FIFTEENTH BIENNIAL REPORT

OF THE

STATE ENGINEER

Compliments of

CHARLES W. COMSTOCK

State Engineer, Colorado

ADO

For the Years 1909-10

DENVER, COLORADO
THE SMITH-BROOKS PRINTING CO., STATE PRINTERS
1911

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GOVERNOR OF COLORADO

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LETTER OF TRANSMITTAL.

Sir:—I have the honor to transmit herewith the fifteenth biennial report of the State Engineer's Office, covering the period December 1, 1908, to November 30, 1910, inclusive.

Very respectfully,

CHARLES W. COMSTOCK,
State Engineer.

To His Excellency,
JOHN F. SHAFROTH,
Governor of Colorado.

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STATE ENGINEERS OF COLORADO

Since Organization of Department, June 3, 1881.

EUGENE K. STIMSON	June, 1881, to April, 1883
EDWIN S. NETTLETON	April, 1883, to April, 1887
J. SIRE GREENE	April, 1887, to April, 1889
JAMES P. MAXWELL	April, 1889, to April, 1893
CHARLES B. CRAMER	April, 1893, to April, 1895
HORACE A. SUMNER	April, 1895, to April, 1897
JOHN E. FIELD	April, 1897, to April, 1899
ADDISON J. McCUNE	April, 1899, to April, 1903
LOUIS G. CARPENTER	April, 1903, to April, 1905
THOMAS W. JAYCOX	April, 1905, to April, 1909
CHARLES W. COMSTOCK	April, 1909, to April, 1911

LIST OF OFFICERS

In Charge of Water Distribution in Colorado, November 30, 1910.

CHARLES W. COMSTOCK	State Engineer
JUNIUS W. JOHNSON	Deputy State Engineer
ARTHUR F. HEWITT	Deputy State Engineer

IRRIGATION DIVISION ENGINEERS.

Div. No. 1	Fillmore Cogswell	Denver
Div. No. 2	E. R. Chew	Pueblo
Div. No. 3	F. W. Swanson	Alamosa
Div. No. 4	Arthur H. Stokes	Grand Junction
Div. No. 5	Theodore Rosenberg	Glenwood Springs

WATER COMMISSIONERS.

Div. No.	Dist. No.	NAME	ADDRESS	Div. No.	Dist. No.	NAME	ADDRESS
1	1	John E. Monaghan	Fort Morgan, Colo.	5	36	No Commissioner.......	....
1	2	James P. Higgins.......	Brighton, Colo.	5	37	L. W. Spangler.........	Gypsum, Colo.
1	3	John L. Armstrong	Fort Collins, Colo.	5	38	Wm. S. Smith..........	Sunlight, Colo.
1	4	Howard H. Kelly.......	Loveland, Colo.	5	39	Wm. J. Murtle	New Castle, Colo.
1	5	Ray R. Mathews........	Longmont, Colo.	4	40	H. C. Getty............	Cedaredge, Colo.
1	6	James Platt............	Boulder, Colo.	4	41	A. J. Baxter...........	Montrose, Colo.
1	7	Wm. M. Elliott.........	Golden, Colo.	4	42	Geo. M. Saunders.......	Mesa, Colo.
1	8	A. E. Gray.............	Littleton, Colo.	5	43	J. D. Moog.............	Meeker, Colo.
1	9	L. E. Ewan.............	Morrison, Colo.	5	44	Arthur Collom..........	Axial, Colo.
2	10	Wm. Frizzell...........	Manitou, Colo.	5	45	G. W. Taughenbaugh...	Rifle, Colo.
2	11	Max Dickman..........	Poncha Springs, Colo.	1	46	J. P. Vaughn...........	Butler, Colo.
2	12	J. W. Augustine........	Canon City, Colo.	1	47	John Jurgensen	Walden, Colo.
2	13	H. W. Hendershot......	Silver Cliff, Colo.	1	48	Walter G. Decker.......	Laramie, Wyo.
2	14	Harry R. Thomson.....	Pueblo, Colo.	2	49	No Commissioner	....
2	15	Samuel Tilden Curtis....	Beulah, Colo.	5	50	Thos. Herriott..........	Kremmling, Colo.
2	16	Parson S. Brown.......	Walsenburg, Colo.	5	51	No Commissioner	....
2	17	Benj. G. Wilson........	Rocky Ford, Colo.	5	52	Clarence Rundell	Sheephorn, Colo.
2	18	Claudius Hart..........	Apishapa, Colo.	5	53	J. Bruce Roup.........	Yampa, Colo.
2	19	W. G. Hines............	Trinidad, Colo.	5	54	E. W. Leggett..........	Four Mile, Routt Co., Colo.
3	20	Geo. D. Nickel..........	Del Norte, Colo.	5	55	No Commissioner.......	....
3	21	Geo. S. Lovett..........	La Jara, Colo.	5	56	No Commissioner.......	....
3	22	B. W. Harrison.........	Manassa, Colo.	5	57	No Commissioner.......	....
1 2	23	Alonzo Wright..........	Pine, Colo.	5	58	F. D. Hutchinson.......	Yampa, Colo.
3	24	J. P. Sanchez...........	San Pablo, Colo.	4	59	F. W. Harper..........	Gunnison, Colo.
3	25	John L. Charles.........	Crestone, Colo.	4	60	C. H. Smith............	Coventry, Colo.
3	26	Alexander Russell.......	Saguache, Colo.	4	61	W. S. Jones............	Paradox, Colo.
3	27	Arthur N. Coolbroth....	La Garita, Colo.	4	62	No Commissioner.......	....
4	28	J. Roy Hicks, Jr........	Sargents, Colo.	4	63	No Commissioner.......	....
4	29	Robert H. Bostwick....	Pagosa Springs, Colo.	1	64	R. C. Perkins..........	Sterling, Colo.
4	30	S. M. Campbell.........	Durango, Colo.	1	65	H. Lepper	Wray, Colo.
4	31	No Commissioner.......	....	2	66	No Commissioner	....
4	32	No Commissioner.......	....	2	67	Harry A. Pettee........	Holly, Colo.
4	33	Fred Mahan............	Hesperus, Colo.	4	68	John W. Martin........	Ridgway, Colo.
4	34	H. M. Barber...........	Mancos, Colo.	4	69	No Commissioner	....
3	35	I. N. Janney...........	Alamosa, Colo.	5	70	Geo. Newton...........	Debeque, Colo.

CHAPTER I.

INTRODUCTORY.

The work of the State Engineer's office may be conveniently classified under seven heads, as follows:

1. Office and clerical work in connection with the filing of claims to water rights.
2. Control of streams and supervision of water distribution therefrom.
3. Examination of reservoir plans and specifications, supervision of dam construction, and inspection of existing reservoirs.
4. Hydrographic work, including measurements of stream flow and study of water resources of the State.
5. Investigation of irrigation projects under the Carey Act, and reports to State Board of Land Commissioners on their water supply and general feasibility.
6. Design and construction of bridges and roads.
7. Engineering work for other departments of the State government to whatever extent may be necessary.

All of the work described under these headings, with the exception of No. 6, is prescribed by the General Statutes relating to this department. The work under the sixth heading varies from year to year in accordance with the terms of the legislative acts appropriating money for the construction of internal improvements, and designating the various boards of construction who will have charge of the work. It has been customary in the past to make the State Engineer a member of each such board of construction, with a view to utilizing the engineering force of this office.

OFFICE AND CLERICAL WORK.

The existing filing law relating to water rights requires that each claimant shall file in the office of the State Engineer "two duplicate copies on tracing muslin or other material adapted for permanent record and preservation," of a map and statement containing certain information which is specified by the statute. The State Engineer's office is required to check over these maps and statements to make sure that they comply in every way with the statute, and that they are duplicates.

During the period December 1, 1908, to November 30, 1910, inclusive, there have been filed under this act, 2,751 maps. Many of these maps consist of from two to ten sheets each. It is, in fact, the exceptional map which consists of a single sheet. In many instances the maps are filed in triplicate or quadruplicate, in order that certified copies may be filed with the County Clerks of several counties. The work of checking and comparing the maps and statements requires almost the entire time of two clerks. As fully half of the maps filed do not comply in all respects with the statutes, and as in many cases maps filed as duplicates are in fact not so, the amount of correspondence resulting from this work is very large, requiring fully half the time of a stenographer.

When the claimant to a water right makes application to the Federal Land Office for a right of way over public land, he is required by the rules of the land office to file a certified copy of the map and statement on file in the State Engineer's office, or to obtain from the State Engineer a certificate that such filing has been made, and giving an abstract of the information it contains. The preparation of such certificates and certified copies has required from one-fourth to one-third of the time of one clerk during the past two years.

The State Engineer's office is frequently asked to furnish a certified list of all claims to water rights from a certain stream, or in a certain district, prior to a specified time. It has been found that the indices which have existed in the office are incomplete, and too unreliable to warrant any such certificates. On this account new indices, under four different classifications, have been undertaken. Three of these are card indices, for which it has been necessary to obtain new filing cabinets and an entirely new system of cards. The first index is one of names of ditches and reservoirs. The office contains at this time about fifteen thousand filings, each representing one or more claims to water rights. About seven thousand of these filings were made before the present filing law was enacted, in 1903. The remaining eight thousand have been made since that time.

The index of names contains about twenty thousand cards, and is now practically complete.

The second card index is arranged according to the names of claimants. This has been partially written.

The third index is arranged according to the names of the sources of supply from which water is claimed. This has not yet been written.

The fourth index is a list of filings in their chronological order, arranged according to water districts. This index has been about half written, and is being prepared in a loose-leaf book, in which all the data can be typewritten.

In preparing these indices it has been necessary to handle every filing in the office several times, and to check the classification by water districts with great care. Many errors have been found and many filings heretofore supposed lost have been discovered out of place. After these indices are completed, it will be possible to prepare such certificates of filings made, as are frequently asked for, with a certainty that they are absolutely correct. At the present time this cannot be done.

A large proportion of the time of one clerk is taken up in answering inquiries for information, which are presented either in person or over the telephone, and in looking up the data contained in the files of the office which are frequently called for. This work has generally been done by one of the clerks who checks the maps and statements presented for filing.

SUPERVISION OF WATER DISTRIBUTION.

The State Engineer is the head of the force of officials charged with the distribution of water from the public streams in accordance with the decrees of the courts, and with the various statutes covering that distribution.

The theory of our system of water officials is that the State Engineer will come in contact with the details of the distribution work only at rare intervals, and then, on appeal from a decision of a Division Engineer, who, in his turn, has been appealed to from a ruling by a water commissioner. As a matter of fact, the water users of the State have not yet become accustomed to such a formality of procedure, and the tendency among them is to bring their complaints and difficulties direct to the State Engineer's office, believing that they will thus get the matter settled once for all. In many such cases it seems advisable for the State Engineer to take original jurisdiction, with a view to avoiding neighborhood quarrels, long-drawn-out disputes, and, in many cases, consequent damage to crops.

In those cases, however, in which the questions presented do not seem of immediate importance, the complaints have been referred back to the water commissioners, from there to the Division Engineers, and thus to the State Engineer by appeal, if it should become necessary. A number of such appeals have been brought to this office, and have been passed upon in the light of the best evidence obtainable. It has not been thought necessary to report them in detail. All the papers filed with them are parts of the record of this office, and are accessible at any time, to anyone interested in the cases.

In some parts of the State there has been a manifest tendency on the part of the water officials to allow things to run in whatever manner has been customary in the past, regardless of the law. This has perhaps been for the reason that it is much easier for the officials to administer affairs in this way than to upset an established custom of several years standing.

For the two years just passed this office has proceeded on the basis of strict adherence to the law. If this practice conflicts with established customs, and if the people prefer the method established by custom rather than that established by law, it is for them to have the law altered to meet their views.

It is believed to be an extremely dangerous practice for any executive official to depart from the law as laid down in the statute books, no matter how many people may wish it. If this is done, the people will never take steps to change the law to conform to altered conditions. If the law is rigidly enforced, but found to be ill-adapted to existing conditions, the people will soon change it.

The work of water distribution is closely connected with that of the hydrographic department. Although the water commissioners and Division Engineers are charged with the duty of distributing water in amounts and according to an order of priority established by the courts, the determination of the amount distributed to each consumer rests upon the measurements which are required by law to be made under the supervision of the State Engineer. The hydrographers connected with the State Engineer's office are therefore in great demand, particularly through the drier part of the summer, to make frequent ratings of measuring flumes, or to measure into the headgate of a ditch a run of reservoir water being made through a natural stream.

The details of the work of water distribution are given in a subsequent chapter, which contains the reports of the Division Engineers for the years 1909-10, together with a tabular arrangement prepared in this office of some of the data from the annual reports of the water commissioners.

During the biennial period just closed it has been necessary to discipline two water commissioners. The water commissioner of District No. 18 refused to execute the decrees of the court in the matter of water distribution, on the ground that he had personal knowledge of false testimony given before the referee in the adjudication proceedings, and that he knew some of the decrees to be unjust and improper. He was promptly advised by this office that he had no discretion in the distribution of water according to court orders, and that he must do so at all times. He was further advised that his only alternative was to resign. No further complaint has been heard from his district, or from the Division Engineer of Division No. 2.

The second instance was that of the water commissioner of District No. 23, who flatly refused to execute an order of the Division Engineer, and entered into an argument as to the correctness of the order, citing some decisions of the Court of Appeals, which he imagined supported his position. His letter to the Division Engineer was referred to this office. The water commissioner was advised by the State Engineer that he must obey the orders of his superior officer, regardless of what he (the water commissioner) might think of the correctness of those orders. Nothing further was heard from the water commissioner, but he still neglected or refused to carry out the orders of the DivisionEngineer. After the lapse of a reasonable time the matter was brought to the attention of his excellency, the Governor of Colorado, who cited the water commissioner to appear at the Governor's office and show cause why he should not be removed. The water commissioner then handed in his resignation, which was accepted, and a new water commissioner appointed. Since that time there has been a closer approximation to the enforcement of the water law in District No. 23 than ever before.

RESERVOIR SUPERVISION.

Sections 3205, 3206 and 3207, Revised Statutes of Colorado, 1908, are as follows:

3205. "No reservoir of a capacity of more than seventy-five millions cubic feet of water, or having a dam or embankment in excess of ten feet in vertical height, and covering an area of more than 20 acres shall hereafter be constructed in this State, except the plans and specifications of the same shall first be approved by the State Engineer; and the State Engineer shall act as consulting engineer during the construction thereof, and shall have authority to require the material used and the work of construction to be done to his satisfaction; and no work shall be deemed complete under the provisions of this act until the State Engineer shall give to the owners of such structures a written statement of the work of construction and the full completion thereof together with his acceptance of the same, which statement shall specify the dimensions and capacity of such reservoir or reservoirs."

3206. "The owners of such reservoirs shall pay to said State Engineer his actual expenses incurred in making personal inspection, and five dollars per day and expenses to any deputy appointed by him to attend to such supervision when necessarily employed for such purpose."

3207. "The State Engineer shall annually determine the amount of water which it is safe to impound in the several reservoirs within this State, and it shall be unlawful for the owners of any reservoir to store in said reservoir water in excess of the amount so determined by the State Engineer to be safe."

The plans submitted under this act during the past two years have been for structures of all sizes and kinds. Some of them were for reservoirs containing only one or two hundred acre-feet and coming just within the limit set by the law. Others have been for structures of unprecedented magnitude intended to form reservoirs of enormous capacity. Many of the plans submitted have shown on their faces that the designers were unacquainted with the fundamental principles of engineering and had no conception of the results to be accomplished or the methods of accomplishing them. Others have been prepared by engineers of recognized standing and unquestioned attainments. All this has been particu'arly true of earth dams. The impression is general that an earth dam is simply a bank of earth, and that one differs from another only in size. That there are established principles of design and construction in relation to dams of earth as well as those of masonry is a fact unheard of by most people outside of the engineering profession. There is, however, no law limiting the practice of engineering to those who are properly trained for it, and therefore no means of preventing any person from risking the lives and property of other people by the improper construction of important structures. The number of persons competent properly to design and construct large dams is very small compared with the number of persons who attempt it.

The burden of responsibility imposed on the State Engineer's office by section 3205 is, therefore, very great. Plans and specifications prepared by trained engineers do not cost the State Engineer much time or trouble in their examination, for they are prepared in accordance with the principles generally recognized and well known to all engineers. By far the larger number of plans presented are, however, prepared by persons entirely ignorant of these principles and contemplate a class of construction which cannot be tolerated by the State. These persons generally resent any suggestions for improvement or alteration of their plans, and the State Engineer consumes much time and energy in argument and discussion in the attempt to have the designs brought within the limits of safety. The indication of approval over the State Engineer's signature, to be found on the plans filed in this office, is, therefore, no indication of the time and thought required in their examination. The plans finally approved are in some instances the third or fourth set prepared and submitted for consideration. There is no record of those plans of which approval has been refused.

The more important structures which have been planned by competent engineers are generally constructed under the supervision of a resident engineer whose ability is recognized. In instances of this kind in which the designing engineer and the resident engineer are personally known to this office to be able men, the inspection authorized by section 3206 has been limited to an occasional examination by the State Engineer or his deputy, supplemented by consultations with the engineer in charge. In other instances in which no resident engineer is provided, or in which the resident engineer and designing engineer are practically unknown to the State Engineer's office, an inspector has been selected by this office and kept continually on the work. Such inspectors are paid by the owners, as provided by law. Their duties are to see that the plans and specifications are rigidly adhered to or that such changes as are necessitated by developments during construction are of the proper character and that all contingencies are properly met. At times during the past two years the office has had as many as six State Inspectors at one time, actively engaged in the supervision of different dams.

The duty imposed by section 3207 to determine annually the amount of water which may be safely impounded in the various reservoirs is one of extreme responsibility, and if the section is to be taken literally is one which cannot possibly be performed. To make an annual examination of every reservoir in the State within the period available for that examination would require the entire time of two engineers of thorough training and mature judgment. The examinations required by this statute have, therefore, been limited to those based upon a specific complaint by persons whose property may be in danger, as provided in section 3209, or upon a request of the owners. Section 3209 requires an examination to be made upon complaint by three or more persons whose lives or property would be endangered by a failure. The letter of this has not been insisted upon. If a complaint has been made by any person who might be injured by a reservoir failure this office has made it a practice to investigate the condition of the reservoir so complained of.

The great responsibility placed upon this office by these statutes lies in this—that it is necessary to steer a middle course between the great financial damage which might be caused by the refusal of a permit to store water, and the damage to life or property by a failure in case such a permit is granted. This State contains many reservoirs whose dams have been constructed with so small a margin of safety that the State Engineer would certainly not have approved the construction or attached his name to the plans. They have, however, cost a great deal of money and agricultural interests of much value and much importance are absolutely dependent upon them. If this office should insist in an absolutely uncompromising manner on absolute safety at all costs many valuable agricultural interests would be wiped out. In the effort to protect these interests as far as possible the State Engineer is obliged to take some chances on the failure of some of these dams, and the effort to draw the line at the right place has cost much worry and many sleepless nights. An increase in this difficulty is inevitable from year to year unless the law pertaining to State supervision of reservoirs and reservoir construction be strengthened by authorizing the Attorney General upon complaint of the State Engineer to bring injunction proceedings to prevent the construction of dams whose plans and methods of construction do not meet the State Engineer's approval.

The present practice among people who have no respect for the law unless it be in the shadow of the penitentiary, is to build in defiance of the provisions of the sections above cited, and then plea that they have large investments which will be absolutely wiped out if they are not permitted to store water. If this plea is unsuccessful with the State Engineer, an injunction against this office is sought and frequently obtained on the ground that the State Engineer's office cannot suffer any possible damage by a failure, and that the owners should, therefore, be allowed to realize on their investment.

In subsequent chapters will be found detailed accounts of examinations of reservoir plans and an account of the location, character and dimensions of the new structures, plans and specifications for which have been approved during the period covered by this report.

HYDROGRAPHIC WORK.

The Fourteenth Biennial Report of the State Engineer records five stream gauging stations as having been maintained by this office. These were on the Boulder creek at Boulder, South Boulder creek at Eldorado Springs, St. Vrain at Lyons, Big Thompson creek near Arkins and South Platte river at Denver.

This report states also that the State Engineer's office co-operated with the United States Geological Survey by paying the gauge readers and part of the expenses of the hydrographers who made the measurements at 16 stations which are named in the report.

During the biennial period just closed a large number of new stations have been installed and equipped and systematic measurements of the flow of the streams at various stages have been made. The total number of stream flow stations now maintained either wholly or in part by the State is sixty-six, of which forty-nine have been established during the past two years.

Under section 3333, Revised Statutes of Colorado, 1908, the fees collected in the State Engineer's office are credited to a fund known as the Gauging Fund, which is available for hydrographic work. The Seventeenth General Assembly made two appropriations for work of this character. One of these, H. B. 138, chapter 58, Session Laws, 1909, appropriated $10,000 annually for making "hydrographic surveys and investigations of each stream, system and source of water supply in the State." The other, H. B. 528, chapter 89, Session Laws, 1909, appropriated $15,000 "for the purpose of obtaining a complete record of the water supply and the effect of the use of the water of the Rio Grande river."

The first of these appropriations was placed in the fourth class and the second in the fifth class. No portion of the hydrographic survey appropriation became available during 1909. About the middle of July of 1910 this office was notified by the State Treasurer that the $10,000 appropriation for hydrographic surveys for the year 1910 was available. No portion of the funds for the investigation of the Rio Grande became available until so near the close of the biennial period that it was impossible to utilize it. The funds available for hydrographic work have, therefore, been the gauging fund, derived from fees paid into the State Engineer's office, and since July, 1910, half the money appropriated by the Seventeenth General Assembly for hydrographic surveys.

The total expenditures for hydrographic work during the biennial period have been $17,909.52, distributed as follows:

Hydrographers' salaries	$5,693.65	
Hydrographers' expenses	4,643.93	
Salaries of gauge readers	2,207.59	
Hydrographic instruments and equipment	5,364.35	
Total		$17,909.52

The number of hydrographers employed at one time has varied from two to six. The salaries we have been able to offer have been too small to enable us to retain the services of competent men for any considerable length of time. They readily find positions at better salaries and leave the employment of the State.

The extent of our co-operation with the United States Geological Survey is indicated by the amount we have contributed toward the expenses of the hydrographers employed by that bureau. This amount has been $1,150.70, while the expenses of the State hydrographers have been $3,493.23. In return for this the State received the benefit of the services of the Geological Survey hydrographers in making measurements at certain stations, these services probably being nearly equivalent to the entire time of one man.

Under the rules prescribed at Washington the officers of the Geological Survey in this State are not permitted to ask the railroads for transportation. This office has, however, made these requests freely when trips were to be taken for the transaction of State business. During the biennial period we have asked and received from various railroads of the State two hundred and six trip passes for the use of the hydrographers of the United States Geological Survey. These trips have ranged from twenty-five to three hundred miles in length and the total mileage represented by these passes is probably not far from forty thousand. Had it been necessary to pay railroad fare at current rates for the trips thus taken at no cost to the State the amount so expended would have been from $1,600.00 to $2,000.00. It may be fairly estimated, therefore, that the State has contributed about $3,000 in the shape of railroad transportation and traveling expenses to the co-operative work of stream gauging.

The Federal government has contributed the services of hydrographers to an extent which would probably cost the State upwards of $2,000 on the current salary schedule.

The item, hydrographic instruments and equipment, includes six modern current meters, twenty-two self recording water level gauges, six cable stations for the measurement of streams and the construction of a meter rating station at Denver. Two years ago there was not a current meter in the office which was worthy of the name, or which was fit for use. The office contained eight or ten meters of antiquated types long since abandoned, all of which were worn out and unreliable. It was absolutely necessary to supply the hydrographers with modern and reliable instruments which would bear comparison with those in use by other hydrographic bureaus.

In the past the office has depended entirely upon the services of resident gauge readers to record the river stages at the various stations. These services are not generally reliable. Gauging stations must be selected at points where the river channels lend themselves to proper measurements. These points bear no relation whatever to the centers of population, and the office is forced to rely upon the services of anyone who may happen to reside near by. In many cases it has been necessary to abandon a valuable station because no one lived near enough to give the proper attention to the gauge. In many instances gauge readers have become careless. They neglect or forget to read the gauges at the times specified in their instructions and fill in the record with any figure that looks reasonable.

To avoid all such difficulties it has become necessary to equip the important stations with self-recording gauges. Such gauges have been installed in the Arkansas drainage basin at the following points: At the outlet of the Twin Lakes reservoir, at Granite, at the outlet of the Clear Creek reservoir of the Otero Irrigation district, at Salida, at Canon City, at Pueblo, at the Oxford Farmers dam near Nepesta. Another will shortly be installed at the Amity dam near Prowers, or at some other point farther down the river.

They have also been installed in the South Platte drainage basin at South Platte, at Denver, and on the Cache la Poudre at the mouth of the canon. Another is in process of installation near Howbert, in South Park.

Recording gauges have been installed on the Rio Grande at Wason, at Del Norte and at Lobatos; on the Grand at Gore Canon; on the Yampa at Steamboat Springs; on the White river at Meeker; on the Dolores at Dolores; on the Animas at Durango and on the Laramie at Glendevey. Another will soon be installed on the San Juan at Arboles.

At a number of stations it has been necessary to span the stream with a cable from which a car is suspended so that measurements may be made at flood stages. Such cable stations have been constructed across the Arkansas at Granite and at Canon City, across the Cache la Poudre at the mouth of the canon, across the St. Vrain at Lyons and across the San Juan at Arboles. Another cable, with a span of 700 feet, is now being stretched across the Arkansas below the mouth of the Purgatoire. By the use of this it is hoped to obtain some exact knowledge of the floods discharged into the Arkansas from the Purgatoire.

The United States Geological Survey formerly maintained a station for the rating of current meters at one of the city reservoirs of the Denver Union Water Company. This station was used by all the hydrographers in this part of the country to make frequent ratings of meters. It, however, fell into decay and the Geological Survey decided to abandon it and send all its current meters to Washington to be rated. This is simple and inexpensive for a Federal bureau since the instruments can be transported under the postal frank, and the work of rating at Washington done by regular employes of the Bureau.

In the case of the State, however, the matter is entirely different. If we should send our instruments to Washington we would have to pay transportation both ways and take all the chances of loss or damage in transit. We should further have to pay the Federal department for rating the instruments and would be subject to annoying delays due to the inability of the Geological Survey officers to rate our instruments as promptly as we could wish. With six current meters in constant use and the necessity for re-rating each of them once every two or three months it became necessary to find some means of rating them at home.

While the Denver Union Water Company was willing that we should rebuild and repair the station which had been maintained by the United States Geological Survey in one of its reservoirs, the place was found to be not altogether suitable. There was always some current past the station, which not only complicated the work of meter rating, but rendered it liable to some uncertainties. Furthermore, the level of water in the reservoir varied through a wide range depending upon the supply and draft on the reservoir from time to time. After preparing various tentative designs, and examining every feasible site for the construction of a new station, permission was finally secured from the Park Commission of the city of Denver to construct a station in Cooper's Lake. A suitable design was therefore prepared and a contract awarded for the construction of the station for $1,450.00. This work is now in progress and will doubtless be completed some time in January.

A detailed description of the hydrographic stations now in operation in this State, together with their mode and expense of operation, their equipment, and the measurements made during the past biennial period will be found in a subsequent chapter. This chapter also contains in tabular form the results obtained at these stations.

CAREY ACT REPORTS.

Section 5145, Revised Statutes of Colorado, 1908, provides that any application to the State Board of Land Commissioners for the segregation of land to be reclaimed and colonized under the Act of Congress known as the Carey Act, "shall be submitted to the State Engineer, who shall examine the same and make a written report to the board, stating whether or not the proposed works are feasible; whether the proposed diversion of the public waters of the State will prove beneficial to the public interest; whether there is sufficient unappropriated water in the source of supply, and whether or not a permit to divert, store and appropriate water through or by the proposed works has been approved by him; whether the capacity of the proposed works is adequate to reclaim the land described; and whether or not the maps filed in his office comply with the requirements of said office, and the regulations of the department of the interior; also, whether or not the lands proposed to be irrigated are desert in character and such as may properly be set apart under the provisions of the aforesaid act of congress, and the rules and regulations of the department of the interior thereunder."

Under this provision of the statutes the following examinations have been made:

THE TOLTEC CANAL COMPANY PROJECT.

This company filed with the State Board of Land Commissioners an application for the segregation of about 16,000 acres of land in the southern part of Conejos county. The application was submitted to this office for examination in May of 1909. Accompanying this application was a report by Mr. Geo. G. Anderson, Consulting Engineer, covering the project and dealing particularly with the available water supply.

The State Engineer designated Mr. Geo. M. Post to make a detailed examination of the project on the ground and the records of this office were searched for all existing data relating to the water supply available for the project.

Mr. Anderson's report affirming the sufficiency of the water supply was confirmed by an examination of the records.

On May 18, 1909, Mr. Post reported to this office that the project was feasible and beneficial to the public interest; that the lands were desert in character within the meaning of the statute; that the water supply was adequate, but that the existing system did not have a sufficient storage capacity. He recommended the segregation requested upon the condition that the storage capacity should be increased and a reservoir so located that all of the lands might be supplied from it. A copy of this report was transmitted to the State Board of Land Commissioners on May 19, 1909.

THE VALLEY INVESTMENT COMPANY PROJECT.

In June of 1909 The Valley Investment Company, of Denver, made application to the State Board of Land Commissioners for the segregation of about 38,700 acres of land in Las Animas and Bent counties, to be irrigated from reservoirs intended to store the flood run-off from their drainage areas.

The data submitted to this office as a basis for an examination of the project were very meager, consisting simply of the maps and statements filed with the claims to water rights, some preliminary construction plans for the reservoirs and canals, and a list of the lands, the segregation of which was requested.

The State Engineer's office designated Mr. Thomas L. Wilkinson, of Denver, to make a detailed examination of the reservoir sites and their drainage areas, the location of the proposed canals, and the character of the lands which it was proposed to irrigate.

The State Engineer made an exhaustive investigation of the water supply probably available for the project, and in this took into acount a large amount of data which was submitted by Mr. F. H. Whiting, the engineer for the Valley Investment Company.

Under date of July 15, 1909, Mr. Wilkinson transmitted to this office an elaborate report on the project, in which he stated that the project was a good one, and all the conditions such that it might properly be undertaken under the Carey Act, but recommending additional storage capacity.

Under date of August 12, 1909, the State Engineer transmitted to the Land Board a report covering his own investigations of the water supply, together with Mr. Wilkinson's report on the physical features of the project.

Following this, a further report by Mr. F. H. Whiting, representing the Valley Investment Company, was transmitted to the Land Board, and finally, under date of November 29, 1909, an additional report by the State Engineer. This final report recommended the segregation of 24,000 acres, to be irrigated under the system designed and presented to the Land Board by the Valley Investment Company.

THE STARK-HAGADORN IRRIGATION PROJECT.

In July of 1909 the Stark-Hagadorn Irrigation Company presented to the State Board of Land Commissioners a project for the irrigation of about 32,900 acres of land in Saguache county. Of these lands the segregation of 18,728 acres was requested under the Carey Act. The remainder was privately owned land. It became necessary, however, to determine the sufficiency of the proposed system for the irrigation of the entire area of practically 33,000 acres, as the Irrigation Company claimed that the expense of the work would be so great that it could not be undertaken for the irrigation of the smaller area.

In addition to the maps showing locations of reservoirs and canals and a list of the lands to be segregated, the Irrigation Company submitted a report by its engineer, Mr. Charles W. Wells.

The State Engineer designated Mr. Thomas L. Wilkinson to make an examination covering the physical features of the project. Mr. Wilkinson's report was submitted to this office under date of September 1, 1909.

The project proposed to take water from the Saguache river and from the head waters of Cochetopa creek and store it in two reservoirs having an aggregate capacity of 27,840 acre-feet.

The State Engineer's office made a detailed examination of all available water supply data, and concluded that the proposed storage capacity, together with the available water supply, was insufficient to irrigate the area proposed. This report, together with Mr. Wilkinson's report on the physical features, was transmitted to the State Board of Land Commissioners under date of September 17, 1909.

Following this report, this office had numerous conferences with the promoters of this project, and with their engineer, and at their request made a further detailed study of some features of the project to which they directed especial attention. As a result of this study the State Engineer transmitted to the State Board of Land Commissioners a supplementary report under date of December 31, 1909, recommending the segregation of 17,000 acres of land, and the limitation of the project to this area.

As the promoters claimed that the enterprise could not be made financially successful on this basis, it was therefore abandoned for the time being.

During the summer of 1910 the matter was again taken up for further engineering study. Mr. Wells, the former engineer of the company, having in the meantime entered the service of the Federal Government, and being therefore no longer available for private practice, the Stark-Hagadorn Company engaged Mr. F. H. Whiting to make further investigations, and to determine whether the project could be so modified as to give promise of reasonable financial success.

Mr. Whiting succeeded in locating a new reservoir site, on which it is possible to construct a reservoir with a capacity of 66,000 acre-feet. The drainage area tributary to this site is sufficient to supply this amount of water in excess of that demanded for existing rights.

After all information and data relating to this modification of the project had been submitted to this office, and had been confirmed by independent investigation, the State Engineer submitted to the State Board of Land Commissioners a report, under date of September 2, 1910, recommending the segregation of 36,000 acres of land for the Stark-Hagadorn project.

THE GREAT NORTHERN IRRIGATION AND POWER COMPANY PROJECT.

During the summer of 1909 the Great Northern Irrigation and Power Company applied to the State Board of Land Commissioners for the segregation of about 145,000 acres of land in Routt county, to be reclaimed and colonized under contract with the State, as provided by the Carey Act.

With the maps showing location of reservoirs and canals, and land to be irrigated, this company submitted a detailed report on the engineering features and the water supply of the project, by Mr. George G. Anderson, consulting engineer.

During the month of October, 1909, the State Engineer made a personal examination in the field, of this project, covering the reservoir sites, the canal lines, the sources of water supply, and the lands to be irrigated. Following this he made an exhaustive examination of all precipitation records, stream measurements, and other water supply data which were available from any public or private sources. As a result of this examination, a report was transmitted to the State Board of Land Commissioners, under date of November 15, 1909, approving the project as submitted, and recommending the segregation of the area asked.

WILLIAMS RIVER HIGH LINE PROJECT.

During the summer of 1909 the Williams River High Line Company made application to the State Board of Land Commissioners for the segregation, under the Carey Act, of about 28,000 acres of land in Routt county, to be irrigated in conjunction with a large area of State and privately owned land, the whole project aggregating about 44,000 acres.

During November of 1909, an examination in the field, of this project, was made by Mr. A. F. Hewitt, Deputy State Engineer, who subsequently made an examination of the water supply data and of the existing claims to water from the same source.

As a result of these studies, Mr. Hewitt reported to this office under date of January 3, 1910, that the available water supply was sufficient for the proper irrigation of 30,000 acres of land. A copy of Mr. Hewitt's report was transmitted to the State Board of Land Commissioners with the recommendation of this office that the area to be irrigated under this project should not exceed 30,000 acres, whether that area was segregated under the Carey Act or whether it was partly State and partly public land.

THE PAWNEE IRRIGATION PROJECT.

In November of 1908, Mr. J. W. Johnson, Deputy State Engineer, made an examination of some lands in Weld county, the segregation of which had been requested by the Pawnee Irrigation Company. The total area which this company had asked to have segregated was 8,525 acres. It was proposed to derive the water supply from North Pawnee and Igo creeks.

Mr. Johnson made an examination of the physical features of the project and a study of all available water supply data, including that furnished by Messrs. Wortham and Washington, civil engineers, of Greeley, engineers for the Pawnee Irrigation Company.

Mr. Johnson submitted a report to this office under date of February 8, 1910, recommending the segregation of 6,300 acres to be irrigated under this project. This report was transmitted to the State Board of Land Commissioners as the report of the State Engineer's office.

THE BADITO IRRIGATION PROJECT.

During the summer of 1910 the Huerfano Valley Irrigation Company made application to the State Board of Land Commissioners for the segregation of about 70,000 acres of land in Huerfano and Pueblo counties, to be irrigated by water taken from the Huerfano river through a reservoir system having an aggregate capacity of about 40,000 acre-feet.

No examination of this project on the ground has ever been made by any representative of the State Engineer's office. The Huerfano Valley Irrigation Company submitted a report by its engineer, Mr. M. S. Ketchum, covering the water supply and the construction features of the project. The State Engineer made a thorough study of all available water supply data and of the existing claims to water rights from the Huerfano drainage basin, taking into account the well known character of the Huerfano river and the well known fact that it is the most difficult district in the State in which properly to distribute water.

As the result of this study this office reported to the State Board of Land Commissioners under date of October 20, 1910, recommending the segregation of 20,000 acres of land for irrigation under this project.

Subsequently Mr. Ketchum made a supplementary report in which he pointed out what he believed to be errors in the data and the reasoning used in the State Engineer's report to the Land Board.

A further examination in greater detail of those points to which Mr. Ketchum took exception was made by the State Engineer and an additional report submitted to the State Board of Land Commissioners confirming the findings of the first report, and disapproving of the segregation of any area in excess of 20,000 acres under this project.

THE ROUTT COUNTY DEVELOPMENT COMPANY PROJECT.

This company has under construction an irrigation project in the valley of the Little Snake river in Routt county, for the reclamation of about 38,000 acres of land heretofore segregated under the Carey Act. During the fall of 1909 the company made application to the State Board of Land Commissioners for the purchase of 6,000 acres of State land at a minimum price, in return for which it agreed to irrigate 6,000 acres of land to be retained by the State. This brought the total area to be irrigated under the Routt County Development Company's system up to about 50,000 acres.

This office was requested to make an examination of the sources of water supply and determine whether the additional area could be properly irrigated. For this purpose a study of the water supply available for the project was made by Mr. Chas. L. Chatfield, one of the hydrographers of the State Engineer's office, who reported to this office under date of February 11, 1910. Mr. Chatfield's report contains the details of his study, but his conclusion is the only thing of interest here. He states that if the system were provided with a storage capacity aggregating 45,000 acre-feet all requirements for the irrigation of 50,000 acres would be met. This storage capacity could be obtained either by the enlargement of the Slater reservoir, there being an ample supply of water in Slater Fork, or by the construction of Savery Creek reservoir in Wyoming.

Mr. Chatfield's report was submitted to the State Board of Land Commissioners as the report of the State Engineer's office.

IGNACIO PROJECT.

This project was designed for the irrigation of 16,000 acres of land in La Plata county, which has already been segregated, and for the reclamation of which the State has entered into contract with the Colorado Land & Water Supply Company. This Company, having been required by the State Board of Land Commissioners to provide reservoir capacity to the extent of at least 10,000 acre-feet, proposed to utilize Emerald Lakes, which are located on the Lake fork of the Pine river, near the western boundary of Hinsdale county.

The State Board of Land Commissioners then submitted to this office the question of the suitability of these lakes for this purpose and of the sufficiency of the water supply. An examination of the water supply and runoff data in that portion of the State was made by Mr. Chas. L. Chatfield, hydrographer in the State Engineer's office, with the conclusion that the drainage area above these lakes is sufficient to supply 10,000 acre-feet per annum, even in moderately dry years.

Under date of March 1, 1910, the details of this study were reported to the State Board of Land Commissioners.

COLT RESERVOIR PROJECT.

This is not a Carey Act project, but a project for the irrigation of a large area of State land, together with some privately owned land.

In the summer of 1910 the State Board of Land Commissioners requested this office to examine in detail the water supply available for this project, with a view to determining whether the State could base on it any hopes for the irrigation of something like 80,000 acres of State land in the Arkansas Valley.

Reports favoring the project made by Mr. Jas. D. Schuyler, Mr. B. F. Powell and Mr. F. T. Lewis, were submitted to this office for examination. These reports were carefully studied and all the information contained in this office relating to the flow of the Arkansas river and to the consumption of water from it was carefully investigated.

As a result of these studies the State Engineer was forced to the conclusion that the favorable findings in the reports by the engineers above mentioned, were results of illogical reasoning, and that they could not be approved by this office.

Mr. Schuyler in his report made an obvious effort to reach a favorable conclusion by logical reasoning. Failing to do so he said: "I regard this as a very attractive proposition, even though its water supply cannot be demonstrated to a nicety."

This practice of making careful examination of irrigation projects, and calmly discarding the logical conclusion because it is not the one desired, is far too common, and is the cause for the frequent discrepancies between the predicted and the actual outcome of so many enterprises.

On August 9, 1910, the State Engineer reported to the State Board of Land Commissioners on the Colt project.

The plan as outlined proposed the construction of a reservoir with a capacity of 262,000 acre-feet, and the irrigation from it of 125,000 acres of land. In this form it was not adapted to the utilization of the extremely variable water supply, and the State Engineer was, therefore, unable to approve it.

OTHER PROJECTS.

In addition to the projects above named on which reports for final segregation have been made to the State Board of Land Commissioners some half dozen projects have been submitted in a tentative way, and requests made for preliminary reports on which temporary segregations might be based. As these temporary segregations are subject to revocation at any time by the State Board of Land Commissioners, and, as in any case, they will not be made final until an exhaustive examination has been made by the State Engineer's office, it is not considered worth while to enumerate the projects thus considered, or to make reference to the conclusions of the reports.

ROADS AND BRIDGES.

The Seventeenth General Assembly named the State Engineer as a member of the board of construction on each of the twenty-nine roads and the twenty-two bridges for which appropriations were made. As the appropriations were small in most cases, and as there was no provision in the State Engineer's office for the organization and payment of a party of field engineers a general policy was adopted of having all necessary surveys and other field work done by the county surveyors wherever practicable. In some instances the counties paid for this work from their own funds. In others it was paid from the State appropriation for the construction of the road. In all cases the State saved the time and expense incident to sending a party from one county to another. In general, however, the system is not satisfactory. While the county surveyors of some counties are able men of mature judgment who make good locations, and whose estimates and recommendations can be relied upon, it happens in many counties that the county surveyors have none of these qualifications. In some instances the survey work has had to be done a second time either by the county surveyor or by someone else selected in his place, but always with a loss of time and at a considerable increase of expense.

I think it extremely important that the State Engineer's office, or the Highway Commission, whichever may be placed in charge of future road work, should be provided with sufficient funds to organize and maintain a field party of competent men whose business it should be to accumulate all necessary data upon which to base specifications and contracts.

Of the twenty-nine roads, with the construction of which the Legislature charged this office as a member of the various boards of construction, all have been completed or are under contract.

Of the twenty-two bridges seventeen are either completed or are in process of construction. Three of the remaining five will be contracted for as soon as the drawings can be completed. The other two cannot be built unless the Eighteenth General Assembly shall see fit to make some further appropriations for them. The amounts appropriated by the Seventeenth General Assembly, in addition to the amounts which could be contributed by the counties and by other interested parties, are not sufficient to build these bridges. These two are the bridge across the Grand river at Grand Junction, in Mesa county, and the bridge across Maroon Creek canon, in Pitkin county.

It has been the policy of this office to design in detail all of the bridges to be constructed under State appropriation, whether of steel, wood, concrete or other material. It has been extremely difficult to get reasonable bids in many instances. For years there has existed a recognized pool among highway bridge contractors who divide the State into districts and allot one district to each contractor. Although there is a semblance of competitive bidding whenever a bridge is advertised the low bidder in each such competition (?) is known in advance to the members of the pool and the others place their bids above his figure. This in itself would not do so much damage if it were not for the practice of "loading the bid" with a certain amount over and above the price which the contractor is to receive, this additional amount being distributed among the other bidders. The amount of which the State or the county is robbed by this practice in any specific case is difficult to ascertain, but a little light is thrown on the subject by the following facts.

In one instance, by a series of fortuitous happenings, a bridge contract was awarded to a contractor not in the pool, after all bids received in response to a previous advertisement had been rejected. The saving on this contract was nearly $6,000, and this was nearly 50% of the price which had finally to be paid for the work. Had the contract been given to the member of the pool who was low bidder at the first competition, practically one-third of the money paid to him would have been in excess of the cost of the work plus the legitimate profit.

In July, 1909, the State Engineer, well aware of the existence of this pool and of its method of operation, endeavored to evade it by awarding a general contract for all the structural steel work to be built by the State during this biennial period at specified prices per pound for the finished work delivered at Colorado common points. Specifications and a contract on this basis were prepared and advertisements for bids inserted in a number of engineering periodicals throughout the United States. A bona fide bid from a responsible firm, accompanied by a check for $2,000 as a guarantee of good faith, was received, naming the following prices:

Riveted steel trusses	3.75 cents per pound
Rolled steel floor beams and joists	3.00 cents per pound
Steel lattice railings	5.00 cents per pound
Tubular piers and bracing	3.40 cents per pound

The State Engineer was prepared to accept this bid and execute a contract at these prices. However, when the proposed contract was submitted to the Attorney General, he, in consultation with the attorneys for the bidder, decided that the contract could not properly be executed under the terms of the appropriation bills. This move, therefore, had to be abandoned.

As an illustration of the saving which could have been made by this contract, the cost of one of the bridges now under construction in Garfield county under this proposed contract, as compared with its cost under the contract which was actually executed, may be shown. The steel in one of these bridges weighs 181,340 pounds. Of this 18,240 pounds is in the steel floor beams, which would have been delivered under the proposed contract at Colorado common points for three cents per pound. The remainder of the work would have cost 3.75 cents per pound, making the total $6,663.45. To this must be added the additional freight from common points to points on the Western Slope at $12.00 per ton. This amounts to $1,088.04. The cost of erection would probably not exceed $15.00 per ton, but if taken at $20.00 per ton would amount to $1,813.40. The total cost of the steel work erected would have been $9,564.89. The wooden floor, at $35.00 per thousand feet, board measure, would cost $1,050. The masonry substructure would cost not to exceed $5,000, basing this on separate contracts for masonry which have been awarded by this office. The total cost of the completed bridge would then be $15,614.89. The actual price named in the contract which was executed for the construction of this bridge is $24,000, a little more than 50% more than the bridge would have cost under the proposed contract.

These two instances are probably fairly indicative of the extent to which the State and county treasuries are robbed by this pool arrangement.

A practice which has become too prevalent in many states is that of building bridges on designs submitted by the bidders with their bids. In cases of this kind the bidders first ascertain how much money the State or the county has to apply to the construction of the bridge in question. The design is then prepared so as to be built with a minimum of metal and at the lowest possible cost. The difference between the actual cost and the amount which will be paid for the bridge is, of course, the contractor's profit. Since he cannot in most cases increase the amount appropriated to pay for the work, he devotes his energies to decreasing the cost, and in doing so takes longer chances than almost any other class of gamblers. Although these structures are nominally designed to carry certain specified loads, few of them would do so with the margin of safety generally accepted by the engineering profession as necessary in such structures. The bidder simply wagers, with the odds in his favor, that the specified load will not actually be applied to the bridge.

In preparing and pushing these designs for shoddy work, the bidder relies on the fact that most of the public officials with whom he has to deal are without competent technical advice, and that they will therefore be misled by showy drawings into overlooking the inherent defects. For these evils this office has a remedy to suggest. This will be set forth in another chapter.

In addition to the roads and bridges, the Seventeenth General Assembly made two appropriations for the drilling of artesian wells, and named the State Engineer as a member of the Board of Supervision of each. One of these wells is to be located in Kiowa county. For this a contract has been awarded, and the work is now under way.

The other appropriation was for drilling an artesian well near the town of Cortez, in Montezuma county. For this work we have not been able to obtain any bids, notwithstanding repeated advertisements in publicatons widely separated, and even private solicitation of well drillers to name a price at which they would undertake the work.

In a subsequent chapter there will be found a detailed statement for each of these roads, bridges and wells, of bids received, contracts awarded, expenditures made, obligations incurred and balances remaining in the various funds.

WORK FOR OTHER DEPARTMENTS OF THE STATE GOVERNMENT.

Section 3325, Revised Statutes of Colorado, 1908, provides that the State Engineer shall give his counsel and services, without extra pay or compensation, to any State department or institution.

During the biennial period just passed there have been only two calls on this office for the services provided for by this section of the statutes.

In May of 1909, this office made the necessary examination of the ground and prepared designs for a septic tank for the disposal of the sewage at the State Industrial School for Girls near Fort Logan. This work was construed under a contract executed by the Board of Control of the school, and, we are advised, has operated satisfactorily.

In September, 1909, by request of the Board of Control of the same institution, this office prepared drawings for a barn for the care and protection of the cattle, horses and vehicles belonging to the school. This office is not advised whether the barn was ever built, but we were not called upon to supervise the construction.

CHAPTER II.

SUGGESTED LEGISLATION.

Experience, not alone of the biennial period just closed, but of the past ten years, has shown that many of the laws relating to the distribution of water, and to the conduct of the State Engineer's office, are no longer adapted to conditions. Most of our legislation on these subjects was enacted more than ten years ago, and much of it more than twenty years ago. However well designed for its purpose it may have been at the time of its enactment, it is now unsuitable because of the changed conditions.

Section 3166, Revised Statutes of Colorado, 1908, should be specifically repealed. The provision therein contained for the appointment by the county judge of three commissioners, whose duty it shall be to distribute water justly and equitably, is clearly in conflict with the duties imposed by later legislation on the water commissioners and on the division engineers.

FILING LAW.

The filing law of 1903 could be modified in several respects, so as to increase the facility of its administration, and to do away with some of the abuses of which it is now capable.

Section 3181 provides for the filing in the State Engineer's office of two duplicate copies on tracing muslin, or other material adapted for permanent record and preservation, of a map showing certain data and information. The State Engineer's office is required not only to check these maps, to make sure that they comply with the law, but to compare them in every detail, in order that one may be certified as a duplicate of the other. This comparison requires always two clerks, and sometimes three or four, since the maps are often filed not simply in duplicate, but in triplicate or quadruplicate, in order that certified copies may be filed with the county clerks of several counties. This duty of comparison not only costs the State at least the salary of one clerk, but also entails a certain amount of delay. In addition to these inconveniences, the cost to the claimant is increased by the necessity for the preparation of two tracings.

I believe every purpose of this section would be served if the law were so modified as to permit the filing of a single copy on tracing muslin and the return to the claimant, after the tracing has been checked and accepted by the State Engineer, of a blue print on cloth. This blue print would be just as indestructible from a mechanical standpoint as the tracing cloth, and although capable of destruction by chemical means, would not be more so than the tracing itself, which is readily destroyed by water. In this way the maps filed in the State Engineer's office could be handled by one clerk, the delays in returning blue prints to the claimants would be less, and the claimant would be saved the expense of making the additional tracing.

Section 3185 requires that the duplicate map shall be returned to the claimant, with a certificate that it has been examined and approved by the State Engineer. This section should be so modified as to agree with the sugested change in section 3181, and also to cut out the certificate of approval now required.

It has frequently been brought to the attention of this office that unscrupulous promoters have deliberately misrepresented this certificate of approval, and made it appear to be an approval of the scheme outlined on the map instead of, as the law intends, merely an approval of the form of the map itself. The law should permit the endorsement on the map, by the State Engineer, of the following form, and of nothing else: "Accepted for filing in the State Engineer's office, on the.......... day of ...., ..., State Engineer." This would do away with the misuse of the certificate of approval which is required by the filing law of 1903.

