DEPARTMENT OF THE INTERIOR

WATER-SUPPLY

AND

IRRIGATION PAPERS

OF THE

UNITED STATES GEOLOGICAL SURVEY

No. 23

WATER-RIGHT PROBLEMS OF THE BIGHORN MOUNTAINS.—MEAD

WASHINGTON
GOVERNMENT PRINTING OFFICE
1899

IRRIGATION REPORTS.

The following list contains titles and brief descriptions of the principal reports relating to water supply and irrigation, prepared by the United States Geological Survey since 1890:

1890.

First Annual Report of the United States Irrigation Survey, 1890; octavo, 123 pp.

Printed as Part II, Irrigation of the Tenth Annual Report of the United States Geological Survey, 1888-89. Contains a statement of the origin of the Irrigation Survey, a preliminary report on the organization and prosecution of the survey of the arid lands for purposes of irrigation, and report of work done during 1890.

1891.

Second Annual Report of the United States Irrigation Survey, 1891; octavo, 395 pp.

Published as Part II, Irrigation, of the Eleventh Annual Report of the United States Geological Survey, 1889-90. Contains a description of the hydrography of the arid region and of the engineering operations carried on by the Irrigation Survey during 1890; also the statement of the Director of the Survey to the House Committee on Irrigation, and other papers, including a bibliography of irrigation literature. Illustrated by 29 plates and 4 figures.

Third Annual Report of the United States Irrigation Survey, 1891; octavo, 576 pp.

Printed as Part II of the Twelfth Annual Report of the United States Geological Survey, 1890-91. Contains "Report upon the location and survey of reservoir sites during the fiscal year ended June 30, 1891," by A. H. Thompson; "Hydrography of the arid regions," by F. H. Newell; "Irrigation in India," by Herbert M. Wilson. Illustrated by 93 plates and 190 figures.

Bulletins of the Eleventh Census of the United States upon irrigation, prepared by F. H. Newell; quarto.

No. 35, Irrigation in Arizona; No. 60, Irrigation in New Mexico; No. 85, Irrigation in Utah; No. 107, Irrigation in Wyoming; No. 153, Irrigation in Montana; No. 157, Irrigation in Idaho; No. 163, Irrigation in Nevada; No. 178, Irrigation in Oregon; No. 193, Artesian wells for irrigation; No. 198, Irrigation in Washington.

1892.

Irrigation of western United States, by F. H. Newell; extra census bulletin No. 23, September 9, 1892; quarto, 22 pp.

Contains tabulations showing the total number, average size, etc, of irrigated holdings, the total area and average size of irrigated farms in the subhumid regions, the percentage of number of farms irrigated, character of crops, value of irrigated lands, the average cost of irrigation, the investment and profits, together with a résumé of the water supply and a description of irrigation by artesian wells. Illustrated by colored maps showing the location and relative extent of the irrigated areas.

1893.

Thirteenth Annual Report of the United States Geological Survey, 1891-92, Part III, Irrigation, 1893; octavo, 486 pp.

Consists of three papers: "Water supply for irrigation," by F. H. Newell; "American irrigation engineering" and "Engineering results of the Irrigation Survey," by Herbert M. Wilson; "Construction of topographic maps and selection and survey of reservoir sites," by A. H. Thompson. Illustrated by 77 plates and 119 figures.

A geological reconnoissance in central Washington, by Israel Cook Russell, 1893; octavo, 108 pp., 15 plates. Bulletin No. 108 of the United States Geological Survey; price, 15 cents.

Contains a description of the examination of the geologic structure in and adjacent to the drainage basin of Yakima River and the great plains of the Columbia to the east of this area, with special reference to the occurrence of artesian waters.

1894.

Report on agriculture by irrigation in the western part of the United States at the Eleventh Census, 1890, by F. H. Newell, 1894; quarto, 283 pp.

Consists of a general description of the condition of irrigation in the United States, the area irrigated, cost of works, their value and profits; also describes the water supply, the value of water, of artesian wells, reservoirs, and other details; then takes up each State and Territory in order, giving a general description of the condition of agriculture by irrigation, and discusses the physical conditions and local peculiarities in each county.

Fourteenth Annual Report of the United States Geological Survey, 1892-93, in two parts; Part II, Accompanying papers, 1894; octavo, 597 pp.

Contains papers on "Potable waters of the eastern United States," by W J McGee; "Natural mineral waters of the United States," by A. C. Peale; "Results of stream measurements," by F. H. Newell. Illustrated by maps and diagrams.

(Continued on third page of cover.)

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UNITED STATES GEOLOGICAL SURVEY

CHARLES D. WALCOTT, DIRECTOR

WATER-RIGHT PROBLEMS

OF THE

BIGHORN MOUNTAINS

BY

ELWOOD MEAD

WASHINGTON

GOVERNMENT PRINTING OFFICE

1899

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DEPARTMENT OF THE INTERIOR,
UNITED STATES GEOLOGICAL SURVEY,
DIVISION OF HYDROGRAPHY,
Washington, October 28, 1898.

SIR: I have the honor to transmit herewith the manuscript for a paper entitled Water-Right Problems of the Bighorn Mountains, by Prof. Elwood Mead, State engineer of Wyoming. This paper calls particular attention to the complications arising in the distribution of water as a result of the haphazard construction of small irrigation ditches. The problems encountered in this region are typical of those which are to be met in nearly every State of the West, or which will be met in the near future. The difficulties found in the area described are accentuated by the diversion of water from one stream across divides into other natural drainage lines, thus connecting and greatly complicating the water rights of one individual with those of others. The calling of public attention to these conditions will go far toward arousing enlightened sentiments in behalf of more comprehensive laws in other States and should bring needed support to the efforts of officials in their attempts to distribute equitably the waters of the flowing streams.

Very respectfully,

F. H. NEWELL,
Hydrographer in Charge.

Hon. CHARLES D. WALCOTT,
Director United States Geological Survey.

A. NORTH SIDE OF CLOUD PEAK.

B. BIGHORN MOUNTAINS AS SEEN FROM BUFFALO, WYOMING.

WATER-RIGHT PROBLEMS OF THE BIGHORN MOUNTAINS.

By ELWOOD MEAD.

INTRODUCTION.

The Bighorn Range is the most impressive feature in the landscape of northern Wyoming, and its scenic beauties are made the more attractive by the striking contrast they afford to the surrounding region. The traveler from the East or the South finds the clear, cold, perennial streams which flow from its snow-clad summits a grateful relief from the alkaline pools or dry sand channels which have to be largely relied on when journeying toward them. The lofty and rugged pinnacles of Cloud Peak (shown in Pl. I, *A*) are made all the more commanding because the bad-land hills, which form the summit of the Cheyenne watershed, are so commonplace and unattractive. West of the range is the Bighorn Basin, the lowest and most arid section of the State, where the dusty roads and gray stretches of sagebrush make a traveler look with longing at the snow-crowned, forest-clad slopes of the mountain barrier to the east.

In the arid States mountains, not plains, control agricultural development, and this isolated barrier, which rises near the middle of the northern boundary and extends southeast nearly to the center of the State, has done more to people the northern half of Wyoming than all other influences combined. Without it the section, now gridironed with ditches and supporting about one-fourth the population of the State, would be an open range supporting a few migratory flocks of sheep and herds of cattle. The latent wealth of the few hundred square miles of rocky, barren, and almost unoccupied land surface, over 8,000 feet above sea level, is far greater than that of any equal area in the valley below. This region gathers and stores the moisture which alone gives value to the land below. The perennial streams thereby created have, in their diversion and use, given employment to more people, attracted the investment of more capital, and created more problems to tax the wisdom of the lawmakers than has all the unimproved unirrigated farming land in the State.

The ease and cheapness with which the streams can be diverted, the fertility of the soil, and the exceptional value of the surrounding grazing land have made this section an attractive location for the home-

seeker of limited means. It is a region of small ditches and individual appropriators of water. On the eastern slope appropriation began before there were any laws governing the recording or establishment of rights thereto, while the isolation of the early settlers made them disregard or give little heed to water-right problems until the needs of users began to exceed the available supply; since then the multitude of rights, resulting from the haphazard location of ditches, has made a satisfactory settlement of many of these problems unusually difficult. Before discussing these problems a brief review will be given of the progress made in the twenty years which have elapsed since Manlius Redmond, a settler on Clear Creek, built the first ditch and became the pioneer farmer of the northern half of the State.

At that time the nearest railway station in the State was Rock Creek, on the Union Pacific, nearly 300 miles away. There was not a flour mill in the State, and the long, hazardous, and expensive trip necessary to secure the plow which turned the first furrow and the food for the men who worked on it added greatly to its cost. Reclaiming the desert under such conditions had many drawbacks, and the earlier ditches were of the crudest and simplest character. There was no attempt at any comprehensive projects. Each irrigator was a law to himself. Cooperative ditches or canals were rare exceptions. This explains the large number of ditches of record, and is the cause of many of the obstacles to the satisfactory division of water which confront those charged with this duty.

NUMBER OF APPROPRIATIONS AND ACREAGE RECLAIMED.

The records of the State engineer's office show that there are 1,051 adjudicated rights to the water flowing out of these mountains. There are also 269 claims which have been recorded and approved, but not adjudicated. In addition there are probably 100 ditches using water for which no claim has been filed. The adjudicated rights describe 139,478 acres of land to which these rights are attached in the orders of the board of control establishing them, and there are appropriations from Crazy Woman Creek aggregating 925.25 second-feet where the land irrigated is not described. Four flour mills have rights to water for power purposes aggregating 324.50 second-feet, and the several cities and towns of this region have adjudicated rights for power and domestic purposes amounting altogether to 80.6 second-feet.

Along the northern end of the range some promising placer fields have been discovered, and rights to 137.6 second-feet have been acquired with which to work them. The total volume of the adjudicated rights (3,455.4 second-feet) is in excess of the low-water discharge of the streams against which they are held, but is below the maximum discharge, so that the securing of a stable and adequate water supply for many of the irrigators holding adjudicated rights is a question of

storage. While all of the rights for irrigation, established by the board of control, are based on State surveys of the ditches and on sworn statements of the acreage irrigated by the appropriators, there is no question that these statements are somewhat in excess of the truth. Irrigation and reclamation are elastic terms. Spreading water over land to increase the growth of grass for pasturage purposes is irrigation and is so held by the board of control, but it is not the complete reclamation that is accomplished by cultivation. The tendency to augment the acreage actually watered is so common as to lead to the belief that it is unconscious. In the absence of exaggeration so gross as to constitute an injustice to other users, such a claim usually passes without protest unless it includes land which the State engineer's surveys show to be not susceptible of irrigation. The total acreage irrigated is, therefore, below the figures before given. A deduction of 10 per cent for exaggerated acreages and for areas which have only a surplus or flood-water supply would not be excessive, and would leave 125,000 acres as the actual area irrigated under rights established by the board of control. This is more than half the acreage given as irrigated in the entire State by the Tenth Census.

It is impossible to speak with equal certainty regarding the acreage irrigated under appropriations approved by the State engineer's office, but which have not yet been established by order of the board of control. In making a summary of these rights from the records of the engineer's office, all canceled permits, or those which have not complied with the requirements of the State law, have been excluded. This disposes of all the speculative filings which were made prior to 1894, during the time that no fee was required for the examination and record of applications to appropriate water. Since that time the stringent regulations governing the preparation of these filings have made applications so expensive that the tendency to make these for speculative purposes has almost disappeared. While the applications for permits recently approved do not represent actual utilization, they do represent projects based on reliable surveys, which are being carried out by people who are in earnest and who have sufficient investment in the work to make its completion probable. This is more nearly true of the appropriation of water from the streams of this region than of any other section of the State, as there are no large projects. These recorded and approved permits describe 214,000 acres of land for which irrigation appropriations are claimed, and 34 rights to water for power and domestic purposes.

VALUE OF WATER RIGHTS.

The value of the rights to the water which fills these ditches and fertilizes the land under them is an interesting subject for consideration. That they give to both ditches and land whatever value they have is unquestioned, because an empty ditch and an arid plain are alike

worthless. But while the right to water gives to the land whatever value it has, it does not make all values alike. Cost of maintaining ditches, ease of distributing water, fertility of the soil when irrigated, and the value and extent of the contiguous range are elements which have their influence. The fact that transfers of these rights have not thus far been recognized by the irrigation authorities of Wyoming has prevented any transactions of this character, so that we have to go to surrounding States for statistics on this subject. A recent sale of a right to 78 second-feet in one of the streams of northern Colorado is perhaps the best illustration of the present value of this form of property. In this sale nothing was sold but the right to take water from the stream. The ditches and lands by which it was conducted remained in the possession of the original holders. The right was moved several miles from its original location and required another ditch for the diversion of the water, and yet sold for a little more than $250 per second-foot. Its value was also lessened by the fact that the purchasers knew that the sale would be contested and that the expense of litigation to establish the legality of the transfer would have to be paid by them. The price paid, therefore, was far below what the property would have brought had the sellers been able to give an unquestioned title to the property, and is not, I think, above the value of an unquestioned right in the Bighorn Mountains. If this is true, the value of the adjudicated rights to the water of this range is already over $1,000,000. That this is destined to be greatly augmented in the near future is beyond question. The commercial importance of the water rights, therefore, makes their legality and the measures devised for their enforcement a subject of great economic interest.

BOARD OF CONTROL.

Under the constitution of Wyoming the board of control is intrusted with the supervision and control of all public waters of the State and of their appropriation, diversion, and distribution. Its administrative powers are therefore very broad. It has not only to determine rights to streams, but to enforce those rights afterwards. It has five members. These are the State engineer, who is president, and the four division superintendents. At the outset the board endeavored to outline clearly and definitely its views of what was necessary to complete or perfect a title to water, and so to simplify the methods of taking proof as to enable all water users to know what was required and to prepare and submit it at the least possible outlay. In pursuance of these views the board adopted and published the following governing principles:

1. In order to constitute a valid appropriation the water must have been used for some beneficial purpose, and in the case of appropriation for irrigation the water must have actually been applied to the land.

2. The amount of an appropriation is governed by the volume used and by the requirements of this use—in the case of appropriations for irrigation, by the needs of the land reclaimed.

3. Where reasonable diligence is shown in the construction of ditches and utilizing water, the appropriation dates from the beginning of work on the ditch, the survey to be considered as part of such work; where reasonable diligence is not shown, the appropriation dates from the utilization of the water.

4. Priority of appropriation gives priority of right, except in the case of appropriations made between 1888 and 1891, during which time the law made appropriation for domestic use a preferred priority.

5. Appropriations for irrigation are restricted to 1 cubic foot per second for each 70 acres irrigated. While this does not necessarily apply to lands reclaimed before the enactment of the State law, no appropriation for a larger amount has been made, because in all cases so far considered this volume has appeared ample.

6. Transfers of rights to water made in advance of any adjudication, either by the courts or by the board, are not recognized, the reason being that parties had not such ownership as would enable them to give valid title to the water sold. No transfers involving changes in location or character of use have been recognized.

As the operation of these principles is uniform, and as the facts on which any appropriation rests are in all cases the same, it was possible to prepare a blank form of proof for the guidance of irrigators, and in that way to simplify both the labor of preparing proofs and of the board in their subsequent examination. The following is the form adopted:

PROOF OF THE APPROPRIATION OF WATER.

From ———, Division No. ——.

State your name.

1. Post-office.

2. State the use to which the water has been applied.

3. State the means of diversion employed.

4. If through a ditch, state its name.

5. State (*a*) the date of the survey of the ditch or other distributing works through which the water claimed is diverted; (*b*) the date when the construction of such ditch was begun and when completed.

6. If any enlargements were made, state the date when begun and the date when completed.

7. State the dimensions of the ditch as originally constructed and as enlarged, and if measured by the county surveyor under the provisions of the act of 1886, give the results of such measurements.

8. State the name of person, association of persons, or corporation who built the ditch or canal, and the name or names of its present owners.

9. If water is claimed for irrigation, give the legal subdivisions of land owned or controlled by you for which an appropriation is claimed.

10. State the nature of your title to the above-described land: and if not owned by you, give the name of the owner and the nature of the possessory right which you exercise.

11. State the year when water was first used for irrigation or other beneficial purposes, and by whom.

12. If for irrigation, give the number of acres watered the first year, giving the legal subdivisions on which used and, as near as may be, the acres irrigated in each subdivision.

13. State the number of acres watered each subsequent year, and give the legal subdivisions on which the water was used and, as near as may be, the acres irrigated in each legal subdivision.

14. State the number of acres irrigated from said ditch in 189—, and give the legal subdivisions on which water was used and, as near as may be, the acres irrigated in each subdivision.

15. State the acreage said ditch is capable of watering, give the legal subdivisions of land which it can be made to irrigate, and state who owns said land.

16. State your proportionate interest in said ditch.

(16) The plat prepared by the State engineer is hereby accepted as showing correctly the location of the ditch and the land which can be irrigated therefrom.[1]

17. When does your irrigation season begin and when does it end?

18. If water is used for other purposes than irrigation, state the nature of such use and the time when such use began.

19. How much water is required for such purpose?

20. During what months is the water used?

21. Have you or any other claimant of said appropriation filed a claim to water in the office of the county clerk? If so, give date of filing and the name of the party or parties interested in said claim.

22. Have you had sufficient water each year since the use for which an appropriation is claimed began?

23. If not, state the years of scarcity, the months when the supply was insufficient, and the reason of such scarcity.

I hereby certify that the foregoing affidavit was read to the affiant in my presence before he signed his name thereto; that said affiant is to me personally known (or has been satisfactorily identified before me by ——— ———), and that I verily believe him to be a credible person and the person he represents himself to be; and that this affidavit was subscribed and sworn to before me at ———, on this —— day of ———, 189–.

———— ————,
Division Superintendent.

DEAR SIR: Your attention is called to the inclosed proof of appropriation. It is the intention of the law and also of the board of control to make the adjudication of rights to the use of water as inexpensive to the appropriator as possible. Consequently you are requested to cooperate with the division superintendent to whom you submit your testimony to the extent that you prepare yourself to answer all questions readily and accurately before the day set for submitting said testimony.

Your special attention is called to those questions whose answers indicate the date of your appropriation and use of the water, and to the acreage of land irrigated and description thereof.

By complying with this request you will not only facilitate the taking of testimony, but will insure the correct establishment of the respective rights and possibly prevent expensive and aggravating litigation.

Yours truly,

———— ————,
Division Superintendent.

[1] In case there is objection to the official plat, the parties objecting must, when giving proof, file a written statement of the reasons therefor, and must within thirty days file with the division superintendent a map of said ditch and irrigated lands, with affidavit of surveyor, giving date of survey, attached thereto.

WATER DIVISIONS AND DISTRICTS.

