega of both sub-humid and semi-arid farming, absolute aridity being left to irrigation.

The eventual feasibility of this tree-planting, pond-building enterprise must be argued from observation and experience, yet there is much of daily discovered scientific knowledge possibly more potent. From the plain's early Spanish visitors come no sign or token as to how far east buffalo grass extended or how far west the tree had taken up abode, for largely by these things are we to determine how far up the Rocky Mountain slope non-irrigated agriculture may hope to climb, unless a system of dust mulch agriculture be adopted. No plain-crossing gold seeker has left satisfactory data on these subjects. Through activity of science, Central Asia, Steppes of Russia and south Mediterranean Sea deserts will eventually produce and sustain, but our plains are enough better to warrant effort for such climatic changes as constant occupancy and agriculture can sustain.

## GRADUAL ENCROACHMENTS OF THE TREES.

Answering my recent inquiry, Col. Van Horn, editor of Kansas City's only paper in 1856, writes: "In 1856 land to the immediate southwest of Kansas City looked like a green ocean to me. Now it looks like a succession of parks." An equally recent letter from Timothy Hersey, in whose log cabin Bayard Taylor ate that now famous last house meal upon crossing the plains, says Dickinson County, Kansas, upland and bottom, was then buffalo grass. From Mr. Hersey's letter and my travels in all but one of Kansas' counties, every county in Oklahoma and each reservation of the Indian Territory, conclusion is that, had the millions of buffalo continued their tireless tramp of soil compacting, buffalo grass would to-day extend east of the 30-inch rain belt. Mr. Hersey insists upon such radical change of climate during the past half century as to warrant us in expecting final and full treeing of both sub-humid and semi-arid belts.

There were even then large trees, but so limited to extremely favorable environment that the country was termed "destitute of timber." Yet the lone

tree's presence indicated possibilities. Those natural tree conditions can, at least to small degree, be made general. Of course, work, looking to the establishing of universal forest conditions on the plains is not to be thought of, knowing one foot of forest humus has been said to require 5000 years of leaf deposits; but I desire to be distinctly understood as holding this question of artificial windbreak and dams for the increasing of atmospheric humidity, to be a part of the nation's obligations to the sub-humid and semi-arid belts, the same as our flood neighbors of the humid and arid belts have been accorded, in proportion as they have demanded and proven themselves worthy. Growing trees are annually giving proof of plains' forestation being practical, and the fact of forest litter reducing soil evaporation 87.5 per cent is enough to insure large result from small effort. And it is well to know that, on equal space, trees evaporate less than field crops.

#### TREE GROWTH IN A GENERATION.

Raised at the head of old Chisolm trail, I have seen Texas droves mill in the Smoky Hill, where banks were destitute of all save the solitary cottonwood. I have lived to see those self-same banks densely forested back just so far as the plowman's avarice will permit. On the old-type mustang I have driven the old-type long-horn, and they fought, when at bay, across bottom lands so rent into drouth-cracks as to frequently admit a hoof, a certain horse once going in with both front legs. These identical lands are now alfalfa meadows and cornfields. Do not tell me climate is immutable as time, though rainfall may not increase.

A professor of the Nebraska University returned to his boyhood home in Brown County, Kansas, finding the brush of neighboring ravines had climbed an intervening hill to, at the apex, intertwine the branches of wide spreading trees. Near Overbrook, while appraising Indian Territory upland, where eight years before the roots of succulent grasses dominated, I have occasionally found it impossible to even lead a saddle horse through post-oak thickets grown since stockmen quit the country and ceased fires eight years before.

#### NOT POLITICAL PLUMS.

Colonel Glazier, who brought the first passenger train into Oklahoma, says sand hills to the immediate north of Guthrie's Cimarron bridge were then, practically, barrens, both as to trees and grasses. To-day wild plum bushes cluster among those hills, while 20-foot elm trees are noticeably common.

This government is proving Nebraska's semi-arid sand hills capable of pine production. Upon reading a paper before the American Forestry Association, during the Omaha Exposition, I had the pleasure of some hours with J. Sterling Morton, father of Arbor Day. He spoke of saw log walnut from seed of his own planting. There was present Tree Planter Stephens, who, as contractor with filers under the old timber culture act, has probably planted more trees on the plains than any ten men. A friend quoted him as saying a catalpa survived an eight-inch annual precipitation on upland 4000 feet above the sea, without any kind of attention. At any rate he enthuses on treeing Nebraska, in some soils, well up to the Wyoming line.



## GOVERNMENT INVESTIGATIONS OF THE TREELESS PLAINS.

Royal S. Kellogg's recent report on western Kansas tree growing, from the Bureau of Forestry, is a wealth of condensed experience and lifetime of observation. In almost any country land should be from 10 to 25 per cent timber, immense stretches of level inland prospering best with far larger percentage. Besides a wood lot for stock shelter beds, common to more eastern farms, there should be field crop windbreaks of from 15 to 30 acres.

If not caring to familiarize yourself with the scalding of seed and freezing of nuts, buy transplanted seedlings, making it possible to reset when conditions warrant, and evading the drying out of roots during shipment.

Unless certain of a wet winter plant just prior to spring growth, full leaf being preferable to during its forming. This same applies largely to pruning, and the wound should be annually coated with white paint. Plains induce low heading, and heavy branches should alternate with tall growers calculated for early use. The less there is to be of cultivation and trimming, the thicker should be the planting, even on uplands, 2x8 feet being preferable to 4x4, each allowing 2732 trees per acre. If selfish enough to crop tree ground, grow a very short-lived crop.

## DISTURB NOT THE ROOTS.

Trees should be constantly cultivated, never plowed. At 4200 feet above the sea, in Colorado's Cheyenne Wells Rainbelt Experiment Station, with water 260 feet below surface and annual precipitation of 13 inches, a semi-monthly treatment of dagger-toothed harrow, or five-toothed cultivator, has kept an unirrigated apple orchard thriving and bearing, green ash and black locust doing as well.

The best time to remove trees is during a rain. The French now replant choice individuals between 10:00 p. m. and 2:00 a. m., for several days bathing the limbs.

Conifers transpire from one-tenth to one-sixth as much as many deciduous trees, requiring the same planting dates, and demanding shade while very young. It has been claimed that seedlings have died from three minutes of root exposure to dry air.

Red cedar, the hardiest of all, and growing about eight inches annually, thrives scarce better on bottom than upland, but it harbors fruit enemies. It is the longest lived of all and is affected the least by cultivation or soil constituent.

Pine is not so hardy as cedar, but its growth is about double. Scotch and Austrian pine, under some degree of care, have proven satisfactory even on dry western upland. In new Mexico, within 75 miles of Kansas, bull pine is habitat, one solitary specimen appearing near 12 miles southeast of Oklahoma's northwest corner.

## DROUTH RESISTERS.

Honey locust, Russian mulberry and Osage orange defy drouth, the last two sometimes freezing back. In Colorado, at 4200 feet, and under 13 inches of annual precipitation, the first, on compact upland, grows 16 feet in

ten years. In Kansas, at 2500 feet, and under about 18 inches, it grew 15 feet in an upland grove and 17 feet in a row on bottom. Largely immune from borers and root sprouting, selection of thornless individuals and such trimming as will thicken foliage can not but make of the honey locust a model western street shade. Osage is the slowest grower of all, but grass can not kill it. Russian mulberry will make a post in ten years, it, like Osage, demanding excessive pruning, unless planted thick. Osage orange grew 40 per cent less on upland than bottom.

Green ash grew 11 feet on upland in 16 years at Cheyenne Wells, Colorado, and 16 feet on bottom at Leoti, Kansas. It is hardy as against dry and cold weather, also being less subject to borers than is black locust.

Within 18 miles of Colorado, a nine-year old Kansas grove of black locust is thriving right among upland buffalo grass. In 1900 at Bryan, Oklahoma, Mr. Updegrove planted eight acres to two-foot black locust trees, every four feet in rows six feet apart. Two cultivations the first year, one the second and one the fourth brought three years of actual growth to 18 feet.

Slow of growth, immune from insects, smaller and harder than the elm, hackberry has proven an acceptable street tree at Columbus, Neb.

Long of life, the heavy soil loving white elm requires time to establish, even then not being so hardy as honey locust, although without a street or park superior. On Kinsley, Kansas, upland, in rows, it grew 15 feet in 12 years, and 25 feet in 14 years on bottom.

#### IMMUNE FROM THE BOLL WEEVIL.

Unless within reach of some sort of constant moisture, cotton wood should not be planted. Slips from staminate trees will produce non-cotton raising trees. The box-elder, a northern tree, makes the same first requirement.

Like silver maple, the walnut is scarce practical off watered valley, or conditions similar.

If determined upon black locust, the fastest post maker, read up on borers and cultivate so shallow as to not cut roots and induce sprouting.

In soil qualified for walnut, catalpa speciosa is a plantation tree beyond compare.

An ultra Presbyterian father taught the efficacy of prayer, and I recall a childhood supplication that God would grow trees on scorched plains and give me a spotted pony to drive cattle. At times, sand hills made the barefoot boy an impossibility, and Easterners have been seen protecting faces with silk handkerchiefs.

Personally, my first tree experience came after winning a homestead in the Cherokee Strip horse race, planting on upland section line a double row of walnut seed. I have picked nuts from those trees, and my neighbor, Mr. J. H. Nelson, had on exhibit at the Omaha Exposition four walnuts on a tree that I personally know to have been less than 27 months from seed.

#### CITY FORESTRY.

My home town's business surrounded a dust driven courthouse square of three bottom acres. Within two years after I had planted 8600 American white elm seedlings, under the county board's contract to pay whatever bills I might

make, a neighboring town offered, for the surplus above park needs, \$172 in excess of total cost. Some of those trees, at nine years of age, are now 30 feet in height, one shading a circumference of 90 feet, and another having grown an 11-foot branch in 120 days.

A few years later the school board gave me charge of one of their two surplus upland blocks for five years. I planted 12,000 elm, maple and black locust seedlings. Two years brought the first to six, the second to eight and the third to twelve feet, selling one-twentieth of the locust for one-half the cost of the whole.

I then induced the city council to order, under my purchase and planting care, 5000 seedling pine for rocky soil planting in the cemetery.

This season a new school board authorized me to make whatever I considered necessary expense in parking a second block, from the first's surplus, and a new city council did the same for a block given it by the government some eleven years ago.

Some few years ago a governor vetoed my measure, introduced upon my city council's unanimous request, authorizing councils in cities of the first class to let seven-year street parking contracts, binding their successors and duly insuring tax levies.

Each contract has stipulated that I receive no remuneration, directly or indirectly. *At last, suspicion has been disarmed and the people lend an ear.* I come to this Congress courting co-operation from those sanguine characters who are gathered to build a yet greater new West, to this end, that the general government financially recognize artificial tree windbreaks on sub-humid prairies and semi-arid plains, as has the paternalism of internal improvement fostered levees and irrigation structures.

This contemplates subsidiary endeavor by state, county, township and individual; but those regions' self effort in this regard has, *through a half century*, been establishing the case as here submitted.

Mr. Little—I will say that I am worried to death with letters from all parts of the Territory, wanting to know how to plant trees. I have to let a great many letters go unanswered.

Mr. Lippincott—I am figuring on inducing the planting of more trees by a tax exemption, that is, that we have a tax exemption to a certain extent. I have talked to several men here, and twenty men are willing to put out trees with a tax exemption.

Gen. Snyman, of Mexico—In Africa the government supplied the land and seed and gave the man the benefit of whatever he might raise for nine years. After ten years the lease expired. This paid the government, and the same system is carried on there now.

Mr. Pinchot—What happened to the land at the end of ten years?

Gen. Snyman—It became forest reserve; and people jumped at it. It was this that gave the people an idea of the necessity of planting on their property. Places like you have in Colorado are now covered with trees.



# Section Production by Irrigation.

• DIVISION A.

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CHAIRMAN: E. BENJAMIN ANDREWS, LL. D.

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Wednesday, November 16, 1904.

This Section was divided among four Chairmen; Prof. Andrews, Prof. Shaw, Mr. O'Donnell and Mr. Myrick. Mr. O'Donnell and Mr. Myrick were unable to attend.

## **THE IRRIGATION OF THE PUBLIC LANDS IN TEXAS.**

DR. WM. B. PHILLIPS, University of Texas, Austin, Texas.

The State of Texas has its own General Land Office and through it administers its own public lands. These lands belong now to the Public School Fund and include also the University and Asylum lands. The National Government owns but little land in this State, some small areas here and there are military posts, wharfage, etc., comprising its holdings. In speaking of the irrigation of the public lands in Texas it must, therefore, be understood that reference is made only to the lands owned and administered by the State.

The Land Office of the Republic of Texas was opened for the transaction of business on the 4th day of January, 1838, within four years after the Declaration of Independence. John P. Borden was the first Commissioner of the General Land Office, having been appointed to this position by President Sam Houston, in 1837. It was not until 1849, however, eleven years after the opening of the General Land Office that any systematic attempt was made to estimate the extent of the public domain. At this early date in its history the boundaries of the State were somewhat uncertain. They included a large part of what is now New Mexico and extended, in a narrow strip, through the southwestern part of Kansas and the central part of Colorado into Wyoming.

In the year 1849, and under the Governorship of George T. Wood, a report was made by Robert Creuzbar to George W. Smyth, Land Commissioner, that the area of Texas was 379,054 square miles. At that time there were outstanding claims amounting to 94,732 square miles. In 1851 Commissioner Smyth reported that Texas had ceded to the United States Government 110,937 square miles of territory and that claims, liquidated and unliquidated, amounted to 99,661 square miles. Most of these claims were subsequently decided in favor of Texas so that the present area is held to be 265,780 square miles.

We need not trace the sale of the public lands in Texas through the last fifty years. Suffice it to say that they comprised about thirty millions of acres in 1882, about twenty-two millions of acres in 1902 and about the same amount in 1904. More than one-half of the acreage belonging to the Public School Fund lies now west of the Pecos River in that portion of the State known as trans-Pecos Texas. The following table gives this acreage:

*Acreage belonging to the Public School Fund west of the Pecos River,  
August 31, 1904.*

County.	Acreage.
Brewster .....	2,064,542
El Paso .....	4,094,674
Jeff Davis .....	770,792
Pecos .....	2,273,033
Presidio .....	1,513,265
Reeves .....	1,027,284
Total .....	11,743,590

The following table gives the number of square miles of area within each one of these counties, together with the total acreage, taking 640 acres as one square mile:

County.	Sq. miles of area.	Acres.
Brewster .....	5,006	3,203,840
El Paso .....	9,353	5,985,920
Jeff Davis .....	1,922	1,050,080
Pecos .....	8,312	5,319,680
Presidio .....	3,970	2,540,800
Reeves .....	2,610	1,670,400
Total .....	31,173	19,770,720

The following table gives the percentage of acreage held by the Public School Fund in these counties:

County.	Percentage.
Brewster .....	64.40
El Paso .....	68.40
Jeff Davis .....	73.40
Pecos .....	42.70
Presidio .....	59.50
Reeves .....	61.50

That is, of the entire amount of land in Brewster County the Public School Fund owns 64.40 per cent; in El Paso County 68.40 per cent; in Jeff Davis 73.40 per cent; in Pecos 42.70 per cent; in Presidio 59.50 per cent, and in Reeves 61.50 per cent.

The valuation placed on these lands varies according to their character, whether they are fit for agricultural purposes, dry grazing, wet grazing or mining. The Land Commissioner may not dispose of the public school lands for less than a certain minimum price, but the valuation affixed above this

minimum is within his discretion. The minimum price may be as low as one dollar per acre, the maximum price for certain oil lands in East Texas has been as high as \$1500 per acre.

### IRRIGATION OF PUBLIC SCHOOL LANDS.

The irrigation of the public school lands in Texas is a subject far too great to be considered within the limits of this paper. One is compelled to discuss it in a very general way or to select a part of the State in which the necessity for improving the land is more imperative. We shall have to disregard, for the present, about one-half of the total acreage held by the public school fund and confine our attention to that part of the State in which this fund owns large blocks of undivided land.

A slight digression becomes necessary here in order that those who are not familiar with the system in vogue in Texas may be apprised of certain vital considerations.

Under the terms of the law granting lands to railroad companies a large portion of the public domain was divided into blocks and sections, the State reserving one section (640 acres) and giving the other to some railroad company. The State then came to own each alternate section. An ordinary checkerboard will illustrate this if we remember that the black squares belong to the State and the white squares to some railroad company. Under this plan neither the State nor the railroad company could own or in fact did own large undivided blocks. To the north, south, east and west of any State section there were railroad sections, and in the same directions from any railroad section there were State sections. Under this plan, furthermore, the railroad companies made a great many of the surveys and the boundaries were not permanently marked by monuments at the corners of the sections. The failure to do this has given rise in some portions of the State to considerable uncertainty as to the location of the section lines.

While the alternate section system maintains over a great part of the region west of the Pecos River, to which we confine these remarks, there are important exceptions and these are of special force in the present discussion. There are large undivided tracts of land in trans-Pecos Texas, in the Panhandle and in the Llano Estacado, but it is to the first named that attention is now directed.

The successful application of the principles of irrigation does not necessarily imply sole ownership of the land, yet, in practice, such sole ownership gives a distinct advantage and in dealing with the improvement of public lands it is almost an indispensable condition. If our checker-board lay wholly within the control of the State there would be no other party of interest and the question of dealing with it would be comparatively simple. But if one-half of it is beyond the State's control, in respect of material improvement its betterment would yield no revenue to the State except that due from increased value, a somewhat uncertain and evasive source of revenue in this part of the world.

It has been stated that in trans-Pecos Texas the Public School Fund now owns 11,743,590 acres of land. Of this amount there are in El Paso County

alone 4,094,674 acres, or more than one-third (34.8 per cent) of the entire amount. This land does not lie in a solid body, but something more than one-half of it does. In other words, more than one-half of the public school land in El Paso County lies in undivided blocks over which the State has absolute jurisdiction. The State may do as it will with this land and consider plans for its betterment in whole or in part. It may select sites for storage reservoirs, lay out and construct canals and ditches, fix water rates, determine how much land may be allotted to any person or association of persons, and collect, with certainty and regularity, revenues arising from its use or occupancy. Most of this land is in blocks of large size, ranging from 15,000 to 30,000 acres. In this county the university owns 499,000 acres in sixteen blocks, one block (M) containing 57,600 acres.

### THE IRRIGATION SUPPLY.

There is not much of the public land in trans-Pecos Texas that can be irrigated from running streams. There are two rivers in this region, the Pecos and the Rio Grande, the one being the eastern boundary and the other the south boundary. There are a few streams which supply more or less water of varying quality at intervals during the year. Comanche and Independence creeks in Pecos; Toyah creek in Reeves; Limpia creek in Jeff Davis; Tornillo, Maravillas and Terlingua creeks in Brewster; Alamito, Cibolo and Capote creeks in Presidio may be given as streams which will supply more or less running water during the year. Of these, Comanche creek, at Fort Stockton, Pecos County, and Limpia Creek, at Fort Davis, Jeff Davis County, are the most important, affording large volumes of good water at all seasons. There are excellent farms near Fort Stockton and Fort Davis. The irrigated area around Barstow, Ward County, is not considered at present, and for the reason that the area under cultivation is on the east side of the Pecos. The same observation applies to the irrigated farms around Grand Falls, Ward County.

It is, perhaps, possible to irrigate portions of the Toyah basin with water taken from the Pecos River near Riverton, but serious demands are already made upon the natural flow of this stream above Riverton. Allowing that this river would supply enough water of fair quality for this purpose, the amount of land that could be so improved is only a small fraction of the public school holdings west of the Pecos. The great strip of land that begins on the Texas-New Mexico border, thirty miles northeast of El Paso, and continues for fifty miles in a southeasterly direction, with a width varying from six to forty miles can not be irrigated by water from any running stream. If improved at all it must be by means of underground water pumped to the surface, or by rain water held in storage reservoirs, or by a combination of these two methods. There is in this part of El Paso County now a body of land of more than 400,000 acres. In places it is well grassed and for the most part would make a good cattle range. But it can not be leased because there is no water on it and but little probability of securing it except from deep wells. Its reclamation is to be hoped for only through the agency of storage reservoirs for rain water.



If the public lands in trans-Pecos Texas generally and in El Paso County particularly are to be improved at all it must be for the most part through the agency of storage reservoirs conserving the rainfall.

The average annual rainfall at El Paso is 9.33 inches. At Kent, in the eastern part of the county, it is 12.72 inches. At Fort Davis, Jeff Davis County, it is 14.03 inches. Taking El Paso County as a whole it is not likely that the average annual rainfall exceeds ten inches, and more than one-half of this falls during the months of June, July and August. There will be, normally, six inches of rain during these three months and four inches during the remaining nine months. At El Paso the annual rainfall, during the last twenty-five years has varied from 2.22 inches in 1891 to 18.30 inches in 1884. During this period there have been sixteen years in which the average rainfall was below ten inches, seven years of which it was between ten and fifteen inches and two years in which it was between fifteen and nineteen inches.

A rainfall of one inch means that on each square mile, or section, we would have 17,612,000 gallons of water, and this is equivalent to about 27,520 gallons per acre.

#### SURVEYS FOR STORAGE RESERVOIRS.

Mention may here be made of two surveys by R. W. Goode several years ago, for they bear on the subject of irrigation of the trans-Pecos lands by means of storage reservoirs. One of these surveys was of a reservoir site nine miles south of Marfa, Presidio County. The approximate area of the catchment basin, which comprised the upper part of the valley of Alamito creek, was 440 square miles. It extends twenty-two miles north of Marfa, eleven miles east, four and a half miles west and ten and a half miles south. The proposed dam was ten and a half miles a little west of south from Marfa. The surface area of the reservoir was 1.43 square miles and the height of the dam was 100 feet. It was calculated that a run-off of one and one-third inches from the entire catchment basin would fill the reservoir and give sufficient water for irrigating about 20,000 acres. The other survey was of a tract of land in Brewster County, the reservoir site being seven miles north-east of Alpine. The approximate area of the catchment basin was 203 square miles. It extended about nine miles north of Alpine, five miles east, ten and a half miles west and six miles south. The surface area of the reservoir was 1.45 square miles and the height of the dam was fifty feet. It was calculated that a run-off of one and one-fourth inches from the entire catchment basin would fill this reservoir and give sufficient water to irrigate about 7000 acres.

Neither of these proposed reservoirs would supply water for undivided public school lands, nor is it known just how much school land would be benefited.

There is a possible reservoir site in the foot-hills of the Sierra Diablo, three miles north of Allamore, El Paso County. Here the approximate area of the catchment basin would be fifty square miles. But at this place also we came in contact with the alternate section system and we do not know how much public school land would be susceptible of irrigation.

If any definite information is to be acquired concerning the possibility of

irrigating even a portion of the large undivided blocks of public school land it will have to be on the initiation and at the expense, in whole or in part, of the State. Up to this time but little has been done under State authority, although a start has been made under a plan of co-operation between the University Mineral Survey and the United States Geological Survey. Last year Mr. George Burr Richardson of the Government Survey was detailed to work under this plan of co-operation and he examined that portion of El Paso County which lies north of the Texas & Pacific Railway with special reference to the water problems. It is in this part of the county that the larger undivided blocks of public school land are situated. Mr. Richardson's report is now in press and may be obtained upon application to the University Mineral Survey, Austin.

In further pursuance of this plan of co-operation an additional 30-minute quadrangle is now being surveyed by a topographic corps of the United States Geological Survey, under charge of Mr. Arthur Stiles. This area of about 1000 square miles lies north of Van Horn, El Paso County, and includes the Sierra Diablo. With the completion of this work we shall have nineteen excellent topographic maps within the trans-Pecos country, to wit: El Paso, Cerro Alto, Salt Basin, Van Horn, Rio Grande, Fort Hancock, Sierra Blanca, Eagle Mountain, Chispa, Valentine, Fort Davis, San Carlos, Marfa, Alpine, Ruidosa, Shafter, Polvo, Terlingua and Chisos. These sheets cover an area of about, 14,000 square miles, or nearly one-half of the entire area west of the Pecos River.

With the exception of some large undivided blocks in Reeves County these maps embrace nearly all of the undivided school lands. They may be used for estimating the areas of catchment basins and for detailed study of the more favorable sites for reservoirs.

#### EXPENSE BORNE BY FEDERAL GOVERNMENT.

The National Government has done this work at its own expense, with the exception of about 1600 square miles comprised in the plan of co-operation referred to. In other words, the National Government has borne the entire expense of preparing excellent topographic maps of more than 11,000 square miles of country in West Texas in which it had no ownership interest whatever. It has done all that could reasonably be expected of it and it now remains for the State to assume further consideration of this matter.

How much of the public school lands in West Texas is susceptible of irrigation? We do not know.

What is the character of the soil and for what purposes is it best suited? We do not know.

There is an impression in some quarters that vast tracts of this domain would produce almost any kind of crops if sufficient water of good quality were brought upon them. This may or may not be the case; we have not data enough for a reliable opinion. But we do know that there are extensive tracts which, to all appearances, would not respond profitably to such attempts at betterment. There has been, it is true, little systematic study of this subject, but in the nature of things there must be radical and far-reaching diversities of soil in so large an area. What then is to be done?

## NEED FOR STATE ACTION.

The State should give authority and means to the General Land Office to inquire into these matters. The General Land Office may have the authority now but it certainly has not the means. How may the means be provided? By setting aside each year a certain proportion of the money derived from leases and interest on sales for the survey of lands that might be improved by irrigation. The money so obtained would, of course, have to be replaced from other sources, for it belongs to the general school fund, but it is sound policy to use a portion of the revenue derived from a portion of any property for the improvement of other portions. For the two years ending August 31, 1902, the interest receipts from sales of all school lands, wheresoever situated, were \$1,005,152, and from leases, \$869,775, a total of \$1,874,927. One half of one per cent of this sum would provide an annual sum of \$9,387 for irrigation surveys.

The sum of \$10,000 a year for each of two years would be sufficient for irrigation surveys, especially when we consider that the active and substantial aid of the National Government could be secured. This would involve merely the extension of plans that have been carried out, with respect to topographic surveys during the last two years. In the light of what has already been done, with respect to co-operation, it may not be too much to say that the National Government, through its Geological Survey, would contribute to the study of irrigation problems in Texas an amount equal to that which the State would contribute. Furthermore, it would be possible to secure the services of trained men who have made a study of such questions and who would bring to their solution practical experience of the highest order.

## THINGS TO BE DONE.

Looking at the matter in a broad way there are four things to be considered.

1. The chemical and mechanical composition of the soils.
2. The topography of the areas in hand.
3. The geological structure of catchment basins and of reservoir sites.
4. The suitability of local materials for the construction of dams.

For the elucidation of these matters specially trained men are required. It is not every chemist, or topographer, or geologist, or engineer who has had opportunity to acquaint himself with the necessities of such work. We are dealing with a region concerning which but little is known, in so far as relates to the possibilities of irrigation, and it would be idle to place its investigation in the hands of any but trained men.

For the improvement of its own lands the State must, so to speak, put its hand into its own pocket. It would not have to incur the entire expense, but it must be willing and able to pay an equal part.

It is not likely that the value of the public lands in West Texas will increase except as the demand for them as grazing and agricultural lands increases and this can hardly be effected unless some assurance be given that the water supply is to be improved.

**FORAGE CROPS FOR IRRIGATED LANDS.**

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Washington, D. C.

Alfalfa is beyond all question the most important forage plant on the irrigated lands of the West. It is the greatest hay plant in the world. In the State of Washington, on irrigated lands, it gives three to four cuttings of hay a year, while in Southern California near the Mexican line, eleven cuttings annually are reported. In the vicinity of Los Angeles, California, it is cut eight times. In Southern Texas, in the vicinity of Carrizo Springs, nine crops a year are obtained from the alfalfa fields. The yield of hay of course depends upon the fertility of the soil. The average yield of alfalfa hay for the whole United States according to the census of 1899 is two and one half tons per acre, while the average of the ordinary perennial grasses is one and one-tenth tons. On the irrigated lands of the West, a good farmer expects at least five tons of alfalfa hay per acre annually. A good many farmers get as much as eight tons, and a few instances are recorded of yields between eleven and twelve tons per acre.

**ALFALFA AN ANCIENT CROP.**

The alfalfa crop was introduced into California by the Spaniards in the early days. When gold was discovered there, prospectors from the Eastern and Middle States found this new and strange forage plant growing in the vicinity of the monasteries where it was used for food for their live stock. As irrigation developed in the West, cultivation of alfalfa spread until it is now the principal forage plant on all of the irrigated lands of the West. It took a great many years for the eastern half of the United States to become thoroughly interested in this crop, but for the past five years it has rapidly invaded the East. It has not been found successful on all types of soils but wherever there is a good rich soil, not too wet, it has succeeded, and the acreage of it at the next census will doubtless be fully twice what it was at the last.

The advantages alfalfa possesses over other hay producing crops are: first, its great yield; second, its richness in protein or nitrogenous material, thus making it, to all intents and purposes, a concentrated feeding stuff. The fact that it draws its nitrogen supply from the atmosphere instead of from the soil makes it a valuable manure and gives it an important influence as a nitrogen fertilizer. For this reason alfalfa does not exhaust the soil as do wheat, corn, oats, and other cereal crops. Another great advantage of this crop is its longevity. Under favorable conditions alfalfa fields last almost indefinitely without reseeding. The yield usually increases for three or four years after sowing and then remains large for ten to twenty years, or even longer. There is one small field of it in South Carolina sixty-nine years old still yielding fair crops. Many fields in the West are doing well at twenty-five and thirty years of age. Ordinarily, however, weeds get in and the trampling of stock pastured on the field kills out plants here and there, so that after twelve or fifteen years it usually pays to plow up the field and reseed it. Another great advantage alfalfa possesses lies in the fact that it

can be fed alone with very good results. This is not ordinarily the best way to feed animals, but almost all kinds of stock do fairly well when fed nothing but alfalfa. In many parts of the irrigated West, dairy cows live on alfalfa the year round and give a good flow of milk. This is an exceedingly cheap way of feeding. It is true the cows would give more milk if fed a little grain with the alfalfa, but it would frequently be inadvisable to feed the grain on account of the cost. Alfalfa is also the best hog pasture in the world. On abundant alfalfa pasture hogs thrive very well without other feed, but where grain is available, the best way to handle hogs on alfalfa is to feed them about one-third of a full grain ration. If grain for this purpose can be had at a reasonable price, there is no better way for raising hogs.

#### A WIDELY DISTRIBUTED FORAGE CROP.

Alfalfa has also very wide adaptability as regards climatic conditions. It thrives from Montana to Mexico, and from California to New York under practically all kinds of temperature and moisture conditions, but it wants good soil. It would be strange that a plant with so many qualities in its favor should have no faults. Alfalfa has its faults, the most serious being the fact that when cows or sheep are pastured on green alfalfa they are very liable to suffer from bloat. In Central Washington farmers state that they lose about five per cent of their cattle annually from bloat, yet they insist on pasturing their cattle on the fourth crop of alfalfa, saying that it pays to do so in spite of these losses. While green alfalfa bloats cattle and sheep, dry alfalfa hay is as good feed for this class of stock as can be found.

The effect of alfalfa on soil fertility has already been mentioned. The fact that so much of the irrigated lands of the West have been devoted to this crop has prevented the possibility of drawing conclusions from the effects of farming on the fertility of irrigated lands. This subject will be referred to below.

Next to alfalfa, sorghum is the most important forage crop on irrigated lands of the West, particularly in the southern half of the irrigated section. By this I mean both the sweet sorghums and nonsaccharine sorghums, such as Kafir corn, dwarf milo, etc. On good land under irrigation, sorghum yields enormous quantities of good feed. It is mostly utilized as green feed, for which purpose it is an excellent crop, all kinds of stock eating the ordinary sweet sorghums in green state eagerly. I was very much interested in a bit of information I picked up recently in Los Angeles in this connection. Sorghum yields enormous quantities of fodder in that section, but the farmers state that they can get more milk by feeding straight alfalfa than they can by feeding part sorghum and part alfalfa. The reason for this undoubtedly lies in the fact that the sorghum is a less concentrated feed than the alfalfa; but for idle animals there is no doubt that green sorghum mixed with perhaps a little alfalfa would be an ideal ration, and it could be utilized for animals that are at moderate work.

#### KAFIR CORN.

Kafir corn is extensively grown on irrigated lands in New Mexico and Western Texas and would undoubtedly succeed throughout the southern half

of the irrigated region. It is grown mostly for grain. It yields large quantities of grain which makes very good stock feed. The value of Kafir corn seed is probably about nine-tenths that of corn for feeding purposes. I was very much interested recently in a crop which was new to me but which I found growing extensively in the Panhandle Country in Texas and in part of Oklahoma. The farmers there call it "maize" or "milo maize," and sometimes "dwarf milo maize." The plant is not a maize at all but is a sorghum, and we have recently bought a hundred bushels of the seed of this plant and are distributing it under the name of dwarf milo. We do not yet know what it will do on irrigated lands in the West, but it is certainly worthy of attention. It somewhat resembles Kafir corn but yields more grain of a better quality. It is also a greater drought resister than Kafir corn. In fact, so far as I know, it is the most drought resistant of any grain crop known in this country. We hope within another year, by means of the distribution we are now making, to ascertain what parts of the country are adapted to the cultivation of this crop. The seed is larger than that of Kafir corn and is more brittle and seems to be better relished by all classes of stock.

#### BERMUDA GRASS.

Bermuda grass has attracted more or less attention on the irrigated lands, particularly on the southern half of the West. This grass, on good land, in a warm country, is perhaps the best pasture grass in the world, but it is very tenacious of life and when once started in an alfalfa field, the only remedy I know is to plow up the field, as it will choke out the alfalfa. It is not difficult to control Bermuda grass if one understands its nature and habits, except in regions where it produces seed as it does in Southern California, Southern Arizona, Southern Texas, and Central and Southern Florida. In sections where it produces seed and where irrigation is practiced it spreads along the irrigating ditches and it is well nigh impossible to control this grass. For this reason great care should be used not to get it started in the sections mentioned. Where it does not produce seed, it can be killed out by growing crops that make a dense shade, such as millet or sorghum sown at the rate of two bushels of seed per acre in summer, and oats or barley in winter. It will not stand shade, and being of a low growth, it is overtopped by the taller growing crops mentioned and thus smothered out.

Johnson grass is also getting introduced on the irrigated lands of the West. This grass is, of itself, a splendid hay grass, but it is so tenacious of life and so vigorous a grower on irrigated lands that it is nearly impossible to grow other crops where it has once been started. Whether alfalfa can be successfully grown on Johnson grass land in the irrigated section, as it can be in the nonirrigated section further east remains to be seen. Johnson grass produces a great many underground stems and soon forms so dense a sod that within two or three years it makes comparatively little growth unless cultivated. When Johnson grass land is plowed up, the roots harrowed out of the ground as much as possible and then alfalfa is sown, by cutting the alfalfa very promptly before the Johnson grass overshadows it and keeping this up for two or three years, the alfalfa usually gets ahead of the Johnson grass, and within six or eight years it practically disappears, leaving the alfalfa

alone. This plant may not succeed on irrigated land but it is worth trying for the reason that it has succeeded further east.

#### FORAGE CROPS MAINTAIN SOIL FERTILITY.

One of the principal reasons for growing forage crops is to maintain soil fertility. On nonirrigated lands in the East this is a question of much importance. As intimated above, we do not know a great deal about the effect of irrigation in preventing the wearing out of cultivated lands, yet a few facts of interest are at hand. Where the irrigation water contains the surface wash from surrounding regions and is loaded with a good deal of decaying organic matter which has been washed from the surface of the soil and leaves this matter as a deposit on the irrigated fields, it would seem that there is a gradual increase of fertility up to a certain maximum which is afterwards maintained, so that lands irrigated with such water do not wear out. Where the irrigation water contains no humus making material conditions are different and the land does wear out sooner or later, not so fast, however, as nonirrigated land, for the irrigation water from ordinary streams, even when perfectly clear, contains a considerable amount of mineral plant foods in a state of solution, thus carrying to the irrigated fields a good deal of fertility and decreasing the draft upon the soil made by the growing crops. It is true that irrigation has been practiced for many ages in some parts of the world, but not in those regions where careful scientific investigations have been made or the relation between irrigation and the maintenance of fertility. Irrigation is too new in our own western country to give very positive results as yet. Studies of this kind, however, are now in progress and we hope within the next few years to be able to learn something more definite on this point.

## ROTATION AND IRRIGATION.

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The producing power of Western soils is proverbial. In some instances it is so great as to exceed the claims of fabled story and to bring into the mind the thought of that golden age when the earth gave up its generous crops without any labor from man. Soils in the Red River valley in Minnesota and Dakota have produced as many as twenty-five crops of hard Fife spring wheat in an unbroken succession. Those around Walla Walla in Washington have grown good winter wheat for nearly fifty successive years, and in some of the valleys of California and others of the mountain States, it is claimed that alfalfa meadows have been grown and cut for twenty-five to thirty successive seasons, and some authorities claim for even a longer period. Such results seem almost incredible to the inhabitants of New England and many parts of the Southern States, where, if one is to get a paying crop, he must first apply some fertilizer, which in nearly all instances is more costly than the labor entailed in preparing the land. Nor can he succeed as a rule in growing the same crop two years in succession without diminution in yield, unless special attention is given to the fertilization of the land. Truly, therefore, may western farmers say that the lines have fallen to them in pleasant places and theirs is a goodly heritage.

But will they care for it as they may and as they ought to? Man is singularly constituted. The doctrine may seem strange, but it is true, that with reference to the maintenance of soil fertility, man will only do what he is compelled to do. Naturally he is a soil robber, not having the slightest regard for those who come after him or even for his own distant future, and it is to be feared that the farmers of those western irrigated lands will form no exception.

Just as sure as the sun shines, the growing of successive crops the same in kind will some time end in agricultural disaster, hence the imperative need of giving attention to the matter of the proper rotating of crops. The farmers of the Red River valley do not get crops of wheat so uniformly good as they did when their lands first came to be tilled. The farmers who grow wheat around Walla Walla and other parts of Washington are not always going to get 30 to 60 bushels of wheat per acre from their lands as at present managed, nor will those around Vernon in the same State continue to reap 100 bushels of oats per acre as regularly as the seasons come and go. The farmers of Illinois who have grown corn successively on this same land for seventy-five years have brought the yield down to twenty-five bushels per acre, whereas lands in the same vicinity farmed by a rational system of rotation still produce from 75 to 100 bushels per acre. Hence, just as sure as irrigating waters run toward the sea, disaster will overtake the operations of the farming of those wonderful mountain valleys unless sufficient attention is given to the proper rotating of crops.

### CROP ROTATION NECESSARY.

The soil calls for the rotating of crops in order to maintain its fertility. Suppose the same crop is grown for successive years upon the same land and



nothing returned, and that the crop is not a legume, it follows that the nitrogen, phosphoric acid and potash, the three most essential elements of plant growth in the soil, will be reduced by the amount removed in each crop. It cannot be otherwise, therefore, than a time must come if the process is continued long enough, when the crops grown will not be able longer to get enough of one or the other of these ingredients. The moment that any one of them is so reduced that the crop cannot get a sufficient supply, it falls below the maximum in production.

The first of these that is likely to fail is nitrogen, since it is the most soluble. When purchased in the market it is the most costly. When soils become nitrogen hungry, only one of two things can be done if maximum crops are to be produced. Nitrogen must be bought and applied at a cost of fifteen to eighteen cents a pound, or plants must be grown which have the power of supplying it from some outside source. Happily for the race, one whole family of plants has the wonderful power of drawing nitrogen from the air and depositing it in the soil to supply the crops that come after them. This is one of the most astonishing and beneficent truths in agriculture and also one of the most important. But the man who goes on growing successive crops of the small cereals on his land has no more regard to the value of this truth than the mole which burrows in the soil which he tills. These legumes include all kinds of clover and alfalfa, and all kinds of peas and beans. By growing one or the other of these in proper rotation the supply of nitrogen in the soil can be maintained and even increased.

#### TO SUPPLY PHOSPHORUS AND POTASH.

But how shall the supply of phosphoric acid and potash be maintained in soils, as legumes cannot increase the supply of these? On the other hand they draw upon the same while they grow. In the first place, most soils are furnished with enough of these to grow crops for a very long period. Western soils are particularly well stored with these as witnessed in the enormous fruitage in proportion to the straw, in grains, and to the size and quality of fruit produced by fruit bearing trees. In the second place, certain crops gather of these in the subsoil lower than the roots of other plants can go. If these crops are grazed or fed and the manure resulting put back upon the land, the equilibrium in the supply of these in the surface soil can be maintained. No plant grown probably is the equal of alfalfa in its ability to gather phosphoric acid and potash in the depths of the subsoil for use in the upper sections of the soil. If the amount of these elements thus brought is less than the amount utilized by the crops grown and sold from the farm or ranch, then the only resource left is to maintain the equilibrium by purchasing phosphates and potash.

In the judgment of the writer a judicious use of alfalfa in the rotation in irrigated areas would maintain a sufficiency of these elements in the soil to produce crops for an indefinite period. This, however, is on the condition that the fertilizer resulting from feeding alfalfa is put back on the land.

## WATER A MANURE.

A third source from which these fertilizers can be obtained is the waters of irrigation, a source of fertility which puts the irrigator on a far higher plane of vantage ground than the farmer who depends upon rain. In other words, irrigating waters are usually much more heavily charged with fertilizing matters than rain waters, owing to the fertilizing matters which they carry in solution and much of which is left in the land as it filters through the same. The amount of these fertilizing materials is dependent largely on the character of the soils through which they previously have filtered or flowed over in their descent toward the plain. The more vegetable matter there is in the soil which those irrigating waters are made to filter through when they are applied, the more the fertilizing matters that will be extracted from them. On the other hand it is easily possible for water passing downward through soil to carry downward and away from it elements of fertility already there. When water is applied in excess it is certain to do this, hence the tremendous importance of adjusting the water to the exact needs of the crop.

## ROTATING IMPROVES MECHANICAL CONDITION OF SOIL.

But the soil also calls for rotation in order to keep it in a proper mechanical condition, that is, to so adjust the relation of the soil particles to one another that the soil will be sufficiently porous and sufficiently compact to make maximum production possible. When soils become too porous they become too leechy and suffer loss of moisture too readily from surface evaporation. Sandy soils are sure to suffer in this way unless supplied with enough vegetable matter to prevent such loss. There are only two ways of doing this. The first is the application of farmyard manure and burying it in the soil; the second is by growing on it some deep-rooted crop, the roots of which fill the spaces between the soil particles in their decay. When these spaces are thus filled in soils, their power to arrest and hold water for the growing crops, whether it comes from above or below, is greatly increased. The bearing of this upon the amount of irrigating waters used is most direct and far reaching. The more vegetable matter thus supplied to the soil, the less the amount of the waters of irrigation that are required. It would probably be correct to say that the amount of irrigating water absolutely needed could be reduced by one-half. This vegetable matter could be supplied by now and then sowing alfalfa or some other legume, but of these in the mountain regions none is so suitable all in all as alfalfa, for reasons that will be given later. The application of this principle to the soils of many areas in the West where irrigation is impracticable would work wonders in the producing powers of the same.

The lack of a sufficiency of humus in loam and clay soils allows them to become so impacted that they become cloddy, rather friable. The particles lie too closely to admit of proper aeration or filtration. The bacteria concerned in soil improvement become less active and these soils do not dry out quickly enough when water is applied to them. The remedy is the same as in the former instance, viz.: to keep them supplied with vegetable matter

on the plan outlined above. Such matter lying between the fine particles of soil prevents them from adhering to one another. Humus thus supplied in sandy and loam soils is a two-bladed axe, both blades of which cut with equal effectiveness.

#### WEEDS A FACTOR IN SOIL ROTATION.

The weeds of the crops grown upon the soil call for rotation for several reasons. First, if only one crop is grown for successive years the element or elements of fertility which it draws most heavily on are very likely to fail first. As soon as they do through even partial exhaustion, maximum crops cannot longer be grown. If, on the other hand, an interchange has been made in the crops grown, by introducing varieties that drew most heavily on the different elements of fertility in the soil, the period of maximum crop production would have been longer maintained, for reasons that will be at once apparent.

Second, some crops feed ravenously on decaying vegetable matter. Where it is sufficiently present, yields will in some instances be doubled as compared with soils in which it is absent. Such are some of the small grains, Indian corn, sorghum, field roots, rape, flax, potatoes, and in fact nearly all non-leguminous crops. But the humus thus helpful cannot be maintained without occasionally putting vegetable matter in the soil and in no way can this be done so cheaply as by growing it there.

Third, where the same crop is grown on soils for an indefinite period, the difficulty in warding off disease is very greatly increased should it appear. It has been the story of disease in field crops or fruit, that it multiplies eventually with increase in the continuance of growing one crop without change. In this way the abandonment of the growth of certain crops in various countries of the world and in some of the States of the Union has been forced, as illustrated in the practical abandonment of wheat culture because of the prevalence of chinch bugs in certain areas and because of the presence of certain fungous diseases in others. Alfalfa happily is more free from disease and insect enemies than other crops, but it is by no means immune. The deadly dodder is increasing in alfalfa fields at an alarming rate in some parts of the country, and in no way can its ravages be so effectively met by a change in the rotation. Disease in the alfalfa crop to the extent of endangering its general cultivation would be the greatest agricultural calamity that could come to this western country.

The farmer who grows but one crop in irrigated areas is happily free from the hazard that the farmer incurs in regions of rainfall of having that one crop greatly damaged by rain, but he does incur the danger of having much of it waste through inability to care for and market it at the proper season. In some of the western hopyards, acres and acres of hops have gone back to earth ungathered some seasons because of inability to get help to do the work of picking, and this is one of the most highly productive hop-growing areas in all the world. What a sad story it would make if it could be told, as to the bushels and bushels of rich ripe fruit that have rotted in this western country because those who grew them were unable to gather and market them.

### LIVE STOCK GROWING CALLS FOR ROTATION.

The needs of the farmer imperatively call for rotation if he is to keep live stock on his farm or ranch. Unless he does his foods will not be in balance. He will have too much protein in the one instance or too little in the other, and he will also need to purchase foods to keep up the equilibrium. It is an axiom in agriculture that the intelligent farmer can usually grow foods more cheaply than he can buy them, hence the wisdom of rotating crops on the part of those who grow live stock.

The growing of live stock will in the end prove the safest and most profitable kind of farming to the average rancher with large holdings. Fruit may glut the market during any very productive season. Hops may again sink below the price of profitable production, but as long as the sun continues to shine in the favored area and as long as the snow rests upon its mountain peaks, just as long will there be a reasonable demand for live stock and live stock products that will amply repay the grower. Through growing live stock, the rancher is compelled to diversify and rotate, and through the same medium he secures fertilizing materials for the land and virtually without cost.

But what, it may be asked, will be the character of the rotation? That will depend largely on the leading line of production. For instance, the rotation of fruit culture will be different from that in grain farming, and in growing live stock and live stock products it will be different from both. What is imperatively insisted on in this paper is that rotation shall be practiced in all the irrigated country, as well as in that where irrigation is not required.

### ALFALFA THE STAR LEADER.

As to the plant that will form the basis of the rotation, there need not be any doubt. That plant is alfalfa. This claim will seem all the more surprising when it is remembered that alfalfa is not usually regarded as a rotation plant. In the Mississippi basin and in the East, many farmers object to growing it because it is not a rotation plant, but the behavior of alfalfa in the West is very different from the same in the East. In the East it grows much more slowly and delicately. There it has in a sense to be nursed to get it safely through the first winter. Here it grows with the vigor of a weed and produces one to two cuttings the first season. Of course the clovers may also be used in soil renovation, and Canada field or cow peas, but of all soil renovating crops that can be grown on irrigated lands, alfalfa would probably be the most valuable, and because of its extended and extensive root system. It not only brings nitrogen nodules to the soil for some distance below the surface for its enrichment, but the roots of the alfalfa in their decay also bring humus to lower areas of the soil and subsoil than other plants and they open up channels which facilitate the movements of water in soils.

In orcharding no fitting of the soil for planting will compare with that which is furnished by an alfalfa sod broken up and prepared by some careful and patient plowman. The decaying roots of the alfalfa furnish food to the trees for years. The roots of the trees easily follow the minute channels

made by the alfalfa roots as they reach down in search of food, and if alfalfa or clover is sown upon the orchard and buried in the same from time to time the feeding process goes on from year to year. Thus managed fertility in orchards should be matured without great cost.

When alfalfa or some other legume precedes a pasture crop grown for fattening animals, the results will be wonderfully helpful. Such are crops of peas grown for fattening sheep or swine while grazing on them in the mature form. Swine pastured on alfalfa with a small grain ration added and then finished on peas consumed by the swine where they grew, will make pork more cheaply than it can be made in the corn belt, and of the very high quality. So likewise peas can be utilized in fattening sheep and lambs when preparing them for market. Or immense crops of rape could be made to follow on those lands adequate to the fattening in good form of fifteen sheep or lambs per acre when grazed upon it and without the necessity of adding a pound of grain. Eight to twelve weeks of such grazing would fit the animals for any market in the United States. Good crops of rape could doubtless be grown on many soils not thus preceded by alfalfa or clover sod, but the yields of the same could in some instances be doubled by growing them on over-turned alfalfa or clover roots.

#### TIMOTHY AFTER ALFALFA.

Timothy of all grasses grown stands king among the grasses of America in furnishing suitable hay for horses. This crop can be grown, as everyone knows, on ordinary mountain valley soils except where the summer climate is too hot, but if grown in an alfalfa or clover rotation, the yields will be immensely increased because of the abundance of the nitrogen in the soil and for other reasons. Similar results will follow from the growing of any kind of grass which it may be necessary to grow. All the grasses pure and simple require much nitrogen to produce a maximum of growth, and this need is met by the roots of the legume in their decay.

But nowhere will results more beneficent be furnished than in following an alfalfa or clover crop by one of small grain or Indian corn, or any of the saccharine or non-saccharine sorghums. With such a rotation enormous crops of wheat, coarse grains, corn and sorghum may be grown. Which of these should be given the right of way in growth depends upon the requirements of the grower and the climate. Where the grower can secure from forty to sixty bushels of barley per acre or sixty to eighty bushels of oats, why should he care whether or not corn was accessible for the fattening of live stock. With from three to four crops of alfalfa per acre and the yields of grain given above on other portions of his land, why should the ranchman of the mountain valleys fear competition in fattening cattle or sheep from any part of the United States? The fact is now known that cattle may be fattened on alfalfa hay as against fattening on corn and corn fodder by using only one-third as much grain in the fattening process. The same is true of sheep.

**PLOW UNDER THE LEGUMES AND MAKE NITROGEN.**

Should the small ranchman be growing garden truck or potatoes, in no way can he so cheaply or so effectively fit his land for growing good crops of these as by burying every few seasons a crop of clover or alfalfa in the soil. In some instances the results will be as good should the alfalfa or clover crop be first reaped and the land then plowed. Such a rotation is peculiarly adapted to the needs of the potato crop.

The frequency with which the alfalfa crop should thus be grown when grown as a rotation crop will depend upon such conditions as the needs of the soil and variety in the crops wanted. The rule is a safe one that would not grow more than two or three crops of small grain between the alfalfa crops. The age at which alfalfa thus used as a rotation crop should be broken will depend upon soil conditions and the ease or difficulty found in plowing the land.

With soils of great natural richness and so easily tilled as nearly all irrigable lands are in the West, and with opportunities so complete for supplying his lands with nitrogen and humus and with good and widening markets for his crops, why should not the western ranchman be prosperous and happy? Why should he not be able to maintain fertility in his lands and increase their producing power, handing them down to his family a legacy of great value? He has the choice of doing this or of so robbing them that in time they will fail to grow paying crops. It rests with him to say which he will do.

## IRRIGATION AND ALKALI.

O. V. P. STOUT, Irrigation Engineer, Nebraska Agricultural Experiment Station, Lincoln, Nebraska.

When "Production by Irrigation" is the subject for discussion it is proper that a fair share of attention should be given to the alkali evil, for it is without doubt a product of irrigation, and its intimate relation to all other products of irrigation is one that has become painfully manifest in many localities.

The subject is not altogether a new one, even in arid America. About twenty-five years ago Dr. E. W. Hilgard, in a report to the regents of the University of California, presented the following:

"This name (alkali soils) is applied in California, almost indiscriminately, to all soils containing an unusual amount of soluble mineral salts, whose presence is frequently made apparent by the 'efflorescence,' or blooming-out on the surface, of a white powder or crust, soluble in water. This 'alkali' becomes most apparent in dry weather following upon rains or irrigation. Later in the season it usually becomes less perceptible from intermixture with dust, as well as from the failure of the soil water to rise near enough to the surface. The first rain, dissolving the salty substances, carries them partly into the water courses, but chiefly back into the soil, whence they rise again at the recurrence of dry weather.

"The immediate source of the 'alkali' is usually to be found in the soil-water, which, rising from below and evaporating at the surface, deposits there whatever of dissolved matters it may contain. Such water, when reached by digging, is by no means always perceptibly salty or alkaline, and the same is mostly true of the soil, an inch or two beneath the surface. For since the soil, acting like a wick, draws up the soil-water and allows it to evaporate at the surface, it is *there*, of course, that all the dissolved matters accumulate, until the solution becomes so strong as to injure or kill all useful vegetation. The injury will usually be found to be most severe just at, or near, the crown of the root, where the stem emerges from the soil.

"One obvious and practically important conclusion to be drawn from the above considerations is that the more water evaporates from the surface of the soil within a season, the more alkali salts will be drawn to the surface. Hence, within certain limits, a greater rainfall will bring up a larger amount of alkali; or if, instead of rain, surface irrigation is made to supply an additional amount of water, the same effect will be produced; *always provided*, that the rainfall or irrigation does not go so far as to actually wash a portion of the salts definitely beyond the reach of surface evaporation, into the lower strata, from which springs or seepage will carry them into the country drainage.

"The measure of the rainfall, or amount of irrigation water, that will accomplish one or the other of these opposite results depends in a large measure upon the nature of the soil, as well as of the underlying strata. It is more difficult to wash the soluble salts out of a clay soil than out of a sandy one; and the moisture and accompanying salts will keep rising through the

former from greater depths, and for a greater length of time after the cessation of rains or irrigation."

Under the head of "Reclamation of Alkali Lands" he continues:

"The most obvious remedy for this evil is, of course, the leaching-out of the injurious salts by flooding, and, if possible, *under-draining*. This method is habitually resorted to in seacoast marshes, near the mouths of rivers, after the salt water has been excluded by embankments.

"The limited salty spots so frequently met with in the uplands of some regions, are promptly cured by a few underdrains, through which the winter rains wash the salts definitely beyond the reach of the soil-water. Such spots are commonly found extraordinarily fertile afterwards.

"The problem of affording relief, however, becomes much more difficult when either a stratum of saline water or an earth layer containing much saline matter lies a few feet beneath the surface in a level region, as is, unfortunately, very often the case in California. When this happens, the evil can only be mitigated, but scarcely altogether cured. According to the value of the land to be reclaimed, one or several of the following remedies may then be employed:

"1. When the 'alkali' is not very abundant or very noxious, *frequent and deep tillage* may afford all the relief needed. For, inasmuch as the damage is in most cases the result of an excessive accumulation *at or near the surface*, it is clear that frequent intermixture of the surface layers with the deeper portions of the soil may so dilute the injurious salts as to render them powerless for harm.

"Moreover, since a perfect tilth of the surface greatly diminishes evaporation, it tends to diminish, concurrently, the accumulation of the alkali near the surface. The same effect may be produced by mulching, or by covering the surface with sand.

"With the aid of deep tillage, it is often possible to raise on salty seashore lands, root crops, such as beets or carrots, which absorb a large amount of soluble salts, and sensibly relieve the soil so that cereal crops may be grown in the second or third year.

"2. *Underdrains* may so far lower the water table from which the saline matters are derived, and may so far favor the washing out of the salts during the rainy season that the latter will thereafter fail to reach the surface so as to accumulate to an injurious extent, with reasonably deep tillage. The roots of plants will go deeper for the requisite measure, but will not be injured by the weak saline water below.

"With the aid of underdrains, in many cases a comparatively small amount of irrigation water may, when applied at the proper time, be made to produce the leaching effect upon the surface soil that would otherwise require a long time and a much larger quantity of water in order to wash the alkali into the country drainage.

"3. When the quantity of the salt or alkali is small, but its nature such as to be nevertheless very injurious or corrosive, the evil may be greatly mitigated or sometimes completely relieved by the application to the soil of *chemical antidotes* cheaply procurable in commerce. In order that the proper



antidote may be chosen, it is of course necessary to determine the nature and in a measure the amount of the "alkali," by chemical analysis."

This extensive verbatim quotation has been made, not only because of its truth and completeness, but because it serves to emphasize the fact that progress in respect to the reclamation of alkali lands, or the redemption of lands which have passed out of cultivation or are about to do so in various parts of the irrigated West, has been remarkably and unjustifiably slow. The statement which has been quoted was made at a time when a large part of the irrigation in this country was in its inception, and was made in a report which presumably has had an extensive circulation in the regions most directly affected and among the men who from the scientific, agricultural and practical or financial standpoints have been most interested in the subject. The additions which have since that time been made to the theory of the rise of the alkali and to the conceptions of the practical and effective methods of combating it, while they have been by no means unimportant, have been chiefly in the nature of minutiae or details, filling in along the line that was marked out so many years ago. It is surprising, in view of the fact that every laboratory investigation or scientific study, and every practical test that has been made since the foregoing statement was published, have fully confirmed the truth of the statement and the judgment of its author, that only a very limited application has been made of the principles which were enunciated. Tracts of land here and there in the irrigated region which have become charged with alkali on the surface have been drained, with the result that the land has been restored to crop production. These instances, while comparatively few in number and of small magnitude, are fairly well distributed geographically and many of them have been well described in publications which have had extensive circulation.

#### HAVE REVERTED TO DESERT.

Still it is true that township after township of land all over the irrigated West, and in localities where neighboring lands suitable for irrigated agriculture or horticulture have the highest values, are lying to-day under a crust of alkali which precludes the growth of crops of any kind, and no move is on foot for their reclamation. The soil under the alkali crust is of a nature which, in the absence of the concentration of the alkali, insures the most liberal returns to cultivation. Therefor even a heavy expense, in many instances far exceeding that to which eastern farmers are accustomed when they undertake to drain their wet or overflowed lands, would be justified and would prove a good financial investment. That very little of the work has been done goes to show that the vaunted western alertness to opportunity is not all-pervading or universal.

I think that I am quoting one of Dr. Hilgard's later expressions, as well as stating a demonstrable proposition, when I say that under-draining of the affected land is the only complete remedy or certain preventive in any case. In view of this fact, and in deference to the limits of this paper, therefore, no more than incidental attention will be given to any of the other remedies or palliatives which have been mentioned.

### DRAINAGE HANDMAID OF IRRIGATION.

It has been truthfully said that drainage should be considered in connection with irrigation works at their inception in every instance. This does not mean that drainage works should be constructed in connection with every system of irrigation works, although the exceptions are remarkably few. Neither does it of necessity follow that in all cases in which it is decided that works of drainage will be needed they should be constructed at the time that the irrigation canals are built, although it will usually be found that the construction presents fewer difficulties at that time than at any later period. An advantage in postponement arises, however, from the fact that it will give opportunity to observe the tendencies in respect to the rise of the ground water and the alkali, thus furnishing a basis upon which the location and dimensions of drains may be determined accurately in accordance with the purpose which they are to serve.

It will sometimes be found that the entire area irrigated or to be irrigated has a good slope and is underlaid at a moderate depth by a bed of gravel, so that adequate natural under-drainage is assured. More frequently, however, this condition does not obtain over the whole area under ditch, and unless artificial drainage is provided the lower lands and those of least slope will become swamped or alkali. When canals are constructed in extensive plains of little slope it may be assumed at once that artificial under-drainage of practically the entire irrigated area will sooner or later be necessary.

### IRRIGATION DRAINAGE A NEW SCIENCE.

The design of a drainage system to counteract the rise of the ground water which results from irrigation involves some considerations of a decidedly different nature from those which come before the drainage engineer of the Middle West who is called upon to design a system for the removal of excess of water from the surface of the land. The permanent service which the drains in irrigated land should render is the prevention of the rise of the ground water to a height such that the capillary action of the soil can bring the water and the dissolved alkali to the surface. That is to say, practically all of the water which the drains receive, after the regimen of the system has been once established, is that which comes up to them through the soil. They must be large enough to receive this practically as fast as it comes when rising at the maximum rate. Correspondingly, in the humid region, the drain must be designed for the rate at which water will come down to it through the soil, either directly and at once, or indirectly and after a time. The designer, therefore, makes a study of rainfall records, the rate of downward movement of water in the different soils, and the length of time which it is allowable that lands may be submerged pending the removal of surface water by drains. In the West we are concerned as to the porosity of the soil in which the drain is to be laid and which surrounds it on all hands; with the degree of freedom of movement of water which this particular soil permits within it, and we must have measurements or statistics bearing upon the rate at which the ground water rises when the ditches are put in operation at the opening of a season, or whenever the rise is the most rapid. If reliable data can be had on these points, the area which a single

drain can serve, and the capacity which the drain must have in order to serve the area completely, can be calculated.

Certain circumstances have been noted in connection with soils as constituting limitations upon the design and operation of drains. Some of these will be discussed briefly in the following paragraphs.

Soils which are permeated by small channels, such as may have been formed by rootlets, or by surfaces of separation caused by the segregation of soil particles into groups or lumps, may present difficulties in the way of the leaching process. When water is applied to the surface that which first goes down carries the alkali from the surface and also soaks up the soil below. The water which follows, carrying little or no burden of alkali, and going by way of root holes or other gravity (as distinguished from capillary) channels, is that which alone reaches the drains. It is believed that success in such cases will attend repeated light floodings rather than a less number of copious floodings.

In this connection it may be observed that if a redistribution of the surface alkali throughout the soil from which it came can be accomplished, the result may be better than if the alkali were washed down into the drains and completely out of the soil, carrying with it many of the soil ingredients which it is desirable to retain.

It is reported that in parts of Idaho where tile drains have been tried it has been found that a fine silt, having cementing qualities, enters the drains and in time interferes seriously with their operation. The writer has not encountered this condition, but it seems that the frequent and systematic cleaning of drains which is practiced in California to remove intruding growths of rootlets might prove effective to prevent this accumulation of hardened silt. The engineer who reports the circumstance considers that the difficulty may be met by using the bottomless plank drain.

A distinction which has been borne in mind in all of the foregoing, but to which no specific allusion has been made, is that which obtains between the first service and the permanent service of a drain laid in alkali land. The first service is to afford opportunity to leach out or redistribute the alkali in the zone of soil above the drain. After this has been accomplished the permanent service is to *prevent* the rise of the ground water into that zone. The drains are laid deep enough so that when the ground water is held down to this level capillary action will not draw the water thence to the surface of the land. This necessitates that the drains be laid much deeper than when their office is merely to remove excess of surface water.

#### A NOTABLE TEST CASE.

In order that some of the points involved in this discussion may be brought out more clearly a brief description of one of the most notable instances of the alkali evil will be given.

In parts of Fresno County, California, the statement is current that when the irrigation water was first applied to the ground it was the first time that it had been thoroughly wet since the creation. It was bone dry down to depths varying usually from thirty to sixty feet below the surface. However, the soil is one which permits the ready passage of water in any direc-

tion in which there may be an impelling force to give it motion. Moreover, the country is a nearly perfect plane, with but a slight slope in the direction of its greatest declivity. Owing to the looseness of the soil the applied water went quickly down, and meeting with the water table standing on approximately the same slight slope as the surface of the plain, it was impossible for it to find its way out into the country drainage, in spite of the open nature of the soil, as fast as it was supplied by the application to the fields and the seepage from the ditches. Thus the water began at once to rise in the ground, until now it has reached a height so near the surface that at the time of the annual rise, following closely upon the date when the ditches first begin to run for the season, the ground water in many places over several hundred square miles of territory comes nearly or quite to the surface. In fact, a large number of low places or depressions in the plain have been converted into lakes with depths ranging up to ten feet or more. But the transformation would attract comparatively little attention if it were confined in its manifestations to these depressions. It is not so confined, but extends to the most fertile lands of the valley, some of which in earlier years reached the highest cultural development. In these places the ground water stands so high during a considerable part of the season that the alkali is dissolved out of the soil, brought by capillarity to the surface, and left there by evaporation. Lands which have been worth from \$150 to \$400 per acre are in their present condition worthless, and return no revenue to their owners. Vineyards which at one time were the show places of the valley are now scenes of desolation and return no revenue to their owners. Their only value is that which is based on a distinct prospect of reclamation.

Several plans have been proposed for the drainage of parts of the affected area. One of the most extensive of these, which has been worked out in detail and has been looked upon with favor, applies to about three quarters of a township consisting of lands immediately adjoining the city of Fresno, lands which when relieved from the actual and potential evil which overhangs them will reach the maximum of production and value. The plan contemplates the subdivision of the region into a number of subdistricts, each to have its own system of tile drains leading to a sump so located that the drainage water can be pumped from it into an irrigation ditch.

#### ALKALIED LAND DRAINAGE CAN BE USED FOR IRRIGATION.

Analyses have demonstrated that the drainage water does not carry an excess of alkali which will unfit it for use in irrigation. While this statement as to comparative freedom from injurious salts is true of the ground water of which the drainage water will chiefly consist after the regimen of the system has been established, it may not be true of the first water which reaches the drains after having been applied on the surface for leaching purposes. It may be expected, therefore, that the leaching according to this plan must be done when the ditches are not in service for the irrigation of crops.

An enumeration of some of the considerations of which account was taken in design may be of interest. It was provided that no drain should be laid at a less depth than five feet, to which depth, according to the evidence at

hand, the capillary action did not extend from the surface. The trouble which might be encountered due to water running alongside the drains and throwing them out of line and grade is avoided by the provision that the drains shall be laid on a plank base. Each drain is made of a size sufficient to carry water at the rate of two and one-half cubic feet per second for each square mile of tributary territory. This estimate of two and one-half cubic feet per second per square mile is based on a number of considerations, including a series of observations which had been made for several years of the rise and fall of the water surface in one of the depressions which have been noted, measurements of the amount of water delivered by the few private drains which have already been constructed, and estimates of the amount of seepage from the ditches traversing the area under consideration.

#### ALKALI FROM CANAL AND DITCH SEEPAGE.

Incidentally it may be remarked that it is believed that the present ground water supply is kept up almost wholly from the seepage which takes place through the beds and banks of the ditches. In all probability the excess of water applied to the land had a significant effect in this respect in the early days of the irrigation system, but it has been observed that the irrigator of the present day in that locality limits his use of water to that which is plainly needed, and the contribution of excess from this source must now be a minimum. The near approach of the ground water to the surface has seemingly reached a limit in some localities, and instances can be cited of vineyards beneath which the depth to ground water is the most favorable, with the result that irrigation of those vineyards has not been necessary for a number of years, in some cases twenty years.

In laying drains in the humid region, care is taken that the line of the drain does not approach within certain limits of water-loving trees or plants, as it has been found that the rootlets will enter and clog the drains. In the fruit regions of irrigated America it is not practicable to observe this precaution. No location can be found for a drain in an orchard or a vineyard which is not close to some deep rooted growth. Consequently the limited experience which has been had with private drains has already established the fact that they must be brushed out regularly with a special form of brush and apparatus for introducing it into the drains and dragging it through them.

Taking into consideration that drains for the prevention or cure of the alkali evil must be laid deeper than drains in the humid region, that in general they should be supported on a plank or other continuous rigid base, and that in many instances the maintenance will involve frequent cleaning of the drains, it would seem that the cost in the West will be very high as compared with what it is in the East. This is undoubtedly true so far as soils of the same texture are encountered in the two localities, but it is a fortunate fact in relation to the soils of the arid region that many of them will permit a remarkably free and rapid passage of water, and for that reason the drains need not be placed as near to each other as in the more retentive soils. The Fresno plans contemplate an expenditure of from about ten to fifteen dollars per acre drained, with the probability that in some instances the individual land owner will find it necessary to build private supplementary drains.

**THE STATE OF NEVADA.**

ROBT. L. FULTON, Reno, Nevada.

No other State in the Union has been so misunderstood and misrepresented as has Nevada. She took up the burdens of statehood unwillingly, at the urgent solicitation of Abraham Lincoln, who found his influence in the Senate rather weak during the last days of the Civil War; and for a generation she was supposed to be little more than an ash heap with a few streaks of silver through it. Later on the word went out that her mines were exhausted, and many intelligent people were led to paraphrase the scripture and ask, "Can any good thing come out of Nevada?"

However, no good citizen of the Republic can look with indifference upon anything that may affect the fortunes of any State. Our country is so strongly bound together, its higher interests are so closely interwoven that none can suffer decay without sooner or later affecting all the others. The different sections of the Union so happily compliment each other that the greater the activity in any part the greater the prosperity of the whole. It is one of the blessed things about our beloved land that in every corner are natural resources which can be developed without coming into competition with those of any other part, and if this Congress serves no greater purpose than to make the West better known to the East and South, make closer friends of our more distant neighbors, break down sectional prejudices, if any remain, it will well serve its day.

The fact is that nothing necessary to the upbuilding of a great State was omitted when Nevada was created. The raw materials were abundantly bestowed and only the lack of human endeavor has prevented her from taking a high place among her sister States. The worst that can be said is that she lacks population, and it must be apparent that if that is a fault it is chargeable, not to those who live there, but to those who remain away. Perhaps the greatest drawback to her reputation comes from the fact that she is constantly compared with California, which is incomparable, instead of with her neighbors to the east. If Virginia, or Massachusetts, or even Maine lay where Nevada does, and the blossoming plains of the Golden State could be reached only after traversing their territory, they would suffer in contrast far more than they do now when surrounded by States of like condition.

**INEXHAUSTIBLE SOIL.**

The indefinable charm which covers all "The Land of Little Rain" extends over Nevada, with its sunny skies, its vivid sunsets, its violet tinted hills and its rush of sudden storm. Within her borders lie some of the richest lands upon the globe and when they can be reached by water the crops are never-failing, the quality the finest and the yield far greater than in the rainy States. Like the island of Sicily, which has raised wheat continuously for 2000 years, her soil is largely volcanic, and its strength has not been dissipated by centuries of showers, but lies ripening in the sun, waiting for the plow which shall tickle its surface and make it laugh a harvest.

In her early years agriculture was merely an incident. The wonderful richness of her mines brought her forward as pre-eminently a mining State,

and only the most tempting inducements were sufficient to lead men to forego the more exciting pursuit of prospecting for that of tilling the soil. The first attempts were made in favorable localities, where hay grew naturally or shallow streams made easy gardening or ranching on a small scale. It was soon found that lands which had been considered worthless desert would produce in astonishing abundance, and the uniform success attending the efforts of everyone who put seed in the ground anywhere shows that all the great stretches of sage brush, the immense valleys and smooth benches require only water and work to make them blossom as the rose. Even the beds of alkali are made by a superabundance of plant food, which can be fertilized by proper treatment. The many valuable premiums taken at the different expositions, from the Centennial down to St. Louis, furnish convincing proof of her capacity and quality. Considerable attention has been paid to stock raising, dating from quite an early day, and it certainly may be said that she has as good horses as any State in the Union. More than one world-beater has been turned out from her stock farms and Governor Sparks' Herefords have brought home many a gold medal.

The finest kind of beef comes in from the ranges and her mutton is second to none. All of the inter-mountain States are famous for wool and most of them come to Nevada for blooded bucks, Hereford and Durham bulls and for Theodore Winter's blooded horses.

#### VOLCANIC GRIST PLUS WATER.

No country in the world yields to intense cultivation as does one with a volcanic soil under irrigation, and the truth is that Nevada should be the seed farm for the nation. Her climate is perfectly adapted to the production of all of the cereals and the finest of the hardy fruits. The elevation is right and the seasons mild. Her wheat is perfect, with a full, rich kernel and a clean, golden straw, free from smut and rust. It has taken prizes at all of the great expositions and wins its way among experts wherever it goes. Some few years ago a bright young merchant of Elko County gathered up all the fine grain he could find, and after cleaning it thoroughly made it up into one pound packages in attractive style. He then advertised in the leading magazines, like Harper's and the Century, "Golden Wheat, One Dollar a Pound." He sold all he had and his customers came back for more. Nevada beets yield as high as twenty-three per cent of sugar; her celery grows large, white and crisp, breaking like ice in the hand. She could raise onion seed of all the finest varieties by the ton, and already furnishes alfalfa seed to the trade. Nevada potatoes are little bunches of meal done up in a clean, bright sack; her turnips have the mountain flavor, and all of her produce is of superior quality. She has the variety of soil, the different slopes of hillside, plain and valley to meet every requirement. Two farms in the Mississippi valley may be a thousand miles apart, but they will be exactly alike in all their important characteristics, both having been built up from sediment carried down by the floods of ages, but the smallest farm in Nevada may have a dozen varieties of soil lying side by side so that one would produce the finest berries, another luscious fruit, the next juicy tomatoes, and so on through a long list, each one receiving that certain food best suited to its needs and

receiving the proper slope for sunshine and having moisture fed to it scientifically instead of at nature's caprice. Such are some of the advantages the Nevada seed grower would have over his neighbors.