Section 3332 authorizes the collection by the State Engineer's office of a fee of $1 for each claim to a water right. It is quite as easy to claim one thousand cubic feet per second as ten cubic feet per second. While such a filing is of doubtful value if not followed up by actual work of construction, there have been many instances in which they have been converted into assets of considerable value because of the unfortunate form of our law. I would suggest that this section be so modified as to provide for a flat fee of $10 for each claim not exceeding twenty cubic feet per second, this fee to include one blue print on cloth, as suggested above, to be furnished by the State Engineer's office. For each additional blue print, if required, an additional fee of $2 should be charged. For each cubic foot per second in excess of the twenty, an additional fee of $1 should be charged. The fee for filing a claim for storage should be $10 for each 1,000 acre-feet of storage capacity or fraction thereof.

These fees would not be a burden on any claimant who really intended to use the water, while they would act as a deterrent on that class of persons who seek to make a profit out of the manipulation of that which is really the property of the whole people. If it be remembered that one cubic foot per second is sufficient to irrigate about one hundred acres of land, and that a right to the perpetual use of that amount of water has a market value of from $4,000 to $6,000 in various portions of the State, it will be obvious that the fees here suggested will not stand in the way of any bona fide development.

A section should be added to this filing law, providing for the automatic expiration of a claim at the end of two years from the date of filing, unless at least ten per cent. of the construction work has been done at that time, and at the end of five years, unless the work is entirely completed.

This is no more than is required by contracts executed under the Carey act between the State and the irrigation companies operating under that act of Congress. It is probable that even with our present law a filing which has not been followed up by some actual construction work within two or three years has little value, but in case of dispute between two claimants, one of whom has been diligent and the other not, an action in court is necessary in each instance. In many instances the existence of old filings has been used as a sort of blackmail to force a cash settlement from people who are undertaking to carry on actual construction. If the fees are increased as suggested, and if automatic expiration of a claim is provided for, there will be fewer filings, but just as much real development.

RESERVOIRS.

Section 3202 provides for the approval of plans for a dam exceeding ten feet in height by the county commissioners of the county in which the reservoir is located. This portion of that section is clearly superseded by section 3205, enacted twenty years later, and should be specifically repealed. The first portion of section 3202, however, authorizing the construction of reservoirs and the storage of water, is satisfactory and should be allowed to stand. Section 3203 provides for conducting reservoir water in natural streams, which in itself is perfectly proper. The latter part of this section, however, provides that the allowance to be made for loss by evaporation and seepage shall be determined by commissioners of irrigation of the district, or if there are no such commissioners, then by the county commissioners of the county in which the water shall be taken out for use.

The latter portion of section 3203 should be modified. Section 3225, which was enacted in 1897, eighteen years after section 3203, and which provides for the exchange of water between reservoirs and ditches, imposes upon the State Engineer the duty and responsibility of determining the loss incident to such exchanges. Sectio 3203 should be so modified as to require the State Engineer instead of the county commissioners to determine the loss incident to the conduct of reservoir water in natural streams.

Section 3205 providing for the examination of plans and specifications for reservoir construction by the State Engineer, and for the control by the State Engineer's office of the construction of dams and reservoirs, is eminently proper as far as it goes. It is, however, weak in not providing sufficient means for its enforcement. If any person wishes to build a dam which he knows will not meet with the approval of the State Engineer, or of any other disinterested party, he may proceed without submitting plans and without reporting progress of construction to the State Engineer's office. In doing this he lays himself liable to no specific penalty. Section 3214 provides a fine to be imposed upon reservoir companies who fail or refuse to obey the directions of the State Engineer regarding the construction or filling of any reservoir, such fines to be recovered by a civil action in the name of the people, by the district attorney, upon the complaint of the State Engineer.

If a dam is actually constructed without the knowledge of the State Engineer the person or company so constructing cannot be charged with failing or refusing to obey the directions of the State Engineer. If, by any chance the State Engineer discovers that the work is in progress before it is completed and issues orders concerning it, which are ignored, he is then dependent upon the district attorney, who is a resident of the locality in which the work is being constructed and in more ways than one accessible to the influence of those who are building the dam, and who finds many reasons for not bringing the action provided for in section 3214. If the State Engineer, after the completion of any such reservoir, refuses to allow it to be used, on the ground that the law has not been complied with, the reservoir company brings an action in court, alleging that the ruling of the State Engineer's office amounts to a confiscation of its property, and nearly always succeeds in having an injunction against the State Engineer issued on this ground.

These difficulties are not imaginary. Most of them have actually occurred during the past two years, and all of them during the past ten.

Section 3214 might be allowed to stand. In addition to it, however, a law should be enacted authorizing the Attorney General, on complaint of the State Engineer, to apply for an injunction stopping the progress of any work not being carried on in compliance with the provisions of Section 3205, and other related sections.

Sections 3215 to 3220, inclusive, provide for the survey, construction and inspection of reservoirs under the direction of the county surveyor, and should be entirely repealed. They serve no good purpose, the fees named in them are ridiculously low and they conflict in some respects with the law placing reservoir construction under the control of the State Engineer.

That portion of section 3332, providing for a fee to be paid to the State Engineer's office for the examination of plans and specifications for reservoirs, dams, etc., should be modified so as to increase this fee. The fee at present provides $1.00 for each $5,000 or fraction thereof of estimated cost of the work. This fee, in my opinion, should be made $3.00 for each $5,000 or fraction thereof of estimated cost. The fee as it stands is by no means commensurate with the time and labor imposed on the State Engineer's office by the conscientious performance of this duty.

DUTIES OF OWNERS.

A law should be enacted requiring owners of ditches to provide and maintain permanent signs in plain view at each headgate, measuring flume, and public road crossing of the ditch; these signs to give the name of the ditch and the dates and amounts of all decreed priorities belonging to that ditch. The expense of providing these signs would be a trifle. The information conveyed to the public would be very great. Too much is now dependent upon knowledge of local topography and geography. The water commissioner of the district, or the old-time resident of it, may recognize each ditch as he crosses it, and may know approximately the amount of water to which it is entitled. A hydrographer from the State Engineer's office coming into the district for the first time, a Division Engineer who visits the district only occasionally, or a new resident of the district acquires this information but slowly. It is information to which everyone is entitled, and it is believed that this provision will do much to prevent the running of water by ditches not entitled to it, since everyone crossing the ditch will know whether it has water and approximately how much.

I very strongly recommend the enactment of a law requiring the owner of each ditch having decrees aggregating twenty-five cubic feet per second, or more, to install an automatic self-registering gauge on the measuring flume. These gauges should be installed and maintained by the owners and the charts from them should be sent to the office of the Division Engineer and should form a part of his records. In conjunction with this requirement the law should authorize the Division Engineer to penalize any ditch for drawing water at unauthorized times, or in unauthorized amounts, by depriving that ditch of double the amount of water improperly drawn at times when the ditch would otherwise be entitled to receive it.

As the law now stands there is a premium on stealing water. The holder of a junior priority who may have been deprived of water because a senior ditch drew more than it was entitled to has no recourse except an action for damages. This he seldom if ever brings because the extent of his damage is very difficult, if not impossible, to prove. The water officials can do nothing except to shut out the excess water when they discover it. A fine of two or three hundred dollars, as provided for in section 3240, is a mere trifle compared with the value of the water which may be stolen within a few hours.

The law which I have suggested would reach the ditch owner in a way that no other one can. It not only prevents him from realizing any benefit from stolen water, but imposes on him the only form of penalty which he can appreciate, i. e., the deprivation of a certain amount of water to which he would have been entitled had he kept strictly within his rights.

In addition to requiring ditch owners to install and maintain automatic gauges, reservoir owners should also be required to provide these gauges at the inlets and outlets of their reservoirs. Section 3225 requires that reservoirs desiring to run water in exchange with ditches shall maintain such self-registering devices at the point where the water is turned into the stream. This, however, is not sufficient. The provision should be so broadened as to cover the inlets and outlets of all reservoirs.

Section 3259 provides that in all cases declared misdemeanors any justice of the peace in the county in which the offense was committed may issue a warrant for the arrest of the offender, and shall hear and determine the cause.

Provision should be made in this matter for an appeal to a higher court by the prosecution, if it shall be deemed necessary or wise. Every water commissioner who has undertaken to prosecute a cause before a justice of the peace has had to fight a local feeling which the people of most localities have that the water running through their district belongs to them, and that no man should be punished for taking water which was in the stream instead of allowing it to run down the stream for the use of some unknown and unheard of person in another county. This feeling is so strong that a conviction in a Justice Court is almost impossible, even where the testimony is all one way. Unless the prosecution in such cases can appeal it will be almost impossible to enforce many perfectly proper provisions of the water law.

WATER COMMISSIONERS.

Section 3427, providing for the appointment of water commissioners, should be modified so as to remove the restriction which the Governor is now under, of appointing someone recommended by the board of county commissioners. This law was enacted thirty years ago, at a time when the duties of a water commissioner were largely local, and when there was seldom or never any question as to the distribution of water between districts. That condition is long past. The distribution of water is a State-wide question. The water commissioner at the present time must be an immediate subordinate of the Division Engineer. The present law, compelling the Governor to appoint someone approved by the county commissioners, and providing for the payment of the water commissioner by the county or counties in which his district is located, is anomalous and highly unsatisfactory. The Governor should have a free hand in the selection of the water commissioners, and the State should pay their salaries. These salaries should be paid monthly for every month in the year, and not on the present per diem basis. I recommend that the water commissioners' salaries should be made $1,200.00 per annum, and that they be placed specifically under the orders of their respective Division Engineers.

Section 3430, limiting the time during which the commissioners shall work, should be repealed.

Sections 3434, 3435, 3436 and 3437, providing for the pay of water commissioners and the appointment of deputies, should be repealed.

I believe there are few, if any, water districts in the State in which the water commissioner alone cannot perform all the duties imposed on him if he gives, as he should, his entire time to the work, under the immediate direction of the Division Engineer. The time is gone when a man can attend to private business, which ordinarily takes all his time, and perform the duties of water commissioner at spare times. The time has gone, also, when the water commissioner's duty is to distribute all water that gets into his district to the ditches and reservoirs in his district, and to see that none passes down stream to the districts below. This is the old local idea of a water commissioner, and it still hangs on in many districts. It can only be eradicated by removing the last fragment of local control, and having it clearly understood that the water commissioners are State officials.

DIVISION ENGINEERS.

Next to the changes suggested in the system of selection and payment of water commissioners, one of the most important reforms to be urged in the organization of the water distribution of the State is in the selection of Division Engineers. The law restricting the selection of Division Engineers to an eligible list established by an examination held by the State Engineer should be repealed, as should also the provision of the law which requires that the Division Engineer shall be appointed from the division over which he has jurisdiction, and that he shall have resided in the division for at least one year prior to appointment. These restrictions are such that the Governor is frequently compelled to appoint inferior men, when he could have readily selected superior men had the law permitted it.

The law requiring an examination has not even the ordinary civil service arguments in its favor, since the appointment is for a two-year term only, and even the successful candidate must take the examination every two years if he desires to remain in office. The law requiring residence in the division over which he is to have jurisdiction is partly due to the local feeling already referred to, and partly due to the idea that great familiarity with local conditions is the most important qualification of a Division Engineer. As against this it may be said that a competent hydraulic engineer, who is devoting all his time to the distribution of water in his division, can become more familiar with local conditions in three months' time than the ordinary resident is ever likely to be, unless he has these matters forced on his attention. As a matter of fact, the man who has long been a resident of the division is apt to take it for granted that he is familiar with local conditions, and will neglect to study them further on that account, whereas, the outsider, knowing that he has all this information to accumulate, will make it his business to do so. The outsider will, furthermore, frequently have the advantage of having no local affiliations and no business associations which may embarrass him in the performance of his duties.

Furthermore, it may be said that most engineers in Colorado, when they get out of employment, come to Denver, as the most likely place in which to get in touch with something new. Under the present law there will seldom be found an idle engineer to take the examination outside of Division No. 1.

The salary offered the Division Engineer is ridiculously small. Some of the water commissioners in the State actually receive more salary than the Division Engineer, who is their superior in office and in qualifications. The theory of the Legislature at the time this salary was fixed was that the duties of Division Engineer would require only a portion of a man's time, and that he could conduct his ordinary business and earn his ordinary income in addition to the salary paid him by the State. However true this may have been at one time, it is so no longer. The proper performance of the duties of Division Engineer in any division in the State requires all of a man's time. Aside from this, it is dangerous to expect a man to carry on a private practice in civil engineering in connection with his duties as an administrative water officer of the State. However careful he may be, and however honorable his intentions, the time is sure to come when there will be some confusion between his duty as a public official and his obligations to his private clients.

In my opinion, the Division Engineer should receive a salary of $2,500 per annum—certainly not less than $2,000, under any circumstances.

As matters now stand, each Division Engineer makes his private office a public office during his term of service. His private property and the State property become confused, and State business and private business are transacted at the same desk. The State office moves whenever the incumbent changes, and it may even move from one town to another. All this is true of all divisions except No. 1, where the Division Engineer has his office in the State Capitol building.

The result of this lack of system is, that there is absolutely no continuity of the records of the Division Engineer's office in any division except No. 1. The Legislature should provide funds with which to furnish a suitable office at some central town in each division, which would be the office of the Division Engineer, to be used for the transaction of State business only. The Division Engineer should be required to give his entire time to the transaction of State business, and could then be expected to maintain a complete and continuous record of the proceedings of the office.

STATE ENGINEER'S OFFICE.

For more than ten years the State Engineer's office has been seriously handicapped by the lack of sufficient technical assistance, and the lack of funds to pay suitable salaries to such assistants as were authorized.

Section 3328, providing for the payment of deputies on a per diem basis, should be repealed. In its place should be enacted a law creating a position of Deputy State Engineer, at $2,500 per year, and two positions, to be known as Assistant State Engineers, at $1,800 per year each. These assistants are greatly needed as field engineers.

Section 3207 requires that the State Engineer shall annually determine the amount of water which it is safe to impound in the several reservoirs within the State, but this has never been done, because the office did not have enough men with sufficiently mature judgment to be intrusted with work of this importance. As a result, the activities of the State Engineer's office with regard to reservoirs have been confined to new constructions, to the examination of those reservoirs which were complained of by some resident who feared his property might be in danger, and to the preparation of post-mortems on reservoirs which had already failed.

The number of reservoirs in the State is very large. The property lying below them, in such a position as to be seriously damaged in case of failure, is of great value, to say nothing of the risk to human life by the failure of almost any reservoir. It is believed that some of the failures which have occurred during the past two years could have been prevented had the engineering force of this office been sufficient to enable a thorough examination of every reservoir to be made, at least biennially, if not annually.

In suggesting the salaries of these engineers as $1,800 per annum, I have named as low a price as I believe suitable men can be secured for. It is only because the State can generally obtain services of this kind at a less cost than private parties are able to, that I venture to make these figures so low.

The amount of correspondence and report work required by the business of the office is so great that it is impossible for one stenographer to do it all. It has been necessary during the past two years to employ extra assistance for this kind of work, to be paid out of such funds as were available for that purpose from time to time. The office should be provided with two stenographers, and salaries for them regularly appropriated.

If the filing law is modified, as suggested above, one clerk will be able to attend to the wants of the public and check maps as they come in. If this filing law is not modified, two clerks for this purpose will be absolutely necessary.

One draftsman will probably continue to satisfy the requirements of the office, particularly if the internal improvement fund is placed in the hands of the Highway Commission, as I recommend it should be.

The office should be provided with an office boy, who could be easily obtained at a salary not exceeding $750 per year. A young man, from seventeen to twenty years old, could easily attend to the filing of correspondence, and to the numerous errands down town, which now have to be looked after by one of the clerks in the office, with a resulting delay in some other business, or by a paid messenger.

The principal purpose of this office has always been to accumulate and disseminate information concerning the water resources of the State, and yet it has never been provided with adequate funds or assistance for that purpose. The Seventeenth General Assembly made an attempt to do something in this direction, and accomplished more than has ever been accomplished before. It appropriated $10,000 per annum for the purpose of making hydrographic surveys, and an additional $15,000 for the purpose of investigating the Rio Grande, making the total $35,000, which it intended to be devoted to hydrographic work during the two years.

Unfortunately, these appropriations were placed in the fourth and fifth classes, respectively, and did not become available until so late that they could not accomplish what the Legislature intended.

During the past two years this office has employed from four to six hydrographers, only one of whom had a salary specifically appropriated, the others being paid from the gauging fund, or from the hydrographic survey fund, after that became available. The salaries paid have been low, in the effort to make the money go as far as possible, but with the result that we have not been able to keep suitable men for any considerable length of time. Frequent changes have been necessitated by resignations, and the work suffers in consequence. The Legislature should provide for one chief hydrographer at $1,800, and for six hydrographers at $1,500. This would provide one field hydrographer for each irrigation division in the State, one man in the office to keep records up to date, and a chief hydrographer to keep general supervision over all the work, and see that nothing is left undone. An expense fund of $9,000 for the seven hydrographers should be provided. This would mean the expenditure in two years' time of $30,600 for hydrographic work, or $4,400 less than the Seventeenth General Assembly intended to be devoted to it, during the past two years.

This fund would permit of a thorough study of the Rio Grande, as well as all other streams of the State, and would permit the accumulation of data which is in constant demand. If these appropriations are made in this form, there will be no question about their availability, and the work can proceed with continuity and with certainty throughout the entire two years. If they should be made as they were two years ago, a year or more might have to elapse before anything can be done, and this means a serious break in the records. It should be remembered that broken records have only a small part of the value of continuous records, and that continuity must be the aim at all times.

The gauging fund, although intended for use in this work, cannot be used as the basis for a suitable organization, since we do not know, from one month to another, what the income may amount to.

Section 3334, providing for the application of the gauging fund, should be so modified as to permit the use of this fund for any necessary purpose connected with the work of the State Engineer's office, instead of apparently restricting it to work immediately connected with the proper distribution of water.

If the recommendations above made should be adopted, the salary list of the State Engineer's office would stand as follows:

State Engineer	$ 3,000.00	
Deputy State Engineer	2,500.00	
Two Assistant State Engineers, at $1,800	3,600.00	
Chief Hydrographer	1,800.00	
Six Hydrographers, at $1,500	9,000.00	
One Draftsman	1,200.00	
Two Stenographers, at $1,200	2,400.00	
File Clerk	1,200.00	
Office Boy	750.00	
Total		$25,450.00

This is about $7,000 per annum more than the salary list recommended by State Engineer Jaycox, in the Fourteenth Biennial Report. This list, however, provides for seven hydrographers, where Mr. Jaycox suggested but two. The suggested salary list, exclusive of hydrographers, amounts to $14,650. The existing salary list, exclusive of hydrographers, amounts to $10,400.

In addition to the salaries and expenses for hydrographers above suggested, reasonable appropriations for incidental expenses and for traveling expenses of State Engineer, Deputy and Assistants, should be made.

It will be noted that almost the entire increase in appropriations suggested for this office over the present appropriation is for the hydrographic department. It cannot be too strongly urged that this is by far the most important department of the State Engineer's office, and that it should be encouraged in every way.

Section 3346 provides that the clerk of any court issuing judicial decrees fixing priorities of appropriation of water shall furnish the Irrigation Division Engineer having jurisdiction, with certified copies thereof. To what extent this may have been complied with in the past it is now impossible to ascertain. As previously pointed out, the offices of the Division Engineers have shifted as often as the incumbents. The records and property of the division have become confused with private property and have been lost or mislaid. Some of the present Division Engineers state that they have some certified copies, but are not sure that they have all. The office of the State Engineer has certified copies of some decrees but there is no means of knowing whether or not it has a complete list. Since these decrees are the final authority for the distribution of water, and since the State Engineer's office is the chief executive office of the water distributing officials, the law should provide that the clerk of each court issuing decrees to water rights should supply a certified copy of each and every such decree to the State Engineer's office. In this office these decrees can be, and will be, preserved and held for reference by all interested parties. From them tabulated statements sufficient to guide water commissioners and Division Engineers can be prepared and issued as occasion may demand, and any loss or destruction of records in the Division Engineer's offices will not seriously impair the efficiency of the administration.

By referring to the financial statement in the following chapter it will be noted that the State Engineer's office has paid about $600.00 for blue prints during the past two years. Probably one-half of this sum can be saved if the office is equipped with an electric blue-printing machine, and the necessary facilities for making its own prints. The work could be done by an office boy and the cost of blue prints would be limited to the actual cost of materials. The installation of such a machine would require that additional floor space be provided for the office. This, however, will soon be necessary in any event as the number of employes working in one room is very large and the confusion correspondingly great.

IRRIGATION DISTRICTS.

It is believed that the organization and financing of irrigation districts should be subject to some sort of State control. The present irrigation district law, while facilitating the formation of mutual enterprises in which each man in securing the irrigation of his own land helps to irrigate that of his neighbor, unfortunately lends itself to the manipulation of shrewd and unscrupulous promoters who do not hesitate to take advantage of ignorance on the part of many landowners with regard to financial and engineering problems to promote districts which may or may not have within them the elements of success.

The experience of the State Board of Land Commissioners during the past two years, in which this Board has found it necessary to cut in two in many cases the areas proposed for irrigation under the Carey act, indicates that a similar regulation and control of irrigation districts would be for the good of all concerned. The irrigation district law should be so modified that no issue of bonds for construction purposes can be made until the enterprise has been approved by the State Board of Land Commissioners. From now on this Board will always have an engineer as one member. It can, furthermore, always command the services and assistance of the State Engineer's office in any investigation which it sees fit to undertake. It is, therefore, believed that it is the proper official organization to exercise control over irrigation districts.

IRRIGATION COURT.

The suggestion to be made in this paragraph will probably require, if it is carried out, an amendment to the Constitution. It is believed that the time has come for the organization in Colorado of a court to have exclusive jurisdiction in all matters relating to the public waters of the State. Such a court should have three judges, one of whom should be a competent hydraulic engineer. It should have authority to sit any place in the State and to hear any and all matters pertaining to the public waters, but nothing else. No other court should have authority to hear matters of this kind, or to issue decrees relating to priorities of appropriation of water.

There are many courts in Colorado which come so little in contact with water matters that they are unfamiliar with the details. The requests for injunctions against water officials are purposely presented to such courts in preference to those more familiar with the intricacies of water distribution. These courts frequently grant such injunctions without a hearing, and in doing so cause tremendous damage to other parties who were not named as defendants in the proceeding and had, therefore, no opportunity to present their side of the case. Ninety per cent. of the injunction cases brought against the officials are brought with the expectation of getting some unfair advantage of another water user, and in the belief that the water officials will not appear to defend the cases. In some instances the applicants for injunction have been plainly put out because the officials did defend and have not hesitated to express in court their dissatisfaction that the officials did not allow the injunction to issue by default.

It is believed that these abuses will be done away with by the establishment of such a court as is here suggested. It is believed, furthermore, that the adjudication of water rights will be on a more rational basis than appears to have prevailed in the past, and that the tremendous abuses incident to the transfer of points of diversion through long distances on a stream will be minimized, if not entirely abolished.

INTERNAL IMPROVEMENT FUND.

The administration of the internal improvement fund in the past has not been efficient. Each Assembly has attempted to chop it up into little pieces so that each county would get a little. The division has apparently borne no relation to the necessities of the different counties, but has depended more upon their relative influence in the legislative halls. Thus it has happened that appropriations of three or four thousand dollars have been obtained to build bridges costing between fifteen hundred and two thousand dollars. In other instances appropriations of two or three thousand dollars have been made to build a road or a bridge which should properly cost ten or twenty times that sum. As a result, the larger works, requiring the expenditure of a large amount of money at one time, have remained undone, while two, three, or four thousand dollars have been almost wasted here, there and everywhere in the building of three or four miles of road, or in the repairing of a road previously built, which should properly have been maintained by the county in which it is located.

This matter properly comes up for consideration in this report since the State Engineer is nearly always one member of the board of construction named in the acts making appropriations for internal improvements. The Seventeenth General Assembly created a Highway Commission, and during the past two years this commission has been appointed, has organized, and has selected an engineer. It is believed that the internal improvement fund can be used more effectively and to better advantage under the direction of the Highway Commission than in any other way. In its administration the Highway Commission should have the widest latitude. It should not be hampered by legislative appropriations or subdivisions of funds. It should have the authority to expend this money at such places and in such sums as seems best to it, after an examination of conditions. If the Highway Commission is given this authority it will not spend some money in each county every year, but what it does spend can be made to count.

The Seventeenth General Assembly appropriated $177,680.00 from the internal improvement fund. The largest appropriation for any one purpose was $7,500.00. It appropriated $6,480.00 towards building a bridge across the Grand river near Grand Junction. A bridge at this point will be at least 1,000 feet long and must be upwards of 20 feet in width. A suitable bridge will probably cost not less than $100,000.00. The State appropriation is a mere drop in the bucket, and it is too much to expect the people of Mesa county to raise all the additional money required, in one year. Had this entire fund been in the hands of the Highway Commission, and had this Commission believed that the demand for the bridge justified the expenditure, it could have very properly paid forty or fifty thousand dollars towards the construction of the bridge, if the people interested had raised the balance. In this way, and in this way only, can larger works which will form a necessary part of the highway system of the State be constructed.

I believe this is one of the most important improvements relating to matters with which the State Engineer's office is connected, which can be suggested. The time will come, as the sale of public lands in the State of Colorado decreases, when there will be no internal improvement fund available. It is extremely important while we still have this fund to get the most out of it, and to use it in the most efficient manner. I believe the suggestion herein contained will accomplish this end, and believe that the change cannot be too strongly urged.

CHAPTER III.

FINANCIAL.

The Seventeenth General Assembly made appropriations, to be expended under the direction of the State Engineer, as follows:

State Engineer, salary	$ 6,000.00	
Two Deputies State Engineer, salary and expenses	8,300.00	
Draftsman, salary	2,400.00	
Hydrographer, salary	2,400.00	
Stenographer, salary	2,400.00	
File Clerk, salary	2,000.00	
Incidental expense	3,100.00	
Irrigation Division Engineer, Division No. 1, salary	3,000.00	
Irrigation Division Engineer, Division No. 2, salary	3,000.00	
Irrigation Division Engineer, Division No. 3, salary	3,000.00	
Irrigation Division Engineer, Division No. 4, salary	3,000.00	
Irrigation Division Engineer, Division No. 5, salary	3,000.00	
Division Engineers' expense	5,000.00	
Total		$46,600.00

From these funds balances were turned back to the General Fund as follows:

Deputies, salary and expenses	$ 398.70	
Incidental expense	400.31	
Division Enginer, Division No. 3, salary	400.00	
Division Engineers' expense	1,451.36	
Total		$ 2,650.37

This leaves a total expended for the ordinary administration of the State Engineer's office, and for the service of water distribution throughout the State, of $43,949.63.

The Assembly also made an appropriation of $10,000 annually, to be expended through the State Engineer's office, for the purpose of making hydrographic surveys and investigations of the water resources of the State. This appropriation was placed in the fourth class, and no portion of it was available for use during the first year. In July of 1910, the State Treasurer notified this office that $10,000 had been placed to the credit of this fund. A balance of $455.40 has been turned back to the General Fund from this appropriation.

An appropriation of $15,000, to be expended under the supervision of the State Engineer, for the purpose of obtaining a complete report on the water supply of the Rio Grande, was made by the Assembly. This appropriation was placed in the fifth class, and no portion of it became available until so near the end of the fiscal period that it was impossible to carry out the will of the Legislature in this matter. No portion of the fund has been expended.

The Gauging Fund is made up of the fees paid into the State Engineer's office in accordance with section 3332, Revised Statutes of Colorado, 1908. The balance in this fund, on December 1, 1908, was $3,148.16, and on November 30, 1910, it was $7,986.85, an increase of $4,838.69 during the period.

A detailed statement, in tabular form, of the disbursements from each of the funds above enumerated, is given below.

In addition to these statements, two other tables are given. One of these shows the distribution of moneys received among the various classifications under which this office is authorized to collect fees. The other shows the total amounts paid as salaries and expenses to Deputies State Engineer, and as expenses to the State Engineer, no matter from what funds. This shows that the total so expended does not exceed the limit of nine thousand dollars fixed by section 3328, Revised Statutes of Colorado, 1908.

In considering the expenses of the various employes of this office, it is proper to take into account the free transportation which has been supplied by the railroads. The State Engineer has made many requests for transportation when it was necessary for the transaction of State business. By the courtesies of the railroad officials, all such requests have been granted. In recognition of this courtesy the office has carefully refrained from any requests for transportation for persons not employed by the State Engineer and traveling on State business.

From April 10 to December 31, 1909, the various railroads in Colorado issued forty-two annual passes and 163 trip passes to employes of this office. From January 1 to November 30, 1910, the office received fifty annual passes and 218 trip passes. Of the 381 trip passes thus issued, 206 were for the hydrographers of the United States Geological Survey, and the remainder for State employes.

The round trips for which these passes were issued will probably average 200 miles each, making a total of 76,200 miles traveled on trip passes. At four cents per mile, the cash value of this transportation would be $3,048. There is no means of knowing what mileage is represented by the annual passes which were issued to the State Engineer and his deputies, to the Division Engineers and to the water commissioners. It is probably safe to say that a conservative estimate of the cash value of railroad transportation, supplied free of cost to the State Engineer's office during the past biennial period, and used for the transaction of State business exclusively, is $5,000.

This must be borne in mind as a necessary and proper increase in the allowance for expenses in this office, in case the granting of passes to State officers is forbidden.

STATE ENGINEER'S SALARY FUND.

Appropriated		$6,000.00
T. W. Jaycox	$1,075.00	
Charles W. Comstock	4,925.00	
	$6,000.00	$6,000.00

DEPUTIES STATE ENGINEER—SALARY AND EXPENSES.

Appropriated		$8,300.00
G. N. Houston, salary	$ 956.00	
G. N. Houston, expenses	15.35	
C. W. Beach, salary	658.00	
A. F. Hewitt, salary	2,727.00	
A. F. Hewitt, expenses	207.00	
J. W. Johnson, salary	2,742.00	
J. W. Johnson, expenses	159.90	
Charles W. Comstock, expenses	108.20	
Thomas Grieve, Jr., expenses	178.35	
C. L. Chatfield, expenses	101.05	
G. H. Russell, expenses	48.45	
Balance	398.70	
	$8,300.00	$8,300.00

DRAFTSMAN'S SALARY FUND.

Appropriated		$2,400.00
Geo. H. Angell	$ 500.00	
O. L. Nelson	1,900.00	
	$2,400.00	$2,400.00

HYDROGRAPHER'S SALARY FUND.

Appropriated		$2,400.00
H. E. Rockwell	$ 800.00	
D. F. Foor	300.00	
Thomas Grieve, Jr	1,300.00	
	$2,400.00	$2,400.00

STENOGRAPHER'S SALARY FUND.

Appropriated		$2,400.00
E. M. Williams	$1,374.20	
N. E. Edginton	1,025.80	
	$2,400.00	$2,400.00

FILE CLERK'S SALARY FUND.

Appropriated		$2,000.00
M. H. Griffith	$ 566.66	
E. H. Rhodes	1,433.34	
	$2,000.00	$2,000.00

INCIDENTAL EXPENSE FUND.

Appropriated		$3,100.00
Hydrographic Instruments and Equipment	$ 902.03	
Hydrographer's salary	270.00	
Hydrographer's expenses	207.15	
Deputies' salaries	264.00	
Deputies' expenses	41.00	
Expense bridge inspection	14.70	
Extra clerical work	173.33	
T. W. Jaycox, expenses	23.55	
Express	21.81	
Analyses of material used in dams	79.00	
Office supplies and equipment	268.01	
Denver Photo Materials Co	185.29	
Typewriter and repairs	100.95	
Western Union Telegraph Co	1.14	
Colorado Telephone Co	58.35	
Blue prints	54.78	
Miscellaneous items	34.60	
Balance	400.31	
	$3,100.00	$3,100.00

DIVISION ENGINEER'S SALARY—DIVISION NO. 1.

Appropriated		$3,000.00
William Rist	$ 537.50	
Fillmore Cogswell	2,462.50	
	$3,000.00	$3,000.00

DIVISION ENGINEER'S SALARY—DIVISION NO. 2.

Appropriated		$3,000.00
John M. Jackson	$ 562.50	
E. R. Chew	2,437.50	
	$3,000.00	$3,000.00

DIVISION ENGINEER'S SALARY—DIVISION NO. 3.

Appropriated		$3,000.00
D. S. Jones	$ 125.00	
F. W. Swanson	2,475.00	
Balance	400.00	
	$3,000.00	$3,000.00

DIVISION ENGINEER'S SALARY—DIVISION NO. 4.

Appropriated		$3,000.00
A. H. Stokes	$3,000.00	
	$3,000.00	$3,000.00

DIVISION ENGINEER'S SALARY—DIVISION NO. 5.

Appropriated		$3,000.00
A. J. Dickson	$ 600.00	
Theodore Rosenberg	2,400.00	
	$3,000.00	$3,000.00

DIVISION ENGINEER'S EXPENSE.

Appropriated		$5,000.00
William Rist ... Div. No. 1	$ 9.18	
Fillmore Cogswell ... Div. No. 1	891.04	
John M. Jackson ... Div. No. 2	108.10	
E. R. Chew ... Div. No. 2	886.82	
F. W. Swanson ... Div. No. 3	412.60	
A. H. Stokes ... Div. No. 4	248.48	
A. J. Dickson ... Div. No. 5	84.40	
Theodore Rosenberg ... Div. No. 5	631.63	
P. J. Preston, conducting exam ... Div. No. 1	6.00	
C. W. Beach, conducting exam ... Div. No. 2	36.20	
C. W. Beach, conducting exam ... Div. No. 3	36.10	
G. N. Houston, conducting exam ... Div. No. 4	37.43	
G. N. Houston, conducting exam ... Div. No. 5	36.10	
Publishing notice of examination ... Div. No. 1	8.07	
Publishing notice of examination ... Div. No. 2	8.66	
Publishing notice of examination ... Div. No. 3	4.84	
Publishing notice of examination ... Div. No. 4	9.27	
Publishing notice of examination ... Div. No. 5	8.22	
W. & L. E. Gurley, Current Meter for Div. No. 1	85.50	
Balance	1,451.36	
	$5,000.00	$5,000.00

HYDROGRAPHIC SURVEY FUND.

Appropriated		$20,000.00
Not available for use	$10,000.00	
Salaries, state hydrographers	1,870.00	
Expenses, state hydrographers	1,840.86	
Expenses, U. S. G. S. hydrographers	217.70	
Salaries, gauge readers	1,155.69	
Hydrographic instruments and equipment	1,399.89	
Special investigation of run from Antero reservoir	584.17	
Office work necessary to proper distribution of water	1,026.29	
Meter-rating station at Cooper Lake, Denver	1,450.00	
Balance	455.40	
	$20,000.00	$20,000.00

GAUGING FUND.

Balance in fund Dec. 1, 1908		$3,148.16
Office receipts, Dec. 1, 1908, to Nov. 30, 1910, incl.		14,493.27
Amount remitted by T. W. Jaycox, State Engineer, to State Treasurer on April 9, 1909, and not covered by office receipts		886.30
Salaries, state hydrographers	$2,253.65	
Expenses, state hydrographers	1,165.82	
Expenses, U. S. G. S. hydrographers	884.55	
Salaries, gauge readers	1,047.94	
Hydrographic instruments and equipment	1,612.43	
Blue prints	523.56	
Office work necessary to proper distribution of water	3,022.11	
Overpayment refunded to R. P. Hilleary	2.60	
Miscellaneous items	28.22	
Balance in fund Nov. 30, 1910	7,986.85	
	$18,527.73	$18,527.73

DISTRIBUTION OF FEES RECEIVED IN STATE ENGINEER'S OFFICE, DECEMBER 1, 1908, TO NOVEMBER 30, 1910, INCLUSIVE.

Filing claims to water rights		$ 9,250.00
Rating ditches		723.80
Postage		74.83
Blue prints		651.53
Certificates and certifications		1,343.30
Sale of "Irrigation Laws"		293.00
Office labor		922.20
Examination of reservoir plans		1,133.00
Sale of bridge plans		55.00
Filing transfer decrees		44.00
Surplus cash due to errors		2.61
Remitted to State Treasurer	$14,493.27	
	$14,493.27	$14,493.27

TOTAL SALARIES AND EXPENSES OF DEPUTIES STATE ENGINEER, PLUS EXPENSES OF STATE ENGINEER.

Statutory limit for two years		$9,000.00
G. N. Houston, salary	$1,008.00	
G. N. Houston, expenses	36.88	
C. W. Beach, salary	708.00	
C. W. Beach, expenses	22.30	
A. F. Hewitt, salary	3,198.00	
A. F. Hewitt, expenses	419.79	
J. W. Johnson, salary	2,994.00	
J. W. Johnson, expenses	254.50	
T. W. Jaycox, expenses	23.55	
Charles W. Comstock, expenses	114.90	
Total expended	$ 8,779.92	
Less than allowable amount by	220.08	
	$9,000.00	$9,000.00

The financial statements relating to the various road and bridge funds, with the disbursement of which this office, together with other members of the boards of construction, has been charged, will be found in a subsequent chapter.

CHAPTER IV.

CLAIMS FOR APPROPRIATION OF WATER.

During the biennial period there have been filed in this office 2,751 maps, with the accompanying statements, claiming water for 2,296 ditches and for 1,506 reservoirs.

The total amount of water claimed for ditches, running one hundred days, would be equivalent to a run-off of twelve inches from the total area of the State, and would be sufficient to irrigate about one-half the State's area, if that amount were arable land.

The total claimed for reservoirs is 22,328,228 acre-feet. If each reservoir is to be filled once annually, this amount of water is equivalent to a run-off of four inches from the entire area of Colorado.

All of these claims are made without any regard to existing systems whose claims are established, or to claims previously filed for systems not yet completed, and, therefore, not demanding water at the present time.

Many of these filings are made with no intention or expectation on the part of the claimants of ever building or attempting to build the systems for which the claims are made. The only purpose of the claimants in most instances is to get some sort of an asset, however vague and intangible, on which to base a bond issue which may be manipulated at a profit, or which may be sold to some one unfamiliar with the first principles of water supply or irrigation.

The above figures are a sufficient illustration of the folly of our present systems of recording claims to water rights and determining order of priority.

The following tables show for each water district, for each irrigation division, and for the entire State, the number of claims filed for ditches and reservoirs, and the amount of water claimed for them.

DIVISION NO. 1.

District Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
1	187	31,374.61	231	115,827,565,037
2	50	4,918.41	36	4,382,590,564
3	49	11,824.09	79	45,022,165,952
4	17	1,122.64	8	1,018,287,124
5	51	4,384.10	62	31,042,293,531
6	45	10,214.77	25	8,374,044,366
7	40	3,871.19	28	1,797,217,682
8	39	4,079.46	31	6,335,507,001
9	17	2,043.00	17	6,098,209,728
23	47	10,062.23	48	74,804,919,381
46	12	3,633.08	6	11,458,376,892
47	16	445.57	5	7,856,416.110
48	12	2,946.00	25	23,784,245,088
64	34	3,338.72	31	2,099,092,293
65	3	228.34	8	3,863,942,663
Total...	619	94,486.21	640	343,764,873,412

DIVISION NO. 2.

District Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
10	23	1,396.21	21	2,993,626,759
11	23	849.25	16	5,462,360,408
12	32	10,811.56	24	27,747,964,756
13	10	33.00	9	840,833,445
14	41	5,825.28	31	7,195,944,847
15	9	724.30	19	2,453,039,801
16	131	6,234.36	77	23,151,415,477
17	85	38,468.66	53	17,551,919,557
18	21	4,721.97	11	1,648,697,250
19	34	6,545.76	20	46,919,087,388
49	5	66.00	1	2,476,800
66	1	22.00	0	0
67	64	16,010.05	61	29,398,921,299
Total...	479	91,708.40	343	165,366,287,787

DIVISION NO. 3.

District Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
20	36	1,989.20	25	56,237,111,882
21	3	70.37	0	0
22	4	330.58	1	10,248,000
24	9	3,373.50	3	7,970,382,492
25	33	1,063.04	22	4,207,939,968
26	7	2,444.66	7	4,151,017,322
27	14	604.08	2	1,115,707,074
35	31	1,974.21	15	5,454,063,300
Total...	137	11,849.64	75	79,146,470,038

DIVISION NO. 4.

District Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
28	18	1,664.39	3	170,921,482
29	9	542.09	1	12,314,790
30	42	14,658.69	6	7,866,626,635
31	39	2,985.44	10	18,191,834,281
32	5	1,921.35	4	10,393,188,357
33	21	2,067.18	8	8,590,305,675
34	19	204.28	5	45,871,789
40	138	11,752.69	99	24,985,704,640
41	15	177.63	6	77,273,714
42	119	25,842.32	75	12,699,108,270
59	15	186.49	3	507,652,682
60	42	1,623.38	10	4,629,011,362
61	41	2,968.06	8	1,616,001,969
62	19	411.43	8	1,661,671,213
63	4	19.42	0	0
68	18	342.47	12	1,694,873,264
69	14	347.51	7	1,216,790,487
Total...	578	67,714.82	265	94,359,150,610

DIVISION NO. 5.

District Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
36	43	4,275.11	9	796,776,494
37	24	1,688.96	13	2,336,768,094
38	33	4,131.38	9	2,622,650,314
39	68	3,534.69	17	4,649,408,871
43	38	17,314.23	18	67,732,745,084
44	44	8,508.91	35	169,210,205,657
45	44	1,020.87	7	670,913,257
50	9	362.65	2	25,988,741
51	19	4,993.94	3	54,022,160
52	1	150.00	2	129,621,644
53	12	76.91	9	101,121,475
54	16	1,688.48	4	1,921,759,763
55	4	4,051.60	1	75,253,419
56	8	176.22	7	10,199,136,446
57	65	6,517.70	35	29,397,677,010
58	44	10,921.36	11	32,581,136
70	11	125.31	1	24,201,435
Total...	483	69,538.32	183	289,980,831,000

CLAIMS FOR APPROPRIATION OF WATER, 1909-1910.

Division Number	No. of Ditches	Total Amount Claimed for Ditches, Cu. Ft. Per Sec.	No. of Reservoirs	Total Amount Claimed for Reservoirs in Cubic Feet
1	619	94,486.21	640	343,764,873,412
2	479	91,708.40	343	165,366,287,787
3	137	11,849.64	75	79,146,470,038
4	578	67,714.82	265	94,359,150,610
5	483	69,538.32	183	289,980,831,000
Total...	2,296	335,297.39	1,506	972,617,612,847

CHAPTER V.

REPORTS OF DIVISION ENGINEERS.

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION NO. 1, FOR 1909.

November 30, 1909.

STATE ENGINEER, Denver, Colorado.

Dear Sir—As provided for in section 12, chapter 125, page 287, Session Laws of 1903, I herewith submit a report of the work of this irrigation division during the fiscal year ending November 30, 1909.

My commission as Irrigation Engineer of division No. 1 is of date April 9, 1909, and I entered upon the duties of the office on April 10, giving a receipt for the record books, court papers relative to changes in points of diversion, and certified copies of decrees gathered by former superintendents of irrigation and Division Engineers. At the same time I was informed that the certified copies of decrees had been turned over to the State Engineer for filing in his office, under an official opinion of a former Attorney General.

As the water commissioners were appointed and entered upon their duties, I soon learned that very few of them had received from their predecessors a full list of the decreed ditches, or any other records of value relating to the duties of that office.

There have been sent to all of them copies of the State Engineer's report for 1907-8, and of the "Irrigation Statutes and Supreme Court Decisions," published in 1909. These books are stamped as being the property of this division, and will be filed in the office of the Division Engineer at the end of the biennial period, for redistribution.

I have furnished the water commisisoners in districts Nos. 5 and 6 typewritten tabulated statements of the decrees rendered in those districts on March 13, 1907.

All the records of the water commissioner in district No. 48 were destroyed by fire during the past summer.

Before the commencement of another irrigation season a tabulated statement of the decrees in districts Nos. 46, 47 and 48 will have to be written; also for districts Nos. 1 and 64, where, during the past summer, a referee has been taking testimony for a readjudication of the water rights.

There has been no serious trouble over the distribution of water, although there was a shortage of water in the South Platte water-shed during May, July and August.

The owner of a ditch in district No. 64 turned in 16½ second-feet of water on August 10, without permission from the water commissioner, and was arrested and fined $25.

On June 8, at the request of the water commissioner in district No. 1, I investigated the conditions existing along the Lone Tree creek and its tributary, the Owl creek, complaint having been made that certain small reservoirs built in the beds of the creeks were taking the entire flow, to the injury of other appropriators lower down. The complaint was shown to be well founded, and a report to that effect was sent to the State Engineer.

To assume that all that one has to do in the distribution of water is to measure the flow of a river and then divide that amount among the various ditches according to decreed priorities, is very far from the true facts in the case. The measurement at any one point on a stream will not give the volume that can be diverted for irrigation, even though there are no natural tributaries. The underflow, springs and return seepage are growing in importance more and more each year.

I have found it necessary to establish gauging stations for the use of the water commissioners on Boulder creek at the Platte ranch, on Bear creek at Morrison and at the mouth, and on the South Platte river at Littleton, Brighton and the "Narrows" near Fort Morgan.

Through the courtesy of the Denver Reservoir Irrigation Company, the water commissioner in district No. 7 was furnished with a rating table of their station on Clear creek, about three miles above Golden, and also daily gauge heights each morning by phone.

In addition to these stations, I have made eight measurements of the South Platte river at the Sixteenth street viaduct in Denver, and during a shortage of water, almost daily rod readings.

Early in the season I found that I was short on reservoirs, and learned that Chambers lake had gone out two years ago. This lake broke the first time on June 9, 1891, and the resulting flood caused much damage upon farms situated in the narrow mountain valley above the canon. On the morning of June 15, 1907, at 3 o'clock, the dam again gave way and the reservoir was emptied in four hours. Among the papers in my desk I found the following statement: "The reservoir contained about 70,000,000 cubic feet. The flood reached La Porte at noon, raising the river two feet. The total flow at that time was about 9,000 second-feet. A number of small bridges in 'Poudre Canon' and the Sugar Company's railroad bridge above Bellevue were washed away, but little damage was done."

Chambers Lake is about fifty miles west of La Porte and the time stated is about ten hours, which gives an average velocity of five miles per hour.

The water commissioner in District No. 1 reported that the outlet of the Empire Reservoir broke on August 2, about 2 P. M., but there was not much damage done to crops by the flood, between the reservoir and the river. Estimated flow was 450 second-feet.

On August 19th it was reported that Lake George had broken and that a wall of water 10 feet high was coming down the river. The reports from Lake Cheesman of that date show that the surface of the lake was raised only 0.90 of a foot and the discharge of the South Platte into the lake increased only 1,645 second-feet. Lake George is about fourteen miles south of Cheesman Lake. The recorder at Sixteenth viaduct, in Denver, at midnight of August 19th showed a reading of 4.40 feet, equal to about 3,100 second-feet. This was the highest stage of water during that week and was only a rise of 0.60 of a foot from the reading at 8 A. M., August 19th. Cheesman Lake is about sixty miles southwest from Denver.

Riverside Reservoir has had some trouble with its slope protection, but the dam has not broken.

On September 7th reports came in that Jefferson Lake had gone out and a high wave was coming down the river. This was a false alarm.

During the past few years there have been constructed along the South Platte river many seepage ditches or drainage systems which empty into the river. The owners of these ditches claim the right to take into other ditches a corresponding amount of water, under the law of 1889, section 3177, Revised Statutes 1908.

This is simply an "artificial" increase and comes clearly under the decision of the Supreme Court in the case of "Buckers Irr. Co. vs. Farmers D. Co.," that "water passing through sand and gravel constituting the bed of the stream and the lands so nearly adjacent that the only natural outlet would be through such channel, * * * are a part of the waters of the stream."

All requests for the use of this seepage discharge, during a shortage of water, have been refused unless the claimant could show a decreed right to the same.

The transfer of water from one stream to another, and from a reservoir to a ditch, is a very perplexing question and needs intelligent supervision on the part of the water commissioners, but I presume that nine-tenths of it is done over the telephone.

In times of shortage the appropriator of the normal flow of a stream naturally looks with suspicion upon later ditches running bank full, while his own ditch is dry. Thousands of dollars might be expended in the investigation of the loss by seepage and evaporation in this exchange of water.

One water commissioner requested instructions regarding an exchange of water under the law of 1897, section 3225, Revised Statutes, 1908, where the reservoir delivers stored water to a ditch and takes in exchange therefor, water from the stream higher up, "when the rights of others are not injured thereby." Although there is no provision for securing a judicial decision that the exchange would not injure the other appropriators, nevertheless it does not appear to me that it is within the province of the irrigation officials to determine that point; they can only distribute the water as the decrees require. This exchange is practically a change in point of diversion, although it may be only a temporary one.

The law of 1879, section 3276, Revised Statutes, 1908, and the decisions of the Supreme Court in the case of the "Fort Lyon Canal Co. vs. Chew," and in the case of the "New Cache la Poudre Irr. Co. vs. Water Supply and Storage Co.," where the court says: "It was a salutary provision for the legislature to require that the party desiring a change should, in a procedure where all the parties affected might be heard, obtain judicial ascertainment that the change would not injure them," clearly point out that the power to decide, when "the vested rights of others are not injuriously affected," "is vested exclusively in the District Court of the proper county." I, therefore, advised him to allow the exchange if there was no objection made by other appropriators, but if there was objection, not to allow it without an order from the court. At the same time it was suggested that he smooth the interested parties the *right* way, and perhaps he could make the exchange without friction. I presume that was the outcome, as I never heard from the case again.

The transfer of appropriations from one ditch to another ditch lower down on the stream, appears to be on the increase. These transfers are ordered by the courts without a saving clause for any deduction on account of loss from seepage and evaporation. It is a well-known fact that from 25 per cent. to 30 per cent. of the water diverted from a stream by ditches, returns to the stream as waste and seepage water.

After the transfer down stream the ditches located between the two points of diversion will be deprived of this source of supply. I have in mind a transfer from two small ditches of 56 second-feet to a large ditch about 25 miles lower down the South Platte river, and, adding insult to injury, from one district into another. This water is of 1871 and 1873 appropriations and will have to be sent down, part of the way at least, through a dry and sandy river bed. The water will go into the air by evaporation and sink into the sand by percolation in crossing sandbars where 5 second feet will sink into the sand in order to get one to the headgate. This loss has to be made good by the intermediate gain of the river from seepage and tributaries. It is simply moving a ditch downstream in order to get control of a certain amount of water, that could not be diverted at the original location of the ditch.

In a small ditch the use of water is neither continuous nor uniform, but largely intermittent and limited. Transferring this water to a large ditch below practically changes this intermittent use to a continuous one, and furnishes still another source for irrigation litigation. In making this transfer, I can simply deliver the 56 second feet at the original headgates in district No. 2 when those ditches would be entitled to the water under their appropriations, and then let it run down into district No. 1 and divert the same amount at the new point of diversion. District No. 1 will have to make up the loss in transmission.

It is a matter of sincere congratulation that in July, 1908, in a case in water district No. 4, the District Court refused to grant a petition, on the grounds that "the transfer of water of early appropriation from a lower point to a higher point on a river, interferes with the right of ditch and reservoir companies to exchange reservoir water."

This was a most important decision, especially in northern Colorado.

No appeal was taken from the above rulings, but it may be a different story next year.

A few ditches have shown a tendency to take more water than they needed, simply because their decrees gave them a right to a certain number of second-feet.

If the District Courts, instead of giving a certain fixed quantity for a continuous flow during the irrigating season, would limit the quantity decreed to any party to the least quantity necessary for the irrigation of his land, with the most careful use, most of the evils resulting from excessive decrees would be obviated and the water would be so distributed as to irrigate the greatest possible area of land.