In order that each of the more than 1,000 holders of water rights shall obtain his share of the common supply there must be some officer to see that the rights are enforced and protected in times of

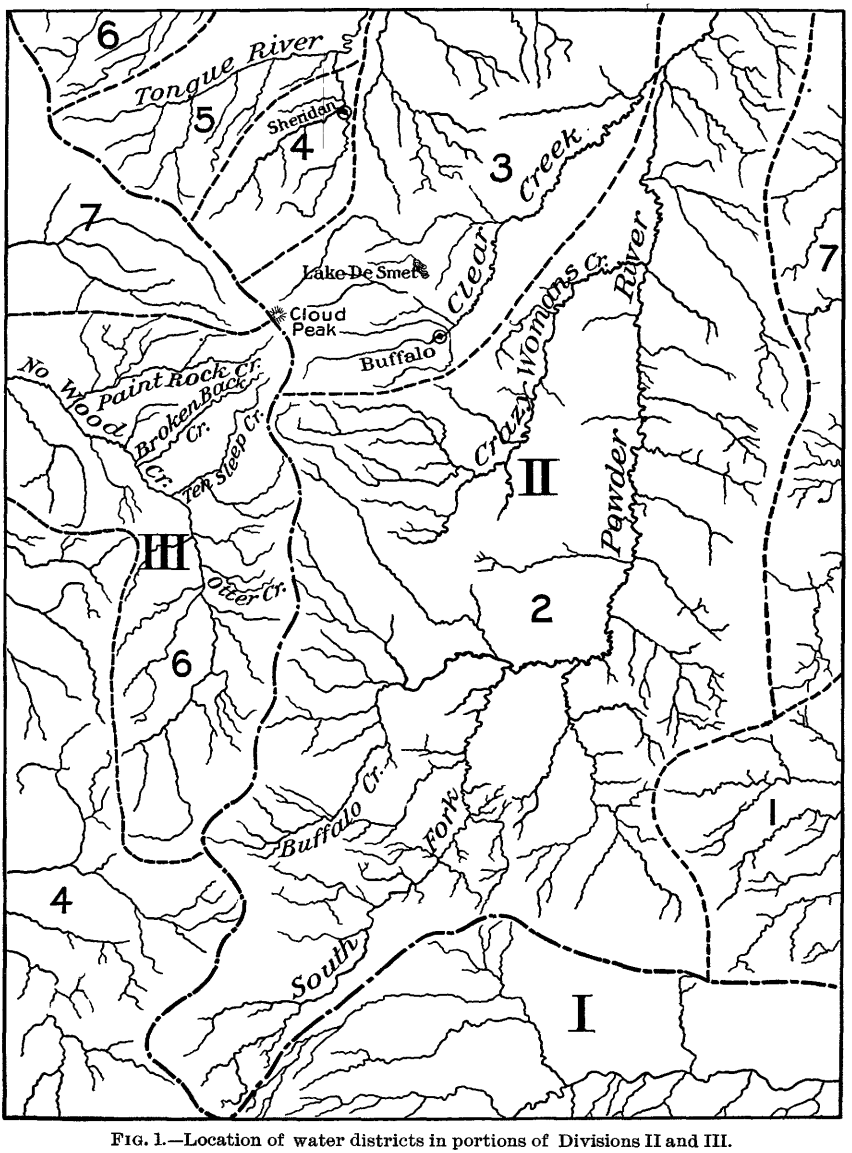


FIG. 1.—Location of water districts in portions of Divisions II and III.

scarcity. For convenience, and in order to make the work more effective, the entire State has been divided into four parts, called water divisions, and these divisions have been subdivided into dis-

tricts, there being at present forty districts in the four divisions. The boundaries of divisions are fixed by statute, those of districts by orders of the board of control, both being determined by drainage lines. The officer in charge of a division is called a water superintendent. He has general control of the work of the water commissioners, which is the title of the officers in charge of districts. The limits of a district are determined by the work to be done. The greater the number of ditches and the more variable the supply the smaller the territory a commissioner can supervise.

The Bighorn watershed forms part of two divisions, the eastern slope being in Division II, and the western in Division III. The portion in Division II is subdivided into five districts, numbered from the south northward 2, 3, 4, 5, and 6. The portion in Division III is subdivided into districts 4, 6, and 7. Fig. 1 shows the location and boundaries of the several districts.

Adjudications of rights to water have been had in districts 3, 4, and 5 of Division II, and in district 6 of Division III. Partial adjudications have been had in districts 2 and 6 of Division II. In the unadjudicated districts, or parts of districts, there is still a surplus water supply, rendering the services of a commissioner unnecessary and permitting further delay in the determination of rights.

APPROPRIATIONS IN DIVISION II.

DISTRICT 2, CRAZY WOMAN CREEK.

In 1889 scarcity of water in Crazy Woman Creek, a tributary of Powder River, led to an adjudication of rights thereto. Wyoming was then a Territory, and the procedure was had under the irrigation law of 1886. Under this law the testimony of appropriators was submitted to a master commissioner, appointed by the judge of the district court, and the final decree was based upon his findings. The outcome was not satisfactory. Water commissioners say that the decree can not be enforced because it does not conform to physical conditions, while late appropriators complain that the earlier priorities are for excessive amounts. The reasons for these objections and the basis of the master commissioner's findings can best be understood from an analysis of the decree. As it deals with the most important and most controverted water-right questions, not of Wyoming alone, but of all the arid States, it merits discussion. The decree, known as "John R. Smith, etc., *v.* Henry W. Devoe, etc.," reads in part as follows:

DECREE OF 1889.

This cause coming on for hearing upon the motion to confirm the report of the special commissioner, made at the present term, and upon the whole case, and the court being sufficiently advised, it is now adjudged that said report of the special commissioner be confirmed, and no exceptions having been filed or taken thereto, that the several findings of the commissioner be approved and confirmed,

and that they be taken, decreed, and held in all respects as the findings of this court in respect to each ditch and canal set out and reported in said report, numbered as to ditches and priorities in the appropriation of water, for beneficial purposes, from Crazy Woman Creek and its several tributaries, respectively, from 1 to 27, inclusively, and that the owner or owners of said several ditches and canals are, and shall be entitled, by original construction and the enlargement of their respective ditches and canals, to priority in the appropriation of water from said Crazy Woman Creek and its tributaries to the extent and in the order hereinafter set out.

PRIORITY NO. 1.

James A. Dowlin, the owner of said ditch by virtue of the construction thereof, shall be entitled, through said ditch, to so much water from Billy Creek, one of the tributaries of Crazy Woman Creek, as may be necessary and useful to irrigate 160 acres of land lying thereunder, not to exceed 8.65 cubic feet of water per second of time, and the same shall be designated and known as priority No. 1.

PRIORITY NO. 2.

That John R. Smith and Agnes D. Smith, the owners of the "John R. Smith ditch" by original construction thereof, shall be entitled, through said ditch, to so much water from Crazy Woman Creek and its several tributaries as may be necessary and useful for the irrigation of 1,200 acres of land lying thereunder, not to exceed 67.03 cubic feet of water per second of time, and the same shall be priority No. 2.

PRIORITY NO. 3.

That the Wyoming Land and Cattle Company, corporation, being the owner of what is known as the "North Fork ditch," taking its water from the North Fork of Crazy Woman Creek, by original construction thereof, shall be entitled through said ditch to so much water from said North Fork of Crazy Woman Creek as may be necessary to irrigate 800 acres of land owned by said company and lying under said ditch, not to exceed 30 cubic feet of water per second of time, and the same shall be priority No. 3.

The wording in the case of the remaining priorities is essentially the same, with the exception of the names of owners, ditches, and other details. The principal facts are given in the table on page 23. In the following table are the dimensions of the several ditches mentioned in the order and decree in this case and given in the report of the special commissioner.

Dimensions of ditches taking water from Crazy Woman Creek.

Priority number.	Name of ditch.	Average dimensions.			
		Top width.	Bottom width.	Depth.	Grade per mile.
		Feet.	*Feet.*	*Feet.*	*Feet.*
1	Billy Creek	7	5	1	7.2
2	John R. Smith	7.5	5	2.75	12
3	North Fork	------	4	1.5	24
4	Harris No. 1	6	4	1.50	6.25
5	Kingsbury No. 1	2	1	1	73.95
6	Halt	5.5	3.5	1	16.5
7	Red Bark	9.5	7.5	1.2	12.7
8	Moreton	6.2	4	1.1	19
9	Cook	10	6	1.8	8
10	North Fork of Crazy Woman	7	4.5	2	4.5
11	Muddy Creek	6	4	1	5
12	Px	7.6	5	1.3	5
13	Kingsbury No. 4	2	1	1	29.94
14	Kingsbury No. 3	2	1	1	29⅓
15	Kingsbury No. 2	2	1	1	71⅓
16	Kennedy	*a* 7.1	------	2.3	5.3
17	Dick	8.5	5	1.75	10
18	Burton, Kelly Creek	*b* 1.5	------	1	15
19	Blue Gap	7.5	5.5	1	23
19½	Teddy Miller	13.75	7	2.25	12
20	Fort Collins	20	10	3.7	3.17
20½	North Fork (*c*)	8.5	5.5	1.5	24
21	Devoe No. 1	14	10	2	8
22	Devoe No. 2	10	8	2.5	5.28
23	Canton, Kelly Creek	5	3	1.5	5.28
24	Thompson Brothers	6.5	3.5	1	20
25	Thompson & Matthews	*d* 9	5	1	(*e*)
25½	Moreton enlargement	------	------	1.9	5.28
26	Mitchell & Long	------	6	1.5	4
26½	Kennedy enlargement	11.7	7.1	2.3	24
27	Harris No. 2	------	3	1	6.28

a Average width as originally constructed.
b Average width.
c Enlarged by Covington and Mays.
d Average width as enlarged.
e Grade 4 feet to the mile part of the way and 15 feet for the remainder.

OBJECTIONS TO THE DECREE.

The water described in this decree would suffice for the irrigation of between 50,000 and 75,000 acres of land even under the wasteful methods which prevail. The property disposed of was of great value. If a second-foot of water is worth $250, rights to 900 second-feet are of enough importance to warrant an inquiry into the methods by which they were acquired. Nothing is more indispensable, if we are to avoid disastrous controversies, than to have the acts by which a right to water is secured clearly defined and the limitations on that right definitely prescribed by law. Every user of water wishes to know how the title thereto is to be secured, while everyone interested in the growth and success of irrigated agriculture wishes to be certain that the commodity on which its success depends shall not be wastefully or fraudulently transferred to private or speculative owners. The results of this adjudication have apparently not answered either of the questions clearly or to the satisfaction of those directly concerned.

Controversies over the legality of these rights and over the discretionary authority of the water commissioner in enforcing the decree began the first season of its operation and still continue. That all should have agreed was out of the question. The Territorial law was both indefinite and contradictory in its provisions. Those claiming rights were not agreed either as to the meaning of the law or in their views of an irrigator's needs. Nor was the method of taking proof calculated to disclose the facts on which a just or satisfactory settlement of these rights must rest. There was no measure of the flow of the stream. There was no survey of the ditches, of the lands irrigated, or of the lands which could be irrigated. There was no proof of the actual volume of water diverted or of the needs of the land for which its use was claimed. All that was required in this disposal of public property was for each individual claiming a right therein to file proof of the building of a ditch and his estimate of the volume it would divert. The first objection to this was the lack of knowledge of the claimants themselves. Not one of them knew accurately the carrying capacity of his ditch or the volume needed to reclaim an acre of land. To all the expression "cubic foot per second" was an almost meaningless term. It would have meant just as much if the volume had been expressed in liters. Granting that the desire of all was to claim only what they were entitled to, their success in doing this would be wholly accidental. Nor was the submission of these statements to a judge or a commissioner having no greater practical knowledge than the irrigators themselves a wise provision. The questions to be determined were physical, not legal, and without some knowledge of either the volume which the stream carried or the water used on an acre of land these officers were in no way prepared to pass on the reasonableness of the claims.

In the absence, therefore, of a contest among the claimants themselves, by which the facts would be disclosed, it was possible for claims to be filed and approved which would establish rights to many times the volume used or, on the other hand, which would be below the claimants' real needs. Both of these results actually occurred in this adjudication. In saying this there is no desire to reflect on anyone. The outcome of this adjudication will compare favorably with that of most decrees rendered under this or similar laws elsewhere. What is desired is to explain at the outset that a law which gave the court no power to get at the facts by an impartial examination, but which, on the contrary, made the disposal of a stream depend almost wholly on the knowledge or honesty of those claiming it, could scarcely lead to anything but dissatisfaction, if not injustice.

It would seem that in fixing the volume of these rights the reasonableness of the claims should have been looked into and some uniform test applied by which their legality or necessity could be determined. The importance of this proceeding and its influence on further development was very great. This was a final transfer of a stream from public to private control. It was the surrender by the State of a part of its most valuable property and on the use of which its ultimate population and wealth depend. Realizing this fact, as all thoughtful minds do, it hardly seems reasonable that an ex parte claim should have been accepted without question and made the basis of the grant of a water right. To give every claimant all he asked without inquiry as to his needs or the work actually done to entitle him to anything would seem to be so unwise as to need no discussion. It makes the expression "adjudication" a farce. It will be seen, however, from an analysis of the decree that this is practically what happened. The statute required the evidence of claimants to disclose the capacity of the ditch diverting water and the acreage of land which could be irrigated, and the implication seems fair that the intention of its framers was that this proof should guide the court in fixing the amounts of appropriations. If this is correct, then, under this law, the amount of the appropriator's right to water should have been determined by two facts: First, the capacity of the ditch or canal to divert water from the stream; second, the volume which had actually been applied to beneficial use and the requirements of that use. The language of the decree in its opening paragraph would seem to imply that the construction of ditches alone gave appropriators their rights and that the application of water to a beneficial use was not deemed essential. The portion of the decree on which this statement is based is as follows:

> And that the owner or owners of said several ditches and canals are, and shall be, entitled by original construction and the enlargement of their respective ditches and canal to priority in the appropriation of water from said Crazy Woman Creek and its tributaries to the extent and in the order hereinafter set forth.

If rights were based on the construction of ditches, it would seem that the amounts appropriated should have been fixed by their capacity. To determine whether or not this was done the capacity of these ditches was computed. The dimensions given in the decree were assumed to be correct, and the discharge was determined by the use of Kutter's formulæ, a uniform coefficient of roughness of 0.025 being assumed. This would give a discharge above the actual flow for all except the largest ditches, because the small ones are poorly built, with rough sides and sharp and irregular curves. In the table which follows the computed capacity and the volume decreed are both given, with the difference between such appropriation and the discharge of the ditch:

Capacity of ditches taking water from Crazy Woman Creek and volume of water allotted by decree of 1889.

Priority number.	Name of ditch.	Name of appropriator.	Volume allotted in decree, in cubic feet per second.	Computed capacity of ditch, in cubic feet per second.	Excess of allotment over computed capacity of ditch.	Deficiency of allotment under computed capacity of ditch.	Number of acres watered or proposed to be watered.	Number of acres to each cubic foot per second allotted.	Total volume allotted, in cubic feet per second.
1	Billy Creek	J. A. Dowlin	8.65	16.20	.....	7.55	160	18.5	8.65
2	John R. Smith	John R. and Agnes Smith	a67.03	59.20	7.83	.....	1,200	17.8	75.68
3	North Fork	Wyoming Land and Cattle Co.	30	18.60	11.40	.....	800	26.6	105.68
4	Harris No. 1	W. Harris	12.2	14.25	.....	2.05	150	12.3	117.88
5	Kingsbury No. 1	D. A. Kingsbury	3.75	3.36	.39	.....	160	43.8	121.63
6	Holt	Wyoming Land and Cattle Co.	8.20	12.60	.....	4.40	150	18.3	129.83
7	Red Bark	B. J. and J. M. Scott et al	37.4	18.70	18.70	.....	800	20.8	167.23
8	Moreton	Moreton Frewen	22.32	28.05	.....	5.73	400	17.9	189.55
9	Cook	Orrin Cook et al	33.55	31.68	1.87	.....	3,300	98.3	223.10
10	North Fork of Crazy Woman.	J. A. Dowlin	28	23	5	.....	300	10.3	251.10
11	Muddy Creek	do	8.4	8	.40	.....	300	35.7	259.50
12	Px	C. Basch and O. Speral	17.9	14.74	3.16	.....	200	11.1	277.40
13	Kingsbury No. 4	D. A. Kingsbury	2.35	1.92	.43	.....	300	127.6	279.75
14	Kingsbury No. 3	do	2.29	3.03	.....	.78	300	133.3	282
15	Kingsbury No. 2	do	3.6	3.04	.56	.....	160	44.4	285.60
16	Kennedy	R. Kennedy et al	32	37.56	.....	5.56	.....	.....	317.60
17	Dick	Powder River Cattle Co., M. Frewen.b	12.32	28.48	.....	16.16	600	48.7	329.92
18	Burton, Kelly Creek.	John Burton	3.6	1.80	1.80	.....	160	44.4	333.52
19	Blue Gap	Little North Fork Ditch Co.	26.5	20.15	6.35	.....	1,500	56.6	360.02
19½	Teddy Miller	F. G. S. Hesse	84.45	58.25	26.20	.....	1,160	13.7	444.47
20	Fort Collins	Fort Collins Land and Improvement Co.	210	166.50	43.50	.....	21,000	100	654.57
20½	North Fork	J. May and C. Covington	25	63	.....	38	800	32	679.47
21	Devoe No. 1	H. W. and C. M. Devoe	60.10	72	.....	11.90	2,000	33.3	739.57
22	Devoe No. 2	do	78.11	58.05	20.06	.....	3,000	38.7	817.68
23	Canton, Kelly Creek.	F. M. Canton	10.50	10.20	.30	.....	100	9.5	828.18
24	Thompson Bros	F. S. and G. F. Thompson.	17.3	16	1.30	.....	160	9.2	845.48
25	Thompson & Matthews.	do	12	10.50	1.50	.....	800	66.7	857.48
25½	Moreton enlargement.	F. G. S. Hesse	45.72	59.33	6.30	.....	4,000	85.3	903.20
26	Mitchell & Long	B. Long, M. F. Mitchell	25	14.40	10.60	.....	1,200	48	928.20
27	Harris No. 2	W. Harris	10	9	1	.....	100	10	938.20

a Based on computation made in State engineer's office. *b* All the land owned by them.

While rights may have been acquired through the building of these ditches, the volumes decreed were manifestly not based on their capacity. Appropriator No. 1, after building a ditch to carry 16 feet, was given only a fraction over half that amount, while in contrast thereto the third appropriator was given 11 feet more than his ditch would divert. The seventh appropriator was given 2 second-feet for each foot the ditch could carry, while the seventeenth was cut down to less than half what had been or could be taken from the stream. Priority No. 18 was favored with a double allowance, while No. 20½ got only half a loaf. Some of the appropriations agree approximately with the volume which the ditch could divert, but the number which are either far above or far below shows that this agreement was accidental and not based on any investigation of this question.