The very fact that Nevada was selected for the first irrigation system under the act of June 17, 1902, is sufficient proof of the capacity of her soil, the abundance and durability of her resources. Mr. Taylor, the engineer in charge, estimates that a million acres can be added to her present area of cultivated land and the remaining sixty-five or sixty-eight million acres are rich in mines, in forage plants and in beds of salt, borax and nitre. Nothing could be more tempting to the settler than the chance to find a good mine near home, and there is not a valley in Nevada that does not lie within sight of ranges of hills containing a good percentage of the precious metals. The farmer's boy in Nevada does not need to loaf in the saloon or the postoffice, if he has energy and sense. He can open a prospect and work all winter in a good warm tunnel or a sheltered cut, and, if he finds ore, he can have it hauled to the quartz mill in the spring, just as his father hauls his wheat in the fall. Mining in Nevada has had a wonderful history, with the record of the finest camp the world has ever seen, where over six hundred million dollars were taken from one rock a mile in length, but the past is but a promise of what is to be when the State is settled and the university has taught our boys how to test the rocks and prospect the hundred thousand square miles of territory that has hardly been scratched as yet. Such is the opportunity for the honest homeseeker, when under a wise and benign statesmanship, the idle men and the idle money of the country will be made use of to carry the idle waters to the idle lands, for it is easy to see that Nevada will receive a larger, speedier and more direct benefit from the reclamation policy than any other State and that it will advance her from the bottom of the class several degrees.

#### A MESSAGE FROM JAPAN.

I have been an optimist in all that concerns Nevada since first I crossed her border, but I never realized the magnificent possibilities of my adopted State until I visited Japan and other countries where land hunger has become chronic, and saw what man's ingenuity could make of tiny bits of ground when his stomach was empty and there was no other way to fill it. The area of the Japanese Empire is almost exactly the same as that of the State of California, and yet upon this small space she subsists nearly fifty million of the happiest and most contented people on earth. But this is not all. The whole region is of volcanic origin and comparatively new, geologically speaking, so that only one acre in eight can be cultivated. Even this restricted area is not very productive in quality. The soil has never been ground to dust and fertilized by glacial action, as have the rolling hills and rich prairies of our own country. A narrow fringe along the shores of most of the islands is nearly enough on a level to be cultivated, while steep, high mountains fill the interior. Unlike our elevated ranges these do not produce nutritious grasses, and generally but poor timber.

In order to support so large a population upon so limited an area of land the most intense husbandry is practiced. Extensive systems of irrigation



are necessary for rice cultivation, although some hill rice of a fine quality is produced, and far up in the mountain valleys the streams are diverted to the terraced paddy fields and the water is never released until it reaches sea level, and sometimes not then. It flows down from one to another terrace until it reaches the planic, where the *noria* or Persian water wheel is a good deal used to overcome slight differences in levels. Nowhere in all Japan did we see the native to better advantage, from an artistic standpoint, than when perched upon the graceful wheel with a long pole which reached the ground to prevent a fall, he patiently and lightly tripped along as the wheel revolved beneath his feet. He was generally naked to the waist, both ways, and his trim and airy figure was a study in the classics for any sculptor. The blades of the wheel fitted in a box, and as it revolved each blade lifted a couple of gallons of water at a time and sent it flowing off in a new direction. During the rice season the streams are polluted and the water carries contagion, making dysentery and diphtheria endemic as well as epidemic.

The finest irrigation system I have ever seen taps a lake about the size of Tahoe, Lake Biwa, a fine sheet of water 14 by 40 miles, in the hills above Kyoto, carrying water under a mountain by means of a tunnel over 8000 feet in length to the valley beyond. At the outlet iron gates 36 feet high are set in stone work of massive strength, with a similar set of gates 60 feet below. Two intakes are built, each 25 feet wide, with duplicate sets of these big iron gates. The intakes are separated by a massive stone wall, but they come together a few yards below the lower gates and make a stream 25 feet wide and 25 feet deep, running four or five miles an hour. The canal is walled in with blocks or cement. Boats ply up and down at intervals and we paid three yen to make the trip, which was most interesting. Three long tunnels were shot, and it was a weird sight to see a boat push forward from nowhere, as its crew dragged it along by a wire cable fastened to the opposite wall. All along the way stone gates are set to measure out water to the farmers. The main canal divides, one branch going to the Kyoto waterworks, generating electric power as it falls to the town, and the other branch goes on to irrigate more farms. It is a government work and cost a million and a half.

Nothing could be more picturesque in the way of landscape gardening than an irrigation system in Japan as seen from any of the steep hillsides above it. The honey bee makes no more economical use of space in building its comb than does the thrifty little Jap in dividing his sloping land and building his banks to form terraces for rice culture. The form of each field is determined by the natural conditions and the tiny farms are cut up in every conceivable shape. The crop averages over twenty-eight bushels to the acre as against fifteen and a half in India and thirteen in the United States. The annual crop is about two hundred million bushels a year, of which about one-eighth is exported. Cereals are absolutely grown by hand; each grain being dropped in a hole made by the finger, liquid manure is poured over it with a dipper and the earth pressed down with the hands. When the barley is receiving the last cultivation in May, beans are planted between the rows, and so three crops are made to grow on the same ground during the year. At this time the rice plant is showing green in the seed beds and

by the middle of June it is transplanted in hills about five inches apart, with rows eight inches from each other. The sweet potato was introduced about 200 years ago and is now the chief food in many of the islands. Fish is a staple diet, and without their use it would be impossible for the Empire to sustain anything like its present population.

Compared with the Orient our own country is indeed a happy one, but the man who seeks a home in the new States might well take a few lessons from the Japanese farmer; in his cheerfulness, his industry and his sobriety, in his happy faculty of developing his resources to the uttermost, he leads the world. They drink liquor there, but we saw only one drunken man in all Japan. We have a better soil, a more healthful climate, a much more comfortable manner of living and we should have the happiest homes on earth.

Sufficient has been said to demonstrate Nevada's future. The very fact that the State, the fourth in size of the whole Union, has but forty thousand people located upon her 71,000,000 acres of land is the best evidence that unlimited opportunities can be found for the earnest and capable man. Every county in the State has undeveloped resources, open lands at two and three dollars an acre, mines to be found by effort, wages at the best rate going for farm work, sheep tending, lumbering and all sorts of trades. With a climate famous for its sunshine, an air free from malaria, with rivers rapid and deep, capable of furnishing unlimited power, with a soil rich in phosphates, and mountains seamed with veins of ore, with valleys that have attracted the attention of both the capitalist and the government as favorable fields for reclamation enterprises, the man who moves to Nevada now will find her just trembling on the rise. The long period of depression is of the past, the future is assured, and not in a thousand years will she be as poor as she is to-day. To become a part of the upbuilding of a great State appeals to the good man everywhere, and the roster of its pioneers is a roll of honor in every community for all succeeding generations.

## **RECLAMATION OF ALKALI LAND.**

**PROF. C. W. DORSEY**, Bureau of Soils, U. S. Department of Agriculture.

Certain of the work now being carried on by the Bureau of Soils of the U. S. Department of Agriculture is the practical demonstration of methods whereby alkali lands can be reclaimed and made productive. Those of us who have spent any considerable time in the West are more or less familiar with the subject of alkali. Whether it is white alkali or black alkali or a combination of both, we know it is injurious to crops, and if it is accumulated in sufficient quantities in the soil no crops at all can be grown.

We who have made a careful study of this subject state that alkali consists largely of some form of sodium salts. The black alkali is sodium carbonate. One form of white alkali is sodium chloride or common salt, while another form of white alkali is sodium sulphate or glaубers salts of commerce. We may have only one form of alkali present in the soil or we may have various combinations of all three forms I have mentioned.

Black alkali is most injurious to plant growth and sodium sulphate is the least injurious form of white alkali. The statement is also made that two-tenths of one per cent of black alkali in the soil is sufficient to prevent successful crop production. Crops will stand considerable more white alkali, but certainly not more than one per cent. We also know that certain crops are more resistant to alkali than others. We know that sugar beets will stand much more alkali than such crops as alfalfa or wheat. The date plum is an example of a tree that will stand comparatively large amounts of alkali. But alkali in excessive amounts always exerts a toxic or injurious effect on plant growth, no matter how resistant the individual plants may be to small amounts of alkali.

### **FOUND THROUGHOUT THE ARID WEST.**

When we consider the extent of land containing alkali we find that almost every irrigated district in the arid West has suffered some loss from just this cause. Careful estimates seem to indicate that from 10 to 15 per cent of every irrigated district contains sufficient alkali to at least very materially lessen the productiveness of the soil, while 5 per cent of every district contains so much alkali that no crops can be grown at all. In order to realize what this means to the irrigation farmers it may be interesting to introduce some figures on the subject. In 1902 the Census Bureau estimated that in the arid States there were 8,470,000 acres under irrigation. Five per cent of this amounts to 423,000 acres in round numbers. That much land carrying alkali is unfit for use. This is actually more than twice the acreage of irrigated land in Washington, nearly twice the amount in Arizona and New Mexico, and nearly equals the amount of irrigated land in the State of Oregon. Estimating that this land if reclaimed would be worth \$50 an acre, a conservative estimate I think, we find the West loses valuable lands to the extent of \$21,000,000 through alkali. This makes us realize how serious the alkali question is at present and we all are aware how fast it is spreading almost everywhere.

### ATTEMPTS TO COMBAT THE TROUBLE.

Farmers have tried to check the spread of alkali in one way or another but with only partial success. Some have flooded their lands for a period of a few hours and have then drawn the water off. In some cases this has effected a partial remedy. Again attempts have been made by soaking the land and driving the alkali below the surface. Often this has enabled the farmer to crop the land for one or two years longer, but no permanent cure was obtained. Again the use of gypsum on black alkali land has been advocated by many, but this does not remove the alkali, but merely changes it to a less injurious form, besides this method is altogether ineffective on white alkali land.

When the Bureau of Soils took up the study of Western soil conditions several years ago a study of the origin, accumulation and spread of alkali was also made. As the various reports were issued covering these studies, specific recommendations were made looking to permanent reclamation of the soils from injurious accumulations of alkali. Especially were the good effects of heavy flooding recommended after a complete system of under-drainage had been installed. By such methods it was claimed even the worst alkali land could be economically and permanently reclaimed. Such suggestions were made from time to time in the various reports, but little or no efforts were made to reclaim any lands, even in the worst districts. Believing that by establishing a number of demonstration experiments in alkali land reclamation much good could be accomplished, certain tracts were selected and their reclamation attempted. At present we have reclamation farms located at Fresno, California, in the San Joaquin valley; at Salt Lake City, Utah, at North Yakima, Washington, Tempe, Arizona, in the Salt River valley, and at Billings, Montana, in the Yellowstone valley. In each case a tract of twenty or forty acres was selected and usually this was the very worst alkali that could be found, and in some cases the ground water was almost at the surface, so we had to fight seepage water as well as alkali. We picked bad tracts of land so there would be no question of the efficiency of the methods after the reclamation was completed.

### BAD LAND SELECTED FOR TESTS.

Some of the tracts were parts of ranches that had gone bad to alkali. others had always been considered worthless and their cultivation never attempted. Complete tests of the soil were made to a depth of four feet, and on some of our tracts the soil contained upwards of three per cent of alkali.

On each of the tracts we have different soil, climatic, as well as varying alkali conditions. At Fresno, California, and North Yakima, Washington, we have been experimenting with black alkali. At Tempe, Arizona, and at Salt Lake City we have white alkali of the sodium chloride variety, while at Billings, Montana, we have sodium sulphate, another form of white alkali.

Our mode of procedure is to lay common drain tile, such as are used so extensively in Indiana and Illinois, at an average depth of four feet. By this means a complete system of under-drainage is assured. Then the tract is nicely leveled and checks thrown up so that all of the land can be flooded to a depth of several inches. The work of flooding is carried on as rapidly as

possible, depending of course on the water supply and the time required for the water to soak through the soil. The principle of this method of reclamation is quite simple. The alkali is a soluble substance that can be dissolved by a copious supply of water and carried downward and out through the drain tile. By continuing such a process even the worst alkali land can be freed from any excess of alkali and made as fertile as fine virgin soil containing no alkali whatever.

#### COMPLETE SUCCESS ATTAINED.

So much for the methods of attacking the problem; now as to the results and what we have accomplished up to the present time. In California two weeks ago I visited our tract, two and one-half miles south of Fresno, and found the owners very well pleased with the manner in which the land had responded to this treatment. At one time this land was worth \$250 per acre and was one of the choice tracts of land near Fresno. At the time we took it, in 1903, it had only a nominal value of a few dollars an acre on account of the large accumulations of black alkali. For crops it was practically worthless. Last year at the close of the season's flooding all but five acres were reclaimed and produced crops this year. This season we have practically completed the reclamation and a good stand of alfalfa is starting while the soil has lost all the bad characteristics of land carrying much alkali.

At Tempe, Arizona, last week I saw a very good stand of barley on land that the owner had attempted to crop for years and had failed each time. This was accomplished after a few months of heavy flooding. The indications point to the reclamation of the entire tract at an early date. At Salt Lake City we took 40 acres that had always been too salty for crops and had no value as farm land whatever. This fall, after two years of flooding, we have calculated that 8000 tons of salt have been washed out of the soil and now it is in shape for almost any crop that can be grown in the vicinity and is easily worth \$100 per acre for farming purposes. At North Yakima, Washington, after a short season's flooding last year and again this year, we believe we have at least four-fifths of the twenty-two acre tract reclaimed and in such shape that alfalfa can be sown on it next spring. The whole tract was seeded to wheat the last of September, and the last reports from there were that the crop was doing nicely, indicating by a practical test that by far the greater part of the tract is reclaimed. This land formerly was a salt grass pasture, of no value for crops. So carefully has our experiment been watched and believed in by the farmers of the neighborhood, that adjoining salt grass pastures have very materially risen in value on account of the chance of reclaiming them and converting them into valuable farm lands. In the Yellowstone valley, at Billings, we can make no statement of our work, for it has only been installed and flooding will not commence until next May, when the water is in the canals. Our problem there is to wash 2300 tons of white alkali out of a stiff gumbo soil and leave it in a fertile condition, suitable for any crop grown in the valley.

#### DOES IT PAY?

So much for the results for the reclamation experiments; now for some questions that will naturally arise about the work. The first that may be

asked is, I think: Is the work practical; can it be done cheaply; and, again, just what is the cost? The cost of reclaiming alkali land will depend largely on the cost of labor in digging ditches and on the cost of the tile delivered at the ranch. To put a tract of land in shape for reclaiming it, that is, installing the drainage system, leveling and throwing up the checks, costs from \$15 to \$40 per acre. If labor can be cheaply secured and a tile factory is near at hand, such work can be done at a very reasonable price. Unfortunately at present tile factories are not common in the West, as there are probably not over a dozen in all of the arid States and Territories, so that the question of freight enters largely into the cost. If tile could be purchased at prices at which it is sold in the Eastern States there would be no question of profitably reclaiming land that would only be worth \$25 per acre after it was reclaimed. As soon as farmers become more familiar with the valuable results to be derived from the use of drain tile there will be created a large demand that will make it necessary for small factories to be located in practically every irrigated district.

#### TILE FOUR FEET DEEP.

Again the question is asked how deep must we lay tile for the best results? Our experience in this direction leads us to believe that the tile should be laid at an average depth of four feet. This means that with tile at such a depth we permanently lower the ground water to that depth, as well as free the soil from alkali to the same depth, with but little chance of its being again pumped to the surface by capillary power of the soil. It is also well to mention that the deeper we have our tile the greater area of land they will drain on each side, so that depth is an important factor to be considered.

Again we are asked how far apart should the drain tile be laid? This depends altogether on the character of the soil. On a heavy clay adobe or gumbo soil it may be necessary to put them 100 feet apart. On the other hand on coarse sandy soils tile 225 feet apart will answer all purposes. Some one will ask how long does it take to reclaim alkali land? This will depend on the amount of alkali originally in the soil as well as on the texture of the soil; as to whether it is a heavy clay or a light sandy loam, for this determines largely how fast the alkali can be leached out of the soil.

The presence or absence of hardpan also enters into the question. With a very large amount of alkali in the soil, say 3 per cent, it will take at least two years to reclaim all of the land. With land only beginning to show alkali, perhaps a few floodings will be sufficient to restore it to its original fertility. The length of the flooding season and the water supply available for such purposes largely influences the question of the length of time necessary for complete reclamation. Even before the final reclamation is accomplished some crops can be grown that will reduce the cost of reclamation.

There are many other question that might be brought up about the different features of the work, but I believe I have mentioned enough to convey some idea of how the work is carried on and just how far we have been successful with this method.

## **THE SIZE OF AN IRRIGATED FARM.**

THOS. H. MEANS, Engineer of Soils, U. S. Reclamation Service.

Farming in an irrigated district is very different in many ways from farming in the rain belt. In two important particulars the irrigation farmer has the better of his contemporary and they are that he gets the right amount of water for his plants and gets that water at the right time. This being so, he is independent of weather in a great measure, particularly so as arid regions are most generally those in which all climatic factors favor plant growth, except in the amount of moisture in the soil. Being independent of the weather, there is no loss on account of dry seasons to be expected, and he should harvest a full crop every year. How often is the crop of the rain belt farmer damaged by adverse climatic conditions? How often at harvest time does the Bureau of Statistics report our staple export crops, the money getters, as having condition 100 or better at harvest time?

Now, I am of the opinion that under many existing systems the irrigation farmer in America is also very apt to harvest a short crop from lack of water. The fault is not with the irrigation method, but is in the works he has built to control the water. He may lack storage facilities to tide over seasons of low water; he may be unfortunate in having more neighbors than the stream can adequately supply; he may be the victim of a water company who has monopolized the water of a stream and sells water rights but don't deliver water; he may be imposed upon by neighbors up stream, but this much can be said of him, that if his irrigation works are built of the proper materials with a competent knowledge of the hydrography of the stream and he is living in a State whose laws respect and protect his rights, he will harvest a profitable and full crop in all years of diligence.

### **SMALLER FARMS UNDER IRRIGATION.**

And by virtue of this, a living can be made on a smaller area than in the rain belt, subject as it is to the vicissitudes of the clouds and sunshine. If there is one national characteristic of American agriculture it is that it is extensive. Large areas are farmed, low yields are obtained; but by reason of the large amount handled the profits per farm are great. As an instance, the average yield of wheat for the United States is thirteen bushels per acre. In consequence, wheat farming is carried on most extensively in those great areas of prairie and plains land where large farms are managed by one man. North Dakota produces on an average twelve and one half bushels of wheat per acre. A small farmer with forty or eighty acres of wheat at this rate can not make a living, but he with a thousand or ten thousand grows rich.

In irrigated lands wheat averages from twenty to forty bushels, and yields of fifty bushels per acre are not uncommon. Here the small farmer can afford to raise wheat and he who has forty or eighty acres can have his patch of wheat and make a profit in handling it.

The following figures from the census of 1900 show the average number of acres irrigated by each irrigator, the average value of products per acre and the average value of products per irrigator. This last figure is actually the gross income per irrigator:

*Size of Farms Per Irrigator, 1899.*

	Acres.	Value per Irrigator.	Value per Acre Irrigated.
Arizona .....	46.0	\$ 755	\$16.40
California .....	45.2	1285	28.40
Colorado .....	73.9	860	11.60
Idaho .....	56.5	605	10.70
Montana .....	94.0	905	9.65
Nevada .....	169.5	1495	8.85
New Mexico .....	23.2	350	15.10
Oregon .....	62.5	660	10.60
Utah .....	30.0	420	13.90
Washington .....	33.6	675	20.00
Wyoming .....	107.9	775	7.20
United States .....	55.5	820	14.70

It is assumed that all irrigation farms are on the average supporting a family. In three States, namely, New Mexico, Utah and Washington, the average number of irrigated acres per farm is less than forty. Where will you find a more prosperous and contented agricultural people than in the irrigated valleys of Utah and Washington? New Mexico's low acreage is largely caused by the number of Spanish speaking Americans in the Territory. There are five States—Arizona, California, Colorado, Idaho and Oregon—in which the acreage per irrigator is between forty and eighty acres, and two States with between eighty and one hundred and sixty acres, namely, Montana and Wyoming, with only one State—Nevada—in which the acreage is more than one hundred and sixty acres. It is well known to all that these last three States in which the acreage per irrigator is more than eighty acres are great cattle growing States and the principal product is forage, frequently being produced by irrigating native grasses. The value of products per acre is smaller for these three States than any others, clearly showing that the maximum production of the land is not being realized. There is no apparent reason why an acre of irrigated land in Nevada should produce products of lower value than a similar acre in Oregon, yet the table shows such to be the case, the value in Oregon exceeding that of Nevada by \$1.75, or nearly twenty per cent. It would seem that the products realized vary almost inversely as the area per irrigator; that is to say, in those States where the area is large the value of products is small and vice versa. By grouping the States into those averaging less than forty acres per irrigator, those with forty to eighty acres, and those with more than eighty acres, the following table is obtained:

*Table showing acreage and value of products per irrigator and per acre by groups of States.*

States in Group.	Acres per Irrigator.	Value of Products per Acre.	Value of Products per Irrigator.
New Mexico, Utah, Washington.....	28.6	\$15.00	\$430
Arizona, Cal., Idaho, Colo., Oregon....	56.7	17.35	985
Montana, Nevada, Wyoming.....	108.5	8.80	955



This table very clearly shows the relation of size of farm and the value of products per acre. Where the farms are large the products per acre are small. The second group includes California with all the tremendous fruit productions of that State, and for that reason the value per acre is higher than in the first group.

#### FROM 40 TO 160 ACRES UNDER NATIONAL IRRIGATION.

The Reclamation Law of June 17, 1902, Section 4, states that the Secretary of the Interior shall give public notice of the lands irrigable under such project, and the limit of area per entry, which limit shall represent the acreage which, in the opinion of the Secretary, may be reasonably required for the support of a family upon the lands in question, also of the charge which shall be made per acre upon said entries. In section 3 the size of the entry is limited to tracts of "not less than 40 nor more than 160 acres." In accordance with this the Reclamation Service is at present classifying all lands which will be irrigated under the various projects. This classification is carried out with the view of determining the value of the land for agricultural purposes. Lands are classed into four grades, as follows:

First-class land includes all which is first-class in every respect. It does not take into consideration the texture of the soil, that is, whether it is heavy or light, provided it has a texture which will permit some crop to grow.

Second-class land should be so fertile as to produce profitable crops but not so well as first class land. It may contain small amounts of alkali; be rough and require leveling; be of such a texture or composition as to be restricted to only a few crops, and therefore not so valuable as other soils which can grow a larger range of crops.

Third-class land is that which may by the expenditure of money and work be brought into a fertile condition, but which in its present condition will not produce profitable crops. It may be too rough for irrigation, may be alkaline, swampy or have an injurious hard pan. In general, it is not considered practicable to attempt the reclamation of third-class land until the first-class and second-class land is exhausted.

Fourth-class land includes all which for any reason is not worthy or impossible of irrigation.

Upon this basis the land is all carefully classified and divided up into farms. The attempt is always to include in each farm sufficient land to support a family.

In some parts of the irrigated West where the land and climate permit the production of high-value products, such as fruits, the area of each farm of first-class land can well be forty acres. In other districts where alfalfa and cattle are the principal products the area may be eighty acres. In other districts where the season is short and production is limited to grain and native hay the area may be 120 to 160 acres.

In no irrigation project can the area of irrigable land be less than forty acres, because this is the smallest farm which it is in the power of the Secretary to irrigate. It seems that one of the southern-most States in the arid West has on the average less than forty acres per irrigator, and Washington, one of the Northern States has a smaller acreage than forty acres per irrigator.

## **MODERN RICE IRRIGATION.**

PROF. T. U. TAYLOR, University of Texas.

Rice is a native of India and Australia. It is raised in India, China, Japan, Malaysia, Brazil, the United States, Italy and Spain, and many islands of the sea. There are many varieties, but the two best known in this country are known as the Japan and the Honduras. As a rule rice is an irrigated crop, but in all countries some trust to Providence to do the irrigating.

Before taking a hasty review of the modern methods employed, it will be well to describe briefly the older practice, both in this and other countries.

### **JAPANESE METHODS.**

The varieties of rice known as Urichi and Moghigome are grown in Japan in the flooded fields. The season is about the same as that in the southern part of the United States from the middle of May to October or November. The first work consists in planting the seed beds which must be prepared with the utmost care, spaded and raked and surrounded by a small dyke or levee. The bed is flooded from the ditch and in June the seed are sown broadcast on the surface of the water and they sink quickly into the mud. In about one month the stalks are high enough (six or seven inches) to transplant into the rice farm. In the meantime while the seed bed was sprouting the young plant the former crop of wheat or barley is reaped and the land prepared for the rice plants. The farm is flooded after being broken up and in the mud and water the stalks are planted two in a hill from eight to ten inches apart, the number of hills varying from 60,000 to 100,000 per acre, thus making 120,000 to 200,000 stalks per acre. These are set out by hand with the utmost care. The yield per acre is from twenty-eight to thirty bushels. The farms or garden patches as we would call them in this country average in size from a quarter to a third of an acre, and one man may be the owner of several of these, contiguous or detached. The sides of the hills are terraced and several farms are located on a common ditch that taps some stream at a higher surface. The water passes from an upper to a lower farm, and so on until all the farms on the ditch are served. About November the first a harvesting is done by hand with the old reap hook, the bundles are hung up on a pole or scaffold and the threshing is done with a form of iron comb or flail followed by the winnowing or separating the chaff from the grain. The rice is then placed in straw bags for the market.

There are about nine million farms in Japan with a total acreage of 7,000,000 acres with an annual yield of 200,000,000 bushels or fifty million sacks, a production about eleven times that of the United States for 1904.

By way of relish it is interesting to note that the Japs are now in Texas in the rice belts at Webster in Harris County, at Garwood in Colorado County, and at Del Rio. At both places the Japs are operating well plants and Mr. Hawhimoto at Garwood made one of the best average yields in Texas for the season just closed.

## THE CAROLINA METHOD.

Under this head is included the methods that were in vogue all along the Atlantic Coast up to a few years ago. It is said that rice was introduced into South Carolina about A. D. 1700 by the accidental wrecking of a ship from Madagascar. Whether this is true or not rice has been a factor as a foodstuff for over 200 years. Methods where any cultivation was attempted consisted in planting rows and in flooding at certain intervals in order to supply the moisture, but the weeds were kept out by the cultivator or hoe and not drowned out by the modern method of flooding. But the methods varied in the different localities. The marshes in some sections were utilized as rice lands where the moisture was in the soil by virtue of its topography or underdrain. Of necessity the reaping had to be done by hand in the old break-back way as machinery in such a situation would soon have been out of sight. Against the tidal streams the farms were dyked in and at high tide the water was deflected into the ditches or on the farm. There was a tide in the affairs of a majority of the rice farmers which, taken at flood, led to a fair rice crop, but omitted, the rest of the year was spent in vain regret for lost opportunity and for unliquidated store accounts.

In all the Atlantic States there was a trust to Providence to supply the irrigating plant and very few were the cases where Providence was assisted with steam or similar power. Notwithstanding this, South Carolina held first place as a rice producing State till seven years ago.

The rice belt of Texas extends from the Sabine to the Rio Grande, and includes at present seven well-developed sections, (1) the Sabine Valley, (2) the Neches Valley (including its water shed), (3) the Trinity, (4) the Brazos Valley, (5) the Colorado Valley, (6) the Guadalupe Valley, (7) the Rio Grande Valley, and several detached areas that are sure, with good management, to be the forerunners of extended systems in the respective localities. In the coast section the land is a flat prairie which heretofore cut very little figure as an industrial factor. It is very flat, some of which having a slope of only 1 in 5000, and in general required small levees and small lifts at the pumps. This flat section extends all along the coast from the Sabine to the Rio Grande. The 250-foot contour above sea level is from 50 to 125 miles from the Gulf, while the strip from twenty to thirty miles wide along the shore rises only a few feet above the sea level. But in addition to this coastal belt the rice section has since 1897 been rapidly spreading along and back from the coast until it has reached the Rio Grande at Del Rio to the west, and at Cuero, Columbus and to Milam County on the north. In the flat sections the water is often from bayous, frequently impregnated with salt sea water to such an extent that injury to the rice occurs. Rice must have an abundant supply of fresh water and a soil that is rich enough to nourish the rice and compact enough to hold the water. It is being successfully grown in Texas where the above factors are grouped, and money and brains are grouping them with a twentieth century effectiveness. No longer is the rice belt restricted to the old bayou country, but in the water sheds of the Sabine, Neches, Trinity, the Brazos, Guadalupe, Colorado and Rio

Grande, over 100 miles from the coast, a high grade of rice is grown. The fresh water can be obtained from a flowing stream, surface wells, artesian wells or from rain. The well method is in its infancy, but it is certain to be a decided factor in rice production in Texas. The well plants at El Campo are the pioneers of many others in Texas, where the farmer can, with a small outlay, convert his flat lands into a successful rice farm. A well twelve feet in diameter, forty feet deep, an engine to supply power, a centrifugal pump, an open box for a flume, a canal easily constructed; total first cost \$1200, constitute a one man equipment. With this 75 acres of excellent rice can be irrigated.

The rice land is laid off in sections, or "cuts," so that the extreme elevation should not exceed four inches. The size of these cuts varies with the character of the topography. A cut is surrounded by levees or dykes to hold the water. It may be that a hillock or a hole will occur in a cut, but this can be ignored as rice producers till time and the plow will level the one or fill the other. The water is pumped to the land by steam, gasoline or water power, by far the greatest part of the work in Texas being done by steam. From the best evidence obtainable in Western Louisiana and East Texas, it seems to be a consensus of opinion that it requires nine gallons of water per minute for each acre of rice, or 1 second-foot of water to each thirty acres of rice, although some companies estimate seven and one-half gallons to each acre per minute. In the Beaumont section the rainfall often reduces the pumping considerably, and in 1900, a wet year, some pumps were operated only four days. But a dry season will require the pumps to furnish nine gallons for each acre per minute, and it is not good engineering to allow less than nine gallons per minute, or 12,960 gallons per 24 hours per acre.

For 100 acres and for a lift of twenty-two feet, an engine exerting fifty absolute horse power would be required. The estimated or nominal horse power will have to be tested or reduced by a substantial fraction if disappointment is not desired.

For some plants, owing to the contour of the ground, more than one lift has to be constructed, that is, more than one pumping station has to be constructed. The pumping capacity of each station is the same if there is no acreage under the first lift, but the machinery in one may be heavier than in the others, depending on the height of the lift.

From the pumps the water is led by means of flumes to the canals and is distributed from the main canal to the laterals, from which it is distributed over the land. The main canals are usually very wide, for in most cases they are intended to be wide enough to act as partial reservoirs. The canals are constructed by the "Humper" (a single man with a wheelbarrow, pick and shovel) by the plow and scraper, or by the modern steam grader which lifts the earth by an endless belt and deposits it on the canal embankment. The motive power is generally supplied by steam.

#### FIRST TEXAS RICE IN 1862.

The first rice raised in Texas by irrigation was produced in 1862, in Jasper County, by the father of Dr. S. W. Sholars of Orange, Texas. The land

was situated on a clear flowing stream. It was covered at first by a thick underbrush which was cleared away. The land was broken by single teams and rice sowed broadcast, and when up several inches was flooded by the stream. A small dam provided with a gate deflected the water onto the land, the depth of the water being regulated by the gate. The manner of flooding was similar to that of to-day. The rice was harvested with reaping hooks, was threshed by crude methods and was milled by the original method of removing the upper stone of a gristmill and substituting therefor a section of log whose under surface was sufficiently rough to remove the husk from the rough rice and produce a clean product. After the husk had been removed the section of log which had replaced the upper stone was taken off, the stone replaced, and the clean rice was then reduced to flour.

The first modern experiments with rice in Texas began in 1888. In these experiments the farmers depended upon rainfall to furnish the water, but this trusting to Providence on the matter of rice cultivation did not pay, and to insure success pump irrigation was resorted to. This had proved satisfactory, regardless of rainfall. The culture of rice by this method began about 1893. Prior to this it had been grown only in a small way in ponds and marshes for home use. The method of growing rice on a large scale by irrigation and with improved machinery is comparatively new and peculiar to the Southwest and radically different from the methods pursued in Georgia and the Carolinas.

#### HIGHEST TYPE OF RICE CULTURE.

In Texas and Louisiana rice is sowed on comparatively high land, with drills or broadcast, cut with self-binders, threshing from the shock, or stacked to suit the convenience of the farmer. The same kind of machinery is used in raising, harvesting and threshing rice that is used with other small grain, the only difference being that rice lands are flooded after the rice is up to the height of three to six inches, and that the "rough" rice from the thresher is milled and made "clean" in a mill. The practice in Texas is to sow the rice at any time from April 15th to June 15th, and to keep it flooded from 80 to 110 days, 90 days being the average. The water kills the grass and weeds and causes the rice to grow very rapidly. Ten days to three weeks before the rice is ripe and ready to harvest the levees on the lower side are cut and the water is drawn off by means of ditches made in throwing up the levees. This drainage for some plants requires more engineering skill in the arrangement of the levees than is required in making them fulfill all the requirements of feeding the land with water.

From  $1\frac{1}{4}$  to  $1\frac{3}{4}$  bushels are sown per acre. The land is plowed and harrowed and prepared as it should be for wheat. On the large canals traction engines are used to pull a gang or disc plow and the land is thus plowed by steam. One traction engine running night and day can break fifty acres in twenty-four hours. The outfit or equipment will vary with the acreage. After the rice is planted and the water is turned on eternal vigilance is necessary to keep canals and ditches in order, to prevent breaks, with a consequent waste of water and a drowning out of part of the crop.

### NOT A LAZY MAN'S CROP.

It is by no means an easy crop to manage. The work from the first day's flooding to harvesting is a muddy history of patience. Just before the crop ripens the water is drawn off to allow the ground to harden enough to bear the binder. If the rains set in at this critical moment it entails an additional amount of expense and worry in saving the crop. In this respect the rice farmers away from the coast and further west have an immense advantage. The rainfall yields a reluctant aid during the flooding period and does not jeopardize the crop during the harvesting time. While the cost of pumping will be more in the western part of the rice belt, the surety of an undamaged product will overbalance the additional cost.

In Texas at the present two kinds of rice are raised, the Japan and Honduras. The latter is longer in grain and generally commands a better price, while the former is hardier, can stand dry weather better, and is more prolific in its field. In general, 44 pounds are allowed per bushel, 162 pounds per barrel, while the sack is rather variable in quantity, but is usually estimated at 180 pounds.

### TYPICAL CANAL PLANT.

The following is a description of a big canal system with a capacity of 16,000 acres, with three lifts as it was actually in operation. The first pumping plant was on the river from which the water supply was taken, and the plant consisted of two 54-inch centrifugal pumps operated by a 250-horse power engine against a lift of 33 feet. The plant at the second lift of seven feet consisted of a 250-horse power compound engine and a 45-inch centrifugal pump with an estimated capacity of 50,000 minute-gallons; and that at the third lift consisted of a 200-horse power engine and a 24-inch Van Wie pump which was worked against a head of  $3\frac{1}{2}$  feet. This plant had two problems to solve in that it had to cross two draws or sags and the tracks of a railroad that ran through the farm. The flume across the sags was made of plank four feet deep, twenty feet wide and two hundred and fifty feet long, and the water was taken under the tracks of the railroad in large terra cotta pipes and in woden boxes. The acreage under the first lift was 9500 acres; under the second, 5000; and under the third 1500, making a total of 16,000 acres. The engineer in making his estimates of the power and pumping capacity needed allowed ten gallons per acre per minute, which for the ninety days of usual pumping would be a supply of four feet per season.

### TYPICAL WELL PLANT.

One of the best shallow well plants in Texas is located in Wharton County. An 8x10 pit ten feet deep was excavated in the surface soil to within four feet of the water-bearing sand and in the bottom of this pit a well was bored to a depth of forty feet from the surface of the ground. A 5-inch centrifugal pump was placed on frame work in the bottom of the pit, and a fourteen horse power gasoline engine was placed on the surface of the ground on stable frame foundation. The plant complete cost \$970 in place and in one year on thirty-five acres of land produced 741 sacks for which

\$3.25 per sack was realized, thus paying for the complete plant exclusive of the land twice over.

Another well plant owned and operated by a Jap irrigated 110 acres during the season of 1904 on raw land and made a yield of 20 sacks per acre.

### RESERVOIRS.

The multiplication of canal systems and the possibility that the decision of the Supreme Court in the 74 Texas in the case of the Mud Creek Irrigation Company vs. Vivian will apply to the rice section of Texas whereby an upper proprietor can take all the water out of a stream even though he does not leave sufficient water for the lower proprietor for the same purpose emphasizes the necessity for storing the waters during flood or freshet before the rice season opens and of husbanding them in dry times. An allowance of seven and one-half gallons per minute per acre or of one cubic foot per minute would mean a season supply of three feet to the land. That each canal system will eventually have to obtain part of its water from its own reservoir storage system (natural or artificial), seems equitable and just. It would not be fair for the upper proprietor to get all his supply from the stream during seasons of low flow and deprive the lower proprietor of sufficient water for the same purposes although the latter might have been the pioneer in the field, whose boldness, pluck and capital made the success of such plants a certainty. If an allowance of three feet per season is made and a reservoir is designed to furnish half of this supply with an effective depth of nine feet, then one-seventh part of the farm must be set aside for reservoir purposes. That this is a feasible solution is shown by its successful operation on some plants in Texas. One plant in Jefferson County was forced to construct a reservoir covering 500 acres to a depth of four feet as a protection against a short supply of fresh water. It is true that there was plenty of water on the bayou, but in dry times this became so impregnated with salt that its use on the rice was dangerous. While the bayou was fresh the reservoir was filled and the rice was flooded by the pumps from the stream supply and the reservoir was kept filled. When the salt water appeared the pumps at the bayou station were stopped and the fresh water in the reservoir was drawn.

At least three of the large plants have taken advantage of natural reservoirs in the form of lakes or creeks to insure a safe supply in dry times. One of the largest projects on foot at the present involves the construction of a dam across an arm of the coast to keep back the salt and impound the fresh water.

### CANAL PLANTS.

1. Sabine Valley section—Cow Bayou Company, Orange County Company, Des Moines Company, Samuel Wilson Company, Clark Canal Company, Giles Brothers Company.

2. Neches Valley section—Beaumont Irrigation Company, McFadden-Weiss Company, Port Arthur Canal Company, Treadway Canal Company, Jefferson County Company, Taylor's Bayou Farms, Hillebrandt Bayou Farms.

3. Trinity Valley section—Raywood Canal Company, Trinity Rice Company.

4. Brazos Valley section—Little River Plants, Washington County Plants, Texas Land and Insurance Company, Brazoria Company, Brazos Company, Fort Bend County, Masterson Plant, Munson Brothers Plant, Walker and Cain Plant.

5. Colorado Valley section—Eagle Lake Company, Donovan Company, Red Bluff Company, Lane City Company, Bay City Company, Matagorda Company, Colorado Company, Nile Valley Company, Stewart Company, Sexton Company, Moore-Cortes, Tres Palacios, Northern Company.

6. Guadalupe Valley, section—Buchel Plants, Victoria Rice and Irrigation Company.

7. Rio Grand Valley section—Brownsville Land-Irrigation Company, Moore Plant at Del Rio.



## THE RATIONAL USE OF WATER IN IRRIGATION.

DR. JOHN A. WIDTSOE, Director, Utah Experiment Station.

In these times, when gigantic reservoirs and canals are being planned and constructed by our great government, we are likely to forget that the development of irrigation in this country lies not alone along engineering lines, but depends, to an equal or greater degree, upon the manner in which the farmer uses the water in the production of crops. The building of canals and reservoirs has been greatly improved during the last fifty years. All the skill of the engineer has been bent to produce irrigation structures that approach perfection. Meanwhile, the farmer has been left to develop his methods, unaided by expert advice or assistance; and in fact, the methods employed by the farmer of to-day in producing crops by irrigation are very little in advance of those that were introduced during the first few years after the Mormons entered Salt Lake Valley.

The projected storage of the waters which now run to waste in the streams and rivers of the Great West will undoubtedly increase the irrigated area many times; but to students of this subject it appears equally true that if the water which is already diverted into irrigation canals should be used in a rational manner, the irrigated area might be doubled, trebled or even quadrupled without the building of another reservoir or canal. By the *rational* use, I mean such a use as will, with a given amount of water, produce the largest yield of crops of the highest quality and with least injury to the soil. To make such rational use of water the farmer requires a knowledge of the relation which exists between the plant and the soil and the water. It is unfortunate that investigations having such knowledge in view have only been undertaken during the last few years. However, many results are already available with which the irrigator of the immediate future must familiarize himself and which he must apply to his practice of irrigation if he desires to obtain the greatest profit from the land and water at his disposal.

## THE OVER-IRRIGATION EVIL.

Perhaps the most prevalent idea in the irrigated sections of this country is that plants do best and yield most heavily when they receive very abundant irrigation. In my experience I have yet failed to find one farmer who has refused to apply to his fields all the water that he could possibly obtain, though in many cases it was manifest that the large amounts of water led to injurious over-irrigation. Plants respond very rapidly in yield and quality to the water applied to the soil, but in reality they can get along with very small amounts of water and in many respects do better when the amount applied is below rather than above the best. In fact, the irrigation farmer who is able to control the amount of water applied to plants controls one of the most important factors of plant life. The air, the sunshine and the soil, the farmer must largely accept as they exist, for he is unable to modify them materially; but the fourth great factor in plant growth, water, is completely under his control; and by judicious irrigation the farmer may obtain a marvelous control over his plant kingdom. In this respect, agriculture in an

irrigated section is greatly superior to the agriculture in districts of abundant rainfall.

With respect to this control note the following reliable results selected almost at random from a great number of experiments on the relation of crops and soils to water, conducted by the Utah Experiment Station. The expression, inches of water, is to be understood as meaning the depth to which the fields would have been covered had all the water been applied at one time.

#### FAST LOSS OF WATER.

One season on a typical western soil five inches of water produced 33 bushels of wheat per acre; ten inches produced 40 bushels; 15 inches produced 48 bushels, and 20 inches produced 40 bushels. Adding more than twenty inches of water to the field did not increase, appreciably, the yield of grain. In the case of the wheat plant, then, the increase of the amount of water increases the yield of grain up to about fifteen inches, but a further application tends to diminish the yield. When it is considered that the depth of water applied to the wheat, over a very large area of the irrigated section, amounts to thirty or more inches annually, it will be understood what a loss in wheat alone occurs year after year through the misuse or too large a use of water.

With oats the variation is somewhat similar. Five inches of water in one set of experiments yielded about fifty-eight bushels of oats per acre; ten inches yielded about the same amount, though the increased quantity of water increased the weight of straw. With fifteen inches, seventy bushels were obtained; with twenty inches, eighty-six bushels, and with thirty inches, eighty-two bushels. Covering the land with more than thirty inches of water diminished the yield of oats decidedly. About twenty inches is, therefore, the best amount of water for oats, yet throughout the irrigated West, thirty inches or more are generally used in the production of oats, and thus again the wasteful use of water is emphasized.

It is generally true with all the ordinary crops grown in the Western States that increasing the amount of water increases the yield up to a certain point, after which an increase of water causes a decrease in the yield. Not all crops are alike in this respect, however. Some crops, because of their nature—leaf surface, root system, etc.—find ten inches of water about right for the season's growth. Other plants, because of their different natures, find fifteen inches or twenty or twenty-five or thirty inches the best.

#### FARMER SHOULD STUDY THE WATER PROBLEM.

Now, the farmer in an irrigated section should know the water requirements of the different plants that he grows as thoroughly as he knows the soil of his farm, his water right or other matters upon which his success as a farmer depends. Not all plants decrease in yield after certain amount of water has been applied. Potatoes appear to be a crop the yield of which increases continually if water is applied, up to the limit of the practicable application of water. To illustrate: In one set of experiments  $7\frac{1}{2}$  inches of water produced 160 bushels of potatoes; 15 inches, 233 bushels; 30 inches,

274 bushels, and 71 inches, 315 bushels. In this series the increase is constant with the increase in irrigation water. This illustrates the necessity on the part of the farmer of knowing thoroughly the natures of the plants with which he deals.

It may be noted in reviewing the yields of wheat, oats and potatoes just considered, that the value of the first few inches of water applied is much greater than that of the later applications. For instance, 5 inches of water produced about 33 bushels of wheat, or about 6.6 bushels per inch; 15 inches of water produced about 48 bushels of wheat, or about 3.2 bushels per inch of water, while 20 inches of water produced 40 bushels of wheat, or only 2 bushels per inch. The value of the first five inches of water applied to wheat, therefore, is more than three times as much as the value of the last five inches, in a total depth of twenty inches. Similar results may be observed in the case of oats. Five inches of water produced 58 bushels of oats, or 12 bushels per inch, while 20 inches of water produced 86 bushels of oats, which is less than five bushels per inch of water. The difference is certainly very striking. Even in the case of potatoes, the yield of which increased steadily with the increase in irrigation water, the same fact holds. Seven and one-half inches of water produced 160 bushels of potatoes, or about 22 bushels per inch, while 30 inches of water produced 274 bushels of potatoes, which is only about nine bushels per inch. Corn, alfalfa, the various grasses, sugar beets, vegetables and all other crops show similar results; namely, that the value of water is highest when it is used sparingly and carefully; that the value of water is lowest when it is applied liberally and carelessly.

With this generalization in mind note how these results may be viewed in their relation to the increase of the irrigated area.

According to the investigations of the Department of Agriculture, under the direction of Dr. Mead and his associates, thirty inches of water or more are used in the majority of places in the irrigated section for the production of crops. Let us apply the varying value of water as just explained to the economical or rational use of water. If the thirty-acre inches be spread over six acres of wheat so that the whole area of six acres will be covered with water to a depth of five inches, each acre will yield  $32\frac{1}{2}$  bushels of grain, or a total of 195 bushels. If the same amount of water be spread over four acres, that is to a depth of  $7\frac{1}{2}$  inches, the total yield of grain will be 165 bushels. Spread over three acres to a depth of ten inches the same amount of water will yield 118 bushels. Spread over two acres to a depth of fifteen inches the total yield will be ninety-five bushels, and spread over one acre to depth of thirty inches, the yield will be 42 bushels. It may thus be seen that in the case of wheat the total amount of grain produced by thirty-acre inches of water may be increased from 42 bushels to 195 bushels by spreading the water over more or less ground.

#### WOULD INCREASE IRRIGABLE AREA.

Certainly the nearly five-fold increase of grain thus made possible will more than pay the farmer for the labor of handling six acres of land instead of one, and of higher importance by using the water rationally the irrigated

wheat area may profitably be increased four or five times without building another reservoir or canal.

Similar investigations of the oat yields would result in a similar conclusion. Thirty-acre inches of water applied to three acres of oats yielded 57 bushels per acre, or 171 bushels for the three acres. Applied over two acres the same amount of water yielded a total of 140 bushels, while if the same amount of water were applied to only one acre it yielded only 79 bushels. Here again the farmer has it within his power to increase his oat yield from 79 bushels to 171 or more by distributing the same amount of water over different acres of land, and here again, also, the possibility is shown of increasing the irrigated area without the building of new reservoirs or ditches. The data referring to potatoes are similar in the conclusions that may be drawn. Thirty-acre inches applied over four acres of potatoes yielded 644 bushels; over two acres, 466 bushels, and over one acre 274 bushels. These great differences in yield unquestionably would more than compensate the farmer for the handling of the extra acres of land.

It is to be remembered in this connection that land without water throughout the West sells at from fifty cents to four or five dollars per acre, while the water right to an acre of land, at least in Utah, seldom falls below forty or fifty dollars, and in many cases it is as high as \$400 or \$500. With land, therefore, of little value, and water of very high value, the energies of the farmer should be directed towards getting the greatest possible returns from the water at his disposal. A large acreage means little in an irrigated district; the water right means nearly everything.

#### WHEN TO IRRIGATE.

Without dwelling longer on this most important phase of irrigation improvement in the farmer's domain, let me suggest that even the same amount of water applied to the same area of land may be made to yield more or less of a crop according to the will of the farmer, providing, of course, the farmer is in possession of the requisite knowledge. The time in the life of a crop at which water should be applied, whether the heaviest irrigations should come early or late, the method of irrigation, whether by flooding or by furrowing, are questions of prime importance to the irrigation farmer. The answers to these questions obtained from one crop will seldom apply directly to another crop; and each crop must therefore be studied independently with respect to its water requirements. That the time and manner of application of water has a high influence on the yield can be illustrated by numerous examples of which the following is an example:

During the season 15-acre inches of water were applied to an acre of oats in two irrigations of  $7\frac{1}{2}$  inches each. The same amount of water was applied to another acre of oats in three irrigations of 5 inches each. The field receiving the water in two irrigations yielded 65 bushels of oats, while that receiving the water in three irrigations yielded 74 bushels, which shows a difference of nine bushels of oats to pay for the labor of the extra irrigation. In all probability the farmer would find nine bushels of oats very good pay for irrigating one acre.

## THE QUALITY OF THE CROP.

In these days of enlightenment and keen competition the yield of a crop is not the only thing to be considered; the quality of the crop must also be given full attention. We have recently learned that the quality of crops may largely be controlled by controlling the application of water. Plants receiving much water usually become richer in fat than those receiving smaller amounts of water. The sugar in beets appears to increase as the water increases up to a certain limit, when the per cent begins to decrease. The quality of fruits and vegetables may be strongly influenced, and in many cases improved by the judicious use of water. In almost all crops the so-called protein or flesh-forming substances are highest in crops that have been grown with the least amount of water. For instance, wheat grown with a small amount of water will yield a better and more nutritious flour than will wheat grown with a larger amount of water. Oats grown with a small or moderate amount of water would form a better horse feed than oats grown with more water, and so on in general with all the grains.

When this rather subtle subject shall have been investigated properly it will probably put the means into the hands of the farmer whereby he can at will produce crops that will excel the crops grown in humid climates in quality, flavor and general desirability, and as a consequence the products of the irrigated section will be superior in value to the products of the humid sections. The great lesson that seems to be enforced by recent investigations similar to those quoted is that in general the more moderate the amount of water used in the production of the crop the better is the quality of the crop.

## UNDREAMED-OF POSSIBILITIES.

This paper would be entirely too long if an attempt were made to go fully into the possibilities of the production of crops by irrigation if irrigation were practiced in a thoroughly systematic manner. The above discussion indicates the important results that may be obtained by rational irrigation practices. It must not be omitted, however, to call attention to the fact that not only does the practice of irrigation bear an important relation to the production of crops but it is also of prime importance in conserving and maintaining the fertility of soils. Investigations carried on at the Experiment Station with which I am connected show that irrigation water a few hours after its application makes its influence felt to a depth of a great many feet below the surface. The water tends to wash the nitrates and other soluble and valuable plant foods into the lower layers of the soil. If excessive irrigation be practiced for any length of time, much of the fertility in the soil will undoubtedly be washed down into the ground water or out of the reach of the roots of plants, and this soil will cause a corresponding decrease in the yield and quality of the crop. If a district persists in over-irrigation, and I regret to say that I have observed very few localities in which over-irrigation is not practiced, the soluble materials of the soils will finally be washed out of the soil, the ground-water will be raised, there will be a seepage downward into the lower lying lands, and an accumulation there of water heavily charged with the

soluble materials of which the higher lying lands have been robbed. Evaporation will then begin. The soluble materials in the water will be deposited near the surface of the soil as alkali, and streaks of fertile lands will begin to form the alkali barrens of the West. At the same time, from the diminution of plant food, the yield and quality of the crops on the higher lying lands will be diminished. From this point of view, also, the moderate use of water is advisable.

#### WOULD DOUBLE AMERICA'S IRRIGABLE AREA.

I am of the opinion that as our knowledge grows we shall find that the rational use of water consists in the use of about fifteen inches of water distributed throughout the season according to the needs of the different crops on the farm. Should this view be correct, it will mean at least the doubling of the irrigated area without the expenditure of another dollar for the construction of new reservoirs and canals. The time will come when the Reclamation Service of the United States shall have finished its first great reservoir and dug its first great canal. It will then find itself ready to allot the water to the farmers. A question that will immediately arise will be, how much water shall be considered the right amount for the production of ordinary farm crops? Not only in general, but on different kinds of soil, on the sandy, clayey, loamy, calcareous and alkali soils characteristic of the arid region, which all differ materially in their water requirements. It will hardly do for one of the experts of the Reclamation Service to allot the water according to his private opinion. The allotment must be done in a manner based on rational experience and experiments. By the time that the Reclamation Service shall have finished its first great undertaking there will be considerable data of the kind at its disposal, for a number of western experiment stations are undertaking elaborate investigations having in view the water requirements of various soils and crops.

The chief difficulty in making the farmer's work with irrigation rational lies in the fact that the farmer himself will probably feel that the necessity of knowing how much water shall be used under different conditions, and applying that knowledge, places another burden upon him. However, when he may be so richly compensated for this extra work as has been shown in this paper, that difficulty should easily be overcome. It is necessary, however, that a campaign be instituted at the earliest possible moment for the purpose of impressing upon the farmer the necessity of measuring the amount of water which he receives upon his farm and which he applies to different fields. It may be more correct, perhaps, to say that the canal companies should be impressed with the necessity of knowing how much water is taken into their respective canals and how much they deliver to their various customers or stockholders. If this work were undertaken by the canal companies it would soon follow that the farmer himself would give more thought to the actual amount of water which he received and the best disposition that he could make of it. There can be little real progress in the farmer's work in irrigation until the old haphazard method of guessing at the amount of water received and used is changed. The greatest advance in the farmer's work in irrigation will be progress in the application of known amounts of water to

fields and the controlling of the amount of water applied so that the farmer may be able to reap the largest possible profits from the water which enters his farm.

#### ROOM FOR EXHAUSTIVE STUDY.

This discussion is far from exhaustive; it is intended to be suggestive. I believe that the subject which it touches is worthy of the attention of all those who are interested in irrigation improvement and advancement. We have left the farmer's side of the work alone long enough. His problems are just as important as those now being solved by engineers, and with the present development in modern science and the increased interest in irrigation, the time seems to demand the undertaking and carrying to completion of such investigations as will develop for the farmer a *science of irrigation*.

In conclusion I can only repeat what I said in my paper read before this body last year, that it will be many years before the Government Reclamation Service can increase the irrigated area and the value of irrigated crops as much by the construction of new reservoirs and canals as may be done by the farmers, at the present time and with the present diverted water supply, by the adoption of rational, scientific methods in the application of water to crops.

# Irrigation in the Humid Region.

DIVISION C,  
SECTION PRODUCTION BY IRRIGATION.

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CHAIRMAN: PROF. THOMAS SHAW.

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Thursday, November 17, 1904.

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## **PRACTICAL SUCCESS WITH IRRIGATION AT THE EAST.**

HERBERT MYRICK, Editor American Agriculturist, New York and Chicago.

In a small way irrigation is quite universal in the Eastern States. The water is applied by means of hose to lawns, flower gardens and kitchen gardens. A constantly increasing number of market gardeners and truck gardeners also employ irrigation.

Until within a few years the so-called average farmer in the Middle and Eastern States has considered irrigation quite impracticable. About one year in three he has suffered great losses from drouth, and nearly every other year dried up pastures and reduced yields of hay, forage and grain testify to the Eastern farmer's necessity for the right quantity of water at the right time. But of late years even this class of Eastern farmers has begun to wake up to the fact that irrigation is a practical necessity, either by drawing water from streams or reservoirs, through gravity ditches or pipes and hose, or by pumping water by hydraulic ram, windmill or engine. The recent improvements in engines run by gasoline or kerosene have made it possible to pump water wherever wanted for irrigation purposes, at the East and South as well as in the West, and at a cost that makes such irrigation profitable in the dry time.

The Eastern farmer rightly regards water as a fertilizer. It comprises from one-quarter to nine-tenths of the various crops. The farmer may plow and harrow his soil ever so carefully, he may cultivate with the utmost thoroughness, he may apply plant food in the form of stable manure or fertilizer, or both, to the extent of \$100 per acre or even more, yet if his land is not blessed with sufficient moisture, all his effort and investment are of no avail. A drouth, even of short duration, may occur at such a time as to reduce his produce to an unprofitable degree. Sometimes only a little artificial watering will make all the difference between profit and loss.



Of course, there is too much wet some of the time in almost every season at the East, yet drouths are inevitable and frequent. The Eastern farmer is being educated to regard any reasonable outlay for assurance against drouth as likely to be a much better investment, and certainly as essential, as insurance against fire or death. And that that has been done to the Eastern farmer's profit is shown by the following compilation of the actual experience of practical farmers in the Eastern States, who have used irrigation methods for several years, as well as by the other statements of experience made by the speakers or essayists from the humid sections before this Congress.

## IRRIGATION IN THE EAST.

GEORGE A. MITCHELL, New Jersey.

During a long drouth all farmers realize what an advantage it would be for them individually to have plenty of water at their disposal so that they could double or treble their crops when the general yield is short and prices consequently high. The value of water during short dry times is not so generally known and recognized. There was a very severe drouth in south Jersey last spring, but plenty of rain during most of the growing season after August 1st. In seasons like this the common opinion would be that many crops gathered in the fall would turn out well. I supposed sweet potatoes would recuperate from the early drouth and give a full yield. I was, therefore, surprised at the extent to which irrigation paid on several crops on my farm the past season.

Hardly a year passes but some crops on every farm are damaged by dry weather. Two years ago sweet potatoes about Vineland looked well the latter part of August and a large yield was promised. September was hot and dry and as a result there was perhaps half a crop. One or two irrigations during that month would have doubled the yield and the irrigation of fifteen acres of sweet potatoes would have meant a profit of from \$600 to \$1000, or enough to have paid twice over for an entire irrigation plant similar to my own. Water can be secured from various sources. By far the best source, where it can be had, is

### FROM A STREAM OR POND

above the level of the land to be irrigated. This is a common source of irrigation water in the Western States. A canal runs past the seed farm of D. Landreth's Sons, near Bristol, Pa., the water in which is higher than the farm. If the canal company were willing to sell this water the whole of the seed farm could probably be irrigated. The water in this canal must come from some river and demonstrates what could be done if large irrigation canals were in use. Near Wayne, Pa., a brook running between two hills has been used for irrigation purposes for several years. A small dam is made and the water let out to one side along the sidehill. The land between the ditch and brook is seeded to grass which is irrigated by causing the water to overflow the banks of the ditch.

When the land is hilly or uneven over which the water is to flow when led from a creek to a field to be irrigated, some other device than a ditch is necessary. The source of water for the irrigation works of J. H. and G. H. Hale of Connecticut is from a small brook a mile distant, and the fields to be irrigated are one hundred feet lower down. The water is conducted in an iron pipe.

Another source of supply is from flowing artesian wells, but it is very rare that one of these can be secured, and when one is found it is liable to be on low ground where irrigation is not greatly needed. There are, however, a few

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\*The author was expected to deliver an address; but did not attend, and sent this article, previously written for "American Agriculturist."

avored localities where flowing artesian wells can be used for irrigation purposes. There are a dozen or more flowing wells near Atlantic City, N. J., which flow from twenty to fifty gollons per minute. It would appear therefore that some of the land near the New Jersey coast could be successfully irrigated in this manner.

The third source of water is by pumping from streams or wells. This is practiced largely in the West and elsewhere, and the pumping is done by water, wind or horse power, gasoline or steam engines. Windmills are successfully used in Kansas and Nebraska, where there are steady winds. In the East it is difficult to find

### A WINDMILL PUMPING PLANT

that has pumped enough water to thoroughly irrigate one acre of garden crops during the entire summer without the use of a reservoir larger than the tank on the mill. Since water power, like a windmill, involves no cost for fuel, it is to be used where practicable in preference to power requiring a constant outlay for fuel. In hilly countries where a brook runs with considerable fall through a farm it may be made to furnish a continuous power. Where a dam can be made a very convenient power can often be secured. If power is wanted solely to pump water a hydraulic ram can be used. With a gasoline engine and pump a large quantity of water can be pumped with small expense and with very little attention to the machinery. Steam engines, especially those of small power, cost more to operate and require the almost constant attention of an engineer. I have used a  $2\frac{1}{2}$ -horse power gasoline engine and centrifugal pump which pumps enough water in three hours to cover an acre one inch deep.

Irrigation from wells in the East is as yet more or less an untried method. Some cities and towns are supplied with water from wells, and wells that will give enough for this purpose would answer for irrigating a large acreage. The water for the Vineland water works is pumped by steam power from fourteen driven wells two and one-half inches in diameter. The average daily amount of water pumped is 250,000 gallons. An irrigation plant recently installed for Johnson & Stokes at their New Jersey seed farm obtains a satisfactory water supply from three two-inch driven wells.

Two brooks run nearly parallel through the farm of P. S. Lorillard of Jobstown, New Jersey, who has irrigated one-fifth of his 1500-acre farm at intervals during the past twenty years. When irrigation was first thought of it was a question whether to build a small dam where the brooks entered the place and pipe the water to the other end of the farm where a considerable acreage could be irrigated by natural flowing, or whether to use for sub-irrigation purposes the seventy miles of drain tile that had been and were being laid to drain all the low land adjacent to the brooks. Irrigation by drain tile was the method adopted.

Substantial dams were constructed along the brooks at every four-foot fall. When it is desired to irrigate, the gates of the first two dams are closed, and a head of water is secured by leaving them closed for several days. After a head is secured the gates of the second dams are closed and the water let in, and so on to the last two dams. Two or three weeks are required to

perform one thorough irrigation. When the brooks are dammed as described the water is forced back into the tile and between the tile into the soil. About 300 acres can be sub-irrigated in this way. Large quantities of potatoes were formerly grown on this sub-irrigated land, but the cost of hired labor was so great that potato raising was abandoned. Mr. Lorillard now uses all his land for pasturing.

The natural facilities afforded by a very small stream flowing along one side of the farm were taken advantage of by W. J. Baldwin of Walpole, Mass. From ten to fifteen gallons per minute of cold spring water flows in the stream. A small dam was put across the stream, which turned the water into a trough. The water was taken by this trough to a patch of potatoes of about seven-eighths of an acre. Two hundred bushels were harvested from the piece and sold for fifty-five cents per bushel, whereas without irrigation Mr. Baldwin believes that not over sixty bushels would have been secured. Another advantage of the irrigation was in

#### HOLDING THE WHITE GRUB IN CHECK.

The ground was badly infested with them and they would have practically ruined the crop if the ground had not been irrigated. The potato crop was followed by turnips, sown July 18th. The usual time for sowing in this neighborhood is June 25th. Without water to hurry the growth, no crop of turnips could have been secured, as was proved by the failure of the neighbors' crops.

A large strawberry grower of Glassboro, New Jersey, who has irrigated since 1884 uses a steam pump and boiler, and pumps water from an artificial pond at the rate of 800 to 1000 barrels in ten hours. The first cost of the plant was \$600. The expense of operating is about \$3.50 per day, including two men, fuel and wear of the plant. Strawberries were irrigated during eight years from 1884 to 1895. His smallest gross sales for any season in which irrigation was practiced were \$300 per acre, while the average gross sales for twelve years were \$250 per acre. Since the plants were allowed to produce only one crop this would mean \$500 per acre for the bearing year. In addition to this was the profit from irrigated celery or lettuce that was grown after the strawberries were plowed under.

Thomas R. Hunt irrigates his farm at Lambertville, New Jersey, using a gasoline engine and pump, and pumps water from an artificial pond at the rate of 2500 gallons per hour. This plant was installed in 1892 at a cost of \$260 for engine and \$100 for iron pipe. Old fire hose and homemade hose are used for distributing the water where there is no pressure. The water is applied to the surface usually in furrows between the rows. Growing plants such as cabbage and celery are sprinkled. The first year in which the plant was in operation the irrigation of one acre of celery more than paid for the entire cost of the plant. Mr. Hunt estimates that the value of the water, merely for the purpose of wetting the plants before and at the time of setting, pays annually more than the initial cost of the plant.

**IRRIGATION IN NEW JERSEY.**

PROF. E. B. VOORHEES, Director New Jersey Agricultural Experiment Station.

Little importance has thus far been attached to the matter of irrigation in the Eastern States. This is due in large part to the fact that the rainfall is usually sufficient to meet the needs of vegetation and because serious or long protracted droughts are the exception rather than the rule. Owing, however, to the changes which have taken place in recent years in the character of the farming, attention has been aroused to the importance of controlling the moisture of soils rather than accepting the conditions as they exist, and a deficiency of rainfall for even a short period is now found to be more disastrous than the long periods of drought under old conditions of farm practice, though, even under extensive systems of farming, the losses from drought are often very serious. For example, in the season of 1899 it was so dry in May and early June that the yield of hay, an important crop in the East, was very light in New Jersey. The shortage in this crop amounted to more than one-half, which at a low estimate averaged fifty dollars per farm, or a loss of more than \$1,500,000 for the State. In the dairy regions the deficiency of rainfall also materially reduced the yield of the pasture and early forage crops, thus affecting the returns from this branch of farming. So seriously does a deficiency of rainfall affect the dairy interests that many progressive farmers now regularly plant a supplementary crop to provide sufficient forage in case of drouth. It pays better to have an excess of forage, which may be wasted in part, in a good season, than to have a shortage. The deficiency of rainfall in 1899 also resulted in very serious injury to early crops, particularly asparagus, strawberries and other berries; early beets and many other important early crops were also affected.

It is estimated that the loss to the hay crop of New Jersey from the drouth in May and early June, 1899, was \$1,500,000, while small fruits and vegetables were even more seriously affected than the grasses. The records kept at the New Jersey Station show that in 1897 and 1898, years of abundant rainfall in April and May, the yield of hay averaged 2.65 tons per acre. In 1899 it was but a fraction over one ton, owing to the deficiency of rainfall in April and May, at the low price of \$10 a ton, a loss for the twenty-five acres of over \$400. The yield of crimson clover forage for 1897 and 1898 was 8.5 tons per acre; in 1899 the yield was but five tons, or in a good year the yield was seventy per cent greater. The deficiency in the rainfall at the critical period was alone responsible for this difference in yield. Oat and pea forage in 1897 and the early seeding of 1898 averaged six tons per acre; in 1899 the yield was but 3.3 tons per acre.

To show the frequency of such drouths as that of 1899, the rainfall records of Philadelphia, from 1825 to 1895, show that in 88 per cent of these years there was a deficiency of over one inch for one month, or that in 62 years out of the 70 there was one month in the growing season from April to August in which such a marked deficiency occurred as to cause a serious shortage of crop, and

that for the same period there were 39 years in which the deficiency extended throughout two months, while in twenty-one years it extended throughout three months.

Experiments conducted by the New Jersey Station were for the purpose of determining whether irrigation during these short periods of drouth would result in sufficient increase of yield to pay for the works necessary to obtain the supply of water. The tests were made on small fruit. Careful records were kept of the yield of plats which received identical treatment, except that some were irrigated and others were not. The yields of the irrigated plats over and above those not irrigated were as follows:

Blackberries 1038 quarts per acre, worth \$93.42.

Raspberries, 329 quarts per acre, worth \$32.90.

Currants, 852 quarts per acre, worth \$85.20.

The increase in yield would not be so marked every year as in 1899 as the drouth of that year was exceptional.

Conditions in parts of New Jersey are favorable to a low cost of irrigation by means of canals and ditches, and it is estimated that 75,000 acres can be watered without the use of storage reservoirs at a cost of about \$8 per acre, not including the annual cost of application. Even if one-fifth of this, 15,000 acres, or even a much smaller area, were brought under irrigation in this way, it would enable the gathering of data which would help to determine whether the more expensive storage plants would be likely to prove a financial success. This irrigable area may also be largely increased without storage, by pumping from wells. The areas thus available for irrigation are now mostly under cultivation, and it is estimated that 175,000 acres could be irrigated in this way. Wells capable of providing 25,000 gallons per day, or sufficient water for an area of ten acres are found in many parts of Southern New Jersey, yet, aside from this, it has been shown that there is enough water wasted annually to irrigate the entire State during the driest year, and, neglecting what may be watered by wells, fully 325,000 acres may be brought under water.

## **PUMPING FOR IRRIGATION IN NEW MEXICO.**

J. J. VERNON, Professor of Agriculture, New Mexico Agricultural College,  
Mesilla Park.

In localities where there are no natural streams from which to draw irrigation waters, other means must be resorted to in order to secure water. The means usually employed for this purpose is that of pumping from the underflow. Irrigation by gravity systems has been practiced for ages, and pumping for irrigation has been employed for a great many years. Irrigators generally are not informed as to the extent to which pumping has already been carried on in the reclamation of lands throughout the arid sections, and the idea is quite prevalent that pumping for irrigation will not pay under existing conditions. If facts and figures regarding what has been accomplished by pumping were disseminated among the rural population, this misconception, in most cases at least, would be corrected. What has already been accomplished in the way of pumping for irrigation is indicative of what may be accomplished in the future. Statistics show that in British India alone there are 12,895,000 acres of land irrigated with water which is raised from wells by mechanical means at a total lift of from twenty to forty feet.

Pumping is employed for the irrigation of very large areas in different sections of this country. California, perhaps, leads in the total area of land watered by this method, and if the writer is correctly informed, the water is lifted from comparatively great depths—in places from a depth as great as three hundred feet—and yet it is a paying proposition. Pumping is spreading very rapidly in Colorado, and very considerable areas in the rice-growing sections of the South are being supplied with water in this manner. In the latter the lands usually lie slightly above the gravity systems and the water has to be pumped only a few feet. It is evident from the vast area of land that is already irrigated by pumping that this method of supplying reclaimed lands with water is of considerable importance, and will eventually have much to do with the reclamation and development of certain portions of the arid West.

### **THREE CONDITIONS UNDER WHICH PUMPING MAY BE ADVANTAGEOUSLY EMPLOYED.**

First—Where there are no surface streams from which to secure water for irrigation, and at the same time an underflow is to be found sufficiently near the surface of the ground.

Second—Where the streams have eroded their channels so deeply that the expense prohibits the construction and maintenance of irrigation ditches through which to lead the water by gravity upon the lands.

Third—Where there is a surplus of water in the irrigation canals, which surplus may be employed by pumping it upon lands lying slightly above the gravity systems.

### VARIOUS SYSTEMS OF PUMPING PLANTS.

Pumping plants in general may be conveniently divided into the following groups:

1. A power and pumping plant located at the head of the ditch system.
2. Power and pumping plants distributed at intervals along the ditch system.
3. A central electrical power plant to supply power to pumping plants distributed at intervals along the ditch system.

These three systems just mentioned have the following disadvantages: Difficulty and great cost of developing water in sufficient quantities at one place; opportunities for misappropriation of water; loss of water by seepage and evaporation; and difficulty of making an equitable division of the water.

4. Individual power and pumping plants situated upon each farm. The objections to this system are: a relatively large initial cost of installation and a comparatively low rate of efficiency and economy of operation.

5. A central electrical power plant to supply power to individual pumping plants upon each farm, serving the land of a whole community or of a whole valley. This system combines practically all of the advantages of the other systems. Sufficient water can be developed in one place without difficulty to supply one farm; misappropriation of water is impossible for the reason that the water is developed upon the farm where it is used, and, therefore, at all times is within the control of its owner; loss by seepage and evaporation is minimized; there is no division of the water, and, therefore, injustice from an unequal division of the water is eliminated; there are no long ditches to maintain a great expense; the initial cost would be within the means of every farmer; and the efficiency and economy would be high and the cost of pumping comparatively low.

### FACTORS THAT WILL CONTROL SUCCESS.

The same principles that are applied by rural economists to the agricultural industry in the rain belts may be applied in an irrigated district. The price of land, the character of its surface, the productive capacity of the soil, climatic conditions, markets, transportation facilities, machinery, systems of culture, personale, and numerous other lesser though essential factors, are all so inter-related that, in a discussion which involves the economics of agriculture, these factors must necessarily engage the attention. To these must be added in an irrigated section the cost of the water and the methods of applying it. These are the factors that will determine the success of any system of irrigation, whether the water is supplied by gravity systems, by means of pumping from the underflow, or by any combination of the two.

Wherever the land is cheap and the irrigation water is inexpensive an extensive system of agriculture may be adopted, i. e., a system that involves a minimum amount of labor and expense in growing crops. With cheap water profits may be realized from the most common crops grown upon fair or even poor soil, and when the surface of the ground is uneven or otherwise in bad condition for irrigation. Under such a system the net returns per acre will usually be comparatively small but the total net profit, if the property holdings are large, may be enormous.



On the other hand, when the irrigation water is expensive, such a system if followed would bring disaster. With expensive water an intensive system of agriculture must be employed—a system that requires a very large amount of labor and expense applied to a comparatively small area. To warrant such great outlay in labor and money the land must have a very high productive capacity and it must be put in the very best condition for the application of the irrigation water. Improved machinery must be employed, approved methods of irrigation adopted and a most judicious selection of crops made. The products must be of excellent quality and of fine appearance; well harvested and properly prepared for market. Furthermore, these markets must be ample and the transportation facilities good. The manager must understand the practical, scientific and economic problems involved in growing and marketing a high class product.