The latest decrees in this division now limit the appropriation to an amount not to exceed a specified number of acre feet each year. It is to be hoped that all decrees in the future will hew close to the same line.

During the past season work was commenced on the construction of the "North Sterling Irrigation District," and the inlet ditch is now completed and work on the reservoir has commenced.

"The Greeley-Poudre Irrigation District" published the notice of their $5,000,000.00 bond sale, but at present the sale is held up by litigation.

Work has continued on the construction of Standley lake and Antero reservoir, and Barr or Oasis reservoir is being enlarged.

The year of 1909, according to the reports of the U. S. Weather Bureau, has been the wettest season in 37 years, the total precipitation being nearly 22 inches. If we hark back to the old limit of successful agriculture as twenty inches of rainfall, Colorado can no longer be classed among the arid states.

But rainfall records like run-off records are quite often very misleading. The run-off for the same conditions of rainfall is always less the greater the water shed, hence the run-off computed from rainfall data is subject to very large errors.

Rainfall data also fail as a basis for estimating run-off because of our lack of knowledge of ground water conditions.

The quantity of water stored in the ground, and carried into the following year will be large unless the rainfall has been small for the last month or two, thus allowing the excess to drain off. One-half of the total rainfall is evaporated or is a "fly-off;" one-third is about the "run-off" and the balance is absorbed by plant life and sinks into the ground; this is sometimes call ed the "cut-off."

The snowfall in the high mountain regions was the greatest in many years. Owing to the cold weather and lack of high winds during the earlier months of the winter of 1908-9, the run-off and loss by evaporation were small. The early falls of snow were packed hard like ice, and the later ones blown by the high winds, filled the gulches and ravines, forming in some places drifts 100 feet deep. The cold spring retarded the melting of this snow and very little damage was done by floods from melting snow.

Local heavy rains during June, July and August flooded the low land along Bear creek and Clear creek, and washed out many headgates. During the week ending June 12th, the crops in districts 6 and 8 were damaged by rain and hail. On June 14th the "Poudre Valley canal" in district No. 3 broke through a weak bank and caused the Larimer County ditch to break also. Damage estimated at about $6,000.00. The latter ditch was out of commission for 9 days and the former much longer.

During the week ending July 10th floods in districts Nos. 7, 8 and 9 caused several ditches to close down for repairs. On July 27th and again on August 7th floods in district No. 7 closed down ditches. Notwithstanding all of this snow, rain and floods, on May 14th an order was issued to close down all ditches postdating July 8th, 1876, in districts Nos. 7, 8, 9 and 23 to comply with a demand for 354 second feet to supply earlier priorities in district No. 2.

The melting of snow in the mountains owing to rains and warm weather increased the flow of the South Platte river so that on May 25th this order was recalled.

On July 20th another order was issued to shut down all ditches postdating October 5th, 1871, in districts Nos. 7, 8, 9 and 23 to supply a demand from district No 2. On July 22nd after water from district No. 7 had reached district No. 2 this order was changed to include only ditches postdating January 18th, 1879. This order was modified from day to day by phone, as the floods in Bear and Clear creeks kept the river in a constant state of fluctuation. On August 19th the order was withdrawn on account of heavy rains. Since that date there has been no demand for water between districts.

District No. 2 is the trouble maker pre-eminent, and the "Highline" ditch in district No. 8 of date January 18th, 1879, is on the deadline, and she knows it and sleeps with one eye on district No. 2 and the other eye on the Division Engineer.

In this connection an interesting fact is developed. On August 4th all ditches in districts Nos. 3, 4, 5, 6, 7, 8 and 9 postdating December 21st, 1874, were closed down for lack of water, but on the same day the Fort Morgan canal in district No. 1 of date October 18, 1882, was drawing 140 second feet and down in district No. 64 the

Pawnee canal of date June 22, 1882, was drawing 135 second feet. The reported amount of water used in these two districts for irrigation on that day was about 1,000 second feet.

Again, on August 10th (which was low water mark for the season), all ditches in districts Nos. 2, 3, 4, 5, 6, 7, 8 and 9 postdating October 5, 1871, were closed down; but on the same day, in district No. 1, the Fort Morgan canal was drawing 100 second feet of 1882 water and the Springdale ditch in district No. 64 was using 25 second feet of 1886 water, and the total amount of water used in the two districts was 980 second-feet. All of this water was practically seepage and waste water, returned to the river in the section from the mouth of the Cache la Poudre to Julesburg, a distance of about 150 miles.

We have here the evidence that a stream may go dry in one place while ditches below may have a full supply, in which case the location of a ditch would be of more importance than its date of priority.

On July 26th an order was issued to district No. 1 to send down to district No. 64, 100 second-feet from ditches postdating June 23, 1882.

The weekly reports of the water commissioner in district No. 64 show that during September there were about 63,000 acre-feet of water passing into Nebraska, and during October about 64,000 acre-feet.

The rental value of an acre-foot of water is from $2.00 to $4.00 according to scarcity of water and amount of valuable crops which are owned by the farmers who have not a sufficient supply. It is a matter of record that in 1901 in Cache la Poudre valley reservoir water sufficient to irrigate 10 acres of potatoes sold for $90.00. A conservative rental would be $3.00 per acre-foot, and hence we have water worth $380,000.00 running to waste during these two months for lack of storage facilities.

On June 18th there were 9,400 acre-feet and on June 26th 9,200 acre-feet passing Julesburg. This is most significant and tells its own story, when viewed in the light of the fact that the decreed rights on the South Platte river and all its tributaries are more than ten times the average flow of those streams, or in the proportion of 30,000 second-feet to 3,000 second-feet. It would seem that there still remains enough unappropriated water to reclaim a few more acres of arid land, if properly conserved.

The duty of water when expressed in terms of acres irrigated per second-foot, assumes a constant and uniform flow for the irrigation season, which may mean 90 to 120 days or even more and is very misleading. I think the better way is to state it as so many acre-feet per acre of land irrigated.

The term acre-feet per acre would at once represent the number of irrigations that may be given from a known quantity of water.

It is generally conceded at the present time that in this division 1½ acre-feet, not including the rainfall, is ample for each acre irrigated. Some of the late reservoirs are selling water rights of one acre-foot per acre of land irrigated.

A condensed statement of the weekly reports of the water commissioners is as follows:

	Amount Stored in Reservoirs in Acre-Feet	Amount of Reservoir Water Used, in Acre-Feet	Total Amount of Water Used in Irrigation in Acre-Feet	Average Daily Amount of Water Used in Irrigation in Second-Feet
May	43,214	None	247,814	3,997
June	88,260	None	348,600	5,810
July	25,364	13,040	389,980	6,290
August	None	48,112	282,100	4,550
September	40,820	18,480	167,520	2,792
October	27,342	410	103,726	1,673
Totals	225,000	80,042	1,539,740	4,185 Mean

Water commissioner in district No. 23 was on duty only from May 15th to August 7th. The irrigated area is mostly meadow land. While the crop of hay was large, much trouble was experienced in gathering it on account of rains and high water.

Water commissioners in districts Nos. 46, 47 and 48 were not on duty, there being water enough for all ditches and a goodly supply for Wyoming. Districts Nos. 46 and 48 have, however, sent in annual reports relative to irrigation and crops in those districts.

The new water commissioner in district No. 64 did not qualify and resigned in July. The old water commissioner was then reappointed, but owing to washing out of dams by the high water, no estimate of the amount of water used prior to August can be made. The highest water of the season is reported on July 10th for that district.

In August there were used for irrigation in district No. 64, 23,700 acre-feet. In September, 25,200 acre-feet. In October, 6,200 acre-feet.

District No. 65 plays a lone hand out on the Arickaree and Frenchman creeks, and his reports were very consistent with each other.

If we take districts 1 to 9, both inclusive, covering the South Platte river and its tributaries from Platte Canon to Balzac at west line of district No. 64, a distance of 150 miles, we have the following table:

During the month of November irrigation has ceased in many of these districts and the water commissioners have finished their work for the season.

From the weekly reports received I would make the following estimate for the month of November: Amount stored in reservoirs, 31,560 acre-feet; reservoir water used, none; amount used in irrigation, 37,200 acre-feet, with a daily use of 620 second-feet. The daily use dropped from 994 second-feet during the first week to 351 second-feet the last week of the month.

It is important that the annual reports of the water commissioners should deal with undeniable facts and I beg leave to offer the following suggestions for your consideration:

Furnish separate blanks for annual reports on ditches and reservoirs.

BLANKS FOR DITCHES.

In the present blank for ditches, make the following changes: Cut out columns 11 and 12 and add to columns 13 and 14 the words "from natural stream." At present some water commissioners include in columns 13 and 14 the quantities given in columns 11 and 12, and some keep the four columns separate. For the sake of clearness, add to the heading "crops irrigated from canal, in acres," the words "and reservoirs," as it is impossible to separate in most ditches the acreage irrigated by reservoir water and water taken directly from the natural stream.

BLANKS FOR RESERVOIRS.

I would ask for the following data:

Column

1 Name of reservoir.
2 Name of owner.
3 Location.
4 Source of supply.
5 Name of feeder.
6 Area of highwater line, acres.
7 Capacity in cubic feet.
8 Quantity of water in reservoir May 1, cubic feet.
9 Quantity of water in reservoir November 1, cubic feet.
10 Name of ditch supplied from reservoir.
11 First day water used from reservoir.
12 Last day water used from reservoir.
13 Number of days water carried from reservoir.
14 Average daily amount of water carried from reservoir during season (cu. ft. per sec.).
15 Number of acre-feet of reservoir water carried during season.

To the above I would add columns 16 to 29 (on crops and cost) of the present ditch blank, changing the word "canal" to "reservoir only".

The crop report would only be filled up in case reservoir water alone was used, and would also be included in the corresponding columns of the ditch blank.

In the field books the daily record of river and reservoir water carried by ditches, should be kept separate and recorded in second-feet.

From reports along lines as outlined above, we would be able to compile tables, showing acreage of crops irrigated under canals using only water from natural streams; or using only reservoir water; or both combined, and also tables giving number of acre-feet of water used per acre of land irrigated.

Provision should also be made for keeping a daily record of the amount of water diverted from one natural stream into another, and annual reports required regarding the same.

From an examination of the annual reports for the season of 1909, no one would have even a "shred of suspicion" that during the past irrigation season as shown by the weekly reports, district No. 3 diverted from district No. 47, 2,856 acre-feet, from district No. 48, 13,678 acre-feet, and from district No. 51, 15,400 acre-feet, a total of 31,934 acre-feet.

I herewith attach a tabulated statement of the water commissioner's annual reports, from which I compile the following tables:

ACREAGE OF CROPS RAISED WITHOUT IRRIGATION.

District	Alfalfa	Cereals	Potatoes	Wheat	Oats	Corn	Other Crops	Total
1		20,000	1,000			10,000	5,000	36,000
2	20	150					35	205
3		No dry	farming					
4—a				20,000	4,500	500		25,000
5—b				6,490		300	200	6,990
6—c				3,500	100	400	Spelts 25	4,025
7		No dry	farming					
8—d	200			4,000	3,000	3,000	400	10,600
9—e	92			560	67	186	65	970
Totals.......	312	20,150	1,000	34,550	7,667	14,386	5,725	83,790

No reports regarding dry farming received from the other districts in the division.

a—Average yield, wheat, 30 bu. per acre; oats, 40 bu. per acre; corn, 25 bu. per acre.

b—Average yield, wheat, 25 bu. per acre.

c—Average yield, wheat, 30 bu. per acre; oats, 30 bu. per acre; corn, 25 bu. per acre; spelts, 25 bu. per acre.

d—Average yield, wheat, 30 bu. per acre; oats, 35 bu. per acre; corn, 30 bu. per acre; alfalfa, 2½ tons per acre.

e—Average yield, wheat, 23 bu. per acre; oats, 25 bu. per acre; corn, 17½ bu. per acre; alfalfa, 2 tons per acre.

TABULATED STATEMENT OF WATER COMMISSIONERS' ANNUAL REPORTS ON WATER STORED IN RESERVOIRS FOR THE IRRIGATION SEASON OF 1909.

District	Capacity in Acre-Feet	Amount of Water in Reservoirs May 1, 1909 Acre-Feet	Amount of Water in Reservoirs Nov. 1, 1909 Acre-Feet	Amount of Water Held Over from 1908 Acre-Feet	Area of High Water Line Acres	Number of Reservoirs Reported
1	192,840	92,385	26,578	700	9,459	12
2	25,480	25,480	6,809	None	2,932	25
3	129,430	75,505	23,287	9,700	9,069	49
4	102,554	79,795	59,298	580	4,824	28
5	42,982	30,269	18,046	None	2,715	15
6	19,714	19,116	16,267	Not reported	1,369	28
7	18,881	11,812	6,207	250	1,303	52
8—a	5,257	2,000	5,257	500	175	1
9—b	9,992	8,801	7,975	850	1,265	37
23—c	79,064	74,854	80,000	55,017	874	1
46		No reservoirs in	district			
47		No reservoirs in	district			
48		No reservoirs in	district			
64—d	28,352	21,809	4,591	Not reported	1,670	1
65	580	580	409	None	Not reported	9
Total....	655,126	442,406	254,724	67,597	35,655	258
Marston Lake.....	19,795	13,491	16,262	11,448	651	

a—All in Castlewood Reservoir.

b—Not including Marston Lake. Used by D. U. Water Co. for domestic purposes.

c—All in Lake Cheesman, which was full on May 13, 1909. On Nov. 1, 1909, depth of water on spillway was 0.33 feet, reported by Mr. C. L. Adams, Supt. In Antero Reservoir water has been stored to an elevation of 13.5 feet on gage rod.

d—All in Jumbo Reservoir. The data relative to amount held over from 1908 was reported to me by the water commissioners last May.

The water commissioner in District No. 3 reports a storage of 116,012 acre-feet of water during the season.

IRRIGATION DIVISION NO. 1.

TABULATED STATEMENT OF WATER COMMISSIONERS' ANNUAL REPORTS FOR THE IRRIGATION SEASON OF 1909.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	1
													CROPS IRRIGATED FROM CANALS, IN ACRES											COST, DOLLARS			
D strict	Amount of Appropriation Cu. Ft. Per Second	Capacity of Canals	Length of Main Ditches in Miles	Length of Laterals in Miles	First Day Water Used	Last Day Water Used	Maximum Number of Days Water Carried from Natural Streams	Maximum Number of Days Water Carried from Reservoirs	Amount of Water Carried from Reservoirs in Cubic Feet	Average Daily Amount of Water During Season, Cu. Ft. Per Sec.	Number of Acre-Feet Used by Canals for Season	Total Number of Acres that Can Be Irrigated	Alfalfa	Natural Grasses	Cereals	Orchards	Market Gardens	Potatoes	Sugar Beets	Other Crops			Total Irrigated	Superintendence	Repairs	Improvements	District
1	1,559	3,734	399	249	Apr. 10	Oct. 22	196	22	2,849,724,260	953	274,115	154,695	30,982	11,650	27,589	87	5	2,844	10,106	3,866	Cabbage 27	Tomatoes 97	87,253	$ 41,055	All three in one		1
2	3,347	2,134	280	99	Apr. 13	Nov. 22	224	0	0	1,173	424,610	94,275	20,799	5,531	23,202	307	5,364	3,944	10,926	1,874	Celery 70		72,017	$ 15,135	$ 8,300	$ 2,610	2
3	3,609	3,475	353	1,010	Mch. 26	Nov. 2	222	Not reported	Not reported	815	242,038	241,550	48,075	7,304	73,111	2,349	1,577	32,504	36,100	6,135	Peas 300		207,455	$ 16,931	$ 19,173	$ 85,243	3
4	2,286	2,239	223	154	Apr. 16	Nov. 15	214	59	1,067,384,000	597	184,978	107,115	27,470	1,930	44,100	650	415	5,845	19,200	1,835	Peas 725		102,170	$ 11,230	All three in one		4
5	2,363	1,192	259	100	Apr. 17	Nov. 11	209	16	122,976,000	507	142,884	89,397	27,940	4,881	47,912	1,718	645	2,271	10,073	500	Peas 200		96,140	$ 3,483	$ 6,855	$ 1,380	5
6	2,931	1,890	257	91	Apr. 20	Sept. 21	155	98	56,106,042	530	84,318	86,517	23,153	8,863	34,916	2,046	1,371	620	3,237	3,729			77,935	$ 4,450	$ 22,893	$ 7,175	6
7	1,581		217		Apr. 16	Nov. 12	211	14	96,586,800	357	118,166	116,175	36,562	4,216	40,073	4,022	8,886	120	1,300	95		Pasture 1,325	96,599		Not reported		7
8	2,478		326	235	Mch. 15	Nov. 15	246	125	270,000,000	454	126,825	65,629	17,459	2,184	9,993	2,783	1,739	4	165	1,797			36,124	$ 7,926	$ 31,553	$ 815	8
9	394	309	52	44	May 4	Nov. 6	187		42,788,160	143	35,598	12,616	5,233	295	4,918	201	136		30	334			11,147	$ 2,373	$ 2,254	$ 120	9
23	No annual report received.																										23
46	1,072	1,007	132		Apr. 22	July 31	101			737	104,749	44,775		44,775	Nat. grasses subdivided as per Col. 22,23						Meadow 28,510	Pasture 16,265	44,775		Not reported		46
47	No annual report received.																										47
48	1,261	559	62	47	Apr. 26	Aug. 1	97					7,728		3,513	10			4					3,527		Not reported		48
64	1,439	2,639	261	299	Apr. 1	Nov. 1	215	105	750,280,700	897	233,230	124,400	24,919	45,980	20,690	294	75	2,080	8,145	1,880			104,063	$ 60,780	$ 3,825	$ 3,510	64
65		115	32		Apr. 1	Oct. 31	214			102	33,748	3,993	719	2,265		3		23	14	619			3,643	$ 240	$ 755		65
Totals	24,420	19,293	2,853	2,328	Mch. 15	Nov. 22	246	125	*5,255,845,962	7,265	2,005,259	1,148,865	263,311	143,387	326,514	14,460	20,213	50,259	99,296	22,664	29,832	17,687	942,848	$163,603	$ 95,608	$100,853	Totals

*120,658 acre-feet.

NOTE.—In districts Nos. 1, 6 and 7, quantities in Column 10 are NOT included in Column 12. In districts Nos. 4, 5, 8, 9 and 64, quantities in Column 10 ARE included in Column 12.

INSERT FACE PAGE 34

A more or less intimate association with water commissioners during the past few years leads me to observe that it is very evident that a successful water commissioner must be a man of good judgment and have a knowledge of the conditions prevailing on the streams in his district and should be, to a certain extent, an irrigation enthusiast.

I wish to say that, as a rule, the services rendered by the water commissioners in this division, during the past season, have been of the most satisfactory nature. With two or three exceptions, they were all new men in the service; but as a matter of fact, if not of civil service rules, a long term in the position does not always improve the services rendered by a water commissioner. They soon acquire the "phone" habit and are seldom accused of "pernicious activity" along the streams of their district. They also, sometimes, appear to have adopted the old motto of the college undergraduate, "Don't let your studies interfere with your education".

Respectfully submitted,

(Signed) F. COGSWELL,
Irrigation Division Engineer, Division No. 1.

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION No. 1, FOR 1910.

Denver, Colorado, November 30, 1910.

State Engineer, Denver, Colorado:

Dear Sir—I herewith submit a report of the work of this irrigation division during the fiscal year ending November 30th, 1910.

Owing to a lack of snow in the mountains during the winter of 1909-10, there has been a shortage of water for irrigation in all of the districts in the South Platte drainage. This deficiency was not made up by local rains, as has been the case in former years. The months of August, September and October show an additional deficiency in rainfall at the head waters of the South Platte of more than two inches below the normal for those three months. This year removes all doubts as to Colorado not being classed among the arid states. The records of the rainfall and run-off in this state for the year 1910 will be of the greatest value to irrigation engineers. The only years of much interest are the few forming the period of least rainfall and run-off, and the average for a few years is not of much practical value. The variation from the mean rainfall for five years' record is said to be 17%, from ten years' record 9½%, and from 35 years' record 2½%.

Owing to the shortage of water during the past season, many ditch and reservoir companies have shown a tendency to ignore or evade any legal distribution of water and restraining orders and court injunctions have fallen upon this office as "thick as autumnal leaves that strew the brooks of Vallombrosa."

The climax, however, was reached when one of the water commissioners took a day off from the arduous duty of supervising two deputies and came to Denver to serve notice of a restraining order upon this office.

I am not advised as to whether or not he returned to his home town and, in his capacity of deputy sheriff, served the same papers upon himself as water commissioner.

The permanency of the irrigation interests of this state depends upon the protection and preservation of the decreed water rights and the impartial enforcement of the irrigation laws, but to many people they look like a song that lingers, half forgotten.

The attempt on the part of certain reservoir companies to compel this office to limit the direct irrigation season to certain months forces into the lime light the two very important questions, of *winter irrigation* and *an over supply of storage reservoirs.*

Many years' experience in both the Arkansas and the South Platte valleys proves that by the irrigation of lands during the late fall and early winter months, less water is needed during the early spring months and the first crop of alfalfa can be grown and harvested without very much irrigation.

The value of storage water depends upon its availability in an emergency, which calls for its use to supplement the direct appropriation of water by the ditches. Its value is materially reduced if it is used alone for the complete irrigation of crops. It is estimated that for each foot of water stored, another foot can be taken directly from the stream and not more than 40% of the flow of a stream will have to be stored in order to utilize the annual flow of the stream. The irrigated acreage will be increased about three times that from the natural flow alone. Uniform flowing streams would require a larger percentage of storage.

Ditches in Districts 2, 1 and 64, extending from above the mouth of the St. Vrain creek to Julesburg have been supplied almost entirely by seepage or return water and stored water, the other districts forming immense underground reservoirs.

All the side streams have been drained dry to supply the districts through which they flow, and the South Platte above the mouth of the St. Vrain creek, above Evans and at Merino, has been dry most of the season.

The farming interests of this state are the greatest resources we have and it is essentially important that the distribution of water should be strictly in accordance with the decrees issued by the courts and the irrigation laws of the state. In order to do this, it becomes more and more apparent each year that there must be a change in the methods of selecting and paying the water commissioners. I find that the assumption that because a man lives in a certain district, he will be familiar with local conditions, is not well taken. This localizing of the water commissioners leads to many abuses.

They too often forget that their district is only one small portion of the division and that "the whole is greater than any of its parts". There is, therefore, an entire lack of the team work in the division that is so essential to the proper distribution of the water. They are subjected to the influence of political and personal friends and the irrigation laws cannot be enforced impartially, and, therefore, are often not enforced at all. I am of the opinion that the water commissioners should be appointed by the Governor from a list of eligibles, furnished him by the State Engineer after an examination as to their qualifications for the position, and they should be paid by the state a certain yearly salary.

The ideal water commissioner would be a young irrigation engineer or hydrographer, with some two or three years' experience in the measurement of water and in the general practice of his profession.

With this class of men in office, holding appointments of either four or six years, there would be many a ditch with late priorities receiving its decreed rights, that now is often shut down for lack of water. Annual reports regarding crops and other irrigation statistics could be compiled that would, at least, be worth the paper they are written upon.

The first demand for water was received on April 30th for 381 second-feet to supply ditches in District No. 2, ante-dating December 19, 1877.

On the same date Mr. Samples, water commissioner in District No. 1, shut down ditches post-dating September 4, 1882, to supply a demand for 103 second-feet for ditches of earlier dates in District No. 64. From that date until October 24th, there was practically a continuous procession of orders to close down late ditches in Districts Nos. 4 to 9 and 23 in order to supply the demands for water for earlier ditches in District No. 2 and demands from District No. 64 upon District No. 1. On October 24th, a general order was issued to Districts Nos. 4 to 9 and 23 revoking all orders to close down ditches in favor of District No. 2. There has, however, continued to be a deficiency in the water supply of all the districts up to the present date, except in Districts Nos. 3 and 4.

On May 28th, a general order was issued to water commissioners in Districts Nos. 3 to 9 and 23 to cease all storing of water in reservoirs until further orders from this office. There was, on that date, a demand for water for direct irrigation in Districts Nos. 1, 2, 8 and 64. This order was also expected to break up the custom that has grown up during the past, of the reservoirs in Districts Nos. 3 to 9 and 23 storing all of the flood waters during the summer and not allowing any of it to flow down into the South Platte river for the benefit of the ditches of Districts Nos. 1, 2 and 64, that needed it for direct irrigation. At the present date this order has not been revoked.

On June 6th I received a written refusal from the water commissioner in District No. 23, to carry out my instructions to shut down ditches in his district post-dating January 1, 1879. On June 18th he resigned and a new commissioner was appointed by the Governor, who reported for duty on June 23rd.

Between the dates of July 11th and July 14th the water commissioner of District No. 23 and the Division Engineer closed down 25 ditches post-dating January 1, 1867, in the South Park, near Hartsel. Since that date the ditch owners in District No. 23 have closed down their ditches whenever they were instructed to do so by the water commissioner.

The only high water of the season in the South Platte was on July 30th, when there was passing through Denver about 1400 second-feet for a few hours, but on the morning of July 31st, this discharge had fallen to about 600 second-feet.

Nearly all of this water came from the head waters of the South Platte. On August 6th I received a report from the water commissioner in District No. 23 that all headgates were closed down and the people praying for the rain to cease.

On August 23rd complaint was made by the owners of ditches on the North Fork of Cache la Poudre river that the Halligan reservoir was storing all the flood waters in the river and that written complaints to the water commissioner of District No. 3 were not even treated with the courtesy of an answer.

On September 2nd I inspected this reservoir and found that the complaint was well taken. The records of the headgate keeper at the reservoir showing a rise of about 4 feet in depth on July 19th and 20th, due to a heavy rain.

On June 16th I found the increase in the South Platte river, due to seepage or return water, in the section between the lower bridge at Evans and the mouth of the Cache la Poudre, was 50.50 second-feet.

On June 22nd, it was 48.60 second-feet.

On Ocotber 6th, it was 46.90 second-feet.

On October 23rd, 1908, the increase in this section was 58.50 second-feet.

On October 7th, 1910, the seepage increase in the section from the mouth of the Cache la Poudre to Hardin was found to be 98.80 second-feet.

On October 24th, 1908, the increase in this section was 91.20 second-feet.

During the past summer I have made 5 measurements of the South Platte river at Littleton, 9 at Denver, 4 at Brighton, 13 at Evans and above the mouth of Cache la Poudre; 4 at Fort Morgan, and 4 at Balzac. These measurements were made for the purpose of serving as first aids to the water commissioners in the distribution of water.

Inasmuch as the State Engineer has been a co-defendant with the Division Engineer in all of the restraining orders and injunctions issued, it is not deemed necessary to make a specific report regarding the same.

A CONDENSED STATEMENT OF THE WEEKLY REPORTS OF THE WATER COMMISSIONERS IS AS FOLLOWS.

If we take Districts 1 to 9, both inclusive, and District No. 64, covering the South Platte river and its tributaries from Platte Canon to the Colorado-Nebraska line, a distance of 250 miles, we have the following table:

	Amount Stored in Reservoirs in Acre-Feet	Amount of Reservoir Water Used in Acre-Feet	Total Amount of Water Used in Irrigation in Acre-Feet	Average Daily Unsupplied Shortage of Water for Irrigation in Sec. Ft.
April	38,580	240	60,000	951
May	22,630	5,642	209,932	1,986
June	3,960	44,880	289,560	4,585
July	0	33,356	157,584	6,725
August	0	38,006	160,084	3,863
September	1,140	9,660	109,320	3,145
October	620	310	103,850	1,832
November	390	0	77,340	1,676
Totals	67,320	132,094	1,167,670	Mean 3,095

DATE OF PRIORITY OF LATEST DITCH DRAWING WATER IN DISTRICTS 1 TO 9 AND 64.

Date	1	2	3	4	5	6	7	8	9	64
Apr. 2	All	All	All		Nov. '71		Feb. '65	Jan. '79	Dec. '82	
Apr. 9	All	Nov. '85	All		Nov. '71		May '70	Jan. '79	Dec. '82	
Apr. 16	All	Nov. '85	All	Oct. '74	Nov. '71		May '70	Jan. '79	Apr. '68	
Apr. 23	All	Nov. '85	Apr. '71	Oct. '74	May '78	1872	Apr. '72	Jan. '79	May '74	
Apr. 30	Oct. '82	Aug. '71	Apr. '81	June '66	Sept. '84	Nov. '73	Apr. '72	Nov. '73	Oct. '65	Sept. '94
May 7	Oct. '82	Nov. '85	Apr. '73	June '66	Sept. '84	Nov. '73	June '72	Jan. '79	May '74	June '82
May 14	Oct. '82	Dec. '74	Sept. '78	June '66	May '78	Nov. '73	June '72	Mch. '68	May '74	June '82
May 21	Oct. '82	Dec. '74	All	Nov. '65	May '78	June '73	Dec. '74	Jan. '79	May '74	June '82
May 28	Oct. '82	Nov. '77	All	Nov. '65	May '78	June '73	Dec. '74	Jan. '79	May '74	June '82
June 4	Sept. '82	Dec. '74	Aug. '79	Nov. 65	May '78	Nov. '73	Nov. '78	Mch. '68	Oct. '65	June '82
June 11	Sept. '82	Aug. '71	Apr. '73	Nov. '65	Mch. '69	June '65	Apr. '72	Mch. '68	Sept. '62	June '82
June 18	June '82	*Oct. '71	July '72	Nov. '65	Mch. '69	June '65	Feb. '71	Mch. '68	Dec. '61	Aug. '75
June 25	June '82	†May '65	Sept. '71	Nov. '65	May '71	June '72	Feb. '71	Mch. '68	Mch. '62	Aug. '75

DATE OF PRIORITY OF LATEST DITCH DRAWING WATER IN DISTRICTS 1 TO 9 AND 64—CONTINUED.

Date	1	2	3	4	5	6	7	8	9	64
July 2	Oct. '81	Nov. '65	Sept. '71	Nov. '65	Nov. '71	May '70	Nov. '65	Dec. '65	Mch. '62	Aug. '75
July 9	Oct. '81	Nov. '65	Oct. '70	Nov. '65	Mch. '69	May '63	Feb. '65	Dec. '65	Mch. '62	Oct. '80
July 16	Oct. '81	May '65	Apr. '70	Nov. '65	Mch. '69	Oct. '62	Nov. '63	Dec. '64	Mch. '62	Oct. '80
July 23	Oct. '81	May '64	May '69	Nov. '65	Mch. '72	May '63	June '64	Dec. '64	Mch. '62	Sept. '82
July 30	Apr. '80	‡Nov. '85	Sept. '71	Oct. '71	Sept. '84	Nov. '73	Dec. '74	Jan. '79	Mch. '69	Oct. '80
Aug. 6	Oct. '81	Oct. '71	Apr. '67	May '64	Nov. '71	June '65	Nov. '71	Mch. '68	Mch. '63	July '86
Aug. 13	June '82	July '76	Apr. '67	Nov. '65	May '78	May '68	Feb. '71	Mch. '68	Mch. 62	July '86
Aug. 20	June '82	Oct. '71	Apr. '67	Nov. '65	Mch. '69	May '68	Feb. '65	Mch. '68	Apr. '62	Nov. '86
Aug. 27	June '82	May '66	June '64	Nov. '65	Mch. '72	Apr. '60	May '62	Mch. '68	Mch. '62	Aug. '75
Sept. 3	June '82	May '64	June '64	Nov. '65	Mch. '72	Apr. '60	Nov. '61	Dec. '65	Mch. '62	Oct. '80
Sept. 10	June '82	May '65	Apr. '66	Nov. '65	May '78	Apr. '62	Nov. '61	Dec. '65	Mch. '62	Aug. '75
Sept. 17	June '82	May '65	Oct. '70	Nov. '65	May '78	Dec. '73	Nov. '61	Dec. '64	Mch. '62	Aug. '75
Sept. 24	Oct. '82	May '65	Sept. '71	Nov. '65	Mch. '72	Apr. '63	May '64	Mch. '64	Mch. '62	Feb. '93
Oct. 1	Oct. '82	Oct. '71	Sept. '71	Nov. '65	Mch. '72	June '62	Nov. '63	Mch. '68	Mch. '62	June '82
Oct. 8	June '82	Oct. '71	Apr. '70	Nov. '65	Nov. '71	June '72	May '62	Mch. '68	Mch. '62	June '82
Oct. 15	Oct. '82	May '65	Apr. '73	Nov. '65	Nov. '71	June '62	Nov. '61	Mch. '68	Mch. '62	June '82
Oct. 22	Nov. '86	May '65	All	Nov. '65	Nov. '71	June '73	Mch. '65	Jan. '79	Oct. '65	June '82
Oct. 29	Nov. '86	Nov. '85	All	Nov. '65	Sept. '84	Nov. '73	Nov. '63	Jan. '79	Mch. '69	June '82
Nov. 5	Oct. '82	July '79	All	Nov. '65	Sept. '84	Nov. '73	Nov. '63	Jan. '79	Mch. '69	
Nov. 12	Oct. '82	Nov. '85	All	Nov. '65	Sept. '84	June '62	Nov. '63	Jan. '79	Mch. '63	June '82
Nov. 19	Oct. '82	Nov. '85	All	Nov. '65	Sept. '84	June '72	July '60	Jan. '79	Mch. '69	June '82
Nov. 26	Oct. '82	Nov. '85	All	Nov. '65	Sept. '84	June '72	Feb. '60		Mch. '69	June '82

*Shortage of 1866 water. River dry at Platteville. †River dry at Lupton. ‡Only 24 hours run of this Nov. '85 water during the flood of 1,400 second-feet at Denver.

Note.—In District No. 2, below mouth of St. Vrain Creek, 1874 water was used, supplied by seepage. In District No. 64, below Sterling, later ditches were supplied by seepage. In District No. 3, at Greeley, 1881 water was used, supplied by seepage.

AMOUNT OF WATER BROUGHT OVER FROM DISTRICTS NOS. 47, 48 AND 51, INTO DISTRICT NO. 3.

	From District No. 47 in Acre-Feet	From District No. 48 in Acre-Feet	From District No. 51 in Acre-Feet
May	310	3,410	2,356
June	1,560	7,560	5,640
July	372	3,658	1,736
August	186	1,364	496
September	0	1,260	0
October	0	471	0
November	0	390	0
Totals	2,428	18,113	10,228

I herewith attach a tabulated statement of the water commissioners' annual reports, from which I compile the following tables:

ACREAGE OF CROPS RAISED WITHOUT IRRIGATION.

District	Alfalfa	Barley	Potatoes	Wheat	Oats	Corn	Other Crops	Total
1	1,037	15,565	3,670	12,452	10,377	25,942	8,782	77,825
2				2,500		2,000		4,500
3				No dry farmi	ng in District.			
4	450			50,000			525	50,975
5				5,000		1,000		6,000
6	500	200		4,000	500	1,000	300	6,500
7	8,000			3,000				11,000
8	2,000	6,000	400	10,500	8,000	15,000	8,000	49,900
9	178	56		1,096	121	128		1,579
64	10,500	3,700	5,350	17,000	8,000	6,000	20,750	71,300
65			No	report on dry	farming recei	ved.		
Totals	22,665	25,521	9,420	105,548	26,998	51,070	38,357	279,579

AVERAGE YIELD PER ACRE OF CROPS RAISED WITHOUT IRRIGATION.

DISTRICT.	Alfalfa Tons per acre	Barley Bushels per acre	Potatoes Bushels per acre	Wheat Bushels per acre	Oats Bushels per acre	Corn Bushels per acre	Spelts Bushels per acre
1	1.25	3		2	4	9	5
2				5		10	
3			No dry farming in District.				
4				15			
5				15		0	
6	2.50	20		10	25	15	15
7	1.50			12.50			
8	1.00	18	15	20	20	12	
9	1.25	16.50		11.50	21	10.50	
64	1.50	12 25	60 100	10 15	20	20 25	30
65	No report on dry farming received.						

THE COLORADO STATE COMMERCIAL ASSOCIATION REPORTED FOR 1909:

Average yield per acre on dry farming land in Colorado—Alfalfa, 2.45; barley, 20.5; potatoes, 102.08; wheat, 19.1; oats, 31.0; corn, 22.0; hay, 1.40.

Average yield per acre on irrigated land in Colorado—Alfalfa, 3.80; barley, 42.4; potatoes, 200.2; wheat, 36.4; oats, 61.6; hay, 2.30.

Average for the irrigated and non-irrigated land in Colorado—Alfalfa, 3.12; barley, 31.4; potatoes, 151.5; wheat, 27.2; oats, 46.3; corn, 22.0; hay, 1.85.

THE UNITED STATES GOVERNMENT CROP REPORTS FOR 1909:

Average for the irrigated and non-irrigated land in Colorado—Barley, 33.0; potatoes, 160.0; wheat, 25.0; oats, 35.0; hay, 2.65.

DISTRICT.	Acreage irrigated using only water from natural streams	Acreage irrigated using only reservoir water	Acreage irrigated using river and reservoir water combined	Present value of water rights per second-foot	Annual rental of reservoir water per acre-foot
1	3,575	12,200	59,810	$1,600	$13.00
2	54,510		17,960	$3,000	$ 4.50
3	23,140		189,800	$2,500	$ 7.00
4			102,300		$ 4.00
5	39,585	800	38,566	$3,000	
6	72,500	5,000	2,675	$1,200	$ 2.00
7	49,928	4,060	28,482	$4,400	$ 3.25
8	22,010	4,000	10,590		$ 3.00
9	3,562	844	4,027	$3,840	
64	47,260		2,500	$2,000	$ 1.10
65	No report received.				
Totals	316,070	26,904	456,710		

The value of a water right has a wide range according to date of priority

TABULATED STATEMENT OF WATER COMMISSIONERS' ANNUAL REPORTS ON WATER STORED IN RESERVOIRS FOR THE IRRIGATION SEASON OF 1910.

DISTRICT.	Capacity in acre-feet	Amount of water in reservoirs May 1, 1910, acre-feet	Amount of water in reservoirs Nov. 1, 1910, acre-feet	Amount of water held over from 1909, acre-feet	Area of high-water line, acres	Number of reservoirs reported
1	140,097	78,485	0	26,578	9,379	6
2	22,344	14,558	0	6,809	2,718	22
3	155,668	71,771	6,726	23,287	9,157	59
4	86,865	64,249	26,534	59,298	5,830	11
5	47,418	31,277	3,000	18,046	2,714	16
6	22,048	9,888	0	16,267	1,496	25
7	20,282	11,978	75	6,207	1,303	52
8*	5,257	45 ft. deep	32 ft. deep	5,257	175	1
9†	9,342	6,541	246	7,975	1,208	33
23	181,340	106,110	83,284	90,700	6,165	5
46	No reservoirs in	District.				
47	No report receiv	ed.				
48	No report receiv	ed.				
64‡	28,352	0	0	4,591	1,670	1
65	582	534	368	409	Not reported	9
Totals	719,595	395,391	120,233	265,424	41,815	240
Marston Lake	19,795	18,982	8,173	16,262	651	

*All in Castlewood Reservoir.
†Not including Marston Lake used by D. U. Water Company for domestic purposes.
‡All in Jumbo Reservoir. Embankment broke March 11, 1910. Total damage estimated at $100,000.00.

IRRIGATION DIVISION NO. 1.

TABULATED STATEMENT OF WATER COMMISSIONERS' ANNUAL REPORTS FOR THE IRRIGATION SEASON OF 1910.

1 District	2 Amount of appropriation cu. ft. per sec.	3 Capacity of canals	4 Length of main ditches in miles	5 Length of laterals in miles	6 First day water used	7 Last day water used	8 Maximum number of days water carried from natural streams	9 Maximum number of days water carried from reservoirs	10 Amount of water carried from reservoirs in cu. ft.	11 Average daily amount of water during season, cu. ft. per sec.	12 Number of acre-feet used by canals for season	13 Total number of acres that can be irrigated
1	1,553	3,410	382	229	Apr. 1	Nov. 30	244	38	843,743,280	591	153,968	155,750
2	3,322	2,162	272	88	Mch. 26	Nov. 30	250	87	434,206,080	813	232,012	87,880
3	3,610	3,476	353	1,186	Mch. 15	Nov. 26	255	174	3,367,134,000	811	261,430	244,550
4	2,340	2,264	223	154	Apr. 7	Nov. 30	237	100	1,526,640,000	267	81,921	107,235
5	1,662	1,532	244		Apr. 12	Nov. 30	232	24	306,367,492	317	83,751	106,028
6	3,048	1,885	273	151	Apr. 18	Nov. 30	226			502	57,251	89,862
7	1,713		233		Mch. 15	Nov. 30	260	4	16,420,000	318	93,488	120,020
8	1,902	1,298	315		Mch. 15	Nov. 30	260	170	1,009,893,160	396	87,470	64,915
9	393	273	40	33	Mch. 27	Nov. 30	248	142	244,105,219	78	14,497	12,633
23	870				Apr. 25	Aug. 10	107					
46	1,125	974	136		Apr. 1	Aug. 5	127			862	121,492	47,445
47	No report received.											
48	No report received.											
64	2,736	2,855	274	338	Mch. 15	Nov. 30	260	14	1,370,880	424	100,860	123,010
65		116	33		Apr. 1	Oct. 31	214			87	28,190	3,545
Totals	24,274	20,245	2,778	2,179	Mch. 15	Nov. 30	260	174	7,749,880,111*	5,466	1,316,330	1,162,873

1 District	14 Alfalfa	15 Natural grasses	16 Cereals	17 Orchards	18 Market gardens	19 Potatoes	20 Sugar beets	21 Other crops	22 Pasture	23 Cane	24 Millet	25 Celery	26 Peas	27 Corn	28 Onions	29 Cabbage	30 Total irrigated	31 Cost, Dollars: Superintendence	32 Cost, Dollars: Repairs	33 Cost, Dollars: Improvements	1 District
	CROPS IRRIGATED FROM CANALS IN ACRES																				
1	22,195	11,656	26,330	13	16	4,130	8,374	118		1,583	1,040				12	117	75,584	$ 9,458	$ 16,931	$ 5,925	1
2	19,338	5,495	28,120	271	4,933	3,618	9,485	1,095				115					72,470	$ 14,980	$ 3,628	$ 12,198	2
3	51,048	7,130	83,416	2,375	1,579	35,970	25,030	6,392									212,940	$ 17,830	$ 33,260	$164,347	3
4	26,820	1,855	50,825	690	416	6,070	12,060	1,770					730				101,236	$ 11,900	$ 2,350	$ 2,000	4
5	22,177	5,156	37,817	1,369	779	3,627	5,498	2,528									78,951	$ 4,730	$ 6,005	$ 20,145	5
6	24,630	9,790	34,930	2,232	1,060	700	2,383	4,000					450				80,175	$ 3,360	$ 17,335	$ 3,750	6
7	27,210	4,690	34,025	4,072	9,948	190	2,240	95									82,470				7
8	14,201	2,090	15,591	2,385	1,384	203	110	65				93			130	348	36,600	$ 35,826	All three in one.		8
9	4,598	227	2,916	213	90	6	8	219						99	28	30	8,434	$ 2,383	$ 1,659	$ 380	9
23		6,600															6,600				23
46		29,245	70						18,130								47,445				46
47																					47
48																					48
64	26,320	50,675	26,910	479	308	7,185	6,664	1,510									120,051	$ 4,645	$ 5,475	$ 12,650	64
65	750	2,060				30	90	475									3,405	$ 240	$ 700		65
Totals	239,287	136,669	340,950	14,099	20,513	61,729	71,942	18,267	18,130	1,583	1,040	208	1,180	99	170	495	926,361	$105,352	$ 87,343	$221,395	Totals

In Districts Nos. 4 and 7 the quantities in column 12 do NOT include reservoir water.

In the other districts the quantities in column 12 DO include reservoir water.

*177,912 acre-feet

INSERT FACE PAGE 42

Through the courtesy of the Union Pacific Railroad Company, the Denver & Rio Grande Railroad Company and the Colorado Midland Railroad Company in furnishing me with annual transportation, I have been enabled to make more frequent personal inspections of the different districts than I otherwise would, on account of the insufficient expense fund of this office.

Respectfully submitted,
(Signed) F. COGSWELL,
Irrigation Division Engineer, Division No. 1.

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION No. 2, FOR 1909.

Pueblo, Colorado, November 30, 1909.

State Engineer, Denver, Colorado.

Dear Sir—I herewith submit my report as Division Engineer of Water Division No. 2, embracing all land watered by the Arkansas river, and its tributaries in Colorado. Recent undeveloped irrigation projects will increase the land that can be irrigated close to one million acres. The bonds for these huge projects are greatly sought after by eastern capitalists, making it possible to complete the largest undertaking.

I submit herewith a list of reservoirs, some of them completed within the year, with a combined capacity of 20,306,925,624 cubic feet, which, when impounded, will be used for irrigation purposes. This, however, does not include as many reservoir projects filed on for a greater capacity than the above, and exploited for irrigation. "The end is not yet." The analysis of such stupendous figures is impossible to the ordinary mind.

We have at a conservative estimate 170,000 acres of alfalfa at an average of four tons per acre the season, equals 680,000 tons at $8.00 per ton, yields the farmers $5,440,000.00; with 40,000 acres of sugar beets at 12½ tons per acre, making 500,000 tons at $5.00 per ton to the farmer, $2,500,000.00. These 500,000 tons of sugar beets are made into 55,000 tons of granulated sugar by the several beet sugar factories in the valley, at Sugar City, Rocky Ford, Swink, Las Animas, Lamar and Holly.

The apple crop of the entire valley exceeds $1,000,000.00, besides cherries and all other fruits. One thousand five hundred acres of market gardens supply the several canning factories, and surrounding towns. Pueblo county alone shipped 46 cars of celery at $300.00 per car, one of the most profitable crops grown. Seven cars of honey were shipped from the valley to eastern points. A total of 75,000 acres of grain. The wheat in many localities averaged 42 bushels per acre; oats, 60 bushels per acre. The cantaloupe crop can safely be placed at $300,000.00.

The stock industry has always been an immense enterprise in this valley. About 70,000 head of sheep and 30,000 cattle and 8,000 hogs are fatted, and marketed in Kansas City and Chicago from this division, besides 5,000 hogs, 8,000 sheep and 5,000 cattle consumed by the Nucholls Packing Company of this city, all products of the Arkansas Valley.

There are several large canning factories and creameries supplied to their fullest with all that is needed in their season, and all on a paying basis.

The water supply has been abundant for all needs, except in Districts Nos. 15 and 16. The crops in No. 16 suffered most; some places were almost a total failure. No. 19 suffered some in the early part of the season.

The several water commissioners have done good work, and all under difficulties, and are deserving praise. They were all new men, had it all to learn, and few of them had anything of value handed down from their predecessors. Nor were they alone, for I found on entering upon my duties that the office had been denuded of all records.

The reservoir question in this division has assumed such stupendous proportions that it will be impossible for either the Division Engineer or the water commissioners to give to them the attention demanded on the limited means furnished. The amount actually needed is absolutely ridiculous as compared with amount supplied.

There are no headgates or measuring devices in hardly any of the ditches in this division, save those drawing water direct from the Arkansas river. I find the farmers give this reason, of some merit, too, under the circumstances, viz., the floods that are liable to and do occur each year from May to September wash away their headgates, and long reaches of ditches and river bank, causing such a loss and expense that it becomes extremely burdensome to replace; he refuses, or replaces them with promises never fulfilled.

In brief, the people are well pleased over the successes of the year.

Yours truly,
(Signed) E. R. CHEW,
Irrigation Division Engineer, Division No. 2.

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION No. 2, FOR 1910.

State Engineer, Denver, Colorado. Pueblo, Colorado, November 30, 1910.

Dear Sir—In presenting my 1910 report, I feel it unnecessary to describe fully this division (as that has been done in every other report) further than to say that Division No. 2 consists of all lands irrigated by water taken from the Arkansas river, the South Fork of the Republican river, the Smoky Hill river and the Dry Cimarron river, and all streams draining into the said rivers in the State of Colorado. I deem it unwise at this time and in this report to enter into any of the legal phases that have been and are constantly arising, chiefly from the numerous water projects being presented to the people, either on paper or partly constructed. I use the above terms because there are none that are fully completed that were begun in the past two years. There are, however, many questions presented, both important and difficult, and demanding the best legal consideration and perhaps legislative action. It is clear, though, that the nature of the development of this division will soon present many interesting storage questions. Further, I think it unnecessary to burden this paper with a detail of the waters stored by and used from reservoirs and in numerous canals, as that is fully and minutely set forth in the official reports and the enclosed summary of all reports.

The past season passes into history as a most remarkable one. During the short time we had rains, there were no floods, and but little high water in the tributaries north of the Arkansas river. The only high water was in Turkey creek, a torrential stream having its source in the Front range southeast of Pike's Peak, draining a very limited area, and dry from its mouth up for many miles almost the entire year. Once only during the season there was a "cloudburst," making about 3,500 second-feet, remarkable for this creek, while south of the Arkansas river there occurred several floods on the upper Huerfano, the Cucharas and Purgatoire, doing an immense amount of damage. The channel or bed of the Huerfano was in places widened from one to ten times its natural or former width, washing out headgates, dams, and great stretches of ditches, leaving one or two large dams out in mid-stream bed. The damage thus caused was immense, not only causing the loss of crops, but time and money for repairs.

Districts Nos. 16, 18 and 19 suffered for the lack of moisture, to such an extent that many crops were a complete failure. No. 16 suffered the heaviest loss, as there was little when needed. The flood damage on the upper Purgatoire was great, but not so much in proportion as the Huerfano. The remainder of the division was not affected by extreme high water, and produced this season the finest and heaviest crops ever before known. The sugar beet crop was remarkable for per cent. of sugar and tonnage. The several factories will cut 165,000 tons (with 13 to 18% sugar). For the above the farmer will receive for his beets from $5.00 to $6.75 per ton, or an approximate total of $866,250.00. The by-product from these factories is fed to cattle and sheep. There are at the several plants 12,000 cattle and 15,000 sheep. There are 30,000 head of steers on the range that are fed beet tops in the winter, besides the sheep fed at the plant. There are 140,000 sheep fed by companies and private parties in the valley, and an estimate of 12,000 goats in the division. Some 400 head of goats are used by Italians for cheese making in Huerfano and Las Animas counties. The alfalfa will produce 895,030 tons from 179,006 acres, worth on an average of $7.00 in the stack, a total of $6,215,210.00. I know personally of several who received $11.00 in stack. There are a number of alfalfa meal mills in successful operation in the Arkansas valley, and one being built at Olney Springs.

The wheat and oat yields were remarkable, as several crops of wheat made 60 bushels per acre. Mrs. Best of Rocky Ford raised 122 bushels of oats per acre.

The valley by conservative estimate will ship 1,600 carloads apples, variety, color and quality unsurpassed; about 50 cars of cherries and 5,000 cars of melons, and 8 cars cucumber pickles from Pueblo to Washington (state); 20 cars of celery already shipped from Pueblo county, worth $600.00 per car; 8 cars of honey and many cars of bush fruits and vegetables.

The canning factories at Canon City, Pueblo, Fowler and Rocky Ford have had a most abundant supply of the various products consumed by each, at all times running at fullest capacity. The truck gardening is ever increasing. Good markets and big yields are the inducements enticing truckers from all quarters. That we have had a bountiful year is evidenced by new farm houses, farm improvements and farmers riding in autos. It seems that prosperity knocked at every energetic farmer's door in the valley this year. For all this they are indebted to a kind providence.