EXCESSIVE AMOUNTS CLAIMED.

Nearly all recent laws and decisions are agreed that simply diverting water does not of itself complete a right to it; that in addition the water so diverted must be applied to some beneficial use. If this test be applied to appropriations for irrigation, the actual acreage reclaimed might properly be taken as the measure by which the volume appropriated should be determined. All of these appropriations are for this purpose, and all except one of them, No. 16, states the acreage to be irrigated, and in the excepted case it is restricted to the land owned by the claimants. A casual inspection of the number of acres irrigated and the amount decreed shows that the need of the land had no weight in fixing these rights. While the measurements of the water used in irrigating an acre of land have not as yet taken the range or embraced all the conditions needed to fix the absolute volume to be used on that area, enough have been made to show the approximate limits of such use. In a series of tests begun by the State engineer and continued by the State University of Wyoming there was not a single instance in which the duty of a second-foot fell below 80 acres. As these tests were made in widely separated localities, embraced a wide range of crops, and were continued for five years, this may fairly be taken as a limit of the actual needs of irrigation, and the State legislature has, since this decree was rendered, made any appropriation in excess of 1 second-foot to 70 acres illegal.

The land along Crazy Woman Creek can be irrigated with less water than is required in some of the localities where the volume used was measured, and there is no reason to question the statement that a duty of 1 second-foot to 80 acres is below rather than above the actual practice along the stream. But whether this be true or not, it is certain that the need of 1 acre is approximately the same as that of every other acre. There is so little variation in the soil and in the crops grown, that sufficient water for one 80-acre tract is enough for any other equal area along the same stream.

This fact could not have been considered in fixing these rights. In the table given, one column gives the acres to be irrigated; in the next column are the acres for which 1 second-foot of water was decreed. It will be seen that the first appropriator is given 1 second-foot for each 18 acres of his land, or at least four times the volume needed, while the fourteenth appropriator is required to spread a second-foot over 133 acres. When the owner of priority No. 20 found he was allowed only 1 second-foot for 100 acres, while his neighbor, owning the twenty-seventh, was given the same volume for 10 acres, he could not be blamed for objecting to the discrimination.

All of these awards are for a continuous flow for the entire year. In practice, however, the use of water in irrigation extends over a period of only three to four months. Assuming one hundred days to be the time of actual need, the irrigator under priority No. 1 is allowed water enough to cover his land to a depth of 10.8 feet, while the irrigator under priority No. 14 can cover his land with only 1.5 feet. The irrigator under priority No. 24 can, if he desires, submerge his farm under nearly 22 feet of water, while the appropriator under priority No. 13 can cover his with less than that many inches.

The excessive volumes of these appropriations make it manifest that the necessities of the land irrigated had no more to do with determining the volume decreed than had the size of the ditches. It is necessary to look further, therefore, to learn the reason for making some rights exceed the capacity of ditches and others fall below, and for allowing some appropriators more water for 80 acres than was given others for 800.

In 1886 a law was passed requiring parties claiming appropriations of water to file in the county clerk's office a statement of their claim. This law required that the statement should contain a description of the ditch, the name of the stream, and the number of acres lying under the ditch and irrigated or proposed to be irrigated. In the same law was a provision for a similar statement of claim for proposed ditches, which required any party intending to appropriate water to file a similar statement with the county clerk. It contained the same provisions as the section relating to existing ditches, with several additional ones relating to protection of existing rights and fixing the time for beginning of work, together with the following ambiguous and misleading clause:

> And from the time of filing any such statement water sufficient to fill such ditch or ditches and to subserve the use or uses aforesaid, if a lawful and just use, *shall be deemed and adjudged to be appropriated.*

Those who know anything about the difficulties which beset engineers in the measurement of water can realize how difficult, if not impossible, it was for farmers having no knowledge of hydraulics to make a correct estimate of the volume they had actually diverted and used, and that it was impossible for them to make an accurate

claim for the volume they proposed to use. A law which would give to each irrigator all he claimed would be an absurdity, if every claim was known to be limited to the claimant's estimate of his actual needs, because of the difference in the capacity of claimants to make a just or accurate estimate; but a law which throws the door open to speculative claims and declares that a speculative absorber of streams can secure an adjudicated right thereto simply by asking for it is an iniquity. The Territorial water law was not framed for that purpose, but it nevertheless opened the door for the water grabber.

Thirty-one claimants to the water of Crazy Woman Creek filed these statements, some being for existing ditches and some for proposed ones. It does not appear from their character that there was any attempt to secure speculative rights, since some of the claimants asked for more water than they needed and others for less. The truth seems to be that the intention of all these irrigators was to comply with the requirements of the law in good faith, but that the volumes claimed had to them no definite meaning, and their statement was entirely unintelligible. There was probably not a farmer along the stream who knew whether he used 1 cubic foot of water or 10. Hence these claims exhibit chiefly the irrigators' lack of knowledge and the necessity, in an adjudication, of some impartial and adequate investigation of the facts on which any reasonable or just right should rest. It was the belief of the holders of these water rights, however, that the filing of this ex parte statement constituted in itself an absolute title to water, and that the further action in adjudicating these rights was only to confirm their title to the volume claimed. The outcome was in accordance with this belief. A comparison of the statements of claims filed in the county clerk's office with the volumes allotted in the decree shows that in nearly every instance they are the same. While a number of those who filed statements of claim do not appear in the decree, and a number of appropriators appear in the decree who did not file claims, there are enough appearing in both to show that the adjudication was almost if not entirely a proceeding to give the makers of these claims all they asked. The following table shows the agreement between the claims filed in 1886 and the appropriations established by the decree of 1889:

Comparison of appropriations under decree of 1889 with original claims filed.

Priority number.	Name of ditch.	Name of appropriator.	Volume allotted in decree, in cubic feet per second.	Volume claimed in statement.
2	John R. Smith	John R. and Agnes Smith	67.03	*a* 80
3	North Fork	Wyoming Land and Cattle Co.	30	55
4	Harris No. 1	W. Harris	12.2	12.2
6	Holt	Wyoming Land and Cattle Co.	8.20	8.20
8	Moreton	Moreton Frewen	22.32	22.32
9	Cook	Orrin Cook et al	33.55	33.55
10	North Forkof Crazy Woman.	J. A. Dowlin	28	28
17	Dick	Powder River Cattle Co	12.32	12.32
16	Kennedy	R. Kennedy et al	32	32
19	Blue Gap	Little North Fork Ditch Co.	26.5	26.5
19½	Teddy Miller	F. G. S. Hesse	84.45	84.45
20	Fort Collins	Fort Collins Land and Improvement Co.	210	210
21	Devoe No. 1	H. W. and C. M. Devoe	60.10	43
22	Devoe No. 2	do	78.11	78.11
25	Thompson & Matthews.	F. S. and G. F. Thompson	12	12
26	Mitchell & Long	B. Long and M. F. Mitchell	25	25
27	Harris No. 2	W. Harris	10	10

a 80 originally; 67.03 later.

If this creek carried enough water for all users, giving each appropriator all he claimed, the decree might not have been open to objection. Unfortunately the stream does not. It may for a few days or few hours each year carry 900 second-feet, although this is to be doubted; but during the latter half of the irrigation season the mean discharge is not one-tenth of this amount, and at times the channel below these ditches is a bed of dry sand. Not one-half the acreage designated in these appropriations has ever been irrigated, nor is there water enough in the stream to irrigate one-half of it without resorting to storage. With storage and with proper economy in the use of water all the land could probably be brought under cultivation, but to secure these there must be some method of restricting appropriators to their actual needs in the first place and some security for the control of stored water in the second. Extravagant appropriation is a prolific source of mischief in preventing both of these desirable results. The holder of a large appropriation claims the

right to control it whether he needs it or not. Parties hesitate to construct storage works to impound water which runs to waste when the title thereto is clouded, as it must be when more water than the stream carries at flood time is decreed to be appropriated.

These excessive rights have been an incessant source of trouble to the water commissioner. The holder of priority No. 2 can close all the ditches above him if his claim is recognized, and if it is not he has a grievance against the commissioner. Two instances have already occurred in which the assistance of the State engineer had to be asked to settle controversies over the right of these holders of a surplus to arbitrarily close the head gates of later appropriators. There is the further danger that these holders of extravagant rights will in time proceed to sell the surplus. If they have the right to do this, as the supreme court of the State has decided in a similar case, the time will come when the owners of the first three appropriations will practically control the stream, and the subsequent rights will not be worth considering. Meantime the water commissioner is forced to be judge, jury, and sheriff in the division of water among users. Under the limitation of the decree which gives to appropriators only the water needed, the commissioner refuses to close the head gates of subsequent appropriators, except in cases of actual need on the part of the holders of prior rights. But this policy is being continually called in question and could be carried out equally well without a decree.

DISTRICT 3.

This district, as shown in fig. 1, includes Clear Creek and its tributaries, and extends from the summit of Cloud Peak on the west to the junction of Clear Creek and Powder River on the east. It is one of the most important districts in the State and one of the most interesting to the student of water-right problems.

FLOW OF CLEAR CREEK.

Measurements of the amount of water flowing in Clear Creek were begun in 1889, their necessity having arisen from controversies over the water rights which the shortage of that year rendered acute. The location of the gaging station is about 4 miles above the city of Buffalo, as shown on fig. 2. The principal diversions above the gaging station are those in the mountains where two ditches carry water across a low divide into the head of French Creek. The measurements made at this point, therefore, do not represent the total flow of the stream, except at such times as the principal ditches are closed. The results of the measurements up to and including 1893 are not available; those for 1894 are shown diagrammatically on page xxxiii of the Second Biennial Report of the State Engineer of Wyoming and are given in the following table. During 1895 observations were

not made because it was impracticable to obtain the services of an observer. The results of the record for 1896 are published in Part

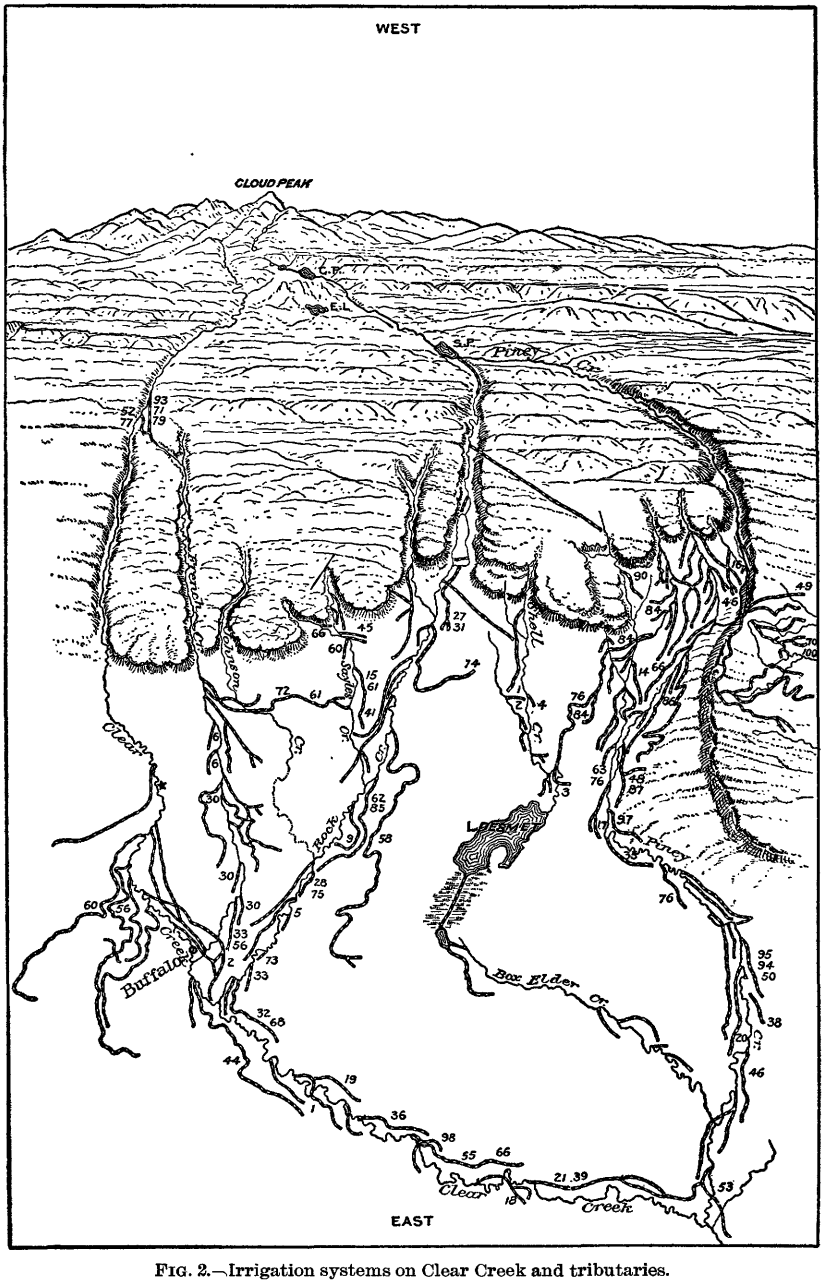


FIG. 2.—Irrigation systems on Clear Creek and tributaries.

IV of the Eighteenth Annual Report of the United States Geological Survey, on page 140, and those for 1897 in Part IV of the Nineteenth

Annual Report, of the Geological Survey, on page 298. The discharge for the three years is also given below and is shown diagrammatically in fig. 3 (page 31).

Estimated monthly discharge of Clear Creek at Buffalo, Wyoming.

[Drainage area, 118 square miles.]

Month.	Discharge.			Total.	Run-off.	
	Maximum.	Minimum.	Mean.		Depth.	Per square mile.
1894.	*Sec.-feet.*	*Sec.-feet.*	*Sec.-feet.*	*Acre-feet.*	*Inches.*	*Sec.-feet.*
June	853	168	283	16,841	2.68	2.40
July	242	62	148	9,100	1.44	1.25
August	80	46	54	3,320	.53	.46
September	80	46	55	3,273	.53	.47
1896.						
May	406	64	139	8,547	1.36	1.18
June	504	82	251	14,936	2.37	2.13
July	323	64	115	7,071	1.12	.97
August	134	40	66	4,058	.64	.56
September	56	40	46	2,737	.44	.39
October 8–19	38	29	32	756	.12	.27
1897.						
May	632	209	345	21,214	3.37	2.92
June	657	189	280	16,662	2.64	2.37
July	246	55	112	6,887	1.09	.95
August	82	39	54	3,320	.53	.46
September	----------	----------	*a* 30	1,785	.28	.25
October	----------	----------	*a* 30	1,845	.29	.25
November	----------	----------	*a* 30	1,785	.28	.25
December	----------	----------	*a* 26	1,599	.25	.22

a Approximate.

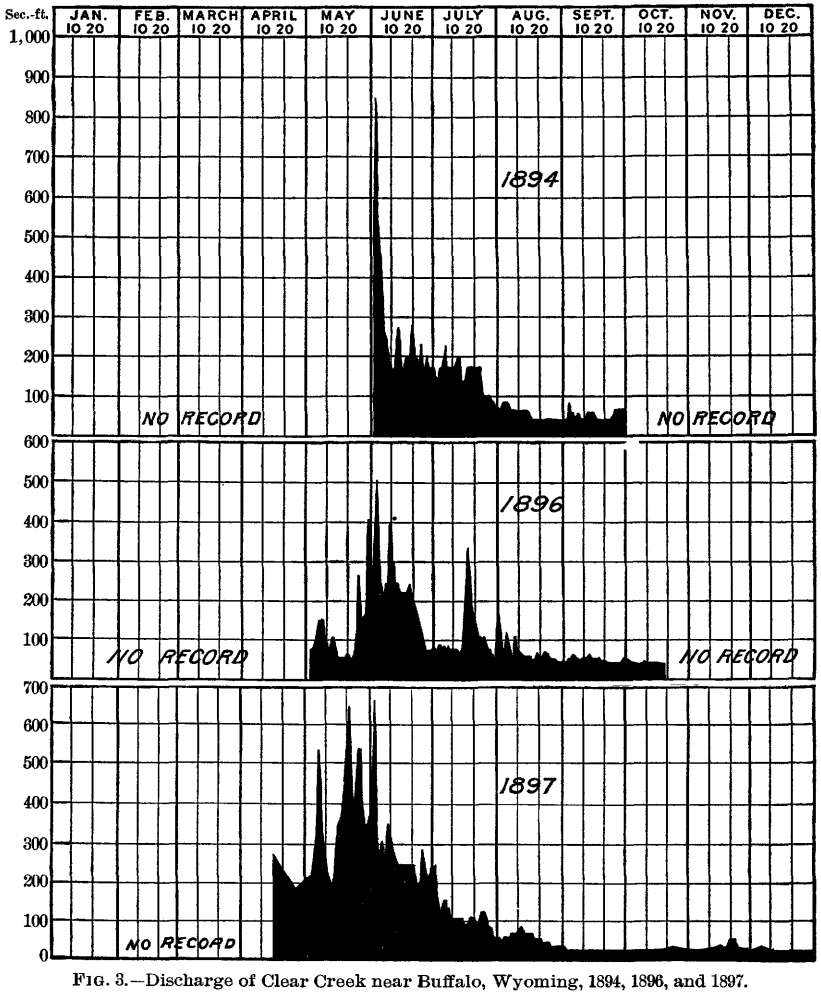


FIG. 3.—Discharge of Clear Creek near Buffalo, Wyoming, 1894, 1896, and 1897.

EARLY RIGHTS AND THEIR ADJUDICATION.

In May, 1878, Manlius Redmond began a ditch to water land along the main stream. It was, so far as the records show, the first attempt at irrigation in northern Wyoming, and the only attempt made that year. Ditches were built in 1879 along nearly every water course of the Bighorn Range, but in the previous year Mr. Redmond was alone. For more than ten years the building of ditches and the extension of the irrigated area made rapid progress, but 1889 was a season of drought, and the shortage on Clear Creek was so marked as to warn the users of water that the limit of profitable reclamation without the aid of reservoirs had about been reached. It also showed the need of an early determination of priorities. In the absence of this, position was everything; the ditch farthest upstream took its full supply

regardless of the rights or necessities of users below, while those farthest down got nothing.

Among the worst sufferers from this condition of affairs was the city of Buffalo. Two large canals, shown in fig. 2, had been built to carry the water of the North Fork of Clear Creek across a divide into French Creek. Their combined capacity was sufficient to drain the stream, and as no seepage returned, the loss to users below was absolute. An adjudication of priorities was begun before the close of the year, but before the preliminary steps had been completed the Territory of Wyoming held a constitutional convention and adopted a provision placing the control of the public waters of the State in the hands of the board of control. The judge of the district court ruled that this action divested his court of jurisdiction, and further progress was stayed until after the admission of Wyoming to statehood and the passage of the State irrigation law.