If time would permit a complete detailed discussion of each of these factors would be highly profitable. The writer firmly believes that it is only through a thorough study and a complete understanding of the practical and economic problems involved that success in pumping for irrigation will come.

#### DIFFICULTIES TO BE MET.

In connection with pumping for irrigation a number of difficulties have presented themselves and some of the pumping plants that have been installed during the last two years have not given satisfaction. These difficulties for the most part, may be grouped under the following heads:

First—Those involving the development of water. In some cases the water-bearing stratum has been so poor that the one well sunk would not supply the quantity of water desired. Misunderstanding of the cause of this failure has led to discrediting engines, to discarding pumps, and to a series of petty blunders causing annoyance and delay.

Second—Too little power with which to do the work required. This trouble has been of frequent occurrence and next to that of the development of a water supply, has created more dissatisfaction than any other feature of the work.

Third—Poor installation. The installation of the machinery should receive the closest attention. The engine should be placed upon a good foundation; the well-pipe, pump and shaftings securely anchored and braced, and a perfect alignment made. If these things are not done it will be only a matter of time until vibrations, slippage of belts and friction due to the shifting and displacement of parts will cause a large loss of energy and waste of fuel.

And fourth—Improper adjustment of the machinery. In order to secure the highest efficiency and the greatest economy in fuel consumption, the adjustment of the machinery must be perfect.

One of the most important features in this connection is that of the proper correlation of the speed of the engine and pump. If the speed of the pump is relatively high, the speed of the engine may be dragged below normal, under which condition it cannot possibly develop its full horse power and may refuse to run altogether. This difficulty is most likely to occur when the power is insufficient. Two instances of this character recently came under

the writer's notice. In one the speed of the pump was so high, when based upon a normal speed of the engine, that the speed of the engine dropped to about 30 R. P. M. below normal. This caused a loss of something like four horse power, which could have been utilized in pumping water if a proper correlation of the speed of the pump and engine had been secured. The other case was similar to the one given except that the engine was smaller and the speed of the pump based upon a normal speed of the engine was still higher. The water never reached the surface of the ground, as might have been expected. Without readjustment and further trial the pump was discarded for one of another make, thus throwing the blame upon the pump. These points illustrate how many of the difficulties come about.

Most of these difficulties are explainable, and have been the result of installing the pumping plant without due information regarding the points involved. In every case before any of the pumping machinery is ordered a thorough test should be made of the water-bearing strata before the wells are sunk, and then of the capacity of those wells. Delay and expense would be avoided by following such a rule. Many of the most reliable firms refuse to guarantee results without some such information upon which to base their estimates. By so doing the good name of the firm is not endangered and at the same time the patron's interests are protected. Such an attitude on the part of the dealer or contractor seems entirely commendable, and in the end, if adhered to persistently, will be the means of preventing many unsuccessful attempts and much litigation. The failure of a single pumping plant, no matter how trivial the cause may be or how easily it might have been avoided may have the effect of delaying the development of a whole section of the country.

Thoroughly competent men to undertake the installation of pumping plants are urgently needed in all sections where pumping must be resorted to in providing water for irrigation.

### SOME RESULTS IN NEW MEXICO.

The New Mexico Agricultural Experiment Station has been investigating problems in pumping for irrigation for upwards of two years. The investigations are made in the following order: the gathering of information in regard to the progress of pumping for irrigation in New Mexico and adjoining States and Territories; the development of water in quantities for irrigation purposes; a test of pumps; and a preliminary test of fuels for use in a steam boiler. The results almost uniformly indicated that pumping could be made successful. I need not give these results here—they may be found in Bulletin No. 45 of the New Mexico Agricultural Experiment Station.

The work, as continued after the publication of this Bulletin, included a test of the use of Beaumont, Texas, crude oil in an internal combustion engine with an attachment for utilizing crude oil and kerosene, and a comparison of the fuel value of crude oil, kerosene and gasoline. Crude oil proved to be the cheapest fuel yet tested. The results in detail will appear in Bulletin No. 52, now in press.

At the same time investigations were begun to determine the relative

cost of growing various crops by means of water supplied by pumping and by means of river water.

The cost of alfalfa hay in the stack on the farm was \$1.70 per ton when river water was used, and \$5.04 per ton when water was supplied by pumping. The cost per ton baled f. o. b. the car about one mile from the farm was \$2.57 for river water and \$5.91 for pumped water. During the season two cuttings were grown by means of river water and four cuttings by means of well water. The net profit, the alfalfa selling at \$10.00 per ton, was \$11.32 per acre for the river water and \$12.68 per acre for the pumped water, a balance of \$1.36 per acre in favor of pumping. Labor, water tax and land tax are included in the cost. The pumping was done with a 20-horse power steam engine and a 6-inch centrifugal pump, with coal at \$6.00 per ton delivered.

The results are brought together in the following table:

	River Water.	Well Water.
Yield per acre, tons.....	1.76	3.10
Cost in the stack.....	\$1.75	\$5.04
Cost baled, f. o. b. car .....	\$2.57	\$5.91
Net profit per acre * .....	\$11.32	\$12.68

The Experiment Station Horticulturist, Mr. Garcia, grew without fertilizers 31,250 pounds of onions per acre by means of well water pumped from the underflow. The water cost \$15.00 per acre. The gross returns, the onions selling at 2¼ cents per pound, was \$703.12½ per acre. The net profit, after paying for the water, labor and all other expense incurred in growing, harvesting and marketing the crop was \$500 per acre.

The following table shows the number of irrigations, the quantity of water and the cost of the irrigation water pumped from the underflow when used in growing alfalfa, wheat, corn and sweet potatoes:

Kind of Crops.	Number of Irrigations.	Quantity of Water. Acres Inches.	Cost of Irrigation Water per Acre.	Yield per acre Pounds.
Alfalfa .....	11	33	\$12.75	21,080
Wheat† .....	4	24	8.30	2,826
Corn .....	4	12	4.15	.....
Sweet Potatoes .....	4	14	4.85	10,000

From the facts that have been brought forward it is evident that we have before us a subject of the highest importance. Pumping for irrigation has been employed in the past in the reclamation of vast areas of arid land and it will no doubt form an equally important factor in the future development of arid America.

\*Alfalfa hay selling at \$10 per ton.

†Turkish red winter wheat.

**RICE IRRIGATION.****THE WORLD'S GREATEST IRRIGATED CROP.**

W. A. WARD, Beaumont, Texas.

Texas has 225,000 acres under irrigation in rice. Rice is the principal food of more than half of the inhabitants of earth, and in the yearbook of 1902 the statement appears by authority of the Department of Agriculture that there are probably more acres of land irrigated to rice in the world than to all other crops combined. Certain it is that rice is one of the most nutritious and easily digested cereals, and its culture in this country has a great future.

Approximately 600,000 acres of rice lands are now under irrigation in the United States, yielding about five million bags or 17,500,000 bushels of rough rice, worth to the rice farmers about \$12,500,000 and to the consumers over \$30,000,000 annually.

**HALF A MILLION ACRES OF RICE LANDS IN LOUISIANA AND TEXAS.**

Twenty years ago the cultivation of rice was confined to the Atlantic Coast region and the lower Mississippi Valley. The lands of the Carolinas are irrigated by tides and those of the Mississippi by gravity, but these lands now form but a small part of the rice lands cultivated in the United States. Of the 600,000 acres now in cultivation the coastal plains of Louisiana and Texas furnish over 500,000. The center of the rice industry is now but little east of the boundary line between Louisiana and Texas, and at the rate this industry is moving westward the center will soon be within the State of Texas.

Rice is now cultivated as far west as the Rio Grande. On the coastal plains of Texas and Louisiana irrigation is by lifting the water from the numerous rivers and bayous by means of powerful centrifugal pumps into surface canals.

**GREAT PUMPING PLANTS.**

The most economical unit is a pump having a capacity of about 35,000 gallons per minute, and the lift varies from fifteen feet to seventy feet, the average lift being about twenty-five feet.

A small part is irrigated from wells. These lands are fairly well drained. The water is applied after the rice is well up—three or four inches—and is held on the land to flood it continuously during the growing season—60 to 90 days—and is drawn off as the rice begins to mature. The crop is cut with twine binder machines and threshed like wheat and oats. The same kind of implements are used in preparing and seeding the land as in wheat farming. These methods of irrigation and culture have revolutionized the rice industry.

It follows that a retentive clay subsoil is necessary in order to hold the water and to sustain the weight of the latest improved farm machinery.

What is herein designated the coastal plain of Texas and Louisiana, a strip of prairie land with an average width of about 40 miles extending from a little west of New Orleans to the Rio Grande, is nearly all of this

character and level enough for rice culture. With her water supply properly conserved Texas has more land well adapted to rice culture than all the lands now cultivated to rice in the United States. The large pumping plants are located near the head of tide water in the numerous streams flowing into the Gulf. These streams are uniformly deep and affected by tides about fifty miles back from the Gulf.

#### DANGER FROM SALINE BACK-FLOW.

The location near the head of tide water is necessary in order to secure an ample supply of fresh water. Numerous mistakes have been made in locating too near salt water, and by over-appropriating, thereby causing a back-flow, and in dry seasons pumping salt water which is worse than no water because it not only destroys the crop but injures the land.

The natural flow of these streams has not been diverted except by pumping. The eastern part of this rice belt of Texas has an average annual rainfall of about sixty inches, while the western part has but little. It requires about thirty inches of water on retentive soil during the growing season to supply soil absorption, evaporation and proper irrigation for rice.

#### IRRIGATION NECESSARY.

The rainfall is almost sufficient in some places in some seasons, but in no part of the rice belt of the United States or in other countries is it safe to rely upon the rainfall to grow rice.

The most important effort being made at present to conserve the rainfall and natural flow of the streams in the rice belt is incidental to the construction by the general government of the ship canal from the mouths of the Sabine and Neches Rivers along the west shore of Sabine Lake to the mouth of Taylor's Bayou where it will connect with the Port Arthur Ship Canal already constructed to the head of Sabine Pass.

#### RIVER AND HARBOR WORK INCIDENTALLY CREATES IRRIGATION.

While the prime object is to open these deep streams to navigation, it is believed the combining of the flow of these two rivers in a narrow canal instead of allowing their waters to mingle with the salt waters of Sabine Lake will extend and increase the available fresh water supply of these rivers to irrigate about 75,000 acres of additional rice lands. These rivers are the source of supply for about 75,000 acres at present. The Sabine and Neches and Trinity Rivers and their tributaries drain all of the vast forests of East Texas, south of Red River, and a part of the timber lands of Western Louisiana.

#### FOREST PROTECTION IMPORTANT.

The protection of these forests and the storing of water along the upper parts of these streams is of very great importance to the rice and other agricultural interests of Texas and Western Louisiana.

Allow me to call attention to the difficulties which will probably be encountered and which have already been experienced in drafting and passing

a law that will apply alike to the arid regions of Texas and to the rice belt. The available water supply under present conditions of the streams flowing into the Gulf have been mostly appropriated by private individuals and private corporations. Some of these companies own large bodies of land and are irrigating for themselves and others as much as 30,000 acres each.

The proposed Irrigation Code, while it appears in general to be admirably adapted to the arid part of Texas and other States, would disturb very important industrial conditions existing in the rice irrigation district. I have been kindly furnished a copy of this proposed Code by its author, Mr. Bien, and it will be given careful consideration by the best legal talent of the rice district in order, if possible, that it may be so drafted that we shall not be compelled by the first law of nature, which is so generally recognized in all the States, including Texas, to fight its adoption by this State.

# Section Rural Settlement.

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CHAIRMAN: WILLIAM E. SMYTHE,  
Author of "The Conquest of Arid America," San Diego, Cal.

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Opening address by the Chairman.

## THE FOOTSTEPS OF THE PIONEERS.

Utah is the classic land of American Irrigation and the systems which began there have spread to others of the Mountain States. We have some of the actors in the Utah drama here to-day, and wish to hear from their lips some of the peculiar features of their colonization work.

One of the early colonies was in Northern Colorado—Greeley. I think the same plan was followed in other instances throughout that portion of the State, and it has become powerful in consequence. Greeley had some peculiar features; the people were moved in a body. A Greeley colony was formed in New York City before the people had seen the land or the land had been selected. It was formed of the devoted followers of Horace Greeley, the great editor of the New York Tribune, and was organized under the agricultural editor of that paper. It came as a sort of far echo of the colonies of the forties. They decided that co-ownership and partnership was not a success, but they wanted to employ as much co-operation as could be made feasible. They co-operated in the first place in the purchase of the land, and in that way effected a great saving. Another thing they did which I think worthy of imitation is this: They had a town site owned by the Colony Company, so that the values created went into a company fund, which was available for the benefit of the colony instead of becoming a real estate speculation for the benefit of a few. The town grew and prospered and finally became wealthy for the benefit of all. I think that is perhaps the best lesson we can learn from Greeley. Greeley was also wonderful in its social life. The first thing they did at Greeley was to put up a colony hall, and that became the center of their social life, which was delightful from the beginning. They did not realize any far-reaching plans of co-operation. It became a struggle of each man for himself, but they teach us something in the fact that the colony was organized before leaving the East; they purchased the property with a common fund, and they started at the beginning a delightful social life.

## CALIFORNIA COLONIES.

A third group of colonies, notably in the territory of the Arid West, is in Southern California, beginning with Anaheim. It was formed by a party of German mechanics and tradesmen from San Francisco. They purchased their land in common, sending out a party first to discover the place; then another

party to dig the ditches and divide the land into twenty-acre farms and plant them principally to wine grapes. Finally when the place reached a self-sustaining stage the main body of colonists went to Anaheim and this has been a very prosperous community. It has the great distinction of being the mother colony. The development of Southern California, of which we know to-day, began, we may say with Riverside, which was contemporaneous with Greeley, and which was formed somewhat on the Greeley model. It gathered its settlers from all parts of the United States and came to a land which was then regarded as worthless.

After Riverside came Ontario; it was different in this respect; it was not a co-operative company in any way, but was started by two brothers, and they put in the works of irrigation, made the streets and avenues, divided the land into small farms and perhaps did a good deal of planting. That was done prior to the seeking of colonists.

Now, I am going to ask Apostle Penrose, of Utah, to tell us about the peculiar features of colonization in that State. As I remarked in the convention hall last night, the Utah people have made an historic success in colonization in this country. Their methods are quite different from those of the ordinary colonization movements, first, because they always move their people in bodies; second, different in their manner of settlement because they employ the central village instead of scattered farm homes; third, in the high development of co-operation which they have had. So I am going to ask Apostle Penrose to tell us how their people have been successful in settling their colonies upon land and making them happy and content. A few years ago I went to the Mormon authorities at Salt Lake and asked them if it were possible to compile a statement showing how much money the Mormon people have taken from the soil of Utah.

"We see" I said "that you have reclaimed these valleys and created these towns and cities; we know that you had almost nothing to start with, and that practically all you have must have come from the arid soil of this desert, irrigated by the sweat of industrious men. Now if it is possible to get the figures I believe we will have a most convincing argument to present to the American people in favor of the reclamation of these desert lands."

Through their perfect organization they sent out circulars, and at the end of six months presented me with an impressive and valuable array of figures which I published at the time in one of the large magazines. They accounted for having taken from the desert of Utah and expended nearly five hundred million dollars. They found that divided annually among the farmers of Utah about \$1482.00 per family, and allowing for a very generous living it left a net income of about \$500 for each family. Now that net income of the Mormon farmer exceeded the average gross income of the highest paid skilled wage earners of Massachusetts.



## **UTAH COLONIZATION METHODS.**

CHARLES W. PENROSE, Salt Lake, Utah.

The people who first inhabited Utah were a band of outcasts, really, from the United States, on account of religious persecution. They had to flee from their settlements in Illinois and they congregated on the banks of the Missouri River, where what is now called the city of Council Bluffs is situated. In 1847 Brigham Young selected a band of pioneers consisting of one hundred and forty-three men, two women and three children; they started on the journey across the plains, then an unknown wilderness. There had been some parties who had crossed the plains at different times, but the country was then unknown to the people of the United States. I will not take the time to tell you anything about the perils, hardships and trials of their journey; suffice to say that on the 24th day of July, 1847, this little band emerged and obtained their first view of the Great Salt Lake; they selected the spot under the direction of the late pioneer, Brigham Young, on which to found their city. They erected a fort for protection against the Indians and congregated together and selected tracts of land nearby for farming purposes. In the fall of the year Brigham Young returned to the United States and collected people together to bring them out in companies, so that they might reinforce the small band that had settled at first at the place now called Salt Lake City.

### **WAS MEXICAN TERRITORY.**

This plan introduced in the beginning has to some extent been followed out since. At that time this land was not on the market. At first it was Mexican territory, but the Stars and Stripes were flung to the breeze, and as five hundred of the best men of our people were then in Mexico fighting the battles of the United States, the pioneers took possession of the country in the name of the United States, and after a number of people had been gathered together there a provisional government was organized under the name of the State of Deseret. We selected our Senators and Representatives and sent them to Washington and asked admission into the Union. That petition was denied, but afterwards a territorial form of government was accorded to Utah. Thus this land was formally made a part of the United States, a territorial form of government was established, and Brigham Young was appointed governor of Utah by the President of the United States. The people who first settled the soil of Utah went there under religious influences. There was to some extent what might be called a union of Church and State; however, the two were always kept distinctly separate. Our State or Territory officers were separate and distinct from the church organization and officers. It is true, as in the case of Brigham Young, the Governor of the Territory was also the President of the church, and the leading men in the church were usually made the leading men in our civil affairs; at the same time the machinery of the Territory and that of the church were kept entirely separate and distinct. The principle that animated the people was the religious principle; they fled from the confines of the United States because of religious

persecution. When they settled on the soil of Utah they were under the immediate direction of the church.

It will perhaps be interesting to some of you if I give you a very brief sketch of the church organization. The Church of Jesus Christ's Latter Day Saints—commonly called the Mormon Church—is presided over by three men, the President of the church and two counselors. The next body in the government of the church is the council of twelve apostles; these twelve when taken as a body, form a council equal in authority to the council of three; that is to say, if the President of the church dies, then its remaining twelve apostles is the next presiding body. Next to them come the councils of seventy elders, organized into bodies and presided over by seven of their number. At the present time there are about one hundred and forty-four of these councils of seventy elders, the whole presided over by seven men and all the first council of seventy; these with the presiding bishop and his two counselors, and the presiding patriarch, form the general authorities of the church. The different departments of the church are called States of Zion; the people composing the church are called Zion—pure in heart. These different departments of the church throughout the various settlements in Utah and regions round about are called States of Zion; each one forms a State of Zion: Now that state is presided over by a presidency of three. There is a high council composed of twelve men, corresponding somewhat to the general authorities, called the council of twelve authorities. Every little settlement is called a ward and over the ward the bishop and his two counselors preside; these are assisted by men called teachers, who are to assist in the management of affairs, and particularly to visit the people in their homes and teach them how to live, both temporally and spiritually. There are other councils in the church that I need not speak about; there is a union of the temporal and spiritual in the Mormon church and system:

#### ESTABLISHING A NEW COLONY.

Coming down to the conditions at present, I will take up the subject of the establishment of a colony. The plan on which we proceed in Utah is this; if some new locality is discovered, considered suitable for a settlement, some valley not before having been inhabited, a man is selected who is supposed to be a good counselor, a man acquainted also with human affairs, is selected to act in the capacity of bishop. He selects two counselors; these three form the presiding authority in the new locality. An invitation is extended to the members of the church to volunteer to go out and settle the newly discovered valley or tract of arid land. When a sufficient number of persons have volunteered to go they are organized into this bishopric. They take their wagons, teams, tools, farming implements, etc., and go out on the soil, all under the direction of the bishop and his counselors. When they arrive at the locality they select enough of the best portion for a town site, and it is usually laid out along the plans of Salt Lake City—streets crossing each other at right angles. Each family receives a city lot, generally ten by twenty rods in size; sometimes it varies a little according to the lay of the land and the extent of the settlement; then land is selected as nearly contiguous to the town lots as practicable, but before anything can be done on

the soil water is to be obtained. In the first place the settlement is located because of its proximity to some natural source of water supply—usually some little mountain stream. A canal is then dug on this principle: Each individual has the opportunity of working upon this original ditch or canal as much as he chooses, and according to the amount of work he performs he has the right to use so much water; the more work performed the more water he has the right to use. The amount of water he is entitled to all depends upon the amount of work he performs on this canal; that is the plan we generally use.

### SMALL FARMS THE RULE.

The farms are generally divided into small sections—about forty acres usually. In later years since the land has come into the market and the homestead law has been in operation, larger tracts of land are often taken up. Usually farms are divided into small sections or portions, and the right to the use of the water (there is no property right, really, in water), the right to the use of the water is determined by the amount of labor that each person performs on this original canal. A water system is organized; they have a head water master who has supervision over the entire ditch, and then there are block water masters, or water masters for different sections all under his direction; these water masters are elected; in the old times they were generally appointed by the people, who got together in mass meeting and appointed men to act as water masters. By this means people obtain possession of a sufficient tract of land for a farm and also a city lot. They live on the city lot and the farming district lies outside. This is for the purpose of religious worship and for educational and for social purposes, and in the early times for protection against the Indians. The principle is still carried out in all our new colonies of having city lots for the farmers to live upon, and a piece or tract of land outside for his farm.

### SOCIAL ADVANTAGES.

The first public building erected was always what we call the school house; it was used as a school house for the education of our children and for holding religious meetings and sometimes for amusements; sometimes they would fix up a stage and have a theatrical performance, so that the original school house was the place for holding the schools and for other public meetings and for the general purposes of the people in the town site. The people also have their dances according to their own arrangements and desires, and these dances are held under the direction of the church authorities. The dances are usually opened by prayer, and they endeavor to conduct them in an orderly and moral manner; no liquor is allowed, and in fact in a great many places no liquor is permitted in the settlements. These dances are usually conducted under the direction of an amusement committee, and if there is dramatic talent in a settlement they sometimes have theatrical entertainments. Also musical talent is cultivated, both instrumental and vocal; generally we have a very good choir which attends to the music, and if there are a sufficient number of musicians in a settlement for that purpose they generally organize a brass band.

I attribute the influence that prevails chiefly to the religious element; at the same time I think the plans that we adopt for the entertainment of the people so that they become associated closely would be adapted to colonization at other points and among other people.

#### CO-OPERATIVE OWNERSHIP.

Another plan usually adopted in these little settlements was to have a mercantile establishment in which every person had an opportunity of taking shares; generally put down to about \$5.00 a share, and in the early times when there was no currency it would be paid in some kind of produce. Each person had an opportunity of putting in so many shares. A general mercantile store was established and the people were invited to take shares in the capital stock of the company, and after a great Zion co-operative mercantile establishment was built up they generally did their trading with the parent institution at Salt Lake City. This kept a great deal of the money within our own borders instead of sending it out. Of course a great deal of merchandise was brought in from distant parts of the country, but the plan in view was to have our own mercantile and manufacturing institutions, with branches all over the Territory or State. We had men of all trades and kinds come in, and we always endeavored to get them into the particular line of their calling; a tailor was encouraged to start a tailoring business, a shoemaker in his line of business, and a tanner in his line of business.

Question—Do you schedule your water and live literally up to the schedule in its distribution?

Answer—Not entirely. We now have a very excellent irrigation law; a State law. I could not sketch it out this morning very clearly. The State divides the water and we have a State Engineer. We are also establishing water rights through the medium of the courts.

Question—Have you any paupers among you?

Answer—No, we have no paupers at all. It is the duty of the counselors and teachers to see that nobody suffers, whether he is a Mormon, Jew or Gentile. We have a society called a relief society, composed of women, who particularly assist the bishop in looking after the sick and afflicted, so that there is no need for anybody to suffer.

Question—Is your system of co-operation a cure for the pauperism that always follows the old system?

Answer—It is to a very large extent; there are some people who will not work, and there will always be the poor and dependent. People are encouraged to work and become independent through their own exertions, but there are persons dependent upon the public; we look after them ourselves in the church. We have a system called tithing, by which it is the duty of each member of the church to contribute for the purpose of looking after the poor and indigent, building school houses, churches, etc.; each man contributes one-tenth of his income annually; this is a voluntary contribution and not a tax.

Question—Do you have tramps; do you have jails?

Answer—We have tramps and jails; that is we have tramps going through the country; we do not have tramps of our own; only transient persons pass-

ing through the State. We have to have jails because sometimes some people will go wrong and commit crime, etc. We honor the law and turn the transgressors over to the State law and officers when it is necessary, so that we have to have jails. We do not have Mormon tramps, and we have very few Mormons who occupy the jails of the State and country.

## A MORMON COLONY IN MEXICO.

A. W. IRVINS, in charge Mexican Colony.

It is somewhat unexpected on my part—to say a word; I came here because I appreciate to a very great degree the labors of our friends in the question of irrigation and colonization, and I came for the purpose of gaining information rather than with the intention of imparting it.

My impression is that the principal thing we want to know this morning, more than any other thing, is which of all the plans that may be proposed can be the most successfully adopted in the establishment of rural settlements. Now, I am going to give you as clearly and briefly as possible, in about five minutes, the results of my experience during the last few years in colonizing our people in Mexico.

In the first place, to successfully establish a colony in this arid region, two elements are necessary—we must have land and we must also have water. Once having decided upon a location or place suitable for the establishment of a colony, we immediately determine, by an investigation by competent engineers, the most convenient and suitable point upon that tract of land for the establishment of the town, taking into consideration, of course, the elevation. We find that drainage is a very important and necessary factor, and therefore we usually select the highest spot or position on the ground or tract of land on which we decide to locate, which is susceptible of irrigation, for the establishment of the town. My opinion is that the most successful plan to adopt in laying out a small rural settlement is to make the blocks about one hundred meters square; divide each of these blocks into four town lots, thus furnishing each colonist with a corner lot. There should be at least two main streets running through the town at right angles; these streets may be made six rods wide, and the lateral streets may be made four rods wide. Of course if you are planning for a city you must plan upon a larger scale.

### FORTY-ACRE FARMS THE MAXIMUM.

Now we have calculated the area of this tract of land and have determined about what the population may be which shall occupy it, allotting each person say not to exceed forty acres of land. Many people who go into a new colony will not require as much land as this; for instance, mechanics will require smaller tracts, but we have demonstrated that forty acres of good land that can be irrigated is amply sufficient to maintain a family of six persons; therefore you can very closely calculate the number of town lots that it will be necessary to lay out in order to colonize there a number of people sufficient to occupy the entire tract which shall be used for agricultural purposes.

Immediately around this town site—after having laid it out in lots and blocks—we have adopted the policy of sub-dividing the land adjacent to it, into very small tracts; say lots or blocks containing about two and a half acres each. The land which is nearest to the town is always the most valuable; it is the land most convenient to the people, and consequently it is advisable that it be divided into small tracts, in order that each colonist may

avail himself of the advantage of having a small piece of agricultural land near his home. The land lying immediately adjacent to these smaller tracts or blocks, we have been sub-dividing again into tracts of say about ten acres, making a series of such blocks or tracts running around the entire tract of land. Then still further out from the center, or the spot which will be the center of population, and immediately adjoining the last mentioned tracts or blocks we have sub-divided the balance of the land again into tracts of say about forty acres each, taking in all the land suitable for cultivation and to which water can be supplied.

### AS A BUSINESS INVESTMENT.

There is another very important question which always enters into this subject—that is the financial part. There is no promoter of a colonization scheme but that expects at least that he will get back the money which he invests in it, and usually a little more in the way of profit; the latter is what is expected and prompts men to promote enterprises of this kind. The plan we have adopted usually is this: we have an incorporated company which acquires the land; this company purchases a large body of land at the lowest possible price, which is sub-divided in the manner I have just described; in disposing of these town lots and the agricultural tracts or blocks to colonists, we place the price to those who first occupy them just as low as it is possible to place it—just as near cost as we possibly can; that induces people to buy the land and occupy it. Of course lands can never become valuable without occupancy. But in disposing of this land to the first colonists we reserve one lot in each block of the town plat, and also one-fourth of all the tracts or blocks of land designed for agricultural purposes. These town lots and the blocks of agricultural land scattered throughout the entire large tract are not sold at first to any one, but are held in reserve until such a time when, either the colonists who have already established themselves on the land, or some incoming colonists, can afford to buy them at considerably advanced prices. The benefits derived from this policy are obvious; the colonists who are first established on the land are usually poor; in the course of time they accumulate means; then they usually desire to become the owners of the unsold and vacant land adjacent to their own, which vacant land has been greatly enhanced in value by reason of the surrounding improvements; when this time arrives and they have accumulated sufficient funds, they will readily pay a much higher price for the adjacent vacant land than that paid for their original holdings, and this reserve land is disposed of at a sufficiently advanced figure so that the company is reimbursed and receives proper compensation for its original outlay of money—a profit on the investment. For example, we are now selling for three hundred dollars lots similar to those sold to the first colonists in the same settlement a few years ago at five dollars.

### CONSTRUCTING THE IRRIGATION WORKS.

One of the first things that is necessary is the construction of the main canal which is to conduct the water onto the land. This is usually constructed by the people who have become the owners of the land; they either acquire interests in this canal by labor on it, or by employing labor on it to pay for

their interests, or may acquire their interests by purchase from those who have acquired it by labor and whose lands are insufficient to use the entire amount of water they are entitled to. Each colonist acquires a water right for the land he owns in proportion to his interest, either by purchase or by labor upon the canal. However, we make the necessary water rights to all lands appertain to the lands as far as possible, and establish rules by which it is made impossible for a person to transfer the necessary water right from the land; neither one must be transferred separate from the other. The water is taken from this main canal in laterals or sub-canals to the water users in each district. In the first place a man is appointed to take charge of the entire water system; in each sub-division there is what we call a sub-watermaster appointed; this sub-watermaster arranges a schedule at the beginning of each month, in which he indicates the hour or hours during which each water user shall take water and the hour at which his time expires, each water user being governed, of course, by the share he has acquired in the irrigation system. That schedule is made out for an entire month, and each water user is furnished with a printed copy, so that each person knows the hour or hours during which he can have the use of the water and the hour when his time expires. He must use it then or not at all; if he omits to use it he loses his opportunity for that time. This schedule is so arranged that each water user has a specified period during which he uses the water each week, and it is arranged so that the water comes upon the entire district at least once a week, thus giving each water user a certain period of the time during each week in which he may use the water on his land and in any manner he may prefer.

In obtaining the original large body of land we always calculate that there should be, adjacent to this farming or agricultural district, lands suitable for grazing purposes, because colonists must have cattle and horses in order to become successfully established, and if there are grazing lands adjacent you see how much greater the convenience is to them.

#### THE SYSTEM GENERALLY ADAPTABLE.

I see no reason why this system cannot be adopted by any one who desires to promote a colonization enterprise; the results obtained by it have been very satisfactory to us in Mexico. We have colonized a large number of poor people there; the land has been distributed in very small tracts, and it is a great source of pleasure to be able to say that while our operations there are only in their infancy, yet their earnings last year amounted to about five hundred thousand dollars, and if you would look at the hundreds of miles of fences and roads, and the bridges they have built, you would agree with me that this system has been eminently successful, and I see no reason whatever why it cannot be applied to any other people.

Mr. Smythe—You are not teaching those people that the dollar is the chief end of life?

Mr. Irvins—No sir; they would be very much disappointed if they expected to get rich quick in Mexico. We do not expect to get rich there.

Mr. Smythe—The main end you have in view is a good living?



Mr. Irvins—Yes, a good, comfortable living; plenty of houses, plenty of clothing, good food, etc., and an independent life. We tan our own leather; we make our own shoes; we have our own wood-working machinery, and we encourage the people to invest their savings as far as possible in these local institutions. These companies are incorporated and conducted upon the same business principles as any other companies, with the exception that our people almost universally become stockholders in them and thus are interested in their maintenance and upbuilding.

Chairman Smythe—We have now given fifty minutes to the consideration of the Mormon colonization and industrial system; it is a very short time to give to a very great subject, but even in that short time I feel that the two speakers have thrown a great deal of light upon the subject. Many people have claimed for years that the success of the Mormon settlements has been due entirely to the church; that the church sustained the industrial system. I have always believed that the reverse was true; I believe so now, though I have no doubt the wonderful organization of the church has been a powerful factor in their success. The main thing for us to learn is that they have worked out a fairly scientific method of colonization which is adapted to our general situation. The next address on the program is by Mr. Guy F. Mitchell on the subject, "Small Farms for the West."

**SMALL FARMS FOR THE WEST.**

THEY CONSTITUTE THE COMMUNITIES OF GREATEST PROSPERITY AND HIGHEST SOCIAL SUCCESS.

GUY ELLIOTT MITCHELL, Secretary The National Irrigation Association  
Washington, D. C.

We have before us the great problem of telling the people of the United States the splendid prosperity which results from the small irrigated farm, of showing the country, which has sanctioned this national irrigation work, that the carefully irrigated sections of the West constitute the best communities in the world.

The irrigation of desert lands is a work which appeals to more classes of men than does any other kind of agricultural development—all the way from the intensely practical money-maker to the high idealist.

The practical land dealer or real estate man appreciates the great increase in value which comes to the agricultural lands when supplied with water; the merchant who sells manufactured articles of all kinds discerns in the dense settlement which follows irrigation a splendid market for his wares; the intending settler looks forward with deep satisfaction to owning a farm where he can control the moisture supply and be assured of maximum crops; the banker considers irrigated land gilt-edged security; the citizen, with his State's welfare at heart, welcomes irrigation development as the highest blessing which can be conferred upon his community; the scientist derives keen joy from the creation of a system of reservoirs and canals which transform the desert into a land of production—the making of something splendid out of nothing; the sociologist becomes enthusiastic at the social conditions arising from irrigation, where land becomes intensively farmed, where the inevitable tendency is to break up large tracts into small and highly productive farms, where the communities become the most substantial and prosperous of any under any form of agriculture, where a greater percentage of men own their lands and homes than under any other social system, where good roads, churches, schools, good transportation, telephones and other urban improvements invade country communities as nowhere else and where an opportunity is presented to find homes on the land for the inhabitants of overcrowded centers. Lastly, the idealist sees in the reclamation of waste places, in the conquest and the subjugation of the desert, in the development of a country's latent resources, in the production of not two blades of grass where one grew before, but of a luxurious vegetation where nothing could previously live, the fruition of a dream of Arcadia, the accomplishment of the seemingly impossible, the absolute creation of wealth, strength, power.

**IRRIGATION COMPELS SUBDIVISION OF LANDS.**

The irrigation movement which is sweeping over the country is pregnant with vast possibilities for good in the United States. Irrigation begets small farms, and no country is so prosperous, so stable, as that which has for its basis a multitude of small farms.

Starting with the greatest bonanza farms in the world, where the plowman followed a single furrow throughout the day, the West will become, in the next generation, a section of small farms. The irrigated unit has already been established in a general way by the National Irrigation Act, at 160 acres; that unit will be in the coming years subdivided into 80, 40 and in some favored sections into 20 and 10 acres upon which a man will live with his family in plenty.

Not under the most exact system of farming can large tracts of irrigated land be worked with as great profit per acre as can the small tract where the farmer gives it his individual attention. Eighty acres can be better farmed than can 160.

As the great benefits of irrigation become more widely known throughout the country the practice will spread to the eastward, even to the Atlantic Coast, until in time every water supply from ocean to ocean will be utilized for increasing and insuring crop production. With this will come a subdivision of the Eastern farm units, for men will find in the East as in the West, that smaller tracts irrigated and well tilled will bring them greater returns than large tracts carelessly farmed and subject to the moods of the elements.

#### LANDS FOR OUR OWN CHILDREN.

America has stood for a century with her arms open to the world; the oppressed of all nations might find a welcome under the Stars and Stripes, nay, more, they might find an individual home on the land which was theirs for the taking. We are of late years becoming a little more discriminating and are taking into our ample fold only those whom we believe to be the desirable ones. Our immigration laws, many believe, might be made even more stringent without harm to ourselves. There is no great necessity for haste in building up our population to the two-hundred-million mark. The United States fears no nation to-day. Will we be the better or the worse for the next fifty million people who come into the country if they are brought in to largely swell the great centers of population now already overcrowded? Rather would it not be better to assimilate those people we already have in our midst, to take the vast floating population of Chicago, of New York and other great cities, and place them on the land and train them to get a living from it so that they might become a strength rather than a menace to the nation?

#### FRENCH STATISTICS FURNISH FOOD FOR THOUGHT.

We are inclined to condole with France upon her vital statistics, the fact that her birth rate does not exceed her deaths. Her population is not increasing, but her peasantry is a contented population; it is established upon innumerable small farms and it is not overcrowded and overcrowding. French statesmen are not confronted with the problem with which their German neighbors across the way are struggling—how to provide in an already crowded country for a rapidly increasing land-hungry population.

In the United States we have not reached the situation where we could not take care of a million new people a year if they were taken past the cities and put upon our lands, and there is no immediate fear of our lands becom-

ing overcrowded, nevertheless we should recognize two facts—that the welfare of the country demands a solution of the overcrowding of our cities and that even our land resources are not entirely inexhaustible.

#### AMERICA'S PRESENT LAND POLICY.

And this brings us to the question of the administration of our public lands. The Eastern half of the United States has been largely given to the people and considerable of the western portion has been taken up under our various land laws.

Of this great acreage it is estimated that nearly a hundred million acres can be irrigated, while a very large additional area is capable of producing crops without irrigation. Now, the question is, are our public land laws to be so administered that this great Empire of rich farming territory, capable of supporting the most dense and prosperous agricultural population in the world, shall be as fast as possible converted into actual homes, in 160-acre or less tracts, or is the present loose system to obtain, so that speculators and land grabbers, so termed, can continue to amass into single ownership immense tracts without settlement or improvement?

#### LOOSE LAND ADMINISTRATION.

All of our land acquiring laws are to-day fearfully abused—the Desert Land Law, the Timber and Stone Law, the commutation clause of the Homestead Law, and even the old 5-year Homestead Law, itself. Our policy has been heretofore that pioneering should be rewarded and that every inducement should be held out to encourage the “settlement and development of the West.” The most liberal construction has been placed upon the laws, and there has been no strict enforcement in letter or spirit of the principle which is assumed to pervade the laws under which the government gives away its public domain on the condition of actual settlement and home-building in as small tracts as men can make comfortable livings from for themselves and families. The practice has been to get the title out of the Government into private hands as easily and expeditiously as possible, with an almost entire disregard as to what the Government is to receive in return. The sentiment in the Western States themselves has largely supported this policy. Men urge that if stockmen and land dealers are willing to acquire large areas and place them upon a tax-paying basis, it is better for the State that they should so pass into private hands, even though they may lie idle in tracts of thousands of acres or be used as grazing properties in tracts of tens of thousands of acres, apparently overlooking that this policy prevents their settlement in 160-acre tracts which would support each a family of from three to ten people and add one hundred times to the productive capacity of the land and the wealth of State and Nation.

#### SINNING, BUT SINNED AGAINST.

Much criticism has been made of the stockmen as a class of land grabbers. It is true that the cattle men and sheep men have acquired ownership and control of the vastest of tracts of territory in the arid West by employment of fraud, thus preventing its settlement. But they are in reality the victims

of a condition which, while they may have been advocates of the cause, has not proven an unmixed blessing to them. In many of the stock-growing sections they have acquired so much land and it has increased so in value, with increased taxation, that their profit has been largely reduced from the days when they ran their herds on the free range. Many of them will state that they have not desired to acquire these large tracts of land under the desert or other land laws, but the very existence of this law has forced them to become large land owners in order to prevent other men from acquiring the land and driving them out of business.

#### RETARDED DEVELOPMENT.

Vast areas of the land of the West which have passed from the Government into private ownership, by a transfer, the spirit of which contemplated its settlement and cultivation is to-day lying idle, is farmed in the most indifferent and shiftless manner because the owner has more than he can attend to, or is irrigated and utilized merely to produce a meager crop of wild hay to winter over stock, whereas were it open to settlement it could be taken up in 160-acre blocks and made to produce an abundance for one if not for two families desiring homes.

It is needless to go to any extent into the question of the productivity of irrigated desert lands or to quote yields per acre. Government and State statistics and even the most casual and random inquiries as to the yield and fertility of Western irrigated lands disclose the generally accepted fact that irrigated lands, tilled with understanding, skill and industry, will produce from two to three times the average of Eastern lands. The result is greater farm value per acre, a higher land value and consequent reduction of the acreage for each farm as the highest degree of development is attained.

#### WHAT FOR THE FUTURE.

Now the question is, not of the past, nor of what has been done in the way of public land administration and public land policies, but of the future. What is the policy to pursue in disposing of our remaining Government lands? Have we yet reached the point where we should conserve our homesteads for families who are looking westward and part with title to each and every 160 acres only upon the strict condition that it shall be made into a genuine home, or can we still say that there is land enough to continue a policy of national squandering for yet a decade or two?

Population is what is needed for the West. Population will come with settlement. The only land law which fosters permanent settlement in any degree is the original Homestead Law, requiring five full years of residence, and that law carefully and strictly administered. The Desert Land Law, the Timber and Stone Law and the commutation clause of the Homestead Law have all, broadly speaking, been an actual and vast detriment to the West; they have shut the door of opportunity to hundreds of thousands of people in the East; they have fostered land speculation, land grabbing, land monopoly; perjury and falsehood run riot, and now they stand as a menace to that grand and most magnificent Western development and growth upon whose threshold we pause to-day, the working principle of which is laid down

in the National Irrigation Act, which provides for 40 or 80 or 120 or 160-acre irrigated homes.

To-day the West is looking through the vista into a glorious future. With one of the wisest measures for internal improvement ever enacted by any nation being pushed forward rapidly and skillfully by engineers of the highest intelligence and honesty, upon a basis of merit and for the general good of the country, it remains only that the United States shall return to the real spirit of the old Homestead Law of Galusha A. Grow and provide that settlement and home-building shall follow the disposal of our magnificent public domains and our splendid water resources.

Chairman Smythe—We will now hear from a gentleman who has grown white in extending the frontiers of our Western civilization, who has been identified with our growth in many different departments—Mr. W. H. Holabird.

## **THE LITTLE COLONY OF ONTARIO, CALIFORNIA.**

W. H. HOLABIRD, Los Angeles, California.

Failure in colonization work is not an unusual result; this is unquestionably due to the lack of thorough preparation by the founder or founders of the colony. Ontario has been selected as an illustration chiefly because of the thorough preparation of the tract of land and the development of the water supply by the original owners. The two gentlemen who developed this colony, George J. Chaffey and his brother, civil engineers from Canada, knew nothing about irrigation unless it was the theory, but they were thorough men in everything they undertook. These two far-seeing men had a vision and saw what lay beneath that soil; they used their engineering skill and executive ability in the development of this colony. They were leaders, while most men want to be led.

When they laid out the colony of Ontario they had very little water. A great plain extends from the headwaters of the little streams that feed into the San Gabriel Valley to the Santa Ana River which supplies the remarkable orange-growing sections of Redlands and Riverside with a part of their water supply. Prior to this development by the Chaffey brothers this great scope of country, some forty miles in length and some six or eight miles in width was a dry sage brush plain; there was not a tree or brush large enough or strong enough to picket a horse to. The water obtainable by gravity flow from the mountain stream was exceedingly limited, hence the utmost importance was attached to the method of conducting and distributing this water.

### **HIGH CLASS CONSTRUCTION.**

Concrete conduits were constructed, so that the loss by seepage was entirely eliminated and that by evaporation was slight. A broad avenue was laid out from the foothills of the Sierra Madre Mountains to the lower line of this tract of land under development. This avenue was one hundred and twenty feet wide. Two rows of shade trees were planted in the center of this avenue, giving sufficient area between them for the development of a street car line, which was afterwards installed. A drive-way thirty feet wide was made on either side of these center rows of trees, with adequate sidewalk space between the gutter and the property lines. The land was all laid off in ten-acre tracts, or squares of six hundred and sixty feet. The water in every instance was carried in open earth ditches from the concrete conduit along the upper side of each tract. Before any of this property was offered for sale the trees had commenced a vigorous growth, the sage brush had been thoroughly cleaned off and the lots and tracts accurately and intelligently outlined by stakes upon which were letters indicating the block and lot. The deeds of conveyance contained a very wise clause, and one which is worthy of serious consideration by any one attempting a colonization enterprise—that is a clause prohibiting the sale or manufacture of any intoxicating liquor; to this fact may attribute the very marked success that attended the establishment of the Ontario colony. It encouraged the settlement in the colony of people of intelligence and refinement, encouraged the establish-

ment of schools of a superior character, where the children would grow up without the contamination of the evils that surround a community where liquor is sold without many restrictions.

### ECONOMY IN USE OF WATER.

The distribution of the limited supply of water was most economical. A schedule was made giving each tract its quantity of water at certain stated intervals, as the water-right attaching to ten acres of land was of itself insufficient in its daily flow to irrigate any area of moment, but the accumulation of the water belonging to the tract (which I think in this instance was one fiftieth of a cubic foot per second flow) this water, I say, when delivered at intervals of thirty days, gave thirty fiftieths or three fifths of a cubic foot per second flow, which was all that one man could judiciously handle and economically distribute throughout his orchard. Immediately upon the termination of the time allotted to one person for the use of this flow of three fifths of a cubic foot upon his land the water was delivered to the next user, and so on throughout the entire tract, so there was not one moment's waste of the water during the twenty-four hours of the seven days of each week, and on through the entire irrigating season.

Domestic water was supplied with a small tax attached, sufficient for reasonable maintenance and absolutely unquestioned in purity.

This colony to-day has reached the acme of its development, not because of lack of land, but because of lack of water, there not being a sufficient quantity of water falling from the mountain stream which supplies the colony, plus the amount developed by pumping from deep wells, to encourage the planting of costly orchards on the still dry lands adjacent to the colony.

### AN IDEAL IRRIGATION COMMUNITY.

To-day Ontario presents a picture of beauty and home-like loveliness that cannot fail to attract the most critical visitor. A trolley electric railroad now operates its line up and down this beautiful avenue for some nine miles. The orchards of orange and lemon trees are exceedingly productive, and because of the intense cultivation given them, due to the intelligence of the owners, they receive the very highest market value for their fruit.

The land at Ontario in the first instance, before the water was brought upon it, was worth about five dollars an acre; when the water was delivered upon it it was worth from one hundred dollars to two hundred dollars per acre. When the orchards were planted on it at a cost of about one hundred dollars an acre additional (some a little in excess of this amount), and had grown into bearing, they were easily worth and frequently sold at one thousand dollars per acre, exclusive of the improvements in the way of houses and other buildings.

I believe it will be appropriate for me to give an illustration of the low estimate placed upon good lands by many of the original habitants of the arid West. In the valley of the Santa Ana River, in Orange County, California, is a very fertile plain, originally given up entirely to the cultivation of barley and wheat and the grazing of sheep and cattle. An astute gentleman from the East, in the early history of the development of that region some thirty years



ago in driving through the valley saw the unusual advantages it possessed and easily ascertained that there was sufficient water to be taken from the Santa Ana River, at an elevation where it could be distributed over a large portion of what is now one of the most thrifty and highly improved colonies in that splendid section. This man went to the owner of the land and asked him to make a price on some five hundred acres. The owner finally agreed to accept four dollars per acre. The gentleman made a small payment binding the bargain and gave the owner instructions as to whom to execute the conveyances; then the old farmer went to the nearest justice of the peace for the purpose of having him draw up a proper deed of conveyance; this gentleman, well known as the Hon. Richard Egan, tells the story as follows: that the old farmer came in and said:

"Judge, a d—n fool Easterner has dropped into my place and wants to buy that five hundred-acre patch of mine lying north of my house, and he has been idiot enough to offer me four dollars an acre for it; I want you to get a deed made just as quick as you possibly can, so I can get back with it and close the trade before the simpleton changes his mind."

He secured his deed, went back and exchanged it for the money, and the sequence of the story is that when our eastern friend had brought the water upon the land this original owner bought back a few acres at a price sufficiently high to pay for the entire tract of five hundred acres, which sold for a very large sum during the few years that succeeded its development by the Eastern gentleman; possibly \$100 an acre and upwards was received for the land at that time. This illustrates that the natives in our Western country are frequently incompetent to pass upon the values in their own territory, or see beneath the surface, or in the air they breathe, attractions that people unacquainted with the arid West are the first to discover.

#### DON'T MAKE THE MISTAKE OF EMIGRATING TO CANADA.

Before closing I wish to say that in going through British North America I was impressed with the awful loneliness of the settlers on those great wheat farms between Winnipeg and the Rocky Mountains. I talked with some of the people who got on the train at different stations and they deplored the indescribable solitude of their lives, and I wish to urge all Americans everywhere who hear me or who may read these remarks to remember that the United States of America has a big enough territory in which to make happy and prosperous homes without going to any portion of British North America. Do not go headlong across the Canadian line for a home until your children's children are occupying the last acre capable of cultivation by irrigation in our own America.

I could dwell upon this subject of small irrigated farms and cite other beautiful illustrations, but I have already exceeded my time, and thanking you for your courteous attention, will say good-bye.

**BACK TO THE LAND.**

CHARLES WOOD EBERLEIN, Portland, Oregon.

About the middle of the eighteenth century there appeared the "Deserted Village." It became at once the English classic of the homeless and expatriated and marks the decay of rural life in England. By the operation of economic laws, rural communities broke up, their population was partially absorbed in urban populations, but the greater part drifted over sea and was forever lost to their native land.

The decline of rural communities of England and Scotland in the time of Oliver Goldsmith brought a lasting change. The independence and the joyousness of lowly country life as reflected in the songs of the old dramatists, faded away and left only the toiling laborer and the hard condition of the tenant farmer.

There are lonely highland glens where to-day not even a shieling remains to mark what was once the abode of sturdy clans.

Two or three decades back there appeared signs of decay in our own rural life. The movement away from the farm set in. The youth of the farms and villages crowded the cities. This tendency was steady and showed no signs of abatement. For almost a generation the press and pulpit wrestled with the problem—its cause and its remedy—but without result. It became the theme of the essayist—the problem of the political economist. While theorists consulted precedent and built up hypotheses, a new dispensation was preparing. Farm machinery lifted the curse from the soil, the laboratory did its share, every department of physical science contributed.

When at last the cry went up "Back to the Land," the practice of agriculture had risen to the dignity of a profession. It was no longer necessary for a young man of mind and ambition to go to the learned professions.

We do not realize that perhaps the present decade is the most splendid in its triumphs for peace of the whole thirteen of our national life, and not the least of these triumphs is the significant turning of young men of American birth and training to the country.

But with this return to country life there will be no return to old conditions. The new rural community life *must*, in great measure, keep pace with the intellectual life of the cities.

American life is already beginning to feel a distinct impetus from this movement. That scientific agriculture and the irrigation movement sprang into life simultaneously, is no mere coincidence. They are two forces upon the wise management of which hangs not only the destinies of States, but the development of individuals. The problem now is how shall irrigation and scientific agriculture be made to produce the highest measure of human development and human happiness. In other words, "How shall the new rural community be builded?"

When the Aims national irrigation became the law of the land, a triumph was achieved, the full measure of which is perhaps not yet suspected. Among other things the *Great Act* strikes a blow at the evil of sectionalism. The vital principle has been evolved and must in time be generally recognized,

*that in the gain or loss of a single section of this Republic, however small or however remote, all the rest have an equal share.* It is a trite saying, but if we reflect upon the work of the irrigation propaganda we must be convinced that no movement of our time *making for peace* has so stimulated mutual interest. Herein lies the opportunity for the builders of a new social order, an order that shall not have for its foundation the wreckage of an old system. The change I have in mind is not a revolution, nor yet an evolution, but a social fabric resting upon new land and upon new ideas. Many have been the experiments in the short span of our national life. Associations of individuals have turned to the soil and have attempted by artificial means to achieve the ideal life. From Brook Farm on, failure has succeeded failure—the result of oversubordination of the individual.

Now we are on the threshold of a new experiment *in living*. The National Irrigation Act establishes private ownership within reasonable bounds, and a wise, steady administration of the law as now enacted will achieve more for the common good than socialism or communism have ever done or can ever do. The settler on reclaimed lands will be assured of a competence, but dependent wholly upon his individual effort. But to get back to our rural settlements. About two years ago I visited the Roswell irrigation district, in western Idaho. The enjoyment of viewing a prosperous irrigation district is, in a greatly intensified degree, that of looking at a beautiful garden set in a glorious landscape. Roswell is a tract of several thousand acres which less than ten years ago was sage-brush desert. The transformation has been complete. The whole tract is reclaimed, and is divided into holdings, the average size of which is far below 100 acres. The houses are new and tasteful, and each stands surrounded by orchards, flowers and shrubs.

The holdings are so laid out as to border on a broad roadway. In the midst is the church, a large graded school and the town hall. The houses lie near enough so that neighbors are within call. The whole place has the air and the appearance of a beautiful suburb. In the homes is refinement and hospitality. The interior surroundings are such as might be found in residences on the outskirts of any eastern city. Roswell is an ideal that may be and should be realized in every community established under the National Irrigation Act.

Given assured independence, healthful occupation, opportunities for culture and social life, and lives that are lived from cradle to grave under the spell of sky, mountain and desert, and a new element has entered into national life.

## GETTING COLONISTS.

C. E. WANTLAND, Kansas City.

"Getting Colonists" would seem to be an easy job to handle. But why do we have to get them? Why don't they come? Because they must be shown that we have something to offer better than the "other fellow" can offer, and the "other fellow" is also after them.

In getting colonists for irrigated districts many subjects have to be considered, which colonization agents handling lands in rainfall districts do not have to wrestle with.

Irrigated districts in the United States happen to be located at long distances from the great centers of population. Railroad rates, climatic conditions, State laws, the high prices which irrigated lands command, and many other things have to be considered.

Colonization work in the West was affected when the railroad companies of the country were prohibited from continuing pooling arrangements. This prohibition forced the reorganization of traffic associations, and the officers of western railroads have ever since been so crowded with difficult problems pressing for immediate solution that colonization problems requiring great attention and a long time for adjustment have not yet been settled upon the broad basis which the importance of the work justifies.

New settlers for the new districts of the West are wanted, and the importance of the work is appreciated, but the conflicting interests in which western railroad systems have been involved have made it very difficult to separate colonization problems from the complications connected with regular passenger business, and the tourist business to the Pacific Coast and the resorts of the Rocky Mountain districts.

## TO OFFSET THE CANADIAN ALLUREMENTS.

As against the difficulties we have to contend with, and the many alluring offers the people we seek have been and are receiving from the Southern districts, and from the North—from the States of this country, as well as from the vigorous work of Canadian land agents and the government of Canada, we present the "*sure crop*" argument, because we make the rain and have it come when it is needed. We present the "*great crop*" argument, because under irrigation more grain, hay, fruit, etc., are produced per acre than in the rainfall districts. We present the "*good climate*" argument, because in the irrigation districts we find also the land of sunshine.

In irrigated districts we offer great inducements to all classes of home-seekers. We offer homes under favorable conditions, in a land where long life is the rule, and where the poor man can find for himself and family the independence they seek.

We offer the inducement of great profits from land investments to the men who are not figuring alone on establishing homes, but who want profits as well.

Intelligence is generally needed among settlers in districts in which laws must be considered by all, and in which co-operation is necessary. A settler

under an irrigation system must know something of the laws governing the distribution of water and must co-operate with his neighbors in the administration of such laws. It is true that millions of dollars were lost in connection with irrigation investments in the early history of irrigation development, where money and energy were not backed by intelligence. It is also true that marvelous profits have been constantly made, and are still being made, in irrigated lands, and we have no difficulty in proving that the investor and the farmer can make money, and the homeseeker can find what he wants in the irrigated valleys of the West. They must use their brains, and colonization agents must be reliable and must tell the truth if they expect to keep on good terms with the railroads they work with and with the people they locate.

### CONFIDENCE GREW GREAT.

When Uncle Sam jumped into the irrigation ring, great confidence was given to all irrigation investments. The capitalist, the homeseeker and the investor feel that if irrigation is a good thing for Uncle Sam, it is a good thing for them, and they are coming West now with millions to invest.

Judicious advertising especially is necessary in presenting the attractions of irrigated districts. Vigorous land agency work is essential. Each State should have an immigration bureau to furnish information for homeseekers. The government of the United States should publish statements showing the resources and attractions of each district in which national irrigation works are located. As the best use of the grazing districts of the West necessarily have an effect upon the lands in the irrigated districts, the Congress of the United States should put into effect some reasonable method for the control of public grazing lands, in order that the present conflicts between the live stock interests using public ranges shall cease and that each man on the public domain shall be able to know just what he can do and how much he can be allowed to use of Uncle Sam's pasture for himself—free from any interference by his neighbor.

"Getting Colonists" is a subject which is too big to be handled in a few minutes and it will pay all who are interested in the development of the West to study well the many problems connected with the work of colonizing irrigated lands.

Intelligent work will prove to be satisfactory and profitable. The homeseeker can find health and wealth in the Irrigation Empire.

**ORGANIZATION FOR IRRIGATION IN THE NORTHWEST.**

A. W. HADLEY, Special Representative of The National Irrigation Association, Spokane, Washington.

Mr. Chairman, ladies and gentlemen: It has been suggested to me to present the conditions found existing throughout the Northwestern States, where I have been operating during the past year as special representative of the National Irrigation Association. You will understand that in that section of the country the subject of federal reclamation is practically a new one, and you who are familiar with what has been going on would no doubt be greatly surprised to see how dense the ignorance along these lines really is. Prominent business men whose keen commercial foresight has established highly enviable reputations for themselves in the communities where they have labored for years are found to be most profoundly indifferent to the vital importance of the irrigation movement, and often absolutely refuse to consider the matter under any conditions.

It is in the face of these difficulties that the association has been prosecuting its campaign of education and bringing to the minds of the people the important facts regarding the movement, by means of its press bureaus and publications. Already composed of more than 2000 of the strongest commercial interests of the country, this organization has for several years been gradually extending its influence on legislation and preparing the way for the steady progress of government reclamation. No particular section of the country is in fact more interested in this movement than another. The West in a prosperous condition is of immediate benefit to the East, and vice versa. We find the factories of New England ready to extend their support because they realize that an increased population in the West means that many more people for them to furnish with clothing, hats, boots and shoes. Every factory wheel must turn that much faster and this increased activity means better markets for the cotton shippers of New Orleans, and in turn the cotton producers of the interior.

**HOME MARKET FOR MANUFACTURERS.**

The manufacturer of Pittsburg expects to increase his output of steel rails and farming implements, which fact in turn interests the great transit companies, the builders of lake-going freight boats and even the producers of iron ore. Go to the iron regions and you will find thousands of laboring men whose families must exist and in whose existence there thrives a host of local retailers, jobbers, manufacturers and agriculturists. Do you see how it is? Verily an endless chain. From the producer to the consumer, back and forth; a continuous round of industrial activity in which we all, individually and as a nation, must thrive and prosper.

The jobbing and manufacturing interests of St. Paul and Duluth have given every support to the national irrigation movement because of their Dakota and Montana trade fields. The grain handling and milling interests of Minneapolis are of course desirous of a greatly increased productive acreage in the Northwest and they are co-operating almost to a man. In several

localities of the Dakotas erstwhile "faithfuls" are abandoning the deities of rain and are now bowing a more fruitful allegiance to King Irrigation. Montana is showing considerable activity of late along these lines and a number of water-users' associations are being successfully formed.

Nothing stimulates mining like the development of local agricultural resources, and this, in turn, demands increased transportation facilities for both of these great industries.

In Washington, the State which I am honored in representing at this Congress, there has recently been expressed more spontaneous, genuine enthusiasm along irrigation lines than any section in which I have ever worked. Let me give as an example the change that has come about in the so-called "Inland Empire." Not long ago so little importance was there credited to the subject that the Chamber of Commerce of a certain city absolutely refused to disseminate irrigation literature from its offices for fear their climatical reputation for humidity might be injured abroad. The National Association entered the field for an educational campaign and an interest was awakened, with the result that a few weeks ago one hundred and fifty of the most prominent business men in the city chartered a private train, and for three days toured the irrigable portion of the State, parading with a brass band the streets of twenty-six towns in the interests of an irrigation convention the week following.

#### DEEP DUST BROUGHT IRRIGATION ENTHUSIASM.

It was my pleasure to accompany this excursion. In some places the dust was three inches deep, but usually where it was the deepest our reception by the assembled natives was the more cordial, the band played louder and the more cider, fruit and brotherly affection we absorbed into our systems.

We have recently completed the organization of a Northwest section of the National Irrigation Association, which will eventually take in all Washington and the northern part of Idaho. Permanent headquarters have been established at Spokane, and the already lengthy membership roll is evidence of a highly successful campaign. We will have at least one thousand active members by next spring. As soon as the irrigable sections of the State are thoroughly organized we will carry the work into the coast cities, including Seattle and Tacoma.

Although little irrigation interest is manifested as yet in the western portion of the State, the jobbing and manufacturing people are bound to derive great benefits from their increased trade fields. If the government expenditure of \$2,000,000 on the Palouse project brings into cultivation 100,000 acres of worthless land, thus creating 4000 new farms and an increased population of 20,000 farmers, who will expend annually \$2,000,000 for manufactured necessities, what will the possible expenditure of \$60,000,000 eventually amount to? These are not pipe dreams, gentlemen, but actual probabilities, and the present generation will live to see the realization of them.

#### ONLY A STARTER.

In carrying on this work I am constantly asked why it is necessary to create this sentiment now that the irrigation law has been passed and an avail-

able reclamation fund is now a reality? Simply because our beginning is in its veriest infancy—the passing of the law but the birth of the movement as it were—and the present fund (\$23,000,000) only the cornerstone of what must come after. It is very much as if we were passing the kitchen door and accidentally caught a whiff of the feast being prepared therein.

Why, the entire fund can be used three times over in the State of Washington alone, and even then you would not have fully utilized the available water nor exhausted the supply of irrigable land.

For another example, take Montana, where fully \$200,000,000 can be spent in putting the available water upon one-third of the lands suitable for irrigation.

What are you going to do? Will the good people of your respective States accept the sums now set aside for the various projects and rest content for the next score of years, or will they arouse from their lethargy and assist in creating a sentiment which, in its demands upon Congress for increased appropriations will prove irresistible?

Congress, so often looked upon as a huge piece of unwieldy public machinery, should be viewed in a different light. Picture it rather as a gigantic mirror reflecting the hearts and minds of the people, and according to the national distribution of population, about nine-tenths of that reflection emanating from the eastern half of the United States. This, then, will be the proposition for congressional aid. One-tenth, or the West, petitioning the other nine-tenths, or the East. Do you think you will be able to get it upon the bare assertion that it is necessary to the welfare of Western development? Certainly you will not. The Eastern congressman has fish of his own to fry and his natural philanthropy is, as yet, a very uncertain quantity. Go to them, however, with a cold business proposition and you will gain attention. Whisper to the "powers behind the throne," or in other words, the great commercial interests of the East, that west of the Mississippi valley there are lying dormant and awaiting only "the man with the hoe," natural resources capable of supporting the entire population of the country to-day.

#### SHOULD BE AN EFFECTIVE APPEAL.

Picture to their commercial minds the millions upon millions of acres wrested from their bonds of aridity, transformed and supporting a dense and prospering agricultural population. Sound the notes of commercial conquest and you will have struck the chord of the Eastern heart. It was this appeal that finally passed the irrigation law in 1902, and it will need but a similar effort to secure the additional funds soon to be needed.

Now this is exactly what the National Irrigation Association is and has been doing. Not only are we enlisting the efforts of the East, but by bringing the facts before the people of the West a sentiment is being created toward the same end.

Allow me to say in closing that the most appalling obstacle in the whole plan is our present system of land laws. Not that these laws have not been of certain benefit to Western development, but that they have outlived their term of usefulness and are now but retarding the irrigation movement, and in fact actually threatening the life of it.



## THERE IS SENTIMENT AGAINST THEM.

The most emphatic demand that the East makes is for a reconstruction of land legislation, or in other words, the repeal of the Stone and Timber, and Desert Land Acts and the commutable portion of the Homestead Law. The East wants trade field and homes on the land. It wants this money spent for the benefit of expansion of internal trade and not to enrich speculating corporations and a few wealthy individuals whose only ambitions are to absorb vast areas of public domain.

Provided it is legal for these great tracts of land to pass into private ownership for future speculative purposes, is it just and to the welfare and prosperity of the nation when that same land might be supporting in contented independence hundreds of thousands of poverty stricken men, women and children now struggling for a miserable livelihood in our congested Eastern cities? Is it right that the scarred remnants of our great timber resources should continue to be exposed to the ravages of fire and the devastating methods of present day lumbering, when upon their preservation depends the future success of this whole irrigation movement as a means of water supply? These are some of the questions which the National Irrigation Association is endeavoring to solve in the minds of the American people to-day, and they are questions which you will be called to pass upon before this convention closes. If you, as delegates to this Congress are here for the purpose of furthering the prosperity of the localities which you represent, if you are working in the cause of humanity and the upbuilding of the nation, then take unto yourselves the true spirit of the irrigation movement, the greatest good to the greatest number, and proceed to crown the achievements of the 12th Irrigation Congress in the way you should have crowned them at Ogden, Utah, in 1903.



## Section Climatology.

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CHAIRMAN: H. E. WILLIAMS,

Assistant Chief U. S. Weather Bureau, Washington, D. C.

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Sessions were held on the morning and afternoon of November 16th, and on the morning of November 17th. A set of charts, consisting of twenty-six different maps, illustrating the climatology of the United States, was displayed on the walls of the room and a large number of Weather Bureau publications were distributed to the delegates and visitors.

The following papers, read before the section, are published in the Proceedings of the Congress. A number of other excellent papers were read, but owing to lack of space, they were unavoidably omitted from the published proceedings:

1. "Wet and Dry Seasons in California and Arizona." Prof. Alexander G. McAdie, U. S. Weather Bureau, San Francisco, Cal.

2. "Snowfall in the Mountain Districts in the Arid Regions and its Relations to Irrigation." Mr. F. H. Brandenburg, District Forecaster, U. S. Weather Bureau, Denver, Col.

3. "Periodic Variation of Rainfall in the Arid Regions." Mr. W. B. Stockman, Chief of Records Division, U. S. Weather Bureau, Washington, D. C.

4. "Evaporation Observations in the United States." Mr. H. H. Kimball, Librarian and Climatologist, U. S. Weather Bureau, Washington, D. C.

5. "Seasonal Precipitation in the Arid Regions as Related to Plant Life and the Growth of Crops." Mr. C. E. Linney, Section Director, U. S. Weather Bureau, Santa Fe, N. Mex.

6. "A Climatological Dictionary for the United States." Prof. A. J. Henry, U. S. Weather Bureau, Washington, D. C.

7. "Long-Range Weather Forecasts." Prof. E. B. Garriott, U. S. Weather Bureau, Washington, D. C.

8. "Distribution of Rainfall in Texas." Mr. W. H. Alexander, U. S. Weather Bureau, Galveston, Tex.

9. "Work of the Rain-makers in the Arid Regions." Mr. G. E. Franklin, Local Forecaster, U. S. Weather Bureau, Los Angeles, Cal.

10. "The Collection and Dissemination of Climatological Data and Weather Forecasts." Mr. James Berry, Chief of Climate and Crop Division, U. S. Weather Bureau Office, Washington, D. C.

**WET AND DRY SEASONS IN CALIFORNIA AND ARIZONA.**

PROFESSOR ALEXANDER G. MCADIE, U. S. Weather Bureau, San Francisco, California.

The country mentioned above has been somewhat poetically called "The Land of Little Rain," but to one traveling in this section during the months of August and September of the current year the characterization given must have seemed out of keeping with the general appearance of the soil. Probably not within recorded history have such heavy and frequent rains been reported; day after day throughout the so-called arid region, especially in the mountains, thunderstorms, cloudbursts, or washouts occurred. The rain, sometimes falling at a rate of an inch an hour, washed the soft surface soil. Every mountain peak seemed to be an energetic water-vapor condenser. As there is little or no forest covering, brush or grass to hold back the flow—the run-off was both rapid and destructive. All transportation companies doing business in southeastern California, Arizona, New Mexico, Utah and Colorado, underwent an experience in repairing washed out roadbeds, weakened bridges, etc., which will long be remembered. Nothing seemed able to withstand the onslaught of the water, moving with considerable velocity and loaded with detritus. Every little water-course was a source of danger to travel.

Naturally the season has been compared with previous wet seasons, and one hears on every hand tales from memory concerning damage and high water marks of previous years.

Without further delay let us agree upon the fact that seasons differ, that there are well marked wet and dry periods and that if it were possible to forecast (upon a scientific basis of course) the general character of an impending season, the achievement would be one of immeasurable value to all who live in the Southwest. The farmer would know in advance whether to sow or not; the merchant could discount the probable volume of trade, the stockman estimate the probable feed on the ranges and stock accordingly, the engineer plan ahead for needed power; and every man in his own way turn to account this fore-knowledge of the seasonal condition.

**CAUSES UNKNOWN WHICH PRODUCE VARIATIONS.**

Causes there must be for these marked variations in seasons, and causes which we believe will yet be understood by man; but not yet are these known. It is easy to fancy that periodicities exist, and it is most natural to correlate seasons which seem to be similar and assume that there will be similar sequences. But to the sane and dispassionate investigator the records of years show chiefly wet seasons sometimes following wet seasons, sometimes dry seasons, seasons beginning with early rains and promising much only to prove disappointing. Dry periods will occur most unexpectedly—sometimes in the heart of a wet season—and in brief no periodic law appears to exist. Our records in California are exceedingly valuable as at several points these now cover a period of fifty-five years. The rainfall data are strictly comparable, the instruments and methods used having been reduced to present

standards. Tables showing the rainfalls for every day for fifty-five years have been prepared; and from these in turn the wet and dry winter months have been collected, grouped and studied. Abnormal rainfalls have been compared with normal conditions; but there appears to be no apparent periodicity either in frequency or intensity.

It is well to explain that we consider the number of rainy days in a wet season, as well as the amount of rainfall. It makes a great difference in the character of the season whether the rain falls in a few heavy showers or is distributed throughout a long period. The effect upon crops, for example, is evident.

#### NO REGULAR SEQUENCE OF WET AND DRY SEASONS.

Considering then, both frequency and intensity, we find that there appears to be no regular sequence of wet and dry seasons, nor may we even assume that a season with marked dry or wet characteristics at its beginning will necessarily continue so to the close. We have, however, been able to detect a general relation between the permanent pressure movements and the general character of the seasons. During wet winters the Continental High is displaced well to the east of the Rocky Mountains, while the North Pacific Low extends well inland, overshadowing western Washington. An example of this is the chart for February, 1902. There were no pressure readings in early years; but so marked is the relation that we can feel reasonably sure that January, 1862, 1866, 1869, 1878; February, 1854, 1857, 1878, 1887; and December, 1852, 1866, 1867, 1871, 1880, 1889, were months of similar pressure distribution. Such a distribution is favorable for frequent southerly winds, of rather high velocity. This is a rain-bearing wind, and the angles of inclination of flow of the low air to the mountains are such as to favor slow, uplifting, cooling, and condensation. The *dry* type is shown in January, 1904. The reason why it does not rain under such a distribution is the steady, slow drift of the lower air, outward from the high; that is, from the northwest. This air can have but little vapor content and moreover passes down the western slope of the Sierra, being probably still further dried. This, then, is the type for January, 1851, 1852, 1889, 1891, 1902, 1904; February, 1851, 1852, 1856, 1864, 1875, 1885, 1886, 1888, 1889, 1896, 1900; December, 1854, 1865, 1874, 1876, 1883, 1901, 1903.

The difference between the air movement in wet and dry seasons is shown by the series of maps herewith. We are interested chiefly in the movement of the lower air; but as it is advisable to know also the air flow at higher levels charts showing the isobars for 3500 feet and 10,000 feet are also given.

The present year serves as an excellent example of the difference between wet and dry conditions. January was dry, February wet. Why should January be dry? Chart 4 shows the isobars and isotherms at sea level and resultant surface winds for January. On such a map we expect a minimum rainfall in southern California, Nevada, Utah and Arizona. This was the case. The isobars at 3500 feet indicate a westerly drift, and at 10,000 feet, a general southwest drift. February (chart 8) shows a southerly surface

drift, and chart 9 compared with chart 5 shows the great difference in rainfall resulting. Chart 10 compared with chart 6 shows more plainly the difference in air circulation. The contrast is brought out in a more striking way by chart 11. It is plain, then, that the swinging of the great pressure belts north and south either causes or coincides with storm movement and intensity of rainfall. But what causes the swinging of the pressure areas? And are the movements progressive? These are the great questions waiting solution; and when they are solved, then the forecasting of the seasons will be established on a proper basis. The trend of modern scientific investigation is to correlate these pressure movements. Hann's studies covering fifty years of European rainfall records indicate that the great pressure areas vary inversely. A striking illustration of this is that the winter temperature of northwestern Europe rises when the great "low" over Iceland is unusually deep and conversely there is cooler weather in Europe when the same "low" is flat.

#### ADVANTAGES OF A WORLD'S WEATHER SERVICE.

The meteorologists of India are keenly alive to the importance of a foreknowledge of the breaking of the Southwest Monsoon in May; and we in California, although better able to undergo periods of deficient rainfall, may well study the pressure swings over the North Pacific and the seasonal conditions in Japan for January, February, March and April. And some day, let us hope, the Weather Services of the world will interchange reports, and the procession of "highs" and "lows" around the girdle of the earth be thus closely followed. The forecasters along the line will foresee conditions favoring stagnation or, on the other hand, unusual activity.