I wish to thank a faithful, conscientious and energetic body of water officials; particular mention I will here make of the commissioners of districts 10, 11, 12, 13, 14, 15, 16, 17 and 67, ever ready and willing to do their full duty conscientiously and energetically.

Respectfully submitted,

(Signed) E. R. CHEW,
Irrigation Division Engineer, Division No. 2.

SUMMARY OF WATER COMMISSIONERS' REPORTS OF DIVISION NO. 2, 1910.

1	2	3	4	5	6	7	8	9	10	11	12
										Crops irrigated from canals in acres	
Name of Commissioner	District No.	Total appropriations, cu. ft. per sec.	Capacity of canals	Length of ditches, miles	Length of laterals, miles	Amount of water carried from reservoirs in cu. ft.	Average daily amount of water during season, cu. ft. per sec.	Number of acre-feet used by canals for season	Total number of acres that can be irrigated	Alfalfa	Natural grasses
William Frizzell....	10	572.9	660.7	125.0	122.5				15,250	4,971	5,364
Max Dickman.......	11	1,233.4	1,233.4	410.7	139.7	1,698,840,000	888.01	208,450	40,040.8	4,917	10,274
J. W. Augustine....	12	1,595.7	1,673.0	290.5	101.0		418.40	108,219	17,364	8,027	1,085
H. W. Hendershot...	13	1,864.9	1,864.9	614.3	109.3		121.50		10,030	810	6,270
H. R. Thompson....	14	2,101.9	2,457.5	299.4	241.0	712,598,040	806.90	219,832	137,155	41,743	11,451
Sam. T. Curtis......	15	264.7	284.8	248.8	78.8		71.40	15,602.9	6,047	2,291	1,334
Parson S. Brown....	16	724.4	936.5	318.0	102.8		778.40	12,792.4	32,213	13,262	3,455
Ben. G. Wilson......	17	2,865.3	2,865.3	366.0	1,078.0	787,467,000	837.00	374,428	185,985	70,724	11,490
C. J. Hart..........	18	266.6							125,000	7,000	4,000
W. G. Hines........	19	654.7									
H. A. Pettee........	67	1,117.22	1,117.22	201.8	321.5	21,481	391.00	111,142	106,235	25,261	4,116
Totals..........		13,261.72	13,093.32	2,874.5	2,294.6	3,198,026,521	4,312.61	1,050,466	675,320	179,006	58,839

1	2	13	14	15	16	17	18	19	20	21	22	23	24
		Crops irrigated from canals in acres									Cost, dollars.		
Name of Commissioner	District No.	Cereals	Orchards	Market gardens	Potatoes	Sugar Beets	Other crops	Water melons	Cantaloupes	Total irrigated	Superintendence	Repairs	Improvements
William Frizzell.....	10	2,186	402	229	95	61	185			13,493			
Max Dickman.......	11	6,011	247	195	404		525	Peas 2,437		25,060		$ 4,715	
J. W. Augustine.....	12	2,180	7,420	357	33		1,001			20,103	$ 8,850.00	$ 4,857	$17,737
H. W. Hendershot...	13	2,890		12			48			10,030			$26,600
H. R. Thompson....	14	29,238	6,057	3,489	432	12,840	8,549	40	1,535	115,374	$16,261.00	$21,918	$67,200
Sam. T. Curtis......	15	814	65		2		71			4,577		$ 2,543	
Parson S. Brown....	16	2,572	245	53	5		334			19,926		$ 4,949	$ 8,283
Ben. G. Wilson......	17	29,493	1,832	490	40	13,740	340	517	2,843	131,509	$36,670.00	$18,550	$372,637
C. J. Hart..........	18		500	550	50	100		Mex. beans 1,500		13,700			
W. G. Hines........	19												
H. A. Pettee........	67	4,276	1,484	171		4,370	4,858	40	608	45,184	$ 6,918.90	$16,809	$19,220
Totals..........		79,660	18,252	5,546	1,061	31,111	15,911	4,584	4,986	398,956	$68,699.90	$74,341	$511,677

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION No. 3, FOR 1909.

State Engineer, Denver, Colorado. Alamosa, Colo., November 30, 1909.

Dear Sir—I herewith hand you my annual report as irrigation engineer for Division No. 3, Rio Grande Division, the annual report of the several water commissioners and tabulation of the same for the entire division.

During the irrigation season of 1909 there has been a very good flow of water in all of the districts in this division. There have been no complaints of shortage of water to me. The several commissioners have handled the water satisfactorily to all the water users except in district 35 where there was some complaint on account of parties stealing water from the Medano creek, and taking it across the range into Huerfano county.

This office has received weekly reports from the following districts, Nos. 20, 21, 22, 25, 26 and 27. Districts Nos. 24 and 35 have not sent in any weekly reports. The commissioner in district 35 has not sent in his annual report, and I can not get answers to any of my letters written to him.

A brief summary of each district for the season is as follows:

District No. 20 has a very large irrigated area of 208,302 acres, distributing daily 1,929.4 second-feet of water from the Rio Grande river and its tributaries. This district is handled by Mr. Louis Nickel and his deputies. There has been plenty of water in this district, and good crops. There have not been any disputes to amount to anything. I have only been called into this district twice to settle disputes, and they were small and did not amount to much. The Rio Grande river was at its highest stage in June, and there was also highwater in the latter part of August and in the early part of September. It did not exceed 6,500 second-feet, and at no time was there any danger from floods. In my 38 years' experience on the Rio Grande river I have never seen a better flow of water, plenty for all and lots to spare.

District No. 21, comprising the La Jara and Alamosa rivers. This district has had plenty of water for all purposes, and the commissioner, Mr. George S. Lovett, reports good crops all over the entire district. The Terrace reservoir, which is under construction on the Alamosa river, has not stored any water up to the present time, nor do I think that they will be ready to store any water next year. During high water in June they had considerable water in the reservoir in order to try it. I think the work done on the dam is first-class in every particular. The reservoir on the La Jara is nearly completed, and they are storing some water now, but only enough to try the dam.

District No. 22, comprising the Conejos river and its tributaries. The commissioner, Mr. B. W. Harrison, reports plenty of water, and crops good, and no trouble of any kind.

District No. 24. This district is situated in the southeast part of the valley, and is supplied with water from the San Luis, San Pablo, Culebra rivers and several other small streams. This is one of the best watered districts in the valley. Mr. J. P. Sanchez, the commissioner of this district, has not made any weekly reports. There has been plenty of water for all and no disputes reported. The crops in this district are very good.

District No. 25. This district is supplied from a large number of small streams, which sink before reaching any of the main rivers in the valley. Mr. John L. Charles, the water commissioner for this district, reports that the water supply has been sufficient for the crops with the rain that fell in the latter part of the season. The crops in this district have been better than the average. I was called up there to settle a small dispute, which was done very satisfactorily.

District No. 26. This district gets most of its water from the Saguache river. Mr. Alex. Russell, the water commissioner from this district, reports that there has been more than they needed, as it rained more this season than usual. The crops were all good.

District No. 27. This district comprises two small streams, the La Garita and Carnero. The water commissioner for this district, Mr. A. N. Coolbroth, reports plenty of water in this district for irrigation. There were some floods caused by heavy rains, but no damage done to crops. The crops are very good throughout this district.

District No. 35. This district is large and is supplied with water from a large number of streams, all of which sink before reaching any of the main rivers. There have been several complaints in this district. One small dispute on the Zapato creek which I settled satisfactorily. On the Medano river there was serious trouble on account of parties diverting the water from the Medano river and taking it across the mountain into Huerfano county. I tried to get the District Attorney to prosecute this case, but I could not get any satisfaction from him. This case is in the District Court now, and I think it will be settled before another season. I do not think that Mr. I. N. Janney, the water commissioner for this district, has done his duty in this district; neither has he sent in any reports to me. It seems a hard matter to get a good water commissioner in this district because the county commissioners will not recommend a good man to the Governor for the position.

This district could be divided so that it could be handled a great deal better than it is. There are some reservoirs under construction in this district which I think will be ready to store water next year. There is one district formed and they have commenced work on the tunnel for the reservoir. This reservoir will be a great benefit to the whole valley and will add a large area of land that will be put under cultivation under this system.

The reports of the different commissioners in regard to crops and water used, are not what I would like to see. In District No. 20, where several large ditches are situated, there are no crops reported. I have personal knowledge of thousands of tons of alfalfa, and many thousands of bushels of potatoes and grain that are grown under these canals and ditches. I would have had this corrected but I did not get the commissioner's reports until the 15th inst., so it was too late for me to do anything. The commissioners in this division are nearly all new men so they could not be expected to be entirely correct. I think that they will do a great deal better next year. There has not been any litigation in the division and very few disputes. This has been a very favorable year for all the water users in the valley.

Enclosed find tabulated report for the division which shows as follows: an average of 76.49 acres irrigated to each second-foot of water used, i. e., the duty of water in this division is about one second-foot of water to every 76 acres for the year 1909.

Respectfully submitted,

(Signed) F. W. SWANSON,

Irrigation Division Engineer, Division No. 3.

IRRIGATION DIVISION NO. 3.

TABULATION OF WATER COMMISSIONERS' REPORTS FOR THE IRRIGATION SEASON OF 1909.

Number of water district	Numbe of priorities	Amount of appropriation, sec. ft.	Length of main ditch, miles,	Average number of days water carried from natural stream	Average daily amount of water during season, sec. ft.	Total number of acres that can be irrigated	CROPS IRRIGATED FROM CANAL IN ACRES		
							Alfalfa	Natural grasses	Cereals
20	375	3,284.90	272	129	1,929.4	262,501	5,748	82,359	104,864
21	88	1,534.47	335	96	1,087.5	30,420	3,015	14,050	13,710
22	144	4,296.22	369	221	698.2	118,814	4,070	36,697	44,229
24	64	389.20	113	129	254.0	54,945	414	7,507	12,363
25	135	386.52	124	79	211.8	54,151	675	80,730	1,224
26	195	515.47		44	849.3		2,897	20,776	1,298
27	51	47.00	22	129	1,212.1		90	3,885	268
35	49	310.00							
Totals	1,101	10,763.78	1,235	118	6,242.3	520,831	16,909	246,004	177,956

CROPS IRRIGATED FROM CANAL IN ACRES

Number of water district	Orchards	Market gardens	Potatoes	Sugar beets	Peas	Total irrigated	COST, DOLLARS		
							Superintendence	Repairs	Improvements
20	31	58	7,285		7,957	208,302	$ 1,390	$19,364	$15,020
21		2	435		730	31,942	$ 260	$ 290	$ 2,996
22			3,322		16,430	104,748	$ 770	$ 3,620	$ 825
24	5	47	76			20,412	$ 1,120	$ 4,100	$27,565
25	4	20	68	4	19	82,744			
26	5	14	31			25,021			
27	4	1	34			4,282			
35									
Totals	49	142	11,251	4	25,136	477,451	$ 3,540	$27,374	$46,406

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION No. 3, FOR 1910.

State Engineer, Denver, Colorado.

Alamosa, Colorado, November 30, 1910.

Dear Sir—I herewith hand you my annual report as irrigation engineer for Division No. 3, Rio Grande Division, the annual reports of the several water commissioners, and tabulation for the entire division.

During the irrigation season of 1910 there has been shortage of water in nearly all of the districts in the division. The different water commissioners have done very well with what water they have had to distribute with the exception of the commissioner in District No. 20 where there was considerable complaint. The commissioner in District No. 20 tried to distribute the water either by telephone from his office or by proxy, and that was very unsatisfactory to the users of water throughout the district. In District No. 24 there was some trouble on account of new settlers coming into the country who demanded their rights, and I had some difficulty in convincing the old Mexican people in this district that they could not handle water the same way that they had been doing for the past generation, but they had to respect other water users' rights. The matter was, however, settled without any serious trouble. This office has only received weekly reports from Districts Nos. 21, 22, 25 and 27. I repeatedly made demands from the water commissioners for their weekly reports.

A brief summary of each district for the season follows:

District No. 20 is very large. It has an area of four hundred fourteen thousand five hundred fifty-one (414,551) acres of land, distributing daily two thousand fifty-eight and thirty-one hundredths (2,058.31) second-feet of water in the district. Mr. Louis Nickel was water commissioner in the early part of the season, but owing to his death the district was without a commissioner until Mr. George D. Nickel was appointed. This caused a great deal of dissatisfaction among the water users. Mr. Nickel is not able to take care of this district, as it is a large district and needs a very able man to give satisfaction. The water in this district was not so plentiful as usual and therefore harder to handle, so I had to do commissioner's work a great part of the time. There was no high water this season, but considering the shortage of water the crops were very good.

District No. 21 comprises the La Jara and Alamosa rivers. This district had a very fair run of water and very few disputes which were very easily settled. The crops were all A No. 1 and everything satisfactory. Mr. Geo. S. Lovett, the regularly appointed commissioner, re signed in the early part of the season and Mr. Thos. McCunniff was acting as commissioner with very good results and satisfaction. The Terrace reservoir did not store any water this season. The La Jara reservoir is completed and was using some water this season.

District No. 22 comprises the Conejos river and its tributaries. The commissioner, Mr. B. W. Harrison, reports that the water was short, but the crops were good. I only had to go there twice to settle disputes.

District No. 24. Mr. J. P. Sanchez is water commissioner for this district. As there are a great many new settlers coming in there I had to go there very often to help Mr. Sanchez settle disputes. This was done satisfactorily to nearly all parties interested. Owing to the condition of the new ditches some crops were lost. The Costilla Land Company is building two reservoirs in this district, so next season there will be plenty of water.

District No. 25 is situated in the northeast part of the valley and supplied with water from several small streams. Mr. John L. Charles, water commissioner of this district, has not called for any assistance from me this season. The flow of water has been satisfactory and the crop very good.

District No. 26 is supplied with water from the Saguache river and Mr. Alex. Russell, the water commissioner of this district, has reported only two small disputes which were easily settled. The crops were good.

District No. 27 comprises two small streams, the La Garita and the Carnero. The water commissioner, Mr. A. N. Coolbroth, has not had any trouble and reports crops in his district fair.

District No. 35. This district is very large and is supplied with water from several small streams which all disappear before they reach any of the rivers in the valley. Mr. I. N. Janney, water commissioner for this district, has not reported any trouble in his district this season. Some reservoirs are being built in this district, but none completed.

The reports from some of the commissioners are not what I would like to have, but I suppose they are the best that can be had, under the system by which the commissioners are paid. I think that the system should be changed, and the State should pay the commissioner, because some of the county commissioners will not recommend competent men. Some of them look upon the water commissioner as a grafter, when in fact it is one of the most important offices in the State where irrigation is practiced. If it were not for the water commissioner there would be no end of litigation, and I therefore think that he is entitled to better treatment than he is getting. I think that this should be brought before the legislature and given due and serious consideration.

Enclosed find tabulated report for division which shows an average of seventy-five (75) acres to each second-foot of water used.

Respectfully submitted,

(Signed) F. W. SWANSON,
Irrigation Division Engineer, Division No. 3.

IRRIGATION DIVISION NO. 3.

TABULATION OF WATER COMMISSIONERS' REPORTS FOR THE IRRIGATION SEASON OF 1910.

Number of water district	Number of priorities	Amount of appropriation, sec. ft.	Length of main ditch, miles,	Average number of days water carried from natural stream	Average daily amount of water during season, sec. ft.	Total number of acres that can be irrigated	CROPS IRRIGATED FROM CANALS IN ACRES		
							Alfalfa	Natural grasses	Cereals
20	266	1,717.50	636.50	127	2,058.30	414,551	6,197	84,035	128,509.5
21	104	1,645.49	902.00	61		70,260	3,030	16,150	13,690
22	145	2,616.60	294.25	87		119,025	4,450	32,482	36,650
24	65	642.26	135.15	214	642.26	36,255	840	6,307	28,594
25	108	497.85	167.35	112	281.30	51,988	741	18,007	1,196
26	207	551.71	69.75	41	273.03	35,382	2,826	20,470	711
27	43	163.70	10.50	152	178.40	5,600	45	4,775	205
35	49	89.82	33.00	88	60.66	6,200	60	3,220	180
Totals	987	7,924.93	2,248.50	110	3,493.95	739,261	18,189	185,446	209,735.5

CROPS IRRIGATED FROM CANALS IN ACRES

Number of water district	Orchards	Market gardens	Potatoes	Sugar beets	Peas	Total irrigated	COST, DOLLARS		
							Superintendence	Repairs	Improvements
20	25	286	10,574	73	18,398	248,097.5	$ 4,530	$28,721	$15,775
21			491		785	34,146	$ 200	$ 85	$ 3,540
22			3,230	120	16,510	93,442	$ 1,835	$ 2,100	$ 1,550
24	6	72	91			35,910			
25	7	29	163		138	20,281		$ 1,085	$ 1,075
26		11.5	36.5	200	454	24,709			
27	2		22		347.5	5,396.5		$ 313	$ 290
35		1	17			3,478			
Totals	40	399.5	14,624.5	393	36,632.5	465,460	$ 6,565	$32,304	$22,230

Annual Report of Irrigation Division Engineer, Division No. 4, for 1909.

State Engineer, Denver, Colorado.

Grand Junction, Colo., November 30, 1909.

Dear Sir—I have the honor to present to you my annual report for the year 1909, together with the reports of water commissioners who have been employed during the season. Under separate cover I also send the field books which they have used during the season.

In submitting this report I have to reiterate the statement that I have made in previous reports that the data, both as to use of water and crop acreage, do not cover the statutory requirements, as given in section 13, chapter 125, Laws of 1903. As I wrote you early in the season, the custom in division No. 4 has been for the water commissioner to start work when he is called for under M. A. S. 2392, upon receipt of an application "stating that there is necessity for their services," and they do not continue performing services after the necessity therefor ceases. I have always advised that during such service they should gather such crop reports as they could, and though they have in some cases extended their time so as to enable them to complete the acreage report, they have in other cases not made any crop report when the time of service for distribution was very short. In no case has a commissioner, who was not needed to distribute water, gone out especially to make a crop report, and in many cases, as in District No. 42, the commissioner has not included in his report large areas irrigated from streams to which he had not been called for the purpose of regulating the distribution of water. I refer to these matters below, mentioning them here as an explanation of the meager report following, which I have arranged according to drainage areas in the division.

As a general statement I might here add that the very absence of reports, and the fact that few commissioners have been employed, means that division No. 4 has been blessed with a plentiful supply of water, and that the cost of distributing the same has been, as it has so often in the last few years, very low.

SAN JUAN DRAINAGE.

District No. 29. San Juan river. No commissioner is qualified for the district, and there was no demand for service.

District No. 30. Animas and tributaries. No commissioner is qualified, and there was no demand for services.

District No. 31. Los Pinos river. The district has not been adjudicated.

District No. 32. Tributaries of San Juan. The district has not been adjudicated.

District No. 33. La Plata river. No commissioner is qualified, and there was no demand for his services.

District No. 34. Mancos river. No commissioner is qualified, and there was no demand for service.

It will be noted that no commissioner was employed on the San Juan and tributaries, and therefore no reports are to hand.

DOLORES RIVER DRAINAGE.

District No. 34. Dolores river. No commissioner qualified, and no service required.

District No. 60. San Miguel river. C. H. Smith, commissioner, Coventry, Colorado. The commissioner states that the report on the flow of water would be of no value this season. The chief reservoirs are used for temporary storage during the irrigation season as part of the ditch system.

CROP REPORT.

	Acres.
Alfalfa	4,096
Natural grass	989
Cereals	4,952
Orchards	795
Other crops	818
Total	11,650

The commissioner was employed for forty-three days at an expense of $215.00. He employed no deputies. He only puts in such days as he finds necessary after being called out. He reports the weather as having been very dry early, then very wet for six weeks, and again later very dry. These conditions and the irregular service resulting therefrom make the report, as he states, not very satisfactory.

District No. 61. Dolores river and tributaries, above San Miguel. W. S. Jones, commissioner, Paradox, Colorado. The only adjudicated stream is the West Paradox, and the service of the commissioner is confined to it. The report covers the time from July 11 to end of season. No deductions as to the use of water can be made from it.

CROP REPORT.

	Acres.
Alfalfa	518
Natural grass	216
Cereals	290
Orchards	36
Other crops	47
Total	1,107

The commissioner worked forty-six days at an expense of $230.00.

District No. 63. Dolores river and tributaries below San Miguel. The district is not adjudicated.

District No. 69. The Dolores river in Dolores county. The district is not adjudicated.

It will be noted that no service was required on the main Dolores river, as is usual, and only about 13,000 acres of this drainage is covered by crop reports.

GUNNISON DRAINAGE.

District No. 28. Tomichi and tributaries. J. R. Hicks, commissioner, Sargents, Colorado.

The commissioner reports six days' service. His field book contains no entries, and he sent no report. Expense, $30.00.

District No. 59. Upper Gunnison and tributaries. This district has been adjudicated, but no commissioner has ever been appointed or needed.

District No. 62. South side of Gunnison above District No. 40. No commissioner is qualified and none was needed.

District No. 40. Gunnison and tributaries. H. C. Getty, commissioner, Cedaredge, Colorado. The report only covers a part of the district, both as to ditches and reservoirs. The commissioner states that all the reservoirs "should be rated as the law requires." The use of water only covers a period from July to the end of the season. The crop report does not seem to cover more than Surface creek and Leroux creek, and no representative estimate either of the crops or of the duty of water in the district can be made.

The commissioner was employed for 150 days	$ 750.00
Twelve deputies worked for 620 days	1,550.00

District No. 41. The Lower Uncompahgre river and tributaries. A. J. Baxter, commissioner, Montrose, Colorado. No data are given as to the use of water, and the entries in the field book do not start until June. The crop report follows:

	Acres.
Alfalfa	23,465
Grass	1,851
Cereals	10,490
Orchards	4,085
Gardens	821
Potatoes	4,603
Beets	2,335
Total	47,650

The commissioner states: "Owing to the condition of the season it is impossible to give the report correctly, but have averaged up the items as best I could. Water spouts and heavy rains locally make it a difficult proposition."

The commissioner worked 105 days	$525.00
Four deputies worked 156 days	390.00

District No. 68. Upper Uncompahgre and tributaries. John Martin, commissioner, Ridgway, Colorado. The commissioner was not employed to distribute water, and gives no data as to its use. At one time it was necessary for the division engineer to call upon him to close down gates in his district in order to supply prior rights in the lower district, No. 41, but heavy rain fell before the order could be carried out and it was not necessary to close down. He sends a full crop report.

	Acres.
Alfalfa	4,711
Grass	2,076
Timothy	2,993
Cereals	3,906
Orchards	99
Other crops	553
Total	14,338

GRAND RIVER DRAINAGE.

District No. 42. The Grand and Gunnison rivers and tributaries. George M. Saunders, commissioner, Mesa, Colorado. The commissioner's returns as to the use of water are not sufficiently definite to enable me to make deductions as to the actual use of water on any stream. The time of use is given generally as "all the year," and there is no possible chance for him to have estimated the average flow during that period. He gives 275,082,685.70 cubic feet (6,315.3 acre feet) as the amount of reservoir water used on a part of the above acreage. The commissioner's work does not take him over nearly all the district, only the Plateau valley and Kannah creek being covered. The Grand Valley, watered direct from the Grand river, is not included in the crop report. From the small area covered he sends the following crop report:

	Acres.
Alfalfa	8,712
Grass	185
Cereals	1,448
Orchards	936
Other crops	509
Total	11,790
The commissioner worked 55 days	$275.00
Four deputies worked 225 days	562.50

It will be noted that the total cost for the water commissioners and their deputies in distributing the water of Division No. 4 was $4,527.50.

GENERAL CROP CONDITIONS.

Generally the crops have been excellent in Division No. 4. The water supply was plentiful, a fact that is sufficiently indicated by the absence of reports from so many districts, and the short term of service in others. For the same reason the administration has been inexpensive. The snow fall of the previous winter was above the average, and there was not the shortage in the spring, which sometimes occurs, and no serious shortage later. On account of the late spring the flood water when it came was excessive, and the Grand river probably carried more water below its confluence with the Gunnison than in any previous year. General rains during the summer helped, but in some localities the hay and alfalfa crops were seriously injured.

Two of the chief crops, viz., fruit and beets, were particularly good, in fact the former was a far larger crop than ever before. As anticipated in my last annual report smudging was resorted to extensively in the Grand Valley; in fact the use of pots burning either coal or oil was quite general. There is no doubt that this fact saved a large quantity of fruit; at the same time the crops were above the average even where no precautions against frost were taken.

The officers of the Western Sugar and Land Company inform me that the crop of sugar beets amounted to 60,000 tons from 5,000 acres of land. The acreage devoted to beets lies in Montrose, Delta and Mesa counties chiefly.

IRRIGATION DEVELOPMENT.

None of the irrigation projects mentioned in my last report have been completed. The tunnel of the Uncompahgre project under construction by the Reclamation Service was temporarily opened during the year, and at the present time a large force of men is employed in enlarging the canal of the Montrose and Delta Company, which has been purchased by the Government. I understand that some water will be delivered to consumers next season. At the time of writing I have not learned that all questions between the Water Users' Association have been settled. It would appear that the Government intends to acquire all such old ditches, with their water rights, as may serve to enable them to unify the system of distribution in that part of the Uncompahgre Valley which is covered by their laterals. It is understood at the present time that no water will be turned into any ditch which is not a part of such system, and I am informed by some who have subscribed lands but who happen to be located under ditches which the Government has not at present acquired, that they are not clear as to how they will get their water. The main body of water provided by the tunnel from the Gunnison river will be turned into the Uncompahgre river, and it is presumed that from that supply and the natural flow decreed to the ditches acquired the amount judged sufficient for any acreage will be delivered in the old ditches. Extensive investigation into the use of water in Montrose county has led to the estimate of one foot per second to 100 acres, to be delivered at the head of the consumers' lateral, as the duty of water.

The Grand Valley project is still being pushed slowly, the need of funds seeming to be the only obstacle to its completion.

The Orchard Mesa District bonds (District No. 42) have been sold and the project is being pushed rapidly.

Bonds to the amount of $160,000 on the Palisade and Mesa county districts have been sold, and the money is being expended on extensive improvements at the intake of the two canals, the construction of a concrete dam across the Grand river, and improvements in the tail race. The expense is being shared jointly by the two districts.

ADJUDICATIONS AND LITIGATION.

Several adjudications are pending, notably in districts 60 and 42, but no new ones have been issued during the year. In the former district rights both for irrigation and other purposes are being adjudicated, in separate proceedings, and it is interesting to note that certain claimants, who use water for power to raise water for irrigation appear in both proceedings. The fact that under the circumstances the power water will go to waste after it has served its purpose, and cannot be used by others, leads one to wonder just how the question will be determined as to whether the use for power is beneficial when the benefit ultimately derived is the use of a different and considerably smaller quantity of water on land. It is notable that similar questions will come up in the adjudication in District No. 42, but for the present only rights for irrigation are being determined. It would seem to the writer that the power rights, on which in many cases the use for irrigation depends on the Grand river, should be determined at the same time, though under the circumstances it happens that the water used for power is again available for use for irrigation or other purposes.

Two interesting cases are now before the Court of the Sixth Judicial District. The first is that of Coppe et al. vs. The Naturita Canal and Reservoir Company, in which proceeding the writer is referee, wherein the owners of shares of stock in the company, who have used the water decreed to the canal in the past, are asking the Court for a decree recognizing their right to the use of such decreed water without any liability to rotate with the owners of other shares, who have not used water from the canal. The other is an action in which the town of Grand Junction seeks to take 300 inches of water from Kannah creek, to obtain a decree granting them a "superior right" to the use of such water ahead of the decreed priorities, by condemnation to have the damages resulting from the taking determined. It will be noted that in this action no attempt is made to condemn any particular water rights, and none are named.

WATER COMMISSIONERS AND THEIR WORK.

One important question that was brought to my attention as to the work of water commissioners involved the duty of the commissioners as regards water from reservoirs or other water sheds which was turned into public streams as conduits and rediverted by the owners. The matter was brought up both by deputy water commissioners, who asked for instructions, and by a board of county commissioners, who saw that the work of the officials was being increased by this practice, and their bills in all probability similarly increased. I wrote a letter to Mr. H. C. Getty, water commissioner of District No. 40, who asked me to advise him on the point, and I believe that the insertion of this letter will explain my view of the case best.

(COPY.)

Dear Sir—Your letter of the 26th referring to a communication from the county clerk of Montrose county, has been received.

The right of an owner to turn stored water into a stream and *take* the same out again, even "without regard to the prior rights of others," is granted in Section 3203, Revised Statutes, and is made fuller by Section 3225 ibid, where the right to *take* an equal amount higher up is granted. Section 3249 ibid, referring to the exercise of this right, makes it obligatory on the owner to construct and maintain certain measuring devices, and in case of failure so to do the State Engineer shall refuse to *"allow to be taken"* any water from the stream on account of delivery thereto.

All the statutes seem to imply that the right is one to be exercised by the individuals owning the water.

In the case of individuals taking water from a stream, Section 3248, ibid, states that in case of failure to erect measuring devices, etc., the State Engineer shall *"refuse to deliver"* any water, and Section 3432 ibid detailing the duty of water commissioners says that they are to *divide* the water in the natural streams, and to close the gates of ditches which are not entitled to water by reason of the priority of right of others below them. Section 3252 puts all gates and measuring weirs under the control at all times of the water commissioner, and Section 3250 ibid shows that they are to measure the water flowing to and from public streams.

After reading the above quoted and other statutes (mentioned below) I am of the opinion that a water commissioner is not expected to take any part in the distribution of water carried in a public stream as conduit, whether from a reservoir or from another water shed except in so far as he is bound to measure the same in order to fulfill his duty "as a guardian of the public streams" (Section 3431). It is a fact that under Section 3497 ibid, it is a misdemeanor to interfere with adjusted headgates in the control of the water commissioner *without authority,* but under Section 3433 ibid, he is evidently given the power to delegate such authority as may be necessary and may arrest anybody "violating his orders relative to the opening or shutting down of headgates or the using of water, etc."

Yours truly,

(Signed) ARTHUR H. STOKES,
Irrigation Division Engineer, Division No. 4.

It appears to me that a water commissioner can rightly give such orders as he may think proper to the "owner or owners or agent or employe" (Section 3429) so that they may be able to enjoy to the full the right which they undoubtedly have of running reservoir water in the public streams as conduits, and the owner of rights to the natural flow may be fully protected. But I do not believe that he is expected or that it is a part of his duty under the statutes to take orders from such owners as to the distribution of their water to the various ditches in which they may desire to turn it. There is no doubt that he must supervise such distribution, but cases have come under my observation where owners of reservoirs expected him to do far more than this, even to the extent of demanding that he turn into many ditches small quantities of water for short periods of time.

Whether or not the work of supervision would entail the employment of fewer deputy commissioners than the actual work of distribution is a question to be decided by the commissioner on the various streams in his district. It is an undoubted fact that the commissioners of Districts No. 41 and No. 42 have been able to reduce their work and number of assistants by following the suggestions made in the above. In any case I am of the opinion that the commissioner (Section 3433) and the Division Engineer (Section 3344) are fully empowered to give such orders as shall enable all reservoir owners to exercise their rights fully by means of proper representatives without it being necessary in many cases to increase the force of state officers employed in the distribution of water from the public streams of the State.

Another question that arises every year is as to whether a commissioner, who has not been needed to distribute water, should under the Act proceed to make his crop report, and further as to whether a commissioner, who has been employed on some few streams, should extend his time to make a crop report from the whole of his district. A good deal of work, and hence of expense, is involved in these questions in Division No. 4, and a ruling on them, it appears to me, would come naturally from you as State Engineer. As Division Engineer I have not thought it advisable to call out commissioners for this purpose, nor to demand full reports from them, since these general reports are ordered by the Statute and are not such as are of special service to the Division Engineer.

Another question has come up as to the legality of a commissioner's services, who is holding over until his successor is appointed and qualified, but who has no bond alive. It has happened that commissioners have served under these circumstances.

The old question as to the pay of commissioners has again come up. The county commissioners of Gunnison county have, I understand, offered to pay one-fourth of the salaries of District No. 40 (suit having been brought for one-third), and the commissioner seeks to obtain one-fourth from Mesa county on account of lands under Escalante creek. The other two-fourths are paid by Montrose and Delta counties, these counties having some years ago paid the whole bill. It is possible that the commissioner will have to bring suit to compel Mesa county to pay, as this is the first time the county has been asked to do so, and there is some question of an agreement between the counties as to the matter.

Generally the whole question of the pay of commissioners and their time of service is in an unsatisfactory condition.

RECOMMENDATIONS.

Some few changes in the field books and annual report blanks occur to me as they usually do after looking over the reports for the year. I think the amount delivered from the reservoirs in the field book should be given in cubic feet *per second*, as this amount could be entered as an original entry. The amount in cubic feet could not be estimated until the period had elapsed during which the water ran. A column for acre-feet should be added, to be filled in at the end of the period during which the water flowed, or at the time of the next change. It would enable one to arrive quicker at the use of water if all reservoir water was also credited to the ditch receiving it, being noted separately from the natural flow. In the annual report blanks I would suggest the following rearrangements of the columns.

No. 10—Number of days water carried from stream. No. 11—Average daily amount in cubic feet per second. No. 12—Number of days water carried from reservoir. No. 13—Average daily amount in cubic feet per second. No. 14—Number of acre-feet used by canal for season. The elimination of cubic feet in reservoir reports will make it simpler for the commissioners, and clearer for the reader.

Except to further suggest that the new commissioners have found, as their predecessors did, that the form of weekly report is not suitable to the districts in Division No. 4, though it may have more value in the future, I have no recommendations to make at this time.

Respectfully submitted,

(Signed) ARTHUR H. STOKES,
Irrigation Division Engineer, Division No. 4.

Annual Report of Irrigation Division Engineer, Division No. 4, for 1910.

State Engineer, Denver, Colorado.

Grand Junction, Colo., November 30, 1910.

Dear Sir—I have the honor to present to you my annual report for the season of 1910, and under separate cover send such annual reports and field books as I have received from the commissioners of the districts in the division. Some of the most important reports are not yet in. It is noticeable, as usual, that those received do not give the information mentioned in the Statute, and it is impossible for the Division Engineer to do anything in the way of tabulation. As I went into this question of commissioners' reports fully in my report for 1909 it is unnecessary to refer to it at more length here. I do, however, wish to recommend that the annual meeting of engineers with you be deferred to a later date than November, so that in the event of the irrigation season being a late one the commissioners can get their reports in in time.

The distribution of water in such districts as the commissioners have served in has been economical and satisfactory. Very few complaints reach the Division Engineer, and the few that do are usually in the nature of appeal from the decision of a commissioner, some point of law being involved in the decision. Some points that have been raised this year are referred to below.

SAN JUAN DRAINAGE.

The only service needed in this drainage area was in Districts 30 and 33. The commissioner of No. 30 has not reported, and the commissioner of No. 33 sent his report to you by mistake. The report of the commissioner of District No. 34 is sent on. His service has been confined to the Mancos river.

DOLORES DRAINAGE.

District 60, the San Miguel river. Mr. C. H. Smith reports the use of 24,120 acre-feet of water on 12,655 acres of land. There was considerable shortage in the district, but he reports that though the crops are short prices for the same are good. He served for 94 days without any deputies.

District No. 61. Part of Dolores. Mr. W. S. Jones sends field book but no report.

GUNNISON DRAINAGE.

District No. 28. Tomichi river. Mr. J. R Hicks reports service for six days. He sends no report.

District No. 68. Upper Uncompahgre. Mr. J. W. Martin reports service for 93½ days. He sends a field book which contains nothing but the crop acreage. In his report he bases the use of water on the use he made himself on his own farm.

There are no further reports from this drainage area, but the commissioners of Districts 40 and 41 have served most of the season.

GRAND DRAINAGE.

District No. 42. Mesa county. Mr. G. W. Saunders reports fully for such part of the district as has needed his services. He was employed for 93 days, with seven deputies employed for 417 days, at a total cost of $1,507.50. His report only covers the period of time that service was rendered, and hence the total use made by the ditches is not shown. The season was a dry one generally, but crops were good on most farms. A shortage of fruit was caused by late frosts. All the reservoirs were emptied, and water is being used for direct irrigation even at this date.

As usual, this report does not touch the Grand Valley, where the commissioner is never needed.

From the above summary it will be seen that the division generally is not nearly covered by reports. There was no service at all in Districts Nos. 29, 31, 32, 63 and 69, all but one of these being unadjudicated. From 33, 40, 41 and 59 no reports have yet come in. In District No. 62 a few days' service was given by a deputy state engineer specially appointed to adjust the water of the Cimarron late in the season.

Generally the season has been a dry one, as far as water supply is concerned, but crops are about up to the average, with the exception of the fruit crop.

IRRIGATION DEVELOPMENT.

Two large irrigating canals, the south canal of the Reclamation project in Montrose county, and the district canal in Mesa county, have been completed during the year, and water has been turned into them during the season. The water supplied by the Government to the Uncompahgre river has been of great value during the year, such water having been rented during the latter part of the year to various ditches. A good deal of ditch building has also been going on in District No. 60 on the San Miguel river, and more is contemplated.

LITIGATION AND DECISIONS.

There has been no suit to which the irrigation officials have been made parties during the season. Three appeals have been made to me from decisions of the water commissioners. The first, from District No. 40, was an appeal against the action of the commissioner for running water under an early decree into the ditch, the claim being made that the legal owners of the water were not using it; that the right had been abandoned; that the ditch had been abandoned; that the water was being conveyed from the ditch into another ditch from another water shed and used on new land; and that the water was being wasted. I sustained the commissioner in turning the water into the ditch, after getting a report fromhim that it was not being wasted and ordering him to see that it was not. I did not consider that any of the other questions raised could be determined by the irrigation officials. On appeal to you the only question raised was apparently the one as to whether or not there was waste, and your decision left that question to the water commissioner and sustained my order.

The second, from District No. 41, was against the action of the commissioner in refusing to turn into a ditch water claimed by certain parties on the ground of development, said water being turned into the Uncompahgre river through various ditches or drains and gullies from certain springs and marshy ground adjoining the river. On the ground that he personally knew that some part of the water had previously reached the river in open channels continuously and that he was unable to determine to what, if any, extent the continuous flow of the river had been increased by the drainage work done, the commissioner refused to allow any water to be taken from the river until the matter had been decided by the court. On appeal, basing my decision on personal knowledge of the flow of some of the gullies, and after examining the ditches at the request of the parties, I sustained the commissioner. On appeal to you our decision was sustained.

The third, from District No. 42, was against a decision of the commissioner refusing to recognize the claim of the town of Palisade for water under Decree No. 1 from Rapid creek, to be used for domestic use, the town having acquired by condemnation the right under a decree which entitles the claimants to the use of water for agricultural use, the proceeding being one to which only the owners of the particular right condemned were made parties, no decree being given in any way amending the original decree. The commissioner also decided that as the decree was in part absolute and in part conditional he would only deliver the amount of water absolutely decreed, in the face of objection from other priority owners on the stream. On appeal to me I sustained the commissioner in refusing to allow a change in the character of use in the absence of any decree recognizing the right to the new use, but I reversed him as to the amount to be delivered for agricultural use. It being the fact that no other rights on the stream had ever been absolutely determined, it appeared to me that the commissioner should follow the decree which numbered the conditional priorities until such rights were absolutely determined, provided that the claimants had sufficient acreage. This case was not appealed to you, but will, I understand, be taken into the courts.

I do not think it necessary to refer to matters which I touched upon in my last annual report, or important to make any recommendations at this time.

Very respectfully,

(Signed) ARTHUR H. STOKES,
Irrigation Division Engineer, Division No. 4.

ANNUAL REPORT OF IRRIGATION DIVISION ENGINEER, DIVISION NO 5, FOR 1909.

State Engineer, Denver, Colorado. Glenwood Springs, Colorado, November 30, 1909.

Dear Sir—I herewith submit my annual report for the irrigation season of 1909:

Division No. 5 comprises, perhaps, the best watered section in the whole State, and this fact was the more emphasized during the last season, owing to the abundance of snow reserves from the winter seasons of 1906-1907, 1907-1908, the heavy snowfall of 1908-1909, and the frequent rains during the spring and summer of 1909.

Such favorable circumstances tended to allow the season to pass without any trouble on account of scarcity of water, although the action by some individuals was, in some instances, subversive to sound irrigation policy. One of these cases was later the subject of a jury trial, but resulted in the acquittal of the defendant. It appears that the owners of the Rockford ditch, in District No. 38, which is used for irrigation and also for the domestic supply of the town of Satank, had previously allowed a party without vested rights in the ditch to use a small amount of water for irrigation, for which privilege he was to help in the cleaning of the ditch. Whether such practice impressed him with a sense of ownership does not appear, but during the last spring he dammed up the ditch, thereby depriving the owners below of the needed supply, and when the owners tried to remove the obstructions in the ditch they were shot at from ambush four times by the former party. A jury of twelve men, good and true, acquitted him, and this verdict seems to have encouraged one of the co-owners in the Weible ditch, in District No. 45, to forcibly eject from his premises another co-owner who happened along for the purpose of ascertaining the cause of shortage of water in his portion of the ditch. This ejection was enforced by the aid of an automatic pistol, and later on considered by the ejector justified on account of the fact that he claimed the right to exclude any party from any point along the ditch upon his premises. Suit has been started in this case, but has not been decided at the time of the writing of this report.

Jury verdicts of this sort cause irrigation officials to feel wearied, but as long as there are laws in existence making such verdicts possible, further comment is superfluous.

The abundance of water during the season has given cause for wasting in some localities, and notably in the section watered by Sopris and Capitol creeks, in Water District No. 38, it became necessary to warn water users from wasting water. The county commissioners of Pitkin county issued a notice to that effect, since their roads were considerably damaged, and I co-operated with them by publishing a separate notice, wherein the consequences of wilful waste were set forth. Since then no complaint has been heard from that quarter.

As long as water consumers are human, sordidness, jealousy, and perhaps lack of understanding of the principles of economic irrigation, will interfere with an ideal administration of irrigation laws. It should also be noted that the present method of appointing water commissioners is susceptible of improvement, and in fact seems to call for a radical change. The various division superintendents, prior to 1903, and later on their successors, the division engineers, have for years recommended such a change. In this connection I wish to point out that the preparation of reports and the payment for the time consumed in this work does not seem important enough to some boards of county commissioners to allow the bills resulting from such preparation.

Another cause for these laches may be found in the fact that the report of commissioners on cultivated areas under certain ditches does not corroborate the statements of water users in their tax schedules, and gives the faithful assessor cause for adding to an already unwelcome land tax.

The policy of the administration of withdrawing fertile areas for reclamation purposes is restricting settlement, notably along and on the mesas above the Grand river, and I trust that concerted action by the legislative branches of our State government will influence our representatives in Congress to have withdrawal orders rescinded and prevent further withdrawal orders.

Numerous large and smaller projects of irrigation by reservoirs have been filed in your office and the United States District Land Offices within this division.

The largest of these projects are, perhaps, the Great Northern and the Yellow Jacket reservoir systems; also the Marvine and other natural lakes have been chosen for reservoir sites; some power projects are planned but withal tentatively only.

The work at the Central Colorado Power Company's Shoshone plant is being continued, and at this writing the permanent intake dam is under construction.

Another important irrigation project, the Spring Park Reservoir System in District No. 38, has been under consideration for some time. This reservoir is capable of furnishing 22,000 acre-feet for an area situate in Garfield and Eagle counties.

The work on the Battlement storage reservoirs, in District No. 45, has progressed during this season, and the owners intend to complete construction in 1912.

The Antlers Orchard Development Company has lately stopped construction work on the Grass Valley canal and Antlers reservoir, in District No. 39, on account of the severity of the weather, but work will continue next season.

The Grand Valley Irrigation & Development Company, in the same district, have had their whole holdings surveyed by plane table, and intend to start construction on an extensive pumping plant and on reconstruction of the entire Willcox canal during 1910.

I have received a number of copies of decrees rendered by the District Court of the Judicial District No. 9. These decrees, in common with all the old ones issued prior to 1909, will be codified so that one series of numbers are given to priorities, another series to ditch numbers, and still another series will show at a glance the succession of priorities of ditches out of one and the same stream. Each water district will be codified in this way, and this will be of the greatest help to irrigation officials and water users.

The crops throughout Division No. 5 have been eminently satisfactory this season, both in quantity and quality, although frequent rains in July and August interfered with harvesting and blackened the cut grasses and alfalfa, without, however, doing any damage.

No notable change of cultivation took place, although sugar beets do not show the increase the advocates of this product expected. Potatoes were the banner crop in District No. 38, yielding as much as 7½ tons per acre on large areas. But in District No. 45 potatoes have also been planted in preference to sugar beets in some instances, and have yielded large crops. With some of the farmers this change was largely an experiment, but the returns satisfied their expectations.

A tabulated statement of crop reports is herewith attached.

Very respectfully,

(Signed) THEODORE ROSENBERG,
Irrigation Division Engineer, Division No. 5.

IRRIGATION DIVISION NO. 5.

SUMMARY OF WATER COMMISSIONERS' REPORTS FOR THE IRRIGATION SEASON OF 1909.

Number of District	Alfalfa	Natural Grasses	Cereals	Orchards	Market Gardens	Potatoes	Sugar Beets	Misc. Crops	Total Irrigated	Not Classified Herein
37	3,568	280	1,464	....	....	141	....	13	15,140	3,047
39	6,330	6,672	1,928	23,245	253.5	1,462	267	126	19,363	....
45	10,391	1,307	3,415	1,117	110	970	280	107	17,679	....
53	1,714	3,480	266	....	5.5	5.5	....	....	5,471	....
58	2,812	18,502	5,020	....	26	70	2	54	26,486	....
70	1,746	68	753	353	12	45	1	164	3,442	....
	26,561	30,309	12,846	3,794.5	407	2,693.5	550	464	87,599	....

Annual Report of Irrigation Division Engineer, Division No. 5, for 1910.

Glenwood Springs, Colo., November 30, 1910.

State Engineer, Denver, Colorado.

Dear Sir—I herewith submit my annual report for the irrigation season of 1910, in Division No. 5.

This report contains some recommendations which also appear in my report for 1909. Where such repetitions occur they have been made inadvertently, but some of these recommendations cannot be repeated too often. In intercourse with other Division Engineers, I am made aware that they coincide with me, and if it is possible, it is expected that your office will endeavor to bring about certain changes which will doubtless make for the improvement in existing laws and regulations concerning this sphere of action and authority of the various grades of irrigation officials. If I have not been able to render a more complete report, the cause of the incompleteness is largely chargeable to the incompleteness of these laws and regulations.

I trust that in coming years these matters will be improved.

WATER DISTRICT NO. 37.

Appropriations in cubic-second feet	352.15
Capacity of ditches	461.90
Length of ditches in miles	62.10
Length of laterals in miles	6.45
Water used from April 1 to September 1	...
Average number of days of use of water during irrigation season	67
Average amount of water used during season in cubic-second feet	305.00
Acre-feet used from ditches	42,120.00
Acreage under irrigation	15,225.00
Total acreage that can be irrigated	19,420.00

	Acres	
Alfalfa	9,600	
Natural grasses	2,910	
Cereals	1,521	
Potatoes	1,173	
Miscellaneous	21	
Total		15,225

This shows a duty of 2.77 acre-feet per irrigated acre. The season was late throughout District No. 37, but farming was carried on extensively, and during the first half of the season the supply was sufficient. The drought during the latter part of the irrigation period caused some slight damage, but rains during August evened up matters. On the whole the irrigated area in this district shows a slight increase over that of 1909.

WATER DISTRICT NO. 38.

Appropriations in cubic-second feet	390.00
Capacity of ditches	687.00
Length of ditches in miles	284.70
Length of laterals in miles	39.08
Water used from May 1 to September 5	...
Average number of days of use of water during irrigation season	68
Average amount of water used during season in cubic-second feet	409.5
Acre-feet used by ditches	56,700.00
Acreage under irrigation	18,482.00
Total acreage that can be irrigated	26,208.00

	Acres	
Alfalfa	9,087	
Natural grasses	1,443	
Cereals	5,105.3	
Orchards	66.3	
Gardens	23.4	
Potatoes	2,757	
Total		18,482

The duty in this district would be 3.067 acre-feet per acre irrigated. This district is watered by the Roaring Fork river and its tributaries, the whole drainage area being favored with a uniform supply throughout the season, except in the case of some very small streams. Where ditches were taken out of the Roaring Fork, some waste was observed; and as it worked detrimental to roads the commissioner's warning to users was necessary to stop the waste in aggravated cases.

The following districts have not furnished complete reports, and I summarize crop statements only:

WATER DISTRICT NO. 39.

	Acres
Alfalfa	6,500
Natural grasses	6,890
Cereals	2,020
Orchards	2,570
Market gardens	261
Potatoes	1,949
Sugar beets	243
Miscellaneous	352
Total	20,785

From measurements of areas under ten ditches Main, West and Government Forks of Rifle Creek, and gaugings of these creeks from June 28th to July 15th, I find that a total of 3,257 acres was abundantly irrigated during that period by an average of 36.62 cubic second-feet; hence the water duty was 0.59 cubic-second feet per irrigated fifty acres. When compared with duties in other districts the difference is striking; and although it is well known that this particular part of District No. 39 has been intensively and continuously farmed for the last twenty years, and on account of the large yields, and consequent higher price of land, the maintenance of ditches is perhaps of a higher order than elsewhere in the district, yet it is remarkable to find this low duty sufficient for the needs of the consumers.

In this connection, I wish to recur to the need of gauging of creeks, on which subject I have your instructions. Wherever gauging stations can be maintained, even for a comparatively short period during the irrigation season, the results amply justify the expense. With the contraction of irrigable areas and the sub-division into small tracts of the larger holdings, it is of the greatest importance to convince the individual water user that economy in irrigation is a prime necessity, and sure to give good results. Throughout the division, the desire to use all the water that is adjudicated, regardless of results, is observable. Strange to say, during the past season when in general there was a short supply of water, the crops did not seem to suffer so much from that cause as from the cold spring weather. And I have examined on several occasions fields of irrigated cereals, for instance, which showed the bad effects of a glutting policy, while the crop next adjoining, with very scant irrigation, was healthy, abundant and withal seasonable.

WATER DISTRICT No. 58.

	Acres.
Alfalfa	3,000
Natural grasses	19,000
Cereals	5,200
Market gardens	35
Potatoes	125
Sugar beets	2
Miscellaneous	75
Total	27,437

No other data from this district are available at this time.

WATER DISTRICT No. 70.

	Acres.
Alfalfa	1,820
Natural grasses	75
Cereals	804
Orchards	409
Market gardens	14
Potatoes	76
Sugar beets	18
Miscellaneous	176
Total	3,392

A slight increase of the areas in potato crops is noticeable in Districts Nos. 39, 45 and 70, while the last season's experience of the farmers in District No. 38, especially along the Roaring Fork river and its tributaries, did not tend to a proportional increase in potato cropped portions.

WATER DISTRICT No. 43.

Appropriations in cubic-second feet	581.06
Capacity of ditches	...
Length of main ditches in miles	209.30
Water used from April 25th to September 1st	...
Average time of use of water from ditches during irrigation season, days...	72.40
Average daily amount of water in cubic-second feet used during season	357.60
Acre-feet used by ditches	74,780.00
Total acreage that can be irrigated	...
Total acreage irrigated during season	23,162

	Acres.
Alfalfa	10,042
Natural grasses	9,578
Cereals	2,797
Orchards	15
Potatoes	66
Sugar beets	2
Other crops	642
Total	23,162

Superintendence	$ 690.00
Repairs	4,205.00
Improvements	6,625.00

This shows a water duty of very nearly 3.22 acre-feet per acre irrigated.