Under the State law rights to water are determined by the board of control, and an adjudication was begun by measuring the ditches which take water from a stream and by making surveys of the land irrigated or which can be irrigated. The measurements and surveys of Clear Creek and its tributaries were begun in 1891; when completed they were placed in the hands of W. J. Clarke, the division superintendent, whose duty it was to take the testimony of appropriators. Mr. Clarke at once began the taking of testimony, but had not completed this when the board of control met, in February, 1892. On his return from this meeting the division superintendent, who was a stockman, became involved in the "invasion" of Johnson County, as it was called, and all the proofs submitted were lost. It was necessary, therefore, to begin proceedings anew and to take all the testimony over again. Before this work was completed the testimony formerly taken was recovered, and both sets of proofs were before the board of control at its final determination of these rights. The two sets of proofs disclosed many discrepancies and contradictions, and were the cause of several contests, which delayed the final determination of these rights until 1895.

DIVERSION ACROSS DIVIDES.

The map of Clear Creek and its tributaries (fig. 2), shows the location and priority numbers of the several ditches; it also shows that one of these tributaries, Piney Creek, drains a larger mountain area than the main stream and also has a greater discharge. In addition there are the smaller tributaries of French, Johnson, Sayles, Rock, Shell, J. A., Boxelder, Bear Gulch, and Little Piney creeks. Clear Creek and Piney Creek each reach to the summit of the range and drain the entire eastern slope of Cloud Peak, its highest elevation. The other streams are cut off from the perpetual snows and only drain the outlying foothills; hence, while they have an abun-

PINEY CREEK BELOW OUTLET OF CLOUD PEAK LAKE.

dant supply for early irrigation, the late supply is wholly inadequate and, unless reenforced, will only serve for the reclamation of a restricted area. These smaller tributaries are, however, bordered by lands equal in area and of equal value with those along the valleys of the larger ones; hence some method of reenforcing their water supply became an early and important problem. The topography of this region offers unusual opportunities for doing this.

The head waters of French Creek are almost directly below Clear Creek, as its torrential flood comes from the rocky, snow-clad slopes of Cloud Peak. About all that is needed to turn Clear Creek out of its channel is a dam high enough to cause the water to overflow its bank, as the slope is toward French Creek from near its northern margin. One canal built to turn water into French Creek is only half a mile long, while the other, in a less desirable location, is only a mile in length. The map of Clear Creek and its tributaries (fig. 2) shows the location of these two canals, together with the priority numbers 71, 79, and 93 of their appropriations.

The turning of the water from Clear Creek into French Creek and the use of the channel of French Creek as a part of two canal systems created some perplexing problems for the board to solve in the determination of the two classes of rights from the latter stream. Both before and after the construction of the canals to provide this supplemental supply, parties had built ditches and appropriated the original or natural flow of French Creek. Some of these appropriators are interested in the canals in order to obtain an augmented supply, so that in a few cases the same individuals claimed rights to water from two sources through the same ditch to be used to irrigate substantially the same land. Other parties who made no claim to the natural flow of French Creek, but who were part owners in the canals to furnish the augmented supply, had built ditches from French Creek for the purpose of taking out the water turned into it.

There are, therefore, three classes of appropriators along French Creek. First, those who claim the natural flow of the stream; second, those who claim a right to the water of both Clear Creek and French Creek; and third, those who claim the right to use the channel of French Creek as a part of their ditch system, but draw their water supply entirely from Clear Creek. Among these different appropriators a difference of opinion exists as to the volume of water supplied by the natural flow of French Creek. At the time of the adjudication it was urged by the owners of the rights from Clear Creek that the claims of appropriators from French Creek were for more water than the creek carried, that the acreage originally irrigated had been extended by the unauthorized use of a part of the supply turned in, and that the board should restrict these claims. This was not done, because it was found impracticable to measure the flow of French Creek. To have done this would have involved shutting down the

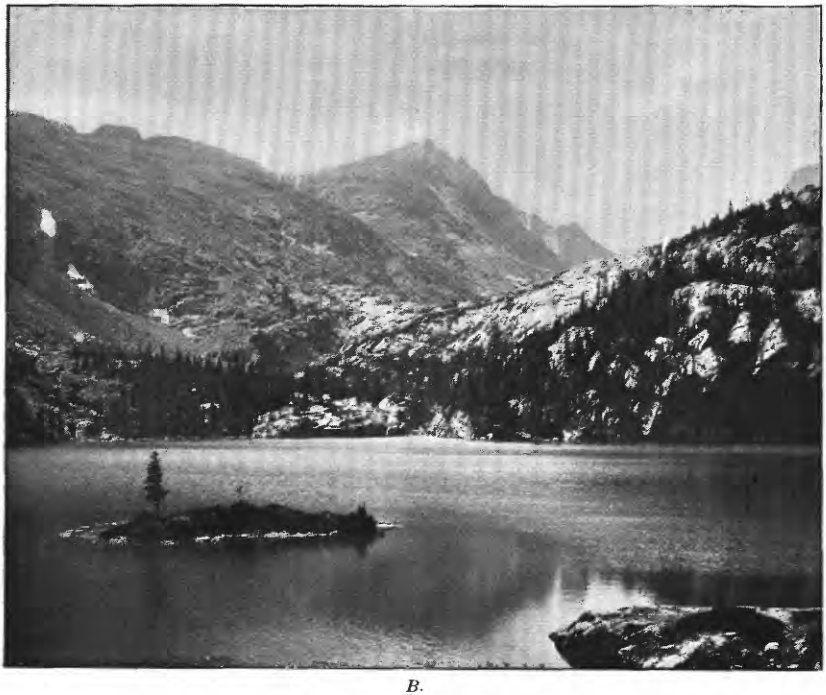
ditches from Clear Creek and the ditches of appropriators above some of the tributaries of French Creek. A single measurement would not be sufficient. In fact, it would take a large number of measurements to reach any definite conclusion.

The demands of the area now under irrigation along the stream are so largely in excess of the natural flow of French Creek that to turn off the water from Clear Creek for a sufficient length of time to permit the measurement of the natural flow of French Creek would have caused the destruction of two-thirds of the crops along the stream. Those appropriators who have an interest in Clear Creek alone or in both supplies naturally objected to such action. The board was therefore compelled to rely on the engineer's surveys and on the proof submitted. Rights were restricted to the actual areas irrigated, but the source of the appropriation recognized was based on statements of irrigators. Those who claimed that their lands were irrigated from French Creek alone were given appropriations for their lands from that source, and those who claimed to have used only the water of Clear Creek were given a right from that stream. Whether or not this was in accordance with the facts will probably never be definitely known. It is one of the instances where haphazard development has reached a stage that renders any accurate settlement out of the question.

The same difficulty now confronts the water commissioner in performing his duties. The two ditches which divert Clear Creek into French Creek are so inaccessible as to make their frequent regulation impossible. Both are mountain ditches with head gates over 9,000 feet above sea level. Their channels are cut among the pines that cover this region and through the rocks from which they spring. To reach them requires a steep and toilsome journey of 15 miles from the mountain's base. They are at an elevation where frost is perpetual and snow almost so. The regulation of such ditches is, therefore, difficult and expensive, and any continuous measurement of the volume they carry is, for the present, out of the question, but the increasing value of these rights will in time render the accurate division of water indispensable. The water from Clear Creek mingles with the natural flow of French Creek until it reaches the first ditches built to divert it. There a part is taken out and carried over the divide between French Creek and Johnson Creek, and serves to reenforce the latter; the ditch is also extended across a second divide, where the remainder is turned into Sayles Creek to reenforce the flow of this stream and of Rock Creek below their junction.

The fluctuations in the flows of French Creek and Clear Creek do not agree, because the latter is fed from the summit of the range, while the former drains a larger area of the foothills region; it rises earlier in the season and also begins to subside earlier, but as the water turned in joins it near its source no measurements to deter-

A.



B.

RESERVOIR SITES ON PINEY CREEK.

A, At Elk Lake; *B*, At Mead Lake.

mine these variations can be had without an outlay greater than can now be afforded. The practical result is that during the early part of the season all users take from the natural flow of French Creek, while during the latter part nearly all are supplied from Clear Creek. The same conditions exist on Johnson and Sayles creeks, while on Rock Creek there is a third element of uncertainty. This, however, has arisen since the adjudication of rights, and will be described later.

PRAIRIE DOG CREEK.

Referring again to the drainage map of this district (fig. 2), it will be noticed that Piney Creek, which rises in the lakes on the northern

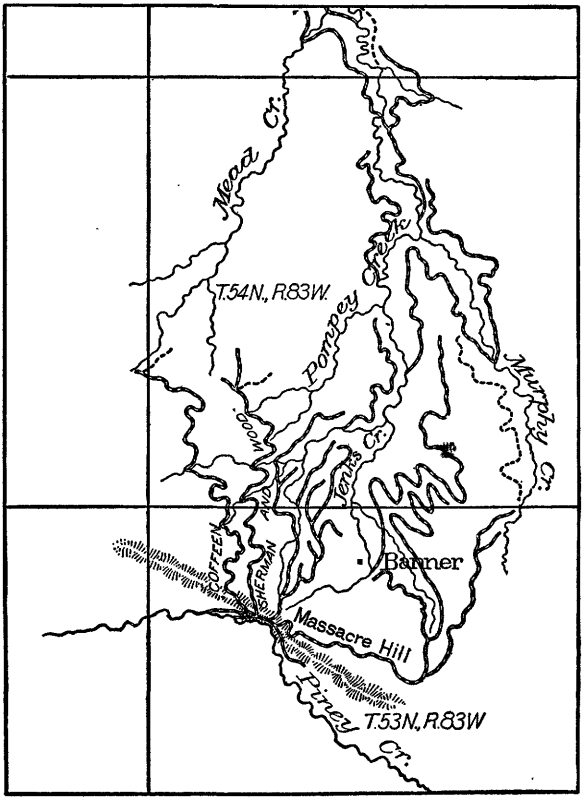


FIG. 4.—Ditches diverting water from Piney Creek across Massacre Hill divide to Prairie Dog Creek.

slope of Cloud Peak (Pl. II), not only drains a large extent of the summit of the range, but effectually cuts off a number of the smaller tributaries of Clear Creek therefrom. Piney Creek, like Clear Creek, receives nearly all its water from one direction. After the stream turns to the north the drainage on the east is into the smaller streams which rise in the foothills below. The most interesting peculiarity of the topography of this stream is, however, the fact that it does

not leave the mountain in a valley, but on a ridge, the mouth of the canyon of Piney Creek being near the summit of the divide which separates the drainage of Tongue and Powder rivers. This divide is an elevated spur of the main range known as Massacre Hill. It leaves the mountain almost at a right angle and extends for a considerable distance eastward. At one point Piney Creek is within 50 feet of its summit. After that it tumbles down into the valley which borders its eastern slope.

Mead, Pompey, Jenks, and Murphy creeks, which form Prairie Dog Creek, a tributary of Powder River, rise on the northern slope of Massacre Hill almost directly opposite the point where Piney Creek so nearly approaches its summit, as shown in fig. 2. Originally this stream was of little importance. It lacked the snowfall necessary to a perennial water supply, and although a few springs are found along its channel, the volume available for irrigation was insignificant. It was an easy project, however, to carry water from Piney Creek over the divide, as shown in fig. 4 and in Pl. IV, and turn it into this stream. Three ditches have been built for this purpose. These ditches follow the prevailing practice of this region in making natural channels a part of the ditch system. The owners of one ditch live along Prairie Dog Creek for 15 miles. The water turned in at the head is taken out by small ditches which divert the creek near their farms. There are 84 appropriations through the ditch of the Prairie Dog Water Supply Company which are diverted from the second stream through a score of smaller ditches.

Before the supplemental water supply had been provided a number of settlers filed on land along Prairie Dog Creek and built ditches therefrom. Some of these settlers became part owners of the ditch to provide an additional water supply; others did not, so that the board again had to deal with three kinds of rights from the same channel—rights to the natural flow, rights to the water turned in, and rights to both combined.

There was a further complication in this case. Prairie Dog Creek is a part of the drainage system of Tongue River, and if drainage lines had to be regarded, it belonged to that district; but since practically the entire water supply came from Piney Creek, the board ruled that water supply rather than the slope of the country should govern its supervision, and this portion of the drainage of Tongue River was made a part of the Clear Creek district.

SUMMARY OF RIGHTS TO WATER.

The diagrammatic map of the irrigation system from Clear Creek (fig. 2) gives the location of the ditches, with the priority numbers of their appropriations. A full list of these is given in the Third Biennial Report of the State Engineer of Wyoming, 1895–96, pages 181 to 194.

NORTH SLOPE OF MASSACRE HILL, ILLUSTRATING EROSION IN DITCHES FROM PINEY CREEK.

The amount of each of the appropriations was fixed by the acreage shown by the proof to have been irrigated, 1 cubic foot per second being allowed for each 70 acres. On Crazy Woman Creek it will be remembered the appropriations were based on the claims filed by appropriators, without regard to the actual use of the water. On French Creek appropriations were based on the areas reclaimed, without regard to the volume of water described in the original statement of claim. The relation of these claims to the actual use of water in irrigation is shown by the comparison of the volume claimed and the volume appropriated on French Creek, as given in the table below.

Volumes appropriated on French Creek as fixed by the order of the board of control and volumes claimed in appropriators' statements.

Priority number.	Name of ditch.	Name of appropriator.	Volume appropriated in decree, in cubic feet per second.	Volume claimed in original statement, in cubic feet per second.
1	Sneider No. 1	Mary L. Carpenter et al	1.64	8
2	Moeller No. 1	Alice S. Rapelyen	1.07	6
2	Moeller No. 2	do	.50	3
3	Moeller No. 3	do	4.28	13.97
4	John A. Fisher No. 1	John A. Fisher	.50	3.35
4	John A. Fisher No. 2	do	.43	23.15
4	Mayhew & Gorgen	Robert Foote	.17	12.40
5,7	Dundee	do	1.57	8.2
6	Gorgen	Peter Gorgen	.28	13.97
	Total		10.44	88.04

It will be seen from the totals that the appropriations established by reason of beneficial use amounted to only about one-tenth of those claimed. The ratio on all of the streams of this district could not be determined, because many of the claims were for the "unappropriated waters of the stream," designating no specific volume; but if these claims to whole streams were excluded, the claims for a definite volume alone were largely in excess of the actual use, as will be seen by the following comparison, in which all of the claims for indefinite amounts have been thrown out.

Volumes claimed and volumes actually used on streams in water district No. 3, in cubic feet per second.

Name of stream.	Volume used.	Volume claimed.
Total Clear Creek	232.78	853.6
Total Rock Creek	187.64	749.9
Total Sayles Creek	8.18	75.1
Total Johnson Creek	3.13	44.7
Total Piney Creek	334.88	943.8
Total Shell Creek	5.52	68.6
Grand total	772.13	2,735.7

ALLOWANCE FOR LOSS OF WATER IN TRANSMISSION.

Among the interesting questions raised in this adjudication was the extent of the loss of water from canals by seepage and evaporation and the authority of the board to provide for this by an increase in the appropriation.

In the original order of the board no such allowance was made, it being held that 1 cubic foot per second for each 70 acres is so much in excess of the requirements of crops, when the water is distributed with reasonable skill and economy, that it will provide for all necessary loss in transportation.

The Wyoming Land and Cattle Company was, however, dissatisfied with this decision, and on this and other grounds asked for and obtained a rehearing, at which measurements were presented showing the losses taking place between the head gate and the place of use.

The conditions on this ditch are somewhat unusual and need to be stated in order that the results may be properly interpreted. The head gate of the ditch is on what was formerly the Fort McKinney military reservation, near the mouth of the canyon and 3 miles above the town of Buffalo. At the time of these measurements, irrigation from the ditch or above the ditch was not permitted within the reservation limits. After crossing its boundary the ditch passes for several miles around and across a series of ridges on the slopes of which losses by seepage are considerable. In the ravines between these ridges and, in one place, along a slope which the ditch crosses there are beds of sand where the loss from percolation is so great that flumes have been built at these points. For 10 miles the following conditions favor an exceptional loss:

The land through which the ditch is built is not irrigated and local atmospheric conditions favor rapid evaporation.

It is the highest ditch and therefore gains nothing from the irrigation of lands above.

The arid land, the steep slopes, and the stretches of sand all add to the drain by percolation.

The measurements submitted were made in 1896 and 1897 by Fred Bond, a civil engineer of Buffalo, Wyoming, and were made in the following manner: A rectangular weir 4.75 feet in length was placed in the ditch immediately below the head gate, and a similar weir, with a length of 5.75 feet, was placed in the ditch near the lands to be irrigated, 10 miles from the first weir and 56 feet below it, that being the fall of the ditch in this distance. It was found by experiments that it took from eleven to thirteen hours for water to pass from one weir to the other. Hence in making these tests the measurements at the upper weir were taken in the morning and those at the lower weir in the evening, in order to measure as nearly as possible the same supply. The tables which follow give the results obtained, that for August 27 being evidently due to an error in measurement or to disturbance by storms.

Loss of water in transmission through ditch of Wyoming Land and Cattle Company.

Date.	Depth of water on upper weir, in feet.	Discharge, in cubic feet per second.	Depth of water on lower weir, in feet.	Discharge, in cubic feet per second.	Total leakage in flumes, in cubic feet per second.	Total loss, in cubic feet per second.	Loss, in per cent.
1896.							
July 10	0.83	11.448	0.56	7.865	(a)	3.583	31.3
July 11	.82	11.328	.55	7.642	(a)	3.686	32.6
July 13	.76	10.123	.55	7.642	(a)	2.481	24.5
August 25	.65	8.058	.50	6.876	(a)	1.182	14.7
August 27	.62	7.515	(?) .58	(?)9.270	(a)	-------	-------
August 28	.60	7.152	.46	5.877	(a)	1.275	17.9
August 29	.59	6.986	.45	5.671	(a)	1.315	18.9
August 30	.59	6.986	.44	5.547	(a)	1.439	20.6
August 31	.59	6.986	.45	5.671	(a)	1.315	18.9
September 1	.58	6.799	.44	5.547	(a)	1.252	18.5
1897.							
August 8	0.562	6.37	0.34	3.74	0.068	2.56	40.2
August 9	.567	6.69	.34	3.74	.09	2.86	42.8
August 10	.60	7.31	.36	4.06	.125	3.12	42.8
August 11	.68	8.59	.43	5.27	.08	3.24	37.7
August 12	.63	7.70	.38	4.42	.047	3.23	42.0
August 24	.467	5.99	.24	2.24	(a)	3.75	62.6

a Not measured.