Prominence has been given in this paper to the winter rains of the Southwest. The other type of rain, that of the summer months, can be also thus investigated. The Mexican, or Sonora rains, are found to occur in excess under certain pressure anomalies. The present season showed a well marked barometric minimum stretching from the country between the Colorado and Rio Grande northeastward to the Missouri. Into this sink there was a steady indraft of southerly moisture-laden air. The mountains acted energetically to condense the vapor.

Under such conditions an individual disturbance such as developed over the Southwest on September 26, 1904, may last for several days and be accompanied by phenomenally heavy rain. The rains from September 26th to 30th of the present year will long be remembered in the Southwest, causing as they did the most extensive and destructive floods in its history. El Paso, for example, had a rainfall of 3.50 inches, or 2.39 inches above the normal; Kent, 6 inches, or 4 inches above the normal; Fort Davis, 7.86 inches, or 4.65 inches above the normal; Santa Fe, 5.37 inches, or 3.89 inches above the normal; Las Vegas, 6.07 inches, or 3.90 inches above the normal; Raton, 7.38 inches, or 6.49 inches above the normal. The normal annual rainfall over a large part of the area in question varies from 10 to 15 inches. During the one month of September from 4 to 6 inches of rain fell. It would be hard to find a more striking illustration of abnormality in seasonal rainfall.

## **THE SNOWFALL IN THE MOUNTAIN DISTRICTS OF THE ARID REGION AND ITS RELATION TO IRRIGATION.**

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For some years the kindred subjects of forestry and irrigation have overshadowed in importance all other public questions in the so-called arid and semi-arid regions of the United States. From matters of strictly local concern, they have developed into subjects of national importance, and with national importance has come national aid. For several years the best available talent, practical and technical, has been devoted to the discovery and application of ways and means for the development of the one and the promotion of the other, until mere hopes have become theories, and these theories have in turn become practical and visible certainties; so that our attention is no longer concerned with a demonstration of the needs and desirability of irrigation and forestry, but with the location of reservoirs, canals and ditches, and the actual restoration and preservation of our forests.

As recently said by President Roosevelt, "None of our internal policies will be of more consequence to the future of the country during the next few decades than this matter of irrigation."

The value of artificial aid in the raising of crops by irrigation was early recognized, though its origin is lost in antiquity. Prof. Gipps, in a paper read in 1887 before the Royal Society of New South Wales, stated that the earliest known reservoir was constructed 2084 B. C., to regulate the inundations of the Nile. In this hemisphere, evidences of the use of irrigation canals and ditches by an earlier civilization are still visible in Colorado, New Mexico, Arizona, old Mexico and South America.

The necessity of reservoirs and the construction of such reservoirs and canals, presupposes the existence of a water supply, and this supply is naturally traced ultimately either to rain or to snowfall. Of these two sources of supply, it is the latter, in its relation to irrigation, that we intend to discuss in this paper.

In the arid region of the United States, rainfall is irregular and uncertain, while the amount thereof varies greatly even in the same section. The fall of snow in the higher altitudes, though also varying greatly, nevertheless is more certain and less variable than the rainfall. At times the rainfall is so heavy and the run-off, since the denuding of the ranges, is so rapid, as to produce floods, with consequent destruction of life and property. Except in localities where forests, the natural reservoirs of the snowfall in high altitudes, have been destroyed, the result of heavy snowfall is more beneficial, the flow therefrom more easily controlled, and, within irrigated areas, is accordingly productive of better results than the flow from heavy rainfall. No scheme of irrigation in the western part of the United States can therefore be successfully established and maintained, without an intimate knowledge and accurate understanding of the extent of the snowfall in the regions in which the rivers and smaller streams furnishing the supply have their sources. The best available records for the ascertainment of this necessary information

are those kept by the Weather Bureau. It is from its records of 137 highest stations, many of which records cover a period of ten years, that the data now presented have been compiled.

#### IRRIGATION SOURCES FORMED AT GREAT ALTITUDES.

In the arid regions proper, the streams that afford the principal sources of supply for irrigation rise along the Continental Divide and the parallel ranges to the west, or among their spurs. The snowfall of value as a source of supply for irrigation during summer may safely be limited to areas in excess of 7000 feet in altitude. The area of territory above 7000 feet in altitude, embraced in the States and Territories of Idaho, Nevada, Utah, Arizona, New Mexico and Colorado, is 112,426 square miles. California, partly arid, has 6246 square miles.

In the study of snowfall in relation to irrigation, it would seem that the ascertainment of the seasonal snowfall should prove of greater value than data as to the snowfall for the calendar year. The averages now presented are, for that reason, the seasonal averages. In Colorado the average for the area between 6000 and 7000 feet is 54 inches; between 7000 and 8000 feet, 58 inches; for the next thousand, the amount is 121 inches, while for the next 1000 feet there is an increase, but not so marked, the value being 145 inches. In Wyoming between 6000 and 7000 feet the average is 40 inches; between 7000 and 8000 feet, 57 inches; and practically double that value, or 110 inches, between 8000 and 9000 feet. Beginning with the area between 6000 and 7000 feet and taking succeeding elevations of 1000 feet, the values for New Mexico are 19 inches, 40, 50, and 76 inches respectively, the last being for the area between 9000 and 10,000 feet. In Nevada, for the area between 6000 and 7000 feet, the records of a large number of stations give an average of 72 inches; for higher altitudes the data are insufficient, but the snowfall is doubtless greater. The same is true of the higher altitudes in Utah, though the records of many stations in that State are available for 6000 to 7000 feet and 7000 to 8000 feet, the values being 56 inches and 41 inches respectively. For Idaho, Montana and Arizona, data are available only for 6000 to 7000 feet. In Idaho the average is 103 inches, in Montana 42 inches, and in Arizona 46 inches. For the entire area above 6000 feet in Colorado the average for the driest season is 64 inches, while for the wettest the average is 150 inches.

In Wyoming it is 55 inches for the driest as against an average of 99 inches for the wettest. In New Mexico the extremes are 26 inches and 69 inches; Nevada, 33 inches and 101 inches; Utah, 16 and 84 inches; and for 6000 to 7000 feet the extremes are: in Montana, 29 and 72 inches; Idaho, 60 and 160 inches; Arizona, 20 and 86 inches.

In view of the variations in the amounts of snowfall of different seasons, as just shown, it is manifest that irrigation interests are much concerned as to the minimum and maximum amounts that may be expected during a season. The greatest seasonal amounts of snowfall within the arid States, shown by the records, are as follows; Montana, at Butte, altitude, 5728 feet, 94 inches; New Mexico, at Chama, altitude 7862 feet, 148 inches; Utah, at Park City, altitude 6846 feet, 195 inches; Arizona, at Flagstaff, altitude 6907



feet, 208 inches; Wyoming, at Battle, altitude 9916 feet, 246 inches; Idaho, at Atlanta, altitude 7000 feet, 318 inches; Colorado, at Ruby, altitude 10,000 feet, 644 inches; and Nevada, at Fordyce Dam, altitude 6500 feet, 1067 inches, the minimum record at this place in ten seasons being 198 inches.

During December and January the snowfall is light along the eastern slope of the Continental Divide, and it is not uncommon for almost all the snow that falls earlier in the season to melt or evaporate under the influence of the warm chinook winds that prevail during these months. April, May and June are exceedingly dry in southern New Mexico and throughout Arizona, while July is a dry month in northern Utah; in Nevada, the dry period extends throughout July, August and September.

### HEAVY SNOWS ON THE CONTINENTAL DIVIDE.

On the western slope of the Continental Divide, February, March and April bring heavy snows, while in the Pacific States heavy snows on the mountain ranges are generally persistent from December to March.

Agricultural operations are most successful at altitudes below 6000 feet, with the possible exception of localities where low latitude offsets to some extent the influence of altitude. Such operations are, therefore, carried on in regions more or less remotely removed from the larger and more reliable sources of supply. The area between the agricultural districts and the higher altitude, being of a merely moderate elevation, where the snow is often melted soon after falling and almost certainly with the approach of warm weather, does not yield a large or constant supply. It is therefore manifest that the regions contributing most largely to the water supply by the melting of snow are to be found at higher altitudes, the region between 8000 and 11,000 feet being the principal source. It is true that snow falls oftener and to a greater amount above timber line, but this area is relatively very small, and being without protection from the sun and winds, a considerable proportion disappears without a corresponding increase in the water supply, while between 8000 and 11,000 feet the protection afforded by the timber not only lessens the melting as a result of the direct rays of the sun, but also partially lessens the wind movement and consequently the loss by evaporation.

Though stimulating evaporation, the beneficial effect of the high winds of winter and spring must not be underestimated. Above timber line, where there is an unobstructed wind movement, large areas are often swept bare, before the snow melts or evaporates, the winds carrying the new snow to the gulches and timber, where it is heaped up in immense drifts, or reservoirs, which release the supply gradually, as melting occurs. The packing done by strong winds is also a valuable help in prolonging the flow, and light falls of snow, which at low altitudes melt or evaporate quickly without any resultant benefit, are not lost at high altitudes, but being swept and packed into some sheltered spot contribute to the general flow with the coming of high temperatures.

### LARGE STREAMS NOT THE BEST IRRIGATORS.

The large streams, with a few exceptions, are not the main reliance of irrigation interests; this is especially true of the streams west of the Continental Divide, where the channels as a rule have been deeply eroded. Small streams on the other hand are more readily utilized, since the expense of diverting the flow is relatively small, though, as a rule, such streams drain small areas, and except at altitudes too high for successful farming, afford water for irrigation only during the first half of the crop-growing season, leaving the latter half of the season oftener than not with a scanty flow, and as a result crops suffer unless the natural flow is supplemented by flow from reservoirs or occasional rainfall.

The supply of water from melting snow is generally greatest during the middle of June, the time of the maximum flow being dependent on the temperature conditions, the absence of abnormally warm weather in the mountains during the first half of the season being a desirable factor in prolonging the flow.

Quickly following the June rise, the supply from melting snow falls off rapidly, as by that time the snow has disappeared from moderate altitudes and exposed localities at higher altitudes. Such flow as comes thereafter is from spring seepage and the gradual melting of the large and solidified snowdrifts of the early winter remaining in the gulches and in the neighborhood of the timber line. The flow from these sources is naturally small, but occasionally a large volume due to local downpours helps the situation.

### NECESSITY FOR RESERVOIRS.

Statistics show that the irrigated area has doubled during the last 10 years. At the same time it is clear, in a general sense, that the limit of possible irrigation without reservoirs has been reached. It is also true that included within the area now classed as under irrigation there is considerable land for which the supply of water is neither regular nor adequate. The construction of reservoirs, therefore, would result, not merely in the extension of the irrigated area, but in making far more valuable much of the area at present classed as under irrigation.

We therefore conclude the information given demonstrates the necessity, first, and as of paramount importance, of the preservation of the forests, the restoration of denuded districts, and the prevention of the use of forests in any way calculated to lessen the natural protection to the snow afforded by them and by the vegetation throughout them; secondly, because of the irregularity in the times of melting, and in the variation of the volume of flow therefrom, the necessity for the construction of reservoirs to conserve the supply of water from melting snow in times of excess flow and its distribution as the needs of agriculture may require.

## **PERIODIC VARIATION OF RAINFALL IN THE ARID REGION.**

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In the preparation of this paper it was not the intention to tabulate all available precipitation data, but to compile them for a few stations in each State, and selected so as to best show the average conditions that have obtained generally over the State and region—due consideration also being given to length and continuity of record, and altitude of station.

In the compilation breaks were found in the continuity of the records from many stations, and from a number of them no record of precipitation from snowfall was obtainable.

Due to the fact that differences in altitude and local topographical features cause dissimilar conditions, or different amounts of precipitation at stations contiguous to each other, and also to the occasional occurrence of torrential rains (so-called cloudbursts), generally over a limited territory, no effort was made to pad or fill out the missing data from the records of some nearby station, but to present the data as they were recorded, except in the case of a very few stations whose contiguity and topographical features are such as to render the belief that like conditions prevailed at both stations almost a certainty. The most distant stations, whose records were thus combined, were Fort Elliott and Amarillo, Texas.

\* \* \* \* \*

In the following discussion regarding the distribution and amount of precipitation over the portions of States and Territories under consideration, it is desired to emphasize the fact that deductions are drawn only from the data that were tabulated therewith, and these stations lie between the 96th degree of longitude and the central portions of Washington, Oregon, and California.

The relatively small average annual precipitation in the Dakotas is due to their distance from the four sources of moisture of the country—the Pacific Ocean, Gulf of Mexico, Great Lakes, and Atlantic Ocean. Although the States lie in the path of practically all the storms from the Pacific Ocean that cross the Rockies, the greater portion of the moisture brought from the Pacific has been precipitated upon the various mountain chains crossed, and the other three of the sources of moisture are so far distant that the center of the disturbance has passed before much of the moisture borne in the southerly and easterly winds is released, and the winds again change to dry northerly and westerly.

### **RAINY PERIOD FAVORS THE DAKOTA FARMER.**

For agricultural purposes the monthly distribution of precipitation is favorable, as the maximum monthly averages occur generally from May to August, inclusive, with fair amounts in April and September in North Dakota; and in South Dakota from April to August, inclusive, with fair amounts in March and in the eastern portion of the State in September. In North Dakota and eastern South Dakota the minimum averages occur in the months

November to February, inclusive, and in western South Dakota from September to February, inclusive.

Nebraska obtains its precipitation from the same sources as the Dakotas, but on account of being nearer the Gulf of Mexico—the main source of supply—the averages, as a rule, are greater than in the Dakotas.

The distribution for crop needs is very favorable, the maximum occurring generally over the State from April to August, inclusive, and in the eastern portion over September. The minimum occurs generally from November to February, inclusive, beginning somewhat earlier in the fall, and continuing somewhat later in the spring, in the western portion. As is the case in the Dakotas the average amounts decrease from eastward to westward.

### KANSAS WATERED BY GULF OF MEXICO.

Kansas, as well as Oklahoma and Texas, receives most of its precipitation from the moisture-laden winds from the Gulf of Mexico. In Kansas the maximum monthly amounts occur during the growing season, from April to September, inclusive, generally over the State, and the minimum amounts from November to March, inclusive.

The precipitation is greater in Oklahoma than in Kansas with a monthly average of more than two inches in the months from April to October, inclusive. The minimum occurs from November to February, inclusive, and is generally over one inch per month.

The season of maximum rainfall in Texas varies a good deal, and the amounts diminish from the Gulf of Mexico northward, and from the eastern portion of the State westward. In the eastern and northwestern portions it occurs generally from May to September, inclusive; occasionally stations show an earlier beginning and a later ending of the periods, when the monthly average amounts to more than two inches. At El Paso there is but one month, July, when the average amounts to two inches. In this section the rainy period may be considered to cover the months of July, August, and September. Generally over the State the months with minimum amounts are from November to March, inclusive, while in the southwestern portion the rainy period continues into April, and at El Paso into June.

The conditions in southwestern Texas differ from those in the region already discussed, and should be classed with the next tier of States to be considered—Montana southward to the Mexican border—and over which area less moisture is received from the Gulf of Mexico, consequently the average monthly and annual amounts of precipitation are less than in the region to the eastward.

In Montana there is but one station that shows a monthly average of two inches, or more, other than in May and June. Havre has an average of two inches, or more, in July also. At Ft. Shaw the greatest monthly average does not equal two inches. At the majority of the stations the monthly average is less than one inch from October to February, inclusive. In the southwestern portion the minimum monthly amounts appear to occur at various seasons from late summer to early spring.

### SMALL RAINFALL IN WYOMING.

There are few months with an average of two inches, or more, in Wyoming. In the eastern part of the State the greatest monthly amounts occur from April to July, inclusive, and in the western portion somewhat earlier. The minimum averages generally occur from October to March, inclusive, except in the extreme southwestern portion where they appear to occur in the summer and early fall.

In Colorado the months of greatest precipitation vary, being from April to August, inclusive, in the central and eastern portions; in the fall and winter season in the southwestern portion, and in the summer and early fall in the west-central portion of the State. In the central and eastern portions the least precipitation generally occurs between September and March, inclusive; in the late spring in the southwestern portion; and generally in the winter in the west-central portion, although the difference between the several seasons is very slight.

### MARKED VARIATION OF RAINFALL IN NEW MEXICO.

The difference in the average amounts of precipitation in New Mexico is very marked. In the northeastern portion the months of greatest precipitation are from May to October, with a small average precipitation during the remaining months. In the western portion the greatest precipitation is during July, August and September, occasionally extending into October. In this section also the average monthly amounts are small during the remainder of the year.

The distribution of precipitation in Idaho is peculiar. Generally the maximum amounts occur from November to February, or March, inclusive, but at several stations it continues into May, and at others into June. The months of least precipitation generally are July, August, and September, in some localities beginning with June, and in others extending into October, but the lack of stations and the entire want of records from some sections render any satisfactory deductions impracticable.

In Utah the average monthly amounts also are variable, and the distribution over the several portions of the State throughout the year dissimilar. In the eastern portion the greatest amounts generally occur in the months of July, August, and September, and over the central and western portions generally from October to May, inclusive, except in the southwestern portion where the season does not appear to be so long.

### YUMA IS PRETTY DRY.

Arizona appears to have two rather well defined periods of maxima and minima monthly amounts, and generally the maximum occurs during July, August, and September, and December, January, and February. In the western portion of the Territory, especially the southwestern portion, the average annual amount is very small, and is but 2.65 inches at Yuma, which is considerably less than some of the average monthly amounts at several stations in the southeastern portion of the Territory.

In Nevada also the annual amounts differ considerably and are least in the western portion of the State. The northern portion has somewhat larger averages than the eastern, but considerably less than the southeastern portion. The months of greatest precipitation are from December to March, inclusive, and at some stations extending into April and May.

#### A COUNTRY OF RAINY SEASONS.

In Washington there is a well-defined rainy season which begins in September and continues into June in the eastern portion, as it also does in sections of the west-central portion. In the northwestern section the rainy season appears to be from November to February, inclusive.

In Oregon a well-defined rainy season obtains and continues generally from November to June, inclusive, and in portions of both the eastern and western sections begins in October.

California's precipitation varies greatly in amounts, ranging from 1.87 inches at Mammoth Tank to 81.66 inches at Upper Mattole. It also has well-defined rainy and dry seasons, the beginnings and endings of which vary in different portions of the State, the rainy season as a rule covering the period from January to April. The least precipitation in the State occurs in the southeastern portion.

**EVAPORATION OBSERVATIONS IN THE UNITED STATES.**

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It is important that irrigation engineers should know not only the rainfall, but also the evaporation over any given region. Unfortunately, the measurement of evaporation presents many more difficulties than the measurement of precipitation. In fact, the rate of evaporation from land surfaces depends upon so many different elements that it can be treated only in the most general manner. Thus, it has been shown that the evaporation from saturated soil covered with growing plants is greater than from a water surface, but becomes less when the level of complete saturation falls a few inches below the soil surface, and continually diminishes as this level recedes to increasing depths. Also, the evaporation from a forest of evergreen trees is greater than from a forest of leafy trees; from the latter it is greater than from grass, from which in turn it is greater than from bare soil. The composition of the soil has its effect upon the rate of evaporation, and so also has the state of cultivation. Furthermore, the rate of evaporation from any surface has been found to vary with its temperature, with the quantity of moisture in the air, and with the wind velocity.

Even if we were able to determine the exact relation between each of these elements and evaporation, we see at once how hopeless it would be to undertake to compute accurately the evaporation over any very extensive region of land surface. It is therefore customary to deduct the run-off from the rainfall over a watershed, and to attribute the difference to evaporation. This has been done by Mr. George W. Rafter in Water Supply and Irrigation Papers No. 80, U. S. Geological Survey, for twelve drainage basins in the eastern part of the United States, as follows:

	Years of Record.	Rainfall.	Run-off.	Evapora- tion.
1. Muskingum River, Ohio .....	1888-1895	39.7	13.1	26.6
2. Genesee River, N. Y. ....	1890-1898	40.3	14.2	26.1
3. Croton River, N. Y. ....	1877-1899	49.4	22.8	26.6
4. Lake Cochituate, Mass. ....	1863-1900	47.1	20.3	26.8
5. Sudbury River, Mass. ....	1875-1900	46.1	22.6	23.5
6. Mystic Lake, Mass. ....	1878-1895	44.1	20.0	24.1
7. Neshaminy Creek, Pa. ....	1884-1899	47.6	23.1	24.5
8. Perkiomen Creek, Pa. ....	1884-1899	48.0	23.6	24.4
9. Tohickon Creek, Pa. ....	1884-1898	50.1	28.4	21.7
10. Hudson River, N. Y. ....	1888-1901	44.2	23.3	20.9
11. Pequannock River .....	1891-1899	46.8	26.8	20.0
12. Connecticut River .....	1872-1885	43.0	22.0	21.0

The rainfall and run-off have been computed for many other watersheds in the United States, particularly in California, where the run-off is a much smaller percentage of the rainfall than in the eastern States.

As a practical problem in irrigation, however, the evaporation from water surfaces is of more importance than the evaporation from land surfaces. The

engineer will naturally determine his water supply, not from the annual precipitation, but from the run-off of available streams. Having determined this, the question of losses becomes important, and if storage basins are of considerable area the loss by evaporation in a dry climate becomes very serious, having been estimated to be as much as 30 to 50 per cent of the amount stored in some cases.

Fortunately, the determination of the evaporation from a water surface presents fewer difficulties than the evaporation from land surfaces. Generally speaking, the determination may be made by two quite different methods; (1) by direct measurements from properly exposed water surfaces, and (2) by computations based upon the temperature of the water surface and the value of certain meteorological elements. With proper attention to exposure, direct measurements of evaporation from water surfaces should give the more reliable results. Unfortunately, proper exposure is not always practicable, and it is therefore necessary to consider the character of the exposure in connection with each series of evaporation experiments, and in some cases to apply a correction before the results will fairly represent the evaporation from a reservoir or a lake.

One of the most exhaustive series of evaporation experiments in the United States was conducted by Mr. Desmond Fitzgerald,<sup>1</sup> between the years 1876 and 1886, in connection with the reservoirs of the Boston water works. He not only measured the evaporation directly by means of tanks floating on the surface of reservoirs, some of them arranged to record automatically the rate of evaporation, but he also conducted elaborate experiments to determine the relation between the rate of evaporation, the temperature of the water surface, the temperature of the air, the amount of moisture in the air, and the movement of the air.

He found that the rate of evaporation depended upon three elements: The vapor pressure corresponding to the temperature of the surface of the water, the vapor pressure corresponding to the dew point of the atmosphere, and the velocity of the wind.

Representing by  $E$  the evaporation in inches per hour from a water surface, by  $e_s$  the vapor pressure in inches corresponding to the surface temperature of the water, by  $e_d$  the vapor pressure corresponding to the dew point of the atmosphere, and by  $v$  the wind velocity in miles per hour, he obtained

$$(E=0.0166 [e_s - e_d] (1 + \frac{v}{2}))$$

as the equation for the hourly rate of evaporation. This equation he found to hold good for an ice surface as well as for a water surface, in the shade as well as in sunshine, and by night as well as by day.

Measurements of evaporation from the water in a tank three feet cube, the top flush with the surface of the ground, have been made since 1887 at Fort Collins, Colo.,<sup>2</sup> under the direction of Professor L. G. Carpenter. The tem-

1)—Transactions of the American Society of Civil Engineers, Vol. 15, p. 581.

2)—See Annual Reports of the Agricultural Experiment Station, Fort Collins, Colo.



perature of the water in the tank was found to be lower than the temperature of the water in reservoirs and lakes in the vicinity, and in consequence the evaporation was less. Fitzgerald<sup>3</sup> notes a like deficiency in temperature and evaporation in connection with tanks set in the ground near Croton reservoir, N. Y.; but at Lakeport, and Kingsbury Bridge, Cal., the temperature and the evaporation as measured in a tank set in the ground were found to exceed like measurements in tanks floating in lakes. Since a great many measurements of evaporation have been made from tanks set in the ground, it is important that these discrepancies in water temperature and evaporation be borne in mind.

From his investigations in 1889 Professor Carpenter found that the daily evaporation could be very accurately expressed by the equation

$$(E=0.3868 [e_s-e_d] (1+0.0025W).$$

in which  $W$  represents the wind movement in 24 hours, the other symbols having the same significance as in Fitzgerald's equation. Reduced to a like period, the latter becomes

$$(E=0.3984 [e_s e_d] (1+0.0208W)$$

The agreement between the two is quite remarkable when we consider the difference in the climatic conditions at the two stations. The difference in the values of the co-efficient of  $W$  was attributed by Professor Carpenter to the fact that Fitzgerald measured the wind velocity at the surface of the water, while Carpenter's wind velocities were obtained from an anemometer on the roof of the college building.

Subsequent observations served to confirm the accuracy of his formula, and after ten years, by means of comparative readings between his standard tank and tanks floated on water surfaces, he computed the average annual evaporation from a free water surface at Fort Collins to be 59.5 inches instead of 46.3 inches as he had measured it.

In 1887 and 1888 Professor T. Russell,<sup>4</sup> of the U. S. Signal Service, investigated the rate of evaporation in standard thermometer shelters by means of observations with Piche evaporimeters. This instrument, as is well known, consists of a glass tube about nine inches long and 0.4 inch internal diameter, hermetically sealed at the top. Over the bottom is placed a disk of porous paper, which is held in position by a copper disk pressed against the open end of the tube by a suitable spring attachment. Capillary action keeps the paper moist. Its exposed area is known, and the amount of evaporation is determined by means of a scale etched on the side of the tube.

To determine the relation between the rate of evaporation from a Piche evaporimeter and a water surface, Russell exposed two of the Piche instruments in a closed room in which were two open tin dishes filled with water. Both the Piche evaporimeters and the dishes were weighed at frequent intervals, and it was found that the Piche instruments evaporated 1.33 times as fast as the open dishes. Eighteen Piche instruments were then exposed at various Signal Service stations from May 31 to September 30, 1888, and the

3)—See Proceedings American Society of Civil Engineers, Vol. 15, p. 617.

4)—Monthly Weather Review, 1888, p. 235.

observed quantity of evaporation was divided by 1.33 to reduce it to the evaporation from a water surface. By the method of least squares, the relation between the rate of evaporation, the temperature of the evaporating surface, and the amount of moisture in the air, was determined from observations made during the month of June. The temperature of the evaporating surface in this case was the same as that of the wet bulb thermometer, and the monthly rate of evaporation was found to be quite accurately expressed by the equation

$$E = \frac{43.88 [e_w - e_d] + 1.96 e_w}{B}$$

in which  $e_w$  is the vapor pressure in inches corresponding to the temperature of the wet bulb thermometer,  $e_d$  is the vapor pressure corresponding to the dew-point of the atmosphere, and  $B$  the barometric pressure in inches. By means of this formula Russell computed the monthly evaporation at 140 Signal Service stations from July, 1887, to June, 1888, inclusive, using the monthly mean wet bulb and dew-point temperatures derived from tri-daily observations. From the data thus computed the accompanying chart showing "Lines of equal annual depth of evaporation in inches" was prepared. Russell states his belief that these figures represent approximately the evaporation that takes place from the surface of ponds, rivers, reservoirs, and lakes, in the vicinity of Signal Service stations, basing his belief principally upon the results of evaporation experiments conducted under the direction of the Central Physical Observatory at St. Petersburg, from May to October, 1875, and discussed by Ed. Stelling in Band VIII, No. 3, of Wild's *Repertorium fuer Meteorologie*, 1882. Stelling's equation, however, is

$$(E = A [e_s - e_d] (1 - Bv))$$

which is identical in form with Fitzgerald's, the symbols having the same significance. His constants were computed for the centigrade system, were found to vary with the seasons, and are therefore not easily comparable with Fitzgerald's.

Russell's formula, however, departs radically from those of Fitzgerald, Carpenter and Stelling, in that it substitutes the vapor pressure corresponding to the temperature of the wet bulb thermometer for the vapor pressure corresponding to the surface of the water, and adds a term depending upon this same vapor pressure,  $d_w$ , in place of the wind velocity term. This latter is dropped, and the equation represents the evaporation with a wind velocity outside the shelter of 7.1 miles per hour, which was the average at the stations where the Piche observations were being made, during June, 1887.

It is evident that this wind velocity will not apply to all parts of the United States for all seasons of the year. Neither will it do to substitute the temperature of the wet bulb thermometer for the temperature of the water surface, the former being cooler than the latter. No doubt the additive term containing  $d_w$  compensates for this substitution in a measure, but we must conclude that Russell's formula does not rest upon as sound a physical basis as does the formula of Stelling, Fitzgerald, and Carpenter. The term  $\frac{1}{13}$  was

introduced on account of the wide variations in the value of B at the different stations. It is unimportant when discussing the observations at a single station.

Upon the organization of the Irrigation Survey by the U. S. Geological Survey in 1888, arrangements were made for measuring the evaporation at several points in the arid regions of the United States. It was recognized that the rate of evaporation depended upon the dryness of the air, the temperature of the water surface, and the velocity of the wind at the water surface. An effort was therefore made to measure the evaporation from a water surface having the same temperature as the surface of lakes or reservoirs, and exposed to the same wind velocity. To accomplish this galvanized iron evaporating pans three feet square and 18 inches deep were floated on the surface of the body of water from which the evaporation was to be measured. The pans were kept nearly full, with the surface of the water in them about on a level with the water outside. The amount of evaporation was at first measured by some sort of gauge, but later was determined from the amount of water added to bring the surface to the top of a pin projecting from the center of the pan. A record of the water temperature inside and outside the pans was kept. Usually a difference was noted, the inside temperature being higher in the daytime and lower at night. The average is, however, about the same in each. It is not probable that the water in pans is exposed to quite so high a wind velocity as is the average over outside surfaces, but to offset this the water in the pan wets the sides, and this increases the evaporating surface. It is therefore assumed that in general the evaporation from a floating pan of this type when kept nearly full represents the evaporation from the outside water surface very closely.

Several of the agricultural experiment stations measure the evaporation from pans, but most of them are set in the ground, and for reasons already given their indications are not considered so accurate as those from floating pans.

For the purpose of checking Russell's computed values, the following table has been prepared. In the first two columns are the names of stations and the evaporation computed by Russell. In the following columns are the names of neighboring stations at which measurements of evaporation from water surfaces have been made, the amount of evaporation measured, and the character of the exposure. We are thus enabled to judge of the probable value of Russell's chart.

## Annual Evaporation.

Russell's Formula.		Surface Measurements.		
Stations.	Evapora- tion, Inches.	Stations.	Evapora- tion, Inches.	Exposure.
Boston . . . .	34.4	Boston . . . . .	34.78	Beacon Hill Reservoir.
.....	.....	Boston . . . . .	39.11	{ Floating pan, Chest- nut Hill Reservoir.
New York... ..	40.6	New York . . . . .	39.64	{ Floating pan, Croton Reservoir.
Cheyenne . . . .	76.5	Laramie, Wyo. . . . .	46.30	Ground.
.....	.....	Fort Collins, Colo . . . .	46.16	Ground.
.....	.....	Fort Collins, Colo . . . .	59.50	Computed for reservoir.
El Paso . . . . .	82.0	Fort Bliss, Tex . . . . .	82.65	Floating pan.
Salt Lake } .....	74.4	Fort Douglas, Utah . . . .	42.46	Floating pan.
City . . . . .				
Arizona:				
Fort Grant . . . .	101.2	Tucson . . . . .	75.78	
Prescott . . . . .	56.0	Tempe . . . . .	65.00	Floating pan.
California:				
Sacramento . . . .	54.3	Lakeport . . . . .	32.38	Floating pan.
.....	.....	Lakeport . . . . .	33.40	Ground.
Fresno . . . . .	65.8	Kingsbury Bridge . . . .	47.79	Floating pan.
.....	.....	Kingsbury Bridge . . . .	59.49	Ground.
Los Angeles . . . .	37.2	Arrowhead Reservoir	36.6	{ Ground, (Elevation 5,160 feet.)
San Diego . . . . .	37.5	Sweetwater Reservoir	57.55	Floating pan.

The results above given are not strictly comparable since the stations are not in all cases identical, and in some cases, especially in California, the reservoirs are at a greater height than the Weather Bureau Stations, and, in consequence, the water surfaces are correspondingly colder. Generally speaking, Russell's results appear to be the higher.

Since Russell's equation was deduced from tri-daily observations, it is not applicable to the present 8:00 a. m. and 8:00 p. m. observations of the Weather Bureau. The equation of Fitzgerald and Carpenter appears to have a quite general application, provided we know the temperature of the water surface, the dew-point, and the wind velocity. It would seem, therefore, that in the absence of reliable measurements of evaporation from water surfaces an effort should be made to determine the temperature of water surfaces near Weather Bureau stations; and where the evaporation is measured from tanks sunk in the ground the relation between the temperature of this evaporating surface and the temperature of lakes or reservoirs in the vicinity should be carefully determined.

Seasonable evaporation naturally varies with geographical position. Some of its peculiarities are shown in the following table:

*Evaporation in Inches.*

Month.	Boston.	Fort Collins.	Lakeport.	Fort Bliss.
January .....	0.90	1.50	0.85	2.35
February .....	1.20	2.00	0.60	2.45
March .....	1.80	3.50	2.00	6.25
April .....	3.10	5.00	2.82	7.35
May .....	4.61	6.50	3.85	10.85
June .....	5.86	8.00	4.30	11.20
July .....	6.28	9.50	5.90	9.60
August .....	5.49	8.50	4.70	9.50
September .....	4.09	6.50	3.72	9.20
October .....	2.95	4.50	2.12	6.80
November .....	1.63	2.50	0.65	4.15
December .....	1.20	1.50	0.85	2.95
Year.....	39.11	59.50	32.38	82.65

Several series of evaporation measurements that do not cover the winter season have not been referred to in this paper. While they are of value, the above table indicates the importance to irrigation engineers that the readings be made throughout the entire year.

## **SEASONAL PRECIPITATION IN THE ARID REGION AS RELATED TO PLANT LIFE AND THE YIELD OF CROPS.**

CHAS. E. LINNEY, U. S. Weather Bureau, Santa Fe, New Mexico.

Large areas of our arid West have come under the beneficent influence of the irrigation ditch and are thus no longer dependent upon nature's supply of precipitation, but much larger areas are still barren because of scant rainfall, and on still other large areas settlers are having a severe struggle in an effort to cultivate with naught save nature's gift. As there is a steadily increasing demand upon the source of supply, over much of the irrigated area, if nature can be depended upon to furnish a part of the required moisture, the draft upon the over-burdened mains and ditches will be correspondingly lightened, and indeed the number of acres irrigated may be correspondingly increased. That you may understand approximately what the seasonal precipitation is over the arid region, I beg your indulgence in quoting a few figures, for the seasonal precipitation is the life of the "dry farmer," and should be a material aid to the irrigator throughout much of the arid West, and one, too, that he should have reason to anticipate.

In the report of the Chief of the Weather Bureau for 1896-97, normal precipitation data are given for the entire country, and from these figures it appears that for the season from April 1st to September 30th, about 15 inches of rainfall may be expected along the 100th meridian, with a minimum amount of 8 inches; decreasing thence to the 105th meridian, the amount falling to 9 inches, with a minimum amount (in southeast Wyoming and in the vicinity of our convention city) of less than 4 inches, while from the middle plateau and the adjacent mountain country westward to the 115th meridian the fall rarely ever exceeds 10 inches, usually 5 to 8 inches, with minimum values of 1, 2 or 3 inches. It will thus be seen that all eastern slope irrigators may reasonably expect nature to carry a third to a half of the moisture burden, and that occasional seasons of bountiful and well distributed rainfall may be expected when the amount of irrigation water required can be reduced to a minimum. This will more clearly appear presently, after a brief study of water duty, and the minimum amount of water that is required for profitable crop production.

### **IN THE "WEBFOOT" COUNTRY.**

Professor Henry, in this same report, summarizes the annual rainfall as follows: "There is a narrow belt of very heavy rainfall on the northwest coast, extending from Cape Flattery on the north, to midway of the Oregon coast on the south, and inland as far as the summit of the coast range, including in that designation the main and collateral ranges of mountains extending from southern Oregon to the Straits of Fuca. Eastward and southward the annual fall diminishes, reaching a minimum on the lowlands and valleys included between the coast range on the west and the Sierra Nevada and Cascade ranges on the east. The precipitation increases from

the valleys to the mountain tops, thence fall away rapidly with descent on the eastern slope until the great plateau is reached. Here the fall ranges from 5 to 15 inches, with isolated areas where it rises to 20 inches and over. There is but little increase as the western slope of the Rocky Mountains is reached, except in central and northern Idaho. The precipitation on the mountain slopes and summits is known to be large, but a qualitative statement of the annual depth can not yet be made. The rainfall of the foothills region east of the Rocky Mountains ranges from 10 to 18 inches, and increases slowly toward the 100th meridian. Eastward of that meridian the annual precipitation varies from a little under 20 inches to about 60 inches on the Florida and Gulf coast."

In the humid portions of the United States it is shown by a number of writers that about 20 inches of precipitation are used by plants, or evaporated directly from the soil, and since the methods of cultivation in those parts were not originated for the careful conservation of soil moisture, it is probable that the amount actually transpired by plants is much less, probably not as much as ten inches, yet this region is known as the humid part of the country.

#### WHEAT GROWN WITH FIFTEEN INCHES RAINFALL.

The exact amount of rainfall required for the successful cultivation of crops has not been definitely fixed, nor can it be in terms of rainfall only, according to Professor Henry, who states that "on the Pacific coast and over comparatively small areas in the arid regions wheat and other cereals are grown with a seasonal rainfall considerably less than 15 inches, but it should be remembered that the climatic conditions, as regards temperature and humidity, are quite different from those which obtain in the wheat region of the Northwest. The character of the soil, especially as regards its ability to retain moisture, is a very important consideration. It is said that wheat is grown in eastern Washington where the yearly fall is generally under 18 inches, that the rainfall of winter and early spring is conserved in the soil and is supplied to the plant by capillary action during the early part of the growing season."

Plants themselves need a certain minimum supply, but a far larger quantity is required to moisten the surrounding soil to such a degree that the vitalizing processes can continue. The soil is constantly losing water by evaporation and percolation, so that the amount used by the plant is relatively small.

#### ENORMOUS TRANSPIRATION OF GROWING PLANTS.

Professor King, in experiments carried on at the University of Wisconsin, found that 300 to 500 pounds of water were required for each pound of dry matter produced. In other words, for each ton of hay raised upon an acre of ground 300 to 500 tons of water must be provided either by irrigation or natural rainfall. Expressed in inches of precipitation (since about 100 tons of water represents an inch of rainfall to an acre of land), 3 to 5 inches of precipitation are required for each ton of hay per acre. Five inches of water were actually required to produce a ton of barley hay.

As our western lands have had deficient rainfall and have been under clear skies for ages, the first season of irrigation often requires an enormous quantity of water. It is said that the amount in many instances has been sufficient to cover the soil to a depth of 10 to 12 feet, and that even after several years of irrigation, 5 feet of water have been used, an amount so far beyond natural precipitation that several years of the latter would be required to approach it, clearly indicating that vastly more water is used than is required. Experienced irrigators often use far more water than is necessary, under the impression that the more water used the larger the crops, and, that having paid for it, they should use it. In the arid region, where sunshine is almost continuous and evaporation large, authorities agree that for ordinary crops at least enough water should be provided to cover the soil 4 to 6 inches a month (and in our humid States the rainfall averages 3 to 5 inches); and yet carefully tilled orchards have been maintained on much less, also, no doubt, many fine gardens.

#### EXAMPLE OF SUCCESSFUL ECONOMICAL USE OF IRRIGATION WATER. •

Successive years of deficient rainfall in California (1897 to 1900) have served to prove that with careful cultivation, crops, orchards and vineyards can be maintained by using very small quantities of water; in some cases an amount not exceeding 6 inches in depth was applied during a year, this being conducted to the plant direct, and the ground kept carefully tilled and free from weeds. Yet for good farming in most parts of the arid region a depth of 24 to 30 inches of water during the crop season should be counted upon, while larger amounts will be required for alfalfa and the higher forage crops, which are cut several times a year. These figures are borne out by Professor King, who increased the seasonal rainfall (5.72 inches) of the dry summer of 1895 to more than 31 inches, by the addition of 26 inches of water, and thereby raised the crop yield more than 200 per cent. His experiments also show conclusively that for the central valleys maximum crop yields may be had with 25 to 30 inches of rainfall during the crop season.

#### WEEDS WILL USE UP THE FARMER'S WATER.

Growing plants evaporate as high as 300 times their own weight of water during the growing season, and it behooves the successful farmer to pay especial attention to careful cultivation, and to the destruction of weeds and worthless plants, for these use water rapidly and eat up the profits of an otherwise profitable field, the weeds and worthless plants often taking as much or more water than the profitable ones. Careful cultivation, to keep the soil well pulverized, is especially to be urged, for this lessens the waste of water, and by providing air spaces, breaks up capillarity and prevents the escape of water, a less amount being required accordingly. When the farmer realizes that nearly one-third of the water applied evaporates from the soil and plants during the first three days after a rain, or the application of water, he will also realize how important is early and continuous cultivation.



### REGULARITY OF IRRIGATION IMPORTANT.

Professor King has also shown that not only is the seasonal precipitation of great importance, but its regular distribution throughout the crop season is of marked importance, so that the plant will receive sufficient moisture and receive it regularly, not losing by drouth of a month or six weeks the gain made by one or two months of well distributed rainfall. He has also found that it is possible to grow fair crops with so small a seasonal rainfall as 9.72 inches, thus leading to the hope of successful cultivation of a vast area of our western land now considered without the farming belt and impossible of irrigation. To our western eye, irrigation is first and foremost the prerequisite for successful farming, at least on the intense plan which pays enormous return for the acreage under cultivation, but may it not be possible, nay is it not imperative that we devise some scheme or plan of cultivation and conservation of moisture so that the many thousand broad acres just without the irrigation area may be made to produce profitably. True it will not be on the intense plan of the irrigation farmer, but if the so-called desert can be reclaimed and made to yield even on a par with the many thousand like acres in foreign lands (alike in the lack of rainfall), then indeed shall a blessing have been conferred upon the people, quite as great as will be conferred by the conservation of our storm and flood waters by impounding reservoirs.

### GREAT FUTURE FOR SUPPLEMENTAL IRRIGATION.

Along the marginal lines between our humid and arid territory it is many times not a question of reclaiming the desert, but rather a question of increasing the productiveness of lands already under cultivation, and this may also be said to be true of that vast area at the foothills of the Rocky Mountains, for something is raised every year, and in certain years bountiful yields are obtained. How to make the best use of their moderate rainfall (which fortunately largely comes during the crop season) is the question. It is undoubtedly one of soil culture, as well as the growth of those drouth-resisting plants and cereals that may from time to time be brought to the western farmer by the Department of Agriculture. Secretary Wilson says: "Experiments are under way to determine more fully the amount of soil moisture which will produce the largest yield; the proper time and manner of applying it; the effect of winter irrigation; the amount of water evaporated from soil surfaces of different kinds and under different conditions; how best to conserve moisture on the irrigated, as well as the dry farms, and farm drainage." May he speed the day when these problems are solved, that the desert may be reclaimed and homes be made for the millions.

## **A CLIMATOLOGICAL DICTIONARY FOR THE UNITED STATES.**

PROF. A. J. HENRY, U. S. Weather Bureau, Washington, D. C.

The trend of meteorological thought and discussion in the United States during the last fifty years has been toward the elucidation of the problems of theoretical meteorology rather than those of climatology proper. Much material has been collected and studied with a view of discovering the underlying causes of storm development and the attendant phenomena, and in the development of the utilitarian aspect of the science. Accordingly the aim has been to furnish precise information as to probable weather changes for comparatively short periods, rarely, however, for more than 48 hours in advance. In following this line of action the interests of climatology were for a time assigned to a subordinate position. In recent years much has been done towards placing climatological investigation on a firm basis. The purpose of this paper is to direct attention to the climatological work that is now being done by the U. S. Weather Bureau, especially to a reference work on climatology now in course of preparation.

There is needed in this country, at least, a reference volume that shall give the broader features of climate, if not the details, for representative stations in all parts of the globe. Verbal descriptions not accompanied by quantitative statements are not as a rule satisfactory. It is true that climatic observations have not been made in many portions of the globe, yet such observations as have been made are so widely scattered and in such form as to be practically useless to the average writer. In the United States, for example, climatological observations have been made for the greater part of a century, yet the seeker after climatic information is unable to find a comprehensive summary in any single volume.

That this state of affairs exists is not surprising when one considers the fact that climatological observations in this country have been conducted under various auspices and for widely different purposes. Some of the results of the chief series of observations are to be found in the following list of publications:

- (1) U. S. Army Meteorological Register, Washington, 1855.
- (2) U. S. Army Meteorological Register, Washington, 1860.
- (3) Results of Meteorological Observations made under the direction of the Patent Office and the Smithsonian Institution, Washington, 1861.
- (4) Smithsonian Contributions to Knowledge, No. 277. Tables Distribution and Variation in Atmospheric Temperatures in the United States, Washington, 1876.
- (5) Smithsonian Contributions to Knowledge, No. 353. Tables and Results of Precipitation in the United States, Second Edition, Washington, 1881.
- (6) Annual Reports and other publications of the Signal Service and the U. S. Weather Bureau.

## A CENSUS FOR THE CLIMATE.

Only a small percentage of the publications named in the above list are now available to students and investigators. For that and other obvious reasons the U. S. Weather Bureau of the Department of Agriculture has in course of preparation a census, so to speak, of the climatology of the United States. It is the intention to bring together in a single volume the available climatic statistics for each State and Territory. The State or Territory will be the geographic unit in the discussion, except that the States comprising New England will be treated as a single climatic province, and the State of Delaware will be included with that of Maryland, with which it is associated by natural as well as climatic boundaries. The ultimate geographic unit for the United States must be the county. Unfortunately, however, climatological observations have not been made in more than probably 20 per cent of the existing counties.

The plan of the volume contemplates a first chapter that will treat of the broader features of climate such as the temperature distribution, the character and amount of precipitation, the prevailing winds, etc. The remaining chapters will deal with the climate of the several States and Territories, each district or political division being treated by the local representative of the Weather Bureau stationed therein. In all, the records of about 600 stations will be used. Of this number about 130 are the so-called regular stations of the Weather Bureau where rather complete observations are made of all the principal climatic elements. The observations at the remaining stations refer mostly to temperature and precipitation, and the state of the sky.

A sample table, viz.: that for Baltimore, Md., is given below to illustrate the character of the information contained in the work:

## MARYLAND.

## NORTH-CENTRAL DIVISION. STATION: BALTIMORE.

OLIVER L. FASSIG, Section Director, in charge.

Established by Signal Service, January 1, 1871; latitude, 39° 18' north; longitude 76° 37' west; elevation (station barometer), 123 feet above mean tide.

This station is (1904) near the center of the city, in one of the buildings of the Johns Hopkins University. The open country to the west and north of the city is gently undulatory, forming the eastern edge of the Piedmont Plateau; to the east is the low, flat country of the Coastal Plain.

The thermometers are mounted in a standard Weather Bureau shelter, the floor of which is 9 feet above the roof of the station building.

The following table shows the height of the instruments in their present location:

	Above Roof.	Above Ground.
Thermometers .....	10 feet	69 feet
Top of rain gage.....	14 "	73 "
Anemometer cups.....	58 "	117 "
Wind vane.....	56 "	115 "

Location of stations and elevation of barometer above mean tide:

January 1, 1871, southwest corner of South and Water streets, 45 feet.

January 1, 1889, Neal building, southwest corner of Baltimore and Holliday streets, 76 feet.

June 1, 1891, Johns Hopkins University (Physical Laboratory), 179 feet.

September 7, 1895, Equitable Building, southwest corner of Calvert and Fayette streets, 142 feet.

August 1, 1896, Johns Hopkins University (532 N. Howard street), 123 feet.

The mean temperatures are derived from the regular series of observations of the Weather Bureau, to which corrections have been applied to reduce to true daily mean based on 24 hourly observations.

## SUMMARY.

### TEMPERATURE.

Mean annual, 55°; mean maximum, 63°; mean minimum, 47°. Absolute maximum, 104°; absolute minimum, -7°. Average number of days with maximum above 90°, 17; with minimum below 32°, 69.

### FROST.

Average date of first killing frost in autumn, November 5, last killing frost in spring, April 4. Number of times in thirty-three years that the first killing frost occurred one to ten days previous to the average date, 12; eleven to fifteen days previous, 2; sixteen to twenty days previous, 1. Number of times in thirty-three years that the last killing frost occurred one to ten days after the average date, 9; eleven to sixteen days after, 2; sixteen to twenty days after, 2. Date of earliest killing frost known, October 6, 1892, latest killing frost known, May 3, 1882.

### PRECIPITATION.

Mean annual, 43.4 inches; spring, 10.9; summer, 12.7; autumn, 9.8; winter, 10.0.

### WIND (miles per hour).

Mean hourly velocity, 5.8 (1879-1888, South and Water streets; elevation of anemometer cups, 86 feet above ground.)

Dates when the maximum velocity equaled or exceeded 40 miles per hour, and direction:

1873	Mar. 29	40 s.	1893	July 26	42 nw.
1874	Nov. 23	40 nw.	1893	Aug. 29	42 se.
1876	Feb. 2	40 nw.	1893	Oct. 13	40 se.
1878	Oct. 23	45 sw.	1894	Jan. 30	48 w.
1878	Dec. 11	40 w.	1894	Feb. 16	42 nw.
1879	Apr. 3	60 nw.	1894	June 12	40 n.
1888	Aug. 8	45 sw.	1895	Feb. 8	42 w.
1891	June 4	40 ne.	1895	Dec. 26	42 s.
1891	Nov. 17	40 nw.	1896	Feb. 6	40 w.
1891	Nov. 23	48 s.	1896	Feb. 11	40 w.
1891	Dec. 16	40 nw.	1896	Mar. 19	50 s.
1892	Mar. 10	42 nw.	1898	Dec. 4	54 e.
1892	June 27	42 sw.	1902	July 20	70 w.
1892	Nov. 15	42 ne.	1903	Jan. 30	42 w.
1892	Nov. 18	42 nw.	1903	Feb. 5	45 w.
1893	Feb. 3	42 nw.	1903	July 12	46 w.
1893	Feb. 19	45 nw.	1903	July 30	42 w.
1893	Feb. 24	40 nw.	1903	Oct. 9	42 n.
1893	Apr. 15	42 nw.	1903	Dec. 13	41 nw.
1893	May 4	40 nw.	1903	Dec. 26	40 nw.
1893	May 23	43 w.			

### MISCELLANEOUS PHENOMENA.

Average number of days with fog, 12 (1891-1903); hail, 2 (1876-1903); snow, 12 (1871-1903); thunderstorms, 22 (1893-1903).

## Monthly, seasonal and annual means.

Months.	Temperature.							Precipitation.						Mean humidity.				Total sunshine.		Direction of prevailing winds.
	Mean.	Mean of the maxima.	Absolute maximum.	Mean of the minima.	Absolute minimum.	Highest monthly mean.	Lowest monthly mean.	Mean.	Number of days with .01 or more.	Total amount for the driest year.	Total amount for the wettest year.	Greatest depth in 24 hours.	Average depth.	Relative, 8 a. m.	Absolute, 8 a. m.	Relative, 8 p. m.	Absolute, 8 p. m.	Average hours.	Percentage of possible	
	°	°	°	°	°	°	°	/ins.	/ins.	/ins.	/ins.	/ins.	/ins.	%	Grs.	%	Grs.	Hrs.	%	
December .....	37	44	73	31	-3	45	29	3.1	11	2.1	0.6	3.3	10.6	74	1.75	68	1.87	159	90	w.
January .....	34	41	73	27	-6	44	24	3.2	12	2.1	4.2	5.6	7.0	75	1.52	69	1.57	162	90	w.
February .....	33	43	78	28	-7	43	26	3.7	11	4.6	2.5	7.5	15.3	73	1.46	67	1.53	179	96	w.
Winter .....	35	43	...	29	...	...	...	10.0	34	8.8	7.3	18.4	...	74	1.53	68	1.66	187	93	w.
March .....	42	49	82	34	5	50	35	4.0	13	3.2	5.7	5.8	12.0	71	1.38	65	2.06	211	57	nw.
April .....	53	61	91	44	24	59	47	3.3	11	2.1	8.7	0.8	5.0	63	2.56	60	2.91	237	60	sc.
May .....	64	73	96	55	34	71	60	3.6	12	1.0	6.8	T.	T.	68	4.04	65	4.41	239	54	sc.
Spring .....	53	61	...	44	...	...	...	10.9	36	6.3	21.3	6.6	...	68	2.83	63	3.13	289	87	sc.
June .....	73	82	99	64	47	76	68	3.8	10	4.3	6.2	0.0	0.0	70	5.77	68	6.16	276	62	sw.
July .....	78	86	104	69	55	82	72	4.7	12	1.5	11.0	0.0	0.0	72	6.74	69	6.99	282	60	sw.
August .....	76	84	100	67	51	80	75	4.2	11	2.9	1.4	0.0	0.0	73	6.41	69	6.66	267	63	sw.
Summer .....	76	84	...	67	...	...	...	12.7	33	8.7	18.6	0.0	...	73	6.31	68	6.60	275	62	sw.
September .....	68	77	101	61	39	77	64	3.8	9	4.3	4.6	0.0	0.0	76	5.15	73	5.64	243	65	sc.
October .....	58	66	90	49	30	64	53	3.0	9	1.7	4.1	T.	T.	74	3.47	69	3.58	211	60	sc.
November .....	46	53	79	39	15	52	42	3.0	10	1.8	6.4	0.8	4.5	75	2.38	69	2.53	163	51	w.
Autumn .....	57	65	...	50	...	...	...	9.8	28	7.8	15.1	0.8	...	75	2.67	70	3.92	206	59	sc.
Annual .....	55	63	104	47	-7	...	...	43.4	131	31.6	62.2	23.8	15.5	72	3.60	68	3.83	219	58	sc.

EXTREMES OF TEMPERATURE FOR THE PERIOD JANUARY 1, 1873,  
TO DECEMBER 3, 1903.

Mean of minima for the coldest month, 27°; mean of maxima for the warmest month, 86°; absolute minimum, -7°, 1899; absolute maximum, 104°, 1898.

Year.	Dates when minimum temperature fell to or below 10°.	Dates when maximum temperature rose to or above 95°.
1873	Jan. 29-31; Feb. 24; Mar. 4, 5	June 20; July 3, 18.
1874	.....	June 8, 9, 23, 29; July 10; Aug. 20, 21.
1875	Jan. 9, 10, 11; Feb. 8, 9, 10, 15, 16, 18	June 24-27; July 18.
1876	Dec. 9, 10, 17, 19	June 27; July 4, 8-13, 20.
1877	Jan. 1, 3-6; Mar. 18	June 26.
1878	Jan. 8	July 18, 19, 21.
1879	Jan. 2-5	July 3, 4, 11, 16.
1880	Dec. 29-31	June 12, 24; July 10, 13.
1881	Jan. 1-3; Feb. 2, 3	May 13; July 5, 6, 13; Aug. 13; Sept. 7.
1882	Jan. 24; Dec. 8	June 25.
1883	.....	July 22, 23.
1884	Jan. 6, 7; Feb. 29; Dec. 19, 20	July 24.
1885	Jan. 22; Feb. 1, 17, 20, 21	June 14; July 17, 18, 20, 21, 25.
1886	Jan. 10-15; Feb. 4-6	.....
1887	Jan. 3, 19	July 13, 14, 16-18.
1888	Jan. 22, 28	Aug. 16.
1889	Feb. 24	.....
1890	.....	July 8, 17, 31; Aug. 1.
1891	.....	.....
1892	.....	July 25-29; Aug. 9, 10.
1893	Jan. 10, 11, 13-16, 18, 21	June 20; July 26.
1894	Feb. 25; Dec. 29	June 23, 24; July 12, 13, 20, 28, 29.
1895	Jan. 13; Feb. 3, 5-9	May 30, 31; June 1-3; July 21; Aug. 10, 11; Sept. 21-23.
1896	Jan. 5, 6; Feb. 17, 18, 20	May 10; July 27; Aug. 5, 7, 9, 11, 12.
1897	Jan. 25, 26	June 30; Sept. 11.
1898	Feb. 2	June 25, 26; July 1-4; Aug. 31; Sept. 1-3.
1899	Jan. 1, 2, 11; Feb. 1, 8-15; Dec. 30-31	June 6-8; July 22; Aug. 20, 27.
1900	Jan. 31; Feb. 1, 2, 24, 25, 27	July 4, 6, 7, 15-18, 21; Aug. 6-12; Sept. 11.
1901	.....	June 29-30; July 1-4, 6, 29, 30.
1902	.....	July 3, 5, 6, 17, 18, 20.
1903	Feb. 18, 19	July 2, 3, 9 11, 30; Aug. 25.

The completion of the work which is expected during the summer of 1905 will only partially meet the demands of geographers. A similar work is needed for all portions of the civilized world, and the hope is expressed that the delegates to this Congress will extend their aid and influence toward the accomplishment of such a desideratum.

## LONG-RANGE WEATHER PROPHECIES.

E. B. GARRIOTT, Professor of Meteorology, U. S. Weather Bureau.

"The master of superstition is the people. And in all superstition wise men follow fools."—*Bacon*.

In submitting to this Congress a paper on prophecies, I am constrained to summons as sponsor one of the greatest philosophers the world has ever known, one who "taught men to look abroad into God's world, and by patient experiment to find their way from outward signs to knowledge of the inner workings of those laws of Nature which are fixed energies appointed by the wisdom of the Creator as sources of all that we see and use," one who expressed as his judgment "that all prophecies, including dreams and predictions of astrology, ought to be despised, and to serve but for winter talk by the fireside, that they have done much mischief and that that hath given them grace and some credit consisteth in three things: First, that men mark when they hit, and never mark when they miss; as they do also generally of dreams. Second, that probable conjectures, or obscure traditions, many times turn themselves into prophecies. The third and last (which is the great one) is, that almost all of them being infinite in number, have been impostures, and by idle and crafty brains, merely contrived and feigned, after the event passed."

The first of the things that have given prophecies credit is pronounced a very just remark as "so-called strange coincidences and wonderful dreams that are verified, when the point is considered, are really not at all marvelous. We never hear of the 999 dreams that are not verified, but the thousandth that happens to precede its fulfillment is blazoned by unthinking people as a marvel. It would be a much more wonderful thing if dreams were not occasionally verified." The second thing applies to Seneca's verse, which, translated, reads as follows: "After the lapse of years, ages will come in which Ocean shall relax his chains around the world, and a vast continent shall appear, and Tiphys shall explore new regions, and Thule shall be no longer the utmost verge of the Earth." This has been interpreted as a prophecy of the discovery of America. The third and most important thing presented affirms that practically all prophecies have been impostures. This judgment regarding human prophecies pronounced four hundred years ago, is valid and unimpeachable to-day, and in its amplification we find that prophecy without evidence is charlatanry, and that the foundation and superstructure of belief in long range weather forecasting is superstition, based upon ignorance.

### SUPERSTITION A COMMON ATTRIBUTE.

Superstition is defined as "belief in omens and prognostics," "belief in what is absurd." Stated as a general proposition it is safe, although scarcely complimentary, to say that the human race is superstitious, that there is probably not an adult human being who is not, in a greater or less degree, superstitious, that there is probably not a man or woman in the most enlightened communities of the earth who is not to some extent influenced by omens, and who does not place more or less credence in prognostics of future

happenings that are based on insufficient evidence. There are, in fact, thousands in our midst who have faith in fortune tellers, and in fakirs who prostitute for pecuniary gain the various sciences and professions. And there is no superstition nearer and dearer to many human hearts than a belief that some men, almanac makers and long range forecasters for instance, "possess a knowledge of the inner workings of the laws of nature" that is not accorded to men who by education, training, association and precedent are preeminently equipped to acquire all attainable knowledge of the physical laws that appear to dominate and influence terrestrial phenomena.

The validity of claims of superhuman wisdom receives too little consideration from the great busy public, and announcements of coming atmospheric perturbations, periods of heat or cold, drouth or flood, by men who have no standing in the field of theoretical and applied science are believed to an extent that rivals the unreserved confidence that thousands of years ago was given to interpretations of the utterances of the Delphi oracle, and arguments and facts that should conclusively prove the fallacy of announcements of this character are too often inadequate to tip the balance on the side of common sense in superstitiously inclined minds.

#### ASTROLOGY AND ASTRONOMY.

Superstition is an inherent human weakness on which charlatans trade, and charlatanry that is based on superstition is a relic of astrology. Before the general laws and processes of the solar system were defined, astrology was the term used in the sense of astronomy. The science of astrology was in favor when men ignorantly supposed the heavenly bodies to have a controlling influence upon terrestrial events and human destinies, a supposition that has for centuries been refuted by astronomical knowledge. Among the several branches of astrology now recognized as charlatanry, long range weather forecasting has ever held a place. In the Babylonian era, the Chaldean priests associated the rising and setting of the heavenly constellations with the character of the seasons of the year, and utilized the astronomical and meteorological parallels thus observed for purposes of astrology. They were able to predict the character of the weather that was peculiar to the seasons, and assumed that certain constellations that were associated with beneficent or malevolent atmospheric conditions could be employed to foretell human events and cast horoscopes. In Egypt the annual rise and fall of the Nile that marked the recurring seasons of drouth and flood was revealed by the appearance of certain heavenly bodies. The Greeks and Romans were also close observers of the weather, and there is evidence that many centuries B. C., changes in the weather were associated with phases of the moon, and that rotations of certain weather types were associated with a nineteen-year lunar cycle.

The astronomical wisdom that followed the solution by Copernicus of the problem of the solar system, showed that the general character of the seasons of the year was due to the influence of the sun upon the earth during the latter's annual journey around the center of our solar system, and the so-called weather predictions of the early ages were recognized as mere state-



ments of climatic changes due to fixed astronomical causes that are peculiarly potent in producing the sharply marked seasonal weather of the tropical and subtropical countries.

So deeply seated, however, was the belief in the ancient art of divination that a disassociation of the now recognized sciences of astronomy and meteorology from the discredited practice of astrology has been exceedingly slow, and to this fact are we now indebted for numbers of fakirs and charlatans in the meteorological field. Following the passage of the astrologer, men of recognized scientific attainments became actively engaged in investigations regarding the composition, physical properties and phenomena of the earth's atmosphere, and climatic problems were systematically considered. Instrumental observations, especially those furnished by the barometer, the invention of Torricelli, and of the thermometer, credited to Galileo, aided materially in determining the character of impending weather changes, and barometric indications of the approach and passage of storms were of great value to navigators. The progress of meteorological advance during the last three centuries is presented substantially as follows, in a paper recently prepared by the writer:

#### DEVELOPMENT OF "OLD PROBABILITIES."

Previous to the nineteenth century, man possessed no knowledge of the laws that govern the weather nor of the mechanical processes that are employed in the production and propagation of storms and other well-marked phenomena of the atmosphere. He had noted without knowing the reason therefor, that in the northern hemisphere northerly winds are usually attended by low temperature, and southerly winds by rising temperature; that in the middle latitudes, easterly winds are generally followed by rain or snow, and westerly winds by clearing or fair weather; that certain cloud formations and movements indicate certain kinds of weather, and that manifestations of atmospheric moisture are of value in determining the character of impending weather changes. He had learned by observation to interpret the meaning of effects produced by certain atmospheric conditions on objects animate and inanimate, and had secured an intimate knowledge of astronomical facts that govern the seasons. In the early part of the nineteenth century a formal announcement of the laws of storms was made by Wm. C. Redfield, of New York, who found that the whole of the revolving mass of air that composed the storms of the Atlantic coast of the United States advanced with a progressive motion from southwest to northeast. Mr. Redfield also drew conclusions regarding storms in general that have not been materially modified by subsequent research. During the last half of the nineteenth century, regular meteorological services were established throughout the world and the sum of the achievements of this period in practical and theoretical work and investigation is represented by a rapidly increasing collection of data and facts that afford a sure foundation upon which future work may rest. Modern science does not employ obsolete methods in meteorological work, nor is it satisfied with the present generally accepted solutions of many of the problems of meteorology, and the acquirement of knowledge and the discovery

of new laws that will justify calculations of the weather for weeks, months and seasons in advance is the aim and object of many earnest and capable workers. Moreover it is believed that present and proposed methods of meteorological services are shaping events towards the accomplishment of that much to be desired end.

The assumptions of modern so-called long range weather forecasters have led to a consideration of the merit of the systems they employ. Planetary meteorology is the term applied to the practice of the more prominent long range forecasters, and planetary meteorology is a relic of astrology. Others place upon the moon and several of the planets of the solar system the responsibility of regular and irregular forms of weather. They base their forecasts upon the moon's path with reference to the ecliptic and the earth's equator, employ a 19-year moon cycle, strengthen their statements by allusions to eclipses and occultations, fall back upon an alleged fund of mysteriously acquired superhuman wisdom, and incidentally employ past records of the weather, the manipulation of the last-named element representing their only stock in trade.

Meteorological literature is deficient with reference to planetary influences on the weather, and from this fact it may be assumed that long range forecasters fear to enter a field where deductions are subjected to mathematical demonstration, and where claims to superior knowledge will be confronted by established and recognized facts pertaining to the more exact science of astronomy. There are no exceptions to this assumption, and the plea for entering the field is invariably a claim of knowledge that is universally recognized as being beyond the scope of astronomy. Although popular belief in the influence of the moon on the weather will not be downed by any marshalling of facts, it is proper to say that the most exhaustive comparisons fail to show any appreciable relation between weather conditions and lunar phases, variations and oscillations. Neither is there the slightest evidence that the stars or constellations of stars have the slightest influence upon weather conditions. Interest in the meteorological possibilities of a study of solar conditions has been very active during the past few years, and the literature of this period that summarizes practically all that has been done in this direction, indicates that investigation regarding the probable association of solar variations with recurring types of weather offers a most interesting and profitable field of labor.

#### ANIMAL SIGNS.

Observations of the habits and conditions of animals and birds and of the appearance of plants have a recognized value in determining the character of past weather, and to a limited extent the weather for a few hours in the future. The thickness of the fur of fur-bearing animals is used as evidence of the character of future weather, when as a matter of fact the character of the fur depends absolutely upon the physical condition of the animal, and the physical condition of the animal depends upon the weather of the past and the extent to which it has affected his food supply and general health rather than upon the weather of the future. The accumulation of food by animals is known to be governed by the supply of food, and not by

future weather. Birds of passage migrate to the south with the first breath of winter, or when their food supply is affected by inclement weather, which is peculiar to approaching cold weather, and return North when the spring sets in the South. That their flights are influenced by present rather than a knowledge of future weather conditions, is evident to all observers.

Neither animals nor plants can possibly be affected by the weather of a future month or season. Moss, bark of trees, and the thickness of nutshells and pumpkin rinds, etc., furnish another basis for long range weather speculations that also confuse and misinterpret conditions that are due to past conditions and have no bearing on future weather. Trees of great age and large growth, like the sequoias, indicate by their rings years that have been favorable and unfavorable for their growth, or in other words, wet and dry years in the region or locality in which they are located, and to this extent establish a record of the seasons that may have a possible value in future calculations.

The weather of days, months, seasons and years afford no indication of future weather further than showing present abnormal conditions that the future may adjust. An assumed, or supposed, six or seven-day period of recurring weather is indicated by the common saying, "If it rains on the first Sunday in the month it will rain every Sunday in the month." This saying possesses value in so far as the weather may conform in particular instances to a general average, and the likelihood of the weather conforming to this extent to general averages is not sufficiently great to justify the employment of the chance in actual forecast work. Sunday was doubtless selected in the saying quoted for the reason that the weather and its seasonal or unseasonal character is more closely observed and studied on certain days, notably Sundays and holidays, when men's minds are not occupied with their usual pursuits; any other day in the week will answer as well for this form of estimating the weather of the future. Long range weather forecasters for purposes of mystification, attribute the six or seven-day period to the moon's influence, and time their disturbances six or seven days apart, starting them on the Pacific coast and carrying them by regular stages across the United States, assuming in each case a conformance to general averages. Equal accuracy or inaccuracy would result if they started the disturbances in the central valleys or on the Atlantic seaboard, on corresponding dates, or introduced them on the Pacific coast on dates intermediate to those they have selected. By claiming for verification purposes a day or two on either side of the dates specified, by carefully avoiding specific forecasts of rain for specified days and districts, and by calling attention to hits that will occasionally be made under any system of chance, and never referring to misses, they successfully pursue in these enlightened times the practices of the fabulous age.

#### HOW THEY FAKE THE COUNTRY.

In this connection I will quote an opinion on long range weather prophets recently expressed by Professor Odenbach, director of the Ignatius College Meteorological Observatory, Cleveland, Ohio:

"How do they gain a following? Nothing easier. They cheat one-half

the country one day and the other half the next day by the vagueness of their prophecy. Such a statement as 'There will be storms in the period of the 20th to the 27th of September,' without mentioning a special day or designating a single State, to say nothing of a county or a single city, are easily made, and any schoolboy has a formula by which he may give the percentage of possibilities for guessing correctly. It is guessing and nothing more.

"It is known that the American people wish to be humbugged. P. T. Barnum did it for years and boasted of it. But in the realm of science or in cases where the comfort and oftentimes the lives of thousands are at stake, we can not tolerate the charlatan, nor for that matter a newspaper whose financial and intellectual resources are at so low an ebb that it must look to the weather prophets to fill its paper with matter which misleads the ignorant and disgusts the intellectual reading public.

"It is unpardonable in a modern newspaper to cram its pages with lies, nonsense and productions of ignorant, eccentric or dishonest fakirs. To give them a chance is a menace to the public and a crying injustice to a set of men that are the pride of the intellectual portion of the American people, commanding the highest esteem of European scientists of all nationalities. We Americans pride ourselves on the strength of our scientific schools and intellectual advances generally. The weather prophet fad is certainly a manifestation in a contrary direction. Any man talking seriously of these quacks is set down in my mind as deplorably ignorant, at least as regards meteorological science. The same may be said for the charlatans themselves, though I would give them the alternative of being ignorant or dishonest. These expressions may seem severe, but the matter is of so serious a nature that I am justified in expressing myself as I do."

In this connection I will say that it is apparent that it is the duty of a government that is charged with the general welfare of a country to warn its citizens against fakirs who for mercenary motives ignorantly or dishonestly commit a fraud on the public; and to those men who represent the industries of the vast regions of the West that depend so largely upon rainfall distribution and rainfall storage, the warning to put no trust in men who claim either to produce rain or to foretell the character, whether wet or dry, of a month, season or year in advance is most earnestly emphasized.

#### GOVERNMENT FORECASTS BASED ON ACTUAL WEATHER CONDITIONS.

The Weather Bureau issues forecasts daily for periods of 36 and 48 hours in advance that are based upon actual conditions observed by the aid of telegraphic reports over an area that extends more than 3000 miles east and west, and from the northern border of South America over Canada. These are the forecasts that appear in the daily press. Its most important work, however, is found in special warnings of severe gales, cold waves, frosts, heavy snow, heavy rain and floods that are made with almost unfailing accuracy, in behalf of shipping, commercial and agricultural interests, and conservative estimates prove that benefits amounting to millions of dollars have been returned in the case of single warnings of storms on our Atlantic seaboard, and of floods

in our great central valleys. A special rainfall and flood service is about to be inaugurated in eastern New Mexico and southeastern Colorado, whereby it is hoped that losses by destructive floods of the character recently experienced may be materially lessened.

The Bureau is extending its rainfall and flood stations as rapidly as appropriations will permit, and the forecasts of floods that will be based upon these observations, and the knowledge of seasonal conditions that have and will be obtained from a rapidly increasing amount of observational data will undoubtedly be of great value in the prosecution of irrigation operations.

In conclusion the fact is affirmed and reaffirmed that there is not at present any known basis for long range weather forecasts, that so-called forecasts of this character are made by men who are either ignorant or who knowingly commit a fraud upon the public, and that when long range forecasts can be made, if they ever can, they will be made by the Weather Bureau.

## **DISTRIBUTION OF RAINFALL IN TEXAS.**

W. H. ALEXANDER, U. S. Weather Bureau, Galveston, Texas.

The known intimate relation that usually exists between the topography of a country and the geographical distribution of its rainfall naturally leads one entering upon a study of this question to an early consideration of this relationship. A cursory glance at the contour any isohyctose lines of charts 1 and 2 seems sufficient to detect a relationship between the topography and the rainfall distribution of Texas, at once so intimate as to appear to be causal, but a more careful study shows this to be rather accidental.

The surface of the State rises as a rule quite gradually, though in places rather abruptly, from the coast line towards the northwest, attaining its greatest elevation in the Trans-Pecos and "Llano Estacado" regions. The annual rainfall decreases quite uniformly from the east to the west, being least in the Trans-Pecos country. But a study of the normal precipitation for each month reveals a very marked departure from this apparently fixed relationship between the elevation and rainfall, beginning, say, with the month of April and extending to and including September.