The cost of maintenance was $23.38, and that of improvements $31.65 per mile of main line of ditches. (No laterals are reported.) This commissioner's report, while lacking in certain details, gives on the whole a fair picture of the vital points of irrigation in District No. 43.

It is interesting to note the cost items. No reservoirs appear in this report. The commissioner evidently found it inadvisable to estimate the total area that can be irrigated in his district, as, in fact, such estimates can only be based on detailed measurements of the affected tracts.

In connection with this subject it is well to point out that the adjudications are generally based on the area which the applicant claims he can put under ditch, which, in most petitions, comprises the whole area of the land owned by the applicant, regardless of barren and high portions.

Almost all such claims for water rights suffer from this defect. Perhaps one applicant in fifty really measures his irrigable land, or has a survey of it made, and it is my experience that litigation arises from such neglect. I refer to this subject elsewhere.

WATER DISTRICT No. 44.

Appropriations in cubic-second feet	317.68
Capacity of ditches	234.20
Length of main ditches in miles	193.00
Length of laterals in miles	42.00
Water used from April 1st to September 1st	......
Average time of use of water from ditches during irrigation season, days.	70
Average time of use of water from reservoirs during irrigation season	......
Capacity in cubic-feet of reservoirs	70,131,600.00
Average cubic-feet of water carried daily by ditches during season	260.00
Acre feet carried by ditches	36,400.00
Total acreage that can be irrigated	28,370.00

	Acres.
Alfalfa	5,275
Natural grasses	5,700
Cereals	1,549
Potatoes	57
Total	12,581

Cost of repairs	$ 3,625.00

The duty in this district would be very near 2.9 per acre. Reservoirs are reported with total capacity of 1,612 acre-feet, and apparently a total use of 249.47 acre-feet of water, twenty acre-feet of the latter quantity being used for stock watering only. Reservoir dams (3) are from twelve to twenty-two feet high, and from 200 to 500 feet long; one is of rock and two of earth construction, and their outlets are from 48 to 120 square inches. No time of use of reservoir water is reported. The duty per acre in this district as given above may be increased, but on the whole is doubtful, yet it could not be assumed to be applied carelessly or wastefully, all conditions considered.

WATER DISTRICT No. 53.

Appropriations in cubic-second feet	185.7
Capacity of ditches	234.2
Length of main ditches in miles	62.85
Water used from May 1st to September 1st	......
Average time of use of water from ditches during irrigation season, days	66
Average time of use of water from reservoirs during irrigation season, days	11
Average cubic-second feet of water carried from reservoirs	31.00
Average cubic-second feet of water daily from ditches during season	126.00
Acre-feet used by ditches	22,658.00
Acreage that can be irrigated	6,427.00

	Acres.
Alfalfa	1,292
Natural grasses	3,195
Cereals	159
Orchards	1
Gardens	1½
Potatoes	½
Pastures	1,160
Total	5,809

The duty would, from this statement, appear to be 3.6 acre-feet per acre, provided the pastures are not irrigated. The short season perhaps explains this low duty.

Nearly fifty per cent of the water was lost by seepage and evaporation, which would be, in fact, a smaller loss than previously reported by other observers. In this district there are located nine reservoirs, of which six are formed by natural lakes, all having earth dams from six to eighteen feet high, and have outlet tubes with from four to eight inches diameter. The crest length of dams run from fifty to two hundred and fifty feet, and their total capacity is 1,328 acre-feet, varying from nineteen to one hundred and forty-seven acre-feet. All dams are reported to be in good condition.

WATER DISTRICT NO. 45.

Appropriations in cubic-second feet	338.80
Capacity of ditches in cubic-second feet	334.33(?)

	Acres.
Alfalfa	9,829
Natural grasses	1,370
Cereals	4,088
Orchards	1,866
Gardens	125
Potatoes	854
Sugar beets	49
Total	18,181

Lacking further information regarding water duty and using the figures for appropriation as above, the duty for 50 acres would be 0.934 cubic-second feet. Note in connection herewith duty of stated area on Rifle Creeks in District No. 39.

Now District No. 45 lacked considerable this last season of its supply in normal years, and from personal examination I learned that shortage of water forced economy, therefore I conclude that here, too, the lower duty was really employed.

The situation on Wallace Creek (in District No. 45) makes it advisable to comment on the experience of last season.

First—From all I can learn and from my own unprofessional interpretation, I am forced to conclude that all the ditches out of Wallace Creek, whether supplying lands in Garfield or Mesa county, are really in District No. 45, and although the District Court of Mesa county has in some cases assumed jurisdiction in the matter of water rights out of Wallace Creek, as affecting people in Mesa county solely, a careful perusal of section 2357, defining the boundaries of District No. 45, will show that the instruction to assume authority over ditches there was based on some sound law.

The matters pertaining to my work there are subject to law suit, and it appears expedient to forego further observations on the subject.

But one thing has been clearly demonstrated in this matter—namely, the appointment of deputies by the water commissioner leads to circumlocutory procedure in cases where quick and decided action is necessary, which is greatly to the detriment of the irrigation service.

I, therefore, respectfully recommend that either instructions issue from your office regulating this custom satisfactorily, or that legislative aid be invoked to abolish a most deplorable state of affairs.

The decision of the State Supreme Court in the case of Drach, Administrator for the State, and H. G. Hammerich et al. vs. H. Rohwer et al., has been of the greatest importance. The term what is "reasonable diligence" has been defined in this decision as to a specific number of years. Whether the period named will affect all the other similar cases, or has only bearing in this particular suit, remains to be seen.

The Central Colorado Power Company is now fully equipped at its plant at Shoshone Falls, ten miles east of Glenwood Springs. Scouring action on the concrete lining of the tunnel has lowered the factor "N" so as to produce the calculated mean of discharge at 1,250 cubic-second feet. On June 20, 1910, the recorded velocity was 8.9 feet per second, producing a peak load capacity of 14,000 K. W.

In conclusion, I earnestly recommend the repeated urgency in the matter of a different way of appointment of water commissioners, under a modus which will insure more effective service, with a condition as to qualification of the appointed official, annual salary, and prompt reports.

Very respectfully,

(Signed) THEODORE ROSENBERG,
Irrigation Division Engineer, Division No. 5.

IRRIGATION DIVISION NO. 5.

PART OF WATER DISTRICT NO. 39.

CANALS AND DITCHES.

TABLE SHOWING DAILY FLOW OF WATER IN CUBIC FEET PER SECOND AND NUMBER OF ACRES WATERED PER SECOND FOOT.

NAME	JUNE, 1910						JULY, 1910											
	28		29		30		1		2		3		4		5		6	
	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.
Rifle Canon Lat.	3.8	73.7	3.8	87.8	3.8	72.6	4.3	66.6	3.8	72.6	3.9	72.2	3.9	59.3	3.7	62.0	3.4	62.7
Rifle Canon	16.8		13.5		18.5		18.5		18.5		18.5		21.7		20.8		20.8	
Grand Tunnel	12.1	70.0	12.6	67.5	12.6	67.5	9.5	89.1	8.0	106.0	10.0	84.7	10.5	80.7	12.6	67.5	12.1	70.0
Raynard & Menard	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4	2.5	106.4
Wisdom & Parker	2.8	76.8	2.8	76.8	2.8	76.8	2.8	76.8	2.8	76.8	2.5	86.0	2.8	76.8	2.6	82.7	2.8	76.8
Austin	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0
Blevins	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	18.5	.7	28.5	.7	28.5	.7	28.5
Town Ditch	.0		.0		.0		.0		.0		.0		.0		.0		.0	
Squires	.5	36.0	.7	25.7	.7	25.7	.8	22.5	.6	30.0	.9	20.0	.8	22.5	.5	36.0	.5	36.0
Pioneer	4.0	74.0	4.0	74.0	4.0	74.0	5.2	50.7	5.2	50.7	5.6	53.0	6.8	43.7	6.0	49.5	5.2	50.7
Total	44.7		42.1		47.1		45.8		43.6		46.1		51.2		50.9		49.5	

IRRIGATION DIVISION NO. 5.
PART OF WATER DISTRICT NO. 39.

CANALS AND DITCHES—Concluded.
TABLE SHOWING DAILY FLOW OF WATER IN CUBIC FEET PER SECOND AND NUMBER OF ACRES WATERED PER SECOND FOOT.

NAME	JULY, 1910																		Daily flow averaged for 18 readings
	7		8		9		10		11		12		13		14		15		
	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	Cubic feet per sec.	Acres irrig. per sec. ft.	
Rifle Canon Lat.	2.0	66.6	2.0	74.1	2.7	101.3	3.9	67.8	3.9	57.3	4.7	56.9	3.4	69.4	5.3	64.3	4.2	70.0	3.8
Rifle Canon	20.8		18.5		12.2		18.5		22.6		22.0		18.5		18.3		17.5		18.8
Grand Tunnel	11.5	73.6	7.6	111.4	13.7	61.9	13.7	61.9	11.5	73.6	9.5	89.1	9.5	89.1	10.0	84.7	10.5	80.7	10.9
Raynard & Menard	2.5	106.4	2.5	106.4	3.0	83.3	3.0	83.3	3.0	83.3	3.0	83.3	3.0	83.3	3.0	83.3	3.8	67.4	27.5
Wisdom & Parker	2.5	86.0	2.5	86.0	1.0	21.5	1.0	21.5	.7	30.7	.7	30.7	.7	30.7	.7	30.7	.7	30.7	18.5
Austin	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.5	48.0	1.7	48.0	1.5	48.0	1.5
Blevins	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	.7	28.5	0.7
Town Ditch	.0		.2	75.0	.2	75.0	.3	50.0	.3	50.0	.4	37.5	.4	37.5	.4	37.5	.3	50.0	0.14
Squires	.5	30.0	.8	22.5	.5	36.0	.6	30.0	.5	36.0	1.0	18.0	1.0	18.0	1.0	18.0	.0		0.63
Pioneer	4.0	74.0	2.6	114.0	4.0	74.0	4.0	74.0	3.7	80.0	3.1	96.0	3.1	96.0	2.6	114.0	4.9	60.5	4.80
Total	46.0		38.9		39.5		47.2		48.4		46.6		41.8		43.7		44.1		

IRRIGATION DIVISION NO. 5.

STREAM MEASUREMENTS.

	JUNE			JULY, 1910														
STREAM	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Rifle Creek (b).............	31.3	29.9	26.0	23.1	24.0	25.0	26.0	28.0	28.9	25.0	23.1	30.9	30.9	30.9	29.3	28.9	32.8	30.9
West Rifle (a)...............	8.0	9.0	8.0	8.0	7.0	8.0	9.0	7.5	7.5	6.7	5.9	5.5	7.0	5.9	7.0	5.5	7.0	7.0
Government Creek (c)........	0.7	-2.7	2.0	1.6	1.6	1.6	1.7	2.7	2.0	1.2	0.5	0.7	1.2	0.7	0.5	0.7	0.7	0.7
Total..................	40.0	41.6	36.0	32.7	32.6	34.6	36.7	38.2	38.4	32.9	29.5	37.1	39.1	37.5	36.8	35.1	40.5	38.6
Lower Rifle Creek Weir (d)....	0.0	1.5	1.2	0.8	0.8	0.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

AMOUNTS AND KINDS OF CROPS IRRIGATED BY VARIOUS DITCHES (IN ACRES).

	Rifle Canon	Grand Tunnel	Raynard &Menard	Wisdom & Parker	Austin	Blevins	Town	Squires	Pioneer	Total acres watered
Fruit....................................	338	242	38	32		4		6	6	666
Alfalfa....................................	641	324	149	138	72	16			113	1,453
Garden....................................	67	16	20	4			15	1		123
Potatoes....................................	203	93	30	5					48	379
Grain....................................	167	154	13	36					43	413
Beets....................................	28	12	12					11	67	130
Pasture....................................	55	6							20	81
Total..............................	1,499	847	262	215	72	20	15	18	297	3,245

CHAPTER VI.

ABSTRACTS OF REPORTS OF WATER COMMISSIONERS.

Letters asking about the reliability of water rights under various ditches, or for information as to the quantity of water available from different reservoirs, are frequently received in this office. With a view to answering as many as possible of these questions through the published report of the department, the following two series of tables have been prepared from the reports of such of the Water Commissioners as have given the necessary data.

The first series shows for each ditch to which twenty-five cubic-feet per second or more has been decreed, the first and last day on which water was used, the number of days water was carried, the average daily amount of water, the number of acre-feet used, the number of acres irrigated and the duty of water under the ditch, all for the seasons of 1909 and 1910, separately. In some instances the figures bear on their faces the evidence of unreliability, but it is believed that most of them are substantially correct. It was not thought best to omit any unless they were obviously incorrect.

The second series of tables shows for each reservoir reported, its capacity, the ditches supplied from it, and the volume of water in the reservoir on May 1 and Nov. 1 of each year of the period. The same remarks as to uncertainty of figures apply here as in the case of the ditches, but the data are the best obtainable.

DISTRICT 1. DIVISION 1.

NAME OF DITCH.	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Deuel & Snyder	45	May 10	Apr. 28	Oct. 10	Oct. 19	153	174	15	7	4,590	2,576	1,655	1,120	2.8	2.3
Johnson & Edwards	63	May 1	May 23	Sept. 30	Oct. 1	153	53	15	13	4,590	1,378	1,696	1,870	2.7	0.73
Hardin	36	June 1	June 13	Sept. 30	July 31	74	48	10.8	6	1,598	576	685	90	2.3	2.64
Tetsel	37	May 5	Apr. 20	Oct. 5	Nov. 1	154	194	19	17	5,852	6,596	950	2,000	6.2	3.3
Illinois	27	....	....	....	......	......	......	......	......	....	....	2,280	....	......	......
Putnam	40	May 5	May 8	Oct. 5	Oct. 31	154	176	17.7	11	5,451	3,872	1,520	1,900	3.6	2.04
Weldon Valley	165	May 10	May 1	Oct. 7	Oct. 15	151	164	109.9	78	33,190	25,584	6,800	7,005	4.8	3.6
Beaver	44	May 1	Apr. 15	Sept. 30	Nov. 10	137	210	12.5	7	3,415	2,996	660	1,805	5.2	1.66
Upper Platte and Beaver	214	May 10	Apr. 20	Oct. 15	*to Nov10	161	190	98	64	31,556	24,360	11,850	10,000	2.7	2.4
Lower Platte and Beaver	322	May 10	Apr. 1	Oct. 15	*to Nov10	159	192	107.9	44	34,312	16,896	13,000	....	2.6	2.0
Fort Morgan Canal	323	May 6	Apr. 5	Sept. 30	*to Nov10	148	113	183	156	54,168	43,672	12,988	10,023	4.2	4.4
Bijou D. R. and Pipe Line	30	....	....	....	....	......	......	......	......	....	....	105	....	......	......
Fort Morgan L. & R. Co.	125	May 5	....	Oct. 19	....	168	......	208	......	69,868	....	19,200	....	3.6	......
Tremont	....	May 30	Apr. 20	Oct. 22	Aug. 2	51	9	42.8	20	4,365	300	1,600	1,382	2.7	0.20
Hoover	45	....	May 20	....	Sept. 20	......	123	......	11	....	2,706	....	362	......	7.47
Bijou	56.25	....	Apr. 28	....	......	......	185	......	68	....	25,360	....	15,681	......	1.61
Corona Ranch	56	....	May 27	....	Oct. 31	......	64	......	18	....	1,908	....	702	......	2.71
Shultz	28	....	June 28	....	Aug. 7	......	40	......	6	....	178	....	800	......	0.22
Brown & Piatt	39	....	May 12	....	July 10	......	57	......	7	....	800	....	502	......	1.6
Huston	....	....	Apr. 20	....	Apr. 29	......	5	......	23	....	230	....	1,900	......	0.12
Cooper	....	....	Apr. 18	....	*to Nov10	......	174	......	5	....	1,740	....	1,700	......	1.02
Union	....	....	July 16	....	July 21	......	......	......	12	....	120	....	1,200	......	0.1

*Still using.

DISTRICT 2. DIVISION 1.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Farmers and Gardeners....	85	Apr. 13	Apr. 1	Nov. 22	Oct. 31	220	214	12	7	5,280	2,996	300	220	17.6	13.61
Burlington..............	350	Apr. 13	Mch. 26	Nov. 15	Oct. 31	179	58	109	150	39,022	17,400	12,601	11,506	3.1	1.51
Dugan..................	141	Apr. 17	Apr. 15	Nov. 16	Oct. 31	208	199	20	10	8,320	3,980	321	320	25.9	1.24
Fulton..................	528	Apr. 17	Mch. 26	Nov. 15	Oct. 31	208	218	150	75	62,400	32,700	10,382	10,015	6.02	3.26
Brantner................	129	Apr. 27	Apr. 4	Nov. 8	Oct. 31	198	210	60	84	23,760	14,200	3,598	4,355	6.6	3.27
Brighton................	124	Apr. 15	Apr. 4	Nov. 10	Oct. 31	180	210	36	20	12,960	4,400	2,319	2,210	5.6	1.99
Lupton Bottom...........	197	May 10	Apr. 26	Nov. 6	Oct. 31	175	190	34	34	11,900	10,920	3,107	2,165	3.83	5.04
Platteville.............	187	Apr. 15	Apr. 25	Nov. 17	Oct. 31	214	190	70	45	29,960	16,020	3,425	3,425	8.75	4.67
Ellwood.................	126	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Farmers' Independent.....	498	May 1	Apr. 20	Nov. 15	Oct. 31	200	194	84	58	33,600	22,900	6,700	6,210	5.01	3.68
Meadow Island No. 1......	49	May 22	May 19	Oct. 31	Oct. 15	173	68	18	18	6,228	2,448	1,679	1,535	3.7	1.6
Meadow Island No. 2......	66	May 14	May 13	Oct. 31	July 31	166	33	12	9	3,988	594	815	680	4.89	1.48
Beeman..................	127	May 9	Apr. 13	Oct. 31	Aug. 24	175	92	14	9	4,900	1,656	839	745	5.96	2.22
Hewes & Cook............	155	May 14	Apr. 20	Nov. 1	Oct. 31	168	194	58	38	19,488	14,744	3,895	3,415	5.05	4.31
Hodgson.................	94	June 1	Apr. 20	Sept. 1	Oct. 8	69	170	2	1	276	560	262	256	1.05	2.18
Lower Latham............	360	May 10	Apr. 20	Nov. 1	Oct. 31	186	194	108	40	40,176	15,520	5,839	7,940	6.88	1.95
Sec. No. 3...............	127	May 20	May 28	Oct. 27	Oct. 28	165	154	46	29	15,180	8,932	1,420	1,380	10.7	7.2
Patterson...............	111	May 31	July 1	Oct. 12	Oct. 29	134	150	15	16	4,020	4,800	1,290	1,280	3.11	3.75
Evans No. 2.............	409	May 6	Apr. 5	Sept. 30	Oct. 31	147	76	95	72	27,930	10,944	5,290	5,095	5.20	2.14
Big Bend................	108	June 7	......	Oct. 10	......	147	......	4	......	1,176	......	210	......	5.6	......
Union...................	187	May 6	Apr. 6	Nov. 1	Oct. 21	184	196	100	67	39,744	24,264	3,475	3,550	11.43	6.82
Wyatt...................	86	June 1	......	Aug. 20	......	75	......	9	......	1,350	......	190	......	7.1	......
Buckers.................	108	May 1	Apr. 18	Sept. 16	Aug. 13	140	43	48	32	15,440	2,752	2,005	4,040	7.7	0.68
Jay Thomas..............	139	May 17	July 1	Aug. 27	Oct. 16	103	100	8	5	1,648	1,080	220	306	5.15	3.52
Highland................	104	......	June 16	......	Oct. 6	......	113	......	15	2,590	......	......	575	......	4.50
Lupton Short Line.......	......	May 1	Apr. 10	Nov. 11	May 19	180	49	30	13	10,800	1,274	1,090	220	10.00	5.79

DISTRICT 3. DIVISION 1.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used 1909	First day water used 1910	Last day water used 1909	Last day water used 1910	Number days 1909	Number days 1910	Average daily amount 1909	Average daily amount 1910	Acre-feet 1909	Acre-feet 1910	Acres irrigated 1909	Acres irrigated 1910	Duty 1909	Duty 1910
Dry Creek...............	50.92	May 10	Apr. 11	Nov. 1	Nov. 9	174	214	25	16	8,700	6,791	2,200	2,300	3.78	2.94
Pleasant Valley..........	138	Apr. 28	Mch. 15	......	Sept. 20	......	71	57	42	......	14,245	7,000	7,000	......	2.03
Boyd & Freeman..........	99	July 30	June 17	Sept. 6	Sept. 11	38	82	8	9	608	1,464	700	700	0.87	2.09
Whitney.................	61	May 17	Apr. 28	Sept. 6	Sept. 20	110	92	25	24	5,500	4,377	3,500	7,500	2.2	1.75
B. H. Eaton..............	41	July 24	May 27	Sept. 6	Sept. 20	44	117	14	11	1,232	2,553	1,100	1,100	1.12	2.23
Larimer & Weld..........	720	May 15	May 3	Sept. 11	Oct. 24	116	175	......	83	......	48,895	47,000	50,000	......	0.97
J. G. Coy................	31	July 14	Apr. 12	Sept. 5	Sept. 21	53	129	......	9	......	2,303	290	290	......	7.94
Box Elder...............	52.7	May 19	May 28	Oct. 20	Sept. 22	154	105	......	20	......	4,119	2,000	2,000	......	2.5
Josh Ames...............	36	June 10	Apr. 27	Sept. 1	Aug. 20	65	81	4	4	520	643	710	710	0.73	0.9
Bristol, Nos. 1 and 2......	30	Apr. 15	......	Sept. 10	......	148	......	5	......	1,480	......	900	1,420	1.64	......
Cache la Poudre Irrigation.	82.5	Apr. 28	Apr. 20	Nov. 1	Sept. 28	187	125	15	22	5,610	5,457	1,600	1,600	3.12	3.41
Fort Collins Canal........	130	Apr. 20	Apr. 5	Sept. 20	Sept. 23	151	170	......	11	......	3,709	3,600	3,600	......	1.03
New Mercer...............	163	Apr. 28	Apr. 24	Sept. 13	Sept. 27	139	95	50	21	13,900	3,967	6,700	6,700	2.08	0.59
Canal No. 3..............	173	Apr. 26	Apr. 11	Oct. 5	Oct. 10	152	183	48	39	14,592	14,156	4,200	4,200	3.47	3.37
Cache la Poudre Irr. Co....	585	May 7	Apr. 21	Sept. 23	Oct. 3	171	139	217	154	74,214	58,528	35,000	36,000	2.12	1.16
Burnham & Emerson......	26	......	......	......	......	......	......	......	......	......	......	300	330	......	......
Lake Canal..............	158	May 19	Apr. 30	July 30	June 16	72	48	......	60	......	7,296	8,000	8,000	......	0.91
Larimer Co. Canal No 2...	175	May 1	Apr. 21	Sept. 12	Oct. 16	135	157	......	26	......	8,096	7,200	7,200	......	1.12
Larimer Co...............	463	May 11	Apr. 23	Oct. 29	Oct. 14	172	174	320	117	110,080	45,110	42,000	42,000	2.62	1.07
Ogilvy..................	57.6	......	......	......	......	......	......	......	......	......	......	4,000	4,000	......	......
Emerson Bros............	30	......	......	......	......	......	......	......	......	......	......	......	350	......	......

DISTRICT 4. DIVISION 1.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Handy	192	Apr. 16	Apr. 7	Oct. 30	Nov. 1	185	176	72	29	26,640	10,208	12,600	12,635	2.11	0.80
Home Supply	278.84	Apr. 18	Apr. 7	Nov. 1	Nov. 15	190	201	57	27	21,660	10,854	21,340	21,365	1.01	0.50
South Side	50.3	May 20	May 12	Nov. 15	Oct. 17	166	148	7	6.3	2,324	1,874	3,095	3,111	0.75	0.6
Loudon	317	May 16	Apr. 14	Nov. 15	Nov. 14	181	212	45	20	16,390	8,480	15,405	15,230	1.05	0.55
Barnes	43.5	Apr. 16	Apr. 7	Nov. 15	Nov. 14	203	153	94	16	38,164	4,896	1,955	1,955	19.5	2.5
Greeley and Loveland	381	May 12	Apr. 7	Nov. 3	Nov. 14	156	155	118	29.5	36,816	9,146	19,405	19,405	19	0.47
George Rist	196	Apr. 16	Apr. 9	Nov. 15	July 30	146	62	16	50.5	4,672	1,922	4,890	4,915	0.95	0.37
Big Thompson Mfg. Co.	66	Apr. 18	Apr. 27	Nov. 15	Oct. 17	119	141	17	14.3	4,046	4,042	1,960	2,125	2.06	1.9
Farmers	164	May 18	May 7	Sept. 8	Sept. 28	106	93	11	11	2,332	2,046	4,105	4,105	0.56	0.49
Hillsboro	248.25	May 14	Apr. 10	Oct. 1	Oct. 8	130	177	42	48.5	10,920	17,168	9,450	9,450	1.15	1.81
Hill & Brush	61	July 15	Apr. 27	Aug. 29	Nov. 14	47	137	15	7	1,410	1,918	1,470	1,970	0.96	1.3
Big Thompson and P. Val.	124	June 1	May 15	Aug. 29	Nov. 14	92	184	31	21	5,704	7,728	1,760	1,760	3.24	4.38
Rist & Goss	65	June 1	June 1	Aug. 8	Aug. 8	100	69	4	3	800	414	435	395	1.84	1.05
Osborn & Caywood	19.76	June 5	May 5	Sept. 10	July 4	98	61	4	2.5	784	....	375	....	2.09	......
Culver & Mahoney	38	May 15	May 21	Sept. 12	June 20	121	31	6	2	1,452	....	400	400	3.63	......
Boulder & Larimer Co.	66.72	June 15	....	Sept. 25	....	103	......	5	......	1,030	....	375	....	2.75	......

DISTRICT 5. DIVISION 1.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used 1909	First day water used 1910	Last day water used 1909	Last day water used 1910	Number days 1909	Number days 1910	Average daily amount 1909	Average daily amount 1910	Acre-feet 1909	Acre-feet 1910	Acres irrigated 1909	Acres irrigated 1910	Duty 1909	Duty 1910
South Ledge	31	May 25	Apr. 28	Nov. 11	Sept. 29	104	44	8.9	4.8	1,851.2	490	7,070	320	2.4	1.53
Supply	92.2	Apr. 28	Apr. 19	Oct. 30	Oct. 19	157	120	3.8	24	11,932	5,712	7,081	3,892	1.68	1.5
Highland	229	May 2	Mar. 18	Oct. 31	Oct. 14	178	183	137	51.3	48,772	18,620	29,808	21,150	1.63	0.88
Rough and Ready	83.3	May 11	Apr. 12	Oct. 31	Oct. 6	155	166	29	24.3	8,990	7,981	6,000	6,500	1.5	1.23
St. Vrain and Palmerton	164.31	Apr. 17	Apr. 15	Oct. 2	Oct. 16	136	174	10.7	16	2,910.4	5,521	2,715	2,990	1.07	1.84
Longmont Supply	53.37	May 9	Apr. 24	Oct. 7	Oct. 6	109	160	12.65	11.2	2,758	3,454	3,365	3,435	0.84	1.03
Chapman	98.13	June 20	May 19	Sept. 11	Aug. 31	84	65	3.3	2.5	554.4	330	395	430	1.4	0.76
Oligarchy	237.51	Apr. 26	Mch. 18	Oct. 14	Oct. 15	172	185	40.6	23.3	13,966.4	8,526	5,055	3,363	2.76	2.53
Goss No. 1	25.11	June 21	June 1	Sept. 4	Oct. 15	63	32	4.7	4.3	592.2	271	300	300	1.97	0.9
James	27.11	May 24	Apr. 29	Oct. 16	Oct. 8	141	163	5	4.3	1,410	1,309	2,618	1,600	0.53	0.81
Zweck & Turner	82.61	June 21	May 12	Nov. 5	Oct. 8	122	140	5	4.6	1,220	1,277	545	565	2.4	2.26
Pella	42.64	June 3	....	Oct. 31	....	148	......	11	......	3,256	....	2,990	....	1.16	......
Ni Wot	29.24	June 3	Apr. 30	Oct. 31	Sept. 7	139	107	8.8	5.8	2,446.4	1,509	745	745	3.28	2.02
South Flat	71.43	June 13	May 11	Oct. 23	Oct. 14	133	116	5.4	4.7	1,436.4	1,081	815	890	1.76	1.21
Last Chance	96.94	May 25	June 6	Oct. 1	Sept. 10	130	97	36	24.8	9,360	4,771	2,720	2,720	3.44	1.75
Coffin & Davis	30	June 10	June 3	Aug. 6	Aug. 22	44	44	6.7	5	589.6	436	480	450	1.23	0.97
Denio & Taylor	41.8	....	June 3	....	Sept. 24	......	78	......	2	....	309	....	800	......	0.38
Left Hand	....	....	May 10	....	Oct. 20	......	162	......	40	....	16,960	....	15,300	......	1.1

DISTRICT 6. DIVISION 1.

NAME OF DITCH	Amount of appro-priation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
S. Boulder and Clear Creek	53.55	May 15	....	Aug. 27	....	64	......	15.3	......	1,958	....	2,254	....	0.86	......
Community	85	Apr. 20	June 1	Sept. 12	June 24	58	5	83.1	53.8	9,640	538	10,310	10,185	0.93	0.05
Davidson	221.35	May 19	May 21	Aug. 28	Aug. 14	72	35	34.8	50.4	5,011	3,528	6,400	7,855	0.78	0.5
Goodhue or Rock Creek	120	May 12	May 28	Sept. 21	Aug. 7	83	24	40.1	39.4	6,657	1,891	7,200	7,225	0.92	0.26
S. Boulder and Bear Creek	16.60	May 19	May 18	Sept. 12	Aug. 13	108	61	3.5	5	756	610	1,040	1,050	0.72	0.58
Dry Creek No. 2	69	May 12	May 18	Sept. 12	Aug. 8	115	68	7.3	6.1	1,679	829.6	1,245	1,265	1.34	0.65
Marshallville	47.76	May 19	May 28	Sept. 18	Sept. 25	83	55	17.3	13.3	2,872	1,463	1,415	1,465	2.02	1.0
S. Boulder Canon	218.37	May 19	May 8	Sept. 18	Sept. 26	102	65	21.3	17.7	4,345.2	2,301	2,980	8,925	1.5	0.8
McGinn	18.5	May 10	May 19	Sept. 12	Sept. 15	103	137	6.9	3.3	1,421.4	9,044	955	925	1.48	0.97
Howard	36	May 19	May 15	Sept. 12	Sept. 18	103	179	6	5.6	1,239	2,005	1,005	1,045	1.23	1.91
East Boulder	228.5	May 19	May 15	Sept. 12	Sept. 15	84	135	6.7	4.8	1,125.6	1,290	857	840	1.31	1.54
Jones & Donnelly	14.26	May 10	May 15	Aug. 20	Sept. 25	52	140	1.1	1.6	114.4	448	187	203	0.61	2.2
Enterprise	128	May 24	May 19	Sept. 12	Sept. 23	98	104	6.2	6.1	1,215.2	1,268.8	935	935	1.3	1.35
Cottonwood No. 2	33.7	June 3	May 25	Sept. 11	Sept. 23	86	114	6.6	5.4	1,135.2	1,231	505	505	2.25	2.4
Leyner & Cottonwood No. 1	7.3	June 10	June 30	Sept. 12	Aug. 17	87	58	17.3	18.2	3,010.2	2,109.6	3,045	2,985	0.98	0.7
Anderson	25	May 18	Apr. 18	Sept. 12	Sept. 17	102	121	8.5	12.6	1,734	3,175.2	764	685	2.26	4.63
Farmers	73.3	May 18	Apr. 21	Sept. 15	Sept. 17	112	129	35	27.8	7,840	7,172.4	2,960	3,375	0.64	2.12
Boulder and White Rock	556.70	May 18	Apr. 22	Sept. 15	July 30	92	49	30	42.2	5,520	4,185	6,625	6,525	0.83	0.64
Boulder and Left Hand	246.60	May 28	Apr. 22	Sept. 15	Sept. 17	73	63	15.5	8.8	2,263	1,108.8	4,225	4,240	0.53	0.26
N. Boulder Farmers	190.8	May 17	June 21	Sept. 15	Sept. 10	113	121	13.5	9.3	3,051	2,250.6	2,032	2,037	1.99	1.1
Butte Mill	110.4	June 3	Apr. 22	Sept. 11	Aug. 24	97	54	6.3	6.6	1,222.2	712.8	1,285	1,405	0.95	0.5
Green	34.5	June 14	Apr. 22	July 13	Sept. 16	46	76	2	7	184	1,064	965	970	0.18	1.09
Leggett or Charity	131.32	May 28	May 12	Sept. 11	Aug. 24	99	56	31.1	17.4	6,158	1,948.8	3,340	3,145	1.84	0.61
Lower Boulder	122	May 28	May 12	Sept. 15	Sept. 11	99	123	36.6	26.4	7,247	6,494	7,110	7,200	1.01	0.9
Boulder and Weld	59.4	June 21	June 3	Aug. 1	June 10	29	5	9.2	6	533.6	60	2,305	2,310	0.23	0.02
Godding, Daily and Plum	7.24	June 21	June 3	Aug. 16	June 15	26	13	7	5.7	364	148.2	240	265	1.51	0.59
Smith & Emmons	47.2	June 21	June 3	Aug. 10	June 14	51	12	4.1	12.4	418.2	297.6	740	710	0.56	0.41
Highland South Side	152.2	June 21	June 3	Aug. 12	July 5	38	15	22.1	9.3	1,380	297	1,205	1,075	1.14	0.26
P. M. Rural	188.3	June 21	June 3	Aug. 6	July 3	47	26	18.8	20	1,767.2	1,040	1,755	1,715	1.0	0.6
Silver Lake	45	....	Apr. 18	....	Aug. 16	......	48	......	6.3	....	995.4	....	850	......	1.7
Smith & Goss	44.2	....	Apr. 18	....	Sept. 17	......	139	......	3.7	....	1,028.6	....	305	......	3.37
Delehant	33.12	....	June 3	....	June 22	......	23	......	9.7	....	446	....	430	......	1.03
S. Boulder and Coal Creek	65.9	....	May 25	....	Oct. 7	......	45	......	18.2	....	1,638	....	5,950	......	0.56

DISTRICT 7. DIVISION 1.

NAME OF DITCH	Amount of appro-priation in cu. ft. per sec.	First day water used 1909	First day water used 1910	Last day water used 1909	Last day water used 1910	Number days 1909	Number days 1910	Average daily amount 1909	Average daily amount 1910	Acre-feet 1909	Acre-feet 1910	Acres irrigated 1909	Acres irrigated 1910	Duty 1909	Duty 1910
Golden Canal	720.6	Apr. 16	Mch. 16	Nov. 12	Nov. 13	182	222	114	73.75	41,496	32,745	42,000	35,200	0.99	0.93
Swadley	26	Apr. 16	Apr. 28	....	Oct. 26	......	124	......	5.8	....	1,438	460	470	......	3.07
Fisher	35	....	Apr. 7	....	Nov. 2	......	140	......	11.5	....	3,220	1,500	2,350	......	1.37
Clear Creek and Platte R.	70	Apr. 20	Apr. 12	Nov. 7	Nov. 13	192	211	22	15	8,448	6,330	2,600	2,690	3.27	2.35
Rocky Mt.	177.8	May 8	Apr. 19	Nov. 7	Nov. 4	155	126	50	44.7	15,500	11,277	7,800	7,900	1.99	1.48
Lee, Stewart & Eskins	33.2	May 7	Apr. 27	Nov. 12	Oct. 24	162	148	8	8.5	2,592	2,516	2,305	2,340	1.13	1.07
Golden City and Ralston	81.4	Apr. 25	Mch. 15	Nov. 12	Nov. 4	147	143	61	39.5	17,934	11,297	12,100	10,000	1.5	1.12
Colorado Agricultural	62	Apr. 22	Apr. 16	Nov. 7	Nov. 10	185	159	21	19	7,770	6,042	2,500	2,170	3.06	2.77
Golden	26	May 11	Apr. 19	Nov. 12	Oct. 15	163	114	12.5	14	4,075	3,192	4,650	5,000	0.87	0.64
Agricultural	150	Apr. 16	Mch. 15	Nov. 9	Nov. 15	153	57	55.5	47	16,983	5,358	12,500	6,000	1.36	0.89

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used 1909	First day water used 1910	Last day water used 1909	Last day water used 1910	Number days water carried from natural stream 1909	Number days water carried from natural stream 1910	Average daily amount of water during season 1909	Average daily amount of water during season 1910	Number of acre-feet used during season 1909	Number of acre-feet used during season 1910	Number of acres irrigated 1909	Number of acres irrigated 1910	Duty in acre-feet per acre 1909	Duty in acre-feet per acre 1910
DISTRICT 8. DIVISION 1.															
Platte Water Co.	85.9	Apr. 9	Apr. 14	Nov. 1	Nov. 5	193	205	32.9	31	12,699.4	12,710	1,776	1,775	7.15	7.17
Nevada	65	Apr. 24	May 2	Nov. 1	Nov. 5	163	188	25.8	23.8	8,410.8	8,960	1,701	1,420	4.9	6.32
Platte Canon	56	June 20	May 14	Nov. 15	Oct. 25	120	143	11.5	6.45	2,772	1,909	855	685	3.24	2.79
Last Chance	32	May 17	Apr. 25	Oct. 31	Nov. 1	134	119	15.5	20.05	4,167.4	4,771	960	1,017	4.34	4.7
Northern Colorado	1184	Apr. 18	Apr. 4	Nov. 15	Nov. 12	191	73	195	159.3	74,490	35,683	21,000	22,000	3.57	1.62
Petersburg	81	Apr. 15	May 1	Nov. 1	Nov. 5	199	188	3	3.9	1,194	1,470	245	198	4.9	7.45
Rough and Ready	58.37														
Platte and Denver	61.75														
Denver City	278.26														
First Attempt	32		Mch. 24		Nov. 1	30	65	3	2	180	260	50	50	3.6	5.2
Arapahoe	50	May 1	Apr. 1	Oct. 15	Nov. 1			25	25	6,250	8,500	2,950	4,000	2.12	2.11
DISTRICT 9. DIVISION 1.															
Simonton	35.76	May 30	May 7	Oct. 19	Oct. 3	89	135	5.5	5.4	979	1,464	553	505	1.76	2.9
Hodgson	70.32	June 10	June 1	Aug. 9	Sept. 5	29	71	2.3	3.6	133	520	128	151	1.04	3.44
Warrior	52.15	May 20	Mch. 27	Nov. 6	Nov. 10	130	197	21.5	12.2	5,605.6	4,806	1,146	1,128	4.86	4.3
Pioneer Union	55.67	May 25	Apr. 29	Oct. 19	Nov. 10	126	147	14.8	5.5	3,729.6	1,626	872	741	4.27	2.2
Lewis & Strouse	30.68	June 12	Apr. 21	Aug. 8	Aug. 1	24	16	3.12	1.8	149.7	60	100	13	1.49	4.6
Arnett	49.65	May 4	Mch. 27	Nov. 6	Nov. 10	167	60	44.4	9.5	14,829.6	1,146	3,326	2,864	4.6	0.4
Ward	63		Mch. 31		May 30		29		4.7		272		11		24.8
DISTRICT 10. DIVISION 2.															
Chilcott	47.63	July 4		Aug. 19		20		21		840		3,000		0.28	
Fountain	29.09	July 1	Mch. 15	Aug. 8		49	160	12.5	9	1,225		359		3.41	
Widefield	26.73	July 4	Mch. 15	Sept. 8		39	60	14.6	15	1,115.7		815		1.1	
El Paso Co. Canal	59.50														
DISTRICT 11. DIVISION 2.															
Missouri Park	40	May 1	May 15	Nov. 15	Oct. 20	195	120	40	30	15,600	7,200	13,224	1,370	1.18	5.25
Riverside & Allen Ext.	26	June 1		Oct. 1		120		6		1,440		147		9.79	
Stevens & Lighter	36		Jan. 1		Jan. 1		365	36	36		26,280				
Bowen	50.9	May 5	June 1	Oct. 1	Aug. 23	140	52	50.9	30	13,252	3,120	446	517	2.97	6.04
Starr	52.1		May 1		Nov. 1		150		52.1		15,645				
DISTRICT 12. DIVISION 2.															
Beaver Land and Irr. Co.	32.5		Apr. 1		Nov. 1		212		21.7		8,989		3,388		2.65
Union	48		Mch. 1		Nov. 1		206		23		9,476		800		11.82
South Canon	35.2	May 1	Mch. 14	Oct. 31	Oct. 31	151	212	24.4	18.3	7,368	7,738	600	610	12.3	12.6
C. F. & I. Canal	62	May 1	Mch. 1	Sept. 5	Nov. 1	102	245	43.2	60	8,812					
Fremont	57		Apr. 1		Oct. 31		157		4.5		1,351		156		8.6
Canon City and Oil Creek	26.5		Mch. 1		Oct. 31		226		22.8		12,543		1,860		6.75
Canon City Hyd. Co.	96		Mch. 1		Nov. 1		195		60.3		23,497		3,200		7.34

DISTRICT 14. DIVISION 2.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Bessemer	370	Jan. 20	Feb. 28	Nov. 20	Oct. 10	256	263	90	98	46,080	52,334	18,468	18,859	2.5	2.76
Colorado	756.3	Jan. 1	Jan. 1	Oct. 18	Nov. 5	56	63	384	216	59,958	75,840	66,640	43,800	0.9	1.73
Rocky Ford High Line	468.5	May 5	Mch. 1	Oct. 23	Oct. 31	172	224	184	224.6	63,462	56,536	28,000	28,000	2.26	2.02
Excelsior	60	....	May 12	....	Aug. 25	......	47	......	50	....	2,350	....	2,695	......	0.87
Collier	26	....	May 16	....	July 6	......	30	......	10	....	600	....	1,660	......	0.36
Oxford Farmers'	130	....	Mch. 1	....	Oct. 15	......	228	......	52	....	23,712	....	5,700	......	4.15

DISTRICT 16. DIVISION 2.

Montez	37.5	May 29	Mch. 22	Oct. 14	Aug. 3	52	50	10	6	1,040	600	245	220	4.25	2.73

DISTRICT 17. DIVISION 2.

Rocky Ford	208.3	Apr. 21	....	Nov. 13	Oct. 31	197	292	93.6	67	36,878	38,588	9,000	9,000	4.1	4.28
Jones Con	124.3	Apr. 21	....	Nov. 13	Oct. 31	205	258	38	33	15,580	17,028	7,000	6,000	2.2	2.8
Town of Las Animas	38	May 3	....	Nov. 13	Oct. 31	155	225	33.1	30	10,276	13,500	2,470	2,470	4.15	5.45
Fort Lyon	933	Apr. 21	....	Nov. 13	Oct. 31	207	349	587	280	243,346	195,440	63,300	65,000	0.37	0.31
Catlin	345	Apr. 21	....	Nov. 13	Oct. 31	150	278	188.6	132	56,586	73,392	20,000	20,000	2.8	3.6
Lake (Holbrook)	600	June 6	Jan. 4	Oct. 16	Aug. 19	85	104	232	141	39,452	29,328	20,000	19,000	1.9	1.5
Otero	123	June 7	May 10	Nov. 6	Aug. 16	40	25	162	144	23,362	6,912	11,000	19,000	2.1	0.36
Timpas Creek	51.8	June 10	May 1	July 31	Aug. 15	38	15	17	8	1,284	240	3,250	3,250	0.39	0.07

DISTRICT 19. DIVISION 2.

Pulaski	160	May 1	....	Aug. 20	....	110	......	......	......	....	....	5,000	....	......	......

DISTRICT 20. DIVISION 3.

Silva	26.2	Apr. 15	Apr. 1	Aug. 20	Sept. 30	125	183	23	33	5,750	12,078	1,150	978	5	12.6
Independent No. 2	30.4	Apr. 15	May 1	Oct. 31	Aug. 25	199	117	15	12	....	2,808	663	1,084	......	2.58
Rio Grande & Piedra Valley	75.7	....	Apr. 10	....	Sept. 10	......	153	......	60	....	18,360	....	7,008	......	2.62
Excelsior	75.1	Apr. 20	Apr. 10	Sept. 2	Oct. 20	135	150	75.2	50	20,304	15,000	7,920	4,000	2.6	3.75
Monte Vista	257.8	Apr. 12	Apr. 4	Nov. 13	Oct. 31	195	190	150	71	58,500	26,980	16,066	19,428	3.64	1.4
Rio Grande	26.4	May 1	May 9	July 20	July 25	80	77	38	18	6,080	2,772	2,000	2,500	3.04	1.1
Rio Grande and Lariat	4.4	....	Apr. 15	....	Sept. 15	......	138	......	35	....	9,660	....	2,985	......	3.22
Empire	666.9	Apr. 15	Apr. 10	Oct. 1	Oct. 15	150	150	350	150	105,000	45,000	19,256	20,000	5.45	2.25
Rio Grande Canal	912	Apr. 5	Apr. 4	Nov. 11	Nov. 7	218	217	470	529	204,920	229,586	81,227	89,904	2.52	2.56
San Luis Valley	92.9	Apr. 1	Apr. 6	Oct. 18	Nov. 3	186	210	200	300	74,400	126,000	11,210	9,130	6.65	13.8
Billings	25.4	Apr. 26	May 1	Oct. 26	Oct. 31	183	120	26	20	9,516	4,800	1,000	1,190	9.5	4.25
Costilla	103.3	....	....	....	....	......	......	......	......	....	....	....	....	......	......
Prairie	105.1	Apr. 26	Apr. 10	Sept. 2	July 2	104	83	155	75	32,240	12,450	15,961	5,286	2.15	2.36
Farmers' Union	138.8	Apr. 15	May 15	Sept. 1	Oct. 15	139	153	75	135	20,850	41,310	27,011	46,500	0.77	0.89
Centennial	82.4	....	May 1	....	Aug. 1	......	92	40	40	....	7,360	....	3,290	2.24	......

DISTRICT 21. DIVISION 3.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Arroyo	53.1	May 1	May 1	June 10	June 10	10	40	50	50	1,000	......	700	700	1.45	......
Union	188.4	May 1	May 1	Oct. 1	Sept. 1	90	120	35	35	6,300	......	1,150	1,150	5.45	......
North Alamosa	49.8	May 1	May 1	June 1	June 1	20	30	40	40	1,600	......	1,000	1,000	1.6	......
Lower La Jara	44.8	May 10	May 10	June 1	June 1	15	30	30	30	900	......	900	900	1	......
Norland	48.5	May 1	May 1	July 30	July 30	40	90	45	45	3,600	......	440	440	8.2	......
Miller	66.4	May 1	May 1	Aug. 30	Aug. 30	70	120	40	40	5,600	......	1,000	1,000	5.6	......
Overflow No. 1	112	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Plano Vista	29.8	May 1	May 1	Aug. 10	Aug. 10	60	90	20	100	2,400	......	500	500	4.8	......
Davies-Chapman	51.8	Apr. 1	May 10	Oct. 1	Aug. 1	60	90	50	50	6,000	......	700	850	8.6	......
Scandinavian	43.5	May 10	May 10	Aug. 1	Aug. 1	60	90	50	50	6,000	......	850	850	7.07	......
Alamosa Creek Canal	166	Apr. 10	Apr. 10	Oct. 1	Sept. 1	90	150	60	60	10,800	......	900	900	12	......
Coddington	29.8	May 1	May 1	June 1	June 30	30	60	30	30	1,800	......	600	600	3	......
Ribera	28.8	Apr. 1	May 1	Sept. 1	June 30	100	60	20	30	4,000	......	400	600	10	......
Hansen	21.3	May 10	......	June 30	......	10	......	20	......	400	......	900	......	0.44	......
Capulin	31.4	Apr. 10	Apr. 1	Sept. 30	Sept. 30	60	150	30	30	3,600	......	450	550	8	......
Head Overflow No. 5	49.8	......	Apr. 1	......	July 1	......	90	......	8	......	......	......	2,000	......	......
Alamosa Springs	62.7	Apr. 1	......	Oct. 1	......	100	......	15	......	3,000	......	1,150	......	2.6	......
La Joya	27	......	Apr. 1	......	July 30	90	......	20	......	......	......	......	600	......	......

DISTRICT 22. DIVISION 3.

NAME OF DITCH	Amount	First day 1909	First day 1910	Last day 1909	Last day 1910	Days 1909	Days 1910	Avg. 1909	Avg. 1910	Acre-feet 1909	Acre-feet 1910	Acres 1909	Acres 1910	Duty 1909	Duty 1910
Cottonwood	185.5	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	820	1,100	......	......
Manassa-Westfield	30	......	Apr. 1	......	May 30	......	60	......	......	......	......	......	......	......	......
Sanford	107.5	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	4,300	3,400	......	......
Richfield, 1st Enl.	112.5	......	......	......	......	......	......	......	......	......	......	......	......	......	......
Alamo	36	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	2,080	1,400	......	......
Antonito	250	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	2,440	2,400	......	......
Mogote	342	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	1,600	2,600	......	......
North Eastern, 1st Enl.	41.2	......	Apr. 1	......	May 30	......	60	......	......	......	......	......	......	......	......
Los Ojos	44.2	Apr. 1	Apr. 1	Nov. 6	......	......	70	......	......	......	......	......	......	......	......
Angustura	42.7	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	160	160	......	......
North Eastern	34.71	Apr. 1	Apr. 1	Nov. 6	May 30	221	60	......	......	......	......	6,720	5,720	......	......
Los Sauces	88.43	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	880	800	......	......
Lobato	27.58	Apr. 1	Apr. 1	Nov. 6	July 9	221	90	......	......	......	......	160	160	......	......
J. B. Romero	25	Apr. 1	Apr. 1	Nov. 6	July 9	221	90	......	......	......	......	6,444	8,120	......	......
Sanchez	27.26	Apr. 1	Apr. 1	Nov. 6	July 9	221	90	......	......	......	......	640	640	......	......
Manassa	73.6	Apr. 1	Apr. 1	Nov. 6	July 9	221	90	......	......	......	......	20,000	13,300	......	......
J. M. Espinosa	26	Apr. 1	......	Nov. 6	......	221	......	......	......	......	......	120	......	......	......
Ephraim	47	Apr. 1	Apr. 1	Nov. 6	July 9	221	70	......	......	......	......	7,100	5,300	......	......
Litchfield	56.2	Apr. 1	Apr. 1	Nov. 6	July 9	221	70	......	......	......	......	4,160	2,950	......	......
Guadalupe	69.82	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	6,982	......	......	......	1,000	1,250	......	......
Heads Mill	117	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	160	160	......	......
El Cado	25	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	1,700	1,720	......	......
Llano	32	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	800	800	......	......
Servietta	31.77	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	800	800	......	......
Seledonia Valdez	31.77	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	400	400	......	......
San Jose	40.28	Apr. 1	Apr. 1	Nov. 6	Oct. 2	221	183	......	......	......	......	1,700	1,700	......	......
Santiago	51.09	Apr. 1	Apr. 1	Nov. 6	......	221	100	......	......	......	......	640	640	......	......