It will be seen by examining these tables that the percentage of loss when a small volume of water was carried was much greater than when the depth was increased, seepage and evaporation being apparently about constant. If the board took the maximum loss of over 60 per cent as a basis for an order increasing the original right so as to give 1 second-foot for each 70 acres irrigated at the place of use, it would result in nearly double the original appropriation, while if the minimum loss of less than 15 per cent were made the basis of a new right, this action would require so slight a change as not to warrant a modification of the order.

The board refused to grant the additional allowance. The rehearing established a right to water for an additional acreage and increased the volume to be turned into the ditch. As the loss from seepage and evaporation seems about constant, and does not materially increase when the ditch is full, the larger the amount turned in the smaller the percentage of loss. Hence, with the larger right a minimum loss of less than 15 per cent may be expected.

Fort McKinney has since been abandoned and the reservation will soon be largely irrigated. It is believed that the percentage shown by the measurements will decrease in the future by the building of ditches above this one and the irrigation and saturation of the land below it.

The allowance of 1 second-foot to 70 acres being in excess of actual needs was regarded as sufficient to meet the average loss from the ditch at the present time and ample to meet the ultimate decrease.

The wide variation between percentages in the months when the use is heavy and in the later ones when the use is small, would make the establishment of a satisfactory or just appropriation to meet this loss difficult, if not impossible, while the probability of a progressive decrease in such loss would make it unwise to interfere. Even if the proportion allowed agreed with the conditions when made there is small likelihood of such agreement five years hence.

The board held, therefore, that the making of appropriations in excess of the statutory limit would not be approved; but that where satisfactory proof of unpreventable losses in transit made it apparent that the volume remaining, when the land was reached, would not produce crops, a temporary increase would be provided for by an administrative order to the water commissioner.

OWNERSHIP IN DITCH NOT NECESSARY TO THE ACQUIREMENT OF A WATER RIGHT.

One of the parties submitting proof of the beneficial use of water from Piney Creek was John Leitner, who showed to the satisfaction of the board that he had irrigated and reclaimed 15 acres of land through the Upper Phil Kearney ditch. The board by order estab-

lished the right to water for this land through said ditch. In his proof, Leitner stated that he was a part owner of the ditch through which the appropriation was made, and this claim was not contested in the proceedings before the board. Subsequent litigation arose over the ownership of the ditch, and the court decided that Leitner had no interest in it, but that Thomas J. Foster was the sole owner. Following this decision Foster requested the board of control to amend its records by making him the owner of the water right for 15 acres of land acquired by Leitner through the use of the water in its irrigation. Foster's request was based on the contention that his ownership of the ditch made him the owner of all the water it diverted or of all the rights to water acquired through it.

As it is the belief of the board that rights to water for irrigation, in the State of Wyoming, do not inhere either in the man who filed the claim or in the ditch which carried the water, but in the land reclaimed, the request for a transfer of the right from both the place where acquired and from the man who acquired it did not seem well founded; but recognizing the importance of the question involved, the board, before rendering a decision, asked the advice of the Attorney-General. The letter of inquiry and the reply were as follows:

CHEYENNE, WYO., *March 20, 1896.*

DEAR SIR: The State board of control is in receipt of a petition for review of the order determining the priorities of water from Piney Creek and tributaries, and requesting that the board of control cancel a certain certificate of appropriation of water to John Leitner, guardian, and find that Thomas J. Foster is the sole owner of the Upper Phil Kearney ditch.

The board of control has given careful consideration to this petition, and to the order of the court determining the ownership of the Upper Phil Kearney ditch, and has examined the evidence submitted before said board in the adjudication referred to. We find that the testimony submitted showed that Leitner had irrigated the land for which an appropriation was issued through the Upper Phil Kearney ditch and was entitled to an appropriation therefor, and after a reexamination of the evidence the board is of the opinion that the decree establishing this appropriation was correct.

In awarding an appropriation for the particular land for which an appropriation was claimed by said Leitner, the board did not attempt to determine that he had any ownership whatever in the ditch of Mr. Foster. It simply decided that the evidence submitted showed that the water had been transported through this ditch. The board has always held that its authority is restricted to the examination and determination of the facts showing the application of the water of the State to beneficial use and the rights thereby created, and that it could not determine the property rights in ditches through which the water was conducted. That question has been before the board repeatedly and the decisions have been uniform. In the same way the board is now of the opinion that it is not within its jurisdiction to say that Mr. Leitner is or is not a part owner in the Foster ditch. The decree of the court is regarded as determining that fact, but its validity or effect will not be in any way enhanced, in our opinion, by an assumption on the part of the board that it has authority to in any way determine such facts.

We have, by order, instructed the division superintendent to notify the water commissioner of the effect of the order of the court, and that the amount of the

appropriation through the Upper Phil Kearney ditch has been reduced by such order by the amount necessary for the irrigation of 15 acres, but we do not feel authorized to cancel the certificate of Mr. Leitner. We believe if he can secure satisfactory arrangements for the transportation of the water appropriated through the Upper Phil Kearney ditch by giving suitable compensation to Mr. Foster for the service rendered, or if he can make arrangements for the transportation of the water appropriated for this land through some other ditch, he has a perfect right under our laws to do so, and that the appropriation for the land is not destroyed by the fact that he is not part owner in a particular ditch.

Recognizing the importance of the questions raised, and desiring to avail ourselves of your assistance in their proper solution, we shall be pleased if you can advise us as to whether or not, in your judgment, the board has any authority whatever to determine or pass upon property rights in ditches, and whether or not the decree of the court in this case makes it mandatory upon us to cancel the certificate of appropriation of said Leitner.

Respectfully submitted.

ELWOOD MEAD,
President State Board of Control.

Hon. B. F. FOWLER,
Attorney-General, Cheyenne, Wyo.

MARCH 22, 1896.

DEAR SIR: Replying to your communication of March 20, with reference to the application of Thomas J. Foster for a review of your decision granting a certificate of appropriation to John Leitner, guardian, in which application for review Mr. Foster claims to be the sole owner of the Upper Phil Kearney ditch, and presents a decree of the district court of Johnson County, in an injunction suit brought by Mr. Foster against Mr. Leitner, the decree establishing the ownership of Mr. Foster:

I desire to state that while the State board of control was correct in respecting the decree to the extent of instructing your water commissioner that the amount of the appropriation for the Upper Phil Kearney ditch should be reduced by the amount of water granted therein to Mr. Leitner for the irrigation of fifteen acres, still at the same time you would not be justified in canceling the certificate issued to Mr. Leitner.

While there are allegations in the petition for review to the effect that Mr. Leitner made fraudulent representations to your board with regard to his having an interest in the ditch in question, still, in the absence of an affirmative showing of such fraud, there would certainly be no authority on the part of your board to take this for granted and cancel the certificate in question. The decree of the district court of Johnson County does not indicate this, nor do I understand that affidavits or other proof have been filed at this time for this purpose. The petition which is filed is not in the nature of a petition for rehearing, and I am of the opinion that this question can not be properly reached by your board in any other manner, and unless with the application for a rehearing proof should be presented to your office showing that at the time Mr. Leitner used the Phil Kearney ditch he did so as a trespasser and without the consent of Mr. Foster, then your certificate should stand.

As to whether or not Mr. Leitner is able to use the water in the future is certainly not a question to be considered, as under the statute he is given two years before he can be charged with abandonment, and if during that time he should build a new ditch or arrange with Mr. Foster or some other person to conduct the water from the stream in question upon his land, he would be entitled to appropriate enough to irrigate fifteen acres.

As to the claim that there is a cloud upon the title to Mr. Foster's ditch by your granting the certificate, this is certainly a mistake, and as Mr. Foster would not get the benefit of the water for the fifteen acres which is appropriated by Mr. Leitner, I can certainly see no advantage to Mr. Foster in securing the cancellation of the certificate in question.

Respectfully submitted.

BENJAMIN F. FOWLER,
Attorney-General.

Hon. ELWOOD MEAD,
State Engineer, Cheyenne, Wyo.

The reply confirmed the board's views and the request was refused, Mr. Leitner being given two years in which either to build a new ditch or to arrange with Mr. Foster for the transportation of the water to which he was entitled through the Upper Phil Kearney ditch.

DISTRICT 4.

This district, shown in figs. 1 and 5, includes Big Goose Creek and its tributaries. Little Goose Creek is by far the most important tributary, the acreage irrigated along its valley being greater than along the valley of the main stream. Among the smaller tributaries, Soldier, Rapid, and Beaver creeks are the principal branches of Big Goose Creek, while Jackson, Hanna, Tepe, Davis, Trabing, Kemp, Sackett, and Kruse creeks are all branches of Little Goose Creek, which aid in augmenting its flow and from which lands are irrigated. Here, as in the Clear Creek district, the principal stream drains the summit of the range and cuts off the late water supply of the smaller tributaries, and here also irrigators along these smaller tributaries have taken advantage of the topography of the country to relieve their shortage by carrying water across the divides. This transfer of water from one stream to another has been carried to such an extent in this district that some users get water from half a dozen sources. Irrigators near the lower end of Little Goose Creek have the natural flow of the stream, water from Piney Creek, and from three ditches from Big Goose Creek, making in all five separate sources of supply. These transfers from one watershed to another and this extended use of streams as parts of ditch systems have undoubtedly greatly extended the acreage of land reclaimed, but it has at the same time enormously increased the difficulty of determining and protecting rights. Determining the rights to one stream is hard enough, because of the uncertainty and conflicts of early records, but when these uncertainties embrace four or five sources the problem is infinitely more complex. Take as an illustration the rights to water through the Last Chance ditch. Its head gate is in Little Goose Creek. Whenever there is a surplus in this stream irrigators take from the nearest source. Whenever the supply is inadequate a ditch owned by the same persons diverting water from Big Goose Creek is opened and water is used from that stream. These irrigators have therefore established a right to water

from both streams. The question which confronted the board was, How to frame a decree which would give to these irrigators the right to take water from both streams and at the same time limit it to a single appropriation. If it was absolutely certain that water rights would remain attached to the land where acquired and the decree could have been so worded as simply to give this land whatever water was

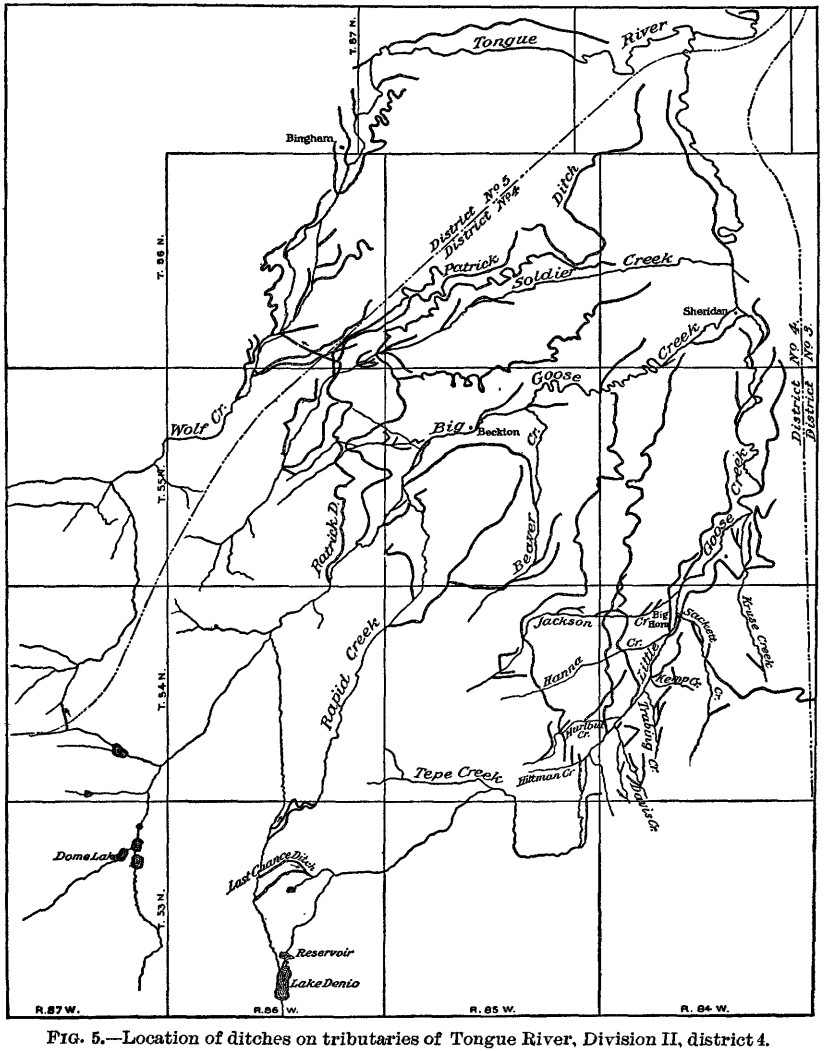
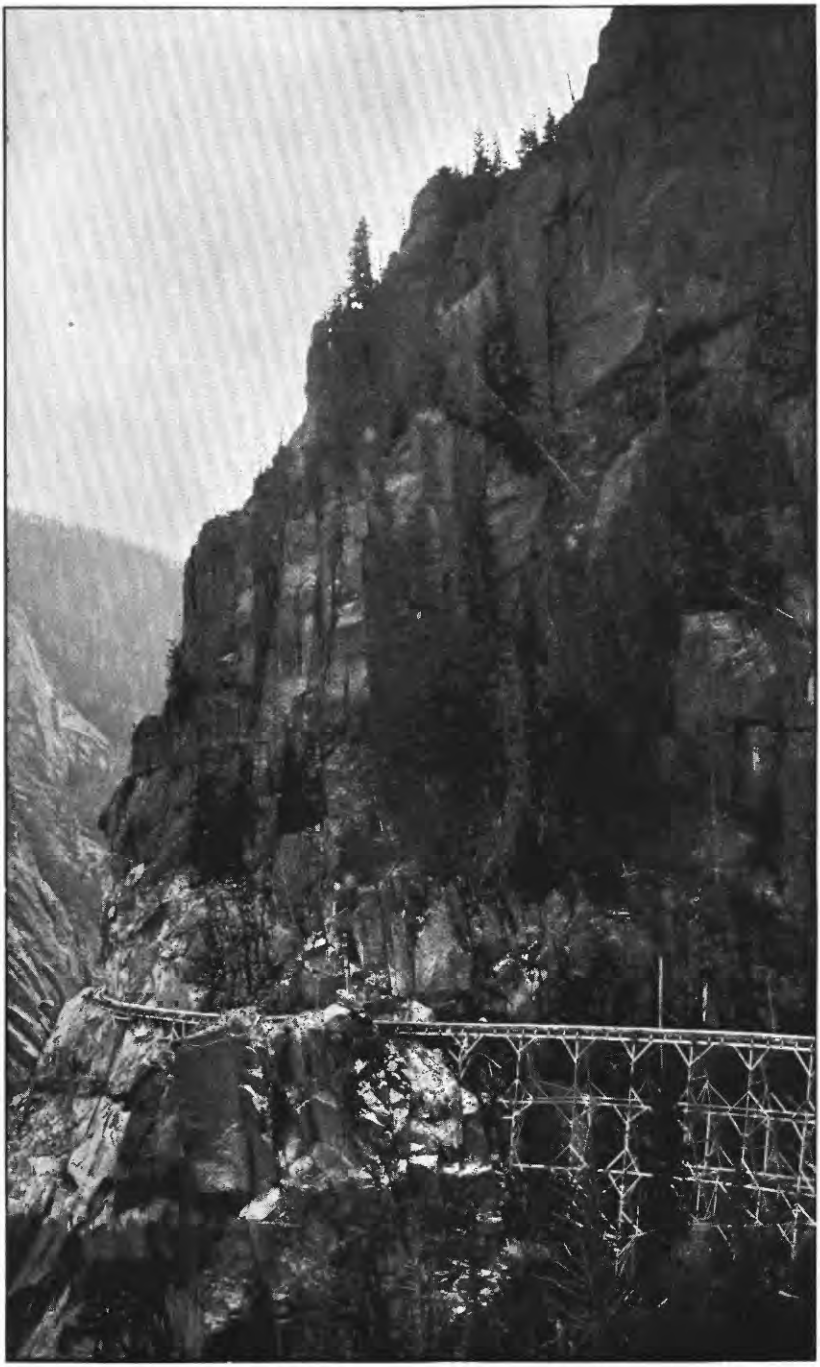


FIG. 5.—Location of ditches on tributaries of Tongue River, Division II, district 4.

needed, there would have been little trouble in preparing the certificates, but the statutes of Wyoming prescribe the form of certificates of appropriation and require the board issuing them to give the volume appropriated in cubic feet per second continuous flow. It was necessary to give the same number of second-feet from each stream, and to



TIMBER FLUME IN CANYON OF TONGUE RIVER.

make this continuous, since there is no authority in the law for limiting the appropriation to certain months or to certain portions of the irrigation season. The board endeavored, in framing its order, to prevent any claim to a double appropriation being set up in the future. But its success will largely depend upon the decision of the supreme court as to whether rights acquired under the Territorial law can be sold and transferred to other lands. If this right should be upheld, there is no question that the right to dispose of the appropriations from one of these streams will become a matter of litigation.

The use of two ditches to divert a single appropriation and the use of a natural stream as a part of the canal system made it difficult to fix priorities. Many of the ditches from Little Goose Creek were constructed prior to those which turn water from Big Goose Creek and have different priority numbers. Hence the same tract of land has a divided appropriation—the two parts coming from different sources and having different priorities.

The boundaries of district No. 4 are based on drainage lines, and prior to the beginning of irrigation there was no connection between the streams of this district and those on either side above the mouth of Big Goose Creek. There are three places at which water is transferred from one district to another. It is turned from the North Fork of Big Goose Creek into the head of Wolf Creek in water district No. 5, and by the Patrick ditch from Big Goose Creek across Soldier Creek, and thence into Wolf Creek at a point about 12 miles farther down; and on the south water is turned into Little Goose Creek by one of the canals from Piney Creek, so that drainage lines are being almost obliterated. When the Granger canal is completed there will be a continuous connection by ditches from Powder River on the south to the Montana boundary, a distance of 100 miles, uniting four districts. A summary of the appropriations of water in this district is given in the First Biennial Report of the State Engineer of Wyoming, 1891–92, pages xxv to xxx, and continued in the Third Biennial Report, 1895–96, pages 177 and 180.

DISTRICT 5.

In district No. 5, shown in figs. 1 and 6, the cost of ditches, rather than the adequacy of the water supply, governed the location of the farms first reclaimed. Tongue River, the main stream, has still a large volume unappropriated, which each year runs to waste, but on a number of its tributaries there are more lands under ditch than these streams will fertilize. This condition of affairs is due to the fact that ditch building from Tongue River is expensive, as shown in Pl. V. After the stream leaves the mountains the grade of its channel is very light and the valley narrow. On both sides are high bluffs with very little irrigable land along their slopes, while to reach the table-lands above requires long, crooked ditches with many dikes or flumes, where ravines or tributary streams have to be crossed.