The fact is one could not reasonably expect to find a single principle or type of rainfall distribution to prevail over so vast an area as the State of Texas, an empire in itself, embracing within its limits more than ten degrees of latitude and more than thirteen degrees of longitude and an area of more than 265,000 square miles. One might just as reasonably expect to explain the rainfall of Illinois upon the principles obtaining in Alabama as to find an explanation of the normal weather conditions of the Panhandle or Trans-Pecos country in the conditions prevailing along the Texas coast. We are not surprised, therefore, to find the State divided hydrographically into a number of sections, each with its own peculiarities. With a view to bringing out these various divisions with their characteristics, a number of charts have been drawn, based upon normals obtained from records ten or more years in length. Unfortunately the Panhandle and western counties are not as thoroughly covered by these records as one might desire, but the records are sufficient to warrant some very general and practical deductions.

### **TEXAS RAINFALL VARIES FROM 10 TO 50 INCHES.**

As regards the total annual rainfall and its geographical distribution, the fall decreases with marked regularity from a little less than 50 inches per annum in the extreme eastern and southeastern counties to less than 10 inches in the extreme west, that is, in the vicinity of El Paso. The same regular decrease is noticed along the coast as inland; there the fall decreases from about 50 inches on the east coast to about 20 inches on the west coast, in the vicinity of Brownsville. The extreme west coast and Panhandle counties have about the same annual fall. The rainfall over the eastern half of the State is ample for agricultural purposes, but over the western half it is rather insufficient and too precarious.

**"RAINY SEASONS" VARY WITH LOCALITIES.**

In the greater portion of east Texas and the north Panhandle counties the greatest monthly rainfall occurs in May or June, generally in May; along the immediate coast, September has the greatest average; over that portion of the State west of the 100th meridian and as far south as, but not including Jeff Davis and Pecos counties, the rainfall is greatest in July, except in the most northern counties of the Panhandle, and along the Rio Grande valley the maximum monthly amount may occur any time from May to October inclusive. Rainfall in Texas is tropical in character in that the greater portion of it falls in heavy showers of short duration. A fall of several inches in 24 hours is not uncommon in the eastern portion of the State and along the coast highly excessive rains sometimes occur.

The question of annual rain variability is a very important one and might be discussed at some length with profit, but it can be only touched upon here. The territory is so extensive and the meteorological factors so complex that it might be safely concluded from theoretical considerations, even were it not actually established by existing records, that rain falls on an average of one day in three in some part of this vast territory during every month in the year; also that some sections of the State are not so favored and are subject to drouths of more or less severity. Such a thing as a general drouth was never known in Texas and the local drouths are not as frequent or as extended as sometimes supposed.

**THE WORK OF THE RAINMAKERS IN THE ARID REGIONS.**

GEO. E. FRANKLIN, U. S. Weather Bureau, Los Angeles, Cal.

As near as can be learned, the work indicated by the caption of this paper was carried on by or under the direction of one Melbourne, either in Kansas or Nebraska, by R. G. Dyrenforth in Texas, by C. B. Jewell in Kansas and California, and also by individuals of lesser repute and shortlived "companies" organized for the purpose.

Of Melbourne's work the writer has been able to gather no certain information of any moment. It is now several years since he operated and the story of his work does not appear to have found a place in periodical literature, though it attracted considerable attention at the time. He has been dead for some time.

Perhaps the most pretentious of all efforts to produce rain artificially were those made by Gen. R. G. Dyrenforth in Texas during August, 1891, and September, 1892. These experiments were notable not only on account of the scale upon which they were conducted and the alleged results achieved, but also for their auspices and the animadversions they incurred.

Dyrenforth's operations had the sanction of the U. S. government, being authorized and made possible by a special appropriation in the Agricultural Bill.

In 1891, a ranch about 25 miles from Midland, Texas, a small station on the T. & P. R. R., was the scene of the operations. The expedition arrived there August 5, 1891, bringing a carload of materials for the manufacture of various explosives, gases, dynamite, etc.

**ENORMOUS CHEMICAL EXPERIMENT.**

The seriousness and magnitude of the experiments are indicated by a partial enumeration of the apparatus and material: Twenty thousand pounds of iron borings and 16,000 pounds of sulphuric acid for the generation of 50,000 feet of hydrogen gas; 2500 pounds of potassium chlorate for evolving 12,000 feet of oxygen gas, involving the use of 50 retorts and furnaces; 68 explosive balloons of 10 and 12 feet diameter, and three large balloons for ascensions. Material for 100 cloth-covered kites and ingredients for the manufacture of several thousand pounds of rack-a-rock powder and other high explosives, together with electrical and meteorological instruments.

The intention was to produce rain by violent and continued concussions, both on the earth's surface and in the air, and there were three lines of operations, each two miles in length and one-half mile apart. The first line consisted of a large number of ground batteries by which heavy charges of dynamite and rack-a-rock powder were to be discharged at frequent intervals. The second line was to be of kites flown high, with connections of electric wire, by means of which dynamite cartridges were to be carried up and exploded. The third and principal line was to be of explosive balloons, to be exploded at elevations greater than those attained by the kites, at one or two-hour intervals throughout the operations.

In the experiments the first line was operated as planned, in connection



with the others and also independently when the others were not in operation, to keep the weather "unsettled." The second line was operated less successfully, high winds rendering kite-flying difficult, also breaking the electric wires; as a consequence, this line was not operated to the extent proposed.

### THE RAIN CAME; BUT?

As to the results of the operations: rain fell for the first time after the arrival of the expedition on August 10th, but it was a questionable credit, as the preparations had not been completed and there had been only a few preliminary explosions by way of testing the dynamite on the previous evening. However, Gen. Dyrenforth telegraphed it as a definite result, claiming two inches of rain; another report says "a light shower."

On the evening of August 17th discharges were begun, followed the next day by explosions of large amounts of oxygen and hydrogen gases by means of balloons, while the ground batteries were kept in constant action for twelve hours. The morning of the 18th was fair and fair weather continued till afternoon, but at 5:00 p. m. the operators were compelled to run through a drenching rain that fell for two and one-half hours.

The final operations of the series took place on August 25th. Balloons were exploded at altitudes varying from 1000 feet to three miles, and cannonading from the ground batteries carried on till 11:00 p. m. At 3:00 a. m. on the 26th heavy thunder was heard, and at 4:00 a. m. rain began to fall "in torrents" and continued till 8:00 a. m. Prof. G. E. Curtis reports concerning this fall that it was "nothing but a sprinkle."

The second experiment by Mr. Dyrenforth was made near San Antonio in November, 1892, but with unsatisfactory results. Prof. A. Macfarlane, of the University of Texas, was present as an invited guest during these experiments, and his conclusions were adverse to the rainmakers.

For the first series of experiments \$7000 were appropriated and expended, and for the second an appropriation of \$10,000 was made, of which, however, only about \$5000 were expended.

### QUITE "IMPORTANT IF TRUE."

Gen. Dyrenforth claimed as result of his operations three heavy storms after the principal operations and nine showers of lesser importance during the sixteen days of experimenting, which was altogether extraordinary for the locality and season of the year. It may be remarked here that the latter part of July and the first half of August of the present year, 1904, show very considerable rains in the same section.

Of these results it must be said that there appears to have been almost a total lack of the scientific method in recording them. No exact measurements are given; "a drenching rain," "fell in torrents" are expressions that have little scientific value under any circumstances, and still less when contradicted by independent reports. They also admit the personal equation to a considerable degree when it is desired to establish a given result.

Of the operations of Jewell and others in Kansas and neighboring sections no detailed statement can be made. It is believed that their methods were

"chemical" rather than mechanical as in Dyrenforth's experiments; if this was not true of all it was of some, they relying upon the liberation of some gas or gases, perhaps, also in connection with electricity, to produce rain.

Companies were even organized to go into the rainmaking business, offering to enter into contracts to produce rain in definite amounts over given areas within given times.

Mr. Jewell, aided probably by several fortunate, for him, coincidences, secured almost unqualified indorsements from one of the railroads running through Kansas, becoming known as its official rainmaker, and many business and professional men vouched for the certainty of results produced by his operations. As a result of these indorsements he was invited to conduct some experiments in Southern California, near Los Angeles, in July, 1899, after a most grievous drouth of several years which had driven agricultural interests almost to the point of despair. Of these experiments, or rather of the method, it is allowed to say only that rain was supposed to be produced by liberating hydrogen gas in connection with electricity.

#### A CONFIDENTIAL FORMULA.

Some of the experiments were conducted by citizens of Los Angeles according to Mr. Jewell's method, though not under his immediate supervision, and the method is still regarded as having been imparted in confidence. Six hydrogen generators were employed, though their capacity was not known, and a battery was used to generate electricity to pass off with the hydrogen. Experiments were carried on July 18 and 19, 1899, and so much alarm was felt lest the matter should be overdone that a contractor having interests that would be adversely affected by rain, procured a court injunction on the 20th, restraining the operators. This injunction was dissolved—though not by the rain—on the 25th, and operations were resumed. In the meantime Mr. Jewell had come upon the scene, and for sixty hours, on the 25th and 26th, operations were carried on. They were a complete failure as far as producing rain was concerned. There was a gathering of clouds in the distance, but no precipitation occurred.

Some hundreds of dollars had been paid to Mr. Jewell, but after the absolute failure of the experiments such representations were made to him that he returned the money in whole or large part.

During the month of April, 1904, experiments were made near El Cajon, situated in San Diego County, in Southern California, looking to the artificial production of rain. The following is quoted directly from a letter written by a participant in the experiments:

"Our outfit consisted of about twenty cannons or mortars, each weighing about 60 pounds. They were about 8 inches high and had a bore of about 3 inches. They were stationed in four groups, each group representing a corner of about one acre of ground.

"We commenced firing at about 6:30 Friday, April 22, and continued steadily until about 1:30 Sunday, April 24—making about 31 hours of actual and continuous bombardment.

### A WASTE OF GOOD POWDER.

"Each charge was about four ounces of powder, tamped in with dirt; we shot twice a minute during the entire time. We had no rain, but on Tuesday following this locality experienced a 'drizzle,' which was of no benefit as the precipitation was very light."

There is at the present time in Los Angeles, Cal., a rainmaker who claims an absolutely successful method for producing rain. Mr. C. M. Hatfield claims that out of nineteen attempts he has produced rain eighteen times. These experiments have claimed the attention of the public only during a comparatively recent period, but Mr. Hatfield says that he has been working on his method for seven years. Of course it is a secret, but Mr. Hatfield in personal conversation has expressed a willingness to reveal as much as possible concerning it. He says, "it is mainly chemical affinity with the atmosphere. I have nothing to do with bombs, dynamite or explosives of any kind whatever. My methods are original."

Mr. Hatfield uses chemicals, the combination of which is known only to himself; these are mixed in casks and allowed to remain for five days. When the operations are carried on Mr. Hatfield uses a tower of varying heights, from the top of which he liberates his gases in connection with a large number of evaporating pans from which water is evaporated by heat artificially applied.

He claims to have been operating at Bonsall, San Diego County, twelve miles east of Oceanside, in July, 1902, and in two and one-half days after he began operations the heaviest rain in 37 years fell. Again in December, 1902, in the same locality he operated with a result of 1.10 measured inches at the place where the experiments were performed. In September, 1903, February, 1904, and July, 1904, he was operating at points a few miles distant from Los Angeles, his experiments in each case being followed by rain, twice in very appreciable amounts. He says, "I have never as yet failed to produce rain in July." This is "important if true," for rain is a scarce article in Southern California in this month.

### DISLIKES EASY JOBS.

Mr. Hatfield claims that he prefers to perform his experiments under manifestly unfavorable conditions in order that there may be no doubt as to his ability to substantiate his claims, and declares his purpose to operate this winter in case the drouth of former years is repeated. He says that for a cost of \$100 a thorough operation can be made, and that rain will follow within five days of the beginning of the process. Upon being questioned closely as to the philosophy of his method he says that he thinks that he "attracts" a rain area even from a distance of a thousand miles.

While it is intended that this paper shall be narrative rather than controversial, it may fairly be said that in practically all cases where rainmaking experiments have not been self-confessed or proven failures, the so-called "results" have been results not of human attempts to produce rain, but of the processes of Nature working on a scale so vast as to make insignificant and trifling the artificial methods of man.

The rainmakers have failed to show any genetic relation between their work and the precipitation that has occurred, rain having been observed in the very same localities at the same season of the year when no experiments were being carried on. In fact, to quote Prof. Curtis' words in regard to Dyrenforth's experiments: "In view of these facts it is scarcely necessary for me to state that the experiments have not afforded any scientific standing to the theory that rain storms can be produced by concussion," we may in place of the word "concussion" put "any known artificial means."

## **COLLECTION AND DISSEMINATION OF CLIMATOLOGICAL DATA AND WEATHER FORECASTS.**

JAMES BERRY, Chief of Climate and Crop Division U. S. Weather Bureau, Washington, D. C.

These features of the work of the Weather Bureau are embraced in its Climate and Crop Service, which is divided into forty-three sections, each section conforming to the political boundaries of the several States with a few exceptions in which some of the smaller States are combined.

In the climatological publications of the several States data from nearly 3500 stations are published in detail, the extremes of temperature and total rainfall for each day for every station being given, together with other meteorological data and a general discussion of the different elements. The value of such publications is incalculable to those pursuing investigations in which climate is concerned, and as few enterprises of moment are unaffected by climate, it will be readily seen what an important bearing the data being collected and published has upon irrigation projects, etc. While the editions of the climatological reports are small, complete files of these publications may be found at most of the larger Weather Bureau stations and in the libraries of many educational institutions. In recent years there has been no very decided increase in the number of observing stations, but the Bureau has standardized the equipment of all the observing stations, many of which until a few years ago were using instruments of various patterns, some of questionable accuracy and in instances from unavoidable circumstances were exposed in more or less faulty manner. All stations are now equipped with the standard instruments of the Weather Bureau, tested for accuracy before issue, and are given the best exposure it is possible to obtain.

### **WEATHER FORECASTS WIDELY DISTRIBUTED.**

The daily weather forecasts and special warnings of cold waves, severe storms, etc., are sent broadcast into every part of the country where facilities for communication will permit. In recent years a most effective means of distributing weather forecasts throughout the rural districts has been made possible by the rapid extension of the Rural Free Delivery Service of the Postoffice Department and by the greatly increased number of farmers' telephone exchanges, more than 80,000 forecast bulletins being distributed by mail through the Rural Free Delivery Service, while several hundred thousand telephone subscribers, principally farmers, in the States of the central valleys, now receive the forecast each morning within a few minutes after the official forecaster has made the prediction. In this work the government bears the expense of telegraphing about 2000 messages daily to distributing points for dissemination by the various means employed therein.

Postmasters and other public spirited citizens favorably situated for reaching outlying towns cheerfully co-operate with the Bureau in distributing the forecasts. It is the custom of the Bureau to supply a simple hand printing outfit, consisting of rubber logotypes and ink pads with which the forecasts

are quickly stamped upon franked postal cards and these mailed on early departing trains so as to reach destination in time to make the forecast of value to communities to which they are sent. This is known as the logotype system, and by it more than 200,000 bulletins are printed daily, distributed and given public display.

Some of the earlier methods of dissemination are now being abandoned for quicker and more effective means. The flag displays that once constituted one of the principal means of dissemination are no longer encouraged except where the better facilities do not exist.

#### SPECIAL SERVICE FOR THE FARMERS.

During the season of planting, cultivating and harvesting of crops there is issued from each Climate and Crop Service section center a weekly bulletin devoted particularly to agricultural interests. This bulletin contains information as to the progress of farm work and also a summary of the prevailing weather and its effects upon farming operations and crops. While a wide distribution of the bulletin is made, its greatest circulation is secured through reprint in daily newspapers and the agricultural press.

In the winter season there is prepared and published at each Climate and Crop center in the semi-arid regions a snow bulletin for each month from December to March, inclusive. A large number of reports from voluntary and special observers enter into the preparation of this snow bulletin, which contains the fullest information obtainable as to the amount and character of the snowfall during the month and the amount and character of that remaining on the ground at the close of each month.

#### SPECIFIC ADVANCE INFORMATION AS TO IRRIGATION SUPPLY.

These special bulletins contain the only authentic history extant of the winter's snowfall in the several western States covered by the published reports. From the data published in these bulletins it is possible to estimate with a reasonable degree of accuracy the probable water supply for the succeeding season. As evidence of this it may be stated that in the early months of the winter of 1903-04 there was a marked deficiency in precipitation throughout the vast mountain system where the reserve supply of moisture is stored up in gulches and ravines for the summer flow. In February, however, and afterward, a succession of winter storms gave unusual snow depths over many of the States and insured an ample water supply later in the season, but throughout middle and southern Utah and practically all of Arizona and New Mexico the deficiency in moisture continued unbroken.

# The National Irrigation Law

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## TO MAKE THE WEST RECLAIM ITSELF.

[Public—No. -161.]

An Act appropriating the receipts from the sale and disposal of public lands in certain States and Territories to the construction of irrigation works for the reclamation of arid lands.

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That all moneys received from the sale and disposal of public lands in Arizona, California, Colorado, Idaho, Kansas, Montana, Nebraska, Nevada, New Mexico, North Dakota, Oklahoma, Oregon, South Dakota, Utah, Washington, and Wyoming, beginning with the fiscal year ending June thirtieth, nineteen hundred and one, including the surplus of fees and commissions in excess of allowances to registers and receivers, and excepting the five per centum of the proceeds of the sales of public lands in the above States set aside by law for educational and other purposes, shall be, and the same are hereby, reserved, set aside, and appropriated as a special fund in the Treasury to be known as the "reclamation fund," to be used in the examination and survey for and the construction and maintenance of irrigation works for the storage, diversion, and development of waters for the reclamation of arid and semi-land lands in the said States and Territories, and for the payment of all other expenditures provided for in this Act: *Provided,* That in case the receipts from the sale and disposal of public lands other than those realized from the sale and disposal of lands referred to in this section are insufficient to meet the requirements for the support of agricultural colleges in the several States and Territories, under the Act of August thirtieth, eighteen hundred and ninety, entitled "An Act to apply a portion of the proceeds of the public lands to the more complete endowment and support of the colleges for the benefit of agriculture and the mechanic arts, established under the provisions of An Act of Congress approved July second, eighteen hundred and sixty-two," the deficiency, if any in the sum necessary for the support of the said colleges shall be provided for from any moneys in the Treasury not otherwise appropriated.

SEC. 2. That the Secretary of the Interior is hereby authorized and directed to make examinations and surveys for, and to locate and construct, as herein provided, irrigation works for the storage, diversion, and development of waters, including artesian wells, and to report to Congress at the beginning of each regular session as to the results of such examinations and surveys, giving estimates of cost of all contemplated works, the quantity and location of the lands which can be irrigated therefrom, and all facts relative to the practica-

bility of each irrigation project; also the cost of works in process of construction as well as of those which have been completed.

SEC. 3. That the Secretary of the Interior shall, before giving the public notice provided for in section four of this Act, withdraw from public entry the lands required for any irrigation works contemplated under the provisions of this Act, and shall restore to public entry any of the lands so withdrawn when, in his judgment, such lands are not required for the purposes of this Act; and the Secretary of the Interior is hereby authorized, at or immediately prior to the time of beginning the surveys for any contemplated irrigation works, to withdraw from entry, except under the homestead laws, any public lands believed to be susceptible of irrigation from said works: *Provided*, That all lands entered and entries made under the homestead laws within areas so withdrawn during such withdrawal shall be subject to all the provisions, limitations, charges, terms, and conditions of this Act, that said surveys shall be prosecuted diligently to completion, and upon the completion thereof, and of the necessary maps, plans, and estimates of cost, the Secretary of the Interior shall determine whether or not said project is practicable and advisable, and if determined to be impracticable or unadvisable he shall thereupon restore said lands to entry; that public lands which it is proposed to irrigate by means of any contemplated works shall be subject to entry only under the provisions of the homestead laws in tracts of not less than forty nor more than one hundred and sixty acres, and shall be subject to the limitations, charges, terms, and conditions herein provided: *Provided*, That the commutation provisions of the homestead laws shall not apply to entries made under this Act.

SEC. 4. That upon the determination by the Secretary of the Interior that any irrigation project is practicable, he may cause to be let contracts for the construction of the same, in such portions or sections as it may be practicable to construct and complete as parts of the whole project, providing the necessary funds for such portions or sections are available in the reclamation fund, and thereupon he shall give public notice of the lands irrigable under such project, and limit of area per entry, which limit shall represent the acreage which, in the opinion of the Secretary, may be reasonably required for the support of a family upon the lands in question; also of the charges which shall be made per acre upon the said entries, and upon lands in private ownership which may be irrigated by the waters of the said irrigation project, and the number of annual installments, not exceeding ten, in which such charges shall be paid and the time when such payments shall commence. The said charges shall be determined with a view of returning to the reclamation fund the estimated cost of construction of the project, and shall be apportioned equitably: *Provided*, That in all construction work eight hours shall constitute a day's work, and no Mongolian labor shall be employed thereon.

SEC. 5. That the entryman upon lands to be irrigated by such works shall, in addition to compliance with the homestead laws, reclaim at least one-half of the total irrigable area of his entry for agricultural purposes, and before receiving patent for the lands covered by his entry shall pay to the Government the charges apportioned against such tract, as provided in section four.



No right to the use of water for land in private ownership shall be sold for a tract exceeding one hundred and sixty acres to any one landowner, and no such sale shall be made to any landowner unless he be an actual bona fide resident on such land, or occupant thereof residing in the neighborhood of said land, and no such right shall permanently attach until all payments therefor are made. The annual installments shall be paid to the receiver of the local land office of the district in which the land is situated, and a failure to make any two payments when due shall render the entry subject to cancellation, with the forfeiture of all rights under this Act, as well as of any moneys already paid thereon. All moneys received from the above sources shall be paid into the reclamation fund. Registers and receivers shall be allowed the usual commission on all moneys paid for lands entered under this Act.

SEC. 6. That the Secretary of the Interior is hereby authorized and directed to use the reclamation fund for the operation and maintenance of all reservoirs and irrigation works constructed under the provisions of this Act. *Provided*, That when the payments required by this Act are made for the major portion of the lands irrigated from the waters of any of the works herein provided for, then the management and operation of such irrigation works shall pass to the owners of the lands irrigated thereby, to be maintained at their expense under such form of organization and under such rules and regulations as may be acceptable to the Secretary of the Interior: *Provided*, That the title to and the management and operation of the reservoirs and the works necessary for their protection and operation shall remain in the Government until otherwise provided by Congress.

SEC. 7. That where in carrying out the provisions of this Act it becomes necessary to acquire any rights or property, the Secretary of the Interior is hereby authorized to acquire the same for the United States by purchase or by condemnation under judicial process, and to pay from the reclamation fund the sums which may be needed for that purpose, and it shall be the duty of the Attorney General of the United States upon every application of the Secretary of the Interior, under this Act, to cause proceedings to be commenced for condemnation within thirty days from the receipt of the application at the Department of Justice.

SEC. 8. That nothing in this Act shall be construed as affecting or intended to affect or to in any way interfere with the laws of any State or Territory relating to the control, appropriation, use or distribution of water used in irrigation, or any vested right acquired thereunder, and the Secretary of the Interior, in carrying out the provisions of this Act, shall proceed in conformity with such laws, and nothing herein shall in any way affect any right of any State or of the Federal Government or of any landowner, appropriator, or user of water in, to, or from any interstate stream or the waters thereof: *Provided*, That the right to the use of water acquired under the provisions of this Act shall be appurtenant to the land irrigated, and beneficial use shall be the basis, the measure, and the limit of the right.

SEC. 9. That it is hereby declared to be the duty of the Secretary of the Interior, in carrying out the provisions of this Act, so far as the same may be practicable and subject to the existence of feasible irrigation projects, to

expend the major portion of the funds arising from the sale of public lands within each State and Territory hereinbefore named for the benefit of arid and semi-arid lands within the limits of such State or Territory: *Provided*, That the Secretary may temporarily use such portion of said funds for the benefit of arid or semi-arid lands in any particular State or Territory hereinbefore named as he may deem advisable, but when so used the excess shall be restored to the fund as soon as practicable, to the end that ultimately, and in any event, within each ten-year period after the passage of this Act, the expenditures for the benefit of the said States and Territories shall be equalized according to the proportions and subject to the conditions as to practicability and feasibility aforesaid.

SEC. 10. That the Secretary of the Interior is hereby authorized to perform any and all acts and to make such rules and regulations as may be necessary and proper for the purpose of carrying the provisions of this Act into full force and effect.

Approved, June 17, 1902.

# 13<sup>TH</sup> NATIONAL IRRIGATION CONGRESS

TO BE HELD AT

PORTLAND, OREGON, 1905.

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WEST VIRGINIA	A. B. White, Charleston.	J. C. Brady, Wheeling.
WISCONSIN	Delbert Utter, Caldwell.	Dr. Clarke Gopen, Madison.
WYOMING		



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P R O C E E D I N G S

of

RIO GRANDE COMPACT COMMISSION

held  
in

Santa Fe, New Mexico,

December 2-3, 1935.

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The meeting was called to order by the Chairman, Mr. S. O. Harper, at 2 P.M., in the Supreme Court Room of the State Capitol Building at Santa Fe, New Mexico, December 2, 1935.

BY MR. HARPER: At this time I wish to welcome to the Commission, the new member from Texas, Mr. Frank B. Clayton.

BY MR. CLAYTON: Thank you, Mr. Chairman.

BY MR. HARPER: The last meeting of this Commission was held in this city on January 28, 29 and 30, 1935. At that meeting, the Commissioners passed a resolution recommending that the present Compact be extended for a period of two years, to June 1, 1937. This action was ratified by the Legislatures of the three States, and also by the Congress of the United States, and the extension of the Compact is now effective. A motion was also made at that meeting to adjourn until the 18th of March last, but for various reasons, some of them beyond the control of the Commissioners, no meeting has been held up to this time, and it is probably just as well that we have not held meetings during the busy season as everyone's nerves were pretty well frazzled last spring over the water shortage of 1934, and with the fear of a similar shortage in 1935, so the conditions were not particularly favorable for getting together on any reasonable agreement. At this time, we have passed through the 1935 season without any very great suffering for lack of water, and with prospects better than a year ago, we hope everyone will be in a much better frame of mind.

We have present with us today, two representatives of the National Resources Committee, Professor Harlan H. Barrows of the University of Chicago, and Professor Frank Adams of the University of California. One purpose of the calling of this meeting at this time was to give these two gentlemen a chance to confer with the Commissioners and present any matters which they may wish to lay before us on behalf of the National Resources Committee. To give you a little of the background behind the presence of these two representatives, I wish to read an order issued by the President under date of September 23, 1935:

THE WHITE HOUSE,  
WASHINGTON.

September 23, 1935.

To Federal agencies concerned with projects or allotments  
for water use in the Upper Rio Grande Valley above El  
Paso:

From information secured by the National Resources Committee, it appears that in view of the practically complete present appropriation of reliable water supply in the basin of the Rio Grande above El Paso, Federal investments in this region which promote increased use of water tend to impair the security of extensive prior investments of Federal funds, to violate the terms of an Interstate Compact to which the Federal Government is a party, and to promote social insecurity in the region.

Please instruct appropriate officials of your agency in Colorado and New Mexico, as well as in Washington or in other supervisory offices, not to approve any application for a project involving the use of Rio Grande waters without securing from the National Resources Committee a prompt opinion on it from all relevant points of view.

(Signed) Franklin D. Roosevelt.

On October 2, 1935, Mr. Charles W. Eliot 2nd, Executive Officer of the National Resources Committee, addressed to me the following letter:

CWE-DJ/VT  
October 2, 1935.

The Rio Grande Compact Commission,  
through Mr. S. O. Harper, Chairman,  
U. S. Bureau of Reclamation,  
Custom House,  
Denver, Colorado.

Gentlemen:

From an investigation recently made for the National Resources Committee by a special board of review, it appears that projects in the Upper Rio Grande Basin for which Federal loans and grants have been made or sought are in violation of, or threaten to violate, vested rights and the interstate agreements under the Rio Grande Compact. In order to avoid further conflict of interest in the Upper Rio Grande Basin the President has requested this Committee to advise on all current projects before action is taken by Federal agencies toward their construction.

The National Resources Committee, in order to adequately advise the President in accordance with this order, is anxious as promptly as practicable to stimulate constructive progress towards the development of an equitable policy to guide Federal allotments for water resource development in this basin and to secure the cooperation of the Rio Grande Compact Commission in the formulation of that policy.

The Committee believes that through a determination of needed basic data and agreement on facts by the three states which are members of the compact, and through prompt collection of such data by procedure to be mutually agreed upon as equitable and impartial, real progress can be made toward Federal and interstate agreements. The Committee desires to contribute its cooperation in this approach.

To that end, it asks for a conference between the members of your Commission, together with such other State officials as you deem appropriate, and two representatives of the National Resources Committee, at a place to be designated by you and at the earliest time which will meet the convenience of your Commission.

Sincerely yours,

(Signed) Charles W. Eliot 2nd,  
Executive Officer  
For the Chairman.

On receipt of these letters, I immediately communicated with the three Commissioners to ascertain whether it would be agreeable to meet with this Committee, and they were unanimous in their expression that it would be so agreeable. In addition to the meeting with this Committee, and listening to anything they have to present, the Commission should proceed with the work of laying a base for a permanent Compact to take effect at the expiration of the present temporary Compact two years hence, and I hope and trust that all of the Commissioners and representatives of the three states will enter into this conference with an open mind and with a willingness to hear what the other parties have to say, and if at all possible to, at least, establish a base at this time for further investigations which will eventually lead to an agreement on this matter which is of so great importance to all three of the states, as well as to the Federal government.

At this time, I will call upon each of the Commissioners in turn to state the names of the representatives who are present here, and who may take part in the proceedings. Mr. Hinderlider, will you name the representatives of Colorado?

MR. HINDERLIDER: Mr. Chairman, and Members of the Rio Grande Compact Commission: By Executive Order of Governor Johnson of Colorado, I have been heretofore designated as the Commissioner representing the State of Colorado on the Rio Grande Compact Commission. My legal adviser is Hon. Schrader P. Howell, Assistant Attorney General of Colorado. The other advisers consist of Hon. George M. Corlett of Monte Vista, Colorado; Ralph Carr, Esq., of Denver; R. J. Tipton, engineering adviser. In the former meeting, Mr. F. B. Goudy was also an adviser to the Commissioner, but he is not here today, and I am not advised if he will attend.

MR. McCLURE: By Executive Order of Governor Tingley of New Mexico, I was re-appointed as Rio Grande Compact Commissioner, under date of November 27, 1935. Legal representative, Hon. A. T. Hannett, Attorney for the Interstate Streams Commission and Special Assistant Attorney General, and engineering adviser John H. Bliss of the State Engineer's office.

MR. CLAYTON: In addition to myself as Commissioner for Texas, my legal advisers are Major Richard F. Burges of El Paso, Judge Edwin Mechem of Las Cruces, Mr. Louis C. Hill of Los Angeles; the Engineering advisers are Mr. Roland Harwell of El Paso, and Mr. N. B. Phillips of Las Cruces.

MR. HARPER: At this time, I would like an expression from the Commissioners as to the procedure which we should follow, particularly with reference to the representatives of the National Resources Committee; whether it is your pleasure to have them present to us at this time the purpose of their visit, or whether you wish that deferred until after each of the Commissioners has made a presentation of his own.

MR. CLAYTON: Before we get to that point, I neglected to state in addition to the other engineering advisers mentioned, Mr. W. A. Laflin. Major Burges is not here today, but we expect him here tomorrow.

MR. McCLURE: We have representatives of the intermediate districts and federal agencies that are more or less consultants in their lines, both legal and from an engineering standpoint, and I would like to name them: R. H. Hanna, Esq., Albuquerque; William Brophy, Esq., Albuquerque, Attorney for the Indians; Pearce C. Rodey, Esq., Attorney for the Middle Rio Grande Conservancy District; C. A. Anderson, Chief Engineer, Middle Rio Grande Conservancy District; H. C. Neuffer, Supervisor of Indian Irrigation Service, and Dr. Sophie D. Aberle of Albuquerque.

MR. HINDERLIDER: I should like to add the name of Hon. John I. Palmer of Saguache, as one of the additional advisers to the Commissioner for Colorado. Judge Palmer attended our last meeting.

MR. HARPER: The record will also show that H. J. S. DeVries, Esq., is present as legal adviser to the chairman.

MR. CLAYTON: In addition to those already mentioned for Texas, Mr. Raymond A. Hill is present; Mr. Louis C. Hill may not be present.

MR. HINDERLIDER: Mr. Chairman, in view of the fact that it is my understanding that the purpose of the meeting here today is to meet with the two representatives of the National Resources Committee, Mr. Barrows and Mr. Adams, and to hear what they have to present, I think it would be fit and proper at this time to invite these gentlemen to present what they have to present, and to have a full report from these gentlemen for the benefit of the Commission before we determine upon any further procedure.

MR. McCLURE: I believe that that's a very good suggestion. Other work after that can be taken up and we will more or less outline our plans along what they have to present.

MR. CLAYTON: I fully concur in that suggestion. I think that would be the advisable procedure to follow.

MR. HARPER: The views of the Commission are unanimous, so we will call upon you, Professor Barrows, at this time for any presentation you may care to make.

PROF. BARROWS: Mr. Chairman, Members of the Commission, and gentlemen of the conference: The National Resources Committee appreciates greatly your courtesy in affording its representatives, Prof. Adams and myself, an opportunity to meet with you today. The Committee recognizes the very great importance of the water problems with which you are dealing. It realizes that grave difficulties, of necessity, are inherent in such problems. It earnestly believes that these problems can be solved, and can best be solved, through neighborly cooperation, by voluntary adjustment. It wishes to assist you in the solution of the problems insofar as it can, provided, and only provided, you wish it so to do. Not for the briefest moment does the National Resources Committee wish to appear to be in the position of attempting to impose upon you any solution of its own; to impose any plan which it has formulated with respect to the solution of these pressing problems. I assure you it has formulated no such plan. Obviously, the Federal government has direct concern and weighty interest in some of the problems of the middle and upper Rio Grande drainage area. It has, for example, large investments in existing enterprises involving use of Rio Grande waters. There is the possibility that in due time it will have further investments of such a nature. It, no less than your three states, is a party to the existing Rio Grande Compact. We come to you, therefore, with what might be called a dual motive. First, it is our desire to prepare the way, as representatives of the National Resources Committee, to assist you insofar as may be practicable

(I repeat, if you so desire) in working out your own problems. Secondly, we come to you also in the hope that cooperative undertakings may be launched that will be helpful, which are, indeed, almost indispensable, to a satisfactory carrying out of the assignment involved in the President's executive order which Mr. Harper read to you. And so, from both of these angles, Prof. Adams and I hope that you will think it wise to consider at the very outset of this conference, these three questions:

1. What additional investigations are needed to determine the facts regarding (a) river flow, and (b) feasible additions to the available water supply by storage, transmountain diversion, drainage and reduction of waste? Perhaps I should say, before proceeding with the other questions, that we realize various agencies already have in hand a large body of relevant data. Perhaps those data need, in some cases at least, re-examination, integration, coordination, with a view to determining in particular what additional investigations along such lines as those indicated in the question are, in your judgment, really needed.

2. What investigations are needed to determine the extent (a) of the present use of water in the area, and (b) of its use at the adoption of the compact?

3. How may these investigations be most effectively and most satisfactorily organized, directed and financed?

Those, I repeat, are three basic questions in our own minds concerning which we trust you will take counsel. The information sought by an investigation along these lines would not only be tremendously helpful to the Committee in carrying out the assignment under the President's executive order, but should help further to pave the way toward voluntary adjustment among yourselves of the troublesome problems with which **you** are confronted; and it is our thought further, that an immediate investigation along those lines would likewise pave the way for an ultimate and comprehensive plan affecting the entire upper Rio Grande area. The matters of immediate concern to you, undoubtedly, have to do with equitable allocations of water among the several states, but we assume confidently that you are looking forward also to complete utilization ultimately, to the most efficient use and effective control of the waters of this great area. What, in the long run, will be your needs for water, not for irrigation simply, but for all other purposes, for city and town water supply, for industry, and the like? What are the prospects with respect to growth in population, and the prospects for new and greater needs for water associated with that growth? What are the possibilities for decentralized industry, involving the use of more or less water? What are your prospective, no less than your existing, aggregate needs? To what extent can these prospective needs be met effectively? What are the possibilities of meeting them by small-scale storage and large-scale transmountain diversion, by increased utilization of ground waters, by

drainage, by adjusting your aggregate irrigated acreage more effectively to the supply of water normally available, by putting the water in greater measure on the best land available for its reception? What, from that longer term view, are the relationships between the supply of water that may be rendered available, on the one hand, and the needs for water, on the other hand? Precisely what, in the long run, no less than at present, are the problems which are of mutual concern to the three states? What problems of the area are of concern only to the individual states?

These last questions which I have asked come to me on the spur of the moment and they are intended only to be illustrative. Surely, you are concerned with that longer view, no less than with the problems that immediately and urgently face you for solution. I repeat that we thought such an investigation as proposed might be useful in all three connections: (1) in the solution of your immediate and urgent problems, (2) in the facilitation of our work under the executive order, (3) in the procurement of data indispensable to sound, long-term planning for the drainage area in the common interest of all the people who live there, and who are likely to be there in a period, let's say, of several decades. I think, Mr. Chairman, that's all I need to say at this time. Prof. Adams now will supplement it.

PROF. ADAMS: Mr. Chairman, gentlemen of the Commission and of the Conference: I do not think it is necessary for me to say anything further at this time. Prof. Barrows has very fully outlined the purpose of our coming here, what's in our minds, and what is more important, what is in the minds of the National Resources Committee, and he has indicated the lines along which, it seems to us, progress might be made. I think it is sufficient to let the matter stand at this time and discuss specific phases of the problem as they come up.

MR. HARPER: I wish to thank you gentlemen, on behalf of the Commission, for your presence here, and the presentation of the situation with which these three states are confronted. Do any of the Commissioners wish to question Prof. Barrows, or Prof. Adams, further regarding any matters they wish to discuss?

MR. HINDERLIDER: May I suggest, Mr. Chairman, that I, personally, would be glad to have an expression of opinion from the representatives of the National Resources Committee of how they would proceed in this matter, to more effectively lend its cooperation so as to more efficiently conserve our time and your time at this meeting. I take it that the principal purpose for this meeting is to have presented by you gentlemen what you have to present, and from that point on, to enter into discussions, possibly for the purpose of laying a foundation for further studies and discussions which I suppose will have to come out of later meetings. I should personally like to have an expression of opinion from the gentlemen as to what you would recommend in the way of procedure at this time.



PROF. BARROWS: Mr. Chairman, I think I speak for us both, when I say, in reply to Mr. Hinderlinder's suggestion that we would like to have an expression of opinion from you as to whether or not you regard such an investigation as we briefly have indicated desirable and feasible; an expression from you, if the investigation be in your judgment desirable and feasible, concerning the nature of the basic data not now fully or adequately in hand. In other words, if we were to take these points each in turn, and get your reactions to them, I think perhaps we would get along much more expeditiously than otherwise would be possible. It is conceivable, in theory at least, that your answer to the first question might be in the negative; that you regard such an investigation as we propose undesirable and impractical, in which case there would not be any need of considering the later questions. Would that be your view, Prof. Adams?

PROF. ADAMS: Yes.

MR. HARPER: I would like to call upon each of the Commissioners in turn for an expression, first, as to his views of the desirability or practicability of such an investigation as Prof. Barrows has outlined, and, second, if he is agreeable to such an investigation, an outline of the general ground which such an investigation should cover. Mr. Hinderlinder, may we hear from you?

MR. HINDERLINDER: I take it, Mr. Chairman, you are calling upon me because Colorado heads the alphabetical list. In reply to Mr. Barrows' request to be advised of the attitude of the several states in respect to his Committee participating with the Rio Grande Compact Commission in our further endeavors to reach an understanding in this very important matter, will state I have heretofore advised you, Mr. Chairman, of Colorado's attitude; that we welcome such an opportunity to lay what we conceive to be the equities in this important matter before an unbiased tribunal, which we take to be the National Resources Committee's status in these matters. We have been attempting now for many years, as a representative of one of the three states in question, to reach some understanding with respect to this all-important problem. We feel that substantial progress has been made, in that at the meeting in this room last December, when it appeared momentarily that the conference might go on the rocks, wiser counsel prevailed, and by unanimous resolution the Commission agreed to continue its efforts seeking a solution of this problem, with the result that the Commission reconvened the latter part of last January, at which time the representatives of Colorado, by previous agreement, presented what we conceived to be a rather exhaustive explanation of what we felt would be, and still believe to be, a basis or formula for reaching a solution of this problem. As our Chairman has just stated, due to unforeseen difficulties, the Commission has not met since that time. As an additional reason why we welcome this opportunity to lay before this tribunal what we conceive to be an equitable solution of this problem, we

are pleased to comply with the request of the Chief Executive of the Nation in offering, through this Committee, his good offices, to see if we can come near to finally - as we hope we may do - reaching a settlement of this problem. I believe, unless I stand corrected by my legal and other advisers, this is the position Colorado takes at this time.

MR. HARPER: Could you amplify a little further your answer to the second question which Mr. Barrows asked, as to the nature of the investigations which you consider should be made under direction of the National Resources Committee, if such investigation is authorized?

MR. HINDERLIDER: Being an engineer, or alleged engineer, we, of course, are strong for the obtaining first, of all factual data pertaining, or bearing, upon the subjects under discussion. These data, essentially, are of an engineering character, as Mr. Barrows has intimated, having to do with availability of water supply, the demands upon those supplies, the deficiencies, the surpluses, when they occur, and, in fact, all matters pertaining to the efficient, and I believe, ultimate utilization of this entire natural resource provided by the Rio Grande. In our studies of this problem, we have attempted to go into, in great detail, the engineering phases of this matter. As a result of the studies that Colorado has heretofore made and presented before this Commission, based upon engineering data that's commonly available to the representatives of the three states, we have reached certain conclusions; although we realize that the representatives of the other two states, using the same basic data, may arrive at other conclusions. It is conceivable that the three Commissioners of the three states, by continuous meetings, by agreement among ourselves upon certain factual data, upon which there can be no controversy, and by elimination of other factors that may be more or less material, resolve this thing down to certain facts, or factors, which may be called, or termed, controversial, and on these factors it may be an independent thought entering at this time, would be most helpful. It may well be that these gentlemen, after reviewing all of the factual data that has been presented, or that is in hand, and after having sufficient time to go over the same, and over the report which we presented here, prepared largely by Mr. Tipton representing my department, would find that sufficient data is now in hand, which would eliminate the necessity of acquiring, through long months of efforts and study, further data. It would seem to me, the first thing to do would be to present these facts to the Committee, that they may have some time to look them over, and then, if it appeared necessary to them to have further data, that matter would have to then have proper consideration by the Commission before we could reply intelligently.

MR. HARPER: Mr. McClure, will you answer the two questions propounded by Prof. Barrows?

MR. McCLURE: I think the suggestion of bringing in this National Resources Committee is very practical, and it's been my opinion all along if we could compile the basic information and data that's available, and bring it before some arbitrary board, or among ourselves, and eliminate the non-controversial parts of it, that we would be a long ways toward reaching some permanent agreement on the controversial questions. I believe if that was carried on, that no doubt this Committee can give us great assistance, and with their help, some program or plan, may be developed in which the question of the Rio Grande can be settled. However, I do think that there is probably the necessity of some additional investigations. I think otherwise, Mr. Hinderlinder has covered the question very well in his statement, and I believe that that's the consensus of opinion of practically all of New Mexico's water users in the valley. If I am wrong, I would like to be corrected.

MR. HARPER: Mr. Clayton do you care to express the views of Texas on these questions?

MR. CLAYTON: Mr. Chairman and Gentlemen: I concur with the two other Commissioners in wishing to cooperate with these two gentlemen representing the National Resources Committee in every way. Not having had the benefit of the experience of the two other Commissioners, and not being an engineer, I am at a loss at this time to venture any opinion as to what form that investigation should take. I am also in need, Mr. Chairman, of conferring with my engineer and legal advisers on that question, and I dare say suggestions will be made from time to time that we can heartily concur in. In brief, I merely wish to say at this time that Texas appreciates very much the aid that these gentlemen are offering us here. I believe we are on the right track, and to the extent of our ability, we are going to cooperate in that undertaking.

MR. HARPER: Gentlemen, the views of the Commissioners are apparently unanimous in the acceptance of your kind offer of cooperation in making these investigations, and reviewing the investigations which have been made. Do you have, Prof. Barrows, any specific plan, or program, in mind which might be followed in initiating and financing such investigations, and in employing a field force of engineers, or have your views crystallized to that point yet?

PROF. BARROWS: In the first place, I may say I am sure the National Resources Committee will deeply appreciate your gracious reaction to its suggestion. For myself, however, I am sorry that you have, for the briefest moment, thought of the National Resources Committee as being, in any sense, a tribunal, or a judge. We will, very possibly, have to judge of certain individual projects in the relatively near future, projects that may be referred to the Committee under the President's executive order, but with respect to the things that

we are considering together today, I am sure, were we all present, that we would much prefer to have you think of us as your helpers, insofar as we can be, and in no sense a tribunal. I fear that I have not been very happy in the choice of words in which I attempted to express the spirit in which we come to the meeting. It is that of an eager assistant, insofar as we can assist, and you want us to assist, and in no sense that of a tribunal. So much for our attitude in the matter. I do not know, Mr. Chairman, how it will be best for you to determine, tentatively and roughly, the nature and extent of the additional basic data required for the purpose in mind. I, for example, have as a background only data that were brought to Washington during my service on the Mississippi Valley Committee, predecessor to the present Water Resources Committee, in support of specific applications for particular projects, plus reports of your State Planning Commissions, various materials from your Engineering offices, and information and data supplied in Washington by the federal departments and bureaus which have to do, in one way or another, with certain problems of this area. I think you - far better than I, and I suspect even better than my associate, Prof. Adams - can form a judgment as to the nature and extent of the data, if any, which still need to be gathered with respect to water resources, existent and potential, with respect to water uses, present and prospective, and the like. The other thing, Mr. Chairman, is the essence of our third question - "How may these investigations be most effectively and most satisfactorily organized, directed and financed?" I suggest, if it be agreeable to you, that we leave the matter of financing them, even the initial consideration of it, to the last. How can the investigations be most effectively and most satisfactorily organized and directed? Don't you think that the reaction of the Commissioners to that part of the third question would be distinctly helpful? I think Prof. Adams had in mind various theoretical possibilities which perhaps he will be glad to indicate, at any moment you may deem appropriate, Mr. Chairman.

PROF. ADAMS: I think it would be well, assuming certain investigations are to be made, for the Commissioners, themselves, to get together separately with their associates, and/or together, and explore the various possibilities of organizing an investigation of that type. To what extent it should be under the direction of the Commission; to what extent it should be under federal agencies, or federal agencies should participate; to what extent we should set up an engineering board. I think it would be very desirable, before we make any more progress on that point, for you Commissioners to give the matter some thought, because you will want to do that anyway. I like to feel we are here to fit in in any way we can, rather than to reach out and propose. We have given these matters a good deal of thought on a theoretical basis, and have some rather definite ideas, but I should like you gentlemen to consider these questions very carefully before we offer our suggestions. I take it, as far as water supply is concerned, you have the basic data; if anything is necessary, it is an analysis, although I may be in error. I am

not sure to what extent you have gone into storage possibilities as they are related to your problem. You, yourselves, realize the need for full information in that direction. I am not sure how far the investigations you have already made have to do with the use of water, and into what detail those investigations have gone; the reasonableness of use here and there are involved; to what extent you have records of diversions; to what extent you have considered land needs in the different portions of the basin. There are many details which become clear to anyone when he gets to outlining an investigation. I think a small group could, in a very short time, rough-draft out a procedure as to material that is to be gathered, and have a general agreement, and that will be fairly satisfactory. I don't think we can make the most progress by trying to go into those details until you gentlemen, for yourselves, have a chance to make up your minds and consider among yourselves, just what you want. That is for you to determine; then we are prepared to go ahead.

MR. HARPER: What is the pleasure of the Commission?

MR. CLAYTON: It occurs to me, in the interest of time, it would be well for the three members of the Commission to confer with their respective legal and technical advisers, and be prepared tomorrow to have some specific statement, perhaps, to make in answer to each of these three questions or suggestions. Speaking for myself only, I am frank to say I am unable to offer any suggestions which I think would be of any value to this Commission or to the two gentlemen from the National Resources Committee. I was somewhat in the dark as to the specific nature of the business before the Commission. I have been somewhat enlightened now, and I believe possibly something of benefit could be accomplished if we would recess for the time being, consider these three questions, and meet tomorrow with a view to presenting some tangible suggestions which will, perhaps, be in accord with your views.

PROF. BARROWS: Would it be helpful or desirable if copies were made of these three questions? They should be thought of in terms of the obvious spirit involved, and not as to niceties of wording, because they were written hastily.

MR. HARPER: I think that is a good suggestion, and the Secretary will be glad to do it.

MR. CLAYTON: Mr. Chairman, if it would be in order at this time, Mr. Harwell has made a suggestion, which I think is pertinent, if these gentlemen are in a position to do it, Prof. Barrows and Prof. Adams, it would be helpful to the Commission, I think, in formulating their ideas on these subjects, for you to outline, generally, at this time, any views that you may have with respect to the financing of the investigation that's in contemplation, if you are in a position to do that.

PROF. BARROWS: I was not authorized to make an offer of federal financial aid in any amount. The National Resources Committee felt earnestly that this is primarily your problem despite the large federal interests along the particular lines I earlier indicated. They felt that the investigation, however it may be set up in detail, should be a cooperative undertaking in which the three states, through their appropriate agencies, shall play a very fundamental part. They felt, further, that it is essential to ultimate success that the three states assume, at the outset, an equitable share of the requisite expenditure, either in terms of services, or in cash, or both. It was hoped that I could take back to Washington, to the next meeting of the Water Resources Committee on December 13th, a statement, if you wish thus to go ahead cooperatively, of the source of the services and contributions which you felt you respectively could make, and that your initial commitments would be sufficient, at least, to evidence your thorough interest in the matter and your cordial commitment in principle to the cooperative undertaking. Then, I was assured, the National Resources Committee would use its earnest endeavors to secure, in some way, the remainder of the financial support needed. I have no fixed idea, however, as to the amount, all told, that would be needed, because I do not know the precise nature of the additional data required, or the investigations requisite for the procurement of this data. If you do your equitable part, however, as seems to you proper and practicable, we will attempt to get the remainder of the money needed, when you, and we, have estimated, in the light of the investigation to be set up, what the total amount is. I fear, Mr. Clayton, that that may not be a very satisfactory answer, but its all I am authorized to say.

MR. HINDERLIDER: I take it that it is the desire of the representatives here of the National Resources Committee at this session, insofar as possible, to obtain the views of each state here represented.

PROF. BARROWS: If I could take back definite information and appropriate resolutions that you may see fit to pass, your statements of what you are prepared to do, or can do, which would enable us promptly to push this cooperative enterprise at that end, I would be very happy, and I am sure the Committee would be happy. We would be sorry to see the matter - and so would you - drag unduly.

MR. HINDERLIDER: I possibly did not convey to you the thought I had in mind, Mr. Barrows, in my preliminary remarks. I feel its highly essential that you gentlemen - and I think I would feel the same way were I a member of your Committee - to have the viewpoints of each of these states involving equities in this entire problem, of which the water supply is only one factor. The interests, relative needs - the Compact provides, of course, in no uncertain terms, that there shall be an equitable apportionment of the waters of the Rio Grande, which we have all been seeking to obtain. I am sure

that's Colorado's viewpoint. No one knows at this time quite the status of "equity"; it's a broad term, but that's been the viewpoint of Colorado all the time, that there should be an equitable use of the benefits. That is one of the fundamentals laid down by the Supreme Court in the case of Kansas v. Colorado, and we are willing to abide by that principle. That's why, personally, I urged upon my associates the extension of the present compact so it may give us further time to work out this problem on the equitable basis the compact provides for. In view of the fact I feel it is highly important, I agree that we recess soon in order that we may confer among our respective delegations in response to your inquiry as to how this investigation might best be conducted, and that on convening here tomorrow, each state may have an opportunity to present, for the benefit of you gentlemen, its position and the reasons therefor, that you may take it back with you, in connection with your other matters, for careful consideration. I take it this study you are going to make, not only of engineering data, but economic data, involves study of the equities between these states, and that being true, we feel each state ought to have an opportunity, tomorrow, to be heard before you gentlemen decide to leave. I offer that as a suggestion, Mr. Chairman.

MR. HARPER: Any other remarks? - The view prevails that we should adjourn the meeting until some hour tomorrow morning. If there is nothing further to be presented by any of the Commissioners at this time, I will be glad to entertain a motion for such adjournment.

MR. CLAYTON: I move that the meeting be recessed until ten o'clock tomorrow morning. (Seconded by Mr. Hinderlider, and unanimously carried.)

DECEMBER 3, 1935.

10:15 A.M.

MR. HARPER: Just before adjournment yesterday afternoon, a set of three questions was drafted by Prof. Barrows, asking for certain information from each of the Commissioners as to the scope of a suggested investigation, and this morning the Commissioners were to be prepared to answer those questions to the best of their knowledge. I will call on Mr. Hinderlider to answer the three questions on behalf of his state.

MR. HINDERLIDER: Mr. Chairman and Gentlemen: The first question propounded was - what additional investigations are needed to determine the facts regarding, first, river flow. I took no active part in the negotiations in 1929 leading up to the adoption of the Rio Grande Compact, but it's my understanding that all of the members of the Commission from the three states at that time agreed upon the basic data covering stream flow records, and used such data in arriving at the present compact. Following the adoption of the present Rio Grande Compact in 1929, there were set up, or carried into

effect rather, the requirements under that Compact, providing for the establishing of certain gauging stations for the collection of stream flow data. That was placed under the administration of the Rio Grande Compact Committee, which has continued to function all of these years, and has carried out that mandate for the collection of stream flow data, and has met regularly in January of every year and exchanged that river flow data, and certain other data, collected in connection therewith. That data is all now available for the use of the National Resources Committee. There may be, possibly, a lapse in there of one or two years, in which we have data. I think that data is published in the biennial reports of the State Engineers, and in that form is available to the National Resources Committee.

The second question, under (b), feasible additions. I think the determination of that would largely depend upon the views of the National Resources Committee, and on their judgment of what further data would be necessary, if any, in addition to that just mentioned. I may add that the information collected by the Rio Grande Compact Committee includes also the records obtained by the Bureau of Reclamation at certain places on the river, the International Boundary Commission at El Paso, and possibly other federal agencies, and it is somewhat questionable to my mind if it's feasible to enlarge upon the scope of the field investigations, other than what is already being collected by the Rio Grande Compact Committee, in time to have the same available for the use of the National Resources Committee, if their report is to be forthcoming within the next few months. We would have to depend upon the information now in hand from various official sources.

The second question - what investigations are needed to determine the extent, first, of the present use of water in the area - there are official records available covering the use of water in Colorado, New Mexico and Texas in the various irrigated areas, most of which, I think, is available in the form of biennial reports of the State Engineers, investigations by the Bureau of Reclamation and other similar agencies, including, I understand, also, the use of water in the Middle Rio Grande Conservancy District, insofar as they have used water to date under recent development. In this connection, Colorado has heretofore made an extensive study of all official records that are available on the stream, of the uses of water in the areas in question, the probable interests of the three states in connection with the plan that has heretofore been presented by Colorado to the Rio Grande Compact Commission for consideration, and I take it, all of this data will be available to the National Resources Committee, insofar as Colorado has made a study of the river situation. I take it, also, insofar as New Mexico and Texas, or agencies in those states, have made similar studies, investigations and reports, such data will also be available to the National Resources Committee. I think, up to the present time, in the deliberations of the Rio Grande Compact Commission, that Colorado



has presented practically all of the data that has been presented in that connection. I assume, however, that New Mexico and Texas will have the results of their data in such shape that it will be available to the National Resources Committee.

The third inquiry - how may these investigations be most effectively and most satisfactorily organized, directed and financed - as has been stated, we feel Colorado has gone into the matter very extensively, and in that connection, Colorado has, through legislative appropriations, contributed very substantially in the way of dollars and cents, to the collection of basic fundamental data, and analysis of the same, which we are constrained to feel may be of advantage to the National Resources Committee in initiating their studies. How many thousands of dollars, I am unable to say at this time. We have a very limited fund left out of the appropriations by the last legislature, out of which any costs in the further collection of data might be financed. The present appropriations available to my department are controlled by the Governor and Attorney General. I am unable at this time to state whether or not any further amounts in that fund would be available for assisting the National Resources Committee in financing their study in this connection. It is very questionable if they would be. We are rather inclined to feel that the contributions of Colorado to date, in the way of basic fundamental data that the Committee will need, would constitute a very substantial contribution in this regard, and we are hopeful that the National Resources Committee may be able to finance its necessities out of federal allocations for such purpose.

As to the organization that might be set up, it has been suggested that possibly one member from each state might serve on such a committee to assist, and work, with the National Resources Committee in the formulation of its report. It was also suggested that possibly the designation of one man of outstanding ability, as a result of his extensive experience in such matters, could more effectively function, in connection with the National Resources Committee, in perfecting the organization and carrying out its functions. I am rather inclined to the latter view, if the proper man can be found, and he could be agreed upon by the representatives of the three states. I think it would probably have the effect of expediting matters. Certainly, there will have to be an enormous amount of work done by the National Resources Committee. We are led to that conclusion from the fact that Colorado has spent, to date, months and months of time analyzing the data we have collected in order to arrive at the conclusions we have arrived at. The studies of this problem are most intricate and require a large amount of effort in order that a conclusion may be arrived at. We can all agree on the basic data, but we may not be able to agree upon the conclusions resulting from a study and analysis of the data, and how it may be applied. I am rather inclined to think if we can get some outstanding man, and that man could devote his entire time to the matter, it would expedite matters, rather than have a man appointed from each state, who

would have to meet each state's viewpoint, which may result in delay. I don't know that I have anything further to offer at this time. It may be, after hearing from the other commissioners, we may have something to add.

MR. HARPER: Mr. McClure, will you present your answer to the questions?

MR. MCCLURE: Mr. Chairman, Prof. Barrows, Prof. Adams and Members: At the meeting of this Commission yesterday, Professor Barrows and Professor Adams of the National Resources Committee presented to the Commission the reasons for their desire to cooperate with this body in arriving at agreements in the uses of the water of the Rio Grande within the three states. An outline of the various factors and conditions was advanced by Professor Barrows pertaining to how this problem should be attacked, and along those lines, he requested the consideration of three questions, and expressed the desire of the National Resources Committee, that each of the Commissioners submit answers setting out their attitude to the questions so advanced. The questions so placed before the Commission yesterday are as follows:

1. What additional investigations are needed to determine the facts regarding (a) river flow, and (b) feasible additions to the available water supply by storage, transmountain diversion, drainage and reduction of waste?
2. What investigations are needed to determine the extent (a) of present use of water in the area, and (b) of use at the adoption of the compact (Feb. 1929)?
3. How may these investigations be most effectively and most satisfactorily organized, directed and financed?

As Commissioner for New Mexico, I submit the following answers to the questions, in the order just mentioned:

1. (a) The desirability of installing additional flow measuring devices on the principal tributaries of the Rio Grande, including, but not limited, to the Rio Colorado, Jemez and Salado, in New Mexico, and such other as the investigation might show are necessary in the three states; also, on the Rio Grande proper, at some points just above Cochiti and at San Acacia, in New Mexico.

(b) Data looking to feasible additions to the present supply through storage, transmountain diversion, drainage and the reduction of waste, is meager, and a thorough finding of facts along these lines should be made. The State of New Mexico feels that a transmountain diversion of water from the San Juan River is a vital factor in looking for the necessary new water to augment the supply of

the Rio Grande in New Mexico. In this connection, New Mexico feels that a detail survey should be made of this project, not only from the diversion standpoint, but as to the effect such a diversion would have on the area that now depends, or would depend, on a water supply from the San Juan River in New Mexico.

II. (a) There is little accurate information available as to the actual diversions waste and drainage returns. It is necessary that data pertaining to diversions waste and drainage returns at the present time be obtained for all areas irrigated within the three states above Ft. Quitman.

(b) This part of Question two can be answered the same as in section (a) - there is very little accurate data available.

III. It is suggested that any program toward organizing, directing and financing the needed investigations include generally the placing of all available facts at the disposal of the proper Federal agency or agencies, such as the Bureau of Agricultural Engineering, Division of Irrigation, United States Geological Survey, and Bureau of Reclamation, who are properly equipped to compile all factual information. This state has no appropriation available at this time to carry on such investigations as are necessary, but it has carried on through several years, and will continue to carry on, extensive studies, and has accumulated much data pertaining to the Rio Grande and the use of its water.

Such data would be submitted for the purpose of obtaining cooperation in the actual determination of facts only, with the understanding that the cooperative investigations would be restricted to the facts bearing on the water resources and uses of the water for the area above Ft. Quitman, Texas. Along this line, I would like, before the Commission leaves, to have the feeling of the Commissioners, or attitude, towards this transmountain diversion of the San Juan waters.

MR. HARPER: Mr. Clayton, will you present your answer.

MR. CLAYTON: I think I am reasonably safe in saying that Texas is substantially in accord, in its answers to these questions, with the views just presented by the Commissioner from New Mexico, Mr. McClure. I am going to call in a moment upon Mr. Hill, the engineering adviser to the Commissioner from Texas, to state such reservations as he may see fit. To come to the third question, first, perhaps, with respect to the financing of this, I regret to say that Texas has no appropriation for this purpose. We have, however, accumulated a large mass of data which we will be glad to make available to such Committee or investigating body as may go into the various points to be investigated. In addition to that, as, in fact, we are called upon to do, as I understand it, by the Compact, we will continue to make the investigations which are incumbent upon us by virtue of the terms of

the Compact, and which have been customary in the past, and this, in turn, will be made available to such committee, or body, as may be charged with the duty of making the investigation, whatever committee or body that may finally be determined to be. I may say, before asking Mr. Hill to present his statement, that we may have some reservation with respect to the San Juan diversion - not with respect to the investigation, because we think that should properly be made - and I may say this too, I think that we would be in favor of any means that would put additional water in the Rio Grande, provided, - and provided, always, gentlemen, - that there is no string attached to it in the way of additional lands to be put under cultivation as a result of that water coming in, and not coupled up with diversions from the watershed of the Rio Grande, but to be regarded, purely and simply, as an addition to the available water supply for lands now under cultivation, and perhaps, definitely supplied with the water in the basin of the Rio Grande above Fort Quitman. I may also say that the investigation to be made should be confined to findings of fact, as distinguished from conclusions to be drawn from those fact findings, and that the only power that's vested in the Rio Grande Compact Commission, in this respect, is under Article IV of the Compact - that any investigation should be confined strictly to the terms of that Article. That Article, in substance, provides that the facts are to be arrived at only by unanimous agreement, and are not to be deemed as conclusive in any judicial or other body. I believe with these preliminary remarks, I will ask Mr. Hill to present, from an engineering standpoint, whatever modifications or reservations he may desire to make to the position taken by New Mexico, which, on the whole, we concur with.

MR. HILL: Mr. Chairman and Gentlemen: The views of Texas on this matter are, primarily, that New Mexico has not gone far enough in its statement. The river flow stations, for example, cited by the Commissioner from New Mexico, are only part of the stations which we feel are essential to any accurate and proper study of the problem. Those stations he has listed are solely in New Mexico. I am not in a position to state what stations may be required in Colorado, but I think it's safe to assume, some of the tributary streams in Colorado should be measured, particularly from which diversions are made directly. In New Mexico, there are now no stations of proper quality between the old Buckman, or Otowi, station, and San Marcial. The Commissioner suggests the desirability of a station at Cochiti and at San Acacia. That's a long stretch and a great many streams come in between those points, and additional stations are essential for an accurate study. As to the records of use, I think I may say, with some assurance, that they are more evident by their lack than they are by their existence. There is a very grave shortage of real records of use of water in the Rio Grande basin, even in the Rio Grande project itself, where the Bureau of Reclamation has kept records. Detail records are lacking, but their general records are available. The records of the Middle Rio Grande area, between the mountains north of Albuquerque, and the Elephant Butte Reservoir,

are woefully lacking, and to the best of my information, the records of Colorado leave much to be desired. These records, we feel, should include not only diversions, but actual measurements of surface waste, and records of drainage return, and where such drainage return is re-used. That is a very essential point, and the data now available is practically negligible. Then, a certain time must elapse. The New Mexico Commissioner did not mention any time period, but a far longer length of time than a few months will be required to collect this data, let alone make an analysis of it. Then, one point that has not been covered, which we feel should be covered, is the collection of data to determine what are the natural losses in the Rio Grande. As we all know, natural losses are actually greater than what might be termed irrigation use, and such natural losses are one of the most vital elements in the solution of the problem of the Rio Grande water; and it is our feeling that these questions should be given most thorough study by the investigating body, whatever that body may be.

MR. CLAYTON: In order to get this in concrete form, I have a resolution to offer. Before doing so, I would like to call the attention of the gentlemen representing the National Resources Committee to certain provisions of the Compact. Before doing that, Mr. Chairman, I would like just a moment to confer with my colleagues. -- Mr. Chairman, I offer the following resolution at this time:

BE IT RESOLVED that the states of Colorado, New Mexico and Texas, acting through their respective commissioners, members of the Rio Grande Compact Committee under Article IV of the Compact, cooperate with the United States in a determination of all salient facts bearing on the present and potential water resources of the Rio Grande Basin above Ft. Quitman, and bearing on past and present uses therein; that this factual investigation be directed by the Division of Irrigation, Bureau of Agricultural Engineering, Department of Agriculture, in cooperation with the Geological Survey and Bureau of Reclamation of the Department of the Interior, and with such other federal agencies as may be advisable. That each state contribute all factual data heretofore collected by, or on behalf of each state, that each state continue the stream flow measurements and other findings of fact which have been customary, and that the United States, in recognition of its major interest in projects along the Rio Grande, be hereby requested to contribute all other services and costs in connection with this finding of facts on the water resources and use of water in the Rio Grande Basin.

MR. HARPER: Any discussion of this resolution?

MR. HINDERLIDER: Of course, I have no way of ascertaining what is in the mind of the National Resources Committee definitely as to how they shall proceed with this investigation, they have asked suggestions

from the representatives of the three states here, and we have submitted certain suggestions. It is my impression, however, that it is the intention of the National Resources Committee, as expeditiously as may be, to go into this matter as fully as may be deemed to be necessary and to conclude their findings within the reasonably near future. I mean by that, covering a period of possibly several months, because such an investigation and report could not be forthcoming shorter of such period. On the other hand, to go into the matter to the extent which has been suggested by Mr. Hill, it would seem entirely impractical to involve a delay of not months, but years of time. I think all engineers will concede that the establishing of stream flow stations and the keeping of records from year to year is a matter which must cover a period of many years. Much data, as I have said, has been collected by all of these agencies mentioned, and is available, or should be made available, to the National Resources Committee for its consideration. We all agree, I think, that the records in all three states are not what we would like to have them, not as great in detail both as to water supply available every year or as to the demands and diversions made out of these water supplies, but nevertheless, we think there is enough factual data available from all of these agencies upon which a report and conclusions could be predicated by the National Resources Committee. It seems to me it will defeat the very purpose of an early solution of this problem by attempting to carry out a program as extensive as suggested by Mr. Hill. Therefore, I do not feel that we should burden the efforts, and delay the activities, of the National Resources Committee to the extent that would be necessary for the program, as suggested, to be undertaken and carried out.

MR. CLAYTON: Before passing on this resolution, it occurs to me the gentlemen representing the National Resources Committee may have some very definite ideas on this subject, and I suggest, therefore, before passing one way or the other on the resolution, and on the question raised by Mr. Hinderlider, we ask these gentlemen if they have any suggestion to make at this time.

MR. HARPER: Before calling on Prof. Barrows, I would like to know if Mr. McClure has any remarks to make.

MR. MCCLURE: Mr. Chairman, I really think, to arrive at any determination of facts at all, that the largest part of this investigation is absolutely necessary, in my opinion. I feel that there is considerable data that should be acquired in regard to waste, and in the use. We have carried on investigations along those lines and we have accumulated a great deal of data, but there are lots of matters that should be gone into deeper before we absolutely attempt to settle this question on the Rio Grande.

MR. HARPER: Inasmuch as this line of investigation has been suggested by the two members of the National Resources Committee who are here, and in view of the fact that the responsibility for the carrying

out of this investigation would be largely theirs, I would like to hear from either Prof. Barrows or Prof. Adams, or both, as to any suggestions they may have as to the detailed conduct of these investigations.

PROF. BARROWS: Mr. Chairman, let me make a brief statement concerning several points, and then call upon Prof. Adams to suggest our view concerning a possible organization of the undertaking. In the first place, let me make it clear that this fact-finding inquiry, in our opinion, should seek knowledge of all relevant facts in the situation. I did not intend, for the briefest moment, to give the impression yesterday that, in our opinion, the items of fact specifically mentioned in the first two questions were the only ones that would be needed. We assume that if this cooperative inquiry should be launched, those conducting it promptly would find the need of adding to that list of facts. We were not intending to exclude other things. Certainly, if this situation is to be handled effectively and to the mutual satisfaction of all three states, all relevant facts must be taken into account. To proceed otherwise, it seems to me, would be unscientific and illogical. I therefore welcome, for example, the addition by Mr. Hill of the item relating to natural losses. I do not believe that is the only addition which in due time should be made to the list. I said that we hoped you would give immediate attention to these three things because we thought that if you reacted favorably, we could get the ball rolling, so to say.

I believe that all of us have the same general ultimate objective in view. I believe that we want, all of us, the same kind of an agreement in principle. I believe we want protection of existing rights and equities; I believe we want an equitable apportionment of the available waters of the Rio Grande among these three states; I believe we want to increase to the fullest extent practicable the available water supply in the basin; I believe we want ultimately to make every available drop of water do full service; I believe we want, in the future, harmony, not discord; security, not insecurity; the possibilities of a higher standard of life in the basin, not merely maintenance of the present standard, and certainly not a lower standard.

Now, if these be our common objectives, I think of the situation - crudely, perhaps - in this wise: There, at the end of a long and difficult road, is this multiple goal, or objective, which I have stated, as I see it. You have, particularly through the medium of your admirable Compact Commission, been making progress along the road leading to that goal, but apparently, of late, for various reasons, you have been stopped. I have thought of you as attempting to roll a ball, representing your interlocking problems, along that road toward your objective. I have thought of that ball as being bogged down because of a depression in the roadway, if you please. You have been straining to move it. Now, if you can

put - along the lines we are in general suggesting - your shoulders to the ball, and if we can join you, then, perhaps, with our united strength, we will be able to again get it into motion. But the road beyond, as I have thought of it, is more or less unovon - there are hills the other sides of which we cannot see - and beyond some of them, if we get the ball moving, we will find streams difficult to ford. We will find some streams that we will have to bridge. We will reach barriers of other kinds, which, from our present position, we cannot see, across which it will be, perhaps, difficult to move. Our tact, patience and skill all will be challenged, but in my own thinking in terms of such a rough picture, I have not been worried, particularly, about those things that lie ahead. I think it would be futile for us to try, in a single day, or several days, to envisage all the streams that cross the roadway - all those difficult stretches of the road we want to follow. If we can begin to move, if we work cooperatively and in good faith - and I am sure we would not work otherwise - then we will be able to solve those difficulties as we proceed, and every success as we move along will make easier the solution of the next unanticipated, or now vaguely seen - difficulty. So I have not worried at all, for example, about the adequate inclusiveness of these three questions. Surely, they are fundamental questions - key questions - and if your decision with respect to them is mutually agreeable, we can get the ball started. But, I repeat, it seems to me absolutely essential that all relevant facts, and not those merely, be taken, in due time, into account. I believe also - and I think this was the opinion of the National Resources Committee - that this should be exclusively a fact-finding inquiry. It could not, under the legal set-up of the Compact Commission, be in any sense binding upon the latter. You could not, in advance, agree to any recommendations which might be made on the basis of those facts by yourselves, or by anybody else. A fact-finding inquiry was all we contemplated at this stage.

Now, a word with respect to any actions which the National Resources Committee may have to take, under the Executive Order which Mr. Harper read to you yesterday. I assume that, if called upon for recommendations at any particular juncture, the National Resources Committee, or the expert consultants whom it may call in for aid at that particular moment, in connection with that particular problem, will have to do the best possible with all available relevant information as of the time in question. Such information will be used as you may be able to supply (and the Committee will greatly appreciate your gracious offers of data in your possession), and such relevant data also as can be obtained from any other source, such as the Geological Survey, Bureau of Reclamation, Bureau of Agricultural Engineering and the Bureau of Indian Affairs.