DISTRICT 22. DIVISION 3—Concluded.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Trujillo	29.08	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					300	300		
Canon	42.89	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					1,200	1,200		
Del Rio	31.14	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					560	560		
Fuerticito	31.47	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					960	960		
Mesitas	38.99	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					960	960		
San Juan and San Rafael	47.76	Apr. 1	Apr. 1	Nov. 6	July 9	221	90					1,200	1,200		
Taos Valley No. 1	500	Apr. 1	Apr. 1	Nov. 6	May 30	221	60					700	1,800		
North Eastern, 2nd Enl.	46.82														
Martinez San Antonio	26	Apr. 1		Nov. 6		221						1,040			
Taos Valley No. 2	500														
Taos Valley No. 3	500														

DISTRICT 23. DIVISION 1.

Beery	39.5		May 1		July 10		71								
Hotel	29		May 1		June 27		57								
Hot Springs	28		May 5		July 12		68								
Weed	25		May 1		July 12		73								
Rogers	42.7														
Kester Sweet	25.4		May 1		July 13		74								
Canon	57.6		Apr. 25		July 15		82								
Rogers North	84														
Ray & Edmonson No. 2	25		May 1		July 1		67								
Hubbard No. 2	30		May 10		July 10		70								
Sacramento	65		May 4		Aug. 1		81								
F. W. Miller	15.7		May 1		July 13		72								
Central	33		May 1		July 12		71								
Parmelee & Shoemaker No. 1	30.5		May 1		July 16		80								
Parmelee & Shoemaker No. 2	44.3		May 1		July 16		80								
Parmelee & Shoemaker No. 3	30.5		May 1		July 16		80								
Foster	42				Aug. 10										

DISTRICT 24. DIVISION 3.

Cordilla	35	May 1	Apr. 1	Sept. 15	Nov. 1	137	214	35	35	9,507	14,980	2,700	2,700	3.54	5.55
San Luis Mill	27	Apr. 1	Apr. 1	Nov. 1	Nov. 1	214	214	20	27		11,556				
Eastdale No. 1	30		Apr. 1		Nov. 1		214		30		12,840		1,600		8.06

DISTRICT 25. DIVISION 3.

Baca Grant	208.9	May 10	Apr. 1	Oct. 20	Oct. 1	100	100	75	100	15,000	20,000	60,000	4,195	0.25	4.79
Wales Shellabarger	40.1		Apr. 6		Oct. 15		150		20		6,000		1,618		3.74
North and San Isabel	26.7		Mch. 25		Oct. 15		120		15		3,600		2,020		1.78

DISTRICT 26. DIVISION 3.

Travis	25		Apr. 1	Oct. 11	June 6	20	76	10.5	19.41			1,000	1,250		
Company	96.3		Apr. 23	Sept. 26	July 9	66	78	27.2	17.11			4,500	3,000		

DISTRICT 30. DIVISION 4.

NAME OF DITCH	Amount of appropriation in cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
Florida Canal	40		May 1		Oct. 15		168		35						
Florida Canal Enlgmt	160		May 1		Oct. 15		168		10						
Florida Farmers	45		May 1		Oct. 25		168		35				3,000		
DISTRICT 34. DIVISION 4.															
Root & Ratliff	82.5		May 15		Sept. 30		135		5.5				286		
DISTRICT 35. DIVISION 3.															
Darling	102														
DISTRICT 40. DIVISION 4.															
Leroux	52.35		May 25		Sept. 15		34		13		1,560		3,200		0.49
Cedar Canon & Iron Spgs	50		Apr. 15		Aug. 31		135		20		5,400		2,800		1.93
DISTRICT 41. DIVISION 4.															
Eagle	33.85	Mch. 1										1,665			
Loutsenhizer	81.6	Mch. 1		Nov. 15			250					4,948			
Delta	30	Mch. 1										350			
Ironstone	151	Mch. 1										6,825			
M. & D. Canal	250	Mch. 1		Nov. 1			240					11,560			
Garnett	93.33	Mch. 1										1,100			
Home Run	46.88	Mch. 1										995			
Selig	84.6	Mch. 1										995			
G. B. Jones	45.89	Apr. 1										320			
Chipeta-Montrose Co.	34.87	Mch. 1		Nov. 15								635			
Montrose City	26.5			Nov. 15								150			
Delta Chief	42	Mch. 1		Nov. 15								1,134			
Logan	25	Apr. 1		Nov. 15								512			
Reservation	26.35	Apr. 1		Nov. 15								642			
High Line	83.4	Apr. 1		Nov. 15								1,956			
Midland	27.95	Apr. 1										398			
Cushman	96.5	Mch. 1													
DISTRICT 46. DIVISION 1.															
Little Grizzly	25	May 1	May 1	July 15	July 25	75	85	15	16	2,250	2,720	550	550	4.1	4.95
Little Nellie	87.5	May 15	May 1	July 15	July 20	61	80	50	50	6,100	8,000	4,000	4,000	1.52	2
Chapman	27	May 15	June 15	July 20	July 10	65	25	20	94	2,600	1,200	880	800	3.25	1.5
Eureka	70	May 3	May 5	July 25	June 20	82	45	35	35	5,740	8,150	2,395	2,395	2.39	1.31
Mallon	37.5	Apr. 25	Apr. 15	July 10	July 20	75	95	25	22	3,750	4,180	1,200	1,200	3.12	3.48
Staples No. 1	35	May 5	May 1	July 10	July 23	65	85	30	33	3,900	5,610	1,820	1,820	2.12	3.08
Mitchell	31.75	Apr. 22	May 1	July 23	July 28	91	85	15	26	2,730	4,420	700	1,200	3.9	3.68
Independent	33.75	May 1	May 5	July 20	Aug. 5	80	90	33	20	5,280	3,600	1,500	1,500	3.5	2.4
Mutual	100	May 15	May 1	July 15	July 25	60	85	28	18	3,360	3,060	3,200	3,200	1.05	0.97
Roaring	38.25	Apr. 22	May 1	July 20	July 25	88	85	15	30	3,640	5,100	1,000	1,000	3.64	5.1
Davis	25	May 15	Apr. 20	July 20	July 8	65	78	25	25	3,250	3,900	1,500	1,500	2.66	2.6
Staples No. 2	29.4	May 7	May 5	July 21	July 25	74	60	28	35	4,144	4,200	3,220	3,220	1.28	1.3
Mallon No. 2	80	May 1	Apr. 15	July 15	July 20	75	80	35	60	5,250	9,600	1,260	1,260	4.15	7.6

NAME OF DITCH	Amount of appropriation in. cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
DISTRICT 47. DIVISION 1.															
Midland	85	....	....	....	....	......	......	......	......	....	....	....	....	......	......
Pomeroy	50.7	....	....	....	....	......	......	......	......	....	....	....	....	......	......
Old S. C.	33.5	....	....	....	....	......	......	......	......	....	....	....	....	......	......
Lost Treasure	55	....	....	....	....	......	......	......	......	....	....	....	....	......	......
DISTRICT 48. DIVISION 1.															
Yelton	30.14	May 10	....	July 15	....	66	......	......	......	....	....	....	....	......	......
Laramie River	400	June 24	....	....	....	......	......	......	......	....	....	....	....	......	......
Lone Tree	25	May 5	....	Aug. 1	....	86	......	......	......	....	....	....	....	......	......
Sand Creek Ditch System	288	....	....	....	....	......	......	......	......	....	....	....	....	......	......
DISTRICT 60. DIVISION 4.															
Gurler or Empire	50	May 1	....	Oct. 15	....	150	......	40	......	12,000	....	4,600	....	2.62	......
DISTRICT 64. DIVISION 1.															
South Platte	137	May 10	Apr. 24	Oct. 15	Nov. 1	175	160	35	30	12,250	9,600	3,864	4,421	3.22	2.17
Sterling	114	May 1	Apr. 28	Oct. 20	Oct. 20	170	172	70	60	23,800	20,640	7,040	8,263	3.38	2.5
Pawnee	157	Apr. 1	Apr. 27	Nov. 1	*	210	225	100	55	42,000	24,750	8,100	10,618	5.2	2.33
Schneider	47	Apr. 15	Apr. 20	Sept. 25	*	160	180	25	20	8,000	7,200	2,652	3,950	3.01	1.82
Low Line	38	May 1	Apr. 15	Sept. 15	Oct. 20	125	200	15	12	3,750	4,800	2,960	2,949	1.26	1.62
Iliff and Platte Valley	150	May 2	Apr. 1	Sept. 15	Nov. 10	125	210	50	30	12,500	12,600	7,770	7,925	1.62	1.59
Sterling No. 2	50	May 1	Apr. 5	Oct. 20	Nov. 31	150	60	20	15	6,000	1,800	1,980	2,455	3.03	0.74
Spring Dale	62.5	Apr. 10	Mch. 19	Oct. 1	*	100	60	40	25	8,000	3,000	4,290	4,610	1.86	0.65
South Reservation	25	Apr. 10	Mch. 22	Sept. 15	*	130	30	15	20	3,900	1,200	1,450	....	2.68	......
Bravo	40	Apr. 15	Mch. 15	Oct. 20	*	120	30	20	20	4,800	1,200	1,980	2,011	2.42	0.56
Powell & Dillon	45	Mch. 25	....	Oct. 15	....	150	......	20	......	6,000	....	2,805	2,080	2.13	......
Powell & Blair	40	May 5	....	Sept. 6	....	90	......	20	......	3,600	....	2,475	....	1.45	......
Harmony No. 1	252	May 1	....	Sept. 20	....	120	......	40	......	9,600	....	3,055	2,000	3.18	......
Chambers	30	May 1	....	....	....	......	......	......	......	....	....	1,000	10	......	......
Lone Tree	82	....	....	....	....	......	......	......	......	....	....	2,020	4,855	......	......
Harmony No. 2	50	Apr. 15	May 9	Sept. 30	Nov. 2	140	12	25	10	7,000	240	1,648	24,600	4.25	0.09
Powell	40	....	May 10	....	Oct. 10	......	115	......	15	....	3,450	....	2,440	......	1.41
Peterson	514	....	Mch. 20	....	*	......	65	......	35	....	4,550	....	14,000	......	0.32
Settlers	377	....	May 10	....	Aug. 10	......	80	......	30	....	1,800	....	12,000	......	0.15
Tamarack	134	....	....	....	....	......	......	......	......	....	....	....	1,025	......	......
Harmony No. 3	219	....	Aug. 1	....	Aug. 5	......	5	......	5	....	50	....	1,800	......	0.03

*Still using.

NAME OF DITCH	Amount of appropriation in. cu. ft. per sec.	First day water used		Last day water used		Number days water carried from natural stream		Average daily amount of water during season		Number of acre-feet used during season		Number of acres irrigated		Duty in acre-feet per acre	
		1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910	1909	1910
DISTRICT 65. DIVISION 1.															
Farmers	....	May 17	May 16	Oct. 31	Oct. 31	167	168	45	42	15,003	14,140	1,095	1,100	13	12.8
DISTRICT 67. DIVISION 2.															
Colorado & Kansas	100	May 24	Apr. 11	Nov. 14	Nov. 15	175	199	59	30	20,650	11,940	5,875	3,670	3.5	3.2
Amity	283.5	May 22	Mch. 26	Nov. 15	Nov. 15	164	119	208	205	68,224	48,076	28,854	30,631	2.3	1.5
Lamar	151	May 24	Mch. 27	Nov. 7	Nov. 15	168	229	67	67	22,472	28,860	6,507	6,114	3.4	4.4
Hyde	23.4	May 31	Apr. 20	Aug. 3	Sept. 8	51	123	26	9	2,652	2,214	3,350	2,010	0.79	1.09
X. Y.	69	May 22	Apr. 20	Nov. 7	Nov. 15	114	168	46	26	10,488	6,736	1,935	5,218	5.4	1.29
Graham	61	June 9	Apr. 20	Oct. 1	Aug. 21	81	63	36	19	5,832	2,294	2,000	1,600	2.9	1.47
Buffalo	67	May 22	Apr. 24	Nov. 15	Nov. 15	105	161	27	15	5,670	4,832	1,619	694	3.5	6.95
Sisson-Stubbs	25	....	Apr. 15	....	Aug. 8	......	66	......	10	....	1,320	700	800	......	1.65

DISTRICT 1. DIVISION 1.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Moore	Deer Trail and Muddy	36,000,000	Moore	0	5,000,000	18,000,000	0
Empire	S. Platte	1,642,629,890	Bijou Canal	512,423,370	0	769,464,040	0
Jackson Lake	S. Platte	1,543,991,407	Morgan, U. Platte and Beaver, L. Platte and Beaver, C. J. Cooper	1,306,872,541	634,654,627	1,255,938,387	0
Riverside	S. Platte	2,505,801,206	In Exchange Bijou, Deuel & Snyder, Tremont, Riverside	2,000,000,000	515,107,012	1,375,431,070	0
Beebe Draw	S. Platte	1,881,225,000		200,000,000			
J. B. Cook	Lone Tree	200,000,000	J. B. Cook				
Bijou	W. Bijou	10,000,000					
Benck	E. Bijou	3,267,000					
Bijou Nos. 1 to 6	Bijou						
Drury No. 1	Crow						
Owl	Owl	28,000,000	Owl				
Wadlin	Crow	44,000,000					
Drury No. 2	Crow						
Bramkamp	Muddy	5,197,000	Bramkamp	5,000,000	3,000,000		
Ft. Morgan L. & R. Co. No. 1	S. Platte						
Ft. Morgan L. & R. Co. No. 2	S. Platte	500,000,000	Bijou	0	0		
Ft. Morgan L. & R. Co. No. 3	S. Platte						
Drury No. 3	Crow						
Mary Lawless	W. Bijou	8,400,111,503					

DISTRICT 2. DIVISION 1.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	1909 May 1	1909 Nov. 1	1910 May 1	1910 Nov. 1
Oasis	S. Platte	495,000,000	E. & W. Hudson	495,000,000	0	164,234,184	0
Higgins	Brighton Lat	4,900,500	Laterals	4,900,500	2,450,250	4,900,500	0
Lutz	Brighton Lat	2,380,200	Laterals	2,380,200	1,000,000	2,380,200	0
Z. J. Fort	Flood Water	7,168,200	Laterals	7,168,200	3,084,100	7,168,200	0
Meek	Burlington Ditch	38,347,200	Bowles No. 2	38,347,200	14,150,100	38,347,200	0
Clark	Burlington Ditch	15,794,480	Burlington Ext	15,794,480	8,340,240	15,794,480	0
East Line	Burlington Ditch	10,960,400	Bowles No. 2	10,960,400	5,480,200	10,960,400	0
Henry Lake	Burlington Ditch	22,549,982	Laterals	22,549,982	11,245,500	22,549,982	0
F. E. Mulvihill	Dry Creek	88,000,000	Laterals	88,000,000	44,000,000		0
Calhoun	Oasis Reservoir	2,742,500	Laterals	2,722,500	1,350,250	2,722,500	0
Second Creek	Second Creek	16,658,000	Second Creek	16,658,000	8,329,000	8,329,000	0
Magers	Burlington Ditch	2,321,021	Lateral	2,321,021	1,160,000	2,321,021	0
Marshall	Lee Lateral	3,118,427	Lateral	3,118,427	1,559,215	3,118,427	0
Lower Latham	S. Platte	270,700,000		277,000,000	135,350,000	270,700,000	0
Smith	S. Platte, Fulton Ditch	3,018,255	Laterals	3,018,225	1,509,125	3,018,255	0
Little Western	Burlington Ditch	5,500,000	Laterals	5,500,000	2,750,000	5,500,000	0
H. A. Smith	Brighton Lat	4,530,240	Laterals	4,530,240	2,265,120	4,530,240	0
Skeel No. 1	Brighton Lat	6,975,000	Laterals	6,975,000	3,487,000	6,975,000	0
Skeel No. 2	Fulton Ditch	2,327,500	Laterals	2,327,500	1,163,750	2,327,500	0
Rutherford	Burlington Ditch	1,787,500	Laterals	1,787,500	893,750	1,787,500	0
Bowles No. 1	Seepage	20,947,360	Bowles Ditch	20,947,360	10,473,680	20,947,360	0
Bowles No. 2	Seepage	27,965,520	Bowles Ditch No. 2	27,965,520	13,982,760	27,965,520	0
Curtis Lake	Burlington Ditch	7,560,000	Lateral	7,560,000	3,780,000	7,560,000	0

DISTRICT 3. DIVISION 1.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Warren Lake	Cache La Poudre	91,250,000	Outlet	65,000,000	6,000,000	20,000,000	0
Windsor Lake	Cache La Poudre	78,408,000	Lake Supply	40,000,000	0	40,000,000	15,000,000
North Gray	Box Elder	12,000,000	Lake Canal	5,000,000	0	10,000,000	0
South Gray	Box Elder	22,293,000	Lake Canal	12,000,000	0	15,000,000	0
Reservoirs 2 and 3	Cache La Poudre	30,000,000	Larimer and Weld	4,000,000	0	20,000,000	0
Reservoir 4	Cache La Poudre	43,370,000	Larimer and Weld	40,000,000	0	40,000,000	0
Spring Canon	Spring Canon	2,683,000	Spring Canon	2,000,000	0	2,000,000	0
Reservoir No. 1	N. Poudre	29,345,600	Laterals	25,000,000	0	19,000,000	10,000,000
Claymore Lake	Cache La Poudre	39,000,000	Pleasant Valley and Lake Canal	25,000,000	0	30,000,000	0
Reservoir No. 1	Box Elder	24,829,300	Mt. Supply Co.	10,000,000	0	9,000,000	3,000,000
Richards	Cache La Poudre	46,000,000	Larimer and Weld	35,000,000	0	40,000,000	0
Reservoir No. 2	Box Elder	8,500,000	Mt. Supply Co.	0	0	3,000,000	0
Reservoir No. 3	N. Poudre	125,000,000	No. 3 Outlet	75,000,000	10,000,000	115,000,000	0
Caverly	N. Poudre	7,500,000	Caverly Outlet	4,000,000	0	4,000,000	0
Curtis Lake	Cache La Poudre	33,902,000	Larimer Co.	40,000,000	0	30,000,000	0
Dixon Canon	Dixon Canon	19,500,000	Dixon Canon	8,000,000	0	7,000,000	0
Reservoir No. 4	Box Elder	11,000,000	Mt. Supply	5,000,000	0	4,000,000	0
Reservoir No. 3	Box Elder	34,500,000	Mt. Supply	5,000,000	0	9,000,000	0
Stuchell	N. Poudre	3,056,500	Wellington	2,000,000	0	0	0
Jameson Lake	Box Elder	3,500,000	Mt. Supply	0	0	2,000,000	0
Mitchell Lake No. 1	Lone Pine	25,278,500	Laramie-Poudre	5,500,000	10,000,000	5,000,000	0
Mitchell Lake No. 2	Lone Pine	4,367,500	Laramie-Poudre	0	2,000,000	3,000,000	0
Mitchell Lake No. 3	Lone Pine	4,335,000	Laramie-Poudre	0	2,000,000	2,000,000	0
Reservoir No. 4	N. Poudre	46,766,000	No. 4 Outlet	20,000,000	0	46,000,000	0
Reservoir No. 2	N. Poudre	169,000,000	No. 2 Outlet	90,000,000	10,000,000	140,000,000	0
Larimer and Weld	Cache La Poudre	390,000,000	Larimer and Weld	270,000,000	65,000,000	250,000,000	0
Windsor	Cache La Poudre	770,545,000	Cache La Poudre	585,000,000	156,000,000	511,000,000	175,000,000
Reservoir No. 1	Cache La Poudre	205,853,600	Larimer and Weld	182,000,000	0	150,000,000	60,000,000
Long Pine	Cache La Poudre	175,865,000	Larimer and Weld	168,000,000	0	130,000,000	15,000,000
Lindenmeier	Cache La Poudre	40,000,000	River	31,000,000	0	15,000,000	0
Cache La Poudre	Cache La Poudre	415,000,000	Cache La Poudre	360,000,000	180,000,000	415,000,000	0
Wood	Seepage and Flood	140,000,000	Wood Outlet	65,000,000	0	60,000,000	0
Reservoir No. 2	Drain	106,000	College Ditch	106,000	0	0	0
Reservoir No. 5	Poudre	250,000,000	Larimer Co.	5,000,000	50,000,000	50,000,000	0
Neece	Flood	6,000,000	Neece Outlet	2,000,000	0	2,000,000	0
Reservoir No. 1	Cooper & Ames Sloughs	35,000,000	Lake Canal	33,000,000	0	25,000,000	0
Doudy	So. Pine	15,145,000	For Sale	10,000,000	12,000,000	5,000,000	0
Reservoir No. 6	Cache La Poudre	445,000,000	Larimer Co.	56,000,000	250,000,000	250,000,000	10,000,000
Deer Lake	Ravine	3,842,000	For Sale	2,500,000	2,000,000	....	0
Fossil Creek	Cache La Poudre	503,000,000	N. Poudre	503,000,000	107,375,000	425,000,000	0
Erie Lake	Lone Pine	3,000,000	For Sale	2,000,000	2,000,000	0	0
Douglas	Cache La Poudre	460,000,000	Larimer and Weld	190,000,000	60,000,000	60,000,000	0
Coal Creek	Box Elder, Coal Creek	178,388,000	Cactus Hill Lateral	70,000,000	25,000,000	40,000,000	0
Reservoir No. 3	Soldier Canon	30,950,000	College Ditch	24,894,000	15,000,000	20,000,000	5,000,000
Big Beaver	Big Beaver	69,201,000	For Sale	40,000,000	50,000,000	12,000,000	0
Twin Lake	So. Pine	1,708,000	For Sale	0	0	0	0
Reservoir No. 8	Cache La Poudre	300,000,000	Larimer and Weld	100,000,000	0	60,000,000	0
Cameron Pass	Joe Wright	34,000,000	Poudre Valley	27,000,000	0	5,000,000	0
Black Hollow	Cache La Poudre	250,000,000	Larimer Co.	45,000,000	0	0	0

DISTRICT 3. DIVISION 1—Concluded.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET 1909 May 1	1909 Nov. 1	1910 May 1	1910 Nov. 1
Tenny	Box Elder	15,000,000	Mt. Supply			8,000,000	0
Reservoir No. 2	Box Elder	6,500,000	Mt. Supply			3,000,000	0
Bubble	Box Elder	9,750,000	Mt. Supply			5,000,000	0
Halligan	N. Poudre	279,000,000	N. Poudre			0	0
Reservoir No. 15	N. Poudre	240,000,000	N. Poudre			0	0
Sheep Creek	Sheep Creek	20,000,000	For Sale			6,790,000	0
Lake Agnes	Zimmerman	5,000,000	For Sale			3,560,000	0
Timber Line	Big Beaver	33,000,000				0	0
Elder	Poudre	100,000,000				0	0

DISTRICT 4. DIVISION 1.

Lone Tree	Big Thompson	400,000,000	Home Supply	400,000,000	300,000,000	400,000,000	40,000,000
Donath	Big Thompson	30,000,000	Seven Lakes	30,000,000	30,000,000		
Marianna	Big Thompson	200,000,000	Home Supply	200,000,000	100,000,000	200,000,000	0
Lake Loveland	Big Thompson	625,000,000	Greeley and Loveland	625,000,000	300,000,000	513,669,587	21,189,587
Lawn Lake	Roaring Fork	38,000,000	Farmers				
Seven Lakes	Big Thompson	212,000,000	Greeley and Loveland	212,000,000	200,000,000	175,000,000	11,840,000
Ryan Gulch No. 1	Gulch	40,000,000	Ex. and So. Side	40,000,000	40,000,000	40,000,000	0
Ryan Gulch No. 2	Gulch	42,000,000	Big Thompson No. 2	42,000,000	42,000,000	42,000,000	0
Fairport	Big Thompson	24,164,910	Private	24,164,910	24,164,910		
Rist & Benson	Big Thompson	24,040,600	La Ural	24,040,600	24,040,600	24,040,600	0
Boyd Lake	Big Thompson	1,873,000,000	Exchange	1,200,000,000	1,000,000,000	1,064,000,000	1,000,000,000
Buckhorn	Buckhorn	60,000,000	Louden		45,000,000	40,000,000	0
Berthoud City	Big Thompson	7,805,614	City of Berthoud	7,805,614	7,805,614	0	7,805,614
Loveland Lake	Big Thompson	93,521,818	Private	93,521,818	45,000,000		
Welch Lake	Big Thompson	300,000,000	Handy	300,000,000	250,000,000	300,000,000	75,000,000
Boulder and Larimer	Little Thompson	253,350,000	Private	253,350,000	61,040,000		
W. T. W. Smith	Big Thompson	6,924,142	Private		3,400,000		
Wilson	Big Thompson	6,982,668	Private		3,400,000		
Cemetery Lake	Big Thompson	24,000,000	Private	24,000,000	24,000,000		
Welch, Nos. 1, 2 and 5	Big Thompson	117,806,087	Private		41,000,000		
Hupp	Big Thompson	3,624,238	Private		1,250,000		
Sunny Slope	Big Thompson	11,287,683	Private		5,000,000		
Strever	Big Thompson	10,271,444	Private		5,000,000		
Hummell	Big Thompson	12,732,269	Private		6,000,000		
Coleman	Big Thompson	22,166,980	Private		11,000,000		
Klein	Big Thompson	920,760	Private		450,000		
Foster & Metz	Big Thompson	3,299,970	Private		1,450,000		
Loveland Lateral Lake	Big Thompson	24,437,546	Private		12,000,000		

DISTRICT 5. DIVISION 1.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Beaver Park	Beaver	122,976,000	Highland and Supply	122,976,000	0	122,976,000	0
Pleasant Valley	St. Vrain	110,300,055	Rough and Ready	110,300,055	1,972	300,055	0
Knoth	St. Vrain	2,000,000	Hanson Private	1,633,504	0	1,633,504	0
Ish	Little Thompson	416,201,000	Mead Lateral	319,893,000	96,308,000	30,452,000	0
McIntosh	St. Vrain	107,153,830	Oligarchy	99,341,680	30,452,000	99,341,680	0
Highland No. 2	St. Vrain	105,280,000	Highland	105,280,000	0	280,000	0
Highland No. 1	St. Vrain	25,071,248	Highland	25,071,248	18,478,708	76,230,000	0
Highland No. 3	St. Vrain	71,023,000	Highland	76,230,000	36,835,000	71,023,000	0
Highland Lake	St. Vrain	24,452,500	Private	20,452,000	4,000,000	52,500	0
Burch Lake	St. Vrain	16,811,437	Oligarchy	16,811,437	....	76,811,437	0
Gold Lake	St. Vrain	19,000,000	Left Hand	19,000,000	0	100,000	0
Crystal Lake	St. Vrain	1,033,000	Private	1,033,000	0	0	0
Hill Top	St. Vrain	1,000,000	Private	500,000	0	0	0
Union	St. Vrain	850,000,000	Union No. 2	400,000,000	600,000,000	850,000,000	0
Arbuckle No. 2	St. Vrain	13,233,920	Supply	....	....	13,233,920	0
Arbuckle No. 4	St. Vrain	20,000,000	Supply	....	....	20,000,000	0

DISTRICT 6. DIVISION 1.

Marshall	So. Boulder	60,000,000	Community	60,000,000	50,000,000	0	0
West Lake	So. Boulder and Coal	30,452,087	....	30,452,087	25,870,520	15,000,000	0
Section 19	So. Boulder and Coal	3,520,000	....	3,520,000	2,550,000	0	0
Section 17	So. Boulder and Coal	1,475,812	....	1,250,000	902,550	0	0
Section 15	So. Boulder and Coal	767,900	....	768,000	697,500	0	0
Section 35	So. Boulder and Coal	2,500,100	....	2,000,000	1,550,000	0	0
Section 11	So. Boulder and Coal	3,598,056	....	3,580,520	2,580,420	0	0
McKay Lake	So. Boulder and Coal	41,678,208	....	40,678,208	38,550,728	0	0
Silver Lake	N. Boulder	35,164,124	Silver Lake	35,435,124	28,164,224	15,250,100	575
Island Lake	Middle Boulder	16,196,629	Silver Lake	15,196,255	15,125,250	5,196,629	629
Goose Lake	Middle and So. Boulder	30,706,608	Silver Lake	25 ,706,608	22,795,525	17,706,675	525
Erie	So. Boulder	5,206,750	Erie	0	5,000,000	206,750	750
Louisville	So. Boulder	4,221,588	Louisville	4,000,000	4,221,588	20,525	525
Lafayette No. 1	So. Boulder	614,685	Lafayette	600,000	614,685	....	....
Lafayette No. 2	So. Boulder	892,600	Lafayette	892,000	892,500	....	....
Harper	So. Boulder	2,713,450	Lateral	2,613,150	1,120,350	550	0
Hiram Prince	So. Boulder	3,502,250	Lateral	3,300,000	3,325,000	500	0
Waneke No. 1	So. Boulder	28,319,000	Lateral	20,000,000	18,000,000	500	0
Wm. Waneke	So. Boulder	172,150	Lateral	75,000	100,000	0	0
Panama No. 1	Boulder	304,920,000	Lateral	304,920,000	304,920,000	204,525,000	0
Panama No. 3	Boulder	196,000,000	Panama	196,000,000	109,000,000	96,000,000	0
Teller No. 5	So. Boulder	4,625,579	Lateral	4,000,000	4,000,000	603,250	0
Teller No. 4	So. Boulder	705,990	Lateral	700,000	600,000	450,200	0
Teller No. 1	So. Boulder	1,994,720	Lateral	1,000,000	1,000,000	75,520	0
Frank Prince	So. Boulder	3,635,910	Lateral	3,000,000	2,000,000	25,000	0
Base Line	So. Boulder	41,678,208	Lower Boulder	40,000,000	35,000,000	75,680,000	0
Colo. Power Co.	So. Boulder	....	....	....	....	....	....
Lower Boulder Ext	So. Boulder	33,461,040	Lower Boulder Ext	33,000,000	30,000,000	0	0

DISTRICT 7. DIVISION 1.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Kelly	Clear Creek	1,306,800	.....	1,306,800	0	.....	.....
Broad	Clear Creek	139,392,000	Laterals	113,256,000	43,560,000	104,544,000	0
Small	Clear Creek	7,840,800	Laterals	7,840,800	0	.....	.....
Hackburys, 1-2-3	Clear Creek	6,969,600	.....	5,575,080	6,969,600	5,225,000	0
Shoops, 1-2-3	Clear Creek	8,494,100	.....	6,795,280	8,494,100	6,200,000	0
Lothrops, 1-2-3	Clear Creek	18,291,100	.....	14,636,160	12,295,100	9,100,000	0
Calkins	Clear Creek	16,988,400	.....	13,590,720	10,988,400	8,500,000	0
J. F. Church	Clear Creek	4,356,000	.....	3,484,800	0	2,200,000	0
Williams	Clear Creek	3,920,400	.....	3,136,320	1,360,000	1,500,000	0
Henrys	Clear Creek	4,791,600	.....	3,833,280	0	2,600,000	0
Storm & Rankin	Clear Creek	9,583,200	.....	7,665,560	2,250,000	4,500,000	0
Burnett	Clear Creek	3,920,400	.....	3,136,320	0	2,000,000	0
Harrington	Clear Creek	9,147,600	.....	7,318,080	0	4,500,000	0
Freys, 1 and 2	Clear Creek	6,969,600	.....	5,575,680	6,969,600	4,000,000	0
Vogel	Clear Creek	3,484,800	.....	2,787,840	1,240,000	2,000,000	0
Heintze	Clear Creek	4,791,600	.....	3,833,280	4,791,600	3,000,000	0
Hussey	Clear Creek	3,920,400	.....	3,136,320	1,920,400	2,400,000	0
Croke, 1-2-3-4-5-6	Clear Creek	39,204,000	.....	32,763,200	5,204,000	20,000,000	0
Finnerty	Clear Creek	2,613,600	.....	2,090,880	0	1,500,000	0
Webster	Clear Creek	6,969,600	.....	5,575,680	3,200,000	6,975,000	0
D. C. Brown, 1 and 2	Clear Creek	13,939,200	.....	11,151,360	5,320,000	7,500,000	0
Hollick	Clear Creek	5,227,200	.....	4,181,760	5,227,200	3,000,000	0
L. M. Smith, 1 and 2	Clear Creek	3,049,200	.....	2,439,360	1,049,200	1,400,000	0
T. O. Brown	Clear Creek	5,227,200	.....	4,181,760	2,260,000	1,500,000	0
J. M. Brewer	Clear Creek	3,920,400	.....	3,136,320	1,250,000	2,000,000	0
Eastlakes, 1-2-3-4	Clear Creek	52,272,000	.....	41,817,600	40,200,000	24,000,000	.....
Ohio	Clear Creek	100,188,000	.....	8,015,040	0	4,500,000	0
King & Wooley	Clear Creek	13,939,200	.....	11,151,360	0	7,500,000	0
Johnson	Clear Creek	3,049,200	.....	2,439,360	3,049,200	3,000,000	0
Poitz	Clear Creek	5,227,200	.....	4,181,760	5,227,200	2,500,000	0
Wadley	Clear Creek	13,939,200	.....	11,151,360	0	7,000,000	0
Neresheimer	Clear Creek	13,068,000	.....	10,454,400	0	6,000,000	0
W. H. Brown	Clear Creek	8,276,400	.....	6,621,120	4,712,000	4,000,000	0
Bromley	Clear Creek	8,712,000	.....	6,009,600	2,500,000	4,000,000	0
Smith	Clear Creek	7,840,800	.....	6,272,630	0	3,000,000	0
Richardson	Clear Creek	13,068,000	.....	10,454,400	6,000,000	6,000,000	0
Porter	Clear Creek	13,503,600	.....	10,802,880	0	6,000,000	0
Myers, 1-2-3	Clear Creek	9,583,200	.....	7,666,560	0	.....	.....
Joint	Clear Creek	5,727,200	.....	4,181,560	0	.....	.....
Clover Knoll	Clear Creek	3,136,320	.....	2,509,056	0	.....	.....
Bancrofts No. 3	Clear Creek	871,200	.....	696,960	0	.....	.....
Wortman	Clear Creek	2,178,000	.....	1,742,400	0	1,000,000	0
Tucker	Ralston	78,408,000	Pleasant View	61,526,400	35,400,000	40,000,000	0
Jones (Standley)	Clear and Ralston	34,848,000	.....	27,878,400	25,000,000	.....	.....
Leyden	Leyden	80,400,408	F. H. L. Canal	0	0	.....	.....
Church	Clear Creek	13,068,000	.....	.....	.....	5,000,000	0
Wilbur	Clear Creek	26,136,000	.....	.....	.....	11,000,000	0
Groves & Dollison	Clear Creek	21,780,000	.....	.....	.....	21,780,000	0
Gay	Clear Creek	.....	.....	.....	.....	2,356,000	0
Legault, 1 and 2	Clear Creek	17,424,000	.....	.....	.....	3,500,000	0

DISTRICT 7. DIVISION 1—Concluded.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Westminster	Dry Creek	15,246,000	...	...	6,524,000	...	...
Bancrofts, 1-2-3	Fall River	17,424,000	Fall River & C ear Creek	6,534,000	17,424,000	3,500,000	0
Ward Lake	Bear and Clear	12,968,000	...	...	...	12,968,000	0
Crown Hill	Clear Creek	6,534,000	...	...	...	3,250,000	0
Dowing	Clear Creek	4,356,000	...	...	...	3,000,000	0
Kountze, 1 and 2	Clear Creek	21,780,000	...	...	...	9,500,000	0
Loch Lomond, 1-2-3	Fall River	16,424,000	...	...	...	16,424,000	0
Copeland, 1 and 2	Clear Creek	4,356,000	...	...	...	4,356,000	0
Leyden & Small	Clear Creek	84,120,000	...	...	...	45,500,000	0

DISTRICT 8. DIVISION 1.

Castlewood	Cherry Creek	229,000,000	Arapahoe	87,120,000	229,000,000	...	...

DISTRICT 9. DIVISION 1.

Bergen	Turkey Creek	16,345,300	Bergen	10,454,400	10,454,400	0	0
Bergen No. 2	Turkey Creek	24,984,500	Bergen	20,908,800	0	8,324,500	0
Brooks	Turkey Creek	435,600	Brooks	435,600	435,600	435,600	0
Dean	Turkey Creek	17,424,000	Dean	17,424,000	16,444,259	15,246,000	0
J. B. Grant No. 1	Turkey Creek	4,356,000	Grant	4,356,000	4,356,000	4,356,000	0
J. B. Grant No. 2	Turkey Creek	522,720	Grant	522,720	522,720	522,720	0
Shearer	Turkey Creek	4,356,000	Shearer	4,356,000	4,356,000	3,484,800	0
No. 7	Turkey Creek	784,080	No. 7	784,080	784,080	435,000	0
Shepard	Turkey Creek	2,439,360	Shepard	2,439,360	2,439,360	2,439,360	0
Gulch	Turkey Creek	4,201,252	Gulch	2,613,600	2,613,600	2,613,600	0
Rollins No. 1	Bear Creek	3,484,800	Rollins	1,045,440	1,045,440	522,720	0
Rollins No. 2	Bear Creek	653,400	Rollins	653,400	653,400	653,400	0
Kendrick	Bear Creek	5,227,220	Kendrick	5,227,220	5,227,220	5,227,220	0
Ward and Kendrick	Bear Creek	17,424,000	Kendrick	8,712,000	17,120,000	17,424,000	0
Smith	Bear Creek	15,424,000	Green	15,424,000	15,424,000	4,365,000	0
Porter	Bear Creek	522,720	Porter	522,720	522,720	522,720	0
Ward	Bear and Clear Creeks	42,864,000	Merrit	34,848,000	34,848,000	17,424,000	0
Agricultural	Bear and Clear Creeks	8,000,000	Agricultural	0	2,000,000	...	...
Deucher	Bear Creek	3,267,000	Deucher	2,000,000	3,267,000	1,960,200	0
Soda Lake No. 1	Bear Creek	10,500,000	...	10,500,000	10,500,000	10,500,000	0
Soda Lake No. 2	Bear Creek	76,860,000	Arnett	76,860,000	76,860,000	76,860,000	0
Harriman	Bear Creek	38,000,000	Johnson	34,848,000	17,946,720	23,748,000	0
Stickford	Bear Creek	150,000	Stickford	0	75,000	75,000	0
Henry	Bear Creek	6,600,000	Henry	6,600,000	6,600,000	6,600,000	0
Henry Lake	Bear Creek	8,700,000	Henry Lake	8,700,000	7,000,000	5,000,000	0
Rucker	Bear Creek	1,100,000	Rucker	1,100,000	1,100,000	366,535	0
Johnson	Bear Creek	11,200,000	Dutch Creek	3,484,800	6,969,600	5,445,600	0
Grant No. 1	Bear Creek	3,000,000	...	2,000,000	2,000,000	613,600	0
Grant No. 2	Bear Creek	3,200,000	Grant	3,200,000	3,200,000	391,940	0
Grant No. 3	Bear Creek	4,900,000	Grant	4,900,000	4,900,000	78,408	0
Coy	Bear Creek	1,100,000	Coy	1,100,000	1,100,000	...	...
Coy No. 2	Bear Creek	300,000	Coy	300,000	300,000	...	...

DISTRICT 9. DIVISION 1—Concluded.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Bowles No. 1	Bear Creek	76,000,000	Bowles	76,000,000	70,000,000	47,602,800	0
Bowles No. 2	Bear Creek	15,681,600	Bowles	15,681,600	15,681,600		
Bowles No. 3	Bear Creek	2,613,600	Bowles	2,613,600	2,613,600		
Bowles No. 4	Bear Creek	2,395,800	Bowles	2,395,800	2,395,800		
Fort Logan	Bear Creek	348,480	Fort Logan	348,480	348,480	261,360	0
Marston	Bear Creek	862,257,600					
Bowles Nos. 2-3-4	Bear Creek	20,691,000	Bowles			20,691,000	10,700,000
Coy Nos. 1 and 2	Bear Creek	1,400,000	Coy			722,720	0

DISTRICT 10. DIVISION 2.

Cheyenne Valley	Fountain	21,500,000	High Line	8,712,000	13,000,000		
Charter Oak	Little Fountain	9,582,000	Charter Oak	9,000,000	9,582,000		
Cheyenne Mt.	Cheyenne	28,500,000	No. 1	15,000,000	24,396,000		
Broadmoor System	Cheyenne	15,000,000	Reservoir Ditch	13,000,000	15,000,000		
Fountain Valley No. 2	Fountain	436,000,000		304,720,000	522,720,000		
Fountain Valley No. 3	Fountain	74,052,000		Included in No. 2	Included in No. 2		

DISTRICT 11. DIVISION 2.

Evans Gulch	Evans Gulch	1,000,000	City of Leadville		449,000	1,000,000	1,000,000
Evans Gulch No. 2	Evans Gulch	1,000,000	City of Leadville		1,000,000	1,000,000	500,000
Big Evans Gulch No. 2	Evans Gulch	4,000,000	City of Leadville		4,000,000		
Mountain Lake	Springs	5,333,333	City of Leadville		3,333,333	1,000,000	5,000,000
Boss Lake	Boss Lake Creek	26,832,960	So. Arkansas River		26,832,960	26,832,960	2,000,000
Sugar Loaf	Lake Fork	738,227,100	Arkansas River	127,853,200	470,527,500	128,306,931	112,410,320
Clear Creek	Clear Creek	409,537,600	Otero Irr. District		253,067,300	348,155,900	51,375,120
Twin Lakes	Lake Creek		Colorado Canal				

DISTRICT 12. DIVISION 2.

Colorado Springs No. 7	West Beaver	6,724,400	Colorado	0	3,600,000		
Colorado Springs No. 8	West Beaver	23,200,000	Colorado	0	23,200,000		
Colorado Springs No. 2	West Beaver	10,133,333	Colorado	3,000,000	10,133,333		
Colorado Springs No. 4	West Beaver	115,272,533	Colorado	0	84,133,133		
Colorado Springs No. 5	West Beaver	89,258,533	Colorado	30,000,000	72,133,333		
Cripple Creek No. 1	West Beaver	16,666,666	Cripple Creek	266,666	16,666,666		
Cripple Creek No. 2	West Beaver	6,666,666	Cripple Creek	160,000	6,666,666		
Cedar Park	Eight Mile	2,178,000	Cedar Park	2,178,000	2,178,000		
Victor No. 2	West Beaver, E. Branch	9,105,676	Victor	1,000,000	8,000,000		
Bison Park	West Beaver, E. Branch	45,540,897	Victor	0	40,000,000		

DISTRICT 15. DIVISION 2.

Corwin	St. Charles	141,000,000	Lake Lavard	16,000,000	100,000,000		

DISTRICT 16. DIVISION 2.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Goose Ranch	Huerfano River	25,381,000	Martins, Smiths, Curtis Garden	....	....	20,000,000	0
A. D. Valdez	Santa Clara Creek	....	....	....	....	0	....
Clark	Apache Creek	50,964,205	Clark	0	3,719,531	12,741,051	0
La Joya	Cucharas	....	Farr	....	....	....	0
Martin & Coler	Cucharas	....	Farr No. 9	....	....	....	....
Holita	Cucharas	....	Andrews & Co	....	....	....	0

DISTRICT 17. DIVISION 2.

Lake Canal No. 1	Arkansas	282,952,000	Lateral No. 1	282,952,000	282,952,000	174,240,000	87,120,000
Lake Meredith	Arkansas	1,132,560,000	Colo. Canal	....	....	....	....
Box Springs	Horse Creek	162,000,000	Box Springs	....	....	0	0
Horse Creek	Arkansas and Horse	1,171,163,000	Ft. Lyon	345,835,720	1,017,386,205	9,583,200	0
Adobe	Arkansas and Adobe	2,682,207,000	Ft. Lyon	....	0	0	0
Swink No. 1	Apishapa	100,318,680	Lateral No. 1	38,202,120	100,318,680	50,000,000	20,000,000
Swink No. 2	Apishapa	12,107,800	Lateral No. 2	....	12,107,800	18,000,000	0
Timpas No. 2	Timpas	128,585,000	Lateral No. 2	0	62,076,000	1,412,000	0
Timpas No. 3	Timpas	79,725,000	Lateral No. 3	0	40,425,000	24,393,000	36,589,500
Red Top	Mustang	26,136,000	Red Top	....	....	0	6,840,000
Hardesty	Mustang	6,846,360	Hardesty	....	....	0	6,846,360
Nee Skah	Arkansas	1,426,852,732	Pawnee and Amity	827,640,000	901,692,000	616,680,800	90,299,880
Nee Noshe	Arkansas	2,641,325,240	Comanche and Amity	516,186,000	1,314,640,800	1,837,186,560	446,097,960
Nee Gronda	Arkansas	2,491,806,240	Comanche and Amity	1,634,825,600	1,459,260,000	1,464,138,720	1,190,059,200
Nee Sopah	Arkansas	1,022,113,620	Comanche and Amity	248,292,000	152,460,000	154,420,200	37,026,000
Mustang	Mustang	144,000,000	Lateral	....	....	0	8,000,000

DISTRICT 19. DIVISION 2.

North Lake	Las Animas, N. Fork	44,000,000	City of Trinidad	44,000,000	44,000,000	44,000,000	40,000,000

DISTRICT 23. DIVISION 1.

Antero	So. Platte	2,552,654,986	N. Colo. Irr. Canal	....	....	481,150,000	0
Cheesman	So. Platte	3,444,038,412	City of Denver	....	....	3,444,038,412	3,147,755,394
Jefferson	Springs	696,000,000	Jefferson Creek	....	....	696,000,000	460,125,600
Lake George	So. Platte	32,000,000	....	....	....	0	20,000,000

DISTRICT 24. DIVISION 3.

Eastdale No. 1	Costilla and Culebra	150,975,000	Laterals 5 and 6	....	....	100,000,000	100,000,000
Eastdale No. 2	Costilla and Culebra	132,468,000	Eastdale No. 1	....	....	132,468,000	0
Salazar	Rito Seco	2,461,199	Salazar	....	....	2,461,199	2,461,199
Mesita	Culebra	21,724,933	Laterals 7 and 8	....	....	0	576,500

DISTRICT 34. DIVISION 4.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Bauer Lake No. 2	Lost and Chicken Creeks	46,221,418				35,000,000	7,000,000
Bauer Lake No. 1	Lost Creek	10,000,000				8,000,000	0
Weber	Middle Mancos	19,250,000	Weber			7,373,000	429,000
Summit	Lost Canon	100,000,000	Turkey Creek			95,000,000	0
Joe Moore	Lost and Turkey	15,000,000	Turkey Creek			15,000,000	0
DISTRICT 35. DIVISION 3.							
Trinchera	Trinchera			0	0		
DISTRICT 40. DIVISION 4.							
Alexander Lakes	Water Shed	324,000,000	Surface Creek	324,000,000	100,000,000		
Youngs Creek	Water Shed	5,586,400	Lookout	5,586,400	0		
Ryan	Water Shed	1,500,000	Brombo	1,500,000	76,800		
Pine	Water Shed	300,000	Cherokee and Texas	300,000	41,000		
Prebble	Water Shed	3,000,000	Cherokee	3,000,000	0		
Trickle Park	Snow and Springs	100,000,000		100,000,000	0		
Weir & Johnson	Snow and Springs	8,000,000		8,000,000	0		
Kehmeyer	Snow and Springs	1,000,000		1,000,000	200,000		
Milton & Sackett	Snow and Springs	2,354,400		2,354,400	0		
Weir Park	Snow and Springs	216,000	Gevney	216,000	0		
Blanche Park	Snow and Springs			0	0		
Cedar Mesa	Snow and Springs		Cedar Mesa	0	0		
Bonita	Snow and Springs	4,850,000	Old Reliable	4,850,000	0		
Lambert & Hill	Snow and Springs	1,000,000	Weir & Johnson	1,000,000	420,000		
Pointer, 1 and 2	Snow and Springs		Weir & Johnson	345,600	0		
Chipmunk	Snow and Springs		C. & D.	800,000	0		
Y. & S.	Snow and Springs		Lone Pine and Rose	3,000,000	0		
Trout Lake	Snow and Springs		Hershue	1,500,000	0		
Cole, 1-2-3	Surface Creek		Cedar Mesa	3,000,000	0		
Wrist	Snow and Springs		Lone Pine	259,200	0		
Twins	Snow and Springs		Lone Pine	Full	Full		
Leon Lake	Snow	100,000,000	Cedar Mesa	100,000,000	0		
James Vela	Snow		Weir & Johnson	814,400	0		

DISTRICT 42. DIVISION 4.

NAME OF RESERVOIR	SOURCE OF SUPPLY	Capacity in Cubic Feet	Ditch Supplied from Reservoir	QUANTITY OF WATER IN RESERVOIR, CUBIC FEET			
				1909		1910	
				May 1	Nov. 1	May 1	Nov. 1
Coon Creek No. 1	Coon Creek		Godding & Elsbury			0	0
Coon Creek No. 2	Coon Creek		Godding & Elsbury				0
Coon Creek No. 4	Coon Creek		Godding & Elsbury			0	0
Grand Mesa No. 1	Kannah Creek		Bowen			0	0
Grand Mesa No. 8	Kannah Creek		Bowen			0	0
Scales No. 1	Kannah Creek		Bowen			0	0
Scales No. 2	Kannah Creek		Bowen			0	0
Grand Mesa No. 9	Kannah Creek		Bowen			0	0
Crane Lake	Kannah Creek	3,267,000	Juniata			0	0
Ternahan	Juniata Ditch	9,234,720	Private			9,234,720	0
Bonham No. 7	Big Creek	80,853,143	2 to 10, inc.			0	0
40-Acre Lake No. 4	Big Creek	11,474,910	2 to 10, inc.			11,474,910	0
Atkinson No. 3	Big Creek	62,221,242	2 to 10, inc.			20,740,414	0
Big Reservoir No. 1	Big Creek	33,059,419	2 to 10, inc.			22,039,612	0
Silver Lake No. 5	Big Creek	5,333,296	2 to 10, inc.			5,333,296	0

DISTRICT 53. DIVISION 5.

Leighton	Floodwater	955,920	Leighton			955,920	0
Sterner	Floodwater	12,270,720	High Water			12,270,720	0
Hooper	Floodwater	19,440,000	Derby			19,440,000	
Keener	Floodwater	15,552,000	Derby			15,552,000	
Clyde	Floodwater	1,347,840	McFarland			1,347,840	0
Gumprest	Floodwater	1,296,000	Merriman			1,296,000	
Edge	Floodwater	4,413,680	Grand R. D. Co.			4,413,680	
Bailey	Floodwater	829,440	Grand R. D. Co.			829,440	
Dome	Floodwater	1,658,680	Roberts			1,658,680	

DISTRICT 60. DIVISION 4.

Gurley	Beaver Creek		Gurley				
Lone Cone	Naturita Creek		Lone Cone		0		

DISTRICT 64. DIVISION 1.

Jumbo	So. Platte	1,235,000,000	High Line, Peterson & Settlers	950,000,000	200,000,000	0	

DISTRICT 65. DIVISION 1.

E. W. Wolf No. 1	Olive Creek	2,178,000		2,178,000	2,000,000	1,742,400	1,592,000
E. W. Wolf No. 2	Olive Creek	1,524,000		1,524,000	1,000,000	1,524,000	1,000,000
J. H. Rosecrance	Dry Willow	14,000,000		14,000,000	10,000,000	8,000,000	9,000,000
E. J. Dowling No. 1	Rush Creek	2,000,000		2,000,000	1,500,000	2,000,000	1,400,000
E. J. Dowling No. 2	Rush Creek	1,200,000		1,200,000	1,000,000	1,200,000	700,000
R. S. Pike No. 1	Spring	1,983,756		1,983,756	1,000,000	1,983,756	1,300,000
R. S. Pike No. 2	Spring	124,735		124,735	100,000	124,522	80,000
R. S. Pike No. 3	Spring	798,722		798,722	600,000	798,722	450,000
George Short	Holy Joe	1,524,000		1,524,000	600,000	1,524,000	500,000

CHAPTER VII.