The shortage of water on the tributaries led to early quarrels over its division. Litigation over water rights on Wolf (east of area shown on fig. 6), Amsden, Smith, and Hewes (or Columbus) creeks began when Wyoming was a Territory, but no conclusion had been reached when the State law went into effect. The testimony which had been taken in this litigation was transferred to the board of control, and these streams were among the first to be dealt with by that body. Since the priorities on these tributaries were earlier than the appro-

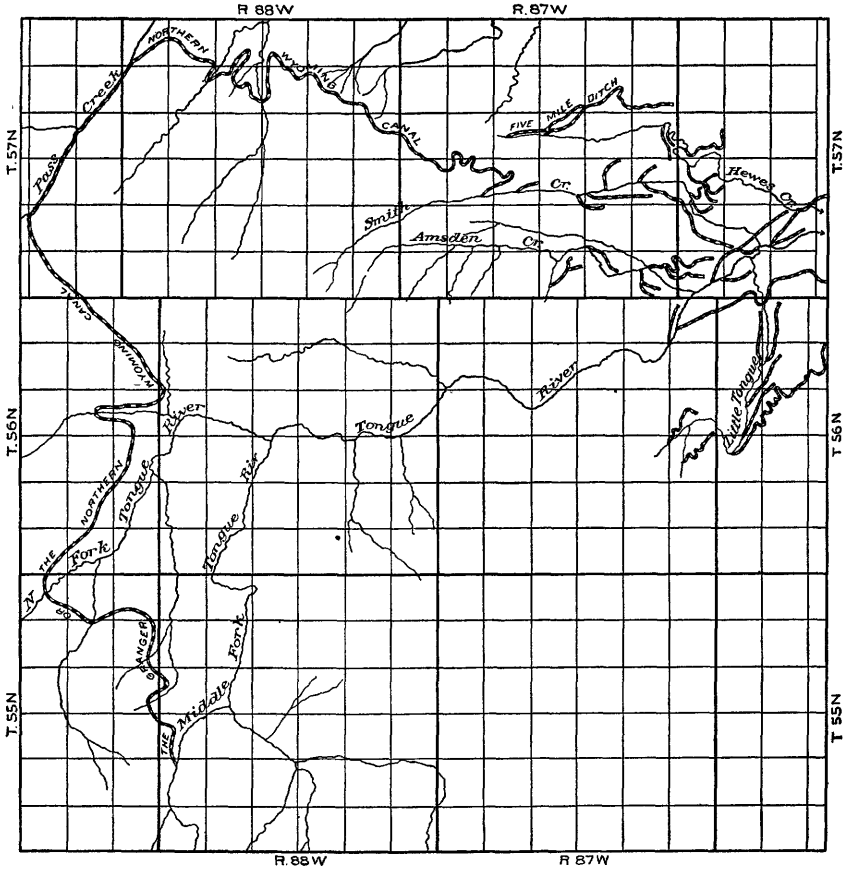


FIG. 6.—Location of ditches on North Fork of Tongue River, Division II, district 5.

priations on the main stream they were independent of any claims on the latter. Hence, in the final determination of these rights, the board of control dealt with each as a separate and distinct drainage basin. The announcement of the policy of the board of control, in limiting water rights to the volume actually used, was not in accord with the views of some of these claimants, who held that their statements of claims described the amounts of their appropriations, and that to reduce these was an encroachment on vested rights.

An appeal from the board's order was taken by the second appropriator from Amsden Creek. This appropriator was allowed 0.86 of a cubic foot per second for the irrigation of 60 acres of land, the location of the land being described. The appeal was based on the claim that water for 150 acres had been appropriated, and made it necessary for the court to rule on the question as to what, under the Wyoming law, constituted an appropriation. The following extract from the proof of appropriation gives the testimony on which the board limited the right to water for 60 acres:

Question. State the number of acres watered each subsequent year, and give the legal subdivisions on which the water is used.

Answer. Claimant increased the amount of land irrigated each year from 1882 to the present time, and now has about 60 acres under cultivation and irrigation.

Question. State the acreage said ditch is capable of watering, and show on a map or plat, on a scale of 2 inches to the mile, the location of said ditch and the land it is capable of watering.

Answer. One hundred and fifty acres.

REMARKS.—Claimant appropriated water sufficient for 150 acres of said land, and now claims water for said land. He does not use said water, has not heretofore, but if farming becomes more profitable he may desire to cultivate all of his land, and his appropriation was made to cover all of said land.

It will be seen from this testimony that only 60 acres had actually been watered, but that the claimant stated it was his intention at some future time, when irrigation became more remunerative, to water more land. The map made by the State engineer's office showed that about 100 acres of land belonging to the claimant could be watered, but that about 50 acres of land belonging to other parties could be watered from this ditch, so that the claim for a possible irrigation of 150 acres from the ditch was correct. The maps and proofs of other claimants showed that about 435 acres of land had been reclaimed, and the actual necessities of this land had more than exhausted the water carried by the stream, so that the resulting shortage had led to litigation over these rights prior to the admission of Wyoming to statehood. This lack of an adequate water supply was shown by the gagings made by the State engineer's office, the volume in July being 5.25 cubic feet per second, while the aggregate of the appropriations made by the board of control on the restricted basis of the necessities of the land reclaimed was 6.21 cubic feet per second. If the claim of an appropriation for 150 acres, instead of 60, had been recognized by the board, the water for the additional 90 acres would have been taken away from lands already reclaimed and from present users, to be held as a speculative property by this claimant until it became valuable enough for him to use, or until, trading on the necessities of those now using it, he could compel them to purchase it from him.

The evils of basing appropriations of water on such considerations would not have ended with this individual. If his belief that he would

at some future time require water enough for 150 acres of land constituted an appropriation, the belief of any appropriator on a stream that he might at some future time use more water would also have entitled him to the full amount of his probable necessities, and appropriations would be fixed not by physical conditions, but by the state of men's minds when filing claims. The first appropriation on this stream was for water sufficient to reclaim 100 acres, but the owners of that ditch had, prior to the adjudication, enlarged it, and had actually reclaimed 110 acres additional, for which they received at the hands of the board of control an appropriation having a later priority. If, however, the contention of the appealing appropriator had been sustained, the appropriator holding the first priority could have maintained that he had intended to appropriate the whole stream and have taken it, while the other five appropriators, including the party appealing from the board's decision, would have been compelled to look to him rather than to the mountains for their water supply.

It seems strange that such an indefinite and unreasonable basis for water rights should ever have had any defenders or received serious consideration; but until the court sustained the board's ruling public opinion in the State was very evenly divided as to the legality of the action. The reason for this lies in the fact that the evils of these extravagant grants are not at once manifest. The term "cubic foot per second" is, to the majority of irrigators, wholly meaningless, and this fact made them unable to appreciate either the effect of an allowance of their claims or the adequacy of the appropriation which the board of control had approved. When a claim had been made for 20, 50, or 100 second-feet of water, and the claimant found that it had been cut down to 1, 2, or 3 second-feet, it was but natural that he should feel aggrieved and be inclined to look with distrust on the assurance that this volume was entirely sufficient to meet all his requirements. The result of basing appropriations on the volumes claimed from Amsden, Smith, and Hewes creeks is not, however, a matter of speculation.

On the last-named stream twenty-eight parties submitted proofs of appropriations, and the surveys of the engineer's office showed that each of them had used water. The aggregate volume of the appropriations approved by the board was 34.8 second-feet, which was less than half the 76 second-feet claimed by the first five. Subsequent experience has shown that the volume fixed by the board's order is more than the stream will furnish, and some of the later appropriators are now building a ditch from Tongue River; but if the stream does not carry 34 second-feet it certainly would not have supplied 76 second-feet, and the allotment of this volume to the first five appropriators would have left nothing for the remaining twenty-three. It is manifest, also, that they have never used more than the stream carries, and of course it is impossible to acquire an appropriation

without ever having diverted or used the water. The injustice of making these claims the foundation of adjudicated rights is strikingly shown in the case of this stream. The claim of the first appropriator was for 21 second-feet, and of the second for 10 second-feet, so that if these two had been given all they asked they would practically have owned the stream.

Smith Creek did not supply enough water to meet the actual needs of users when the priorities were determined. The order of the board limited the rights of all the appropriators to 13.97 cubic feet per second. This was probably in excess of the volume actually used, but it was a great reduction from what was claimed, since that of the first appropriator alone was for 150 second-feet, or more than ten times the volume which the stream carries. The claimant of 150 second-feet received 6 feet, and was indignant because he believed that he had been unjustly deprived of the difference.

LITTLE TONGUE RIVER.

The rights to water from Little Tongue River, the principal tributary of Tongue River, have not as yet been determined. At the time of the adjudication there had not been a sufficiently thorough investigation of the physical conditions to enable the board to reach a satisfactory conclusion as to the merits of some of the questions which must be decided. One of these is a physical problem of great interest. It is a well-known fact that all of the streams draining the eastern slope of the Bighorn Mountains lose more or less water through underground channels. One of the branches of Powder River sinks, to reappear below with diminished volume. The losses on the South Fork of Clear Creek amount to a considerable percentage of its entire flow during the latter part of the irrigation season, and a ditch built to turn water therefrom into Crazy Woman Creek has been a failure, because the water diverted disappeared. But of all these streams the loss in Little Tongue River is the greatest.

During an examination made five years ago a number of funnel-shaped openings were discovered, through which large volumes of water were disappearing, with no evidence of their reappearance. In one case the volume was measured and was found to be in excess of 3 cubic feet per second. In the places examined the water sinks where streams cut across the upturned edges of a limestone stratum of great thickness. Whether the total volume lost from Little Tongue River is greater than that from the main stream is as yet unknown, but the percentage is greater and the loss more apparent. Those dependent on the stream have made many efforts to ascertain the location of these underground channels and close them up, and much has been accomplished in this direction. One of the parties engaged in this work claims that the water thus saved should not be subject to the rights of appropriators of the normal discharge, but

should be wholly independent thereof. In his claim for a separate right and for its adjudication apart from the rights on the main stream he sets forth by affidavit the facts on which the claim is based. The affidavit is here given:

John R. Gatewood, being first duly sworn, deposes and says that he is a citizen of the county and State aforesaid; that he is the person described in the annexed "Application for a permit to divert and appropriate the waters of the State of Wyoming," and that the water which he desires to appropriate from the South Fork of the Tongue River, one of the natural streams of the State, is water which has not as yet been appropriated by any person for "beneficial uses;" that in the said South Fork of Tongue River, back in the mountains, at places described in said "application," there are natural holes on the bottom of the stream through which about 20 per cent of the natural flow of said water, at low water, escapes into the earth, and that, as far as affiant has been able to ascertain, does not again run into said stream or any other natural stream, but is wholly lost; that said affiant believes that he can save said water for beneficial uses; that he is the owner of possessory rights to agricultural lands in said county, and has not water to reclaim the same, and that by being allowed to save this water he verily believed, and does believe, that he can secure said water for said beneficial uses.

A list of the adjudicated rights in water district No. 5 is given in the First Biennial Report of the State Engineer of Wyoming, 1891–92, pages xxxiii to xxxvi and pages xxiii and xxiv. These tables are continued in the Third Biennial Report, 1895–96, page 176.

APPROPRIATIONS IN DIVISION III.

On the west side of the range but little has been done by the State irrigation authorities. Rights have been determined in the sixth district, but not in the fourth and seventh (see fig. 1), there being so large a surplus as to obviate any controversy among users.

DISTRICT 6.

The following order and tabulation gives the rights established in the sixth district and the form in which the entry of the board's action is made in the records of the board of control:

ORDER ESTABLISHING PRIORITIES AND AMOUNTS OF APPROPRIATIONS OF WATER FROM NO WOOD RIVER AND ITS TRIBUTARIES.

In the matter of the determination of the rights of appropriators of water from No Wood River and tributaries, in water division No. 3, Bighorn County, Wyoming.

In this matter the board of control having heretofore, at its regular meeting held on the 21st day of March, 1896, duly made and entered an order for the adjudication and determination of the rights to the use of the waters of No Wood River and its tributaries, in water division No. 3, and directing the State engineer to proceed as soon as possible and survey and measure all the ditches diverting water therefrom;

And it appearing that the State engineer, in pursuance of said order, after giving due and legal notice according to law to all appropriators from said stream and its tributaries, did survey and measure all the said ditches, and prepared and filed complete maps and a report in the office of the said board:

Thereafter N. H. Brown, superintendent of said water division No. 3, after due

and legal notice to appropriators of water fixing the time and place of receiving proof of appropriation from said stream and its tributaries, did appear at the time and place fixed, and did take and receive the sworn proofs and testimony in writing of all persons appearing and claiming rights to water in said stream, and thereafter exposed said proof to public inspection on a day fixed according to law, and said proofs having been examined and no contests having been instituted were thereafter duly filed, with his report and findings, in the office of said board;

And now this matter coming regularly on for hearing and determination by the board of control, upon the records in the State engineer's office and the proofs of appropriation duly taken and submitted by said superintendent, and upon the maps and report of surveys and measurements of streams and ditches duly made by the State engineer and his assistants, and the board having now examined the records in the State engineer's office, the proofs of the beneficial use of water, filed in the office of said board, and having read the report and tabulation and heard and considered the recommendations of said N. H. Brown, superintendent of said division No. 3, that certificates of appropriation be issued, and the board, being now fully advised, finds as follows:

FINDINGS.

The board finds that the appropriations of water determined and established by this order were made from the following-named streams:

No Wood River proper and Bear Creek, Boxelder, Upper or Little Canyon Creek, Crooked Creek, Otter Creek, Spring Creek, Tensleep Creek, Broken Back Creek, Alkali Springs Creek, Paint Rock Creek, all tributaries of No Wood proper.

Cherry Creek, tributary of Boxelder.

North Fork Spring Creek, tributary Spring Creek.

Lower Canyon Creek, tributary Tensleep.

North Fork Broken Back, tributary Broken Back.

Buffalo Flat Creek, tributary Alkali.

Medicine Lodge Creek, tributary Paint Rock.

Coon Holler or Coon Creek, tributary Spring.

That in order to adjudicate and establish the rights of the various appropriators from these several streams it is necessary, in addition to the determination of the order of priority and general priority number of each of the rights to water from No Wood and its tributaries, taken as a whole, for the board to determine and establish the priorities of right growing out of appropriations from each of said streams as between the appropriators therefrom themselves.

The board finds that the rights of appropriators from each of the various tributaries are subject to the rights of prior appropriators on the main stream below, or on the stream into which said tributary flows, and to these rights only.

Subject to the foregoing limitations and conditions, the board finds the name of the appropriators, the priority numbers of said appropriations, the maximum amounts thereof, the uses for which the water was appropriated, and the legal subdivisions of land on which the water appropriated is to be used and to which it is attached are as set forth in the following table.

ORDER.

It is therefore ordered by the board of control that each of the following-named appropriators from No Wood and its tributaries above named do have the use of the water of the stream from which said appropriation was made by him, or them, for the beneficial purpose for which acquired and for no other, and that the names of the appropriators, the priority number of each of said appropriations, the maximum amounts thereof, the names of the ditches or other diverting works through which the appropriation is made, the dates of said appropriations, the beneficial use to which the water is appropriated, and, when for irrigation, the description

of the land to which the water appropriated is attached, shall be the same as stated in the following table under its appropriate heading, which said table is hereby made a part of this order.

It is further ordered that each of the appropriations for irrigation shall be sufficient for the economical irrigation of the land described and no other, not to exceed 1 cubic foot of water per second of time for each 70 acres irrigated.

NO WOOD RIVER PROPER.

Priority number.[a]		Name of ditch.	Name of appropriator.	Post-office address.	Date of appropriation.	Use to which water is applied.	Amount appropriated, in cubic feet, per second.	Number of acres irrigated.
5	1	S. V	John D. Gill	Redbank, Wyo.	May 1, 1885	Irrigation	0.79	55
11	2	Cornell No. 1	Enoch Cornell	do	Apr. 2, 1886	do	.90	20
12	3	Mead No. 1	John Mead	do	May 1, 1886	do	.15	10
38	4	Spratt	Thos. Spratt	Bonanza, Wyo.	May 13, 1889	do	3.21	225
41	5	Green Spot	Chas. Mills	Redbank, Wyo.	1889	do	.15	10
41	5	Cornell No. 2	Enoch Cornell	do	1889	do	.12	8
42	6	Suez	Taylor Bros	Bonanza, Wyo.	Mar. 15, 1890	do	1.86	130
43	7	Harmony	O. C. Morgan	do	Mar. 20, 1890	do	2.28	160
43	7	do	Henry Jordan	do	do	Domestic and irrigation.	.88	60
43	7	do	Louisa M. Smith	do	do	do	.21	15
43	7	do	A. G. Smith	do	do	do	.53	37
43	7	do	Jas. A. Quiner	do	do	do	.74	50
46	8	Umslopogaas No 2.	A. L. Coleman	Redbank, Wyo.	Nov. 1, 1890	do	.64	45
49	9	Western	L. J. Diehl	Bonanza, Wyo.	Aug. 2, 1892	do	2.78	195
49	9	do	Nich. Carstensen	Hyattville, Wyo.	do	do	1.14	80
49	9	do	Geo. A. Bell	do	do	do	4.08	286
53	10	Ilg	E. M. Ilg	Bonanza, Wyo.	Oct. 16, 1893	do	.71	50
53	10	do	Otto Ilg and Arthur A. Ilg.	do	do	do	.68	48
60	17	Avent	Ira M. Avent	do	July 5, 1895	do	1.71	120
62	18	Cornell No. 2, enlargement.	John Mead	Redbank, Wyo.	Sept. 16, 1895	do	.21	15
63	19	Harmony Mill enlargement.	Henry Jordan	Jordan, Wyo.	Jan. 4, 1896	Mechanical	1.15	.....

BOXELDER CREEK, TRIBUTARY OF NO WOOD RIVER.

1	1	Two Bar	Estate of Harvey Booth.	Redbank, Wyo.	Apr., 1884	Irrigation	0.57	40
16	2	Helms No. 1	Henry Helms	do	Apr., 1886	do	.40	28
21	3	Wells No. 1	Chas. Wells	do	May, 1887	do	.46	32
24	4	Wells No. 2	do	do	Sept. 1, 1887	do	.63	44
25	5	Helms No. 2	Henry Helms	do	Sept., 1887	do	.31	22

UPPER OR LITTLE CANYON CREEK, TRIBUTARY OF NO WOOD RIVER.