It would be futile, I venture to think, to plan a fact-finding inquiry that could be concluded in two months, or three, an inquiry that would be of very much value. We had been thinking, roughly, in terms of a fact-finding inquiry that would last for



approximately a year; a fact-finding inquiry of a scope and nature which we roughly estimated - or various engineers estimated for us - would cost something like \$150,000. My feeling is that that figure is probably much too low rather than too high. Whether or not, if you agree that an undertaking of that scope and of that duration is desirable, you and we will be able to get the requisite funds, is to me entirely unknown. As I told you yesterday, I have no authorization to make any definite financial commitment for the National Resources Committee. It wished to know what you could do, what you could contribute, (1) in the way of data already in hand, (2) in the way of services for the accumulation of additional data which it might be agreed was needed, and (3) in the way of funds. Then the National Resources Committee could see more clearly what further was necessary, particularly in the way of financial support, and could undertake to get it, if possible. The more your contributions of one helpful sort or another are, the better, obviously, its chances will be of getting the further support that is needed. The greater your combined aggregate contribution, the more evident it will be in Washington that you are going into this matter whole-heartedly, with determination to do your utmost to carry it through successfully. The more you contribute, the more evident it will be that the federal government is helping you help yourselves, rather than assuming, in undue measure, a task for you. Certainly I shall do all I can to get the requisite support over and above that, which, in one form or another, you are able to provide; and, apparently, you will be able to contribute much in one way or another. Prof. Adams, will you continue along the lines, particularly, of the question concerning possible organization?

PROF. ADAMS: Mr. Chairman, there is an old adage, that one well lathered is half shaved, and its just as true in connection with any investigation - that one well planned, is half accomplished. Prof. Barrows has, I think, very clearly shown you that it has not been our conception that we could plan such an investigation as we have in mind in a minute, and, as I tried to ~~express~~ to you yesterday, it is not our desire to do so independently of those immediately interested in the three states. There are two parts to carrying out any investigation, or even planning one. The first, is the details of the field to be covered, the exact data to be sought. We feel very grateful for the contributions of thought you have given on this subject. It was with the feeling that you would make contributions, that we suggested yesterday that before we presented our suggestions, you get together among yourselves and reach your own conclusions. As to who shall undertake the work, the first thing is to find out who is available, what governmental agencies might undertake such an enterprise; what individuals might be available to undertake it. It is our thought, that in close cooperation with you, and constant touch with you, and, of course, in line with the wishes of those most concerned, and in harmony with your views, the National Resources Committee should work out those details. So Prof. Barrows and I

have put in writing what seemed to us might be a desirable action on the part of the Compact Commission at this time looking to these ends, and, with your permission, I will read it:

That the National Resources Committee, through the Water Resources Committee, be hereby requested to arrange immediately for such investigation of the water resources and of the irrigable and irrigated lands of the Rio Grande Basin above El Paso, and of the present and prospective uses of water for agricultural and other purposes in such basin, as may be deemed necessary for prompt action by the National Resources Committee under the executive order of the President relating to the Rio Grande dated September 23, 1935, and as will assist in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande above Ft. Quitman, as contemplated by the existing Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the Federal government and the member states of Colorado, New Mexico and Texas.

The action suggested is not very different from that of the Resolution offered by Mr. Clayton, except insofar as specifically designating the agency to undertake the investigation. It seems to us, I would just like to repeat, that it is impossible to determine in a minute, or at this meeting, just the agency which should undertake it. The availability of men and agencies, what they can contribute, the funds available - all of these things need to be taken into consideration, so I think we should prefer to see some such action as this, rather than the action suggested by Mr. Clayton where the particular agency is specified. There are so many questions involved, that if, in future contact with you, and after your own deliberations, the National Resources Committee should select some such agency, I am sure it will work out in a way that will satisfy you. I think, Mr. Chairman, that's all I need to say.

MR. HARPER: In order to give the interested parties more time to review these two suggested plans, it has been suggested that we adjourn until this afternoon, so I will be glad to entertain a motion to that effect.

MR. HINDERLIDER: I move we recess until 2 P.M. (Seconded by Mr. Clayton and unanimously carried.)

DECEMBER 3, 1935.

2:15 P.M.

MR. HARPER: The meeting will please come to order. To clear up the parliamentary procedure, I wish to state, as I understand it, there is no motion before the meeting at this time. Mr. Clayton read a resolution which he proposed, but did not move its adoption. Prof. Adams read a suggested substitute for the consideration of the Commission. So we will proceed from here with a clean slate.

MR. HINDERLIDER: Mr. Chairman and members of the Commission: With the exception of one amendment to the suggestions made this morning by Prof. Adams, on behalf of the State of Colorado, I should like to offer a substitute resolution for the one offered this morning by the Commissioner from Texas, and in order that there may be no question about the wording of that Resolution, I should like at this time to read it:

That the National Resources Committee, through the Water Resources Committee, be hereby requested to arrange immediately for such investigation of the water resources and of the irrigable and irrigated lands of the Rio Grande Basin above El Paso, and of the present and prospective uses of water for agricultural and other purposes in such basin, as may be deemed necessary for prompt action by the National Resources Committee under the Executive Order of the President relating to the Rio Grande dated September 23, 1935, and as will assist in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande above Ft. Quitman, as contemplated by the existing Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the federal government and the member states of Colorado, New Mexico and Texas.

The amendment to the suggestion of Prof. Adams, which I have just read, relates to a change, or substitution, in the fourth line, of the words "El Paso" for the words "Ft. Quitman". It may be, that the latter part of the first paragraph which mentions Ft. Quitman may be sufficient to correct what we consider to be the deficiency above mentioned. I think it is the understanding of all of us that the duties of the Rio Grande Compact Commission relate to that area of the Rio Grande Valley above Ft. Quitman. Certainly, the investigation, if it is carried out, should include the area between El Paso and Ft. Quitman.

I want to say in this connection, Mr. Chairman, Colorado is heartily in sympathy with the plan suggested by Prof. Adams. We think it is eminently fair; it is sufficient in its scope and sufficiently comprehensive to accomplish the purposes contemplated by this study and investigation. And in conformity with our views, I desire to move the adoption of these suggestions by Prof. Adams which I have just read, with the inclusion of the above mentioned amendment, and offer the same as a resolution for the consideration of the Commission, and move its adoption. - - It has been suggested that there should be also added to the proposed resolution a limitation of the use of the waters which would definitely place the same within the United States, and to that end, it would seem sufficient to incorporate in the 10th line, after the words "Rio Grande", the words "in the United States".

MR. HARPER: Are there any remarks?

MR. McCLURE: I have no remarks at present to make, Mr. Chairman.

MR. CLAYTON: Mr. Chairman, I don't wish to muddy these waters here in any way. There having been no second to the motion which I made this morning, I wish to withdraw that resolution at this time. I have prepared a resolution here which I think meets, in all essential particulars, and perhaps a little more in detail, than what you gentlemen suggested this morning. Before introducing it, I would like to show it to these gentlemen and have them read it and see if it doesn't agree with the spirit and intention of their own resolution. I think its more specific.

PROF. BARROWS: Suppose the Chairman read it.

MR. HARPER: (reads) RESOLUTION

WHEREAS, the Rio Grande Compact Commission is desirous of obtaining all factual data relevant to an equitable apportionment of the waters of the Rio Grande, as contemplated by the existing Rio Grande Compact, and

WHEREAS, the President of the United States, by Executive Order on September 23, 1935, directed that the National Resources Committee investigate any proposed project which would involve the use of water of the Rio Grande above El Paso, and

WHEREAS, the Rio Grande Compact Commission holds that a thorough finding of all facts relevant to the amount of water now available in the Rio Grande Basin above Ft. Quitman, and which might be made available from sources outside of the Rio Grande Basin, and relevant to the use of water for irrigation and other beneficial purposes in said basin, and relevant to the natural losses of water

within said basin, is a necessary preliminary to any equitable apportionment of the waters of the Rio Grande, and to any investigation of projects involving new and additional storage or diversion of waters, and

WHEREAS, representatives of the National Resources Committee have suggested the Rio Grande Compact Commission to advise how such investigation of water resources and use of water might most effectively and satisfactorily be organized, directed and financed.

BE IT RESOLVED, that the National Resources Committee be, and it hereby is requested to arrange for an investigation of the water resources and uses of water in the Rio Grande Basin above Ft. Quitman in the United States, to assist the Rio Grande Compact Commission in reaching a satisfactory basis for the apportionment of the waters of the Rio Grande; that such investigation be restricted to the findings of facts relevant to the water supply available in said Basin, and which could be made available from outside thereof, and relative to the use and consumption of water within said basin; that said factual survey be directed by the Division of Irrigation, Bureau of Agricultural Engineering, Dept. of Agriculture, in cooperation with the Bureau of Reclamation of the Department of the Interior, Geological Survey, or with such other federal agencies as may be advisable, and that the individual members of this Commission use their best efforts to secure allotments of state funds, or services, or both, for the purpose of the aforesaid factual survey, in such amounts as will distribute equitably the cost thereof between the United States and the member states of Colorado, New Mexico and Texas, and that said factual survey be deemed to be carried out under the provisions of Article IV of the Rio Grande Compact.

MR. CLAYTON: I wish at this time to offer that as a substitute in lieu of the one offered this morning.

MR. HARPER: Wouldn't you care to discuss it with those two gentlemen before proceeding with its consideration?

MR. CLAYTON: I would suggest that these gentlemen make some expression as to whether that resolution is not in keeping with the spirit and intention of the one proposed this morning.

MR. HARPER: As I understand the parliamentary situation, you read a resolution and did not move its adoption; so there is nothing before the meeting except Mr. Hinderlider's resolution.

MR. CLAYTON: I had intended to move the adoption of the resolution this morning, and this resolution was intended to be in lieu of that one. I thought that this resolution was more in keeping with the suggestion that was made by those gentlemen from the National Resources Committee. My understanding was that the paper you handed us this morning was only intended to be a suggestion, or outline, for our guidance, and this resolution was drawn with the intention of making it more specific.

MR. HARPER: My only desire is to have those matters discussed in an orderly procedure. As I interpret the present situation, Mr. Hinderlidor's motion is before the meeting at this time, and I would prefer that you discuss this resolution with Prof. Barrows and Prof. Adams informally, and then we will proceed in an orderly way to permit you to introduce it if you still so desire. Will that be agreeable?

MR. CLAYTON: May I make this suggestion. I don't know what the parliamentary rule is here, but if this may not be introduced at this time as a substitute for the one I offered this morning, then I move its adoption as a substitute for the resolution offered by Mr. Hinderlidor, in order to get it before the house at this time. I would prefer to handle it that way, and I will be pleased to hear discussion after they have a chance to digest the terms of the resolution.

MR. HARPER: There appears to be quite a divergence of opinion; I think mainly on the details, and perhaps relatively unimportant points. We are in a rather confused situation at present, in that there are three resolutions - each of the Commissioners has written one. Two have been presented to the Commission, and I would like to call on Prof. Barrows at this time to give any views that he may have to express, and see if he cannot clarify the whole situation.

PROF. BARROWS: I don't want to shirk any duty, but I do think that my associate, Prof. Adams, can probably be more helpful with respect to the matter than I could. If it is entirely agreeable to you, I would like to suggest that he speak first, and I will follow him.

MR. HARPER: That is agreeable.

PROF. ADAMS: Mr. Chairman and Gentlemen: Prof. Barrows and I are not concerned at all in the wording of the resolution, or the action of the Commission, insofar as it does not put us in the embarrassing position of going back to the National Resources Committee and asking them to undertake a rather important, an exceedingly important, investigation, and pay, perhaps, the major portion of the cost, but not to do certain things. The resolution presented by Mr. Clayton, in the preamble, seems to me to circumscribe the work of whatever agency should undertake this study in a way which they do not intend shall be the case. It limits the investigation to the gathering of factual

material relating to water supply and the use of water within the basin, or by transmountain diversion from other basins. I am not prepared right here to see clearly all of the things that would need to be done in such an investigation to make it complete and most helpful to the Commission, and also meet the needs of the National Resources Committee in passing on matters that come to it under the President's Executive Order. I know you would not intend to limit the National Resources Committee to considering any particular facts on matters coming before it. They must deal with matters in a broad way on the basis of their best judgment from such facts as are available, and I have always found you never have too many facts before you when you are dealing with a complicated question.

So the first fear I have of the resolution as presented by Mr. Clayton occurs in connection with the preamble, where it proposes to limit the investigation to certain specific things. I don't quite see the advantage of doing that. One of the limitations, which I take it is intended - at least I read it that way in the wording - is to confine the investigations of the use of water to a study of the lands that are now actually under water. I spent Saturday in the Middle Rio Grande Conservancy District, and the area farther down - it has been some years since I have been in the San Luis Valley so I have no distinct recollection as to that - but particularly in the Middle Rio Grande Conservancy District, at one time there was much more land irrigated there than is now irrigated. A large part of that went out of irrigation because of being flooded. With the work they have accomplished there, that land is gradually coming in. I don't know where, under the resolution as proposed by Mr. Clayton, the Committee would stop in the study of those lands, and I don't see any advantage in attempting to do so. Suppose there are certain areas on the border of lands that are now irrigated. They may, or may not, have been irrigated before. A knowledge of what the situation is in any portion of your Rio Grande Valley, as to lands which might be, or might have been and ~~are not~~ now irrigated, and as to lands that are now irrigated, would be pertinent, and almost necessary, for a thorough understanding of the problem. Suppose it were found, for instance, that it would be possible to bring more water into this basin. Must the Committee think of that, or those in charge of this investigation think of that, in terms only of lands irrigated today? Or should they think of it also in terms of other areas that might possibly be irrigated? The Committee cannot decide any of these matters; but all of the facts would be set forth as to what other lands there are, and you gentlemen, finally, would have to come to an agreement on how to decide these things. I cannot conceive how additional facts are going to embarrass you at all, and they certainly would be helpful, and almost essential to the National Resources Committee in passing on pending projects, and also, as I stated, at some future time when a broader study of this whole basin problem is undertaken after the immediate troublesome questions are satisfactorily adjusted.

So the essential difference between the resolution presented by Prof. Barrows and myself, and those proposed by Mr. Clayton, is to limit the scope of the investigations. I thought it was very clear that what we have in mind is a factual study. If it is desired to state, going back to our original resolution, that no conclusions are to be drawn, that can be done, but I think it would be rather unwise for this reason: that the investigation would be made in the spirit of the action of this Commission, and in the spirit of those who will advise with the Commission, from time to time; that is, if the investigation is to be made, it must be made in such a way as is satisfactory to you, and deal sufficiently with the matters that are pertinent - otherwise, it will have very little effect. It would be as futile to undertake an investigation in which you are not heartily interested in all its aspects, as it would be for this Committee to come out here and say you shall do this or that. Suppose we disregard for the moment the wording of all of these proposed actions, and two or three of us sit down together and see if, without unduly interposing restrictions which seem to us almost impossible of acceptance by the National Resources Committee, we can not write a resolution on which we all might agree. But the substitute resolution I have difficulty in accepting in my own mind for the reasons stated. Mr. McClure has proposed a resolution which, in spirit, is very much the same as the one suggested by Prof. Barrows and myself. The only difficulty is in the second "Whereas", but that is a detail which could be ironed out.

MR. HARPER: Will you read Mr. McClure's resolution?

PROF. ADAMS: WHEREAS, the Rio Grande Compact Commission was established for the purpose of making an equitable division of the waters of the Rio Grande, and in conjunction with the representatives of the President formulate a Compact looking to that end, and

WHEREAS, the President has directed the National Resources Committee to make investigations to that end, and

WHEREAS, the National Resources Committee has indicated its desire to cooperate with the Rio Grande Compact Commission,

NOW, THEREFORE, BE IT RESOLVED, that the National Resources Committee, through the Water Resources Committee, be hereby requested to arrange immediately for some investigation of the water resources and of the irrigable and irrigated lands in the Rio Grande Basin, and of the respective uses for agricultural and other purposes in such Basin, and of the means of augmenting the water supply, by diversion or otherwise, as may be deemed necessary for prompt action by the National Resources Committee, under the Executive Order of the President dated September 23, 1935, as will assist



the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande as contemplated by the existing Rio Grande Compact.

MR. McCLURE: There are one or two minor corrections that should be made in that copy.

PROF. ADAMS: (cont. reading) Next paragraph: Such factual survey shall be conducted in the spirit of the Rio Grande Compact. It is recommended that said factual survey be arranged by the National Resources Committee for the proper federal agency or agencies, and when a plan is evolved, said plan shall be submitted to the Rio Grande Commission for its approval. There is no objection on our part to having this brief paragraph inserted, or something to that effect - that the survey shall be conducted in the spirit of Article IV of the Compact; I think there would be no objection to that. The last paragraph: It is recommended that said facts shall be arranged, etc. That again, is where the action sought is contrary to the thought we had in mind, that the National Resources Committee could use what is finally the consensus of judgment as to the best procedure. Some have suggested that there be an engineer employed to take hold of this thing; I don't know whether that's the way to do it or not. That's generally the customary way, but it may not be the best way here. I think the National Resources Committee would want to weigh that, along with other methods of procedure, before reaching a decision. Now, you mention here a plan - our thought is a plan is not involved in this set-up; we are simply making an investigation of facts. If the National Resources Committee is to assist in making a plan, I think it should come by subsequent request. The first essential is as complete as possible gathering of facts, and all of the facts, unlimited in scope, so far as this investigation has a direct bearing on the problem. The matter of a plan is not at present in the minds of Prof. Barrows and myself, and I think the National Resources Committee, when they consider these matters, would prefer to postpone that phase of the matter until they have all essential pertinent facts before them.

MR. McCLURE: The last clause is probably poorly worded. The idea and intent of that clause is, when your organization does make a plan, that that plan be submitted to the Commission for approval.

PROF. ADAMS: This is December 3rd. How long did it take this Commission to come together for a discussion of this problem? I wonder if all bodies don't move slowly, especially when they are scattered. It will take the National Resources Committee some time to reach their own conclusions. Do you know when they meet, Prof. Barrows?

PROF. BARROWS: The Water Resources Committee meets on the 13th, and it is merely an advisory body to the National Resources Committee. The date of the earliest meeting of the latter, following December 13th, I do not know.

PROF. ADAMS: I haven't any other idea than that the National Resources Committee will want to take you people fully into its confidence in everything it does; I can't conceive of their doing otherwise. An investigation which does not have your hearty approval and cooperation from the beginning is going to run on the rocks as to accomplishment. Personally, I see no objection to asking them to submit it to you, but I think you can leave that to their good judgment; however, Prof. Barrows is a member of that committee, and I am not. He might enlighten you more than I can. Prof. Barrows will you take on from here?

PROF. BARROWS: I concur fully in all that Prof. Adams has said. I was sure he could state our position initially more effectively than I, particularly because he would be able to illustrate concretely certain points in view of his experience in the last few days in the valley south of us. I frankly confess that I was apprehensive with respect to the substitute resolution along precisely the two lines which Prof. Adams has indicated. I think that for various reasons it would be unwise to mention any particular federal agency or agencies that should have immediate supervisory direction of the fact-finding inquiry. I am glad indeed that that difficulty, for it seemed to me to be a real one as I looked forward to our participation in the enterprise at the Washington end, I am very glad that that difficulty was promptly overcome. Prof. Adams, in connection with that phase of the matter, alluded to the possibility that the National Resources Committee might suggest to the Compact Commission the desirability of retaining the services of a single individual as a directive engineer. Now, I can assure you, I can promise you, what, if that suggestion were made to you, the procedure would be. As I have said to a few of you individually, such a man would have to be a man of the highest technical qualifications for the particular duties involved; a man absolutely impartial; a man of unquestioned integrity; a man who would command the immediate respect and confidence of all of you. I know, from experiences in the past along somewhat parallel lines, that the Water Resources Committee, if it were deemed wise to proceed, initially, along that line, with a view to making appropriate representations or suggestions to you, would canvass the matter most carefully, and would then bring the name of this individual to the National Resources Committee and its chairman, Mr. Ickes, for approval. Would then confer with you, through your Chairman, to see whether or not the suggested individual was to you acceptable. If Mr. A were not acceptable for any reason, then, with the utmost practicable promptness, we would suggest for your consideration Mr. B. No individual would be chosen by us independently of you. I beg of you to believe me that such would be the procedure, and that, therefore, so far as that point is concerned, your interests would be abundantly safeguarded.

I had the same reservations which Prof. Adams has voiced with respect to paragraphs 2 and 3, and a later paragraph, the number of which I do not recall, in the substitute motion. Those

paragraphs to which he alluded, as he interpreted them, would tend unduly to restrict the investigation in advance, to specify and delimit the activities to be undertaken. I greatly doubt whether, if that resolution were passed as worded - I am expressing my personal view only - it would meet with the approval of the National Resources Committee; whether the Committee would deem it practicable to go ahead on that basis. Certainly it would be hard to get approval. At that point, again, I beg of you to think of this undertaking with us in terms of the spirit of the thing, the obvious intent - not the particular words or phrases involved, though they should not be ambiguous, but rather as clear and understandable as possible. Let us not tie the thing up in advance with a rope. Let us leave it reasonably elastic. Let us have, as fully as you can, confidence in the desire of the National Resources Committee to aid you, not to force anything upon you, not to restrict or limit you. Let us leave it a matter of investigating all relevant facts; let's have it, however, distinctly understood that it is a fact-finding inquiry simply. I believe, with Prof. Adams, that if he and I could sit informally with the members of the Commission, during a brief adjournment, we very probably could come readily to an agreement that would involve only a few minor changes in the wording of the suggested resolution which was submitted to you this morning by us. I wish that that procedure, Mr. Chairman, might be followed.

MR. HARPER: Would you mind repeating that, Prof. Barrows; I was engaged in a conversation just then.

PROF. BARROWS: I wish the procedure suggested by Prof. Adams could be followed; that during a recess of proper length we might, if such procedure is appropriate, sit with you gentlemen of the Commission as a committee which would undertake to reword our suggested resolution in a way that might be agreeable all around. We could then bring it back to the meeting. I think it would be very easy, for instance, to introduce a phrase or sentence to the effect that this was understood to be a fact-finding inquiry only. With respect to the other matter, I thought of a modification near the beginning that might accomplish, in part, what several of you apparently have in mind, without a specific listing of things. (reads) That the National Resources Committee, through the Water Resources Committee, be hereby requested to arrange immediately for such an investigation of all relevant facts relating to the water resources and the irrigable and irrigated lands of the Rio Grande Basin above Ft. Quitman, and of the present and prospective uses of water for agricultural and other purposes in such basin, as may be deemed necessary, etc. A slight change in wording here and there would tighten the thing up in the way which the authors of the substitute motion intended, without unduly hampering us; and without, in effect, saying to the National Resources Committee, that the agency or agencies charged with the work might investigate this, but might not investigate that.

For example, I might say there already have come to us for consideration, certain new projects in this drainage area that did involve the irrigation of new land, and those had to be considered, and very possibly they will have to be considered again under the Executive Order. For us to concur in a wording which would seem to preclude such consideration, would be, in the very nature of the case, impracticable. I assure you that neither Prof. Adams nor I had any pride of authorship in the wording of this, but we do desire that it shall remain reasonably elastic. We hope you will have confidence that your every interest will be safeguarded to the utmost ability of the National Resources Committee if we proceed under such a broad authorization.

MR. HARPER: The Chairman will take the responsibility at this time of recessing the meeting for 30 minutes, until 4:15, to permit the Commissioners to go into executive session with Prof. Barrows and Prof. Adams in an endeavor to work out a wording of this resolution satisfactory to all concerned.

5:40 P.M.

MR. HARPER: I wish to offer our sincere apologies for keeping everyone waiting so long, and also our appreciation for everyone staying. We rather expected to find this room vacant. We have drafted a resolution which has been tentatively agreed to by the Commissioners, subject to examination and confirmation by their respective advisers. It is our plan to have a number of copies of this resolution made, to be available for the advisers to examine, and we will then reconvene at La Fonda Hotel at 8 o'clock, and if no serious objections are manifested to the resolution, we will be able to terminate the meeting at that time. If not, we possibly will hold over until tomorrow. As long as so many of you are here, I will ask Prof. Adams to read the resolution before we adjourn.

PROF. ADAMS: (reads)           RESOLUTION

WHEREAS, The Rio Grande Compact Commission was created for the purpose, among others, of making equitable division of the waters of the Rio Grande above Fort Quitman, Texas, between the States of Colorado, New Mexico and Texas, and

WHEREAS, the National Resources Committee has expressed its willingness to cooperate, if practicable, with the Rio Grande Compact Commission in the collection of relevant basic data,

NOW, THEREFORE, BE IT RESOLVED, that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation of the water resources of the Rio Grande Basin in the United States above Fort Quitman; of the present and

prospective uses of water for agricultural and other beneficial purposes in such basin; and of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman as contemplated by such Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the federal government and the member states of Colorado, New Mexico and Texas.

It is understood that the report of the investigation requested herein shall be limited to the presentation of the facts gathered and their analysis, and shall not include recommendations for action except upon request of the Rio Grande Compact Commission, based upon the unanimous approval of its members.

It is further understood that the said investigation shall be in harmony with the spirit and intent of the Rio Grande Compact, and nothing herein contained shall be taken to be a modification or alteration of the terms thereof.

MR. HARPER: We will adjourn until 8 P.M. in room 101, La Fonda Hotel, if available.

8:00 P.M.

MR. HARPER: I am advised that the three Commissioners have informally agreed to a final wording and revision of the Resolution which was worked over in executive session this afternoon, and I will leave the meeting open now to such action as the Commissioners see fit to initiate.

MR. HINDERLIDER: On the convening of the meeting of the three Commissioners, with yourself, and the members of the National Resources Committee, we considered the two resolutions which had been offered, one by myself and one by Mr. Clayton, and after analyzing both

resolutions we agreed upon this resolution subject to the approval of the advisers of the three Commissioners, and with your permission, I will proceed to read this at this time so it may have further consideration.

#### RESOLUTION

WHEREAS, The Rio Grande Compact Commission was created for the purpose, among others, of making equitable division of the waters of the Rio Grande above Ft. Quitman, Texas, between the States of Colorado, New Mexico and Texas, and

WHEREAS, the National Resources Committee has expressed its willingness to cooperate, if practicable, with the Rio Grande Compact Commission in the collection of relevant basic data,

NOW, THEREFORE, BE IT RESOLVED that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation of the water resources of the Rio Grande Basin in the United States above Fort Quitman; of the past, present and prospective uses of water for agricultural and other beneficial purposes in such basin; and of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Ft. Quitman as contemplated by such Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the federal government and the member states of Colorado, New Mexico and Texas.

It is understood that the cooperative investigation requested herein shall be limited to the collection, correlation and presentation of factual data, and shall not include recommendations except upon request of the Rio Grande Compact Commission, based upon the unanimous approval of its members.

It is further understood that the said investigation shall be in harmony with the spirit and intent of the Rio Grande Compact, and nothing herein contained shall be taken to be a modification or alteration of the terms thereof.

Mr. Chairman, in order to get this matter before the Commission, I move the adoption of this resolution. (Seconded by Mr. Clayton.)

PROF. BARROWS: May Mr. Hill raise a point concerning which he and I conferred and which I think was, perhaps, not presented to the Commissioners?

MR. HILL: I raise the question regarding the second item in the third paragraph of the resolution, which now reads: "of the past, present and prospective uses of water for agricultural and other beneficial purposes in such basin". As discussed with Prof. Barrows, that might be construed as omitting consideration of natural loesses, which, as I stated, is a very major factor in any investigation, and Prof. Barrows in talking over the language, made the suggestion that it read "of the past, present and prospective uses of water and other consumption of water in such basin". Domestic uses, and then consumption, which takes place naturally, striking out "for agricultural and other beneficial uses".

MR. HARPER: Is that agreeable?

PROF. BARROWS: I merely said, Mr. Adams concurring, that there was no objection to the change. It seemed to me advisable. It eliminates nothing that was here and adds something, the omission of which would be regrettable, and which by a strict reading of this might be considered a deliberate omission.

MR. HILL: Another point Mr. Barrows and I suggested - his suggestion, for clarity that after the word "investigation" in the fourth line of that paragraph, you insert the figure (1), and then, successively, the figures (2) and (3) at the beginning of the subsequent clauses.

PROF. BARROWS: It seemed to us, the sentence being somewhat complex, that these guide posts, or sign posts, together with the substitution of commas for the semi-colons, would make the statement much easier to read.

MR. CLAYTON: So it will now read: NOW, THEREFORE, BE IT RESOLVED that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Fort Quitman, (2) of the past, present and prospective uses and consumption of water in such Basin, and (3) of opportunities

for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact.

MAJOR BURGESS: May I suggest that under (2), you insert "in the United States"; it might avoid some international complications. And since you are trying to make it read smoothly, don't you think you should change the word "approval" to "agreement" in the last line of the next to the last paragraph.

MR. HARPER: I suggest that you read that again, now, with the additional changes.

MR. HINDERLIDER: It has been suggested by the Chairman that the third paragraph of the resolution be re-read: NOW, THEREFORE, BE IT RESOLVED that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Fort Quitman, (2) of the past, present and prospective uses and consumption of water in such Basin in the United States, and (3) of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact.

PROF. BARROWS: Before the vote, and while discussion is still in order, may I make a very brief statement concerning my understanding of the relation of this resolution to the duties of the National Resources Committee under the Executive Order to which reference was made this morning? I am sure my understanding is that of the Commissioners and of their Chairman, but I want to be sure, in view of a question that I was asked in the lobby a few minutes ago. If this resolution is adopted and carried out, then the Water Resources Committee of the National Resources Committee, will, in consultation with the members of the Rio Grande Compact Commission, arrange for certain investigations along specified lines. It will do that by setting up, with you, a proper fact-finding organization, and that organization will gather data with a view to assisting the Rio Grande Compact Commission in reaching a satisfactory basis for an equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman. As I understand it, that eliminates entirely the question of activities of the National Resources Committee in connection with that Presidential Order. Under that Order, from time to time, very probably if not certainly, the National Resources Committee will be requested to consider, and make recommendations with respect to, specific projects in behalf of which applications



will have been made, and we will, at such times, gather all relevant data available to us. We will have the data submitted by the applicants. We will gather relevant data from every federal agency and from other sources, and will, in accordance with the Presidential Order, make recommendations for action with respect to these specific projects. The question I was asked in the lobby seemed to imply the possibility that we could come down here and enter into an agreement under which we would not be able to function as provided by the Executive Order of September 23, without the consent of the Rio Grande Compact Commission. I am sure that was not in anybody's mind, save possibly the mind of my friend who raised the question. Is there any doubt? Am I stating rightly our common understanding now concerning it?

MR. HARPER: It is my understanding that you stated correctly the relationship between your work in cooperation with the Compact Commission and your work under the direct order of the President, which has no connection with the operations of the Compact Commission, under this cooperative arrangement. Is that the understanding of the other Commissioners?

MR. HINDERLIDER: I think Mr. Barrows has made his position entirely clear to Colorado's representatives.

MR. McCLURE: That was my understanding of the meeting.

MR. CLAYTON: This has nothing to do with the Presidential order whatever.

MR. HARPER: I will now entertain a motion for the adoption of this resolution as revised.

MR. HINDERLIDER: You have heard read the suggested corrections, to which I understand we are all agreed; that being the fact, I move the adoption of the resolution with the corrections as read. (Seconded by Mr. Clayton and unanimously carried.)

MR. HARPER: Is there anything further to be brought before the meeting before we adjourn?

PROF. BARROWS: I should like to express to you, before you do, adjourn, for Prof. Adams, I am sure, no less than for myself, our grateful appreciation of the friendly and gracious way in which all of you have greeted us, and our appreciation of the good will and the patience you have shown. If I, at any juncture, spoke unhappily, I assure you that at least I spoke sincerely and from the heart, and I thank you very much.

MR. HINDERLIDER: On behalf of the members of the Commission, I should like to move the adoption of a resolution to the effect that we extend to the members of the Water Resources Committee of the

National Resources Committee, our sincere appreciation of the suggestions they have offered to us, the constructive method in which these matters have been presented, their assurances to this Commission of their whole-hearted desire to cooperate in reaching a solution of our common problem, and with the hope that we may meet again in the future when it is deemed necessary by the Chairman of this Commission, upon request of the members of the Water Resources Committee of the National Resources Committee. (Seconded by Mr. Clayton and unanimously carried.)

MR. HINDERLIDER: May I suggest, it is my understanding that copies of this resolution, as prepared by the stenographer, will be promptly mailed to you and you, in turn, will send them out to the Commission, and I think it would be advisable if additional copies might be made at the same time so we might send them to our advisers.

MR. HARPER: Yes sir, that arrangement will be carried out. The consideration of the matter of paying for the expenses of this meeting, stenographic and secretarial services, should be taken up at this time. The arrangement which has heretofore been carried out, has been that the three states have each contributed one-third of the charges of the secretary. The Reclamation Bureau has absorbed the expense of mimeographing and furnishing each of the Commissioners 15 or 20 copies of all proceedings. If that procedure is agreeable to the Commissioners, a motion is in order.

MR. HINDERLIDER: I think it may be assumed that that plan will be carried out.

MR. HARPER: We will assume then, without further formal action, that that plan will be carried out.

MR. HARWELL: Do you adjourn permanently tonight, or do you have in mind further meetings?

MR. HARPER: As far as I am advised, we are to adjourn this meeting subject to the call of the chairman, as I think was stated in Mr. Hinderlinder's resolution - either upon request for conference in the future with representatives of the National Resources Committee, or upon request of any of the individual commissioners if they have any phases of the matter which they wish to present.

MAJOR CORLETT: If New Mexico and Texas have a concrete plan of any kind, whereby we can make an adjustment of this most difficult problem, I think certainly the representatives of Colorado would be willing to continue this meeting.

MR. HARWELL: I merely inquired for information.

MR. HARPER: I will be glad to have the views of the Commissioners on this point.

MR. CLAYTON: Speaking for myself, I have no such plan in mind. I will be glad to discuss any such if one is suggested.

MR. HARPER: Does the Commissioner from New Mexico have anything further to present?

MR. MCCLURE: Nothing at this time.

MR. HARPER: If no one else has anything to add to our discussion, a motion to adjourn will be in order.

MR. HINDERLIDER: I move we adjourn, subject to the call of the Chairman of this Commission. (Seconded by Mr. McClure and unanimously carried.)

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RESOLUTION

WHEREAS, the Rio Grande Compact Commission was created for the purpose, among others, of making equitable division of the waters of the Rio Grande above Fort Quitman, Texas, between the States of Colorado, New Mexico and Texas, and

WHEREAS, the National Resources Committee has expressed its willingness to cooperate, if practicable, with the Rio Grande Compact Commission in the collection of relevant basic data,

NOW, THEREFORE, BE IT RESOLVED, that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Fort Quitman, (2) of the past, present and prospective uses and consumption of water in such Basin in the United States, and (3) of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact.

In making this request the Rio Grande Compact Commission, and its individual members, declare it to be their desire to cooperate and assist in such investigation in all ways within their power, and it further declares that, through its individual members, it will seek

to obtain the allotment of state funds, or services, or both, for the purposes of the investigation in such amounts as will equitably distribute the costs thereof between the federal government and the member states of Colorado, New Mexico and Texas.

It is understood that the cooperative investigation requested herein shall be limited to the collection, correlation and presentation of factual data, and shall not include recommendations, except upon request of the Rio Grande Compact Commission, based upon the unanimous agreement of its members.

It is further understood that the said investigation shall be in harmony with the spirit and intent of the Rio Grande Compact, and nothing herein contained shall be taken to be a modification or alteration of the terms thereof.

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P R O C E E D I N G S

OF

RIO GRANDE COMPACT COMMISSION

Held  
in

Santa Fe, New Mexico,

March 3 and 4, 1937.

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P R O C E E D I N G S  
OF THE  
RIO GRANDE COMPACT COMMISSION

Held in  
Santa Fe, New Mexico,  
March 3 & 4, 1937.

The meeting was called to order by the Chairman, Mr. S. O. Harper, at 2:00 p.m., March 3, 1937, in the Court Room of the Federal Building at Santa Fe, New Mexico.

MR. HARPER: At a meeting of this Commission held January 28 to 30, 1935, a resolution was adopted recommending extension of the 1929 Compact which expired on June 1, 1935, for an additional period of two years. This placed the expiration of the extended compact on June 1, 1937. At another meeting held on December 2 and 3, 1935, the Commission conferred with representatives of the National Resources Committee regarding a proposed comprehensive investigation which the Committee proposed to make in order to assist the Commission to reach a conclusion on the proposed Compact. The Commission passed a resolution accepting the cooperation of the National Resources Committee from which I will read an extract:

"NOW, THEREFORE, BE IT RESOLVED, that the National Resources Committee, through the Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Fort Quitman, (2) of the past, present and prospective uses and consumption of water in such Basin in the United States, and (3) of opportunities for conserving and augmenting such water resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact."

The investigation was to be made by the National Resources Committee under the general direction of Professors Barrows and Adams, who are here with us today, and under the direct supervision of Mr. Stafford who is unable to be present.

The calling of the present meeting has been suggested by the individual members of the Commission for the purpose of arriving at a determination as to whether or not this Compact is to be extended for another period so as to permit the National Resources Committee to

complete its investigation, which I understand will not be finished for perhaps two months yet, or whether we will take no action and let the present compact expire by limitation. It appears that we have reached the cross-roads and it is essential that this Commission, if it is to take any definite action toward an extension of the present compact, do so at this time,

In order to place on record the names of those who are present, in addition to the Commission, I will at this time ask the Commissioners to state the names and positions of any official representatives of their several states who are here:

MR. HINDERLIDER: Representing Colorado:

M. C. Hinderlider, Colorado Rio Grande Compact Commissioner.  
Charles Corlett, representing the interests of the Rio Grande Water Users Association. Mr. Corlett, Sr. was unable to be present, nor was any representatives of the Attorney General's office of Colorado able to be present.

MR. McCLURE: Representing New Mexico:

Thomas M. McClure, Rio Grande Compact Commissioner for New Mexico.  
A. T. Hannett, Attorney for the Interstate Stream Commission.  
Wm. Brophy, Attorney for Middle Rio Grande Conservancy District.  
C. A. Anderson, Chief Engineer of the Middle Rio Grande Conservancy District.  
John H. Bliss, Engineer of the New Mexico State Engineer's office.  
Fred E. Wilson, Attorney for Middle Rio Grande Conservancy District.

MR. CLAYTON: Representing Texas:

Frank B. Clayton, Rio Grande Compact Commissioner for Texas.  
Alan Laflin, Engineer, representing the State of Texas.

MR. HARPER: Representing the United States:

S. O. Harper, Chairman, Rio Grande Compact Commission.  
H. J. S. Devries, District Counsel.  
E. B. Debler, Hydraulic Engineer.

There are also present at this meeting, as representatives of the National Resources Committee; Professor Harlan H. Barrows, Professor Frank Adams, and Mr. Fred C. Scobey.

MR. HARPER: The meeting is now open to the Commissioners for the discussion of any business they see fit to initiate. (Pause) In the absence of voluntary response, I will call on you, Mr. McClure, as the Commissioner who suggested holding this meeting, to present your views.



MR. McCLURE: My position in suggesting the meeting was done by former suggestion to me in regard to reaching an agreement so that the necessary legislation, if desired, could be carried through at the present session of the Legislature. Due to the fact that Santa Fe was more or less a central point I issued an invitation to meet here. It seems that our position under the Compact has been changed a little bit since our last meeting in which the Compact was extended. Our idea of the compact was more or less status quo of conditions on the river; to hold in that condition until some permanent compact could be drawn up in which there could be equitable distribution of the waters. But, as I see it, the position of New Mexico is not that now, as we are in a law suit in the Supreme Court. Under the present compact it is questionable what effect that suit will have on New Mexico and at the present time it has not been definitely settled in New Mexico's mind what we should do about it, and I prefer to hear some other discussion at this time from the other Commissioners to see what their decisions are on the present compact or the drafting of a new one.

MR. CLAYTON: Mr. Chairman, we have in progress an investigation by the Rio Grande Joint Investigation and I believe I understood you to say the report would not be completed for two months. Our legislature will adjourn by the end of April and my authority as Compact Commissioner will terminate June 1, with the expiration of the time provided by the Compact for the appointment of Commissioners. It seems to me that it is desirable that legislation be introduced authorizing continued negotiation after that date, or that provisions of the Compact itself be extended for a period of time sufficient to permit the report of the Rio Grande Joint Investigation to be made and studied and analyzed before the Commissioners of the respective states attempt to reach some agreement based thereon or partially thereon. I do not think that it is advisable at this time to attempt to negotiate definitely to reach a permanent Compact because in attempting to reach a permanent Compact we should have the aid of the report of the Rio Grande Joint Investigation. As I understand it, this was the purpose of the investigation.

As I say, we have reached the conclusion, and in that I am upheld by an opinion of the Attorney General of Texas, that my authority as Rio Grande Compact Commissioner will terminate on June 1, with the expiration of many important provisions of the present Compact at that time, unless additional legislation is passed by the Legislature of the State of Texas there will be no one authorized to negotiate with the States of Colorado and New Mexico over the equitable distribution of the waters of the Rio Grande. No such authority can be given until the next meeting of the Legislature, which will be two years hence unless a special meeting is called.

As to my attitude in this matter, I do not wish to be understood as pressing this at all, but it seems to me that if we are to derive any benefit from the Rio Grande Joint Investigation, which has cost a great deal of money and a great deal of time, that this Compact should be extended for a period of time sufficient to receive



the report and for the Commissioners to get together to review it and submit their findings to their respective legislatures or ask that the legislatures of each of the three states, if the Commissioners deem it necessary, to pass additional legislation authorizing further negotiations after the expiration of the present Compact. For my part and on behalf of the State of Texas, I am willing to assume either course, but it seems to me the extension of the present Compact will be the most desirable course.

MR. HINDERLIDER: Mr. Chairman and Members of the Committee: Unfortunately, I have been in the East for more than two weeks immediately prior to attending this meeting and I just returned to Denver last Sunday and have had no time to confer with our Attorney General who left yesterday for Washington. Neither have I had opportunity to confer more recently with Mr. George M. Corlett, who represents the Rio Grande Water Users in the San Luis Valley, to obtain his views with respect to the advisability on the part of Colorado to agree to an extension of the present Compact. The invitation for this meeting was extended by Commissioner McClure, and after arriving in Washington I received a letter from the Chairman in which Mr. McClure had advised him in turn that the legislature of New Mexico would probably not be disposed to take any action at this time looking to an extension of the present Compact in the absence of a favorable report from the Water Conservation Commission of New Mexico. As I recall also, Mr. McClure stated that in all probability the Legislature of New Mexico would have adjourned by February 28. I assumed therefore, that any attempt on the part of the Commission, in view of those conditions, looking to reaching an understanding in this matter would be futile.

However, upon my return to Denver, I received advice from the Chairman of the Commission in which he stated that Professor Barrows and Professor Adams wished to appear before the Commission to talk over other matters and upon arrival in Santa Fe this morning, I find that the Legislature of New Mexico is still in session. The Legislature of Colorado will probably be in session for some time. I understand, Mr. Clayton, that there is an opportunity to have this matter considered by your Legislature for some weeks.

MR. CLAYTON: Until the end of April. That is, I presume the session will continue that long. It is slated to adjourn at the end of April.

MR. HINDERLIDER: My own personal feeling is in conformity with that just expressed by Commissioner Clayton; that is, that it is desirable to extend the life of the present compact for some period at least sufficient in time to permit the three states to avail themselves of the results of the comprehensive investigation and forthcoming report of the Rio Grande Joint Investigation. I realize, of course, that continuing negotiations by the representatives of the three states is not necessarily contingent upon having the Compact

extended. On the other hand, the provisions of the present Compact which were reached after long and laborious negotiations, I feel contain several provisions which should not be lost to the three states. I realize that there is an element in my own State, particularly in the San Luis Valley, which is at this time luke-warm toward extending the life of the present Compact. We, however, early in the session of our present Legislature caused a title for an Act to be introduced, authorizing the extension of the life of the present Compact upon the assumption that during the session of the legislatures in the three states it might be deemed expedient by the representatives of the three states to request an extension of the Compact. Of course, nothing that the three Commissioners can do at this time would in any way be binding upon the three states in question, and the legislature of each would have an opportunity to act in conformity with the wishes of the citizens of the state in nullifying any action we might take here today. I express this from the standpoint of my own views in the matter, which may be contrary to those of the majority of the water users of the San Luis Valley of Colorado, but to me it does seem that it would be desirable to have the present compact extended for such a period of time as will enable the states to continue their negotiations based upon the mass of information that will be made available to the three states by the Rio Grande Joint Investigation, and that, finally, whatever action the three Commissioners may take here looking toward an extension of the present Compact will finally be passed upon by the present session of the legislatures of the three states.

Of course, Colorado is not involved in the present suit between Texas and New Mexico, and I realize that New Mexico's position as a defendant in this suit, may be materially different than it was a year ago or two years ago, as stated by Mr. McClure, which contention may justify New Mexico in not extending its approval to the extension of the Compact. I take it that before we finish here it will be decided definitely whether or not the Commissioners can reach an agreement in this matter.

MR. McCLURE: I would like to clear up the records a little in regard to our Legislature. I think Mr. Hinderlider misunderstood my letter. We have a sixty-day session and this session started approximately the 12th of January. Two years ago they hurried the work up and it terminated in approximately fifty days, and in my statement the date March 3rd was given as there was a possibility of it being too late to accomplish anything in the New Mexico legislature. At that time it was anticipated there would be a shorter session than sixty days. However, it has developed that it is going to take sixty days to dispose of the amount of bills that has been introduced. For that reason the session will terminate around the 12th or 15th of this month. Of course, the dead line of bills to come in under the forty-five-day limit has been reached but the Governor can give permission to introduce bills up to the last.

MR. HINDERLIDER: Do you understand that no bill has been introduced?

MR. McCURE: No, for the reason that it was definitely stated to the Interstate Stream Commission that no action would be taken on any bill without recommendations, and for that reason there has been no bill introduced. We cannot introduce by title in New Mexico.

MR. HARPER: Mr. Hinderlinder and Mr. Clayton have stated their views very clearly and I gather that they are both favorably inclined to an extension of the Compact.

MR. McCURE: I request a ten-minute recess.

MR. HARPER: The meeting will be recessed for ten minutes.

Mr. David Chavez, Chairman of the Interstate Stream Commission, came in.

Meeting called to order by Mr. Harper.

MR. McCURE: Mr. Chairman, as I stated in the beginning, New Mexico is in a peculiar position in regard to the present Compact. There is a question in our suit as defendant, Texas complainant, that this compact has brought up an interpretation which we more or less are on the fence in regard to its meaning of some parts of the compact. Certain questions as to whether it was the intent of the ones who drew the Compact to mean one thing has been interpreted to mean another, and due to those facts it has brought questions before the Interstate Stream Commission, not only affecting this one stream system, but other stream systems that are interstate, the development of New Mexico will depend a great deal upon definite provisions in our Compact.

In regard to negotiations for other compacts or the extension of this Compact, our Interstate Stream Commission has the authority to negotiate and draft compacts as well as other provisions. The set-up is such that New Mexico can go ahead even after the compact is terminated. We can start negotiations the next day under our Interstate Stream Commission Act in New Mexico.

New Mexico has always been a compact state. We realize that it is the compact which in most cases prevents expensive and long drawn out litigation and we believe in compacts, and were well satisfied with the compact up until the time that we were sued on a more or less technicality in the provisions of the compact, and I am not at the present time in a position, and will not and cannot, make a statement until I confer further with the Interstate Stream Commission and also the Governor of New Mexico. We have only two members of the Commission here at this time. We would like very much

to have Professor Barrows or Professor Adams give us an outline of what the joint investigation has done so far. We know in a general way and know something in regard to when the report of the investigation will be available, and I would like very much to request that the Chairman ask either one of them for a statement.

MR. HARPER: I had intended to ask Professor Barrows to tell us something of the Rio Grande Joint Investigation, and we would be glad to hear also his general views as to the advisability of leaving the matter of negotiations between the states until the completion of the report.

MR. HINDERLIDER: May I interject a question at this time? Do I understand the position of New Mexico to be at this time that they are unable to discuss this particular matter, that is, the extension of the present compact, until they have had opportunity to confer with the Interstate Stream Commission?

MR. McCLURE: And the Governor.

MR. HINDERLIDER: You anticipate that it might be done during the present session?

MR. McCLURE: I anticipate that it can be done today.

MR. HINDERLIDER: You can tomorrow make a definite statement?

MR. McCLURE: Yes.

MR. HARPER: Professor Barrows, may we hear from you in regard to this matter?

PROFESSOR BARROWS: I was just recalling that I attended with Professor Adams my first meeting of this Compact more than a year ago. I came as a stranger, as I did not know any of you and I had not at that time met Professor Adams. I certainly realize that I came this second time with a very different feeling, not that of a stranger, but a friend. I feel that I am in a sense one of a group working with you to solve problems which are common to all three states. I want to say particularly that the three state compact commissioners have helped the progress of the joint investigation in every way in their power.

It is certainly a pleasure to be with you again. The whole experience has been for me an impressive one.

We expressed to you the hope sometime ago that by the middle of April we would have, not in final printed form, but in mimeographed or typed form, the report of the joint investigation. Frankly, I am not very hopeful now that we shall be able to meet that tentative date. Mr. Debler told me a few moments ago that he brought with him a



copy of the report of the Bureau of Reclamation today for Mr. Stafford. I have not yet seen the result of the work of the quality of water program. The Bureau of Agricultural Engineering has been confronted with serious and time-consuming difficulties along various lines that originally were not anticipated. Mr. Scobey will correct me if I am in error, but it is my understanding that they probably will not be able to get the complete report in Mr. Stafford's hands until approximately the first of April. My present judgment is therefore that we will not have in mimeographed form the complete report before the first of May at the earliest. This is to say that if we do not get the report of B. A. E. before April 1, it would be a prodigious task to meet the May 1st date. We realize and you realize that if we are able to make delivery on April 15, that the time left is very short and unfortunately a brief interval before the expiration of the present temporary compact.

If Mr. McClure desires, or if anyone desires, a statement as to the scope of the investigations, I am sure that Mr. Scobey, who has been so intimately associated with it all along, can give you that information more effectively than I could.

With respect to the other query which you addressed to me, Mr. Harper, there is very little that I can say which has not already been stated or implied in remarks which the compact commissioners themselves have made. You called to the attention the basic objective in the resolution of December 2, 1935, namely, to provide these factual data which assist in reaching a basis for satisfactory and permanent compact.

In deciding the procedure you will follow with respect to the present temporary compact or some equivalent provision under which negotiations among you could effectively proceed, you will, of course, consider that failure to extend the temporary compact would defeat that basic objective. You will consider, of course, whether or not that if negative action were taken along this line you would not have an opportunity to benefit from the results of the investigation. I do not presume to answer that dual question for you, and in answering it I am simply putting in a slightly different form thoughts already implied by at least one speaker.

I might say that the \$50,000 made available for the Bureau of Reclamation, only a part of which was allocated this year to you, makes the entire sum that will be involved in the joint investigation approximately \$375,000, \$55,000 of which has been or will be contributed by the three states, the remainder by the Federal Government. Now since it fell in considerable part to me to attempt to get that Federal backing, or perhaps I may venture to say that the Federal funds were obtained largely in the light of that basic objective because it was hoped, more or less definitely hoped, that if the facts were obtained it would be possible to negotiate a permanent compact.

And so I am sure you will consider whether or not by taking a negative action you would leave the National Resources Committee in an embarrassing position.

Then next, I want to say just a few words with respect to the National Drainage Basin Investigation, which something more than a year ago the President instructed the Water Resources Committee to undertake. Summary of the report on that investigation was transmitted to the Congress and President on February 3, as part of the report of the National Resources Committee on Public Works planning. The complete report, relating to 157 basins, will be submitted on or about March 7.

Now that investigation, under the President's instructions, had three major objectives. First, the investigation was to determine the principal water problems in the various drainage areas throughout the country. Second, it was to outline in broad terms a pattern of water development and control designed to solve these problems, and third, it was to present specific investigation and construction projects as elements in the particular outline with general priorities of importance and time.

The compact commissioners themselves will remember a discussion which they had with me last June with respect to what we should do in the case of the Upper Rio Grande. Professor Adams and I had agreed and very willingly, for we thought it was a proper provision, when with you in December 1935, that the report of the joint investigation should contain no recommendations for action. These basin reports for which the President called, did require the presentation of recommendations of specific investigation and construction projects in the major areas of the country. Recommendation for action was the very essence. Wisely, it seemed to me, you decided last June that it would be best, and of course in keeping with the agreement which had been willingly entered into that no such recommendation be made in the case of the Rio Grande area until completion of the joint investigation. That was agreeable to the Water Resources Committee and others interested in this summary report, copy of which I have with me; in the report transmitted March 7, there is only a description and location map of the Upper Rio Grande, without entry of any projects. On every other map there is given a greater or less number of projects and on the individual basin maps the number will be increased. Here is one of the Missouri basin shown in red and black and accompanying that map in each case you have definite project lists in two groups. I might say that the President had hoped that the Committee could give absolute priority and to individual projects through the country. Most of you are engineers and I need not point out or explain or discuss the impracticability of doing this. It could not be done as a whole for the 17 districts in which it was divided. It could not be done in individual basins, but it was found practicable for individual basins and groups of basins to classify the projects in three broad classifications:

Group A, - Immediate projects - Investigation of construction projects that have been found technically sound and economical, and projects which were ready to go and which were recommended for construction as soon as possible.

Group B, - Deferred projects - Projects which appeared to be entirely worthy of early construction but which were deferred more or less because of legal, administrative or other difficulty or because of additional investigation which could not be furnished at this time for the report.

Group C, - Indeterminate projects which in sequence of investigation had to follow B projects, which, while included in the development of the basin plan were not sufficient to give them at the present time proper classification.

Now, in the summary report you have the A, B, and C list and you have nothing for the Rio Grande. It seemed to be currently believed in Washington that the President's plan, perhaps with some modification, will be included in the reorganization of the plan of the Government. One phase of the reorganization of the executive departments is the establishment of a permanent National Resources Board and it is contemplated that the project lists will be revised from year to year, and they must be qualified and justified in the light of specific needs and new knowledge and the like. It is anticipated that from this list which will be continually revised, the Board will recommend through the President to the Congress each year a group of projects for construction.

I felt under those circumstances that it was highly desirable in such a program to have formulated a plan for the equitable apportionment of the waters of the upper river by the several states, and a plan for the physical works that would be needed to complete and carry out the allocation of the scheme at the earliest possible moment in the light of the joint investigation.

Now, if you do not extend the present temporary compact or provide some other equivalent for negotiation of a permanent compact, it may unfortunately delay this action for development to which I referred a moment ago. If you take negative action, I assume that in due time, and doubtless shortly, you would release the consulting board from its agreement.

I have been hoping heartily in my own mind that you might see fit to extend the compact or make other equivalent effective provisions toward a final permanent compact. Other interstate problems have been assigned in part to me involving more or less similar difficulties and I have come to feel that the compact method is the one to be followed. Experience has shown that litigation is a slow, costly method and unsatisfactory in settling interstate difficulties over water problems.

PROFESSOR ADAMS: In all of our experience together, Professor Barrows and I have found ourselves in entire agreement. The statement that he has just made meets with my complete approval. I should like to add only that I have felt it a pleasure to be identified with this undertaking; it is a pleasure to come back and discuss this problem with you again.

(Informal discussion - Meeting recessed)

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Meeting convened at 10:55 A. M., March 4.

MR. HARPER: The meeting adjourned to give Mr. McClure an opportunity to consult with state agencies and officials, and I will ask Mr. McClure to submit his findings.

MR. MCCLURE: Mr. Chairman, indicating a willingness to extend the Compact for the purpose of having the benefit of the report now in process of being made by the Rio Grande Joint Investigation, we do so with the understanding that: First, any extension shall not be construed as an admission on the part of New Mexico to mean that the original compact was an acknowledgment on the part of New Mexico that Texas or its citizens had any specific rights to the use of waters of the Rio Grande by reason of any appropriations made through the State Engineer's office of New Mexico or otherwise; Second, that such extensions shall not be construed as in any way changing the position of New Mexico in the present suit pending between Texas and New Mexico as to the meaning of the language used in said compact.

It will be understood that New Mexico's position is that the original compact was an agreement to negotiate as to what the actual rights of the respective states are, without resort to the courts, and was a truce merely, and entered into for the purpose of maintaining the status quo as specified in the provisions of the compact during the time of such negotiations.

In short, in agreeing to recommend an extension, we want it understood that we do not seek any advantage in the pending lawsuit between Texas and New Mexico by reason of such extension, nor do we intend that we shall suffer any injury or disadvantage in said pending lawsuit by reason thereof.

Further, such extension of the present compact, if made, shall be upon the express agreement of the contracting parties to maintain the status quo as specified in the compact on the Rio Grande during the period of such extension, and the agreement of Colorado during such extension that she will not make or suffer to be made any new or increased diversions or storage of water on the Rio Grande.



The agreement to extend said compact on the part of New Mexico, acting through its Legislature, is conditional upon a similar action and similar ratification by the other contracting states.

MR. HARPER: I believe Mr. Clayton has previously expressed his views rather definitely as to the extension of the compact and I will ask Mr. Hinderlider if he is in position now to state Colorado's position.

MR. HINDERLIDER: Mr. Chairman and members of the Committee: In listening to the statement just made by Commissioner McClure, we note that the only reservation New Mexico proposed is that Colorado is not to build further reservoirs in the Rio Grande Basin during the life of the compact or as it may be extended. I believe that I express the feeling of our people in Colorado when I say that the mere building of the additional reservoirs in the San Luis Valley would not create a further inroad upon the common water supply of the river. Our position has heretofore been and still is, as the record will disclose covering former meetings in this same room, that we believe additional reservoir construction in the San Luis Valley would not adversely affect either New Mexico or Texas, but would enable that valley in Colorado to make the water supply more nearly parallel with the seasonal needs of our water users, and not for the purpose of making new consumptive uses of water in our state. We of course know the position of Texas and especially of New Mexico in this light, that they feel material expansion of reservoir development in Colorado might have the effect of increasing consumptive use of water in Colorado.

I do not think that Colorado could agree to an extension of the compact which would include reservations just announced by Mr. McClure, which would be, on its face, I believe, an acknowledgment on the part of Colorado that further reservoir construction on the Rio Grande and tributaries in Colorado would, in effect, be equivalent to an increase in consumptive use of water in Colorado. I may further state that, while in our opening statement yesterday we went on record as favoring the compact method for settling interstate controversies and we personally viewed with favor the extension of the life of the present compact, that was a personal viewpoint. Very obviously any statement that the Colorado Commissioner might make as a result of this meeting would have to be defended before the Legislature of Colorado, and we could not conscientiously, I feel, make such defense if our position should be antagonistic to the viewpoint of the people in the San Luis Valley. In the absence of a representative of the Attorney General's office of Colorado and within the very limited time which has been made available to me, as soon as this meeting convenes I must state at this time that before Colorado could acquiesce in extending its approval to the life of the present compact, I would have to have further opportunity to confer with our State representatives.

I hope that the other members of the Committee and those present will appreciate the position I find myself in, as expressing my personal views rather than those whom I am supposed to represent at this meeting.

It may well be that if the reservations which have been imposed by New Mexico could be made acceptable to the other two states, that Colorado would still have certain objections to the extension of the compact, or it may be, on the other hand, that our people could see their way clear to authorize me to recommend an extension,

MR. HARPER: I would like to clear up one point. Was it the intention, Mr. McClure, in your reservations to place greater burdens on Colorado than are now contained in Article V of the present compact?

MR. MCCLURE: There is one other point I would like to clear up in regard to a former meeting in regard to allocation. It is true that Colorado did submit a proposal to the Commission, but it was a formal proposal with maps, charts, etc., and an extensive report explained by Mr. Tipton, which New Mexico has never had since the time it was proposed for study. It is physically impossible for New Mexico engineers or any other engineer to make any conclusions on such a report without having it for study.

MR. HINDERLIDER: Our records show that we turned over a copy of this report to New Mexico.

(Informal discussion in which it was further stated that Mr. Hinderlider had believed New Mexico had a copy, but Mr. McClure stated they did not.)

MR. HARPER: Mr. Clayton, do you have any further remarks to make?

MR. CLAYTON: Mr. Chairman and gentlemen of the Commission, with respect to the reservations which have just been read into the record by Mr. McClure, I wish my interpretation of these reservations to become known, in order that there may be no misunderstanding between us. The first paragraph of the reservation reads as follows:

"Mr. Chairman, indicating a willingness to extend the Compact for the purpose of having the benefit of the report now in process of being made by the Rio Grande Joint Investigation, we do so with the understanding that: First, any extension shall not be construed as an admission on the part of New Mexico to mean that the original compact was an acknowledgment on the part of New Mexico that Texas or its citizens had any specific rights to the use of waters of the Rio Grande by reason of any appropriations made through the State Engineer's office of New Mexico or otherwise:

Second, that such extensions shall not be construed as in any way changing the position of New Mexico in the present suit pending between Texas and New Mexico as to the meaning of the language used in said compact."

It is my understanding that paragraph is simply to meant that if the compact is renewed for a period of two years or whatever period of time is agreed upon, it shall be without prejudice to the States of Texas and New Mexico respectively in the pending lawsuit between the two states, as to any construction to be placed upon the terms of the compact. Is that correct?

MR. McCLURE: That is correct.

MR. CLAYTON: It is understood that on certain points of the compact we have disagreed. We disagree as to the interpretation of certain paragraphs and clauses in the compact, and that neither Texas nor New Mexico, by agreeing to the extension of the compact, concedes anything in this respect to the other party as far as the lawsuit is concerned. Our interpretation will depend upon the interpretation made in the lawsuit itself, without prejudice to either party.

The second paragraph provides:

"It will be understood that New Mexico's position is that the original Compact was an agreement to negotiate as to what the actual rights of the respective states are, without resort to the Courts, and was a truce merely, and entered into for the purpose of maintaining the status quo as specified in the provisions of the compact during the time of such negotiations."

I agree that the Compact was to negotiate. I do not agree that the compact prohibits resorting to the courts. As a matter of fact, Article 15 specifically gives the right to any of the Compact States to invoke the protection of any court of competent jurisdiction for the protection of any right.

It may be that it is not definitely agreed between us as to what that paragraph and that other paragraph of the compact means. At any rate, I have no objection to the provision of the second paragraph of New Mexico's stipulations, provided it be understood between you that neither Texas nor New Mexico concedes anything with respect to the other's contentions on that point.

With reference to the third paragraph:

"In short, in agreeing to recommend an extension, we want it understood that we do not seek any advantage in the pending lawsuit between Texas and New Mexico by reason of such extension, nor do we intend that we shall suffer any injury or disadvantage in said pending lawsuit by reason thereof."

At this time I will say I have no objection to that provision, provided it not be construed to mean that the provisions of the compact as they may be interpreted by the court in this lawsuit are not binding upon either of the contracting parties for the period of time mentioned in the compact or any extensions thereof, whether such time be definite or indefinite. Is that your interpretation, Mr. McClure?

MR. McCLURE: I think it is.

MR. CLAYTON: Further, with reference to the fourth paragraph:

"Further, such extension of the present compact, if made, shall be upon the express agreement of the contracting parties to maintain the status quo as specified in the compact on the Rio Grande during the period of such extension, and the agreement of Colorado during such extension that she will not make or suffer to be made any new or increased diversions or storage of water on the Rio Grande."

I want to deal with that first clause of the fourth paragraph with reference to maintaining the status quo. I have no objection, providing it does not relate, and I do not think it can relate, to projects now under way in the lower Rio Grande Valley above Fort Quitman relating to and in connection with the Caballo Dam, river rectification and canalization and the like, over which the State of Texas has no jurisdiction.

The balance of the stipulations I can say positively we have no objection to. And, Mr. Chairman, I will be prepared not later than 2:00 P.M. to state definitely my conclusions based upon my understanding of them as expressed here.

MR. HARPER: Is it agreeable then that we resume the meeting here at 2:00 P.M.? Will that give you time, Mr. Hinderlider, to communicate with representatives of your State?

MR. HINDERLIDER: I hope it will, Mr. Harper. It will depend on whether or not I can get in touch with the Attorney General's office for a conference with the Attorney General and he can advise me what his position is.

MR. HARPER: Is there anything further anyone would like to say before we recess?

MR. McCLURE: The only thing I meant to relate to is Section V of our Act, in which we ratified the extension two years ago.

MR. HINDERLIDER: Mr. Chairman, the record is silent with respect to the question that I raised and was answered by Judge Hannett.



GOVERNOR HANNETT: Our position does not purport to press upon Colorado any additional burdens other than those imposed by the Compact, but in any extension the same restrictions placed upon Colorado by the Compact should continue during the period of the extension.

MR. HINDERLIDER: We would expect the same of New Mexico.

MR. HARPER: We would like to hear from you, Professor Barrows, on this question.

PROFESSOR BARROWS: In principle, Mr. Chairman, it seems to me personally that it would be desirable to extend the compact on the one hand for a period sufficiently long to afford with prompt and vigorous action, the development of a plan of allocation of the waters of the river and a plan of physical development or implementation of that plan, and on the other hand, to have it as short as in your judgment seems feasible. I do not know enough about your situation in the three states involved to have any very clear reaction to this last angle. I should suppose that a year would be long enough, unless you felt that two years is essential in view of the interference of other matters that must be taken care of by your Commissioners. Am I right in supposing that if you were to extend it for a year and a permanent compact were developed you would be morally responsible for submission to the legislatures of your states.

MR. CLAYTON: Mr. Chairman, Professor Barrows: The Legislature of Texas meets as a matter of law every two years. It is in session now and will not meet again as a matter of law until January of 1939. The Governor may call a special session at any time and the legislature can consider at special sessions only subjects which are submitted to them by the Governor. I am confident that the Governor would not call a special session of the legislature, which entails a tremendous amount of expense, solely for the purpose of passing on a renewal of the compact or the ratification of a new and permanent compact. It is quite possible, in the light of history, that there will be one or more special sessions between now and January 1939, but there is no certainty about it and there is less certainty as to when such a special session would be called. It may be after the expiration of a year from now if at all. I would say it would be unsafe to count upon such a special session for the purpose of ratifying a renewal of the compact or a new or permanent compact.

MR. McCLURE: Mr. Chairman, the time limit on it as it would affect New Mexico would involve considerable questions legally and otherwise that can better be placed before the Commission by Governor Hannett.

GOVERNOR HANNETT: As to New Mexico's position in regard to time - We feel that the compact has been in force now for something less than seven years. There has been, as we see it, no real effort on the part of the states to get together and distribute the waters of the river equitably between them. We are faced with a lawsuit that is costing a

great deal of money. We could not, in justice to our State, agree to extend the compact longer than say the first of September of this year. As I understand it, the purpose of the extension is to have the benefit of the investigation and recommendations made by the Joint Investigation Committee and that that report and recommendations will be available not later than June 1st of this year. That would give you June, July and August to conclude a final compact. It is my judgment that if we cannot agree within three months we never can agree, and if we are urged by this short time it would have the effect, in my judgment, of hastening the final determination. As I said, we are faced with a suit, Texas vs. New Mexico. We are being sued for specific performance of a contract and if the contract expires, as I see it the lawsuit expires with it and it would be childish on our part to surrender the technical defense we have in this lawsuit, in the hope that we could accomplish in the remaining months what we have not been able to accomplish in the last seven years. The Supreme Court of the United States has said many times that its jurisdiction between the states is a substitute for war and that a compact is a treaty, and as I see it, a state of war exists technically between the states of Texas and New Mexico in the form of litigation, and while we are still willing to negotiate, I do not want to surrender our artillery to the enemy. We have never sued a sister state and we do not intend to unless as a last resort. On the other hand, we expect to defend our water rights wherever they are questioned.

The Supreme Court of the State of Colorado has held that the La Plata River Compact is invalid, that states cannot enter into compacts that will deprive individuals of vested rights. I think the Supreme Court of Colorado is wrong. I think we could go into the Supreme Court of the United States and successfully enforce the terms of the La Plata Compact. We have not chosen to do so, and I want to say, in behalf of Mr. Hinderlider, that his attitude has been perfectly loyal in respect to the La Plata Compact but the Supreme Court of his State has taken a contrary viewpoint. We are not willing to surrender, at this or any other time, our right as we see our rights to be in this lawsuit and we feel that during the months of June, July and August of this year we can enter into a treaty if we ever can. The treaty that settled the great world war was entered into in less time. I have no doubt if you go into history you will find that most wars were settled by treaty in less time.

As far as New Mexico's capacity to negotiate is concerned, I feel that we can effect a reasonable compromise in that period of time and it is not that it is our desire to evade the issue that we take this position. We are ready to deal and start dealing now or any other day in an effort to reach a just and final agreement.

MR. HARPER: Is it your opinion that whatever action is taken today, in regard to an extension, will have to be ratified by the legislature?

GOVERNOR HANNETT: Position will be unchanged. If the compact is extended or there is a final agreement, it still must be ratified by the States and Congress of the United States.

MR. HARPER: What is the situation on the Rio Grande between the States during this interim?

GOVERNOR HANNETT: Our contract would be binding. It would require the unanimous approval of the various states, but I think we should have sufficient faith in one another's obligations so if we enter into a contract that it would continue until the respective legislatures had opportunity to pass on it.

MR. CLAYTON: Mr. Chairman: For the purpose of the record I wish to state in response to the point made by my affable opponent in this suit between Texas and New Mexico, that we do not concede either that New Mexico's obligations under Article XII of the Compact will cease on June 1st of this year or on whatever date the compact is extended to; nor do we concede that the suit between Texas and New Mexico is one simply for specific performance of the Compact. Our position is now and always has been that the suit is one to enforce and defend the primary rights of the states without reference to the compact, as well as being one for specific performance of the compact. Our position with respect to Article XII is that New Mexico's obligations are continuing obligations, at least until a permanent compact is entered into and until the legislatures of the three compacting states see fit to ratify or not to ratify such a permanent or different compact.

With reference to the Compact or the terms of the compact, I am informed that the Commissioner from New Mexico has the power to enter into a binding compact without ratification by the New Mexico Legislature. Unfortunately, that is not the situation in Texas, and before a compact can become effective it must be ratified by the Legislature of the State of Texas. It is for that reason and for that reason alone that I suggest that any extension should be made for two years. If it is made for a less period of time, I can only hope that a special session may be called for this and other reasons. My authority will cease upon the expiration date fixed in this or any extension for the appointment of commissioners. It is possible that by legislation the Legislature of the State of Texas may be able to provide that any compact entered into by the Commissioner from the State of Texas will be binding on the State during the interim between its adoption by the three commissioners and its ratification by the states. I have not explored that possibility and in the event that we are not able to agree upon a longer extension of the compact I shall endeavor to determine what can be done and if it can I will seek the necessary steps to bring it into effect. I entertain some very serious doubts as to whether the legislature of the State of Texas will be willing to abrogate its functions to the extent that it will vest any commissioner with power binding upon it without its consent. I am in hopes

that this compact will be extended for a period sufficient for the Legislature of the State of Texas to pass upon it, and I feel that until September 1st is not enough time.

GOVERNOR HANNETT: We are engaged now in a lawsuit just as expensive and just as burdensome as if there were no compact. New Mexico would be willing to do this - That a suit be filed in the Supreme Court of the United States by one of the three states, let the others come in and answer, then enter into a stipulation that could be crystallized into a judgment in the Supreme Court and let that fix for all time the rights of the respective states. In my judgment, that is the most effective way of agreeing.

MR. HINDERLIDER: I was interested, if I am quoting Mr. McClure correctly, and Judge Hannett, that the Commissioner for New Mexico is given authority by the Legislature of New Mexico to enter into a compact. While the Colorado representative has similar authority from its Governor, it has heretofore been the practice in Colorado, for the Legislature to first give the Governor authority to negotiate a compact on any stream involved. That was given to the Governor prior to the appointment of Delph E. Carpenter. No such authority has ever been extended to the Governor of Colorado which would authorize him to appoint a commissioner to act without ratification and approval of the Legislature. I am inclined to agree with Texas concerning the calling of an extraordinary session of the Legislature to ratify any permanent compact or proposed extension of the present compact. It is questionable if the Governor would see his way clear to do so. Ratification of a permanent compact would have to be predicated probably upon the time of the meeting of our next regular session of the Legislature. The present legislature is in session and it is thought that if the three Commissioners see fit to recommend an extension of the life of the present compact, that ratification or approval could be extended by the present Legislature.

Meeting recessed until 2:25 P.M.

MR. HARPER: We recessed this morning to give Mr. Hinderlinder an opportunity to confer with his people and also to give Mr. Clayton a similar opportunity. Are you ready to report, Mr. Hinderlinder?

MR. HINDERLIDER: Mr. Chairman, Members of the Committee: I have just talked with the Assistant Attorney General, Mr. Howell, who at my request, had conferred with Senator Headly and I think we all realize the difficulties with which we are confronted in this matter. I am inclined to think at this time that probably our people in the San Luis Valley do not oppose an extension of the present compact for a limited time, which time might probably be sufficient in which to analyze the report of the National Resources Committee and any recommendations that that Committee may see fit to make to the Rio Grande Compact Commissioners upon request of such Commission to the Committee for its



recommendations. I doubt very much if our people would care to extend the life of the compact possibly beyond June 1, 1938. It is possible that that viewpoint might be modified if we had time in which to confer with our people in Colorado. If time were available that might be desirable from the standpoint of all three members of the Commission, but of course we are confronted with an early adjournment of the Legislatures of our respective states and we do not have much time in which to go back to our people and confer further with them.