IRRIGATION DISTRICTS.

Under the Irrigation District law of Colorado, the State Engineer's office has no supervision or control over the organization or operation of irrigation districts authorized by the act of 1905.

With a view, however, to collecting as much information as possible relating to these districts, a letter was addressed to each county clerk in Colorado asking for the names of any irrigation districts which had been organized in the county and for the names and addresses of the officers of these districts.

A blank inquiry form was thereupon prepared and sent to the secretary of each irrigation district, with a request that the information therein asked for be supplied to the State Engineer's office.

Seventeen districts complied with this request and the information thus obtained is abstracted below.

It should be understood that the information here published is that supplied by the district officials, and that the State Engineer's office has no independent means of verifying any of the figures or statements so supplied.

MONTEZUMA VALLEY IRRIGATION DISTRICT.

This district is located in Montezuma county, Colorado, and was organized in December, 1901. The office address is Cortez, Montezuma county, Colorado.

Bonds to the amount of $795,000 were issued on May 1, 1907. An additional issue of $125,000 has been authorized.

Water is obtained from the Dolores river. The district has priority No. 21 for 64.6 cubic-feet per second and priority No. 50 for 1,235.4 cubic-feet per second.

There are two reservoirs. The Narraguinnep reservoir, which has a capacity of 9,270 acre feet, was begun May 3, 1907, and completed September 15, 1907.

The Ground Hog reservoir, which is partly constructed, will have a capacity of 14,280 acre feet.

Feeder Canal No. 1 is 6,600 feet long and has a carrying capacity of 375 cubic feet per second.

Feeder Canal No. 2 is 31,000 feet long and has a carrying capacity of 375 cubic feet per second.

The district contains 38,000 acres of irrigable, patented land which was taxed for district purposes in 1909. In addition to this about 12,000 acres of State land is so situated that it can be irrigated through the district system. There are also about 10,000 acres of government and other lands which are not a part of the district, but which would depend upon it for water supply.

FORT MORGAN IRRIGATION DISTRICT.

This district is located in Morgan county, Colorado, and its office address is Fort Morgan. It was organized in 1903.

A bond issue of $178,600 was made on January 1, 1904. Of this, $170,000 worth have been sold.

The water supply is derived from the South Platte river. The district owns 19,500 acre-feet in the Jackson Lake reservoir. The land is located under the Fort Morgan ditch, which has a decree for 323 cubic-feet per second for direct irrigation, as of date October 18, 1882.

The area of land in the district is about 12,500 acres.

ORCHARD MESA IRRIGATION DISTRICT.

This district is located in Mesa county, Colorado, and has its office in Grand Junction. It was organized in 1904.

On December 1, 1908, bonds to the amount of $1,075,000 were issued.

Water is taken from the Grand river, from which 450 cubic-feet per second is claimed. This has not as yet been decreed. No reservoirs are provided. There are two distributing canals, each 18 miles long. Construction was begun on June 10, 1909, and completed on July 16, 1910.

There are 12,000 acres of land in the district.

GREEN CITY IRRIGATION DISTRICT.

This district is located in Weld county, and its office is at Masters, Weld county, Colorado. It was organized in 1906.

In June, 1906, $46,000 in bonds were issued.

Water is taken from the South Platte river through the Riverside reservoir. The district contains 1,960 acres.

RIVERSIDE IRRIGATION DISTRICT.

The office of this district is at Fort Morgan, Colorado. The lands comprising the district are located in Weld, Morgan and Logan counties.

The district was organized on March 5, 1907. On July 1, 1907, a bond issue of $747,500 was made.

Water is taken from the South Platte river through the Riverside reservoir. Claim is made for 450 cubic feet per second, but no adjudication has as yet been made.

The intake canal of the Riverside reservoir is 11 miles long, and has a carrying capacity of 700 cubic feet per second. The reservoir itself has a capacity of 55,000 acre feet. The distributing canal is 110 miles long, and has a carrying capacity of 300 cubic feet per second.

The area of deeded land in the district is about 15,000 acres.

NILE IRRIGATION DISTRICT.

This district is located in Morgan county, Colorado. The district was organized on July 11, 1908.

A bond issue of $700,000 was made on August 15, 1908.

Water is to be taken from Bijou, Muddy, Antelope, Rock and Kiowa creeks. No adjudication of the water rights of this district has been made.

It is proposed to construct the following reservoirs:

	Acre feet.
Macarthy	8,083
West Nile	17,064
Adams	9,937
Total	35,084

These will be supplied by the Upper Nile ditch, two miles long, with a carrying capacity of 2,000 cubic feet per second, and the Lower Nile ditch, five miles long, with a carrying capacity of 1,000 cubic feet per second.

The district contains about 9,000 acres of deeded land. No actual construction work has yet been done.

EAST PALISADE IRRIGATION DISTRICT.

The office of this district is at Palisade, Mesa county, Colorado, and the lands are located in Mesa county. The district was organized in 1908. During that year a bond issue of $26,000 was made, and in 1909 $15,000 of additional bonds were issued.

Water is to be taken from the Grand river and raised by pumps operated by steam. Claim is made for 10 cubic feet per second, dating from 1904.

There are two distributing lines. The lower ditch has a capacity of 8 cubic feet per second and a length of 9,000 feet. The upper line consists of 5,400 feet of 8-inch pipe and 4,000 feet of open ditch, and has a capacity of 2 cubic feet per second.

Construction work was begun by the Grape Growers' Ditch Company, about 1904. This district was organized to take over the projects of the Grape Growers' Ditch Company and of some other parties, and took up active construction work in 1910.

There are about 675 acres of deeded land in the district.

SAN ARROYO IRRIGATION DISTRICT.

This district is located in Morgan county and has its office at Fort Morgan. It was organized in 1908, and in July of that year bonds to the amount of $235,000 were issued.

The Williams-McCreery reservoir is under construction to supply water to the district. It depends on the flood run-off from its drainage area for water supply. The capacity of this reservoir is 17,600 acre feet.

The east distributing canal has a carrying capacity of 50 cubic feet per second and a length of eight miles. The west distributing canal has a carrying capacity of 75 cubic feet per second and a length of sixteen miles.

Construction work was begun in the spring of 1910, and at this writing is nearly complete.

The district contains 3,000 acres of deeded land.

GOLDEN-LITTLETON IRRIGATION DISTRICT.

This district is located in Jefferson and Arapahoe counties, and has its office at Edgewater. It was organized December 6, 1908. No bonds have yet been issued, and no construction work has been done.

SAN LUIS VALLEY IRRIGATION DISTRICT.

The office of this district is at Center, Saguache county. The lands are located in Saguache, Rio Grande and Costilla counties.

The district was organized January 11, 1909, and on June 1, 1909, bonds to the amount of $530,000 were issued. Water is taken from the Rio Grande, and the district claims appropriations of the following dates and amounts:

	Cubic feet per second.
Nov. 9, 1887	140.00
June 30, 1889	5.45
June 30, 1890	105.41
June 30, 1891	280.47
June 30, 1892	159.69
June 30, 1893	149.69
June 30, 1894	82.91
June 30, 1895	57.51
June 30, 1896	58.17
June 30, 1897	40.79
June 30, 1898	18.07
June 30, 1899	7.95
June 30, 1900	18.13
Total	1,124.24

The district has acquired the ownership of about 100 miles of distributing canal built twenty-three years ago. It now has under construction the Rio Grande reservoir, with a capacity of about 43,000 acre feet, located on the Rio Grande about 35 miles above Creede, in Hinsdale county.

The district includes 80,000 acres of deeded land.

BADGER CREEK IRRIGATION DISTRICT.

This district is located in Morgan county, and has its office at Fort Morgan. It was organized February 15, 1909. On June 1, 1909, bonds were issued to the amount of $350,000.

Water will be taken from Badger creek, one of the tributaries of the South Platte river.

The Badger Creek reservoir has a capacity of 9,900 acre feet, and depends on the flood water of Badger creek for its supply.

The east distributing canal is between ten and twelve miles long. The west distributing canal is about eight miles long. Construction work was commenced in August, 1909, and completed in August, 1910.

The district contains about 5,000 acres of deeded land.

DENVER-GREELEY VALLEY IRRIGATION DISTRICT.

The lands of this district are located in Adams and Weld counties. It has offices at Hudson, Weld county, and in Denver.

The district was organized March 8, 1909, and on April 5, 1909, issued $2,000,000 in bonds.

The district owns 3,500 shares of stock in the Farmers Reservoir and Irrigation Company, and will derive its supply of water from a system now under construction by that company.

Sixty-two thousand five hundred acres of land will be irrigated in this district.

THE GREELEY-POUDRE IRRIGATION DISTRICT.

This district is located in Weld county and has its office at Greeley. It was organized April 14, 1909. On December 1, 1909, bonds to the amount of $5,100,000 were issued.

Water will be derived from the Cache la Poudre and Laramie rivers, from Crow creek, Lone Tree creek, Indian creek, Robinson creek, Oak creek, Coal creek and Rattlesnake creek.

The water rights and water system of this district are as follows:

(a) Rights of appropriations of water from Laramie river and tributaries thereof in Water District No. 48 of the State of Colorado, evidenced by decrees of court confirming the same, as follows:

Priority No. 1, pertinent to the Mansfield ditch No. 2, for 19.84 cubic feet of water per second, as of date June 1, 1880.

Priority No. 2, pertinent to Hill's ditch, for 11 cubic feet of water per second, as of date July 1, 1880.

Priority No. 3, pertinent to the Warren ditch, for 6.67 cubic feet of water per second, of date March 25, 1881.

Priority No. 5, pertinent to the Stuck creek ditch, for 16.12 cubic feet of water per second, of date April 1, 1881.

Priority No. 7, pertinent to the Bliler and Boswell ditch, for 16.43 cubic feet of water per second, of date April 1, 1882.

Priority No. 8, pertinent to the Mansfield ditch, for 11.61 cubic feet of water per second, of date April 20, 1882.

Priority No. 9, pertinent to the Yelton ditch, for 30.14 cubic feet of water per second, of date July 1, 1882.

Priority No. 15, pertinent to the Smith-Brown ditch, for 16.63 cubic feet of water per second, of date June 10, 1884.

Priority No. 17, pertinent to the Homestead ditch, for 9 cubic feet of water per second, of date July 10, 1884.

Priority No. 24, pertinent to the Comet ditch, for 7.40 cubic feet of water per second, of date December 7, 1892.

Priority No. 27, pertinent to the Link ditch, for 14.22 cubic feet of water per second, of date June 1, 1894.

Priority No. 32, pertinent to the Link ditch No. 2, for 2 cubic feet of water per second, of date June 15, 1896.

Priority No. 56, pertinent to the Long Park ditch No. 2, for 10 cubic feet of water per second, of date June 1, 1902.

Priority No. 59, pertinent to the Long Park ditch, for 10 cubic feet of water per second, of date July 10, 1902.

As well as all appropriations pertinent to the Link Lake Ditch & Reservoir System, as claimed by Wallace A. Link and Abram I. Akin, for 224 cubic feet of water per second, of date July 24, 1902; and the Laramie tunnel ditches and feeders, claimed by Harry L. Monroe, of date August 6, 1904, for 664 cubic feet of water per second from the east and west forks of Laramie river, 334 cubic feet of water per second from Deadman and Nunn creek, and 225 cubic feet of water per second from Rawah creek. As well as all appropriations pertinent to the East Fork ditch and reservoir, made by Myron H. Akin, of date of March 14, 1904, for 1,000 cubic feet of water per second, and appropriations pertinent to the Laramie river tunnel, ditches and reservoirs, made by the Laramie-Poudre Reservoirs and Irrigation Company, or its predecessors, of date June 19, 1904, for 786 cubic feet of water per second, together with all rights of appropriation held or to be acquired by the company pertinent to the Laramie-Poudre canal, Pierce lateral, Link lakes, Dowdy and Twin lakes, Lake McGrew reservoir, March reservoir, Drury reservoir No. 3, commonly known as Camfield reservoir No. 3, Drury ditch, Camfield ditch, Douglas lake reservoir, and all other properties and appropriations pertinent to and represented by the 2,774 shares of the capital stock of the Poudre Valley Reservoir Company, to be assigned to the district hereunder, and all and singular the rights of appropriation and rights to the use of water which heretofore have or hereafter shall accrue, by virtue of the use of all the irrigation works which shall be completed and conveyed to the district hereunder, in accordance with the terms and conditions herein contained, to secure which right the said district may, at its option, make full and proper claims of appropriation for irrigation purposes to and upon all water to be diverted, carried, stored and distributed through and by means of said system of irrigation works.

(b) Two thousand seven hundred seventy-four (2,774) shares of the capital stock of The Poudre Valley Reservoir Company, subject to the rights and easements in the Poudre Valley ditch, as now fixed and vested, the said Poudre Valley ditch to be enlarged so as to have a total safe carrying capacity from its headgate to the terminus thereof, of 1,200 cubic feet of water per second of time, according to Kutter's formula N=.025, with a margin of safety of embankment above the high water line of said ditch of 2 feet, unless the Stove Prairie reservoir shall be completed and sold to the district hereunder in lieu of the storage capacity to be furnished in North Poudre reservoirs Nos. 5, 6, 7 and 9, and Cobb lake, in which event the said Poudre Valley ditch, from its headgate to its present terminus (being the place of beginning of the Laramie-Poudre canal), shall be built to a total safe carrying capacity of 900 cubic feet per second; the district to have the right to use the same and to have the same used for filling of the reservoirs now filled by means of said ditch to the full carrying capacity of said ditch; the enlargement of said ditch to be the property of the district and the district to pay its pro rata portion of the cost of the maintenance and operation of the ditch pertinent to said 2,774 shares of the capital stock of The Poudre Valley Reservoir Company, and to pay its pro rata portion of the cost of maintenance and the cost of operation of said ditch as pertains to the enlarged capacity thereof, and as the same shall bear to the whole carrying capacity of said ditch after such enlargement.

(c) The Laramie-Poudre canal, with its place of beginning at the terminus of the Poudre Valley ditch and extending from thence in a general easterly and northeasterly direction to and discharging into Lake McGrew reservoir in townships 8 and 9 north, range 65 west, and thence in a general easterly direction to a point at or near Crow creek, as the same is now surveyed, with rights of way and all appurtenances connected therewith, the said ditch to have a total safe carrying capacity according to Kutter's formula N=.025, with a margin of two feet of embankment from the high water line of said ditch to top of embankment on the lower side and in fills on both sides, from the place of beginning of said canal to the place of discharge of water therefrom into the North Poudre reservoirs Nos. 5, 6, 7 and 9, of 1,200 cubic feet of water per second of time, and from said place of discharge into said reservoirs 5, 6, 7 and 9, to the place of discharge from said Laramie-Poudre canal into Cobb lake, of 575 cubic feet of water per second, and from said place of discharge into Cobb lake to Lake McGrew reservoir of 350 cubic feet of water per second, and from Lake McGrew reservoir to the terminus thereof, to have a safe carrying capacity at the place of discharge from said lake of 350 cubic feet of water per second, which ditch shall be gradually reduced in capacity as the burden thereon is reduced to its terminus, in accordance with the plans and specifications for said ditch hereto attached and made a part hereof; unless the Stove Prairie reservoir shall be completed and conveyed to the district as herein permitted and provided in lieu of reservoirs Nos. 5, 6, 7 and 9, and Cobb lake, in which event the said ditch shall be constructed to a safe carrying capacity in accordance with the plans and specifications aforesaid of 900 cubic feet of water per second from its place of beginning at terminus of Poudre Valley canal to the place of discharge into reservoirs Nos. 5, 6, 7 and 9, and from thence to Black Hollow, of a safe carrying capacity of 575 cubic feet of water per second, and from Black Hollow to Lake McGrew, of a safe carrying capacity of 500 cubic feet per second, and from the place of discharge from Lake McGrew to the terminus of said ditch of a capacity beginning at said place of discharge of 350 cubic feet of water per second of time, to be gradually reduced as the burden thereon is reduced, to the terminus of said ditch, all in acocrdance with the formula, plans and specifications hereto attached.

(d) The Pierce lateral to have a safe carrying capacity from its place of beginning to its place of terminus and discharge into Owl creek in section 34, township 9 north, range 65 west, of 325 cubic feet of water per second, according to Kutter's formula N=.025, with margin of safety of embankment of two feet above the high-water line on the lower side and in fills on both sides, and to be so constructed as to be able to divert and carry from reservoirs Nos. 5, 6, 7 and 9, of the North Poudre Irrigation Company, at the outlet tube therefrom into said

Pierce lateral, either by construction of a ditch from said place of discharge of a carrying capacity equal to said 325 cubic feet per second from said place of discharge of said reservoir into said Pierce lateral, or by means of an enlargement of the Larimer county ditch of the Water Supply & Storage Company, or a carriage privilege through said ditch from point of discharge from said reservoirs Nos. 5, 6, 7 and 9, to and into said Pierce lateral so as to secure to the district a right and means of carriage for water from the place of discharge from reservoirs Nos. 5, 6, 7 and 9, in amount equal to 325 cubic feet of water per second, and through the same into Owl creek, all according to the stipulations, plans and specifications therefor herein agreed and hereto attached; unless the Stove Prairie reservoir shall be completed for the district, in which event said Pierce lateral shall be connected with the Laramie-Poudre canal where said canal crosses Black Hollow by means of a ditch with drops, if found necessary, extending from said Laramie-Poudre canal at the point where said canal intersects said Black Hollow, to and into said Pierce lateral so as to permit of the carriage from said Laramie-Poudre canal into said Pierce lateral and through said Pierce lateral to Owl creek, of a total of 50 cubic feet of water per second in addition to the present carrying capacity of said ditch, and, in any event, there shall be conveyed to said district by the company in addition to either enlargement in said ditch, 48.65 carriage rights in said lateral, evidenced by deeds to said rights, together with rights of way therefor and all appurtenances and appliances therewith connected to be installed, now held by the company, as more fully appears from the plans and specifications for said work.

(e) The center lateral, or Owl creek ditch, having its point of beginning upon Owl creek and extending in a general easterly direction and terminating near the east side of said district and discharging into Drury reservoir No. 3, commonly called Camfield reservoir No. 3, to have a safe carrying capacity at its place of beginning on Owl creek of 325 cubic feet, which shall be gradually reduced in capacity as the burden thereon is reduced to its terminus, together with rights of way therefor and all appliances and equipment therewith connected, according to the plans hereto attached; provided, that if the Stove Prairie reservoir shall be completed for the district in lieu of reservoirs Nos. 5, 6, 7 and 9, and Cobb lake, that then the point of intake or commencement of this ditch may be changed from its present location, as shown upon the maps, plans and drawings in accordance with the judgment of the engineer of said district, and if said change shall be made, corresponding changes may be made in the carrying capacity of the outlet ditch from Lake McGrew reservoir, to the end that each acre of the district to be served by said Lake McGrew reservoir outlet and Owl creek ditch or center lateral shall be accorded a like distribution capacity from the district works.

(f) The Rawah ditch, as now constructed, discharging into the west fork of the Big Laramie river near the diversion dam in said stream of the Sky Line ditch of the Water Supply & Storage Company, together with the rights of way and all and singular of the dykes, embankments, appliances and equipments as now constructed and used in connection with said ditch.

(g) The Rawah and lower supply ditch, extending from Rawah creek, which creek is the main outlet from Rawah lake, and to discharge as per plans and specifications hereto attached, into the tunnel reservoir of the company, together with the rights of way therefor and all and singular the dams, headgates, flumes, dykes, embankments, appliances, equipment and all appurtenances in any wise connected therewith.

(h) The McIntyre ditch, extending from McIntyre creek and McIntyre lake and discharging into Rawah creek at a point above the headgate upon said stream of the Rawah and lower supply ditch of the company, together with the rights of way therefor, the dams, headgates, flumes, dykes, embankments, appliances and all equipment and appurtenances in any wise connected therewith, and so constructed and completed as to divert waters from McIntyre river and in connection with the water works described in paragraphs (f) and (g) aforesaid, so as to intercept and divert water and discharge the same into the tunnel reservoir of the company from Rawah creek, Spring creek, Rapid creek, Fall creek and Mill creek and other streams tributary of the Laramie river, together with rights of way, dams, flumes, dykes, embankments and equipment in any wise connected therewith as shown upon the plans and specifications.

(i) The Deadman and Nunn Creek ditch, having its place of beginning and headgate upon the south bank of Deadman creek in Larimer county, Colorado, and extending from thence in a general southerly direction, to be so constructed as to divert water from Deadman creek, Nunn creek, Porter creek, Brinker creek and other streams and tributaries of the Laramie river, and to discharge the same into said Tunnel reservoir of the company, together with all and singular the headgates, flumes, dams, spillways, dykes, embankments, rights of way, equipment and all appurtenances in any manner connected with the said ditch, as more particularly described upon the plans and specifications hereto attached.

(j) The Laramie river tunnel, extending through the divide between the Laramie river and the Cache la Poudre river in Larimer county, Colorado, to be constructed to a carrying capacity capable of diverting and carrying 800 cubic feet of water per second of time, together with all and singular the rights of way, devices and appurtenances in any wise connected therewith, according to the plans and specifications hereto attached.

(k) The Link Lakes reservoirs, Nos. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10 and 11 (otherwise called Camp Lake); Tunnel reservoir, East Fork, or No. 12 reservoir; reservoirs Nos. 13 and 14, near the headwaters of McIntyre creek, all of said reservoirs when completed, according to the plans and specifications, to have a safe storage capacity capable of being drawn off, and utilized, of not less than 270,000,000 cubic feet of water, 170,000,000 cubic feet of said capacity to be in Tunnel Reservoir, together with dams, embankments, rip-raps, inlet and outlet ditches, conduits, spillways, rights of way and all appurtenances and equipment in any manner connected therewith, as set forth and described in the plans and specifications hereto attached.

(l) Dowdy and Twin lakes, located in the valley and connected with Lone Pine creek in Larimer county, Colorado, to have, when fully completed and enlarged, a safe storage capacity, capable of being discharged, of not less than 130,000,000 cubic feet of water, together with the rights of way and all appropriations and appurtenances, to be constructed and enlarged in accordance with the plans and specifications hereto attached.

(m) Lake McGrew reservoir, together with the inlet and outlet devices, dams, embankments, rip-raps, conduits, and all rights of way therefor, and appurtenances in any wise connected therewith, to have a safe storage capacity, capable of being drawn off and utilized by the district of not less than 775,000,000 cubic feet of water, in case the Stove Prairie reservoir be not completed for the district in lieu of reservoirs Nos. 5, 6, 7 and 9, and Cobb lake hereunder, and in case the said Stove Prairie reservoir be completed for the district hereunder, then the total storage capacity of said reservoir capable of being drawn off and utilized by the district, shall be 825,000,000 cubic feet of water, to be completed in either event in strict accordance with the plans and specifications therefor hereto attached. It is distinctly understood and agreed, anything herein to the contrary notwithstanding, that the district shall take the said reservoir subject to and burdened with whatever rights, if any, which may have heretofore attached to, or vested in, certain individuals claiming capacity in said reservoir, under and by virtue of certain deeds evidencing said rights; the said reservoir to be completed by enlargement so as to be capable of storing the additional capacity to be completed for the district therein, it being understood that said rights in said reservoir and the exercise thereof shall not in any manner interfere with or affect the efficiency of said reservoir for the purposes of the district hereunder nor the storage capacity in said reservoir to be secured for the district to the extent above designated.

(n) The March reservoir, together with its inlet and outlet ditches and devices, embankment, rip-rap, rights of way and all appurtenances in any wise connected therewith, to have a safe storage capacity capable of being drawn off and utilized by the district of not less than 450,000,000 cubic feet of water, as shown upon the plans and specifications hereto attached.

(o) The Nunn lateral, together with pumping plant (site of which and right of way for said lateral to be furnished by the district free of cost to the company), to elevate water into the same from the Laramie-Poudre canal, together with the dams, sumps, pumps, wells and all devices and appliances and equipment in any wise connected therewith as per plans and specifications hereto attached.

(p) A system of secondary laterals to extend from the Laramie-Poudre canal and outlet of Lake McGrew reservoir and the center lateral or Owl creek ditch, to require a total excavation of 175,000 cubic yards of material, 4,200 lineal feet of 18-inch steel pipe, No. 18, installed, together with twenty-three headgates, headworks and appliances necessary to divert water from the main distributing canals of the district aforesaid into said laterals, the said laterals to be located by the engineer of the district, and rights of way to be acquired by the district, and the said laterals to be completed thereon by the company on or before the first day of December, 1910; provided, that the place of location and alignment of said laterals shall be fixed and determined by the board of directors of the district and the district engineer, on or before the first day of March, 1910; the said ditches to be constructed and headworks thereof installed in accordance with the plans and specifications therefor, hereto attached.

(q) Reservoirs of the North Poudre Irrigation Company Nos. 5, 6, 7 and 9, to be completed and constructed to a total storage capacity sufficient to accommodate therein for the use and benefit of the district 1,800,000,000 cubic feet of water in excess of the storage right and storage capacity therein of 500,000,000 cubic feet held by the said The North Poudre Irrigation Company in said reservoirs, which water of the district to be stored therein shall be capable of being drawn off and discharged from said reservoirs in an amount equal to 325 cubic feet per second of time into the Pierce lateral, either by means of a ditch from said reservoir outlets discharging directly into said lateral or by enlargement of the ditch of the Water Supply and Storage Company and privilege of carrying there through into said Pierce lateral at all times said quantity of 325 cubic feet of water per second from said reservoirs, together with right of way and all appurtenances and appropriations in any wise connected therewith, and the said reservoirs to have a total outlet capacity through the outlet conduits therefor and into said outlet ditch to Pierce lateral and said Larimer County ditch of not less than 600 cubic feet per second, with 15-foot head on the outlet gates; all in accordance with the plans and specifications hereto attached.

(r) Cobb Lake reservoir to a total storage capacity of 700,000,000 cubic feet of water, capable of being drawn off for the use and benefit of the district, together with dams, embankments, conduits, rights of way and all appropriations and appurtenances therewith connected, including an outlet ditch therefrom into Pierce lateral capable of carrying from said reservoir to and into said Pierce lateral not less than 325 cubic feet of water per second, which outlet ditch may be discharged directly into the Larimer County ditch, provided a carriage privilege without cost to the district other than maintenance shall be secured for the district through the Larimer County ditch to and into said Pierce lateral with an outlet capacity of 400 cubic feet per second, under a fifteen-foot head, all in accordance with the plans and specifications hereto attached; provided, that any and all rights of the district in said Cobb lake to be acquired pertinent to said 2,774 shares of the capital stock of the Poudre Valley Reservoir Company shall be allowed to be used by the company in case said Cobb Lake reservoir be completed for the district herein.

(s) The Stove Prairie reservoir, located in the bed and channel of the Cache La Poudre river, in sections 5 and 6, township 8 north, range 71 west, sections 31 and 32, township 9 north, range 71 west, and sections 1, 11 and 12 in township 8 north, range 72 west, in Larimer county, Colorado, to be sold to the district and completed to a storage capacity sufficient to safely store therein and to discharge therefrom 1,500,000,000 cubic feet of water, together with all appropriations for irrigation appurtenant to said reservoir as heretofore initiated and to be acquired by virtue of the use of said reservoir and the water to be stored therein for irrigation, reserving to the company and its assigns all right to use said reservoir and the water stored and impounded therein for power purposes and to install therein such devices and equipment as may be necessary to utilize the water stored therein for power purposes, and the right to make such exchange or exchanges of water therein impounded hereafter as may be necessary to fully utilize water for power purposes; provided, however, that the installation of such devices and machinery, or the exchange of water stored therein, shall in no manner interfere with the use of said reservoir or the water therein impounded by the district for the irrigation of the lands of the district, its water users and consumers, which reservoir is to be completed and sold to the district hereunder only at the option of the company, and if constructed and completed shall be completed for the district in lieu of Reservoirs Nos. 5, 6, 7 and 9 and Cobb lake to the extent herein above set forth, it being expressly understood and agreed that the company shall have the option of constructing for the district either the Stove Prairie reservoir, as herein provided, to the extent herein set forth, or in lieu thereof Reservoirs Nos. 5, 6, 7 and 9 and Cobb lake, to an extent and in the manner and under the terms herein stipulated; provided, that if said Stove Prairie reservoir shall be constructed, then the total storage capacity to be completed for the district in Lake McGrew reservoir, in lieu of 775,000,000 cubic feet as herein agreed, shall be a total of 825,000,000 cubic feet in said reservoir for the district; and provided, further, that the company shall elect, on or before 120 days after the confirmation of the bonds of the district, whether it will complete and sell to the district hereunder the said Stove Prairie reservoir to the extent herein stipulated, in accordance with the terms herein set forth, or will complete said Reservoirs Nos. 5, 6, 7 and 9 and Cobb lake as herein provided, and the company shall notify the board of directors of the district of its decision and election thereunder in writing within the time limit above specified; provided, also, that if said Stove Prairie reservoir shall be constructed, the dam thereof shall be constructed of solid masonry or concrete or steel, or a combination of said materials, firmly imbedded upon bed rock and into the canon walls, all under the supervision and to the satisfaction and approval of the State Engineer of the State of Colorado, acting during the construction and completion of said reservoir, and in accordance with the plans and specifications to be agreed upon by the engineer of the district and the engineer of the company, the said reservoir outlet constructed through the solid rock of the walls of the canon at the dam site, capable of discharging from said reservoir not less than 2,500 cubic feet of water per second of time, and a spillway, the bottom of which shall be at the elevation of the high-water line of said reservoir and which shall have a total discharge capacity from said reservoir, when the reservoir is filled to high-water line, of not less than 3,000 cubic feet of water per second.

Construction was commenced about January 1, 1910. It is expected that construction will be completed about June 1, 1912.

The district includes 125,000 acres, of which 78,000 acres are deeded land and the remainder is held under homestead and desert land entries upon which final proof has not yet been made.

HOLBROOK IRRIGATION DISTRICT.

This district has its office in La Junta. The lands are located in Otero county. The district was organized May 11, 1909, and a bond issue of $650,000 was made on December 1, 1909.

This district receives its water supply from the Arkansas river through the Lake canal. The Lake canal has one decree for 155 cubic feet per second, dated September 25, 1889, and one for 445 cubic feet per second, dated August 30, 1893.

The district also owns two reservoirs. Reservoir No. 1 has a capacity of 7,500 acre-feet; Dye reservoir has a capacity of 5,000 acre-feet.

Reservoir No. 1 has a decree of date March 2, 1892. The Lake canal is used as a feeder to both of these reservoirs. Its length to the Dye reservoir is 49,693 feet and to reservoir No. 1, 79,278 feet. The outlet canal from reservoir No. 1 has a carrying capacity of 300 cubic feet per second and a length of 14,476 feet. The outlet canal from the Dye reservoir has a capacity of 500 cubic feet per second and is only about 1,500 feet long to the point where it discharges into the river.

The original construction was begun about February 1, 1890, and completed about April 1, 1892. There are 16,000 acres of deeded land in the district.

The Lake canal, with a decreed capacity of 600 cubic feet per second, and Reservoir No. 1 with a decreed capacity of about 4,200 acre-feet were constructed and owned by the Laguna Canal Company, and were operated by them for many years.

In 1909 the territory watered by this system was formed into an irrigation district for the purpose of bonding the same and purchasing the interests of the Laguna Canal Company, and developing a better reservoir system.

In January, 1910, the district purchased all the interests of the Laguna Canal Company and immediately commenced construction work raising the embankment on Reservoir No. 1, and building an outlet from the same to the Arkansas river. This work is now completed; and the construction work of developing Dye Reservoir (a natural depression on the line of the Lake canal) to a capacity of 5,000 acre-feet is now almost completed.

The enlargement of the Lake canal from its headgate to Dye Reservoir, for filling the same, will be completed during the winter of 1910 and 1911. The water from both reservoirs will be run into the river, and a like amount turned into the head of the Lake canal for direct irrigation, this being necessitated from the fact that the water level in the reservoirs is below the lands to be watered.

The sole purpose of the organization of the district was to secure a better and supplemental water supply for lands which are (and have been for years) under cultivation, and not for the purpose of bringing new lands under cultivation.

HIGHLAND IRRIGATION DISTRICT.

This district is located in Bent county and has its office in Las Animas. It was organized June 26, 1909. Bonds to the amount of $100,000 were issued December 1, 1909, and a further issue of $25,000 was made March 1, 1910.

The water supply is obtained from the Purgatoire river. The district owns decrees in the Sizer Ditch of 16.6 cubic feet per second of date 1866 and 7.4 cubic feet per second of date 1884. It has also filed claim to 120 cubic feet per second, under date of March 1, 1909.

Construction work was begun January 1, 1910, and completed November 1, 1910. The district includes 4,000 acres.

THE HENRYLYN IRRIGATION DISTRICT.

This district has its office in Hudson, Weld county, Colorado, and its lands are located in Weld and Adams counties. It was organized in September, 1909, and bonds to the amount of $4,387,000 were issued in February, 1910.

It will derive its water supply from the South Platte river, Clear creek, Horse creek, Box Elder creek, Lost creek and Sand creek; also from the Williams Fork of the Grand river through the Intermountain Tunnel.

A claim to 1,011 cubic feet per second for the Denver-Hudson canal dates from November 23, 1907, and a claim for 700 cubic feet per second for the Williams Fork Supply canals dates from May 15, 1902.

The district has purchased from the Intermountain Water Company a decree of 700 cubic feet per second, dating from August 7, 1906.

The Williams Fork Supply canals will have an aggregate length of 16.5 miles, the Clear Creek-Platte canal a length of 4.5 miles and the Denver-Hudson canal a length of 44.5 miles.

The Horse Creek Reservoir will have a capacity of 29,400 acre-feet, the Lost Creek Reservoir a capacity of 1,400 acre-feet, the Sand Creek Reservoir a capacity of 1,800 acre-feet, the Boot Leg Reservoir a capacity of 6,200 acre-feet and the Schoffe Reservoir a capacity of 21,500 acre-feet.

The Boot Leg Reservoir has already been constructed. As to the others this office is not advised. Construction work was begun by this district in May, 1908. It is expected that the entire system will be completed in 1912.

The district includes about 60,000 acres of deeded land.

GRAND VALLEY IRRIGATION DISTRICT.

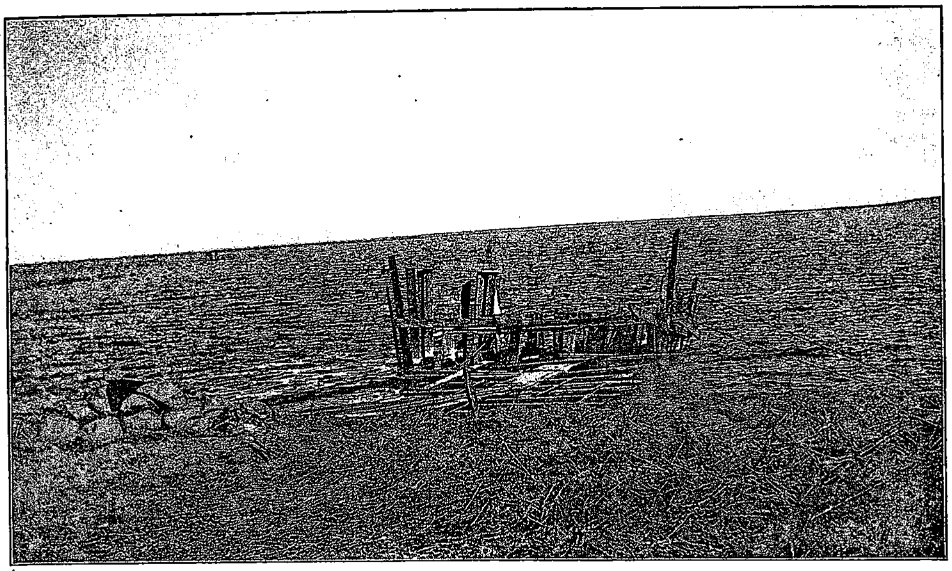
The lands of this district are located in Garfield county and the office is in the town of Grand Valley in that county.

The district was organized December 27, 1909. On June 1, 1910, bonds were issued to the amount of $425,000.

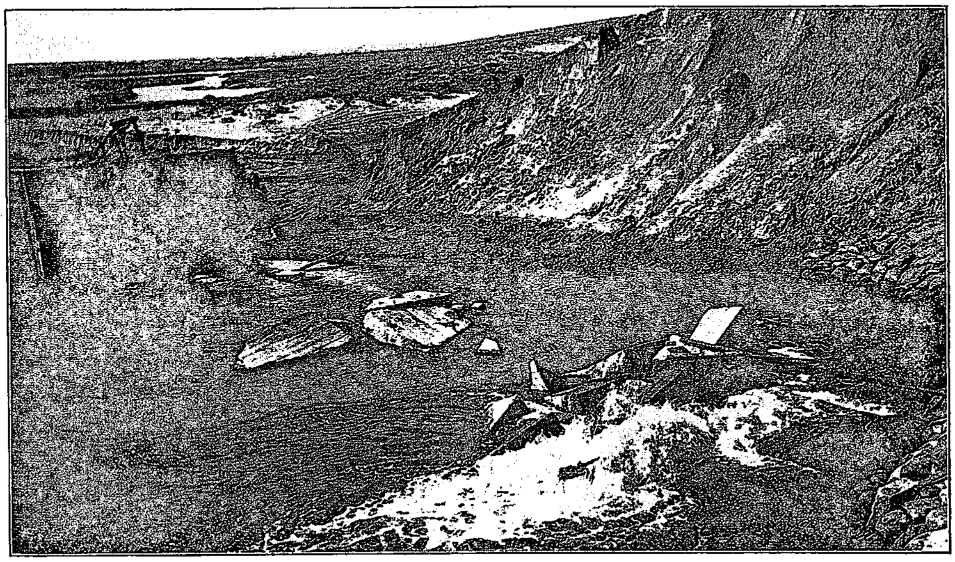
Water is to be taken from the Grand river and from Rifle creek. The district owns Priority No. 150 A, dated December 1, 1891, for 100 cubic feet per second from the Grand river; Priority No. 161, dated September 1, 1901, for 200 cubic feet per second from the Grand river; also an alternative right to 200 cubic feet per second from Rifle creek, dated June 15, 1902, in lieu of Priority No. 161 from the Grand river. It owns also Priority No. 92, dated March 1, 1887, for 1.5 cubic feet per second from Rifle creek and Priority No. 1, dated May 10, 1884, for 1 cubic foot per second from Rifle creek. The system includes no reservoirs.

The district owns the Willcox canal, about 28 miles long with a carrying capacity of 130 cubic feet per second, and the C. J. ditch, about 5 miles long, with a carrying capacity of 5 cubic feet per second. Work on the original construction was begun December 1, 1891. Enlargement was begun September 1, 1901, and further enlargement is contemplated.

The district contains about 8,950 acres of land of which 7,500 acres are under existing ditches.



EMPIRE RESERVOIR BREAK.
Method of reducing flow through conduit. August 15, 1909.



EMPIRE RESERVOIR BREAK.
Remains of gate well and broken outlet conduit. August 15, 1909.

CHAPTER VIII.

RESERVOIR FAILURES AND RECONSTRUCTION.

EMPIRE RESERVOIR.

Early in August, 1909, a break occurred in one of the dams of the Empire Reservoir in Morgan county, Colorado. An examination of this break was made by a deputy from the State Engineer's office, who reported as follows:

August 25, 1909.

State Engineer, Denver, Colorado.

Dear Sir—According to instructions I made an inspection of the Empire Reservoir Dam, near Orchard, Morgan county, Colorado, on August 15, 1909, and desire to make the following report:

This reservoir was filed in the State Engineer's office on July 1, 1905, the Bijou irrigation district, by W. B. Chapman, president, claimant.

The reservoir is located in sections 36, 35, 34, 26, 25, township 4 north, range 61 west; sections 1, 2 and 12, township 3 north, range 61 west; sections 30 and 31, township 4 north, range 60 west; section 6, township 3 north, range 60 west, all of the 6th principal meridian.

The outlet for this reservoir was under Dam No. 2 and consisted of three concrete conduits 4 feet wide, 2½ feet vertical sides and semi-circular arch top of 2 feet radius. Length of conduit 227.5 feet.

The flow through conduits was controlled by gates placed in a concrete well forty feet deep in the center of dyke.

In July, 1909, a leak was noticed in outer slope of dyke which rapidly increased in flow washing out the dyke around the conduits. The gate well soon collapsed, breaking the conduits and destroying the gates. The unchecked flow rapidly washed away the outer and central portions of the dam, leaving, however, enough of the inner side to prevent the water of the lake from overflowing.

The break was discovered early and efforts to stop the overflow were immediately made.

The flow was finally reduced to an amount which could be handled by the outlet ditch. This amount has been allowed to run continually since break. The conduits were partially closed by placing planks over the intake end of conduits, and aiding this by means of straw and brush. The remaining portion of dyke was protected by sacks of sand.

This break was evidently caused by a leak in the conduit which had cracked from settling. The water jetting through these cracks washed the earth fill from around the conduits and from underneath the gate well. The foundation of the gate well being destroyed, the gate well settled and broke itself loose from the conduits. A large flow of water immediately occurred which destroyed the dyke and allowed the gate well to collapse. These gates were not located at the proper point, which is at the intake end of conduits. Had they been so placed the water could have been shut off from leak as soon as discovered by closing the gates. The conduits would then have been empty and the proper repairs could have been made by entering the outlet end of conduits.

As constructed the conduits from intake to gate well were filled with water under pressure. Closing the gates had no effect on this pressure and did not shut the water away from the leaks as it should have done.

The new outlet for this reservoir should be moved away from the old location as the ground is badly soaked and it would be difficult to construct proper foundation for a gate well and conduits. Conduits, properly reinforced, should be constructed. Control gates with strong foundations should be placed at intake end of conduits.

Photographs Nos. 1 and 2* show reduced flow at the break, conduits and remains of gate well. No. 3 shows method of reducing flow by means of temporary plank gates at intake end of conduit. These planks are in position where gate well should have been located.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

The Empire Reservoir has a capacity of 37,700 acre-feet at the 30 foot contour, which was intended to be the high water line. At the time of the break the water surface stood at about elevation 20 above the bottom of the outlet. The reservoir has never been filled to the high water line.

The files of the State Engineer's office contain plans for the construction of the dams and outlet of this reservoir, but there is nothing to indicate whether these plans were ever approved by the State Engineer. The plans were prepared by Mr. C. D. Page, engineer for the Bijou Irrigation District, and bear the date of April 26, 1906. Under date of May 24, 1906, the State Engineer wrote Mr. Page, returning the specifications submitted as "incomplete and too indefinite for approval," and stating that the plans presented were deficient in detail.

The reservoir was built during the summer of 1906 and the concrete work on the outlet was built under the supervision of Mr. P. O. Gaynor, State Inspector. Mr. Gaynor took charge of this work on May 24, 1906, and on August 14, 1906, reported that the outlet had been completed, and added, "I consider the work very satis-

*Photograph No. 2 is omitted.

factory." Under date of August 8, 1906, the State Engineer instructed Mr. Gaynor to report in Denver as soon as the concrete work was completed "as it does not seem necessary to have an inspector on the work of making the reservoir embankment." The District Engineer, Mr. C. D. Page, made frequent reports to the State Engineer during the progress of the work. The records of the State Engineer's office disclose no further details concerning the original construction of the reservoir.

Plans for the construction of a new outlet were prepared by Mr. J. E. Youngquist, engineer for the Bijou Irrigation District, under the direction of Mr. E. E. Baker as consulting engineer. These plans were approved by the State Engineer on November 26, 1909. As recommended in the report of Mr. J. W. Johnson, a new site affording a much better foundation than the old was chosen for the new outlet.

The new conduit consists of three lines of 36 inch standard cast iron pipe resting on a continuous concrete foundation and provided with concrete cut-off walls 6 feet high and 15 feet wide at every 12 feet along the length of the conduit. These walls extend below the bottom of the continuous foundation and above the top of the pipe and it is believed that they will effectually prevent leakage along the line of the conduit.

The gate well is located 75 feet from the inner toe of the embankment and communicates with the reservoir by an open channel having a clear width of 11 feet on the bottom and 15 feet at the top. This channel has a concrete bottom and concrete side walls effectually braced. The gate well, the half of the inlet channel nearest to it and the first three cut-off walls on the conduit rest on pile foundations. The water cushion and outlet channel at the discharge end of the conduit together comprise a length of 52 feet and are constructed of reinforced concrete. The design is believed to be substantial and well adapted to the conditions which had to be met.

The construction was continuously under the supervision of Mr. Julius Hornbein, State Inspector, from the commencement of the work in September, 1909, to its completion in the middle of March, 1910. Mr. Hornbein reported that the work was well done in every particular and that the plans on file in the State Engineer's office were closely followed.

It is believed that the reconstructed portion of the Empire Reservoir is substantial and permanent and that there is absolutely no danger of any failure in or near the new outlet.

LAKE LIDDERDALE OR LAKE GEORGE.

On August 19, 1909, a break occurred in the dam of the Lake Lidderdale reservoir in Park county, Colorado. The capacity of this reservoir is small, and no damage resulted other than to the reservoir itself.

On August 22, 1910, Mr. J. W. Johnson, Deputy State Engineer, made an examination of the broken dam and submitted the following report:

August 30, 1909.

State Engineer, Denver, Colorado.

Dear Sir—According to instructions, I made a trip of inspection to the Lidderdale reservoir, known as Lake George, on August 22, 1909, and desire to make the following report:

This reservoir is located on the South Platte river, in the E. ½ of Sec. 30, W. ½ of Sec. 29, N. E. ¼ of Sec. 31 and N. W. ¼ of Sec. 32, T. 12 S., R. 71 W. of the 6th P. M., near the station of Lake George on the Colorado Midland Railroad, in Park county, Colorado, Irrigation Division No. 1, Water District No. 23.

This reservoir was filed in the office of the State Engineer on October 14, 1890, by George W. Frost, claimant. The area of said reservoir is 83.7 acres and capacity is 32,000,000 cubic feet of water.

The water is impounded by means of an earthen dam approximately 1,100 feet long and 19 feet high at highest point, and well riprapped with large rock.

The reservoir is provided with a forty-foot spillway, five feet below crest of dam, located at the extreme west end.

There is an outlet flume in bottom of center of dam. The control of this gate has been broken and at present it is impossible to use this outlet.

On August 19, 1909, an unusual flood on the head waters of the South Platte raised the elevation of lake so that the water flowed over the dam at the extreme eastern end and washed out a portion of the dam about 100 feet long and eight or nine feet deep. No particular damage to other property was done, nor was any material damage done to the reservoir.

Mr. J. M. Kellogg, the manager of the reservoir, was intending to put in an extra spillway 125 feet long on east end, and had started the construction of same to the extent of paving the outer face of dyke with rock. His idea was to pave the outer and inner faces and crest with rock and concrete.

I would recommend that this extra spillway be constructed to a length of 125 feet, with the crest at an elevation the same as spillway on west end of dam. Outlet gates should also be repaired and protected against future damage.

Photos attached show riprapping, location of conduit, break in dam and action of water on face.

The principal use of this reservoir is to impound water for the cutting and storing of ice.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

This reservoir was constructed prior to the passage of the act of 1899, requiring the submission of plans and specifications to the State Engineer for approval. Plans for the repair of the embankment and the construction of an additional spillway, in accordance with the suggestions contained in Mr. Johnson's report, were filed with the State Engineer and approved by him on September 8, 1909.

RIVERSIDE RESERVOIR.

No actual failure of the Riverside reservoir has occurred, but its condition has always been unsatisfactory and it has never been considered safe to impound the volume of water which the reservoir was intended to contain.

In August, 1909, a committee of landowners of the Riverside Irrigation District visited the State Engineer's office and requested that an examination of the reservoir be made with a view to its formal acceptance, as provided by law, in case it was found to be in satisfactory condition. In compliance with this request an examination was made by Mr. J. W. Johnson, Deputy State Engineer, who submitted the following report:

August 20, 1909.

State Engineer, Denver, Colorado.

Dear Sir—According to instructions I made a trip of inspection to the Riverside reservoir near Masters, Weld county, on August 15, 1909, and desire to make the following report:

The Riverside reservoir was filed in the office of the State Engineer on the 8th day of July, 1903, by The South Platte Land, Reservoir and Irrigation Company, by D. A. Camfield, vice-president.

This reservoir is situated on portions of sections 1, 2, 11, 12, 13 and 14, T. 4 N., R. 62 W., parts of sections 25 and 36, T. 5 N., R. 62 W., on parts of sections 30 and 31, T. 5 N., R. 61 W., and upon all or parts of sections 5, 6, 7 and 8, T. 4 N., R. 61 W., all of the 6th P. M.

The reservoir covers 3,811 acres at high water and 40 acres at low water. Depth that can be drawn off is 40 feet. Available storage capacity claimed is 3,070,525,600 cubic feet of water. The supply of water is derived from the South Platte river.

The reservoir is in a natural depression, the depth of which is increased by an earthen dam, with a variable height of from five (5) to twenty (20) feet, extending along the southeastern, southern and southwestern edges of reservoir, a distance of about six miles. (See photo marked No. 1.)

This dam is constructed of a very sandy loam. The slopes on outside face are three horizontal to one vertical, and on the water face one and one-half horizontal to one vertical; the width of top is sixteen feet.

The inside, or water face, has been faced with a layer of concrete which varies at different places from 3—5/8 to four inches in thickness. It was the evident intention to have this concrete reinforced with wire mesh. This reinforcing should have been placed in the center of concrete facing, and the specifications for this work so provide. This has not been done, as can be seen at all points where breaks in facing have occurred. The wire mesh was laid on the slope of the freshly completed fill and the concrete thrown on top of it.

No effort was made, I am informed, at the time of construction to place this wire mesh in the center of concrete. In its present position the wire is of no value at all to the strength of dam.

This wire is stuck to the bottom of concrete facing, but at no one of the five or six places where I was able to see the under side of facing was the wire imbedded out of sight.

There are at present three large breaks in the facing where the action of water has beaten holes. One of these breaks extends from top to bottom of facing; the other two are in the central part of facing, but do not extend the full length from top to bottom. (See photos of these breaks marked Nos. 2 and 3.) These breaks have been filled with sacks of sand and earth, and it was with great difficulty, I am informed, that the dam was saved from being washed out at the time of break. The breaks occurred last fall at the time of a high wind blowing from the northwest, which lasted for two or three days. These winds form large waves in the lake, which break directly against the facing of dam.

At a number of places, possibly ten, breaks or washouts have occurred along the lower toe of facing. Most of these places have occurred at points where dam crossed small knolls and where the concrete facing was not carried to a sufficient depth.

The action of water has eroded these knolls and exposed the toe of facing. The water action has then been against the earthen part of dam below the facing. In some places large holes have been washed out under the concrete. These have been filled with sacks of earth and sand and protected by short posts driven into bed of reservoir. (See photo marked No. 6.)

The material from which the earthen part of dam was constructed is a very fine, sandy loam, which is very difficult to compact properly, and which allows water to seep through it very rapidly.