13	1	Red Bank	H. A. Richards	Redbank, Wyo.	June, 1886	Irrigation and stock.	4.57	320
40	2	Umslopogaas	A. L. Coleman	do	May, 1889	Irrigation	.50	35
45	3	Rosebud	Harvey Smith	do	Sept., 1890	do	.10	7
55	4	Hillside	C. S. Walu	do	Feb. 16, 1894	do	.93	65
55	4	do	Alex. Arledge	do	do	do	.50	35

CROOKED CREEK, TRIBUTARY OF NO WOOD RIVER.

8	1	F. D. Helmer, or Brunner No. 1.	Frank D. Helmer	Redbank, Wyo.	May 15, 1885	Irrigation	1	70
8	1	Ainsworth	F. S. Ainsworth	do	do	Irrigation and mechanical.	1.14	80

[a] The first number is the general priority number in reference to the rights to water from No Wood River and its tributaries taken as a whole; the second is the priority number in reference to the rights from each stream.

OTTER CREEK, TRIBUTARY OF NO WOOD RIVER.

Priority number.		Name of ditch.	Name of appropriator.	Post-office address.	Date of appropriation.	Use to which water is applied.	Amount appropriated, in cubic feet, per second.	Number of acres irrigated.
4	1	Grout	C. E. Shaw	Redbank, Wyo.	Apr. 1, 1885	Irrigation	1.05	73½
7	2	Dyson	do	do	May 10, 1885	do	.66	46½
28	3	Daly	do	do	1887	do	.54	38
31	4	Higbie	C. J. Higbie	do	May, 1888	do	2.51	176
58	5	Sawyer	George Sawyer	do	Nov. 7, 1894	do	.71	50

SPRING CREEK, TRIBUTARY OF NO WOOD RIVER.

5	1	Emge & Robinson No. 2.	Wm. Robinson	Redbank, Wyo.	May 1, 1885	Irrigation	0.43	30
5	1	Walu Bros	R. A. Walu	do	do	do	1.43	100
16	2	Emge & Robinson (Hollywood).	Wm. Robinson	Tensleep, Wyo.	1886	do	.43	30
17	3	Standish & Henderson.	Elmer Chatfield	do	Mar. 20, 1887	do	1.93	135
35	4	Tunnel	A. F. and L. Walu	do	Sept., 1888	do	2.86	200
52	5	Tunnel enlargement, No. 48.	R. A. Walu	do	Sept. 14, 1893	do	.36	25

TENSLEEP CREEK, TRIBUTARY OF NO WOOD RIVER.

2	1	Winn	Milo Burke	Tensleep, Wyo.	Sept. 1, 1884	Irrigation	2.43	160
7	2	Columbian	Milo Burke and Bessie C. Burke	do	May 10, 1885	do	3.00	210
10	3	Bay State No. 1	Bay State Cattle Co.	do	1885	do	1.57	110
22	4	Burke	Milo Burke	do	Aug. 1, 1887	do	.43	30
30	5	Perfection	Fred G. S. Hesse	Buffalo, Wyo.	Apr. 10, 1888	do	7.14	500
44	6	Bay State No. 2	Bay State Cattle Co.	Tensleep, Wyo.	May, 1890	do	.43	30
48	7	Wyman	S. A. McLaughlin	do	July 2, 1892	do	1.14	80

BROKEN BACK CREEK, TRIBUTARY OF NO WOOD RIVER.

7	1	Carothers No. 2	Ed Carothers	Hyattville, Wyo.	May 10, 1885	Irrigation	.21	15
10	2	Cranky Jack	John D. Hopkins	Tensleep, Wyo.	1885	do	1	70
18	3	Hardscrabble	W. R. Williams	do	Mar. 25, 1887	do	.64	45
28	4	Carothers North Fork.	Ed Carothers	Hyattville, Wyo.	1887	do	.09	6
28	4	Carothers No. 1	do	do	1887	do	.36	25
28	4	Carothers No. 3	do	do	1887	do	.29	20
29	5	North Fork	John D. Hopkins	Tensleep, Wyo.	Apr. 1, 1888	do	.71	50
41	6	Dry Fork	H. E. Miller	do	1889	do	.08	5
47	7	Carothers No. 5	Ed Carothers	Hyattville, Wyo.	1890	do	.43	30
47	7	Carothers No. 6	do	do	1890	do	.08	5
47	7	Carothers North Fork No. 1.	do	do	1890	do	.06	4
57	8	Williams	W. R. Williams	Tensleep, Wyo.	July 10, 1894	do	.29	20

PAINT ROCK CREEK, TRIBUTARY OF NO WOOD RIVER.

6	1	Big Bear	David Matthews	Hyattville, Wyo.	May 2, 1885	Irrigation	.43	30
6	1	do	John Luman	do	do	do	1.14	80
14	2	Meyers	H. W. Meyers	do	Sept. 11, 1886	do	.96	67
14	2	do	John Weintz	do	do	do	.15	10
14	2	do	Lee Nansell	Bonanza, Wyo.	do	do	.86	60
19	3	Luman & Allen	John Luman	Hyattville, Wyo.	Apr. 8, 1887	do	.83	58
19	3	do	Jas. D. Allen	do	do	do	.89	62
23	4	Bernstein	Clara F. Collins	Basin, Wyo	Summer, 1887.	do	.86	60
27	5	Elk	Abraham Gotwals.	Hyattville, Wyo.	Fall, 1887	do	2.86	200

PAINT ROCK CREEK, TRIBUTARY OF NO WOOD RIVER—Continued.

Priority number.		Name of ditch.	Name of appropriator.	Post-office address.	Date of appropriation.	Use to which water is applied.	Amount appropriated, in cubic feet, per second.	Number of acres irrigated.
27	5	Elk	John Luman	Hyattville, Wyo.	Fall, 1887	Irrigation	2.64	185
27	5	do	Jas. D. Allen	do	do	do	1.43	100
28	6	Bernstein No. 1	Estate of Fred Bernstein, D. B. Stanton, agent.	Basin, Wyo	1887	do	5	350
33	7	Military	T. F. Nelson	Hyattville, Wyo.	May, 1888	do	.54	38
37	8	Go Ahead	Willis J. Booth	do	May 1, 1889	do	1.79	125
37	8	do	H. D. Hendricks	do	do	do	1.57	110
37	8	do	T. F. Nelson	do	do	do	.43	30
50	10	Shuck & Wilson	Zelotes Wilson	do	Mar. 20, 1893	do	.79	55
50	10	do	Asa Shuck	do	do	do	1.71	120
54	11	Rinehart	Dan H. Rinehart	do	Jan. 23, 1894	do	.18	12
56	12	Hyattville	S. W. Hyatt	do	July 2, 1894	do	1	70
56	12	do	D. W. Hunsinger	do	do	do	.86	60
59	16	South Side	Lee Nansell	Bonanza, Wyo.	July 5, 1895	do	.43	29.3
59	16	Weintz	John Weintz	Hyattville, Wyo.	do	do	1	70
59	16	do	H. W. Meyers	do	do	do	.51	36
59	16	do	Nora O. Meyers	do	do	do	.50	35

CHERRY CREEK, TRIBUTARY OF BOXELDER CREEK.

61	1	Helms No. 3	Henry Helms	Redbank, Wyo.	July 11, 1895	Irrigation	.26	18

LOWER OR BIG CANYON CREEK, TRIBUTARY OF TENSLEEP CREEK.

3	1	Hunsinger No. 1	Jacob Hunsinger	Tensleep, Wyo.	Oct. 15, 1894	Irrigation	2.28	160
15	2	Hunsinger No. 2	do	do	Oct. 1, 1886	do	2.64	185
51	3	Canyon Creek Ditch.	Frank M. Simmons (C. E. Shaw, agent.)	do	Sept. 4, 1893	do	3.64	255

BUFFALO FLAT CREEK, TRIBUTARY OF ALKALI CREEK.

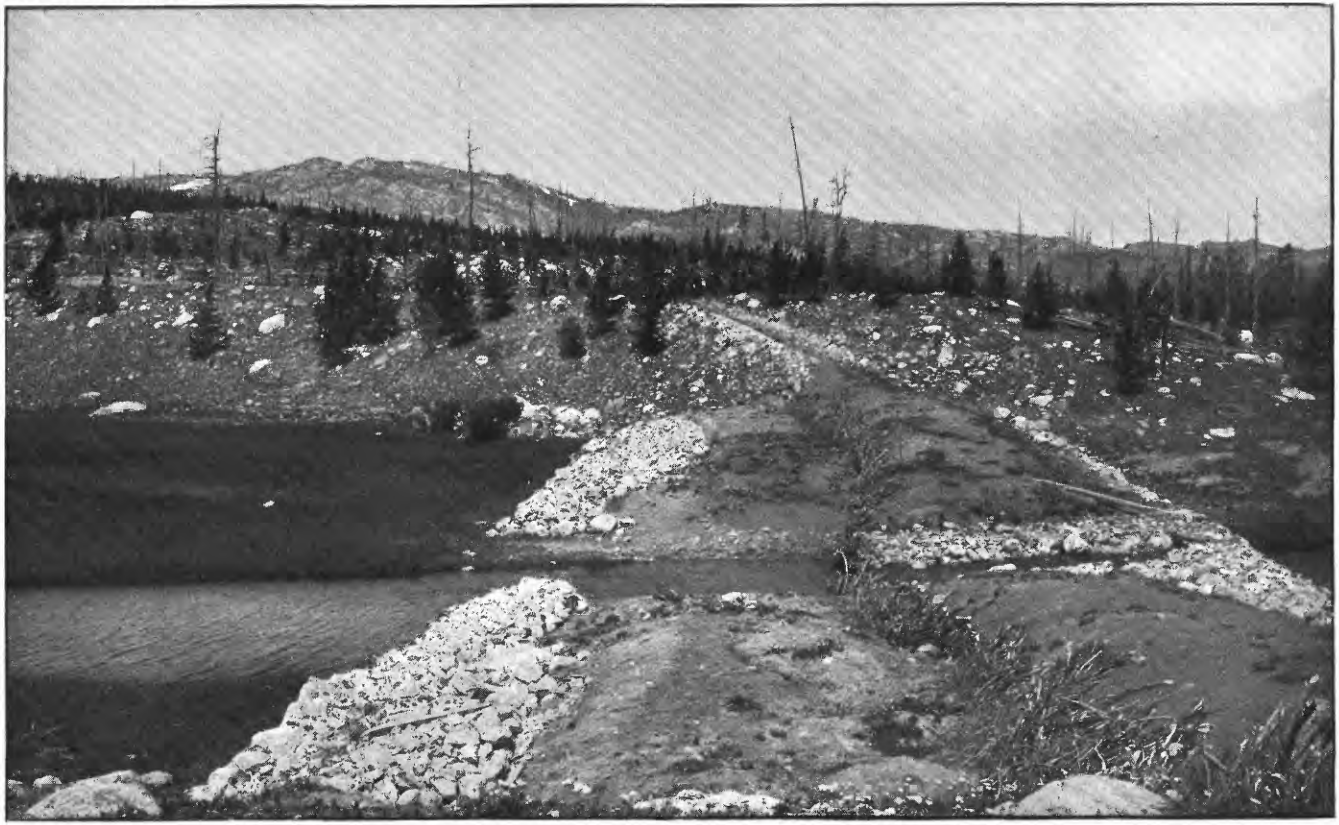
36	1	Buffalo Flat	John J. Smith	Hyattville, Wyo.	1888	Irrigation	.93	65

MEDICINE LODGE CREEK, TRIBUTARY OF PAINT ROCK CREEK.

9	1	George Bayne	D. V. Bayne	Hyattville, Wyo.	May 10, 1885	Irrigation	3.19	223
9	1	do	Estate of George Cassell, F. P. Carr, administrator.	do	do	do	2.53	177
10	2	Wickwire	Byron Wickwire	do	1885	do	.36	25
20	3	Allen & Nelson	Theodore F. Nelson.	do	Apr. 10, 1887	do	1.10	77
20	3	do	Jas. D. Allen	do	do	do	.87	61
26	4	Highland	Lorenzo D. Walu	do	Nov., 1887	do	.49	84
26	4	Walu No. 2	do	do	do	do	.57	40
32	5	Hyatt No. 2	Saml. W. Hyatt	do	May 10, 1888	do	1.21	85
34	6	Anthony	Byron Wickwire	do	Sept. 20, 1888	do	.08	5
34	6	do	David Matthews	do	do	do	3.50	245

COON HOLLER OR COON CREEK, TRIBUTARY OF SPRING CREEK.

39	1	Dutch	John J. Smith	Hyattville, Wyo.	May 17, 1889	Irrigation	.26	18



BEGINNING OF CONSTRUCTION OF DAM AT NORTH END OF DOME LAKE RESERVOIR.

It is further ordered that certificates of appropriation be issued to the said appropriators in accordance with the provisions of the foregoing findings and order.

In witness whereof, the president of the State board of control has hereunto set his hand this 10th day of March, A. D. 1898.

RESERVOIRS.

By drawing on the larger streams when the smaller ones were exhausted it has been possible to utilize a large percentage of the flow from the east side of the range without resorting to storage, but the time is approaching when storage will be necessary if the reclaimed area is to be extended. Storage has been somewhat delayed, because there is no law at present defining and protecting rights to stored water. This is one of the legislative questions to be dealt with in the near future. Much can be done whenever it becomes necessary. The sites for mountain reservoirs are both numerous and valuable. From the summit of Cloud Peak over 100 mountain lakes can be counted, and a large percentage of these will in time be utilized.

Actual construction has begun on only one of these reservoir sites—Dome Lake. The location of this lake is shown in fig. 5, and a detailed sketch of the lake and surroundings is given in fig. 7. The elevation of the lake is 8,720 feet, as determined by the topographers of the United States Geological Survey during the season of 1897. The area of the water surface is 320 acres, the average depth 20 feet, and the total flow of water 6,400 acre-feet. The estimated cost of the reservoir is $50,000. The improvements have been made with the double object of storing water for irrigation and of making this point an attractive summer resort.

The importance of the lakes on the head waters of Piney Creek is clearly shown in the able report of Capt. Hiram M. Chittenden, giving the results of his preliminary examinations of reservoir sites in Wyoming and Colorado.[1] The relative location of these lakes is shown on the Cloud Peak topographic atlas sheet of the United States Geological Survey, the area being mapped during the field season of 1898. From a report by Mr. François E. Matthes, the following facts concerning South Piney Creek have been obtained:

The South Fork of South Piney Creek flows from the snow banks and glaciers east of Cloud Peak, and has therefore an abundant water supply throughout the year. Its valley, above the point where the ditch to Rock Creek begins, is the bed of an ancient glacier, and is thickly covered with morainal deposits of irregular disposition, giving rise to a remarkable number of lakes of all sizes. Among these are Cloud Peak Lake and Mead Lake, shown in fig. 8, both of which

[1] Preliminary examination of reservoir sites in Wyoming and Colorado, by Capt. Hiram M. Chittenden, with monograph on Reservoirs and their effects on the floods of the Mississippi system, by James A. Seddon: House Doc. No. 141, Fifty-fifth Congress, second session. Washington, 1898. 110 pp., 10 folding maps.

have at various times been proposed for reservoir sites. Both are deep and are surrounded by steep mountain sides; the altitude of Cloud Peak Lake is 9,703 feet and of Mead Lake 9,950 feet, approximately. (See Pl. III, *B*.) Unfortunately but one of the two main canyons on the east side of Cloud Peak drains into these lakes. The other (lesser) canyon joins the main canyon half a mile below Cloud Peak Lake.

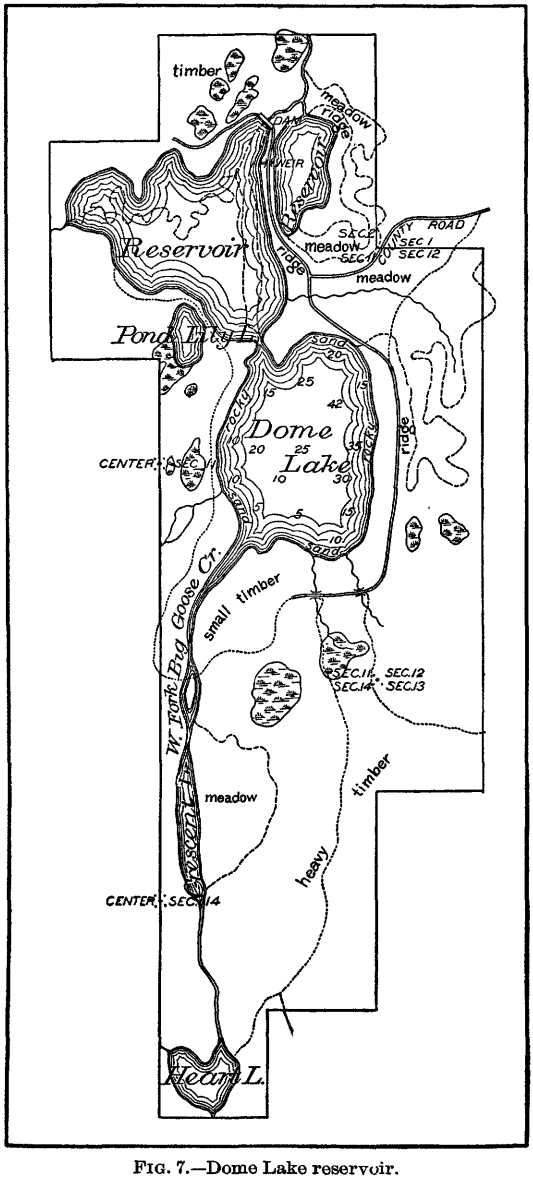


FIG. 7.—Dome Lake reservoir.

Another large body of water, Elk Lake, draining into the South Fork of South Piney Creek, lies on a broad shelf and is very shallow. The lake is at an elevation of 9,850 feet. Its catchment area is very small, almost entirely above timber line, and contains nothing larger than insignificant rills. In spring it probably receives a large amount of water from the melting snowdrifts on the peaks. The outlet of the lake is wide and flat and of a swampy character. The stream at that point is quite small, but increases farther on. It apparently sinks into the ground on leaving the lake, a phenomenon quite common in a country covered with glacial débris. By building a low dam the area of the lake will be considerably increased, but the water supply will be limited practically to that obtained in spring from snow banks which entirely disappear each summer.