I do not think that I can add further to what I have stated and I would be glad to hear further from Mr. McClure and Mr. Clayton.

Of course, the statement I have just made with respect to the probable attitude of our people, is with the distinct understanding that there be no reservations whatever placed in such an agreement and it must be based strictly and entirely upon extension of the compact as it is.

MR. CLAYTON: Mr. Chairman, Members of the Commission: With reference to the written statement that was read by Mr. McClure this morning, I wish to say that the remarks I made this morning I now ratify subject to the interpretation of the stipulations which were agreed upon this morning and with this further exception which has been agreed upon by the Commissioner from Texas and the representatives of New Mexico in consultation during the noon hour.

The first paragraph of the statement did read:

"Indicating a willingness to extend the Compact for the purpose of having the benefit of the report now in process of being made by the Rio Grande, etc."

It is Texas' position and always has been that Section XII of the Compact amounted to a recognition of Texas' right in the water supply of the Elephant Butte Reservoir. We do not and can not recede from that position, and we can not accept any reservations or exceptions which would or might have the effect of qualifying the position of Texas with respect to that provision. As I understand it, the intention of the representatives of New Mexico in preparing this statement was to safeguard them from any admission as to the meaning of any of the provisions of the compact and to that we have no objection. At the same time, we wish to preserve to ourselves the right to make our own interpretation of the provisions of the compact and in particular the provision of Section XII. Consequently, with the permission of the representatives from New Mexico that paragraph has been interlined to read as follows:

"Indicating a willingness to extend the Compact for the purpose of having the benefit of the report now in process of being made by the Rio Grande Joint Investigation, we do

so with the understanding that, First, any extension shall not be construed as an admission on the part of New Mexico that the original Compact was an acknowledgment on the part of New Mexico that Texas or its citizens etc."

With that change, which I understand Mr. McClure agrees to, I have no further objection to the statement as read by Mr. McClure.

Speaking now with reference to the time of the extension of the compact, I am very frank to say that in my judgment an extension only to September 1st, would accomplish nothing. I do not believe that is physically possible to receive the report of the Rio Grande Joint Investigation, to study and analyze it, to negotiate with reference to it, and to arrive at any conclusions based upon it, in such a short time.

As I understand the position taken by Governor Hannett this morning as counsel for New Mexico, they felt that they had what he termed a technical defense to the present lawsuit which they might waive in agreeing to a longer extension of the compact. I cannot concur in that view. New Mexico's position in this lawsuit is that she has not violated the terms of the compact. If they are correct in that contention, then they are certainly not prejudiced by an extension of its terms for any period. But, on the other hand, if they are wrong in that contention and Texas is right that there has been a violation of the terms of the compact, I feel sure that New Mexico would want to live up to its obligations which they have formally incurred. I have already stated, in my judgment, that the provisions of Section XII of the Compact are indefinite in duration and do not terminate on June 1st. I understand that New Mexico takes a contrary position but that is a point which need not be discussed here.

It seems to me, however, in the light of the fact that any compact or any extension of the compact that we may agree upon here must be ratified by the legislatures of the three states, that unless we extend this compact for a period sufficient to receive the report and to analyze its contents and to negotiate with reference to it and to attempt to reach some definite conclusion based upon it or partly upon it, then the benefits of this investigation have been lost. It is probable, in my judgment, that within a year from June 1, 1937, the Legislature of Texas will be called in special session and if it is and if at that time we have recommendations to submit they can then be acted upon by the Legislature. I am sure that there will be no special session prior to September 1, 1937, and in all probability, none prior to June 1, 1938. Because of these considerations I think that if we should agree on a renewal of this compact it should be for a period of at least two years from June 1, 1937.

I do not wish to be understood that I would not agree on a shorter extension. I would think that an extension to September would not accomplish any good. An extension to January 1st, may have the

desired result, but I think to safeguard all interests in this matter that it would be far preferable to extend it to June 1, 1938.

GOVERNOR HANNETT: I think it is fruitless for us to discuss the extension beyond October 1st of this year. If we were to go before the Governor and tell him what the true situation is as to the pending litigation and this proposed extension and be frank with him as we must necessarily be, I am sure he would dispense with our services and you would have to deal with another lawyer and another engineer. I am convinced that the people of our state would not ratify an extension that would jeopardize our defenses in the pending litigation.

Now as to the possibility that we would not be able to agree during this period of time, I see no difficulty if we continue under a gentlemen's agreement, that during the period of negotiations there would be no overt act on the part of any one to endeavor to take advantage of a sister state. The original compact was enacted eighteen months after the ratification by the States before the Congress of the United States ratified it and during that interim there was nothing done by any of the States to encroach upon the rights of other States. I believe that none of the states are in a position financially to finance dams, storage or other development without the assistance of the United States. Any compact agreed upon would necessarily have to have the approval and consent of our Chairman as representative of the President and the Federal Government, and certainly would be in a position to know that no money was expended for new or increased construction.

MR. HARPER: We would like to hear further from Mr. Hinderlider and Mr. Clayton.

MR. HINDERLIDER: As I endeavored to explain this morning, there is some question as to our authority to negotiate, but this difficulty would be corrected by the later ratification by the Legislature of any agreement we might reach. There is pending in the Legislature of Colorado a Bill for an Act to create a State Water Conservation Commission and in that bill specific provision or authority is granted to the Governor to appoint Commissioners to negotiate with sister states.

MR. McCLURE: I concur with Governor Hannett.

MR. HINDERLIDER: If the difficulty that has arisen between Texas and New Mexico on this particular point could be ironed out as a result of an agreement in the present suit, during the extended life of the compact.

MR. CLAYTON: As Rio Grande Compact Commissioner I have no authority to deal with reference to the lawsuit. That is in another capacity. As Rio Grande Compact Commissioner I have no jurisdiction over the lawsuit and no authority to enter into any agreement with respect to it.

MR. HARPER: It would appear, as I size up the situation, that we have only two possible actions which can be taken; perhaps I should say two alternative actions which might be taken. First, to agree to an extension of the compact to October 1, 1937, with the understanding that negotiations would be continued after that time under authority secured from each of the States; or that we take no action whatever toward an extension and allow the present compact to expire on June 1, 1937. I would like to have the views of each Commissioner on those specific questions.

MR. HINDERLIDER: I think you have very clearly stated the two alternatives the Commission now has. I think, however, it would be necessary for the Commissioners to make a report of its findings to our respective Governors.

My position would be that we extend the compact to October 1st, if that is the limitation, rather than let it expire by taking no action.

MR. CLAYTON: I suggest that Professor Barrows may have some views on this subject.

MR. HARPER: I intended to call on Professor Barrows but wanted an expression from each Commissioner first.

MR. McCLURE: New Mexico concurs with Colorado, but that the compact be extended to not later than October 1, 1937.

PROFESSOR BARROWS: My feeling, Mr. Chairman, all along has been of course that it is desirable to get a permanent compact at the earliest possible moment, but I realize, at heart at least, what a prodigious amount of work will be involved along the several lines which Mr. Clayton indicated. I wish that New Mexico had found it practicable to agree to an extension until June 1, 1938, or even until February 1st, in order to give that month to the legislatures for consideration of a compact that they hope will be submitted at that time. But, if New Mexico feels, as apparently her representatives do, that that is out of the question, then personally, I say lets talk in terms of October 1st. I have repeatedly in the past seen the impossible accomplished and I am optimistic, but in view of the other heavy and numerous tasks of the Commissioners, I feel that during the closing days of September we are going to wish that we had more time.

MR. HARPER: As I understand it, it would be perfectly feasible for these negotiations to continue after October 1, provided the representatives of the three states are agreeable to such continuation. In fact, June 1st, 1935, was the expiration date for the original compact and it was clearly contemplated that negotiations would continue after that time. The only objection would be the danger of overt acts on the part of any of the states which might prevent

the successful completion of the negotiations. Aside from that objection, I cannot see any reason why we cannot continue negotiations after October 1st, if Mr. Clayton has authority to act after the termination of the compact.

MR. CLAYTON: I am almost at a loss to know what to say. I feel, as I have stated before, that very little will be accomplished by an extension to October 1st. However, since the other two Commissioners and Professor Barrows have stated themselves as being in favor of extending the compact to October 1st, as the only alternative, rather than let many effective provisions of the compact expire on June 1st, I will concur in that view and agree to extend it to that date.

MR. HARPER: If that is the consensus of opinion of the three commissioners, I would be glad to have one of you introduce a resolution to put this matter into the record.

(Ten minute recess.)

MR. HARPER: The meeting is open to present a resolution or for such other action as the Commission sees fit to make.

MR. CLAYTON: I move the adoption of the following resolution:

BE IT RESOLVED by the Rio Grande Compact Commission, in meeting duly and regularly called and held on March 3 and 4, 1937, at Santa Fe, New Mexico, that the Members of the Commission recommend to the Governors of their respective States that they in turn recommend to the Legislatures of their respective States that the life of the present Rio Grande Compact between the States of Colorado, New Mexico, and Texas be extended for a period of four months from June 1, 1937, to October 1, 1937.

BE IT FURTHER RESOLVED that negotiations for a permanent compact be continued during the extended period, and thereafter, if necessary, and that, if necessary, legislation be enacted by the Legislatures of the several compacting states, authorizing Commissioners representing the several States, together with a representative of the United States, to continue negotiations for and to conclude a compact after October 1, 1937.

BE IT FURTHER RESOLVED that, in the event the Legislatures of any of the compacting states do not approve the extension of the life of the compact, then legislation be enacted, where



necessary, authorizing the appointment of Commissioners to  
continue negotiations with the Commissioners of the other  
compacting states and with a representative of the United  
States for a permanent compact after the expiration of the  
present Compact.

(Sgd.) M. C. Hinderlider,  
Rio Grande Compact Commissioner for Colorado.

(Sgd.) Thomas M. McClure,  
Rio Grande Compact Commissioner for New Mexico.

(Sgd.) Frank B. Clayton,  
Rio Grande Compact Commissioner for Texas.

(Sgd.) S. O. Harper,  
Chairman, Rio Grande Compact Commission,  
Representing the United States.

MR. McCLURE: Second the motion.

MR. HARPER: It has been duly moved and seconded that the resolution  
just read by Commissioner Clayton be adopted; all in favor signify by  
saying Aye.

MR. HARPER: It is unanimously carried.

Is there any further business to come before the meeting?  
If not the meeting will stand adjourned.

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P R O C E E D I N G S

OF THE

MEETING OF THE

RIC GRANDE COMPACT COMMISSION

Held  
in

Santa Fe, New Mexico,

September 27, to

October 1, 1937.

- - -

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Santa Fe, New Mexico,  
September 27, 1937.  
2:00 P. M.

The Rio Grande Compact Commission was called to order at 2:00 P.M., September 27, 1937, by the Chairman, in the Federal Court Building, at Santa Fe, New Mexico, whereupon the following proceedings were had:

MR. HARPER, Chairman: This is the fifth meeting of the Rio Grande Compact Commission as now constituted. It was called pursuant to a letter of the Chairman dated September 1, 1937, in which the purpose is stated, "for considering the report of the Rio Grande Joint Investigation, conferring with the consultants of the National Resources Committee, initiating the formulation and writing of a permanent compact, and transacting any other business which may properly come before the meeting."

As most of you know, the last meeting of this Commission, which was held on March 3 and 4 of this year, was adjourned after the Commissioners had passed a resolution recommending to their respective states that the present temporary compact be extended to October 1, 1937. It was the expectation at that time that the report of the Rio Grande Joint Investigation would be available some time in June, but, through the force of circumstances which no one could control, the report was not completed until some six weeks ago and then could be made available only in preliminary mimeographed form, of which a limited number of copies were furnished to the Commissioners and to a few others most vitally concerned. The engineering advisers of the Commissioners have, I understand, spent such time as has been available in analyzing the report, but the time has been too short for them to secure the benefit of the advice of all of the interests in their respective states which are concerned in this matter.

Before proceeding with the regular business before the Commission, I will ask the several Commissioners, for the benefit of the record, to state the names of the different representatives of their states who are here in an official capacity. Mr. McClure, will you speak for New Mexico?

MR. McCLURE: Mr. Chairman and Members of the Commission: Thomas M. McClure, Commissioner for New Mexico; Governor A. T. Hannett, Special Assistant Attorney General and attorney for the Interstate Streams Commission; Fred Wilson, attorney for the Middle Rio Grande Conservancy District; W. C. Oestrich, chief engineer, Middle Rio Grande Conservancy District; H. C. Neuffer, consulting engineer, Middle Rio Grande Conservancy District; Edwin Mechem, attorney for the Elephant Butte Irrigation District; N. B. Phillips, manager, Elephant Butte Irrigation District; John H. Bliss, engineer in the State Engineer's office; George M. Neel, consulting engineer for the State of New Mexico; Judge R. H. Hanna, attorney for the Middle Rio Grande Conservancy District; Stanley Felipe, assistant chief engineer, Middle Rio Grande Conservancy District.

MR. HARPER: Mr. Hinderlider, will you state the names of the representatives of your State?

MR. HINDERLIDER: Mr. Chairman and Members of the Commission: M. C. Hinderlider, Rio Grande Compact Commissioner of Colorado; Clifford M. Stone, attorney for the Colorado Water Conservation Board; Hon. George M. Corlett, attorney and representative of the Rio Grande Water Users Association; Oscar Lindstrom, secretary of that Association; R. J. Tipton, engineering consultant to the Colorado River Commissioner, and consultant to the Rio Grande Water Users Association. I may say, also, Mr. Tipton is consultant for the Colorado Water Conservation Board and and for the State Planning Board. We had expected Ralph Carr, attorney for, and representative of the Conejos Valley Water Users Association, but thus far Mr. Carr has not put in appearance, but we trust he will be here later. There are also present Mr. J. B. Frazey, Mr. Beers and Dr. H. C. Myers, representing the water users of the Conejos Valley in the San Luis Valley in Colorado.

We regret to have to state that no official representative of the Attorney General's office of Colorado is present. Attorney General Rogers was compelled to be absent from Colorado at an important meeting in Kansas City, and Assistant Attorney General, S. P. Howell, who has attended former meetings of the Commission, is likewise engaged in the taking of testimony at Lincoln, Nebraska, in the case of Nebraska v. Wyoming. I believe that constitutes the list of all those present who are representing Colorado and the water users of that State.

MR. HARPER: Mr. Clayton, will you give us the names of the representatives of Texas?

MR. CLAYTON: Mr. Chairman and Members of the Commission: Frank B. Clayton, Rio Grande Compact Commissioner for Texas; Raymond A. Hill of Los Angeles, consulting engineer for Texas; Allen Laflin of Albuquerque, consulting engineer for Texas; Major Richard F. Burges, of El Paso, attorney for El Paso County Improvement District No. 1; Roland Harwell, manager, El Paso County Improvement District No. 1; C. S. Clark, Chairman of the Board of Water Engineers of the State of Texas at Austin. There are also present Judge R. B. Renfro, president of the Water Conservation Association of the Lower Rio Grande Valley, Brownsville, Texas; and Mr. F. S. Robertson of San Benito, Texas, Secretary of the Water Conservation Association of the Lower Rio Grande Valley.

MR. HARPER: Professor Barrows, will you give us the names of the representatives of the National Resources Committee who are present?

PROF. BARROWS: Members of the Consulting Board of the Rio Grande Joint Investigation, Professor Frank Adams and myself, H. H. Barrows; engineer in charge of the Joint Investigation, Harlowe M. Stafford; consultant to the Joint Investigation, Mr. John C. Stevens; Member, Water Resources Committee, N. C. Grover; Chief Hydrological Engineer of the Geological Survey, who supervised the work done by the Geological Survey in connection with the Joint Investigation.

MR. HARPER: There are also present a number of representatives of the Office of Indian Affairs, including Director Wathen. I would like to have him state for the record the names of the members of his organization present.

MR. WATHEN: A. L. Wathen, Director of Irrigation in the Indian Office; George Humphreys, Chief Field Counsel; Robert H. Rupkey, Engineer of United Pueblos.

PROF. BARROWS: I did not name Mr. Debler on the National Resources Committee. I understand he is your technical adviser.

MR. HARPER: Yes, I will add him. There is also present, as adviser to the Chairman, E. B. Debler, hydraulic engineer of the Bureau of Reclamation. As I stated in my opening remarks, the report of the Rio Grande Joint Investigation has been available in a very limited number of copies to the Commissioners and their immediate advisers, but a great many of those present at this meeting have had no opportunity to see the report or to learn anything concerning its contents or conclusions. Inasmuch as this meeting is convened primarily for the purpose of reviewing the findings of the Rio Grande Joint Investigation, and attempting to write a permanent compact based on the findings and conclusions of that investigation, it is fitting at this time that we call on Professor Barrows, Consultant for the National Resources Committee, who has had a large part in the conduct of this investigation and the writing of the report, to make a general statement of the present status of the report and the work accomplished, following which he will call upon Mr. Stafford to review in some detail the work which has been accomplished by his organization in the last year and a half.

PROF. BARROWS: Mr. Chairman and Gentlemen: I think that all of us may derive much satisfaction from the completion of the Rio Grande Joint Investigation. The scope of the investigation was fixed by the resolution adopted by the Compact Commission on December 3, 1935, which, as many of you doubtless will remember, read in part as follows:

"Now, therefore, BE IT RESOLVED: That the National Resources Committee, through its Water Resources Committee, be requested, in consultation with the members of the Rio Grande Compact Commission, to arrange immediately for such investigation (1) of the water resources of the Rio Grande Basin above Ft. Quitman, (2) of the past, present and prospective uses and consumption of water in such basin in the United States, and (3) of opportunities for conserving and augmenting such resources by all feasible means, as will assist the Rio Grande Compact Commission in reaching a satisfactory basis for the equitable apportionment of the waters of the Rio Grande Basin in the United States above Fort Quitman, as contemplated by such Rio Grande Compact."

These statements, read from the Resolution, indicate in a general way the scope of the investigation. The Rio Grande Joint Investigation constitutes a unique approach to the underlying problems of a serious controversy over an interstate river. For the first time, I think, in the history of the United States, the states involved in such a controversy undertook, in cooperation one with another, and with the Federal government, to find a satisfactory basis for the allocation of the waters of a great river by assembling the factual data essential to such an allocation. Other states in other parts of the country have cooperated in various ways looking toward compacts of other types, but, I repeat, this appears to have been a unique approach to the underlying problems of this particular field.

The cordial willingness with which the official representatives of Colorado, New Mexico, and Texas entered into the undertaking exemplified constructive statesmanship. From first to last they have displayed the spirit of the "good neighbor", about which President Roosevelt and Secretary Hull have had so much to say. Each of these states is properly concerned first of all with its own welfare, yet in the Rio Grande Joint Investigation, each of them recognized an obligation to its sister states. Each of them tacitly accepted the principle that the conflict of interests in this drainage area should, and must be adjusted. Life in this valley, above Fort Quitman, obviously depends on **water**. Obviously, too, the existing situation with respect to the life-giving water of the valley is inimical both to public and private interests and it must be corrected.

It is unfortunate, as our Chairman indicated a few moments ago, that the report on the Joint Investigation was not available sooner, and that it was necessary to distribute it to the members of the Compact Commission in mimeographed form. Unavoidable and uncontrollable circumstances occasioned unexpected delay. It is now hoped that the printed report will be available during the month of November next. It will then lack, however, numerous tables relating to surface water and quality of water, as well as the large maps that are to be published in three colors. The tables, excluded from the printed report because of lack of funds, will appear next year in the Water Supply Papers of the United States Geological Survey, and, of course, in the printed report reference will be made to their present availability in that form. Copies of the colored maps will be distributed next spring or early next summer to all persons having copies of the printed report. The publication of these colored maps is requiring much more time than we had anticipated. The low bidder for the map contract was the Geological Survey. In its bid, it asked for 150 working days before submitting proof of the maps, and thereafter 40 working days to complete the undertaking. If that seems to you an unduly long period, I may say that the high bidder for the contract requested 250 working days to show proof.

The patience of the Compact Commissioners in awaiting the report is, I assure you, deeply appreciated by the Consulting Board and by the Water Resources Committee. Perhaps I should add at this point that single copies of the maps will be available to this meeting of the Compact Commission in a form which we hope may serve all of your practical purposes.

The Consulting Board, which was responsible to the Water Resources Committee for the organization and conduct of the Joint Investigation, is deeply grateful to all who took part in it. The agencies to which major units of the work of the investigation were assigned cooperated superbly; and the field organization worked enthusiastically from first to last, apparently sensing in the enterprise a great opportunity and an equally great challenge. Each of these Federal agencies to which a major unit of the investigation was assigned wrote its own part of the report. The summary and synopsis of the reports thus provided was written by Mr. Stafford, engineer in charge of the investigation, was checked by an eminent consultant, John C. Stevens, and was reviewed by the Consulting Board.

The report, as some of you already know, and as all will later discover, makes no recommendations for action, and presents no conclusions as to what should be done or should not be done. That is in accord with the promise which Professor Adams and I made to the Compact Commission - a very fitting one, we thought - at the conference in December 1935. The methods of analysis utilized in the report are intended merely to be illustrative. They leave complete freedom for choice of other methods based on other assumptions. Some of the material of the report may very possibly, if not probably, be regarded as inconclusive because of the limited period during which the observations upon which that material is based were made, or perhaps for other reasons. The Consulting Board earnestly holds the conviction, however, that the report provides a basis, a factual basis, for an allocation of the waters of the river above Ft. Quitman that would be fair and just to each of the three states and to its citizens dependent upon the river. Whatever the imperfections of the report may be, whatever its utility may prove to be, it represents on the part of the Water Resources Committee and the other Federal agencies involved a very earnest effort to contribute in a practical and useful way to the solution of the many intricate problems associated with our great interstate rivers.

For three-quarters of a century the western states have been creating and perfecting, gradually and definitely, the legal principles and social institutions needed where irrigation is the chief basis of economic life. Much remains to be accomplished along those lines, but no western state lacks authority for the adequate control and administration of intrastate waters, whether surface or underground waters. On the other hand, the authority of a state to administer and control interstate waters is limited; so also, is the authority of the Federal government. When the interests in such waters of two or more states are in conflict, those states may attempt to compromise the situation, to adjust and overcome the difficulties confronting them, through the negotiation of an interstate compact, or they may have recourse to the

Supreme Court of the United States for adjudication of the questions at issue. Public opinion decidedly favors the compact method. Moreover, the Supreme Court repeatedly has taken an attitude friendly to the compact mode of action. The Water Resources Committee accordingly feels that it is acting in conformity with enlightened public opinion, both lay opinion and judicial opinion; when it attempts to promote or to help promote public welfare by aiding, through compacts, in the solution of interstate water problems. Let us not conceal from ourselves the patent fact that no court decision possibly could provide for the orderly and full development of the available and potential water resources of the Rio Grande.

Friendly negotiation, in the light of relevant facts, can open the door to such development, and conflicting interests in the drainage area can thus be adjusted. The efficient and equitable utilization of all the waters can thus be promoted. Whether the outlook, through many years, for life in this part of the great drainage basin is bright or dark, depends fundamentally on decisions to be reached and lines of action to be adopted with respect to its waters in the immediate future. Fortunate it is, gentlemen of the Commission, that your patience, forbearance and fair judgment can confidently be counted upon in the fateful negotiations which you are here and now undertaking.

Mr. Harper, our engineer in charge of the investigation, Mr. Stafford, will, if you wish, informally and without opportunity for preparation, undertake an outline statement, or summary, of what he conceives to be the outstanding features of the report. Is that your wish?

MR. HARPER: Before Mr. Stafford proceeds, I want to take this opportunity to express, on behalf of this Commission, our deep appreciation for the work which the National Resources Committee has done in completing this Rio Grande Joint Investigation. Regardless of whether or not we eventually reach an agreement on a compact for the division of the waters of this river, I think no one can ever say that the National Resources Committee has not performed a work of tremendous value which will be useful for all years to come, and I, for one, confidently hope and believe that their work will be used as a basis for reaching a compact for the equitable division of the water of the Rio Grande. Now, Mr. Stafford, if you will please come up here.

MR. STAFFORD: Mr. Chairman, and Members of the Commission, and of this Conference: I thought when I had these data assembled, prepared and distributed, that my work would be over, and I hardly expected to make a resume of all these volumes (indicating stack of books). I think you will recognize my difficulty. There are 1,700 mimeographed pages and a summary and introduction of about 40 pages, so you can see it is going to be rather difficult to summarize it very briefly. As stated in the Resolution of the Compact Commission, under which this work was undertaken, the National Resources Committee was asked to conduct the investigation and determine factual data on the water supply, water utilization and water requirements, with the possibilities of augmenting supplies to the basin by transmountain diversions or conservation by storage.

In order to initiate the investigation and carry that out, as Professor Barrows stated, it was made a cooperative undertaking with three major Federal agencies taking different parts of the work.

Under the heading of "Determination of Water Supply", it was necessary that stream flow, return flow, drainage and various other hydrographic measurements be made throughout the Basin, and that part of the investigation was given to the U. S. Geological Survey, and the results of their measurements and studies comprise Volume 2. Water Resources of the Upper Rio Grande Basin has to do with the utilization of water, the consumptive use, the mapping of irrigated areas and water consuming areas, and to study to some extent the history of past irrigation, and that part of the investigation was delegated to the Bureau of Agricultural Engineering. They brought in a very large force of engineers and established experimental stations throughout the basin for investigation of consumptive use, and they had many field parties making maps showing the water using areas, and the results of that investigation by that Bureau are in Volume 3, Water Utilization in the Upper Rio Grande Basin.

There was another element of great importance in this investigation, which was the investigation of the quality of water from the San Luis Valley to the lower Ft. Quitman section, and that was conducted as a cooperative investigation by the U. S. Geological Survey and the Bureau of Plant Industry of the U. S. Department of Agriculture. All the sampling throughout the basin and the analyses were made by the Geological Survey, and the assembling of the data was handled and the interpretative report was written by the Bureau of Plant Industry, so Volume 4 is the quality of water in the Upper Rio Grande Basin and contains everything which was collected in connection with that feature. Then, as to the possibilities of augmenting the supply to the basin by transmountain diversions and conservation through storage, that part of the investigation was delegated to the Bureau of Reclamation. That ran over the whole period and continued somewhat after the summary report was completed. There was a preliminary report from the Bureau of Reclamation gotten out in March which was included. We have now the final report of the Bureau's investigation which has gone back to the printer at Washington. They investigated the transmountain diversion of the San Juan-Chama very thoroughly, and in Colorado, the San Juan south fork. They investigated storage reservoirs at Wagon Wheel Gap, the Vega-Sylvester and various sites on the Conejos. They had to extend that investigation much further than anticipated at first and try to determine every possible reservoir that might be utilized, so there are quite a number of reservoirs reported on. They investigated the State Line Reservoir on the Colorado-New Mexico State line. So the report of the Bureau of Reclamation is Volume 5.

Part 1, as Professor Barrows has said, is the part where we endeavored to bring together the results of the facts presented in these other reports in summary fashion and present studies we made concurrently with these other investigations, so this Volume 1 gives you first an introduction and summary that goes somewhat into the historical background,

the outline of previous investigations, purpose, scope, etc. Then we included as an appendix to this report, all of the records of water supply, with an analysis, over the whole basin and determined means based on the 46-year period from 1890 to 1935. We took up runoff at key stations, return flow and groundwater and summarized the results of these investigations. There is also a summary of the quality of water, history of irrigation development, water uses and requirements, tables of acreages of irrigated land, of native vegetation and miscellaneous water consuming areas. We have summed it up in almost every kind of segregation we thought anybody could ask for; by districts, sections, canal systems, counties and every other way possible. There is a summary of the data the Bureau of Agricultural Engineering obtained on diversions and major canals, and taking those data in this report, we have endeavored to develop what we call diversion requirements of major units of the basin.

These data we had gave us the consumptive use and stream flow depletion of major areas like the Rio Grande area in the San Luis section, the Middle Rio Grande and below the Elephant Butte Reservoir, and we then endeavored to convert that data into what we would consider the major requirements for that unit. Under storage development we have summarized the present development and proposed development, outlining the projects, and the same thing for transmountain diversion. Then, as the last section of this report, having all of these data together as to water supply, water uses and requirements, we endeavored to set up purely illustrative examples of the stream flow at the State Line, at San Marcial, and what the distribution of that stream flow would be by months and what shortages might occur in the San Luis Valley, the Middle Rio Grande and the Elephant Butte-Fort Quitman sections under the operation of these hypothetical conditions which we set up. I could hardly take the time to go into all of these conditions and the results - you have the report before you, or the Commissioners have. I don't know how, in a general way, to say much more without going into some figures.

MR. HARPER: Let me suggest that you just read from the summary, even though you do read some of the figures, the high points of your conclusions as to acreage of land and present use of water in the different valleys - any of those pertinent figures, because no one here has seen the report, except the Commissioners and a very few others.

MR. STAFFORD: There are three million acre-feet, on the average, of water produced in the whole basin; 99 percent is produced in Colorado and New Mexico, about equally divided between the two states. Then in irrigated and water consuming areas we find something close to two million acres in the whole basin; only 924,000 of that is actually irrigated, with the balance taken up by areas temporarily out of crop and areas occupied by cities and towns and bare lands. I might read a section of this table of the irrigated acreage. Total for the basin 924,000; 600,000 in the San Luis section; 153,000 in the Middle Rio Grande section, which includes acreage in tributary areas; and 171,000 in the



Elephant Butte-Fort Quitman sections. On the estimates of the requirements, or that is, results of the study of consumptive use and stream flow depletion, the report shows a stream flow depletion in the whole basin of 2,700,000 acre-feet. In other words, of the three million produced in the whole basin, there is about 200,000 surplus in a mean year on a 46-year period. That's about what now flows at Fort Quitman. That stream flow depletion of 2,700,000 is divided about 1,047,000 acre-feet in the San Luis Valley, exclusive of the consumption in the closed basin; 768,000 in the Middle section and 885,000 in the Elephant Butte-Fort Quitman section. That comparison I gave you between water production and stream flow depletion, which left a small surplus in a mean year, compared with that in a minimum year over the past 46 years, there would have been a deficiency of a million and a half acre-feet, and in a maximum year a surplus of about the same amount. I might read the figures on diversion requirements. 650,000 acre-feet would be the diversion demand at Del Norte; in the Conejos area 230,000; Middle Rio Grande area 580,000 at Otowi Bridge; between Middle Rio Grande and San Marcial about 80,000, and Elephant Butte-Fort Quitman section 953,000 at San Marcial; or, taking out the estimate of seepage and evaporation, 773,000 acre-feet demand on the reservoir. Those figures are set up on the basis of the irrigated acreage as follows: In the San Luis section 353,000 acres; Conejos, 80,000; Middle Rio Grande, 100,000; Elephant Butte-Fort Quitman section, 145,000 acres. That would not be total irrigated acreage, but the maximum for any one year.

MR. HARPER: What is the pleasure of the Commission as to procedure from here on?

MR. CLAYTON: When we were discussing it among ourselves a few moments ago, it seemed to me that Governor Hannett had a suggestion that was worthy of attention. As I understand it, he proposed that the Commissioners submit, in writing, to the Chairman, the views they entertain as to the minimum conditions under which we would be willing to negotiate. It strikes me that is about as good a place to commence as any, and in order that the Commissioners might meet with their technical advisers and prepare such written statements, I think it would be in order to recess until some time tomorrow; I would say not earlier than 11 o'clock in the morning.

MR. HINDERLIDER: I would suggest you make it after lunch.

MR. CLAYTON: I move then, Mr. Chairman, that the Commission recess at this time to meet at 2:00 P.M. tomorrow afternoon, before which time the Commissioners will have submitted to the Chairman written statements on the order I just mentioned. (Seconded by Mr. McClure).

MR. HINDERLIDER: May I ask this question - was it the intention of the Texas Commissioner that this proposed outline be submitted by the Commissioner from each State to the Chairman only, or to the Commissioners of the other states as well?

MR. HARPER: I suggest the outlines be made in quadruplicate so there will be a copy for each state.

MR. CLAYTON: I amend my motion to include that. (Motion carried).

Whereupon, at 4:00 P.M., the meeting recessed until 2:00 P.M.,  
September 28, 1937.

Santa Fe, New Mexico,  
September 28, 1937,  
3:30 P.M.

MR. HARPER: The meeting was recessed yesterday until 2:00 o'clock this afternoon to permit each of the Commissioners to prepare written statements of the views of their respective states. The Colorado Commissioner was unable to complete his statement in time, so, at his request, the calling of the meeting was deferred until 3:30. I now have on my desk copies of the three statements which have been prepared by the respective Commissioners in consultation with their advisers. For the benefit of those in attendance at the meeting, I will ask each of the Commissioners to read his statement at this time, beginning with Mr. Hinderlider.

MR. HINDERLIDER: Mr. Chairman and Members of the Commission: Colorado presents this statement of the views as to the essentials for a permanent compact on the Rio Grande: Article VII of the Rio Grande Compact, among other things, provides: "That the Governors of each of the signatory states shall appoint a Commissioner for the purpose of concluding a compact among the signatory states providing for the equitable apportionment of the use of the waters of the Rio Grande among the said states, and that the Commission so named shall equitably apportion the waters of the Rio Grande as of conditions obtaining on the river and within the Rio Grande Basin at the time of the signing of the Compact."

Colorado, therefore, assumes that this conference of necessity is called in harmony with the aforementioned provisions of the compact. It is the position of Colorado that an adequate supply of water exists in the Upper Rio Grande Basin above Fort Quitman which, if properly regulated and used, will meet the requirements of present irrigation development in that Basin at the date of the signing of the Compact, and under present conditions to the extent indicated by the report of the Rio Grande Joint Investigation.

Facilities now exist in the Middle and Elephant Butte-Fort Quitman sections of the Basin to regulate the water in such manner as to provide a perfect water supply, except during very infrequent periods of severe drouth. Such periods are so infrequent that it would be uneconomical to provide additional storage, or other means, to relieve shortages due to such drouths. Inadequate facilities exist in the San Luis section to regulate the water supplies required for the proper irrigation of lands, the irrigation of which was initiated many years prior to the construction of all present reservoirs in the two lower sections of the river.

For more than forty years Colorado has been denied the right to properly regulate the waters theretofore applied to beneficial use, which has resulted in a direct loss and injury to Colorado and its citizens, conservatively estimated at not less than \$200,000,000. Colorado asserts that equitable apportionment of the use of the waters of the Rio Grande, as provided by the Rio Grande Compact, must include the necessary regulation of these waters for the most efficient use of the same. Sufficient storage capacity can be provided and operated to furnish a water supply for the San Luis section comparable to that which now exists in the Middle and Elephant Butte-Fort Quitman sections, without adversely affecting the water supplies for those sections. As a matter of fact, the usable water supply for the Middle section would be improved by the construction and operation of the reservoirs required in the San Luis section.

All this is shown by the attached graphs which have been prepared from certain tables appearing in Part I, Vol. I, of the report of the Rio Grande Joint Investigation. The first graph hereto attached shows shortages in irrigation requirements which exist under present conditions of development in the San Luis Valley section along the main river, and in the Middle and Elephant Butte-Fort Quitman sections. The periods covered are 1892 to 1904, inclusive, and 1911 to 1935, inclusive. The period 1905 to 1910, inclusive, is not included since there was no critical period of water supply during those years. The second graph shows the shortages which would exist in the three sections of the Basin if the Wagon Wheel Gap Reservoir were constructed and operated. The data from which the graphs were prepared were taken from tables 114 to 116 of Part I, Vol. I, of the report of the Rio Grande Joint Investigation.

It will be noted from the first graph that shortages in irrigation requirements would occur in the San Luis section in each of the years covered by the graph. As a matter of fact, shortages would occur during every single year of a 48-year period such as that of 1890 to 1937. Many of such shortages would amount to over 50 percent of the irrigation requirement. The shortage would average more than 30 percent of the irrigation requirement for periods as great as 13 years. Similar shortage would occur on the Conejos River also. On the other hand, it will be noted from the graph that in the Middle section of the Basin there are only eight years during the entire period under consideration when shortage would have occurred, and only three years in the Elephant Butte-Fort Quitman section. During four of the eight years in the Middle section and one of the three years in the Elephant Butte-Fort Quitman section, the shortages would have been negligible.

Attention is now directed to the second graph which shows conditions which would obtain in the three sections if the Wagon Wheel Gap Reservoir were constructed and operated. Note that in the San Luis section the shortage would have been eliminated for all years from 1892 to 1935, except in the five years from 1899 to 1902, and 1904. In the Middle section the shortage during the years 1894, 1899 and 1931 would have been entirely eliminated and other indicated shortages would have been materially reduced. In the Elephant Butte-Fort Quitman section the operation of the

Wagon Wheel Gap Reservoir would have reduced the indicated shortage in 1902. The indicated shortage of 1904 would have been increased somewhat by increased uses of water in the Middle section. Only those two years of shortage, in addition to a negligible one in 1903, would have occurred in this section during a period such as 1892 to 1935, and such shortages would occur without the Wagon Wheel Gap Reservoir being in operation.

Part I, Vol. I, of the report of the Rio Grande Joint Investigation under assumed condition No. 7, page 379, and Table 115, shows that storage capacity at least equal to that of the capacity of the Wagon Wheel Gap Reservoir could be constructed and operated on the main stem of the Rio Grande in Colorado, and storage in an amount of at least 162,000 acre-feet could be constructed and operated on the Conejos River without adversely affecting the water supply of the lower sections of the Basin. The above analysis, together with the attached exhibits, show the lack of parity between the San Luis section and the two lower sections of the Basin. Colorado submits that recognition be accorded its citizens to construct and operate the reservoirs required in the San Luis section of the Basin to place the water supplies of that section on a parity with the water supply of the Middle and Elephant Butte-Fort Quitman sections of the river.

MR. HARPER: Mr. McClure, will you please read your statement.

MR. MCCLURE: Mr. Chairman and Commissioners: New Mexico is willing to negotiate with Colorado and Texas for a permanent compact to equitably distribute the waters of the Rio Grande among the states on the basis of the following minimum requirements for the State of New Mexico:

First: New Mexico is willing to negotiate with Colorado for increased storage within the Rio Grande Basin in Colorado, provided that proper safeguards for the rights of New Mexico shall be made to protect the interests of the water users of New Mexico; and provided also that the transmountain diversion from the San Juan River and its tributaries to the Chama River is made an accomplished fact coincident with the construction of such storage in Colorado.

Second: New Mexico is willing to negotiate with the State of Texas as to the right to the use of water claimed by citizens of Texas under the Elephant Butte Project on the basis of fixing a definite amount of water to which said project is entitled. Provided, however, that upon the completion of the All-American Diversion Dam and canal, Mexico shall be limited strictly to treaty provision of 60,000 acre-feet per annum for use in the Republic of Mexico.

Third: Provided, further, that New Mexico and the Middle Rio Grande Conservancy District shall not be deprived of their rights to the full development and operation of the Middle Rio Grande Conservancy District, as shown by its plans on file with the State Engineer, for the development, irrigation and cultivation of approximately 123,000 acres from the waters of the Rio Grande.

Fourth: All existing rights to the use of water in the Rio Grande Basin in New Mexico shall be recognized as having the right to an adequate supply of water from said river system.

Fifth: New Mexico shall have the right to construct all necessary flood protection works to safeguard property, within the Rio Grande Basin in New Mexico, against flood damage.

MR. HARPER: Mr. Clayton, please let us hear from you.

MR. CLAYTON: Mr. Chairman and Commissioners: To Mr. S. O. Harper, Chairman, and Members of the Rio Grande Compact Commission from Colorado and New Mexico: Although the State of Texas feels that it should share in the benefits from new works for the augmentation of the water supply of the Rio Grande, it will not insist thereon, provided that the States of Colorado and New Mexico will release and deliver at San Marcial a supply of water sufficient to assure the release annually from Elephant Butte Reservoir of 800,000 acre-feet of the same average quality as during the past ten years, or the equivalent of this quantity if the quality of the supply is altered by any developments upstream.

MR. HARPER: You have heard these three statements read. What is your pleasure as to future procedure for considering these statements?

MR. McCLURE: I move we recess for 10 minutes.

MR. HARPER: The meeting will be recessed for informal discussion by the Commissioners and their advisors. (4:00 P.M.)

(In the next room).

MR. HARPER: (5:15 P.M.) We want to thank you for your indulgence for waiting so patiently. After a good deal of discussion we have reached this decision on future procedure: That tomorrow at 10:00 A.M., the Commission will go into executive session, at which meeting each Commissioner is privileged to have present two advisers, who will be free to enter into the discussions, and in addition three other representatives of his State, who will be listeners and will not enter into any discussion except through the Commissioner. In addition to these six representatives of each State, we also wish to invite the representatives of the National Resources Committee, Professor Barrows and Professor Adams, Mr. Grover, Mr. Stafford and Mr. Stevens, to sit in with us if they will have the patience to listen. We will probably give them an opportunity, sooner or later, to have plenty to say. If there are no other suggestions, the meeting will be recessed until 10 tomorrow morning.

Santa Fe, New Mexico,  
September 29, 1937,  
10:30 A.M.

MR. HARPER: The Commissioners in informal conference this morning, after further consideration of the decision as to the attendance at this meeting arrived at yesterday, decided that for the present we will relax somewhat the requirement of only six representatives of each state to be in attendance, and we propose now to permit each Commissioner to have one engineer and one legal adviser to sit around the table, with freedom to join in the discussions; and, in addition, each Commissioner will be permitted to have present such other representatives of various interests in his State as he wishes to include in the group. To check up on this attendance, I wish to ask each of the Commissioners, in turn, as quickly as possible, to give for the record a list of all those in attendance here whom they are sponsoring.

MR. CLAYTON: Mr. Chairman, will we be confined in naming observers to residents of our State?

MR. HARPER: No. Are you ready, Mr. Hinderlider?

MR. HINDERLIDER: Mr. Chairman, in response to your request, in addition to those gentlemen who were mentioned the first morning of our conference, we would like to add the following list of names of people from our state who have a vital concern in the negotiations now pending before this Commission, and in the water of the Rio Grande River; Corbyn Wright, president, Rio Grande Water Users Association; Oscar A. Lindstrom, Secretary of that Association; J. C. Schmittle, Member of the Board of that Association; Chris Wallrich, Vice President of the Colorado State Water Conservation Board; Sen. Fred Christenson; James McKelvey; James A. Reed, Member of the Board of the Rio Grande Water Users Association. These latter four gentlemen live in the Conejos area of the Rio Grande Basin, while the former members mentioned are water users more particularly under the main stem of the Rio Grande.

MR. McCLURE: Do I understand you want just the additional names, or the names of everybody?

MR. HARPER: If you gave a complete list on the first day, just the additional names will be sufficient.

MR. McCLURE: I believe the only additional names that I have are Reginald Laughlin, of the Reconstruction Finance Corporation; and William Brophy, attorney for the Middle Rio Grande Conservancy District.

MR. CLAYTON: Mr. Chairman, as my legal adviser I name Major R. F. Burges, attorney for El Paso County Improvement District No. 1; Engineering adviser, Raymond A. Hill, consulting engineer for Texas; As observers, C. S. Clark, chairman, Board of Water Engineers of Texas; Roland Harwell,

manager, El Paso County Improvement District No. 1; N. B. Phillips, manager, Elephant Butte Irrigation District, who was named the other day by Mr. McClure; Edwin Mechem, attorney for the Elephant Butte Irrigation District, who was also named by Mr. McClure; F. S. Robertson, secretary of the Water Conservation Association of the Lower Rio Grande Valley; R. B. Renfro, attorney for the same association; W. E. Anderson, member of the executive committee of the same Association.

MR. HINDERLIDER: It was my understanding there would not be a resubmission of the names of the official representatives of the various states, so I failed to include the names of the official representatives of the State of Colorado at this conference. I notice the Commissioner for Texas did resubmit the names of the official delegates for his state. I want the record to show we were not changing at all the names of the official representatives in not having called their names at this particular time. I should also like to suggest that there may be other persons from my State of Colorado, rightly interested in this discussion, who should be permitted to sit in this conference as observers if they see fit, as they arrive here, and we extend the same courtesy to the Commissioners from the other states. Unfortunately, as a result of the order of the Commission yesterday afternoon, some of our people, fearing they would not be permitted to sit in on this conference, returned to the San Luis Valley, which we consider rather unfortunate, so we want to be in a position to invite them back at a later date, and possibly increase the number of our observers at any time we see fit.

MR. HARPER: We have with us the same five official representatives of the National Resources Committee who were named on the opening day, and their names need not be repeated. The Chairman has as his legal adviser H. J. S. DeVries of El Paso; as engineering adviser, E. B. Debler of Denver. In addition, L. R. Fiock, superintendent of the Rio Grande Project at El Paso, is present as an observer. Is anyone present whose name has not been mentioned? If not, I believe the meeting is ready to proceed.

MR. CLAYTON: I believe I neglected to name Allen Laflin at this time, assistant engineering adviser for Texas, in Albuquerque.

MR. HARPER: We propose to conduct this meeting from here on in a very informal manner and we hope that will result in each of the Commissioners and his accredited representatives feeling free to express themselves without restraint. No representatives of the press are present so that there is no danger of misquotations or glaring headlines being passed out for home consumption. I would like to suggest that the Commissioners and their two advisers gather around the table here to make it a little more convenient for us to participate in these discussions. The meeting is now open for your pleasure.

At 12:15 the meeting recessed until 2:00 P.M.

MR. HARPER: (2:15 P.M.) When we recessed we asked Commissioner McClure to submit in writing a statement of his position which we were discussing. He tells me he has not had time to get that in shape, so it seems we will have to proceed along some other line of discussion meanwhile. Mr. Clayton, if you want to take up the matters you were discussing before recess, perhaps we can put in the time profitably.

Discussion followed until 3:30 P.M., when the meeting recessed until 10:00 A.M. the following day.

Santa Fe, New Mexico,  
September 30, 1937,  
10:20 A. M.

MR. HARPER: We will resume our deliberations at the point where we left off yesterday. I presume Mr. Clayton and Mr. McClure have now prepared schedules which they will submit to the meeting. Mr. Clayton, may we hear from you?

MR. CLAYTON: I have handed copies of this to each of the other Commissioners. If the Chairman desires, I will have Mr. Hill read it, with such explanations as he desires to make.

MR. HILL: You all have copies before you, but by way of explanation, we made an analysis of the relation between the historical flow at San Marcial and the historical flow at Otowi, less the historical flow at Lobatos. Owing to material changes in the amount of flow at Lobatos, we subtracted the flow at Lobatos from that at Otowi so that these changes in the Lobatos flow were washed out of the picture. We come, then, to the relationship which Governor Hannett suggested yesterday, that is, the relation of the flow at San Marcial to the natural runoff above some point where the runoff was not materially affected by any agricultural development, storage release, or anything else. Most of the runoff originating above the Otowi gage is from New Mexico, excepting the flow at Lobatos, and if you deduct the flow originating in Colorado you get a factor which is a good index, although not an absolute one, of natural runoff; in other words, a good index of the conditions which would affect the flow downstream. The relation between this and the flow at San Marcial in individual years shows a wide variation. However, on account of storage in Elephant Butte Reservoir, it is possible to consider groups of years. We took five years as the longest time it was possible to anticipate in operating the reservoir. Taking then the five-year moving averages of the flow at San Marcial, and comparing that to the five-year moving average of the difference between Otowi and Lobatos, we find the relation is reasonably consistent, and particularly during the last ten or fifteen years it has been very consistent. In fact, the variations are well within the limits of accuracy of measurement. That curve which you could draw through these points, in order to make it simpler of proportioning between



successive points on the curve, has been represented by a series of straight lines. The tabulation which you have before you is merely taken from the curve, the points being angle points on each straight line.

In the first paragraph of the draft you have: "Over each period of sixty consecutive months the total discharge of the Rio Grande as measured at San Marcial shall be not less than that set forth in the following tabulation as corresponding to certain amounts of full natural runoff of the Rio Grande at Otowi originating in New Mexico, and for other amounts of such natural runoff the corresponding total discharge at San Marcial shall be equal to that corresponding to the next lower amount of runoff plus the same proportion of the respective increments between said lower values and the next higher amounts set forth in the tabulation below:

Full Natural Runoff at Otowi,  
originating in New Mexico,  
over any period of 60 conse-  
cutive months.

Corresponding Total Dis-  
charge at San Marcial over  
same period of time.

1,000,000 ac. ft.  
2,000,000 "  
3,000,000 "  
4,000,000 "  
5,000,000 "  
6,000,000 "

1,000,000 ac. ft.  
2,000,000 "  
3,500,000 "  
5,500,000 "  
8,000,000 "  
10,500,000 "

That's quite a few words to say merely you are given these points on a curve and that intermediate points shall vary along the curve in proportion. It's merely expressing in words the curve which comes from historical data.

MR. DEBLER: You said points on the curve in the first part of your explanation, which led me to think that these points are not on the curve but points outlining the angle line, the results of which are equal - -

MR. HILL: The values give a series of points on a general curve, and by the language of the first paragraph between those points it's a straight line.

MR. DEBLER: It's a broken line with a series of angles.

MR. HILL: Yes; however, in that distance it looks like a curve.

MR. DEBLER: The intention is to apply the broken line rather than the smooth curve.

MR. HILL: That's right. (Reading from memorandum), "Said deliveries at San Marcial may be made at any time within the sixty-month period."

In other words, it is immaterial to Texas whether that water comes into Elephant Butte the first, second, or third year, or in the first month or the last month, provided it is not held back in the

reservoirs above. This is covered by the clause: (Reading from memorandum), "Provided, that the total amount of water stored in reservoirs in the Rio Grande Basin in New Mexico above San Marcial shall at no time exceed 30 percent of the quantities then in storage in reservoirs on the Rio Grande between San Marcial and Fort Quitman."

Except for reservoirs in Colorado, and for the State Line Reservoir which would be substantially in Colorado, 30 percent is well above any physical reservoir capacity which they have today or contemplate.

MR. DEBLER: It might be advisable to give that, as to how you would provide for the terminal storage. It might be constructed in the Rio Grande watershed for regulation of imported water. You are not intending to include that water?

MR. HILL: No, we exclude that later. (Reading from memorandum), "Provided, further, that the amounts of water to be delivered at San Marcial as set forth above, shall be increased by five percent for each ten percent increase above 0.7 tons per acre-foot average concentration of dissolved solids in the water so delivered."

That 0.7 tons is a value somewhat above the average for the years preceding 1930, and below that in recent years during which, I believe we agree, the concentration in the river at San Marcial is above its normal condition. (Reading from memorandum), "All provided that each incomplete sixty-month period shall be deemed ended whenever all reservoirs on the Rio Grande between San Marcial and Fort Quitman are filled, and the next succeeding sixty-month period shall commence when water is thereafter first withdrawn from storage in any of said reservoirs."

MR. CORLETT: Is it assumed that the reservoirs will remain at spill until release starts? Is that the idea?

MR. HILL: If I may explain. The intent of that is that any period of 60 months - whether 30 or 40 has elapsed - shall terminate, and the responsibility of the upper states to pass water shall terminate when the reservoirs are filled. Then the obligation to deliver water in accordance with this schedule shall not commence until there is draft on storage from any of the reservoirs, by withdrawal of the stored water and not spillwater.

MR. DEBLER: Your schedule is suspended so long as spill continues?

MR. HILL: Exactly, and any obligation to deliver up to that time is cancelled.

MR. HARPER: May I ask you if both the Elephant Butte and Caballo Reservoirs will have to be filled? It seems to me, with the requirement at Caballo for flood control, it might not be advisable to fill that reservoir.

MR. HILL: Any flood, as a matter of fact, which would fill Elephant Butte Reservoir - there is a 100 to 1 chance that any such flood will occur only as spring runoff, at which time there is no necessity for leaving in the Caballo Reservoir the capacity for local floods, and if Elephant Butte started to overflow, I think it would be proper that Caballo should be filled and the water not merely allowed to run down the river.

MR. DEBLER: You may recall that the contract with the State Department provides we must maintain 100,000 acre-feet for flood control at all times. You are going to get into this position sooner or later - where you have a heavy runoff from the upper Rio Grande and the Elephant Butte spill in July. Under our contract with the State Department we will have to have in July 100,000 acre-feet available in Caballo for flood control. We are under obligations under that contract to maintain an open capacity at 100,000 acre-feet at Caballo although that results in a spill down the river.

GOV. HANNETT: That's spill from the Black Range.

MR. HILL: The spill would have to be construed to be the filling of the storage capacity as distinguished from flood capacity.

MR. DEBLER: That cannot be included in figuring spill.

MR. HILL: That was not intended to apply to gross reservoir capacity but only storage capacity available.

MR. DEBLER: What you had in mind was available capacity.

MR. CORLETT: I understood there was no conservation space in Caballo.

MR. DEBLER: There is for this purpose, 250,000 acre-feet capacity.

MR. CORLETT: We have been told Caballo would not make any additional charge on the river. That was the way it was presented to Congress when we asked for that.

MR. DEBLER: The 250,000 capacity in Caballo replaces, in part, the capacity losses at Elephant Butte in silting.

MR. CORLETT: That isn't the way it was put up.

MR. DEBLER: That's the way it operates.

GOV. HANNETT: Caballo is to take care of tributary flow from the Black Range. It must be held available to control floods originating below Elephant Butte.

MR. TIPTON: This is so written that the slate is wiped clean and under that situation we would have spill from Caballo.

MR. HILL: Unavoidable spill.

MR. TIPTON: Even though you have 100,000 acre-feet in spill, it wipes the slate clean, and it could be so written that it would involve only storage capacity.

MR. HILL: Exclusive of storage for flood control - those words could be put in. (Reading from memorandum), "For the purposes of this Compact, the flow as measured at Otowi minus the flow as measured at or near Lobatos, but below any dam near the State Line (if a state line reservoir was built, it would be measured below and not above) if such be constructed, shall be deemed to be the natural runoff at Otowi originating in New Mexico, provided that the measured flow at Otowi shall be adjusted for the effect of any works constructed after October 1, 1937, which alter the consumptive use of water in New Mexico above Otowi or which increase the quantity at Otowi by importations from without the Rio Grande Basin."

The purpose of that was it seemed unnecessary to go back and attempt to adjust conditions above Otowi to virgin conditions. The data available to do that is uncertain - much of it - and it is of little moment anyway, because we are concerned with the maintenance of the status quo and we can just as well accept the Lobatos-Otowi relationship at San Marcial, provided only, if present conditions are changed, adjustments should be made. I don't know that there is likelihood of any new irrigation above Otowi in New Mexico, but if there were any which altered present conditions, the flow at Otowi would be adjusted to take care of that increased consumption. And if San Juan water was brought in - if a million acre feet reached Otowi in these five years, from the total flow at Otowi you would deduct that million before you entered the curve.

MR. TIPTON: First, what period was covered in setting up the relationship?

MR. HILL: We took all the historical years first and applied them. They were more erratic in the earlier years because of the inaccuracy of the records. Then to enable the curve to be drawn more easily, the last 20 years were taken, from 1912 when Elephant Butte was started, up to the last five years, inclusive; and the relationship is particularly accurate as to the last 10 or 12 years. It becomes somewhat more erratic before that time due to some question of the San Marcial and Otowi records in earlier years. However, the curve which corresponds with this series of points fits all of the historical data as well as it does more recent data.

MR. TIPTON: The only question involved - if, during the period used, you have established the relationship and there has been a change at Lobatos, in other words, a gradual decrease, then the relationship might reflect more water at San Marcial than actually would occur under present conditions. That would have to be checked, and it's easy to check. I won't pursue the question any further until we do.

MR. HILL: I don't believe it does, because the effect on the consumption in New Mexico above San Marcial isn't affected.

MR. TIPTON: That's not the point. The change in the Lobatos flow is gradually becoming less, and yet the Lobatos flow still appears in your San Marcial tabulation.

MR. HILL: Actually the consumption in the Middle Rio Grande area from Otowi to San Marcial is, with few exceptions, in excess of the Lobatos flow, so, for purposes of computation, you can assume Lobatos water is consumed and the other water comes down.

MR. TIPTON: I say it's subject to checking.

MR. HILL: The practical angle is this - that over the past ten years the points representing progressive five-year averages are almost squarely on the curve with the maximum departure, being 200,000 out of four million. During that ten years the conditions at Lobatos have been substantially frozen. For the larger years where points become more erratic, if we were to get seven million acre-feet at San Marcial in five years, there would be a period of spill that would interrupt it anyway. If you go beyond the conditions prevailing from 1920 to 1935, you run into conditions of spill, so the real curve is fixed by the points for conditions from 1920 to 1935, during which time the flow at Lobatos has not been materially affected.

MR. CORLETT: May I make a suggestion? They have repeatedly referred to "historical" data relative to the Elephant Butte, but it should not be confused with the data on the Rio Grande. In other words, history didn't commence on the Rio Grande with the construction of the Elephant Butte.

MR. HILL: I merely said the historical data as to runoff at Lobatos, Otowi, and San Marcial had been used in this table.

MR. HINDERLIDER: We reserve the right to check this schedule presented by Texas after Mr. McClure has presented the New Mexico schedule.

MR. HARPER: I will ask Mr. McClure to present the New Mexico schedule at this time.

MR. MCCLURE: Before I take up the schedule I would like to make the statement that the Chairman requested in regard to Condition 1 by the State of New Mexico. New Mexico, having presented certain minimum conditions under which she will negotiate with Texas and Colorado toward reaching an agreement on the equitable distribution of the waters of the Rio Grande, now desires to make the following statement on the first condition so submitted.

New Mexico believes that in the meeting of this Commission on March 3 and 4, of this year, it was the consensus of opinion of the Commissioners that the temporary compact should be extended for a long enough period that the Rio Grande Joint Investigation report would be available so that the basic data in this report could be used by the Commission in arriving at a permanent compact on the Rio Grande. As I understand it, this invitation included such surveys of transmountain diversion projects in both New Mexico and Colorado that the states thought were pertinent to an investigation which would set up basic data for consideration by this Commission. New Mexico feels that the consideration of the San Juan-Chama transmountain diversion should be included in this compact, in order to stabilize the safeguards of her rights in their relation to additional storage on the Rio Grande in Colorado.

To obtain and place this project in a position for authorization there are certain statutory and other obstacles in Colorado to be removed, which New Mexico believes she should have the cooperation of Colorado in their removal. We believe that Colorado in this Compact should take these conditions into consideration and through this Compact remove such obstacles and place this project in the same position for authorization as any storage projects they desire in Colorado. The second part of the first condition, regarding the safeguard to our rights in New Mexico is more definitely set out by the schedule set up for the discharge of the Rio Grande to pass the New Mexico-Colorado State Line. I am going to ask Mr. Bliss to go into this schedule.

MR. BLISS: This schedule was made up by comparing the natural flow of the Rio Grande at Del Norte. The hypothetical reservoir operation in the San Luis Valley would include only the Wagon Wheel Gap Reservoir construction, but an operation which would return to the state line the same amount of water which presumably would be returned under present day conditions. That is, the present depleted flow of the river. The relation is set out in the table here. I might read the first part of this: The aggregate discharge of the Rio Grande passing the New Mexico-Colorado State Line in each period of sixty consecutive months shall be not less than the quantities stated in the following table when the aggregate discharge of the Rio Grande immediately above the first point of diversion to lands in the San Luis Valley over the same period of time is as follows:

<u>Aggregate Discharge near Del Norte in 60 Consecutive months:</u>	<u>Corresponding Aggregate Discharge passing N. Mex.- Colo. State Line.</u>
2,000,000 ac. ft.	1,200,000 ac. ft.
3,000,000 "	1,800,000 "
4,000,000 "	2,600,000 "
5,000,000 "	3,500,000 "
6,000,000 "	4,500,000 "

Referring to the first point of diversion, I think it must include any diversions up to Del Norte and probably include the Del Norte Irrigation District Canal. It is not intended to include mountain diversions. Intermediate quantities shall be in proportion to the respective values in the above table. As Texas explained, their schedule is merely an interpolation between the control points set forth in this table. Then there are two controls that we felt should be necessary for the protection of New Mexico; one is the amount of water passing the state line in any given year, and the second is the minimum flow which we feel should appear at the state line at any time. The first provision is: Provided that the total discharge passing the New Mexico-Colorado state line in any 12 consecutive months shall not be less than 25 percent of the total quantity in the Rio Grande measured immediately above said first point of diversion in the same period of time. The 25 percent includes, of course, provision for construction of reservoirs on the Conejos, and the saving to be effected which is the return flow to be accomplished by such storage. Provided, further, that the flow passing the New Mexico-Colorado state line shall not be less than 100 cubic-feet per second during the period of time from June 15 to September 15 of any year. That is merely to protect the State of New Mexico against unusual depletion which might be effected by extravagant use in Colorado during the late summer period. Provided, further, that quantities set forth above shall be exclusive of any amount of water which may be discharged into the Rio Grande from the sump drain or other drains from the San Luis lakes.

MR. TIPTON: Any explanation of that last paragraph?

MR. BLISS: We feel that perhaps the sump drain water might not be as desirable as it should be, and that no credit should be due Colorado for such water.

MR. TIPTON: In other words, eliminate the provisions of the present compact.

MR. BLISS: It would seem to in that respect.

MR. McCLURE: The sump drain isn't included in the studies they have made into conditions.

MR. HINDERLIDER: The report of the National Resources Committee very definitely says that the quality of water in that basin is very good, doesn't it?

MR. McCLURE: It indicates 87 percent sodium content in the sump. I am not talking about the whole closed basin, just the sump and the San Luis lakes. The analysis shows an 87 percent sodium base and we don't consider that very good water, from that standpoint.

MR. HILL: Speaking for the people at the lower end of the valley, that water is of a highly undesirable quality, and added to the Rio Grande it would be necessary for dilution at the lower end to offset it, and we much prefer that it not be dumped into the river.

MR. TIPTON: It's in strict violation of the provisions of the present compact.

MR. McCLURE: Does the present compact have anything to do with the permanent compact?

MR. TIPTON: No, not necessarily.

MR. McCLURE: A \$900,000 allocation was made for the building of it and it seemed like there were possible chances for it at one time.

MR. TIPTON: It would have been built at one time had the San Luis Valley been permitted to construct the reservoir.

MR. McCLURE: The proposal was made that New Mexico should help maintain it.

MR. HINDERLIDER: You are in error; the first requirement was that the State of Colorado make arrangements as to the maintenance of the drain.

MR. McCLURE: You wanted us to help maintain it.

MR. HINDERLIDER: There was so much opposition to us building reservoirs we couldn't build them to utilize this water that would become available from the drain.

MR. TIPTON: I want just a few points cleared up. I presume the 60 consecutive months is put in due to that being the period covered by the Texas schedule. You wouldn't care, as far as the Middle Rio Grande is concerned, with respect to the time taken to make up delivery so long as this low flow season was taken care of, except for the fact that if you agree to the Texas schedule, you are limited to 60 months. That's the purpose of that.

MR. McCLURE: Yes.

MR. TIPTON: It would be your position also that by the wiping of your slate clean from a spill of project storage that would naturally wipe our slate clean. When Elephant Butte and Caballo spill, that wipes both slates clean as far as delivery is concerned. You would be obligated under the Texas schedule to deliver this water over a period of 60 months.

MR. McCLURE: We haven't accepted the Texas schedule.



MR. TIPTON: No, but if during that period, any accumulated debits would be wiped off the books and we would assume it would be wiped off at the state line, and we would start all over again. We are not agreeing to the 60 months, but under that assumption.

MR. McCLURE: I don't think New Mexico can agree to that.

MR. TIPTON: You are not interested in over-all quantity in a period of years; the main thing is seasonal quantity.

MR. McCLURE: With a definite quantity on a period of years.

MR. TIPTON: Only insofar as you might be obligated to deliver at San Marcial. We would have to meet your requirements as far as time is concerned for delivery at San Marcial.

MR. HILL: There is one point in that - their delivery at San Marcial will be accomplished in part by flood waters in the streams which New Mexico is unable to divert and you might have the condition where Elephant Butte is full and that water largely originating downstream.

MR. TIPTON: That's true.

MR. HILL: And the fact Elephant Butte spills doesn't have any bearing on the amount of water available at the upper end of their irrigation works.

MR. TIPTON: It certainly does, by virtue of the same statement, the flood water that fills Elephant Butte might go past Lobatos; and supposing; after a three-year period, Colorado, by bookkeeping processes, owed 200,000 acre-feet to the river; supposing at that time Elephant Butte and Caballo were full. It certainly would do nobody any good to release 200,000 acre-feet to pay up that debit, because it would add to the spill. Certainly would not do New Mexico any good - I am talking about the Middle Rio Grande - because it would add 200,000 acre-feet to the spill.

MR. McCLURE: It would all depend on the conditions of that spill. Supposing we needed water in the Middle Valley itself - not to pass to the Elephant Butte from the state line to the spill.

MR. TIPTON: That wouldn't help the Middle Valley; after the spill was a slug they couldn't use it.

MR. McCLURE: I don't anticipate any release like that.

MR. TIPTON: It's very definitely an integral or major part of our idea with respect to the state line delivery that spill of Rio Grande Project storage must come into the picture essentially in the same fashion as it is in this proposal of Texas. These things, when we begin to go into details, will iron themselves out. I thought possibly New Mexico might

make a statement at this time with respect to that; if they cannot without further study all right, but we want to make our position clear. That state line delivery, as far as we are concerned, must embrace that principle in some fashion.

MR. McCLURE: That will depend on the construction of the State Line Reservoir.

MR. TIPTON: As to the schedule here, John, wouldn't it have been as well to bring Conejos in as part of the yardstick as a method of determining water supply as part of your first claim?

MR. BLISS: It perhaps would have; the only reason Del Norte was used was the fact the addition of Conejos didn't seem to improve the correlation in any respect.

MR. TIPTON: There's a long-time station on the Conejos and the flow of the two of them constitute 25 percent of the total original water supply involved, so it would seem better to take that into consideration. I presume there would be no objection to that.

MR. BLISS: No objection.

MR. TIPTON: You speak of natural flow. In other words, you are making our reservoirs in operation a great many years subject to this schedule.

MR. BLISS: The natural flow is merely recorded Del Norte flow corrected if reservoirs were in operation.

MR. TIPTON: But you didn't correct Lobatos? We would have to object to that. It would have to be on the basis of Del Norte recorded flow, not corrected flow, because that would make our present reservoirs subject to this schedule. We are visualizing status quo reservoirs in operation many years.

MR. HILL: Unless there is something beyond what the statement reads, the flow at Lobatos is related to the actual flow at Del Norte, part of which is regulated and part of which is not.

MR. TIPTON: He has corrected the Del Norte natural flow for reservoir operation.

MR. HILL: I think the actual effect would be very slight.

MR. TIPTON: It would be satisfactory to you to use recorded flow at Del Norte?

MR. HILL: I don't think it would make any difference.

MR. DEBLER: In that connection, under future conditions, with Wagon Wheel Gap built, would you still in the left-hand column use the flow as actually measured at Del Norte?

MR. TIPTON: No, that's corrected for new reservoir operation.

MR. DEBLER: In order to comply with your ideas, this column would be corrected for reservoirs constructed after 1937.

MR. TIPTON: It would have to be on the basis of the flow after 1937, and reservoirs constructed after then. That's the intent, isn't it?

MR. DEBLER: I don't know - I am trying to find out.

MR. BLISS: The Lobatos flow is adjusted for all storage.

MR. DEBLER: It is the recorded flow at Del Norte, otherwise there could be no comparison for present runoff.

MR. TIPTON: I understood you to say it was corrected for future reservoir operation.

MR. BLISS: Yes.

MR. TIPTON: Our point is it should be river flow.

MR. DEBLER: May I ask, don't you want a provision that it will not include any imported waters?

MR. TIPTON: Certainly imported waters would be subtracted. Provided that the total discharge passing the New Mexico-Colorado state line in any 12 consecutive months shall not be less than 25 percent of the total quantity in the Rio Grande measured immediately above said first point of diversion in the same period of time. We cannot comment on that until we check it. Are there any years when the flow at Lobatos falls below?

MR. BLISS: I haven't checked that fully, but I don't believe many years.

MR. TIPTON: Are there any?

MR. BLISS: I don't know; I haven't checked that far.

MR. TIPTON: Provided, further, that the flow passing the New Mexico-Colorado state line shall not be less than 100 cubic feet per second during the period of time from June 15 to September 15 of any year. The same question applies to that.

MR. BLISS: I think the record shows there are four months of the entire period in which that did occur.

MR. TIPTON: We will have to check on that further. We have already commented on the last paragraph and that's subject to further discussion.

MR. HINDERLIDER: Colorado suggests a recess until our delegation will have time to analyze these statements. After discussing the matter with my technical adviser, Colorado feels we will probably have time by three o'clock to consider these schedules submitted by Texas and New Mexico, after which time there will doubtless be further observations on the part of Colorado, and possibly further questions to be propounded in connection with the data they have submitted.

MR. HARPER: Would it be possible meanwhile to confer informally with Mr. McClure and Mr. Hill to straighten out doubtful points in the interest of economy of time?

MR. TIPTON: I think we have straightened out most doubtful points. It will resolve itself into consideration of major points and better be discussed with the Commissioners themselves. There are some major points that can be worked out very satisfactorily, I think, but I believe that will have to be done first in a preliminary way and later undoubtedly with the engineers.

MR. HARPER: The meeting is recessed until 3:00 o'clock.

MR. HARPER: (3:30 P.M.) If Mr. Hinderlinder is ready to proceed with the discussion of the schedules submitted by Commissioner McClure, the meeting is at his disposal.

MR. HINDERLIDER: Mr. Chairman and Members of the Commission: As I rather anticipated when we recessed at noon, Colorado has had time only to give a cursory examination to the schedules submitted by New Mexico. There are, however, certain things to which Colorado cannot accede.

1. To the proposition of eliminating the use of the water which may be recovered from the Closed Basin in Colorado in arriving at a schedule of deliveries at the state line.

2. Colorado must insist upon credits to Colorado for spills from Elephant Butte Reservoir projects in like manner as that accorded New Mexico by Texas.

3. Colorado must insist upon some definition of the capacity of reservoirs in the Elephant Butte-Fort Quitman section.

4. With regard to the requirement of the 25 percent delivery at the state line, this figure may be acceptable, but requires further study.

5. With respect to the limitation or requirement of 100 second feet at Lobatos, a consideration of past years' records discloses that there are many months in which such quantity is not passed at the state line; and with respect to the schedule submitted by Texas, as I have heretofore stated, lack of time has not permitted Colorado to give consideration to such schedule and to determine how it may affect Colorado's interests.

I desire the record also to show that Colorado reserves the right to make a complete check in due time of the data submitted by both New Mexico and Texas, and these statements do not in any way bind Colorado with respect to any future position she may take. We do feel, however, that based upon the matter submitted by New Mexico and Texas the way is open for further discussions at this afternoon's session to see if we can clarify some of these points and possibly arrive at a situation which will permit further discussions based upon a schedule of state line deliveries.

MR. HARPER: May I suggest if you are through with your general statement that we take up the several points that you brought out in their order for discussion.

MR. HINDERLIDER: That is agreeable to Colorado, and in that connection, I will ask Mr. Tipton, my consultant, to continue the discussions for Colorado.

MR. CLAYTON: I think in order to eliminate the third reservation of Colorado, we can stipulate now that in Texas' statement as to delivery at San Marcial, the storage be limited not to exceed 2,638,000 acre-feet, and we can remove that from discussion hereafter.

MR. HARPER: The meeting will be in recess for 15 minutes.

MR. HARPER: We will now resume proceedings; do you have some further matters to present?

MR. HINDERLIDER: We have just listened to some discussions with respect to the schedule of state line deliveries proposed by Texas and New Mexico, and Colorado will state at this time that it is willing to submit tomorrow morning a schedule of state line deliveries, merely as a basis of discussion, it being understood that Colorado is not at this time, and does not, commit itself to the principle of state line deliveries. We will submit a schedule tomorrow morning if it is the desire of the Commission for consideration and discussion.

MR. CLAYTON: Did you have in mind this statement by Texas with respect to the state line deliveries that we brought in this afternoon? I think that is pertinent and should be considered in any schedule Colorado prepares. Suppose we ask Mr. Hill to explain this statement first.

MR. HILL: (Reading from statement). "In order that no physical situation should develop which would make it impracticable for Colorado to deliver in the latter part of any sixty-month period, the remainder required under the schedule suggested by New Mexico, the measured flow at Del Norte should be the index of deliveries at the state line, and the accumulated delivery throughout any part of a sixty-month period should bear the same relation to the accumulated discharge at Del Norte, over the same period of time, that the total required delivery at the state line over any period of 60

consecutive months as set forth in said schedule bears to the total discharge at Del Norte over the same sixty months". The purpose of that is merely to provide some yardstick of minimum delivery by Colorado to the state line during the sixty-month period. If, for example, at the end of one year a million acre-feet had passed Del Norte, with reference to the schedule presented by New Mexico, the value in that schedule of New Mexico, would be 1,200,000 acre-feet; and if you went to the second year, and by the end of that second year three million acre feet total had passed Del Norte from the beginning of the period of sixty months to the end of the second year, the total to the state line, the aggregate passing the state line, would be 1,800,000 acre-feet. At the end of the fourth year, if four million acre-feet had passed Del Norte, 2,600,000 would be the minimum to pass the station at Lobatos. The effect of that is, taking for example, five million acre-feet passing Del Norte in five years, the schedule suggested by New Mexico would provide  $3\frac{1}{2}$  million should pass Lobatos, but nothing in the New Mexico schedule says whether any of that should pass in the first four years, excepting the qualification that 25 percent of the flow at Del Norte, which might be only 200,000 acre-feet a year.

MR. TIPTON: It's providing an annual delivery based on a five-year average.

MR. HILL: It isn't quite that for this reason; if we take the five years, that would be an average of one million at Del Norte and an average of 700,000 at Lobatos. If the first two million of that five happened in two years - for discussion we'll say, after the first two million came down, instead of being required to pass Lobatos two times 700,000 acre-feet, you would be allowed 200,000 debit.

MR. TIPTON: We will study this over.

MR. HILL: The intent of the provision is not to require you to pass in each year the average set forth in the schedule but in the first years to pass something less than that and in the latter part of the period to make it up, giving you a chance to accumulate some debit in the earlier part but limiting you to the extent of the debit which you can accumulate. We suggest this merely as a means of measuring the extent you can depart from average delivery, with departures on the side of low and not high deliveries. The whole point is, there must be some provision whereby Colorado will not hold back water for several years to the minimum required by the other paragraph and then come to a condition in the last year where a flood did not materialize and there wasn't the water to send down.

MR. TIPTON: In our set-up to be submitted, we will take care of the fears that you have in a different way, and it might give Colorado more freedom.

MR. HILL: We don't care how it's worked out, but we suggest this as a basis.

MR. TIPTON: We know what your fears are, and sympathize with them.

MR. HARPER: Are there any other matters which any of you wish to discuss at this time?

MR. HINDERLIDER: I suggest we recess until 10:00 o'clock tomorrow.

MR. HARPER: We will stand recessed until 10:00 tomorrow.

(Recessed at 4:30 P.M.)

Santa Fe, New Mexico,  
October 1, 1937,  
1:00 P.M.

MR. HARPER: The meeting which was recessed yesterday afternoon until 10:00 o'clock this morning was postponed until 1:00 o'clock this afternoon at the request of Mr. Hinderlinder, to give him more time to work out the revised schedule at the state line. I was worried for a little while when I noted the date on the morning paper, October 1, 1937; so many people left for home last night that I thought possibly Governor Corlett had his men on the way up to San Luis Valley to build reservoirs, and that Tom was building a barrier so you couldn't get water down to the Elephant Butte. But we are facing the fact today that we have no compact. In any event, I am sure that is not going to make any difference in our deliberations. I feel sure we will go right ahead with these compact negotiations, regardless of the status of the expired compact. Mr. Hinderlinder has prepared a revised schedule for deliveries at the state line. I think he has distributed copies to everyone here and it will be in order now for Mr. Hinderlinder to explain this schedule in detail and answer any questions in regard to it.

MR. HINDERLIDER: Colorado presents the following schedule and comments for discussion, pursuant to an understanding had last evening at the time the Commission recessed: Deliveries of water shall be made by Colorado at Lobatos gaging station near the Colorado-New Mexico state line in accordance with the following schedule, which indicates the relation, under present conditions (1928-1937) of development, between the recorded flow of the Rio Grande at the gaging station near Del Norte, plus the recorded flow of the Conejos at the Mogote gaging station, and the recorded flow of the Rio Grande at the Lobatos gaging station.

Recorded flow of Rio Grande  
near Del Norte, plus recorded  
flow of Conejos at Mogote

Recorded flow of Rio  
Grande at Lobatos

400,000 ac. ft.	80,000 ac. ft.
500,000 "	120,000 "
600,000 "	175,000 "
700,000 "	230,000 "
800,000 "	285,000 "
900,000 "	350,000 "
1,000,000 "	420,000 "
1,100,000 "	490,000 "
1,200,000 "	565,000 "
1,300,000 "	650,000 "
1,400,000 "	745,000 "
1,500,000 "	840,000 "

Delivery shall not be required on an annual basis in accordance with the above schedule, but credits and/or debits shall be allowed to accumulate over a period of years subject to the following conditions:

1. At any time when accumulated debits exceed the unfilled effective capacity of Rio Grande Project storage, that portion which is in excess of the unfilled capacity shall be written off.
2. Accumulated credits shall be reduced by the amount of actual spill from Rio Grande Project storage during the periods when spill occurs.
3. The mean required releases from Rio Grande Project storage shall be considered as 750,000 acre-feet per year.
4. In calculating Colorado debits, cumulative debits shall be reduced by an amount that the total releases from Rio Grande Project storage exceed 750,000 acre-feet per annum.
5. In the event that the contents of Rio Grande Project storage shall drop below 300,000 acre-feet on April first of any year, and Colorado owes water to the river, the amount owed shall be released from reservoirs constructed after the consummation of a permanent compact, and delivered to the state line.
6. Future reservoir construction and operation in Colorado shall not impair the present flow at the Lobatos gaging station during those periods when the flow at Otowi bridge gaging station would be insufficient under present conditions to supply the requirements of the Middle Rio Grande Conservancy District as defined by the report of the National Resources Committee.

New Mexico, and the Middle Rio Grande Conservancy Project, shall agree not to deplete the flow of the river at San Marcial. Any cumulative shortage in the river flow at San Marcial, caused by water uses above that point in New Mexico, shall be supplied by New Mexico, should the contents



of Rio Grande Project storage drop below the amount specified above. In calculating the combined flow of the Rio Grande at Del Norte, and the Conejos at Mogote, for application to the above schedule, water imported to the area above either, or both, of these gaging stations by projects constructed after October 1, 1937, shall be subtracted from the combined recorded flow at those stations, and the resulting indicated flow shall be applied to the schedule to determine the amount of water that shall be delivered at the Lobatos gaging station.

When and if water is imported to the Upper Rio Grande Basin below the Colorado-New Mexico state line at no expense to either of the signatory states, the amount of water required to be delivered by Colorado at Lobatos gaging station, as defined by the above schedule, shall be reduced in an amount equal to 50 percent of the imported water as measured each year. In the event water is imported from Colorado to the area below Colorado-New Mexico state line by projects financed by New Mexico, the amount of water required to be delivered by Colorado at Lobatos, as defined by the above schedule, shall be reduced in an amount equal to 20 percent of the imported water as measured each year.

In the event that power is developed by projects constructed to import water to the basin below the Colorado-New Mexico state line, Colorado shall not be discriminated against in the allocation of the power or the establishment of rates.

The provisions outlined above with respect to state line deliveries, in accordance with the suggested schedule, shall not become effective until the contemplated storage in the San Luis section is constructed and placed in operation.

Now, gentlemen, any questions that may be propounded by New Mexico and Texas, particularly of a technical nature, I would ask Mr. Tipton, my consultant, to answer. It may be desirable, as Mr. Tipton states, to offer some further explanation following the reading of what Colorado has just submitted prior to the propounding of any questions.

MR. TIPTON: In general, this was designed with the idea of protecting both lower basin states absolutely against any depletion at the state line by reservoir construction which would adversely affect present uses in those areas. As to the details of the method, I think we all realize that anything that is finally accepted in principle by the conference, must be worked out in considerable detail first by the engineers and then by the Commissioners, and worked out on the basis of a long-time plan in order to see whether it is going to afford the protection to the lower basin states it is intended to. No. 2 permits Colorado to do as she desires, so this is all set up on that basis. The schedule of delivery is built on the relationship between recorded flows for the years 1928 to 1935. The last two years is not in that as that data was not available. The schedule, as suggested, provides for delivery during low water periods as nearly the amount actually delivered as it is possible to arrive

at. During the recent period it's rather difficult to find out the upper extremes of the curve due to the absence of high flow during those years. As I say, this schedule, or any other that might be proposed, we all realize would have to be applied to the entire period of record and to the operation in the various basins to determine how it would affect them. I think possibly the conditions under which this suggested schedule would operate, and suggested deliveries would be made, are explained and need no further explanation. Conditions 1 and 2, that's a matter we discussed yesterday, wiping the books clean in the event of spill at Elephant Butte or spill by Rio Grande Project storage. Item 3 was arrived at - -

MR. DEBLER: On item 3 you don't wipe off all the credits and debits at the time of spill?

MR. TIPTON: No.

MR. HILL: What do you mean by debit and credit?

MR. TIPTON: The amount Colorado might owe the river, accumulated amount, at any time, based upon this proposed schedule of delivery, or any other schedule which might be adopted. Credits would be accumulated amounts of water delivered at the state line by Colorado in excess of that required to have been delivered under whatever schedule is adopted. So that in No. 1, you can visualize this situation: If Colorado owed the river 100,000 acre-feet and the Rio Grande Project storage was up to within 50,000 acre-feet of spilling there would be 50,000 acre-feet of debits written off. In event of a spill, if Colorado had credits, the credit would be reduced by the amount of the spill. In the former case, where Colorado owed water to the river, it of course would do no good to anyone to release that entire amount if that amount would fill the Rio Grande Project storage to overflowing and would be spill and that is the purpose of writing that amount off.

Item No. 3 was worked out on two bases; the first being 800,000 acre-feet of releases from Elephant Butte, suggested the other day as a mean release over a period of years, and deducting from that all what appears to have been over-diversions by Mexico in an amount of some 74,000 acre-feet, as I remember, in 1930, up to 1935, and then adding an amount to that, 20 to 30,000 acre-feet, which brings it up around 750,000. Another basis was taking releases from Elephant Butte Reservoir since the signing of the former compact, eliminating the year of low release in 1935, since the operation was materially curtailed that year, but not including the last two years, that amounts to a mean of 783,000. That's eliminating the low releases of 1935, deducting 74,000 acre-feet of over-diversions and then bringing it back up to 750,000 by adding an additional amount.

MR. HILL: Going back to No. 1, suppose that on the first of May that Elephant Butte, as you stated, was full to within 50,000 acre-feet of capacity, and at the same time you had an accumulated debit of 100,000.

I presume the principle you are considering is that the release of that debit would result in waste.

MR. TIPTON: Yes.

MR. HILL: Actually in the month of June the releases from Elephant Butte Reservoir in the order of 2,500 second-feet will be as much as any release which you could physically make, so even if you did release the 100,000 acre-feet, by the time you did so the reservoir would be lower than when you started.

MR. TIPTON: That's true.

MR. HILL: So why should you wipe out a debit which if you were to satisfy that debit would not result in waste?

MR. TIPTON: Supposing we did satisfy the debit, it would result in waste - satisfy the debit say April 1. The date is immaterial; we fixed April 1 as the date for which you should be protected against a shortage during the oncoming season by virtue of any accumulated debits that we might owe the river, and so if we chose to release the debits as of that date it is conceivable there would be waste.

MR. HILL: But under paragraph 1 you say, "At any time, etc." I don't see the validity of that.

MR. TIPTON: There is not intended to be any joker in that particular provision; there is only an attempt to eliminate debits which if releases were made would result in basin waste. That's the only intent. If it can be worked out in a way that that is accomplished satisfactorily to all concerned, I don't see any reason why it should not be done.

MR. HILL: The debit might be 500,000 and you release up to 300,000 and wipe off the other 200,000.

MR. TIPTON: I see your point. The intent is plain. We are not intending by that provision - -

MR. HILL: What you really mean, at any time when the release of accumulated debits would result in waste and spill at Elephant Butte you can write that off?

MR. TIPTON: That's the underlying principle, but as I suggested, I think the intent of the provision is plain and if it can be worked out in a way that is satisfactory, the date can be set up.

MR. HILL: That's the principle you mean, that if release of debits would result in waste, then the debit to that extent should be written off.

MR. CORLETT: There is a further proposition - if we comply with the schedule and maintain that supply there, there is no reason why it should not be written off.

MR. TIPTON: The ironclad protection you have against us is in paragraph 5. In other words, by that provision we are insuring you against any shortage which would result from our act.

MR. HILL: I would object to the figure 300,000 and also to the date. The date is so late in the year, if you did release it the losses in transmission would make it physically difficult to get the water down there, and the 300,000 is an unduly low figure. The project gets 300,000 long past the time they need water. If it was 500,000 on the first of January, I wouldn't quarrel. You are releasing the water for our benefit so it's got to be released when losses from transmission will be at a minimum.

MR. TIPTON: I don't think there will be any argument about that. Your suggestion as to getting down on the ragged edge, that, to my mind is neither here nor there. If we released the amount we owed the river it would bring you to the stage you would be under present conditions.

MR. HILL: If you made it January 1st, we can do it, but you realize our planting season would have to be on that basis.

MR. TIPTON: There would be no advantage to us to delay the date to April 1, in the hopes of materially increasing our storage during that interim, because we would have very little increase at our location, so there is no objection on our part to making the date at any time during the year. January 1 would be all right.

MR. DEBLER: May I suggest that the dates for both the schedule and item 1 be January 1. In other words, the year controlling, whether or not you have a debit or credit, would be determined as of January 1.

MAJOR BURGESS: There is an option to deliver at any time available, or convenient to the upstream. Suppose they would deliver in excess, very considerable excess, in the first year of the period instead of being distributed over the period for some reason. Wouldn't it then result in the ensuing period in an excessive loss from Elephant Butte from evaporation? That would not be protected.

MR. HILL: There would be greater loss, but I don't believe that's an element because under natural conditions you would have a large reservoir anyway. I don't think that would disturb the situation. In paragraph 5 the time in which that is released could be between January 1 and April 1.

MR. DEBLER: Would you want it in April when they were irrigating in the Middle Rio Grande?

MR. HILL: Regardless of whether the Middle Rio Grande diverts it or not, the channel losses and seepage are at a minimum in that period, from January to April and there is no use of letting the water down in order to have it dissipated.

MR. BLISS: What protection has New Mexico under that provision of writing off credits?

MR. TIPTON: We are, in effect, insuring New Mexico against shortage. We are suggesting here for discussion that you have a status quo condition in the Middle Rio Grande; I cannot see how you are interested in the long-time debits or credits because it is not affecting your development in any way.

MR. BLISS: The long time would be only in the surplus flow?

MR. TIPTON: Just supposing we do devise a plan whereby Middle Rio Grande is protected against increased shortage by Colorado; isn't it true you are not interested in time to time credits or debits?

MR. CORLETT: If we were to deliver that between January and April 1, especially up to March 15, anyway, the ice conditions up there might mean we would pile a lot up in the channel. I don't believe we could deliver at that time.

GOVERNOR HANNETT: If the Elephant Butte was down to 300,000 acre-feet in April, it would indicate a long period of dry seasons antedating that April 1, and it would mean that the Middle Rio Grande had been suffering a shortage. Then when the valley was to be compensated by releases from Colorado they would pass through in the winter although we had suffered several dry years.

MR. TIPTON: Yes, but not by any act of ours. Those would be natural shortages and not shortages during those dry years that would otherwise have been by virtue of our acts.

GOVERNOR HANNETT: You don't have to release any water except when you owe it to the river and you would have been storing water there; by some reason or other we couldn't tell in advance, you would be releasing water and passing it through in the winter to Elephant Butte. Where would we get any relief?

MR. TIPTON: You are not entitled to any relief from that particular water. We don't owe that water to you; we owe it to the Rio Grande Project. We owe you water seasonally during those periods at all times of this discussion, but under this plan we would owe you water only on a seasonal basis, month by month under present conditions. We would agree that during a month when, under present conditions, you would not receive

sufficient water at Otowi to take care of your demand, we would not do anything to lessen that amount. We believe you would have more water.

GOVERNOR HANNETT: Whenever the flow at Otowi was low, you would compensate us in that way.

MR. HINDERLIDER: We agree not to change the situation at the state line.

MR. TIPTON: When you would be short at Otowi, we would guarantee that there would be no act of ours which would reduce the flow at Otowi below what it would be under present conditions during those periods. We are not agreeing to status quo at Otowi through the seasons, but only during periods during which you would be short. That's a matter of detail that can be worked out.

MR. BLISS: Your curve is based on recorded flow, not assumed reservoir operation?

MR. TIPTON: That's correct.

MR. BLISS: You admit the recorded flow would change the shape of that flow?

MR. TIPTON: We think it would. If our theory was correct, during low water years there would be more flow at the state line. However, there is this much about it, the operation being based upon recorded flow in the future there is very small range of the curve that would be dealt in. We would be dealing with controlled water at the yardstick end of it and there would be just a small range of the curve - the only times we would go outside of that range would be during periods of excess spill in San Luis storage or when releases were curtailed due to shortages. As I stated before, this schedule, or any other proposed schedule, will have to be taken by all of us and applied to a long-time operation of the river as a whole and see how it fits. If it don't fit someone's condition, we will have to adjust it so it will fit everybody's condition. We think it can be done and we are willing to sit down and attempt to do that to see how it comes out.

MR. DEBLER: May I speak again on the point of the date in the schedule. The reason I mention that is because with your proposed developments in San Luis Valley you will change the regimen of the river and there would, of course, have to be some specific date set as to when the year ends.

MR. TIPTON: I think that's true. You mean in connection with provisions 1 and 2.

MR. DEBLER: I mean the schedule itself - what the beginning of the year is. You won't be able under this plan to determine how much you are

ahead or behind the schedule during the year because nobody can say what you are going to do, but it would seem there would have to be a date of definite accounting.

MR. TIPTON: We realize this is a long-time operation. I think it would be material that the date be set, as you suggest, insofar as provisions 1, 2, and 5 are concerned. That's the only way the date would be material.

MR. DEBLER: When are you going to determine the point I am making? It's true it's a long-time operation, but here comes a time when Elephant Butte Reservoir is up fairly close to spilling, as you pointed out, and that, we'll say, comes on April 17 of some year. How are you going to determine at that time with respect to your debits or credits?

MR. TIPTON: Those dates will have to be fixed.

MR. HILL: Going back to Bliss' question - if you take two years for illustration, one in which the combined discharge at Del Norte and Mcgote is 600,000 acre-feet under present conditions, and another is 1,400,000, according to the values of your curve, for the first year the flow at Lobatos would be 175,000 acre-feet and the second year, 745,000 acre-feet, which total 920,000 for the two years. If you were to regulate that same volume of water so that in each of these years you release a million acre-feet, according to your curve, the value would be 420,000 for each year, or a total of 840,000 - a difference of 80,000 acre-feet, or a deduction in the supply which, under present conditions, reached Lobatos. I don't believe that's your intention, that the supply at Lobatos should be curtailed in any such manner. In other words, your statement is correct, that the curve will have to be adjusted, the concavity of the curve will have to be taken into account so under reservoir operation, which is what you are contemplating, you would have one curve before you build and one after you do, so that the total volume will not be altered at Lobatos.

MR. TIPTON: The intent is not to do anything to the detriment of the lower basins. That goes back to the original statement - this will have to be fitted in the operation so it will be satisfactory to all. We will be dealing now under a controlled river within a fairly small range of the curve, and if this does not fit that condition, if this is such that it would operate to the detriment of the lower basin states, we will have to make an adjustment.

MR. HILL: The point is simpler than that.

MR. TIPTON: I understand your point.

MR. HILL: You have a curve which in itself would result in subtraction of flow at Lobatos so that curve would have to be adjusted to reflect conditions as they will be in the future.

MR. TIPTON: The curve should be such that under contemplated operation, we are accomplishing what we intend, the protection of the delivery at Lobatos on an average of the same amount of water delivered under present conditions. Obviously, under conditions of spill by wiping off the debits, it's conceivable there might be some benefit to both Colorado and New Mexico over a long-time period, and there might not be as much water delivered by New Mexico at San Marcial, or by Colorado, and yet the lower basin conditions would be absolutely protected.

MR. HILL: Except insofar as the water which you pass at Lobatos would spill at Elephant Butte, the quantity which you will pass down to the state line over a period of years should not differ from the quantity which you do pass down to the state line under present conditions. If that's the premise, we will not quarrel about the details.

MR. TIPTON: That's the intent - there isn't supposed to be any jokers in this set-up.

MR. DEBLER: I would like to point out what I conceive to be a possible result of item 2 - accumulated credits to be reduced by amount of actual spill. I can see where Colorado, for instance, in a period of fairly high runoff would accumulate credits, we'll say, of three million acre-feet; and the spills have been relatively small. You go into the year 1925, which was the beginning of a critical period, and Colorado comes in with a credit of a million acre-feet. This provision would authorize Colorado, in the critical period beginning with 1925, to reduce the flow of the stream by one million acre-feet.

MR. TIPTON: We can't build credits during periods of high runoff; only during periods of low runoff.

MR. DEBLER: I don't know whether you can or not, but under this provision that might result, it looks to me. You could start in a critical period for Elephant Butte with accumulated credit which has not been wiped out by spill and the result would be a reduction in the supply below San Marcial.

MR. TIPTON: But this is the point - during this particular period of the building of this credit that you are suggesting, Elephant Butte Reservoir is not under status quo condition but receiving benefit of Colorado development to the extent of the debits.

MR. DEBLER: It can't receive any benefit during periods of spill.



MR. TIPTON: That's the point - You can't receive any benefit during this period of spill but we will wipe it off and you still retain remaining credit, because it's built up the reservoir that much.

MR. DEBLER: At the beginning of this critical period, you go into any critical period at the time Elephant Butte is full and that's the last of the spill for 15 years. With any credit whatsoever, you are injuring the project.

MR. TIPTON: We have built them up to the point where they do spill by the credits, and they have more water in the reservoir than they otherwise would.

MR. DEBLER: Bear in mind from operation studies, maybe Elephant Butte will spill in 1924 and not thereafter. Now, to the extent that you can carry any credit whatsoever through that last spill, to that extent you are going to shorten the supply for that project thereafter.

MR. TIPTON: As a matter of fact, when you apply this to operation you don't have that situation.

MR. DEBLER: No irrigator can depend entirely on an engineer's analysis that may or may not show credits carried through that year of 1925. What would you suggest in lieu thereof in event of a spill?

MR. TIPTON: That's the only thing that can cover that situation that I can see. We might find something else.

MR. DEBLER: I am just bringing that up as an illustration that this provision may not cover that problem.

MR. HILL: You could easily have this situation. If you take the historical record from 1915 to 1925, Elephant Butte Reservoir, without any releases above a million acre-feet, would have been full repeatedly and gone back up full again. Now, during those years, if you could deliver more water into the river than required, and build up a credit, we come, as Mr. Debler says, to 1924 and the reservoir fills, and the spill is actually in that year, and the amount they released to avoid spill was around 100,000 or 200,000 acre-feet. If you would deduct only that amount from the other, then the next ten years you could accumulate debits in the amount of whatever credit you carried forward, and the water you passed prior to that time, in the form of credits, would serve no useful purpose; the reservoir would have kept high and so the effect would be to definitely deplete the supply during dry periods. So I say the simplest thing to do is what is suggested in the schedule for New Mexico, that the obligation slate is wiped clean when the spill occurs, and the obligation doesn't commence until the spill ceases, which seems to me to be the only practical way to consider it because nobody can anticipate now what conditions may be 20, 30, or 40 years in the future.

MR. TIPTON: We are willing to consider it further.

MR. HILL: (Quoting) "Delivery shall not be required on an annual basis in accordance with the above schedule, etc." Let us assume that we have a series of dry years and Colorado should short-change the river 100,000 acre-feet a year, which would be entirely possible; if that runs for 10 years, that's a million acre-feet, and our reservoir gets down to 300,000 acre-feet. We say we want a million; you say you don't have it; what are we going to do about it? There must be some reasonable limit upon the magnitude of accrued credits.

MR. TIPTON: In the first place, your basic assumption is wrong, because low water periods we cannot deplete the stream any more than at present by using all the water available during those periods. It's almost inconceivable we can build debits during low water periods. We cannot do it by storing in our contemplated reservoirs; we cannot build them by increased use because we are using all the water available.

MR. HILL: I can only refer you to the project on Salt River, where in a period of low years the Salt River Project very successfully dried up the river downstream. If they can do it, you can, and I think it's idle to say you won't.

MR. TIPTON: I think we are as near doing it at the present time as possible.

MR. HILL: You haven't exhausted the possibilities by a long ways. It is physically possible to deplete that flow. It would be like the gage on the Gila - it's 100 percent accurate - no water has passed it in 18 months.

MR. TIPTON: I think Mr. McClure accuses us of that right now.

MR. HILL: Let me ask you this - if you contemplate you cannot accumulate large debits physically, then there should be no objection on your part to putting in a limit and it might satisfy us.

MR. TIPTON: If you can develop something which would take care of your situation, we would be glad to consider it.

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At 3:30 P.M. the meeting recessed for 15 minutes. Upon reconvening:

MR. CLAYTON: It seems we have finished the discussion of the engineering features and I suggest it would be a good time to hear from Professor Barrows, if he is prepared.

MR. HARPER: Is that agreeable to you? (Addressing Professor Barrows). If so, we will be glad to call on you at this time.

PROF. BARROWS: Mr. Chairman and Gentlemen: I am going to begin by telling a story - that's a right which University professors always reserve to themselves. A number of years ago I happened to be a member of a faculty committee appointed to nominate a new director of our libraries. We interviewed men, carefully chosen to confer with us, from various parts of the country and finally decided we wanted to get, if possible, Dr. Raney, Director of the Library at Johns Hopkins. He came to see us on three occasions - reluctantly on the third occasion. We had a dinner for him that night at the Faculty Club, and at the conclusion of the dinner, the chairman of the committee called upon each man around the table to express himself, and each man presented arguments as to why he thought Dr. Raney ought to accept our invitation. Dr. Raney answered each one in turn, making it repeatedly clear, I thought, that he had practically decided to decline the invitation - he couldn't come. Finally they came around to me - I happened to be almost the last member of the committee to be called upon - and I said to him, "I am glad to know that you are coming to us and I congratulate you upon your decision". He looked a little blank, but said, "What do you mean?" I said, "You have repeatedly told us that this is the most baffling library problem in the United States, and I know a man of your ability couldn't decline this challenge and ever be satisfied with his decision. I congratulate you, therefore, on the fact that you are going to accept it." The next morning he reconsidered and the next noon he accepted, partly because I had said that to him.

In the same spirit, I congratulate you upon the fact that you are going to have a compact. Ever since December 1935, I have expressed to everyone with whom I have conferred on these problems individually, and I have repeatedly declared to most of you, my firm conviction that you were going to have a compact. I am just as confident about it as I was about Dr. Raney. You have been confronted with a great challenge - you could not be satisfied, any of you, if you didn't successfully meet that challenge. You are confronted by no insurmountable obstacles, however, and you are men of reason; when you have that combination, there can be only one outcome to your deliberations. I am happy for you, and with you, that you are going to have a compact. I am happy especially for three reasons which may not have been as clear in some of your minds as they have been in mine.

I have been eager to see the successful consummation of these years of effort, partly because this is going to constitute a great precedent. Right now, various public agencies in other parts of the country, including the National Administration, and many, many individuals in all parts of the country, are hopefully and expectantly awaiting the outcome of your deliberations. Certainly, this is one of the most baffling interstate water problems in the country, and when it is solved successfully, it is going to promote profoundly, I assure you, the successful solution of various other interstate

problems. I hope that many years ago I got the western point of view with reference to water problems, I think I succeeded in doing so, at least in some measure, and I believe that I speak for the western states when I say that they want to see state control over waters maintained to the greatest practicable degree; or, to put it another way, I think they would be loath to see any unnecessary extension of Federal control over water problems, interstate water problems particularly. But I cannot escape the conviction that unless compacts are made to work successfully, we will all see, as night follows day, a material extension of Federal control over interstate waters, not simply in connection with navigation, in instances where they are subjects of international treaty and the treaty provisions have to be upheld, and not only where the Government owns the land, but in all connections, and I believe that the successful conclusion of your work will help to check that tendency, will contribute materially to success in other instances.

The second reason why I am happy is because, if you had failed, if the current suit had to be resumed, I confidently believe the scope of that suit inevitably would be extended. It is entirely possible that the United States would intervene in it, and I take it that is something which all of you, with me, would deplore.

There is a third reason why I am particularly gratified. The President has instructed us to revise the drainage basin report of last year, with which probably most of you are more or less familiar. Probably it will be revised annually hereafter, to bring it currently up to date. In the first report, (1936) the upper Rio Grande area was left blank. No recommendations were made for construction of projects of any kind. The Compact Commissioners, as they themselves will well remember, decided, with us, that it would be illogical to recommend authorization for construction of projects until, in the light of the Joint Investigation, we knew what was called for. Colorado wants storage; New Mexico wants augmentation of supply through importation. Various gentlemen have asked me what would happen, in the unhappy event a compact was not consummated. Could we, in revising the report, recommend these projects, and could the proponents of these projects go to Washington in the expectation of getting help for them? I said that consideration had not been given to that possible angle of the situation as yet, and that I did not know what the Water Resources Committee might decide. That, to my mind, the settlement of the long-standing controversy among Colorado, New Mexico, and Texas over the waters of the river is a prerequisite to the adoption of measures for conserving and augmenting the supply of water. Personally, I think there would be no chance for you to get Federal support for new and costly projects if these problems were to continue in an uncertain status because of litigation, at least until the litigation was ended. In my judgment, neither Colorado nor New Mexico would have a chance to get Federal backing if the United States, in the absence of a compact, were

forced to enter the field in case of a resumption of the suit. That would mean years and years of intermittent litigation, at great cost, and meanwhile, no development would be possible. Fortunately, it seems reasonably certain that you will get a compact, and that you shortly will find yourselves in a strategically strong position to get help.

I have mentioned three reasons why I am especially delighted at the outlook. When some weeks ago it was suggested that we sit in with you on this occasion, a suggestion which shortly was followed by an invitation so to do, it appeared to Professor Adams and to me that we ought not to come without any preparation in advance, because, if we should be asked to express any views, or make any suggestions, we obviously would not want to be in a position of attempting to pull a rabbit out of a hat. It happened that several men with whom we wanted to confer in preparation were to be in Salt Lake City on September 3 and 4, so we arranged to devote four days preceding that meeting to exploratory discussion of our various individual notions concerning a compact, based on the report of the Joint Investigation. There were present, in addition to the members of the Consulting Board, Mr. Stafford, Mr. Stevens, Mr. Debler, Mr. McLaughlin, and Mr. Grover, the last three representing the three Federal agencies to which major units of the investigation, you remember, were assigned. We put in four long and busy days. We recognized that certain additional computations, in the light of our discussions, needed to be made, and for that purpose, Mr. Stafford and Mr. Stevens came to Santa Fe last week, spending some four days here before Professor Adams and I arrived last Saturday with Mr. Grover.

The five of us took up again, on Saturday and Sunday, the matters which had been discussed at Salt Lake City, considering them in the light of the computations which Mr. Stafford and Mr. Stevens made. We conceived that your objectives in planning a compact would be of two types. We thought first that an understanding was needed with respect to the allocation of the waters of the river as of the present, an immediate allocation on that basis. We thought, secondly, that you doubtless would be concerned with a longer view, with the problem of augmenting the supply of available water in the basin, and of developing to the full, in orderly, equitable fashion, the potential resources, as well as those now available. In any long view of compact planning, or any other type of planning for water development, we are concerned, of course, in the last analysis, with the welfare of the people within the area involved; with maintaining, or creating and maintaining, a satisfactorily high standard of living. I almost hesitated on Monday to declare it was perfectly obvious that in this area water is life, but assuredly, if you are going to promote the welfare of the people in the immediate future, and in the long future, you must make possible the effective, equitable and full use of the available and potential water resources.

What are the possibilities in terms of water? I do not need to waste your time by painting in detail a picture of the future. You are all as familiar with it as I; perhaps everyone of you is better qualified than I to attempt a picture. I conceive, however, and I think my associates conceive, in the case of the San Luis Valley, of a regulated supply through storage to the end that the available waters may be brought properly into step, in time, with the need for water. And frankly, I do not myself sympathize with the view expressed by some of the Coloradoans themselves, that they do not care to irrigate more land. Taking a long range view, I am disposed to envisage a material increase in the irrigated acreage of San Luis Valley. Coming to the Middle Valley, here in New Mexico, it is almost superfluous to say that it is the heart of the State; it always has been, and always will be. Great in extent, New Mexico, throughout much of its area, is inevitably doomed to a sparse population because of lack of water. Here in the Middle Valley you have one of the denser, if not the densest, rural population in the United States, and the irrigated acreage is much less now than formerly. Here I envisage, in this long view, an augmented supply of water which will make it possible to restore the irrigated acreage to, or considerably beyond, its maximum figure in the past. Going to the lower valley, - shall I say for the sake of brevity the El Paso District, meaning the whole lower end, - what does it need if it is to realize, so far as conditions of water and land are concerned, its potentialities? Of course, it needs an adequate supply of water, a reliable supply and a supply of good quality. Even there I envisage some extension of the irrigated acreage. Hudspeth has poor water and it ought to have good water. There are possibilities for additional irrigation south of that, clear to the canyon - I don't know how many acres, say 10,000 or 15,000. Now all of these things, gentlemen, are possible.

We have been thinking, as Mr. Harper probably has, of a compact of two parts, two titles; title I would allocate the waters now available; title II would provide for a long range development that would bring to the three sections of the valley the possibilities, to which I briefly referred a moment ago. We outlined a plan, in terms of principles for the most part, which it seemed to us constituted an essential framework for the accomplishment of the ends I have indicated. Subsequently, because of your work on the flow schedules, we deleted certain things in our original set-up and had it retyped. I want first to read it through with you, without comment by me or question by you, and without discussion; then I want to go back and comment very briefly perhaps on each of the paragraphs in turn, or at least on several, and then, having thus oriented you with respect to our view, informal discussion can proceed to any extent desirable. (reads)

Suggestions for a Compact submitted by the Consulting Board,  
Rio Grande Joint Investigation.

1. Colorado, New Mexico, and Texas to cooperate in securing the financing and construction of the San Juan-Chama diversion, Wagon Wheel Gap Reservoir. (feasible storage on the Conejos), and State-Line Reservoir at the Ute Mountain site, and, if on further investigation found to be feasible, the enlarging and lining of the Franklin Canal, all on the basis of an equitable apportionment of costs as between the Federal and State Governments and other agencies and the water users to be benefitted.

It is understood that construction of the San Juan-Chama diversion must be predicated on full protection of the rights of the people of San Juan Basin in both Colorado and New Mexico, and must be subject to the terms of the Colorado River Compact as to division of the water allocated by that Compact to the states of the Upper Basin of Colorado River.

2. Colorado to agree to maintain a schedule of state-line flows, and to be permitted to construct storage and alter or increase development at will within the limits of this obligation, and New Mexico to agree to maintain a schedule of inflow to Elephant Butte Reservoir, and within this limit to be allowed to utilize water at will.

3. When the San Juan-Chama Diversion is completed, Colorado to be permitted to reduce the scheduled flow at the state line by any amount she is able to withhold concurrently with the importation from the San Juan Basin, but not to exceed such fractional part as may be agreed upon, and the remainder of the water made available by the San Juan-Chama diversion to be available for use by New Mexico.

4. Subject to the control of releases of water from diversion and storage works provided for in paragraph 5, the Compact to be administered by a Compact Commission composed of three state representatives, to be appointed by the respective Governors of the three states, and one Federal representative, to be appointed by the President of the United States.

5. The Compact to provide for the appointment by the Compact Commission of an Interstate Water Supervisor (who might be designated as the administrative officer of the Commission) with the following duties and authority:

Duties:

(a) to maintain such records, to make such investigations, and to gather such data as may be required for the effective administration of the Compact, and for the cost of which funds

shall have been provided by the Federal government, the compacting states, and other agencies.

(b) To advise with the members of the Compact Commission in any matters relating to compliance with the Compact.

(c) To perform such other duties as shall be assigned to him by the Compact Commission. *with reference to administration of Compact*

*Article*  
*Section*  
Authority:

(a) To control releases of water from diversion and storage works in the basin of the Rio Grande above Ft. Quitman, Texas, the operation of which is essential to the successful working of the Compact, provided he be appointed for that purpose by the authority or agency vested by law with the control of such works.

(b) To exercise such other authority with reference to the administration or enforcement of the Compact as shall be delegated to him by the Compact Commission.

6. The Compact to provide for temporary adjustments by the Compact Commission of the flow schedules agreed upon if there is surplus or anticipated surplus of water at reservoirs below San Marcial.

7. The United States, Colorado, New Mexico, and Texas each to contribute one-fourth of the expense of administering the Compact.

8. The Compact to provide opportunity for revision of its terms, on application of any two of the four Compact Commissioners, after the expiration of an appropriate trial period.

9. The Compact to contain an agreement to submit to arbitration controversies, not satisfactorily adjusted by the Compact Commission, which may arise under the Compact. In determining the nature and the methods of arbitration, the following may well be considered:

(a) Whether the agreement to arbitrate shall include an agreement to abide by the arbitral award.

(b) Whether there shall be an agreement that arbitration shall be invoked prior to court action to enforce the terms of the Compact.

(c) Whether arbitration shall be conducted by one or more arbiters to be appointed by the Chief Justice of the United States, or otherwise.

(d) Whether the matters to be submitted to arbitration shall be specified in the Compact and be limited to the following:

Interpretation of the Compact.

Compliance or non-compliance by any State with the terms of the Compact.

The relative rights of the states under the Compact arising out of changed conditions.



Now, before leaving the outline of the plan with you for any discussion which you may think it merits, let me go back please and comment briefly on successive paragraphs, or at least on some. We have been disposed - and again I am taking the longer and larger view - to think of the San Juan-Chama diversion and Wagon Wheel Gap Reservoir as indispensable elements of the plan.

MR. HINDERLIDER: I do not like to break in and interrupt you, Professor, but I would like to call to your attention that you have inadvertently left out reference to the Conejos Reservoir, and I think it should be included because of the notes being taken down. Or you may have intended to leave that out.

PROF. BARROWS: We did. We thought the Conejos Reservoir should perhaps be looked upon, so far as interstate problems are concerned, as one of the various reservoir sites which, in due time, may be developed, both in Colorado and New Mexico. That, of course, like many other things, is open to difference in judgment and, perhaps, to challenge, but the omission of the Conejos Reservoir in the first paragraph was not due to inadvertence. I might say, since Mr. Hinderlinder raised the question, that we feel reservoir development there to be highly important from the long range point of view. We regret that investigation did not seem to establish, certainly not definitely, the usability of the lower valley site at which most of us looked when we were up there a year ago last spring. We have not the slightest intention of ignoring the Conejos Reservoir, or other projects in New Mexico, for example, which might fit effectively into this picture later.

We are disposed to think that the State Line Reservoir is an essential feature of the plan, and that's another matter on which I do not believe you will be of common mind. We think it is desirable, in part, for re-regulating purposes, and in part for the flood protection which it would provide for the Middle Valley.

The concept with reference to the Franklin Canal - using that term in an inclusive sense - was first suggested to us during the course of our Salt Lake City discussions by Mr. Debler. It seems to me that the value of enlarging, tying up, extending, and cement lining the trunk canal through much, if not all, of its length, is obvious, from the standpoint of augmenting the supply of water and particularly from the standpoint of the highly troublesome salinity problem. If that were done, and if all of the lower lands were served from the trunk canal, not from the river, and if the river channel were used - shall I say - as a sewer, it seems to us that there would be substantial relief of the salinity problem and that such a procedure would effectively supplement any amelioration of conditions through application of the contemplated volumes of water and through dilution. We are sufficiently impressed with the qualitative relationships to be highly desirous of having the best judgment as to their quantitative value that we can get with funds unexpectedly remaining at our disposal. There are left some \$4,000 or \$5,000 from the \$50,000 Caballo Dam fund which, you will remember, was transferred to the Bureau of Reclamation for use in the Rio Grande Joint Investigation. The Consulting Board proposed, the Bureau cordially acquiescing, to spend that money in studies of this subject.

MR. HILL: Does that contemplate by-passing the lower Mesilla Valley drains around the head of the Franklin Canal?

MR. DEBLER: I am thoroughly familiar with those details. I would say this: those drains could form a part of the flow that's given to Old Mexico at the International Dam; then they would be by-passed at this canal head.

MR. HILL: I only raised the question because control of salinity in the El Paso Valley would not be materially improved unless the lower Mesilla Valley was by-passed around the head of the Franklin Canal.

MR. DEBLER: Even though it isn't by-passed, the entire El Paso, Tornillo and Hudspeth Valleys would secure water which now is used by the upper El Paso Valley. In other words, the drain waters of the El Paso Valley itself would not be mixed into the water used for irrigation as they are now. The detail as to these drains I have not thought about because it seems to me it offers further possibility of improving the water supply of the El Paso Valley.

PROF. BARROWS: You will remember how much we all regretted, no one more than Professor Adams and I, that we did not have more money available originally with which to study quality of water. We are glad that some additional studies can now be made that may throw further light on the situation.

May I direct your attention particularly to the closing part of this first paragraph. It is proposed that the various things there indicated shall be brought about by cooperation between the three states and Federal government on the basis of an equitable apportionment of the cost between the Federal government, the states, and the water users. The present estimate for the San Juan diversion is  $17\frac{1}{2}$  millions; Wagon Wheel Gap Reservoir, 11 millions; Ute Mountain Reservoir \$2,600,000; and for enlarging and extending the Franklin Canal - it's only a rough guess - three or three and a half millions - Mr. Hill says \$5,000,000. The combined sum of these items, if we assign five million to the Franklin Canal, would be less than 37 million dollars. It has seemed to me that during the last few days several of you have spoken of the prospective cost of these essential undertakings in a half apologetic manner, as though you considered it as a pretty staggering total. I don't agree with you. When you think of the manifold interests involved, of the interstate relationships with which you have been struggling, of the related international questions, and of all the rest of the program, that program would be justified, in my opinion, if it cost twice as much.

Now with respect to the second paragraph under No. 1, I think no comment is necessary. It seemed to us that the need for such an understanding is obvious.

I will frankly say that we had flow schedules, or a table of suggested schedules of flow, worked out in connection with our original memorandum and were happy when your progress made them irrelevant. Accordingly, reference is made to state line deliveries and to deliveries into Elephant Butte only in principle, as in paragraph 2.

I observe there is a difference of opinion with respect to our statement in paragraph 3. Participation by Colorado in the transmountain diversion might be considered from two distinct points of view: (1) from that of Colorado's interest as a party to the Colorado River Compact, and (2) from that of Colorado's interest entirely aside from the Colorado River Compact. In one case Colorado naturally would participate as a member of the Upper Colorado Basin group and be charged with any water carried through the San Juan-Chama diversion and made available, by exchange, for her use. In the other case Colorado's interest in a supply originating within her boundaries might be a factor. However, the states concerned may regard this analysis, the Consulting Board does not propose that New Mexico be charged with water carried through the San Juan-Chama diversion and credited, by exchange, to Colorado. Continuing my practice of utter frankness, I am going to say, without authorization by my associates, that we had conceived of an allowance to Colorado of approximately one-fourth of the San Juan-Chama diversion as a possible basis for discussion. If you were to ask why one-fourth rather than one-fifth or one-third, I couldn't put on the table factual data in support of it. I do feel, and we all do, that Colorado should have some recognition in the use of this proposed diversion route, but we feel it should be definitely minor.

In connection with paragraph 4, I think I need to say nothing, perhaps. We conceive that you will want, of course, and will need, carefully to consider your administrative machinery, the machinery of control, and we discussed it at length in Salt Lake City. Subsequently, Professor Adams conferred with various men in Washington who have had experience in other fields with some of the things with which we think you would be confronted in principle, and out of that consideration and those discussions came the suggestions of item No. 5, and also of 9, I might add. No. 6, you have already covered in principle in your discussions. No. 7 seems to us fair and reasonable. If this Compact is consummated, and if there is a federal representative on the proposed Compact Commission, it would seem entirely fair that the United States bear one-fourth of the cost of administering the Compact.

I think we all felt rather earnestly in connection with No. 8; certainly I did, and perhaps I had better express myself with respect to it, on a personal basis, lest I over-emphasize it from the point of view of my associates. I do not know how it is here, but I do know that in certain other parts of the country, the lay mind shrinks from the implications of the term "permanent" compact. You have a temporary compact and all of us, therefore, naturally talk about a permanent compact, but I cannot conceive of a compact of indefinite duration that would not need review, and possibly revision, from time to time. It would seem desirable that the agreement specifically provide opportunity for revision of its terms, after the expiration of a trial period.

No. 9 seems somewhat important and is based on the Salt Lake City discussions and the later interviews in Washington to which I have already referred. We believe that the Compact might well contain an agreement to submit to arbitration any controversy that may arise and may not be satisfactorily adjusted by the Commission. As the wording of the memorandum indicates, we have merely set down various items with reference to methods of arbitration which we thought might well be considered. I believe, Mr. Chairman, that's all I need to say.

MR. HARPER: We are very grateful, I am sure, for your very lucid and frank statement of the problems confronting us as you see them. I am sure Professor Barrows will be glad to answer any questions which any of the Commissioners, or those sitting around the table, wish to ask. If not, I will be glad to have any suggestions from the Commissioners as to procedure from here on.

MR. HINDERLIDER: I want to say on behalf of Colorado, we very deeply appreciate the splendid work that has been done by Dr. Barrows and his associates, not only with respect to the Rio Grande Joint Investigation and the fund of information that work has provided for use of the three states, but also for the suggestions he has made; and also for the constructive views he has expressed. We, of course, do not say at this time we would agree, in whole or in part, with any and all of the suggestions, but I think they are such as we may all profitably take home and give careful and serious consideration to.

MR. CLAYTON: I join in your remarks of appreciation for the interest Dr. Barrows and his associates have shown, and I concur in what Mr. Hinderlinder has said about the suggestions that have been made by Dr. Barrows, but it is, of course, something we will have to study. Off-hand, speaking for myself, it seems to me that many, if not all, of these suggestions have a great deal of merit. It occurs to me that the Commission would hardly be in a position to pass definitely upon these proposals by tomorrow, as at that time, as I understand it, at least one of the Commissioners, and perhaps two, and certainly some of their advisers, have to leave. Therefore, unless there are proposals by the other two states which we can consider tomorrow, it would be my thought that we should recess at this time for such period as would be satisfactory to the Commissioners, in order that we can give careful and mature consideration to Dr. Barrows' very meritorious suggestions. We have discussed, and we have exhausted, until further research is possible, the engineering suggestions for deliveries at the state line and San Marcial, and until the engineers have had an opportunity to check on these figures, I think further discussion would be profitless. If the other Commissioners concur with me in these views, I think it would perhaps save time to recess this afternoon until some time in the future.

\* \* \* \* \*

MR. HINDERLIDER: I offer a resolution that the suggestion made by Dr. Barrows and his associates be accepted, and that copies of their proposal be not handed to the press or made public.

MAJOR BURGESS: Shouldn't that also include our State's business?

MR. HINDERLIDER: Yes, I will include that also.

The resolution was seconded by Mr. McClure and unanimously adopted.

\* \* \* \* \*

MR. CLAYTON: In line with the conversation had by the Commissioners, I move that one engineering consultant of each State, together with Mr. E. B. Debler, meet in Santa Fe, or such other place as they may mutually elect, on October 25, for the purpose of discussing the engineering features, particularly of the state line deliveries and deliveries at San Marcial, in order to determine if they can arrive at a determination of general principles and if possible agree on the details of the deliveries, and the engineering factual data which should underlie the compact. Also that the meeting of the Commission itself be deferred to such date as may be mutually agreed upon, pursuant to the call of the Chairman.

Said motion was seconded by Mr. Hinderlider and unanimously carried.

MR. HARPER: If there is nothing else to come before this meeting at this time, we will stand adjourned, subject to call of the Chairman.

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EXHIBIT NO. 1.

STATEMENT OF THE VIEWS AS TO THE ESSENTIALS  
FOR A PERMANENT COMPACT ON THE RIO GRANDE,

Submitted by

The Commissioner for Colorado at the Conference of the Rio Grande Compact Commission at Santa Fe, New Mexico, September 28, 1937.

Article VII of the Rio Grande Compact, among other things, provides:

"That the Governors of each of the signatory states shall appoint a Commissioner for the purpose of concluding a compact among the signatory states providing for the equitable apportionment of the use of the waters of the Rio Grande among the said states, and that the Commission so named shall equitably apportion the waters of the Rio Grande as of conditions obtaining on the river and within the Rio Grande Basin at the time of the signing of the Compact."

Colorado, therefore, assumes that this conference of necessity is called in harmony with the aforementioned provisions of the Compact.

It is the position of Colorado that an adequate supply of water exists in the Upper Rio Grande Basin above Fort Quitman which, if properly regulated and used, will meet the requirements of present irrigation development in that Basin at the date of the signing of the Compact, and under present conditions to the extent indicated by the Report of the Rio Grande Joint Investigation.

Facilities now exist in the Middle and Elephant Butte-Fort Quitman sections of the Basin to regulate the water in such manner as to provide a perfect water supply, except during very infrequent periods of drouth. Such periods are so infrequent that it would be uneconomical to provide additional storage, or other means, to relieve shortages due to such drouths.

Inadequate facilities exist in the San Luis section to regulate the water supplies required for the proper irrigation of lands, the irrigation of which was initiated many years prior to the construction of all present reservoirs in the two lower sections of the river.

For more than forty (40) years Colorado has been denied the right to properly regulate the waters theretofore applied to beneficial use, which has resulted in a direct loss and injury to Colorado and its citizens, conservatively estimated at not less than \$200,000,000.

Colorado asserts that equitable apportionment of the use of the waters of the Rio Grande, as provided by the Rio Grande Compact, must include the necessary regulation of these waters for the most efficient use of the same.

Sufficient storage capacity can be provided and operated to furnish a water supply for the San Luis section comparable to that which now exists in the Middle and Elephant Butte-Fort Quitman sections, without adversely affecting the water supplies for those sections. As a matter of fact, the usable water supply for the Middle section would be improved by the construction and operation of the reservoirs required in the San Luis section.

All this is shown by the attached graphs which have been prepared from certain tables appearing in Part I, Vol. I, of the Report of the Rio Grande Joint Investigation.

The first graph hereto attached shows shortages in irrigation requirements which exist under present conditions of development in the San Luis Valley section along the main river, and in the Middle and Elephant Butte-Fort Quitman sections.

The periods covered are 1892 to 1904, inclusive, and 1911 to 1935, inclusive. The period 1905 to 1910, inclusive, is not included since there was no critical period of water supply during those years.

The second graph shows the shortages which would exist in the three sections of the Basin if the Wagon Wheel Gap Reservoir were constructed and operated.

The data from which the graphs were prepared were taken from tables 114 to 116 of Part I, Vol. I, of the Report of the Rio Grande Joint Investigation.

It will be noted from the first graph that shortages in irrigation requirements would occur in the San Luis section in each of the years covered by the graph. As a matter of fact, shortages would occur during every single year of a 48-year period such as that of 1890 to 1937. Many of such shortages would amount to over 50 percent of the irrigation requirement. The shortage would average more than 30 percent of the irrigation requirement for periods as great as 13 years. Similar shortage would occur on the Conejos River also.

On the other hand, it will be noted from the graph that in the Middle section of the Basin there are only eight years during the entire period under consideration when shortage would have occurred, and only three years in the Elephant Butte-Fort Quitman section. During four of the eight years in the Middle section and one of the three years in the Elephant Butte-Fort Quitman section, the shortages would have been negligible.

Attention is now directed to the second graph which shows conditions which would obtain in the three sections if the Wagon Wheel Gap Reservoir were constructed and operated. Note that in the San Luis section the shortage would have been eliminated for all years from 1892 to 1935, except in the five years from 1899 to 1902 and 1904.

In the Middle section the shortage during the years 1894, 1899, and 1931, would have been entirely eliminated, and other indicated shortages would have been materially reduced.

In the Elephant Butte-Fort Quitman section the operation of the Wagon Wheel Gap Reservoir would have reduced the indicated shortage in 1902. The indicated shortage of 1904 would have been increased somewhat by increased uses of water in the Middle section. Only those two years of shortage, in addition to a negligible one in 1903, would have occurred in this section during a period such as 1892 to 1935, and such shortages would occur without the Wagon Wheel Gap Reservoir being in operation.

Part I, Vol. I, of the Report of the Rio Grande Joint Investigation under assumed condition No. 7, page 379, and Table 115 shows that storage capacity at least equal to that of the capacity of the Wagon Wheel Gap Reservoir could be constructed and operated on the main stem of the Rio Grande in Colorado, and storage in an amount of at least 162,000 acre-feet could be constructed and operated on the Conejos River without adversely affecting the water supply of the lower sections of the Basin.

The above analysis, together with the attached exhibits, show the lack of parity between the San Luis section and the two lower sections of the Basin.

Colorado submits that recognition be accorded its citizens to construct and operate the reservoirs required in the San Luis section of the Basin to place the water supplies of that section on a parity with the water supply of the Middle and Elephant Butte-Fort Quitman sections of the river.

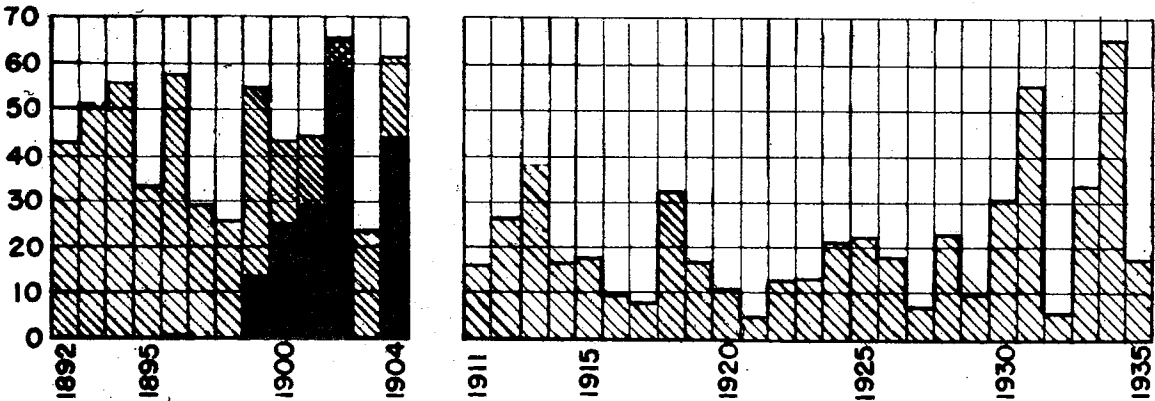
(Sgd.) M. C. Hinderlider,  
Rio Grande Compact Commissioner  
for the State of Colorado.



UPPER RIO GRANDE BASIN  
SHORTAGES ASSUMING WAGON WHEEL GAP  
RESERVOIR CONSTRUCTED

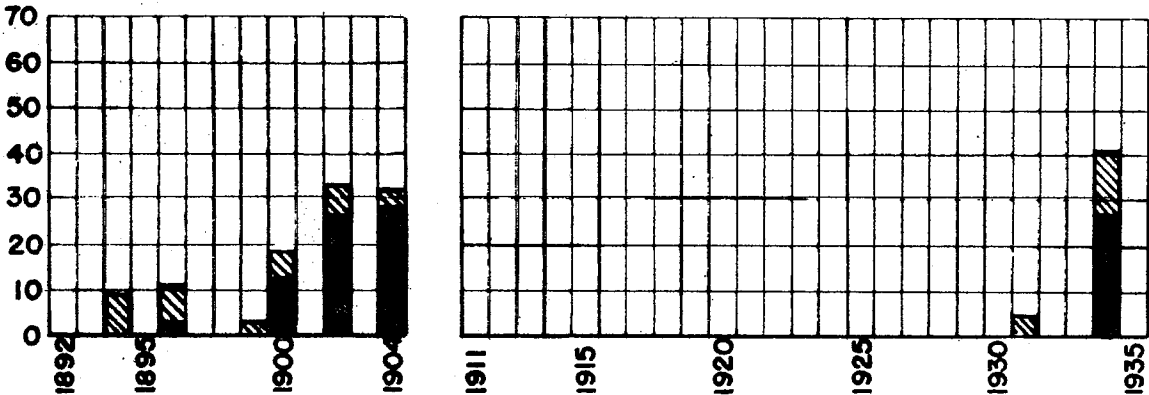
SAN LUIS SECTION — MAIN RIO GRANDE

Table 114



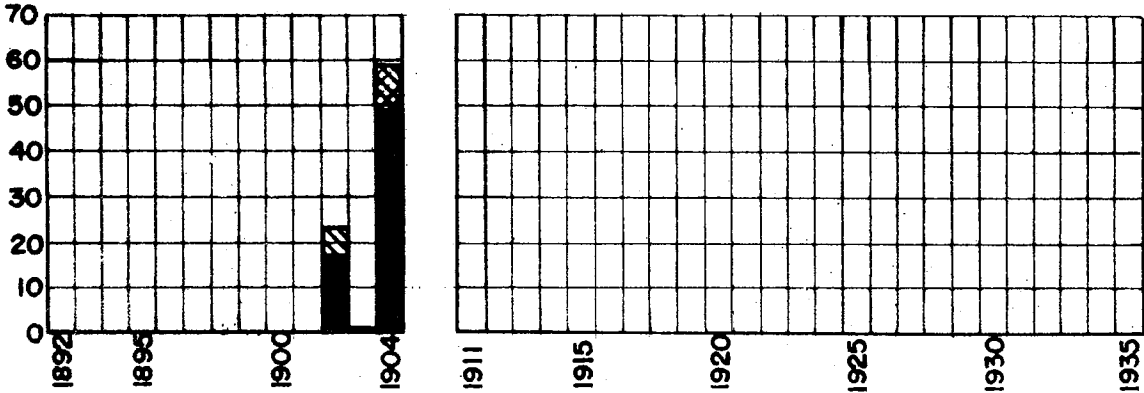
MIDDLE SECTION

Table 115



ELEPHANT BUTTE — FT. QUITMAN SECTION

Table 116



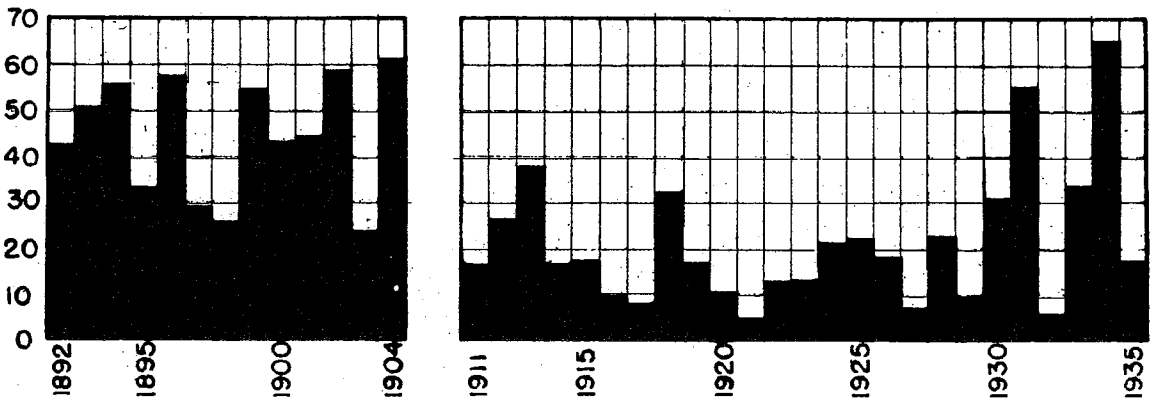
■ SHORTAGE WITH RESERVOIR    ▨ SHORTAGE WITH RESERVOIR IN EXCESS OF PRESENT SHORTAGE  
▩ SHORTAGE RELIEVED BY RESERVOIR

DATA FROM RIO GRANDE JOINT INVESTIGATION—PART I, VOL. I  
COLORADO STATE PLANNING COMMISSION — SEPT. 1937

UPPER RIO GRANDE BASIN  
SHORTAGES UNDER PRESENT CONDITIONS

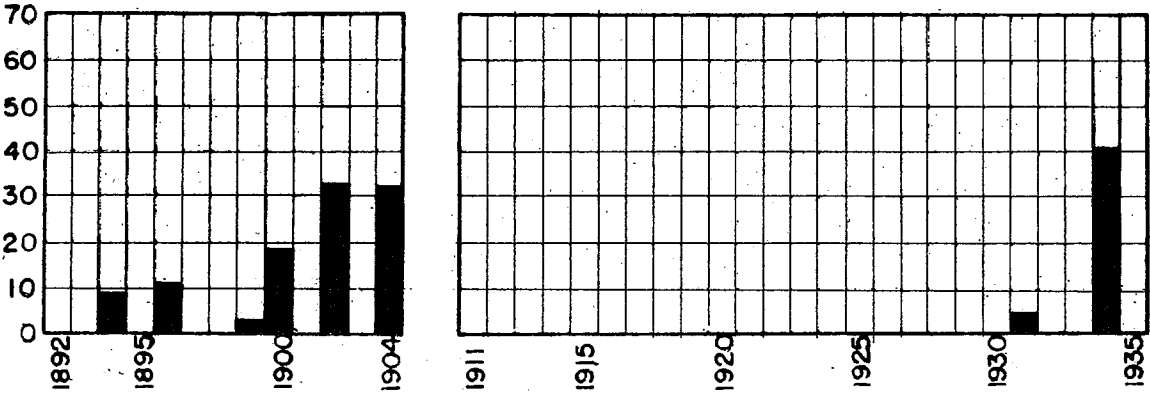
SAN LUIS SECTION — MAIN RIO GRANDE

Table 114



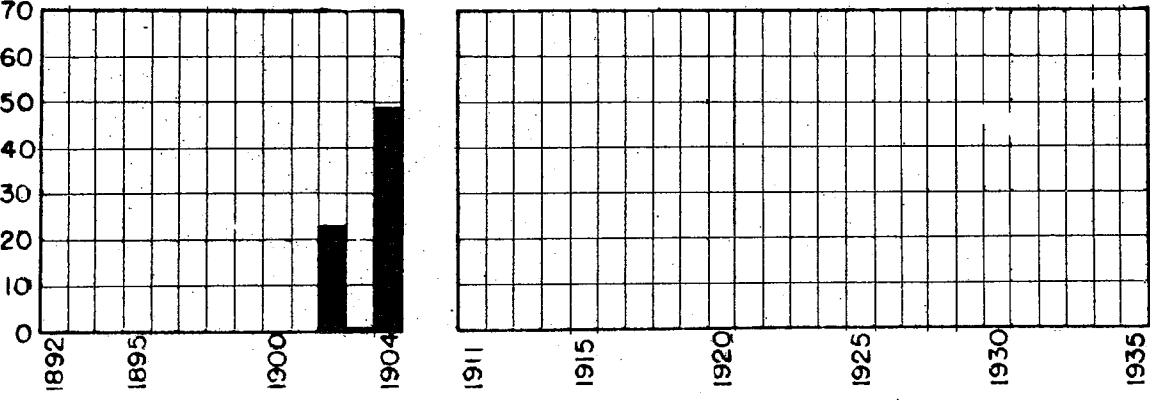
MIDDLE SECTION

Table 115



ELEPHANT BUTTE — FT. QUITMAN SECTION

Table 116



DATA FROM RIO GRANDE JOINT INVESTIGATION — PART I, VOL. I

EXHIBIT NO. 2.

STATEMENT SUBMITTED BY THOMAS M. McCLURE,  
COMMISSIONER FOR NEW MEXICO.

New Mexico is willing to negotiate with Colorado and Texas for a permanent compact to equitably distribute the waters of the Rio Grande among the states on the basis of the following minimum requirements for the State of New Mexico:

First. New Mexico is willing to negotiate with Colorado for increased storage within the Rio Grande Basin in Colorado, provided that proper safeguards for the rights of New Mexico shall be made to protect the interests of the water users of New Mexico; and provided also that the transmountain diversion from the San Juan River and its tributaries to the Chama River is made an accomplished fact coincident with the construction of such storage in Colorado.

Second. New Mexico is willing to negotiate with the State of Texas as to the right to the use of water claimed by citizens of Texas under the Elephant Butte Project on the basis of fixing a definite amount of water to which said project is entitled. Provided, however, that upon the completion of the All-American Diversion Dam and Canal, Mexico shall be limited strictly to treaty provision of 60,000 acre-feet per annum for use in the Republic of Mexico.

Third. Provided, further, that New Mexico and the Middle Rio Grande Conservancy District shall not be deprived of their rights to the full development and operation of the Middle Rio Grande Conservancy District, as shown by its plans on file with the State Engineer; for the development, irrigation and cultivation of approximately 123,000 acres from the waters of the Rio Grande.

Fourth. All existing rights to the use of water in the Rio Grande Basin in New Mexico shall be recognized as having the right to an adequate supply of water from said River System.

Fifth. New Mexico shall have the right to construct all necessary flood protection works to safeguard property, within the Rio Grande Basin in New Mexico, against flood damage.

(Sgd.) Thomas M. McClure,  
Rio Grande Compact Commis-  
sioner for New Mexico.

September 28, 1937.

EXHIBIT NO. 3.

STATEMENT SUBMITTED BY FRANK B. CLAYTON,  
COMMISSIONER FOR TEXAS.

To Mr. S. O. Harper, Chairman,  
and Members of the Rio Grande Compact  
Commission from Colorado and New Mexico.

Although the State of Texas feels that it should share in the benefits from new works for the augmentation of the water supply of the Rio Grande, it will not insist thereon, provided that the States of Colorado and New Mexico will release and deliver at San Marcial a supply of water sufficient to assure the release annually from Elephant Butte Reservoir, of 800,000 acre-feet of the same average quality as during the past ten years, or the equivalent of this quantity if the quality of the supply is altered by any developments upstream.

(Sgd.) Frank B. Clayton,  
Rio Grande Compact Commis-  
sioner for Texas.

EXHIBIT NO. 4.

SCHEDULE SUBMITTED BY COLORADO.

Deliveries of water shall be made by Colorado at Lobatos Gaging Station near the Colorado-New Mexico State Line in accordance with the following schedule, which indicates the relation, under present conditions (1928-1937) of development, between the recorded flow of the Rio Grande at the gaging station near Del Norte, plus the recorded flow of the Conejos at the Mogote gaging station, and the recorded flow of the Rio Grande at the Lobatos gaging station:

<u>Recorded flow of Rio Grande near Del Norte, plus recorded flow of Conejos at Mogote.</u>	<u>Recorded flow of Rio Grande at Lobatos.</u>
400,000 ac. ft.	80,000 ac. ft.
500,000 "	120,000 "
600,000 "	175,000 "
700,000 "	230,000 "
800,000 "	285,000 "
900,000 "	350,000 "
1,000,000 "	420,000 "
1,110,000 "	490,000 "
1,200,000 "	565,000 "
1,300,000 "	650,000 "
1,400,000 "	745,000 "
1,500,000 "	840,000 "

Delivery shall not be required on an annual basis in accordance with the above schedule, but credits and/or debits shall be allowed to accumulate over a period of years subject to the following conditions:

1. At any time when accumulated debits exceed the unfilled effective capacity of Rio Grande Project storage, that portion which is in excess of the unfilled capacity shall be written off.
2. Accumulated credits shall be reduced by the amount of actual spill from Rio Grande Project storage during the periods when spill occurs.
3. The mean required releases from Rio Grande Project storage shall be considered as 750,000 acre-feet per year.
4. In calculating Colorado debits, cumulative debits shall be reduced by an amount that the total releases from Rio Grande Project storage exceed 750,000 acre-feet per annum.

5. In the event that the contents of Rio Grande Project storage shall drop below 300,000 acre-feet on April first of any year, and Colorado owes water to the river, the amount owed shall be released from reservoirs constructed after the consummation of a permanent Compact, and delivered to the state line.

6. Future reservoir construction and operation in Colorado shall not impair the present flow at the Lobatos gaging station during those periods when the flow at Otowi Bridge gaging station would be insufficient under present conditions to supply the requirements of the Middle Rio Grande Conservancy District as defined by the report of the National Resources Committee.

New Mexico, and the Middle Rio Grande Conservancy Project, shall agree not to deplete the flow of the river at San Marcial. Any cumulative shortage in the river flow at San Marcial, caused by water uses above that point in New Mexico, shall be supplied by New Mexico, should the contents of Rio Grande Project storage drop below the amount specified above.

In calculating the combined flow of the Rio Grande at Del Norte, and the Conejos at Mogote, for application to the above schedule, water imported to the area above either, or both, of these gaging stations by projects constructed after October 1, 1937, shall be subtracted from the combined recorded flow at those stations, and the resulting indicated flow shall be applied to the schedule to determine the amount of water that shall be delivered at the Lobatos gaging station.

When and if water is imported to the Upper Rio Grande Basin below the Colorado-New Mexico state line at no expense to either of the signatory states, the amount of water required to be delivered by Colorado at Lobatos gaging station, as defined by the above schedule, shall be reduced in an amount equal to 50 percent of the imported water as measured each year. In the event water is imported from Colorado to the area below Colorado-New Mexico state line by projects financed by New Mexico, the amount of water required to be delivered by Colorado at Lobatos, as defined by the above schedule, shall be reduced in an amount equal to 20 percent of the imported water as measured each year.

In the event that power is developed by projects constructed to import water to the basin below the Colorado-New Mexico state line, Colorado shall not be discriminated against in the allocation of the power or the establishment of rates.

The provisions outlined above with respect to state line deliveries, in accordance with the suggested schedule, shall not become effective until the contemplated storage in the San Luis section is constructed and placed in operation.

EXHIBIT NO. 5.

SCHEDULE OF RIO GRANDE FLOW TO PASS THE  
NEW MEXICO-COLORADO STATE LINE,

Submitted by New Mexico.

The aggregate discharge of the Rio Grande passing the New Mexico-Colorado state line in each period of sixty (60) consecutive months shall be not less than the quantities stated in the following table when the aggregate discharge of the Rio Grande immediately above the first point of diversion to lands in the San Luis Valley over the same period of time is as follows:

<u>Aggregate Discharge Near Del Norte in 60 Consecu- tive Months.</u>	<u>Corresponding Aggregate Discharge Passing N.Mex.- Colo. State Line.</u>
2,000,000 ac. ft.	1,200,000 ac. ft.
3,000,000 "	1,800,000 "
4,000,000 "	2,600,000 "
5,000,000 "	3,500,000 "
6,000,000 "	4,500,000 "

Intermediate quantities shall be in proportion to the respective values in the above table.

Provided that the total discharge passing the New Mexico-Colorado state line in any twelve (12) consecutive months shall not be less than 25 percent of the total quantity in the Rio Grande measured immediately above said first point of diversion in the same period of time.

Provided, further, that the flow passing the New Mexico-Colorado state line shall not be less than 100 cubic-feet per second during the period of time from June 15 to September 15 of any year.

Provided, further, that quantities set forth above shall be exclusive of any amount of water which may be discharged into the Rio Grande from the sump drain or other drains from the San Luis lakes.

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EXHIBIT NO. 6.

SCHEDULE SUBMITTED BY TEXAS.

DELIVERIES AT SAN MARCIAL.

Over each period of sixty consecutive months the total discharge of the Rio Grande as measured at San Marcial shall be not less than that set forth in the following tabulation as corresponding to certain amounts of full natural runoff of the Rio Grande at Otowi originating in New Mexico, and for other amounts of such natural runoff the corresponding total discharge at San Marcial shall be equal to that corresponding to the next lower amount of runoff plus the same proportion of the respective increments between said lower values and the next higher amounts set forth in the tabulation below:

<u>Full Natural Runoff at Otowi, originating in New Mexico, over any period of 60 conse- cutive months.</u>	<u>Corresponding Total Dis- charge at San Marcial over same period of time.</u>
1,000,000 ac. ft.	1,000,000 ac. ft.
2,000,000 "	2,000,000 "
3,000,000 "	3,500,000 "
4,000,000 "	5,500,000 "
5,000,000 "	8,000,000 "
6,000,000 "	10,500,000 "

Said deliveries at San Marcial may be made at any time within the sixty-month period, provided that the total amount of water stored in reservoirs in the Rio Grande Basin in New Mexico above San Marcial shall at no time exceed thirty percent of the quantity then in storage in reservoirs on the Rio Grande between San Marcial and Fort Quitman.

Provided further that the amounts of water to be delivered at San Marcial as set forth above, shall be increased by five percent for each ten percent increase above 0.7 tons per acre-foot average concentration of dissolved solids in the water so delivered.

All provided that each incomplete sixty-month period shall be deemed ended whenever all reservoirs on the Rio Grande between San Marcial and Fort Quitman are filled and the next succeeding sixty-month period shall commence when water is thereafter first withdrawn from storage in any of said reservoirs.

For the purposes of this Compact, the flow as measured at Otowi minus the flow as measured at or near Lobatos, but below any dam near the state line, if such be constructed, shall be deemed to be the natural runoff at Otowi originating in New Mexico, provided that the measured flow at Otowi shall be adjusted for the effect of any works



constructed after October 1, 1937, which alter the consumptive use of water in New Mexico above Otowi or which increase the quantity at Otowi by importations from without the Rio Grande Basin.

#### IN RE STATE LINE SCHEDULES

In order that no physical situation should develop which would make it impracticable for Colorado to deliver in the latter part of any sixty-month period, the remainder required under the schedule suggested by New Mexico, the measured flow at Del Norte should be the index of deliveries at the state line, and the accumulated delivery throughout any part of a sixty-month period should bear the same relation to the accumulated discharge at Del Norte over the same period of time that the total required delivery at the state line over any period of sixty consecutive months as set forth in said schedule bears to the total discharge at Del Norte over the same sixty months.

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