The North Fork of South Piney Creek flows through a valley similar

to that of the South Fork. The number of lakes, as shown in fig. 8, is even larger than on that branch, but few are available for water-storage purposes. Among these are the Kearney Lakes, altitude 9,156 feet, in reality one lake, which, however, is fast being converted

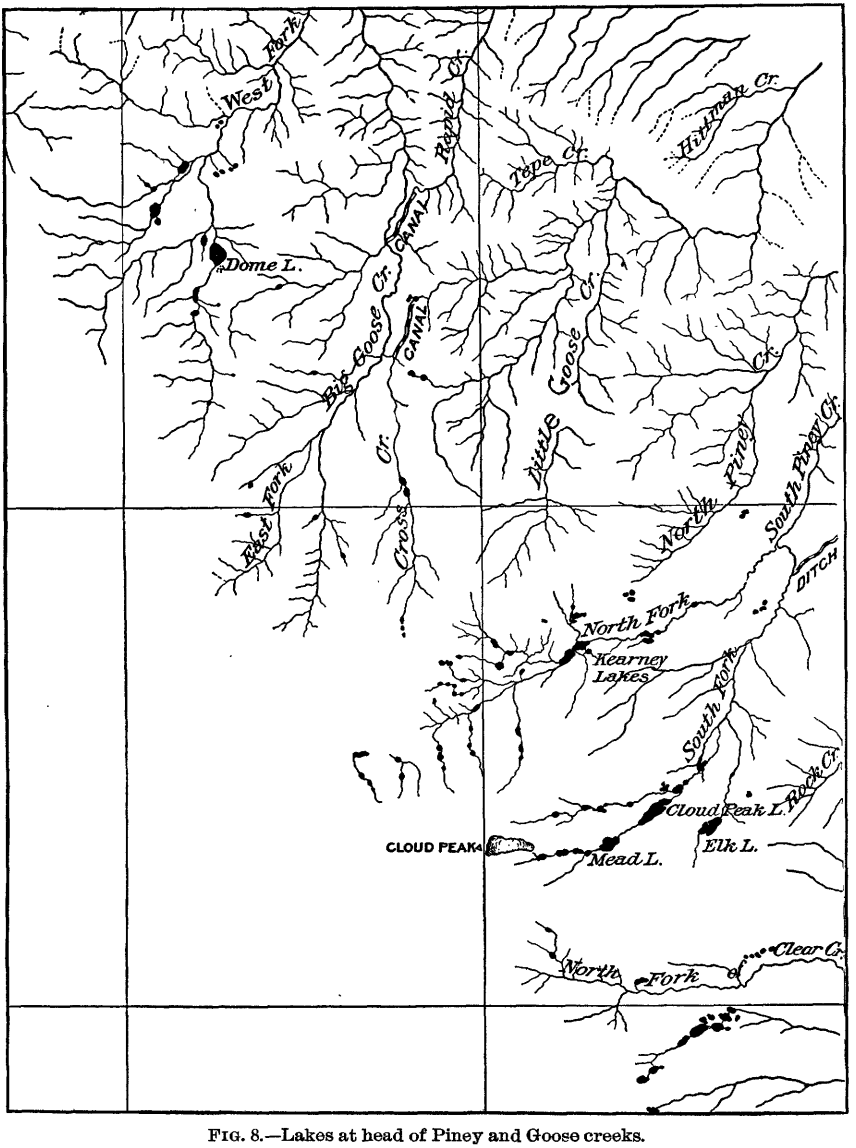


FIG. 8.—Lakes at head of Piney and Goose creeks.

into two separate lakes, as shown on Pl. VII, by the sediment of two small brooks entering near the middle, opposite each other. The twin lakes thus formed are deep and can easily be dammed at the outlet. They receive all the water from the glaciers in the canyons north

of Cloud Peak and that from the perpetual snow banks on the peaks of the main range. It is expected that surveys for a reservoir dam at these lakes will be commenced early next season.

The northern forks only of Clear Creek were mapped during 1898, but a general survey of the entire drainage area revealed the fact that each of the half dozen canyons which form its head waters contains a number of lakes, some of them almost as large as the Kearney Lakes. The entire basin is thickly covered with morainal ridges; it is extremely rough and practically inaccessible.

Sites along Tongue River will serve to increase greatly the acreage that stream will reclaim, while on the western slope the improvement of the lakes on Medicine Lodge and Tensleep creeks will serve not only to double the reclaimed area but to call attention to a region of unsurpassed scenic attractions.

The maps filed in the State engineer's office serve to show the location of the projects on which work was begun and the nature of the improvements proposed.

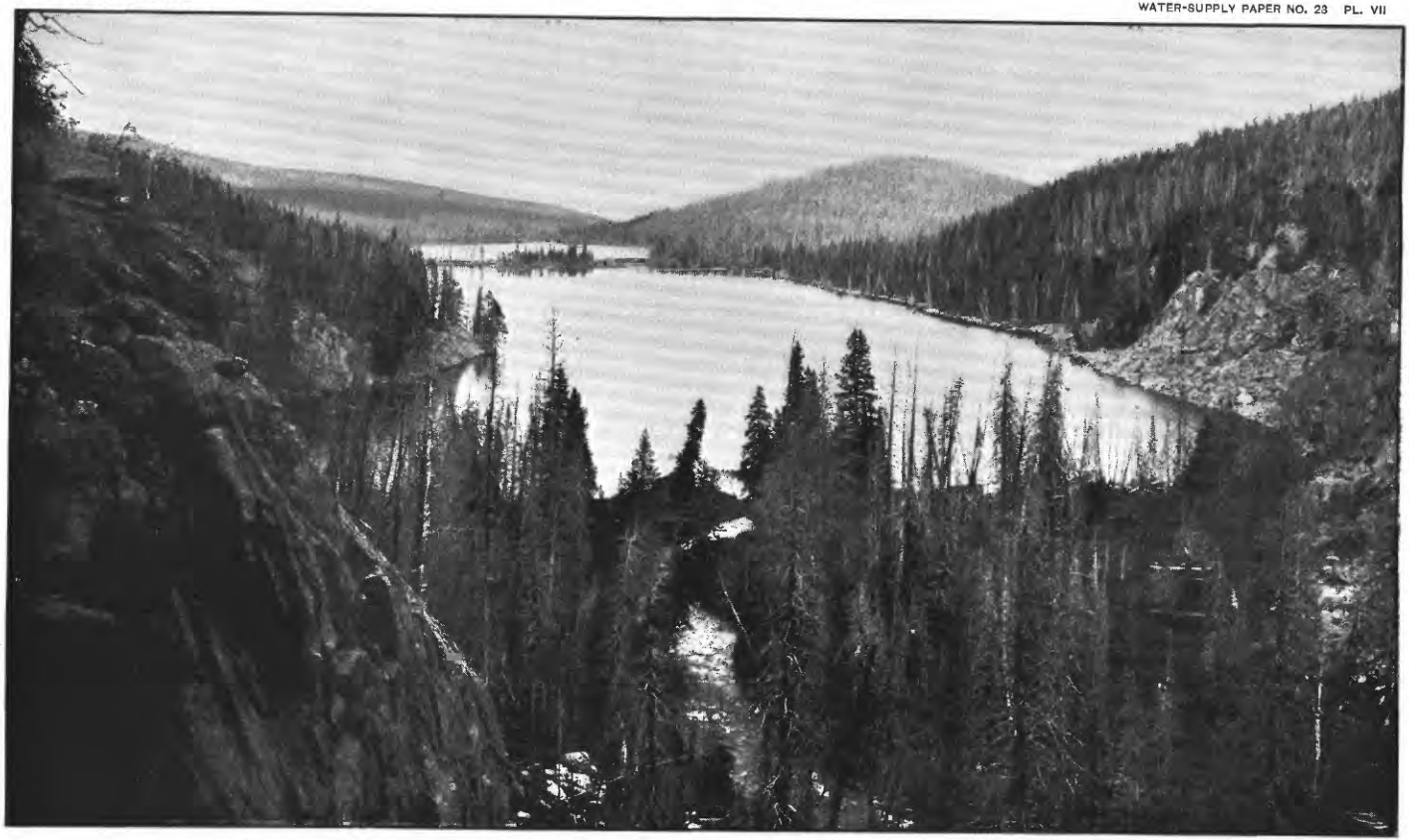
Names, superficial area, and contents of the reservoirs in the Bighorn Mountains for which permits have been issued by the State engineer.

Name.	Superficial area in acres.	Contents in acre-feet.
Dana reservoir	4	25
Kearney reservoir	146.2	3,801
Dome Lake reservoir	211.2	3,168
Willow reservoir	57.8	650
Barr reservoir	48	450
Treichler & Parsons reservoir	5.1	61.2
Ella reservoir	45	1,000
Denio reservoir	193.75	1,743.75
Cross & Cruse Co. reservoir	21	----------
Elk Lake reservoir	197.55	2,570
Cloud Peak reservoir	170	2,500
South Piney reservoir	95.4	1,050

ADMINISTRATIVE QUESTIONS.

The commissioners in charge of the districts described in this bulletin have to deal with unusual conditions. The division of a stream among users is a difficult problem under the most favorable circumstances, but the commissioners of these districts are confronted with complications seldom encountered in equal measure elsewhere. These are:

1. The interchange of water between streams in the same district and its transfer across district boundaries.



OUTLET OF KEARNEY LAKE RESERVOIR ON NORTH PINEY CREEK.

2. The frequent use of streams as part of a ditch or canal and making not one stream but three or four streams part of a single system.

3. The attaching to one piece of land of rights from more than one stream through one or more ditches.

4. The construction of canals to carry water across divides in remote and inaccessible locations in the mountains, thereby rendering the regulation of head gates expensive and difficult and the measurement of stream flow practically impossible.

Even when the streams are gaged and the commissioner knows the supply to be divided he is often unable to perform his work to his own satisfaction or that of irrigators. The wide and rapid fluctuation of streams is to blame for this. From the records of the gagings of Clear Creek, made by the State engineer and the Geological Survey, it is seen that the discharge ranges from three or four times the total volume appropriated to about one-third this volume, and that at times these two extremes are reached within a few days of each other.

The gaging station is below the mountain ditches, and its record does not show what they divert, but it does show how rapid must be the commissioner's movements to protect the rights to the 232 second-feet appropriated. On May 23, 1896, as shown in fig. 3, less than 100 second-feet was passing over the weir; on the 24th there was over 200. On June 3 a flow of 504 second-feet permitted all users to waste water, if they so desired. Three days later the discharge was less than the amount appropriated. On the 19th the flow was 209 second-feet; on the 29th it was 82. The distance from the highest to the lowest head gate on this stream is 50 miles, and an examination of the map (fig. 2) will show the haphazard location of the appropriations and the rapid changes necessary to protect these rights when the demand begins to exceed the supply. The commissioner would have enough to do in times of scarcity to regulate this stream only, but he has in addition to watch the fluctuations of half a dozen others and keep track both of their natural discharge and of the water turned in from other streams.

While doing this he can only estimate the volume to be distributed. From the highest ditch on Clear Creek to the foot of the mountain is a day's journey. It takes half that time to go from the highest land irrigated on Rock Creek to the head gate of the Piney feeder in the mountains along that stream. From the last ditch on Prairie Dog to the first on the stream which supplies it the distance is 40 miles in one direction, and it is an equal distance to the last ditch along the valley of that stream in almost the opposite direction. Without telephone or telegraph connection, the commissioner can deal only with what he sees. Under the circumstances the success achieved has been little less than marvelous.

The water turned from Big Goose Creek into Little Goose Creek enters that stream 9 miles from and 2,000 feet above the land first

irrigated. The head of the ditches can only be reached after a day's journey, and frequent inspections can not be made. Because irrigators can not know the facts, they are all the more likely to resent any interference with their supply. Appropriators of the natural flow are sometimes disposed to believe that those dependent on some other source get more than their share, and vice versa. Users of water along Piney Creek, Big Goose Creek, and other large streams do not look with favor on the diversions into other drainage basins where the subsequent regulation is so expensive and difficult. It is, therefore, a high tribute to the honesty and tact of the commissioners and superintendent to say that they have thus far performed their duties in such a way as almost entirely to avert litigation. To enable them to continue this, however, their labors should be supplemented by comprehensive measurements of the discharge of these several streams. The turning of water across divides and the use of a stream as part of a ditch is no doubt economical, but unless the methods so largely employed here are supplemented by numerous stream gagings, it is hard to see how commissioners are to distribute successfully a supply coming from three or four sources.

Lack of gagings add to the perplexities of the State engineer. It is a part of his duty to refuse permits for additional ditches when the water supply is exhausted. So long as he has no knowledge of the volume being diverted, nor where it goes, he has to depend largely on conjecture. The extensive construction of reservoirs along the channels of these streams which is certain to result in the near future, and the use of their channels to transport the stored water to the place of use, will aggravate these complications. That they can all be removed is not to be doubted, but to accomplish this it will be necessary to have a full understanding of all the conditions, and foremost among these is the amount of water there is to be stored, divided, and used.

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1895.

Sixteenth Annual Report of the United States Geological Survey, 1894–95, Part II, Papers of an economic character, 1895; octavo, 598 pp.

Contains a paper on the public lands and their water supply, by F. H. Newell, illustrated by a large map showing the relative extent and location of the vacant public lands; also a report on the water resources of a portion of the Great Plains, by Robert Hay.

A geological reconnoissance of northwestern Wyoming, by George H. Eldridge, 1894; octavo, 72 pp. Bulletin No. 119 of the United States Geological Survey; price, 10 cents.

Contains a description of the geologic structure of portions of the Bighorn Range and Bighorn Basin, especially with reference to the coal fields, and remarks upon the water supply and agricultural possibilities.

Report of progress of the division of hydrography for the calendar years 1893 and 1894, by F. H. Newell, 1895; octavo, 176 pp. Bulletin No. 131 of the United States Geological Survey; price, 15 cents.

Contains results of stream measurements at various points, mainly within the arid region, and records of wells in a number of counties in western Nebraska, western Kansas, and eastern Colorado.

1896.

Seventeenth Annual Report of the United States Geological Survey, 1895–96, Part II, Economic geology and hydrography, 1896; octavo, 864 pp.

Contains papers on "The underground water of the Arkansas Valley in eastern Colorado," by G. K. Gilbert; "The water resources of Illinois," by Frank Leverett, and "Preliminary report on the artesian waters of a portion of the Dakotas," by N. H. Darton.

Artesian-well prospects in the Atlantic Coastal Plain region, by N. H. Darton, 1896; octavo, 230 pp., 19 plates. Bulletin No. 138 of the United States Geological Survey; price, 20 cents.

Gives a description of the geologic conditions of the coastal region from Long Island, N. Y., to Georgia, and contains data relating to many of the deep wells.

Report of progress of the division of hydrography for the calendar year 1895, by F. H. Newell, hydrographer in charge, 1896; octavo, 356 pp. Bulletin No. 140 of the United States Geological Survey; price, 25 cents.

Contains a description of the instruments and methods employed in measuring streams and the results of hydrographic investigations in various parts of the United States.

1897.

Eighteenth Annual Report of the United States Geological Survey, 1896–97, Part IV, Hydrography, 1897; octavo, 756 pp.

Contains a "Report of progress of stream measurements for the calendar year 1896," by Arthur P. Davis; "The water resources of Indiana and Ohio," by Frank Leverett; "New developments in well boring and irrigation in South Dakota," by N. H. Darton, and "Reservoirs for irrigation," by J. D. Schuyler.

1898.

Nineteenth Annual Report of the United States Geological Survey, 1897–98, Part IV, Hydrography, 1899; octavo, 814 pp.

Contains a "Report of progress of stream measurements for the calendar year 1897," by F. H. Newell and others; "The rock waters of Ohio," by Edward Orton, and "A preliminary report on the geology and water resources of Nebraska west of the one hundred and third meridian," by N. H. Darton.

Water-Supply and Irrigation Papers.

This series of papers is designed to present in pamphlet form the results of stream measurements and of special investigations. A list of these, with other information, is given on the outside (or fourth) page of this cover.

Survey bulletins can be obtained only by prepayment of cost, as noted above. Postage stamps, checks, and drafts can not be accepted. Money should be transmitted by postal money order or express order, made payable to the Director of the United States Geological Survey. Correspondence relating to the publications of the Survey should be addressed to **The Director, United States Geological Survey, Washington, D. C.**

WATER-SUPPLY AND IRRIGATION PAPERS.

1. Pumping water for irrigation, by Herbert M. Wilson, 1896.
2. Irrigation near Phœnix, Arizona, by Arthur P. Davis, 1897.
3. Sewage irrigation, by George W. Rafter, 1897.
4. A reconnoissance in southeastern Washington, by Israel C. Russell, 1897.
5. Irrigation practice on the Great Plains, by E. B. Cowgill, 1897.
6. Underground waters of southwestern Kansas, by Erasmus Haworth, 1897.
7. Seepage waters of northern Utah, by Samuel Fortier, 1897.
8. Windmills for irrigation, by E. C. Murphy, 1897.
9. Irrigation near Greeley, Colorado, by David Boyd, 1897.
10. Irrigation in Mesilla Valley, New Mexico, by F. C. Barker, 1898.
11. River heights for 1896, by Arthur P. Davis, 1897.
12. Water resources of southeastern Nebraska, by Nelson Horatio Darton, 1898.
13. Irrigation systems in Texas, by W. F. Hutson, 1898.
14. New tests of pumps and water lifts used in irrigation, by O. P. Hood, 1898.
15. Operations at river stations, 1897, Part I, 1898.
16. Operations at river stations, 1897, Part II, 1898.
17. Irrigation near Bakersfield, California, by C. E. Grunsky, 1898.
18. Irrigation near Fresno, California, by C. E. Grunsky, 1898.
19. Irrigation near Merced, California, by C. E. Grunsky, 1899.
20. Experiments with windmills, by Thomas O. Perry, 1899.
21. Wells of Indiana, by Frank Leverett, 1899.
22. Sewage irrigation, Part II, by George W. Rafter, 1899.
23. Water-right problems of the Bighorn Mountains, by Elwood Mead, 1899.

In addition to the above, there are in various stages of preparation other papers relating to the measurement of streams, the storage of water, the amount available from underground sources, the efficiency of windmills, the cost of pumping, and other details relating to the methods of utilizing the water resources of the country. Provision has been made for printing these by the following clause in the sundry civil act making appropriations for the year 1896–97:

Provided, That hereafter the reports of the Geological Survey in relation to the gauging of streams and to the methods of utilizing the water resources may be printed in octavo form, not to exceed 100 pages in length and 5,000 copies in number; 1,000 copies of which shall be for the official use of the Geological Survey, 1,500 copies shall be delivered to the Senate, and 2,500 copies shall be delivered to the House of Representatives, for distribution. [Approved June 11, 1896; Stat. L., vol. 29, p. 453.]

The maximum number of copies available for the use of the Geological Survey is 1,000. This quantity falls far short of the demand, so that it is impossible to supply all requests. Attempts are made to send these pamphlets to persons who have rendered assistance in their preparation through replies to schedules or who have furnished data. Requests made for a certain paper and stating a reason for asking for it are granted whenever practicable, but it is impossible to comply with general demands, such as to have all of the series sent indiscriminately.

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