All of the borrow pits, at the time of my visit, when water was very low, were full or partly full of seepage water from the reservoir. (See photos for appearance of borrow pits and lake, marked Nos. 1, 4 and 5.)

The outlet from this reservoir is by means of three concrete conduits, three feet wide and four feet high, with semi-circular top with 18-inch radius. The flow through conduit is controlled by gates placed in a 12-foot 6-inch by 4-foot well, 44 feet deep, located in the center of dam. The gates are operated by 2½-inch gate rods, threaded at upper end. This upper end works through a large nut supported by wooden beams and supplied with four horizontal holes. Gates are raised by inserting an iron rod in these holes and turning the large nut. The center one of these rods has been so badly bent, due to this twisting action and its length (almost 40 feet) that center gate cannot be operated at present. This accident happened when gate was partly up and the outflow was finally checked by means of canvas and straw.

These gates are on the outlet side of gate well. The well is of the type known as "wet well."

The outlet end of conduit has an apron extending 8 feet into ground, and is also supplied with wing walls extending twenty feet to each side. These wing walls are badly cracked at junction with main wall.

The main wall, for some reason not apparent at the time of my visit, has been braced with horizontal stringers. (See photo marked No. 7.)

In my opinion the concrete facing was not properly constructed and should be entirely removed and replaced. Sufficient care was not taken in compacting fill at time of construction.

Wire mesh was not placed in proper position in concrete facing. This should be placed in the concrete and near the center. The toe of facing should be carried well into the ground, especially at points where the dam crosses knolls. The control gates for outlet should be changed to the intake end of outlet conduit and supplied with proper arrangements for controlling them. Care should be taken to repair earth dam at once wherever there is any washing due to overflow from waves, as this earth is very loose and sandy and washes quickly and easily. There should be not less than eight feet freeboard (vertically) between water level and top of concrete facing.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

Photographs Nos. 3, 5 and 7 are not reproduced.

No plans or specifications for the construction of this reservoir have been approved by the State Engineer, as required by section 3205, Revised Statutes of Colorado, 1908. In the files of the State Engineer's office there is a drawing of the outlet conduit for the Riverside reservoir, prepared by Baker & Badger, engineers, marked "1904—Not approved." There is also a drawing of the outlet gates for the Riverside reservoir, which does not bear the name of any engineer, and this is also marked "1904—Not approved." There are no other drawings and no specifications relating to this reservoir in the files of this office. A search of the correspondence files has not brought to light any letters relating to this work, and this office contains no evidence of inspection by any State official, either during or subsequent to the construction.

From Mr. Johnson's report it was evident that some important reconstruction work must be undertaken before this reservoir could be permitted to store water to its full capacity. A large area of land is absolutely dependent upon the system of which the Riverside Reservoir is an essential part, for its water supply, and this land is covered by a mortgage to secure the bonds from the proceeds of which the system was constructed. To make this land productive, so that the assessments for the payment of interest on the bonds and the establishment of a sinking fund might be made, it was imperative that the reservoir be put in condition to impound water to its full capacity. On the other hand, the location of the reservoir is such that a failure would cause enormous property damage, if not actual loss of life.

Considerable correspondence between this office and the officers of the Riverside Irrigation District, and a number of conversations between the directors of the district and the State Engineer, were not productive of any plan which met the approval of all parties concerned.

In April, 1910, the Union Pacific Railroad Company, whose track is so located that it would suffer great damage from a failure of the Riverside Reservoir, engaged the services of Mr. Geo. T. Prince, consulting engineer, of Denver, to make an examination of the condition of this reservoir in the interest of the railroad company. The State Engineer made a personal examination of the reservoir in company with Mr. Prince. Through the courtesy of the railroad officials a copy of this report was furnished to the State Engineer's office, and is here reproduced. Mr. Prince's report is very profusely illustrated with drawings and photographs, only a few of which are here shown.

REPORT OF THE CONDITION OF RIVERSIDE RESERVOIR, WELD COUNTY, COLORADO, APRIL 20, 1910.

List of photographs accompanying report on the condition of Riverside Reservoir, Weld county, Colorado.

No. 1—Taken in very poor light (snowing) showing heavy spray washing over the bank. April 14, 1910.

No. 2—One end of a break. April 14, 1910.

No. 3—Showing a break. April 14, 1910.

No. 4—Showing a break starting at the toe. View taken last August, 1909.

No. 5—View of a break taken last August, 1909.

No. 6—End of bad break, over 400 feet in length. April 18, 1910.

No. 7—Sand in "riffles" on top of bank, showing its light, shifting character. April 18, 1910.

No. 8—Showing cheap concrete construction at headgates, held in position by braces. Falling water is from seepage under dam. Valve chamber can be seen at top of bank in distance. April 18, 1910.

No. 9—End of bad break. April 18, 1910.

No. 10—One of the many "seep holes" at toe of lower slope.

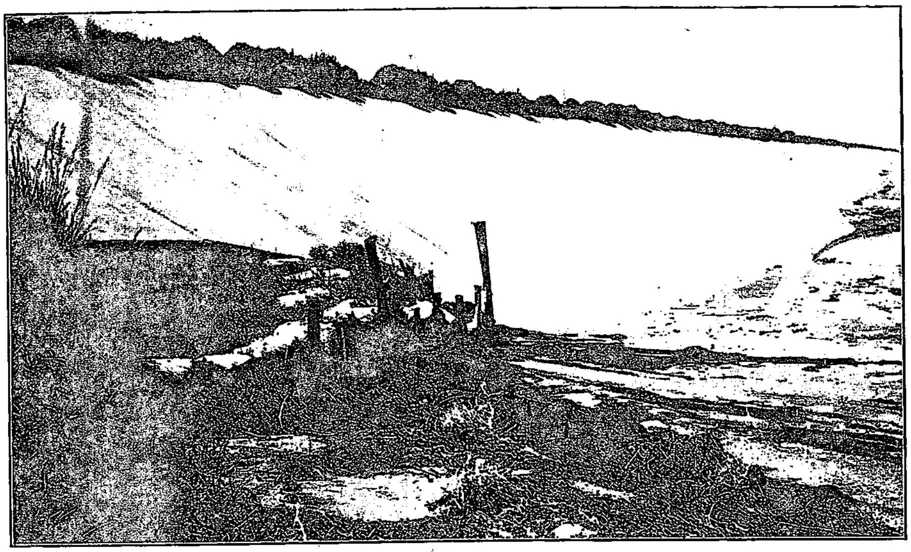
No. 11—Seepage water from under dam, flowing about 2 cubic feet per second; same flow shown in No. 8.

No. 12—Seep hole at toe of lower slope.

No. 13—Seep hole at toe of lower slope.

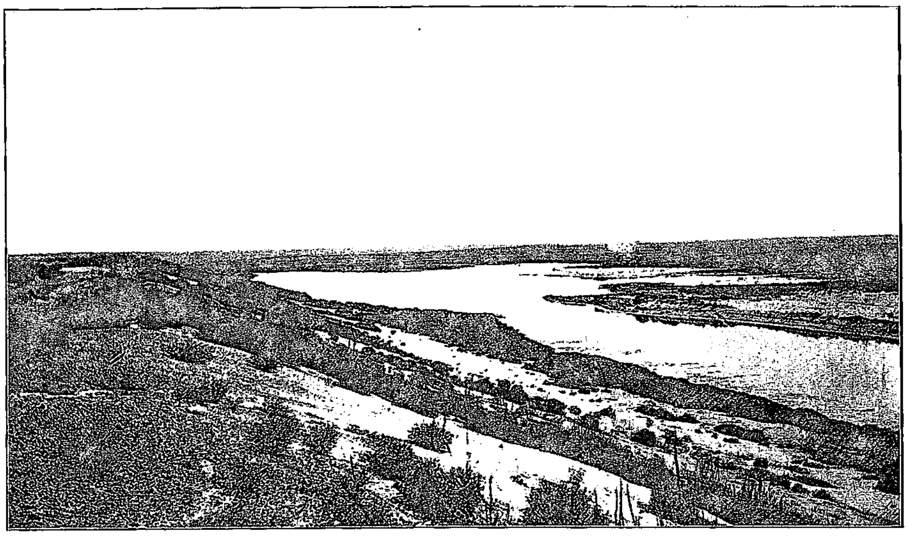
No. 14—View looking east along dam.

No. 15—View looking east along dam.



RIVERSIDE RESERVOIR.
Undermining of concrete paving at toe of slope, and method of making temporary repairs. August 15, 1909.

RIVERSIDE RESERVOIR.
Large break in concrete paving filled with sacks of sand. August 15, 1909.



RIVERSIDE RESERVOIR.
Seepage water in borrow pits below dam. Looking east from outlet. August 15, 1909.

No. 16—View looking north, across reservoir.

No. 17—Showing seepage near U. P. R. R. tracks, more than a mile from the reservoir.

Denver, Colorado, April 21, 1910.

Mr. R. L. Huntley, Chief Engineer, Union Pacific Railroad Company, Omaha, Nebraska.

Dear Sir—I herewith submit report of my observations, conclusions and recommendations relative to the Riverside Reservoir, requested in your letter of April 8, 1910. (No. A11383.)

This reservoir is located in Weld county, Colorado, about one and one-half miles north of Masters, in sections 1, 2, 11, 12, 13 and 14, T. 4 N., R. 62 W.; sections 25 and 36, T. 5 N., R. 62 W.; sections 30 and 31, T. 5 N., R. 61 W.; sections 5, 6, 7 and 8, T. 4 N., R. 61 W., all of the 6th P. M.

The reservoir is of recent construction, last year (1909), being the first year of service. As will be noted from the accompanying plat, the dam impounding the water in the reservoir, extends along the southern and southeastern portion of the basin, for a distance of 4½ miles.

The acreage of the reservoir site ranges from 40 acres at extreme low water to 3,811 acres at high water.

Water is conducted to the reservoir from the South Platte river, through a ditch 12 miles long, and is conveyed from the reservoir to the land, lying to the east and south, through a ditch 60 miles long.

Storage Capacity. The reservoir has a storage capacity, when full, of 2,400,000,000 cubic feet, equal to 55,096 acre-feet.

Height of Dam. The height of the dam, above the natural surface, varies from five (5) to twenty-five (25) feet.

Slopes. The outer or lower slope approximates throughout the length of the dam, three (3) horizontal to one (1) vertical, and the inner slope is one and one-half (1½) horizontal to one (1) vertical.

Concrete Facing. The inner slope is paved with a concrete facing, varying in thickness from 3⅝ inches to 4 inches. Some wire mesh was used in connection with this concrete, which was evidently intended as a reinforcement, but through carelessness in its placing, it is of no practical value. At the several breaks which I have inspected, this wire mesh is mostly entirely below the concrete, in places it is adhering to it, but adding no strength to the concrete. This concrete evidently was made from the "blow-sand," which is not suitable for that purpose, and tends to detract from the strength of the mixture, as you well know.

Parapet Wall. A parapet wall extends along the top of the concrete facing, having a width of six inches and a height of 18 inches.

Headgates. The concrete conduits built side by side, conduct water through the embankment to the outlet ditch. Each conduit is stated by the Deputy State Engineer, to be 3 feet wide, 4 feet high, with semi-circular arch of 18 inches radius, and each is supplied with a sluice gate, there being three in all, which are placed in a concrete chamber, located near the top of the lower slope. This chamber is 12½ feet long, that is, in line of the main dam, 4 feet wide and 44 feet deep. The gates are manipulated by a cheap method, very similar to the operation of an ordinary "jack-screw." The middle gate is out of order and cannot be operated. It is open about 9 inches and the opening below the gate has been closed by means of a mattress.

PRESENT CONDITIONS.

Poor Material for Filling. The embankment along the southern and southeastern borders of the reservoir was built of the fine, light sand, prevalent in that particular locality, and commonly termed "blow-sand." It is even finer and lighter than beach sand, and not at all suitable for dam construction. The result is that the contour of the top and lower slope is continually changing by the shifting of the sand under the action of the wind.

Headgates. No Foundation. In this instance as in almost all of the irrigation dams of eastern Colorado, no foundation was provided for this dam. So far as I am able to learn, the sand was placed upon the original surface, no provision being made to cut off possible seepage under the dam by constructing walls or driving sheet piling. The result is that all of the borrow pits along the lower toe of the dam contain a considerable depth of seepage from the reservoir and this is also apparent along the tracks of the U. P. R. R. Co., more than a mile distant. Photographs herewith submitted show this seepage.

Mention has already been made of the condition of the middle outlet valve. Not only are repairs to this valve essential, but it emphasizes the weakness of this method of placing regulation valves in the heart of the dam. By this method the water is admitted through the outlet conduits to the valves located in the center of the dam.

If either of the outlet conduits were to fail or collapse between the reservoir and the regulating valve, the hydrostatic pressure from the reservoir is at once imparted to the dam section, thus relieving it of much of its weight and seriously, if not entirely, destroying the integrity of the structure. This is what happened to the Empire reservoir which came very nearly going out last year.

Cement Facing Too Light. As above noted the concrete facing is of light construction and evidently not of sufficient strength to withstand the pounding effect of the wave action. I counted nine holes in the concrete facing, some of which are over 40 feet in length, involving the entire slope from water to parapet wall, and in one instance washing the bank back of this wall. The bank is attacked harder at the southeastern end of the reservoir, since the northwest winds get a longer and more direct sweep across the deepest water of the reservoir at this point. It is here that the greater damage has been done.

TEMPORARY RELIEF.

The situation demands most careful and active attention on the part of the Reservoir Company. A capable superintendent with an ample force of men and needed materials should be on the ground from now until all danger is passed.

I admit that I withdrew, with considerable hesitation, the suggestion to lower the reservoir at least 5 feet, without delay, but if the present head of water is to be saved, it can only be done by the most careful application of all possible safeguards.

The sand that is being put into the bags is so fine that it is washed out under direct action of the waves, leaving the bags empty.

I would suggest that the old broken concrete facing be broken into small pieces, measuring about 6 inches on a side and placed in bags and these bags laid on top of the sand filled bags. There would not be enough of the old concrete to cover all of the sand bags. It is, therefore, recommended that a sufficient number of bags to do this, be filled with a mixture of one part of Portland cement and eight parts of sand, the contents of these to be wet and allowed to harden in the air and then placed over the sand bags.

Wherever the concrete facing has been broken, sufficient protection of this temporary character should be provided to insure against further undermining of the facing and erosion of the bank.

PERMANENT IMPROVEMENTS.

Free-board—By "free-board" is meant the vertical distance from top of bank to water surface, and in this particular case, the "free-board" at high water is intended to be 5 feet.

It is recommended that the bank be raised 5 feet or the high water mark be lowered 5 feet, in other words, the "free-board" shall be at no time less than 10 feet.

CONCRETE FACING.

My inspection of the concrete facing indicates that it is altogether too light in construction to protect the slopes, which are too steep, even for more stable material. To adequately protect this "blow-sand" dam, requires a heavier and well constructed concrete lining laid in blocks, to guard against expansion and contraction, of at least 6 inches in thickness, and composed of one part (by weight) of Portland cement, three parts of sharp sand and five parts of broken stone, no particles to exceed 1½ inches in any dimension.

TOE-WALL

There seems to have been no adequate provision in the nature of a "toe-wall" along the foot of the inner slope, as a preventive against the cutting effect of wave action. The result has been, what might be expected, the undermining in many places of the toe of the concrete facing, which can have but one effect, that of the destruction of the facing.

PARAPET WALL.

The present parapet wall is too frail, being but 6 inches thick and 18 inches high. It is recommended that a parapet wall be constructed, having a thickness of 12 inches, and a height of 3 feet, and well bonded into the facing.

HEADGATES.

In the opinion of the writer, by far the most serious defect in the construction of this dam is the location of the headgates in the heart of the dam. If the *bank* were to fail, when the reservoir were full, there would result a flood of water about 20 feet in depth, which would probably scour a channel 10 or 15 feet deeper, whereas, if the outlet conduits were to collapse in front of the gates, the depth of water would be 32 feet, and this would doubtless scour to near 50 feet in depth, releasing a very much larger amount of water and consequently causing a far greater amount of damage than would the failure of the bank, serious as that would be.

The present arrangement of the regulating valve is a menace and should be reinforced by the construction of a gate chamber at the reservoir end of the outlet conduits, and the erection of 3 sluice gates therein. In this way, only, it is possible to shut out the reservoir pressure from the interior of the dam.

ORDER OF PROCEDURE.

After the reservoir is lowered sufficiently to proceed with the permanent improvements as above outlined, it is recommended that all concrete facing to the east of the headgates be removed, the old concrete put through a crusher, and used as far as it will go in the construction of a new facing, and in the toe and parapet walls.

The work of replacing the remainder of the facing and building toe and parapet walls can then follow.

Before November the reservoir should be drained and a new concrete gate house constructed as above stated, particular care being taken to make a secure bond with the outlet conduits.

It goes without saying that all eroded or weak places in the top or back of the dam shall be reinforced by additional filling.

The above recommendations are the result of considerable thought and study of existing conditions, and it is believed that nothing has been suggested, that is not essential to insure stability. The expense is unfortunate, but it is only another instance of false economy in building too cheaply.

There is considerable seepage, as already observed, but the writer does not believe that it will impair the stability of the dam. Much of it undoubtedly comes from portions of the reservoir site considerably removed from the dam and seeps through the sand formation many feet below the base of the dam, appearing at the surface more than a mile to the south of the dam.

The water seen in the borrow pits along the lower slope of the dam, undoubtedly comes through the sand a little below the base of the dam.

Respectfully submitted,

(Signed) GEO. T. PRINCE.

In view of the somewhat complicated contractual relations between the Riverside Irrigation District, the Riverside Reservoir and Land Company and the Empire Construction Company, and of the vital importance of the whole matter to the Union Pacific Railroad Company and to the State of Colorado, a commission of engineers, representing all the different interests, was selected charged with the duty of preparing plans and specifications and estimates for the repair and reconstruction of a portion of the Riverside Reservoir. This commission consisted of Mr. J. W. Johnson, Deputy State Engineer, Mr. John E. Field, consulting engineer, representing the Empire Construction Company, and Mr. Geo. T. Prince, consulting engineer, representing the Riverside Irrigation District and the Riverside Reservoir and Land Company.

This commission visited the reservoir a number of times and made a most exhaustive study of all the conditions. Following this work they prepared two reports, plans and specifications and a form of contract for the work of reconstruction. The reports, omitting the drawings, are reproduced here:

Denver, Colo., July 27, 1910.

To The Empire Construction Company, The Riverside Reservoir & Land Company, and The Directors of the Riverside Irrigation District:

Gentlemen—We, the undersigned, submit the following statement as the result of our conclusions and recommendations relative to the condition and needed repairs at the Riverside reservoir, as requested by your combined interests.

We have visited the said reservoir and have made very careful examination regarding its condition. We find that the concrete lining on the inner face of the dam is in good condition for a depth of one inch to one and one-half inch below its upper surface, but below this depth the moisture has been absorbed from the concrete to such an extent as to very seriously impair its integrity, rendering it dry and brittle.

Many measurements of the thickness of this concrete lining indicate that it varies from 3 inches to 4 inches.

We find that the steel reinforcement is of little or no value, since it is mostly below the plane in which it would contribute to the strength of the concrete; in fact, the major part of this steel is entirely below the concrete or simply adhering to its under face.

The depth of the toe-wall varies from nothing to 3½ feet below the natural surface; its average thickness is about 6 inches. This wall was placed along an irregular line determined by the intersection of the slope with the natural surface.

Wave action has cut down many of the knolls over which this toe-wall was laid, resulting in undermining the wall and concrete lining.

With few exceptions we find that the failure of the concrete lining has started at the joints which extend from the parapet wall to the toe-wall and generally 10 feet apart. It is evident to us that the continued flooding and ebbing of the surf over these joints has gradually disintegrated the concrete surfaces along these joints and the repeated washing and sucking influence of the waves as they rise and recede has resulted in first softening the underlying sand bed, and as each wave receded, it has drawn from the joints a portion of this sand foundation, thus creating a cavity which has grown larger until rupture of the lining has occurred.

We were gratified to find that the sand bed upon which the concrete lining rests, though not hard and compact, is nevertheless solid and in full bearing under the concrete. We found no cavities or pits, as we had feared we would find.

A coping or parapet wall extends along the upper line of the concrete lining and for the entire length of the dam, a distance of about 4½ miles. It has a thickness of about 6 inches and is 14 inches high.

CONCLUSIONS AND RECOMMENDATIONS.

We find the dam, for the most part, in an insecure and unsafe condition and not adapted for holding water.

The inner slope upon which the concrete lining is laid is so steep (1½ to 1) as to demand especial stiffness and support to successfully withstand the wave action, which is at times very severe.

The eastern end of the main dam has not apparently been subjected to as severe conditions as the main portion of the dam, and we recommend that action be deferred in repairing 1,200 linear feet of the dam lying at the eastern end, also upon 6,800 linear feet lying at the extreme western end, with the exception of 900 linear feet near the western end, where the toe of the slope paving has been undermined.

Along the balance of the dam, a distance of 12,000 feet, it is recommended that wood piling, consisting of three thicknesses of 2-inch plank, be sunk along the inner toe. of the dam to a depth of 10 feet below the natural surface, thus forming a water-tight curtain wall. We believe that a cut-off wall of this character would very materially reduce the seepage beneath the base of the dam, in amount approximating 2,000 to 3,000 acre-feet. Whether or not this estimate is confirmed, the suggested curtain is in line with conservative practice, since it is generally recognized that it is desirable to secure a compact, firm base under a dam, as free as possible from seepage of water.

For the same distance (12,000 feet) we recommend that the present concrete lining be covered with an additional thickness of concrete lining, 5 inches thick and laid in blocks about 10 feet by 15 feet in surface dimension. These blocks should be composed of concrete consisting of one part of Portland cement, three parts of sharp sand and five parts of screened river gravel, ranging in size from 3/8 inch to 1½ inch.

Between consecutive blocks there should be placed two thicknesses of tarred felt. Upon the completion of the laying of the concrete the projecting edges of this felt to be cut off flush with the top surface of concrete and the joints well calked and afterwards filled with liquid cement grout.

It will be noticed that we do not recommend steel reinforcement for this concrete lining, preferring to utilize the expense of such steel in making the concrete thicker, without additional expense over what steel concrete would cost.

It is recommended that three rows of "weep-holes" be cut through the present concrete lining, the upper row to extend along the high-water line, the other two rows to be equally spaced between the upper row and the toe of the slope.

These "weep-holes" should be about two inches in diameter and spaced about two feet apart in line of the dam.

Before placing the new concrete lining, these "weep-holes" should be filled with sand and covered with tarred felt, in a manner to prevent the liquid cement from saturating and hardening the sand in the holes and thus interfering with free drainage.

By "free-board" is meant the distance from the high-water line to the top of the parapet wall, and in the present case the "free-board" is taken as 7½ feet.

Considering the heavy winds which at times sweep across the Riverside reservoir, and the resulting wave action, this "free-board" is not considered sufficient; it should not be less than 10 feet. In order to maintain the present elevation of the high-water line it is therefore necessary to increase the height of the present parapet wall. We therefore recommend that the present parapet wall be broken up and replaced by a new wall of 5 feet 2 inches in height and with a varying thickness of 6 inches to 12 inches, to extend along the dam for a distance of 14,800 linear feet. In connection with this coping we recommend using some expanded metal as a reinforcement.

With the plank sheet-piling well bonded by concrete to the concrete lining, and the latter well secured to the coping, there would be a water-tight curtain, extending from a depth of 10 feet below the base of the dam to the coping, and it is believed that this would effectually prevent any damage from water or ice.

We further recommend that the regulating gates be placed at the reservoir end of the outlet conduit, and, in order to prevent, as far as possible, delay in storing water in this reservoir, we think that the water should be at once drained from the basin, so that inspection of the conduit can be made, and any needed repairs completed at the earliest possible date.

We suggest that the gates be placed in a concrete chamber in the reservoir, but on the same inclination as the slope paving, the stems to extend up the slope to the top of the embankment, proper protection from ice to be provided.

All knolls along the toe of the inner slope should be cut down and the sheet-piling sunk to practically the same depth throughout the length of the dam, inasmuch as the action of the water will eventually reduce the sand to a uniform beach slope.

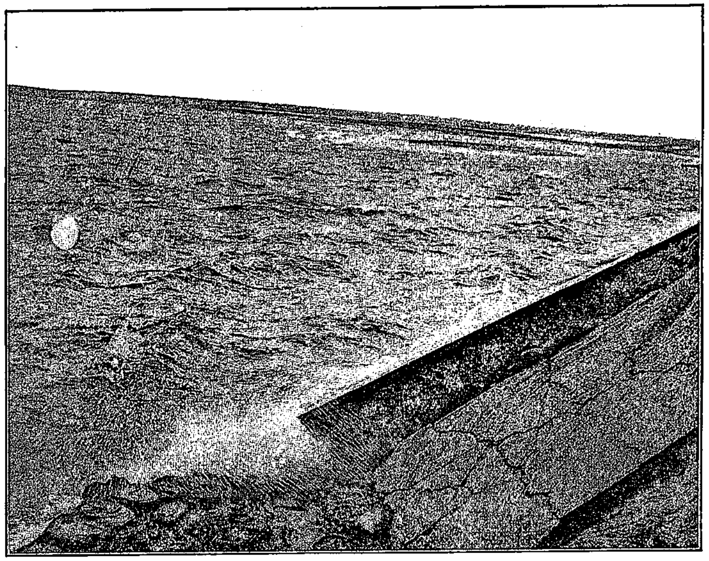
Regarding the breaks in the inner slope of the dam, we recommend that the holes be cleared of all sand-bags, hay, straw or other temporary filling and then properly filled with new material, the slopes of the holes trimmed to properly bond with the new filling, which should be well tamped. Upon this new filling a lining of concrete should be laid, of not less than 8 inches thickness. This lining should be in block form, similar to the additional course above described.

Estimated Costs.

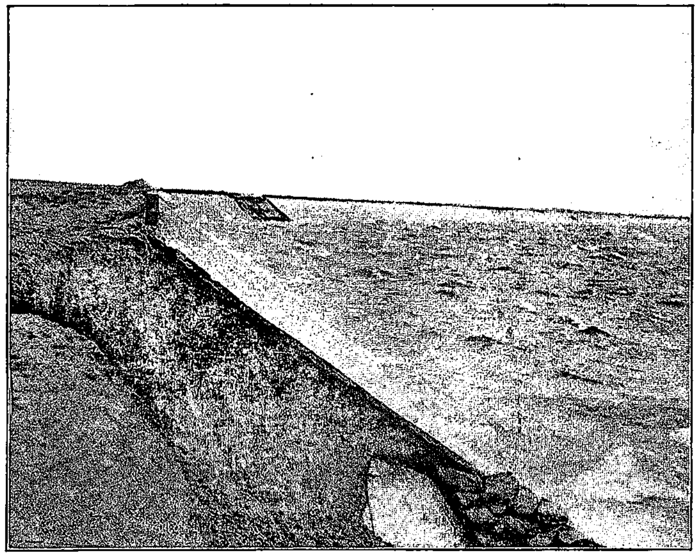
Trenching at foot of paving		$ 5,000
Sheet-piling in place, 17,200 linear feet		30,000
Concrete—		
Footing, 1,000 cubic yards @ $10.00	$10,000	
Coping, 3,000 cubic yards @ 10.00	30,000	
Lining, 7,550 cubic yards @ 7.50	56,625	
		96,625
Steel reinforcement, 51,600 sq. ft. @ 6c		3,096
Extra earth filling		1,000
Four miles of fence		2,000
		$137,721
Engineering and contingencies		13,772
		$151,493

It is impossible to determine the cost of repairing the outlet conduit and placing gates in the reservoir. This item may approximate $10,000.

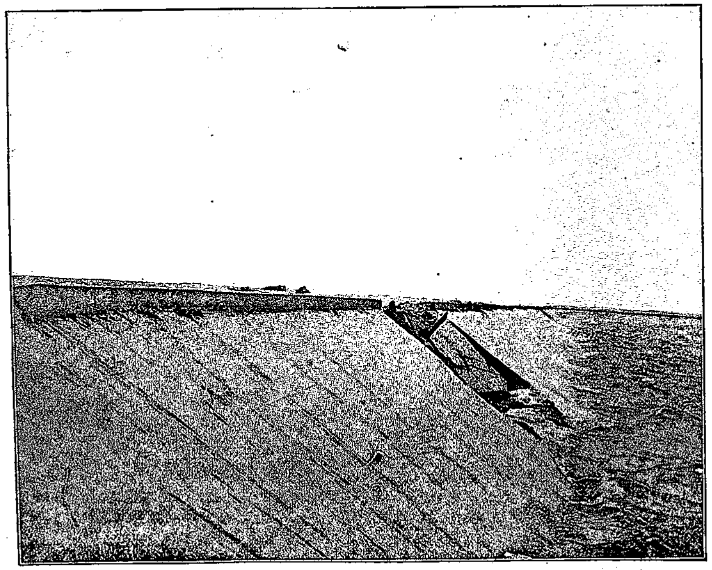
We consider the fence as an additional and desirable improvement, as it will protect the embankment and cause the same to build up instead of eroding from the action of the wind.



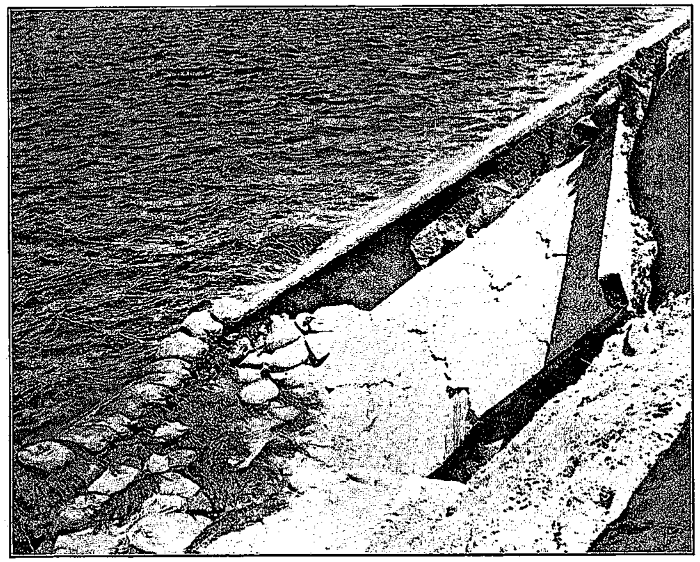
RIVERSIDE RESERVOIR.
One end of a bad break in concrete pavement. April 14, 1910.



RIVERSIDE RESERVOIR.
One end of bad break (more than 40 feet long), in concrete pavement. April 18, 1910.



RIVERSIDE RESERVOIR.
A bad break in concrete pavement. April 14, 1910.



RIVERSIDE RESERVOIR.
One end of bad break in concrete pavement. April 18, 1910.

We herewith submit a form of contract and specifications embodying our recommendations.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.
JOHN E. FIELD,
GEO. T. PRINCE.

Denver, Colo., August 11, 1910.

The Empire Construction Co., The Riverside Reservoir and Land Co., and the Riverside Irrigation District.

Gentlemen—We, the undersigned, submit the following supplemental report, in accordance with your instructions, which were about as follows:

That we make an estimate of the cost of raising the parapet wall to a height of 5 feet 2 inches, instead of 3 feet 8 inches, as previously designed; also to substitute a 5 foot concrete cut-off wall for the 10 foot plank cut-off wall.

We found it necessary, under the changed requirements, to again visit the reservoir, with a view to determining the probable effect of raising the water 1½ feet above that previously contemplated.

In our previous report we stated that the eastern end of the dam had not aparently been subjected to as severe conditions as the main portion of the dam, and we recommended that action be deferred in repairing the 1,200 lineal feet of dam lying at the eastern end, and also upon 6,800 lineal feet lying at the extreme western end.

Under the changed conditions imposed by raising the water about 1½ feet, our conclusion was that considerable work was necessary in addition to that recommended in our report of July 27. We therefore, in lieu of the recommendations in the said report relative to the work necessary, recommend the following:

At the easterly end of the dam there should be a vertical wall of concrete, from 4 to 10 feet in height, 350 feet in length, extending beyond the small auxiliary dam, in a northerly direction. Also a similar wall should be built between the main and auxiliary dam 450 feet in length, thus connecting up the main and auxiliary dams.

On this portion of the work we also recommend a footing at the toe of the slope of the auxiliary dam 1,050 feet in length, one foot in thickness and 4 feet in depth.

From Station 0, the easterly end of the main dam, to Station 12, we recommend that a footing be placed along the foot of the present slope paving, this footing to be of the standard type, 5 feet in depth and 1 foot thick.

Also between Station 0 and Station 12 a coping should be placed beginning at Station 0, 1 foot 2 inches in height, and gradually increasing to Station 12, where the parapet should be standard section of 5 feet 2 inches in height.

From Station 12 to Station 139 we recommend standard footing, 5 inch surfacing over the old concrete, and 8 inch surfacing where there is at present no old surfacing, and the standard 5 feet 2 inch coping.

The standard surfacing, coping and footing are shown on Plates 1, 2 and 3.

From Station 139 to Station 160 standard footing only is contemplated at this time. It is our opinion, however, that both surfacing and coping will ultimately be necessary, but we recommend that these improvements be deferred until the weaknesses develop and the improvement is necessary.

From Station 160 to Station 182 we recommend standard footing, surfacing and coping, the same as from Station 12 to Station 139.

In our previous report we have stated in some detail the character and dimensions and other things pertaining to the work. This report is intended to supplement the report of July 27th, and the requirements relative to thickness of concrete, proportions of cement, sand and gravel, size of blocks in the paving, joints, weep-holes, reinforcement, free-board, regulating gates, cutting down of knolls, the repair of breaks and all other details therein mentioned, are intended to apply and be a part of this supplemental report.

Our revised estimate of quantities and cost is as follows:

Trenching at foot of paving		$7,000	
Concrete:			
Concrete facing, 9,260 cubic yards at $7.50		69,450	
Standard concrete footing,	3,148 cubic yards		
Standard coping,	3,565 cubic yards		
Coping, east end	264 cubic yards		
Footing, east end	378 cubic yards		
New vertical wall, east end	215 cubic yards		
Total	7,570 cubic yards at $10	75,700	
Steel reinforcement		6,000	
Fence		2,000	
Re-fill		1,000	
		$161,150	
Engineering and contingencies, 10%		16,115	
Total			$177,265

Our previous estimate was $151,493. Under the changed conditions, therefore, there is an increase in cost of $25,772. This extra cost is due almost entirely to the increase in the amount of surfacing required and to the extra construction at the east end of the dam.

Attention is called again to the outlet conduit. During our visit it was found that no water was being drawn from the reservoir. We would urge that the water be drawn off as soon as possible, so that proper examination, plans and repairs can be made upon the outlet conduit and gates.

Respectfully submitted,
(Signed) J. W. JOHNSON,
Deputy State Engineer.
JOHN E. FIELD,
GEO. T. PRINCE.

DESCRIPTION OF WORK CONSIDERED IN FORMULATING ESTIMATE OF COSTS IN REPAIRING AND IMPROVING THE DAM OF THE RIVERSIDE RESERVOIR AND LAND COMPANY, IN WELD COUNTY, COLORADO.

WALL EAST OF AUXILIARY DAM.

North and east of the small auxiliary dam, lying to the east of the main dam, it is determined to construct a vertical concrete wall, the top to be at elevation of the present parapet or coping wall and the bottom to extend four (4) feet below the surface of the ground; the thickness at the top to be nine (9) inches and the thickness at the base twelve (12) inches. The wall is to rest upon a base two (2) feet wide and twelve (12) inches high. Its length is to be three hundred and fifty (350) feet.

WALL BETWEEN MAIN AND AUXILIARY DAMS.

The estimate further provides for a wall of similar construction described above to be built east of auxiliary dam; to be constructed between the eastern terminus of the parapet wall of the main dam and the western terminus of the parapet of the auxiliary dam. At the eastern end of the main dam for at least one hundred (100) feet the bottom of this wall shall be four (4) feet below the new high water mark, which is at elevation six (6) feet below the top of the present coping or parapet wall. At no point in its length shall the bottom of the wall be less than four (4) feet below the surface of the ground and changes in the grade or elevation of the foundation of this wall shall be gradual and on a uniform grade. The top of the wall shall correspond with the elevation of the present parapet walls.

TOE WALL ALONG AUXILIARY DAM.

Along the toe of the inner slope of the auxiliary dam the estimate provides for the construction of a concrete wall four (4) feet deep and twelve (12) inches thick, the top to be at elevation of present foot of slope.

EXPLANATION REGARDING STATIONING.

Station 0 is at the eastern terminus of the main dam. Each station represents a length of one hundred (100) feet and stations extend in numerical order from Station 0 to Station 182, near the western terminus of the main dam.

TOE AND PARAPET WALLS BETWEEN STATIONS 0 AND 12.

From Station 0 to Station 12, the estimate contemplates constructing a toe wall along the toe of the present inner slope. This wall to extend five (5) feet below the present foot of slope and to have a thickness of twelve (12) inches. Between Stations 0 and 12 it is provided to construct a parapet or coping wall; the elevation of the top of this wall at Station 0 shall conform to the elevation of the top of the present coping at that point. From that elevation and that point, the top of the wall shall increase in elevation at each station four (4) inches, and at Station 12 it shall have a height of five feet two inches (5′ 2″) above the top of the present slope or four (4) feet above the top of the present parapet or coping wall. The section and dimensions of this wall shall conform to the drawings shown upon the report.

LENGTHS OF CONCRETE LINING, MEASURED ON SLOPES, INDICATING LOCATION OF TOE WALL.

From Station 12 the lengths of slopes measured from the top of the slope to the outer or reservoir face of the toe wall are given below for stations up to and including Station 182. These figures were used by us in calculating the amount of concrete lining as reported.

Station	Feet
12 to 25	34.00
26	25.33
27	36.67
28	38.00
29	39.33
29+50	40.00
30	40.71
31	42.14
32	43.57
33	45.00
34	45.82
35	46.54

Station	Feet
	47.46
36	48.28
37	49.10
38	49.92
39	50.74
40	51.56
41	52.38
42	53.20
43	54.00
44	53.30
45	52.60
46	51.90
47	51.20
48	50.60
49	50.00
50	40.00
65 to 78	35.00
79 to 100	40.00
101 to 120	35.00
121 to 134	27.50
135	20.00
136 to 149	
150 to 182, same alignment and location of present toe and slope.	

Inner slope in all cases to be 1½ horizontal to 1 vertical.

CONCRETE LINING

Surfaces of all inner concrete slopes above noted between Stations 12 and 182 are to be covered with additional course of concrete lining five (5) inches thick, as described in the report and specifications, except that portion extending between Stations 139 and 160.

Wherever the length of the inner slope as above given exceeds the length of the present concrete facing, the estimate provides for furnishing and laying additional concrete facing eight (8) inches thick, having broken joints as shown in report and extending along a continuation of the present slope between the present toe-wall to the foot of the slope, located at stated distances, from the top of the slope, measured on the slope, as above noted.

TOE-WALL FROM STATION 12 TO STATION 182.

The estimate also provides for the construction of a concrete toe-wall from Station 12 to Station 182. This wall is to have a thickness of twelve inches throughout its height, which is to be five (5) feet. The top of this wall is to be at the elevation of the toe of the concrete lining on the inner slope, as shown by Detail B, Plate 3 of the specifications.

EARTHWORK AND REPAIRS OF BREAKS IN CONCRETE FACING.

The estimate also provides for all earth excavation made necessary for laying this additional concrete lining and constructing the new toe-wall. It also provides for all expense in removing all sand bags, hay, straw or other similar protection used at places where the concrete lining has been broken and refilling the holes with new earth, properly moistened and tamped, to correct lines and grades, and the estimate further includes repairing these breaks in the concrete facing by the furnishing and laying of a new concrete lining or facing, the same to be eight (8) inches thick, laid with broken joints, as shown and described in the report and specifications.

PARAPET OR COPING WALL BETWEEN STATIONS 12 AND 139 AND STATIONS 160 AND 182.

A parapet or coping wall of section shown in the report and having a height of five feet, two inches (5′ 2″) above the top of the present slope facing is included in the estimate to extend from Station 12 to Station 139 and from Station 160 to Station 182.

ENGINEERING AND SUPERINTENDENCE.

After estimating the cost of all materials and labor necessary and essential to complete the repairs and improvements outlined above, there was added to the estimate ten (10) per cent. to cover all expenses of whatever nature not already included in the estimate, such as engineering, superintendence, inspection, cement testing and possible contingencies. The sum total of the estimate as contained in the supplementary report is intended to include all expenses to be incurred by the district in paying contractors and providing for all incidental expenses of whatever nature required to complete the repairs and improvements as above outlined.

FINAL STATEMENT.

The above is a true statement of the conditions and premises assumed by us as a basis upon which we formulated the estimate of costs contained in our supplementary report, relative to repairing and improving the dam of the Riverside Reservoir, located in Weld county, Colorado.

(Signed) J. W. JOHNSON,
Deputy State Engineer.
JOHN E. FIELD,
GEO. T. PRINCE.

The plans and specifications were approved by the State Engineer and are on file in this office. It is not thought worth while to include them in this report.

The reports of this commission of engineers were accepted by all parties concerned and a contract entered into between the owners of the reservoir and the Empire Construction Company for the necessary repair and reconstruction work in accordance with the specifications drawn by the commission.

This work was carried out under the engineering supervision of Mr. George T. Prince, and at this writing is nearly complete. It is believed that the reservoir is now in conditon to store all available water for the coming season.

JULESBURG, OR JUMBO RESERVOIR.

On March 11, 1910, there was a sudden break in one of the dams of the Jumbo Reservoir, belonging to the Julesburg Irrigation District. On March 14, 1910, Mr. J. W. Johnson, Deputy State Engineer, made an examination of this break and of the remaining portion of the embankment. His report was as follows:

State Engineer, Denver, Colorado. March 25, 1910.

Dear Sir—According to instructions I made a trip of inspection to the Julesburg Reservoir on March 14, 1910, and wish to submit the following report:

The Julesburg Reservoir is located about six miles northwest from Sedgwick, Colorado, on the line between Sedgwick and Logan counties, in sections 7, 18, 19, T. 11 N., R. 47 W., and sections 13, 14, 24, T. 11 N., R. 48 W. of the 6th P. M.

This reservoir was filed under the name of the Jumbo Reservoir on April 7, 1904, filing number 1377 of the State Engineer's office. There are three dams for this reservoir aggregating about 8,000 feet in length. The highest point of dam is fifty feet above the outlet. The high water line is forty-four feet above outlet. Total capacity to high water line is 1,028,813,148 cubic feet of water, or 23,620 acre-feet.

The crest of dam is 16 feet, outside slope two horizontal to one vertical, inside slope four horizontal to one vertical. The top 16 feet of dam is paved with concrete and has a concrete wave breaker above crest of dam.

The break which occurred about two o'clock a. m. of Friday, March 11, 1910, is in the westerly dam, in a small draw or gulch.

The natural surface is underlaid with a soft sandstone at a depth of three or four feet. This sandstone dips to the west and south. There has been considerable seepage from the reservoir at this point since its construction in the spring of 1905. Mr. Cogswell, Division Engineer, reported about twelve cubic feet per second from this reservoir and inlet ditch in the fall of 1908. Of this amount, about seven cubic feet was directly from the reservoir.

The break occurred at this point and washed out about three hundred feet of the dam. The break was about 400 feet wide at the top and 300 feet wide at the bottom. The water eroded the soil and sandstone to a depth of about twenty feet below the natural surface.

The water in the reservoir at time of break was about twenty feet above outlet, and amounted to about 42,000,000 cubic feet. The break is entirely away from the outlet, which is in good condition.

Construction plans and specifications were filed in the State Engineer's office when work was started on this reservoir, but there is no record of approval of same.

Mr. T. W. Jaycox, who was at that time Deputy State Engineer, made a report to State Engineer L. G. Carpenter, criticising the plans and specifications. The following extract is taken from Mr. Jaycox's report, dated February 14, 1905:

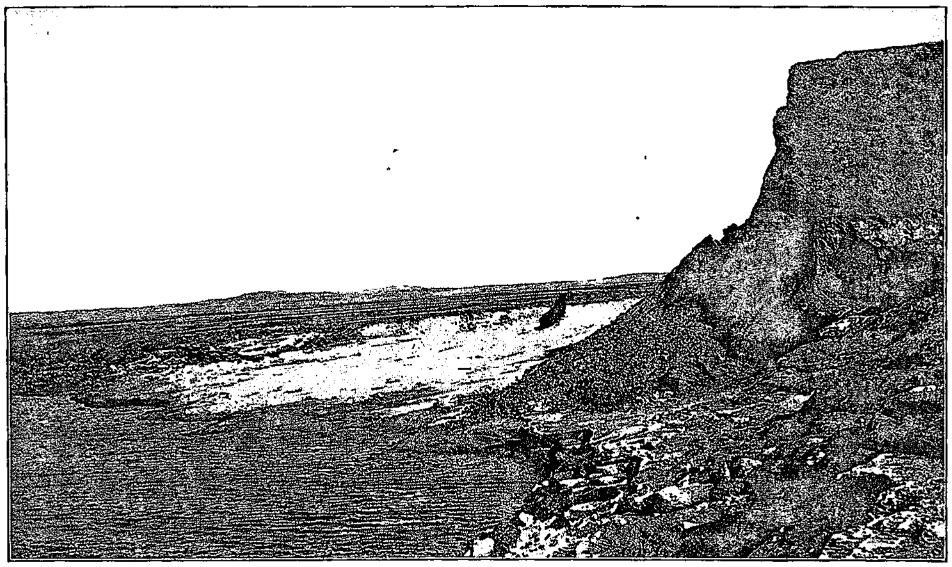
"Foundations. The specifications for the preparation of the foundation for the dam simply state 'the sod must be thoroughly plowed to a depth of 10 inches before any earth is put in place.' Nothing is stated as to the removal of the sod or further preparation of the foundation.

"The entire area under the dam should be prepared for receiving the artificial embankment, by removing all unsuitable material of every nature, as sod, silt, sand, gravel, vegetable matter, etc., to such a depth, so that the embankment shall rest on solid earth. The sides of the valley should be stepped, with a rise of not more than one foot, over the whole area of contact with the dam, and should also be horizontally offsetted, so that the continuity of the surface shall be broken into irregular planes.

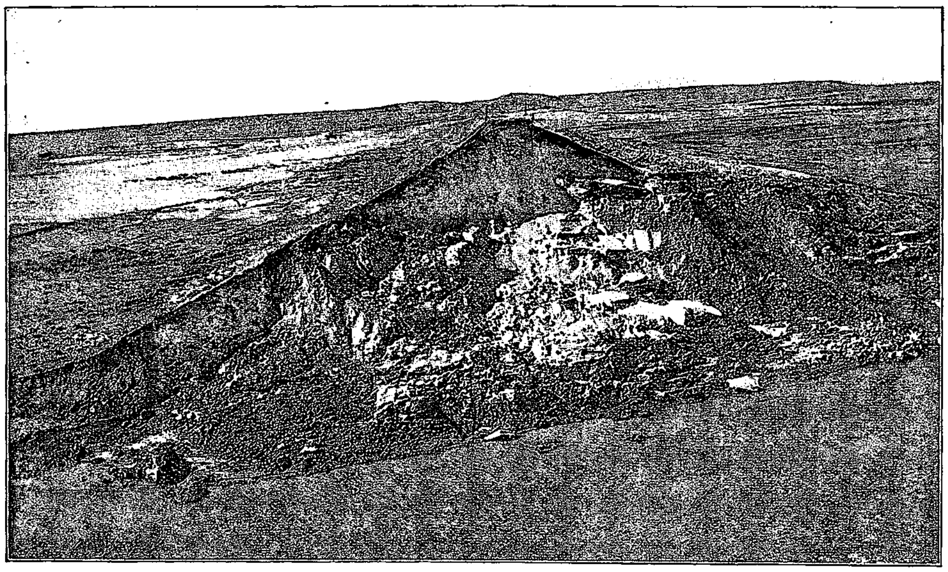
"Embankment. The entire specification for the construction of the dam is, 'earth shall be placed in the dam in level layers, which layers must not have a thickness of more than 4 feet. If any layer is made of a thickness of more than 4 feet, the contractor will be required to remove the excess before he puts on the next layer. No large clods or frozen chunks will be allowed to stay in the dam.'

"The method herein proposed to be used, layers of earth 4 feet thick, in the forming of the dam produces a loose and porous bank, readily admitting water, and causes a loss of firmness and stability, and may be so porous as to allow water to form a channel through the bank which would cause its destruction. The ultimate consolidation of the earthwork placed by this method is effected by the slow process of percolating water, from the filling of the reservoir, which usually produces longitudinal cracks in the inside slope of the dam, not only destroying the symmetry of the slope, but form openings which add to the insecurity of the dam.

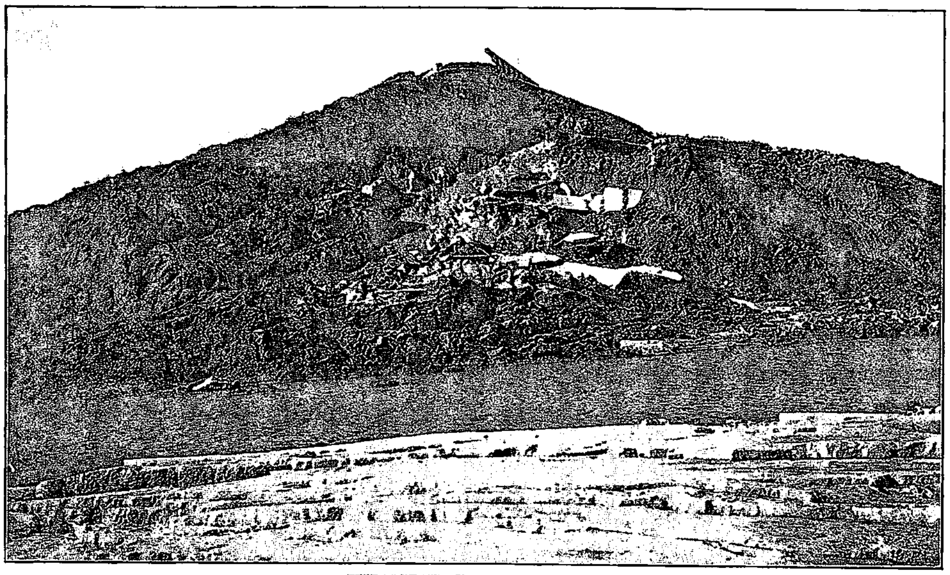
"In the construction of an earth dam the most important operation is the consolidation of the material, which is the only safeguard against permeability and instability of form, and it must be effected by mechanical means.



JULESBURG RESERVOIR.
East face of break. Looking north. March 14, 1910.



JULESBURG RESERVOIR.
West face of break. Looking west from top of dam at east end of break. March 14, 1910.



JULESBURG RESERVOIR.
West face of break. Structure of rock underlying dam is shown in foreground. March 14, 1910.

"The material should be selected, applied in thin layers, wetted when necessary, and compacted under heavy rollers, which, properly done, should produce a homogeneous mass that will avoid unequal settlement and deformation.

"The height proposed for the difference between the spillway and top of dam, that is 6 feet, may be entirely destroyed by the settlement of the dam, constructed according to the specifications submitted."

The material from which the dam is constructed is fairly good, and should make a reasonably watertight dam if properly constructed. The material is clay mixed with sand and gravel.

The break was evidently due to seepage along the underlying sandstone and through the natural surface and lower part of fill. This seepage could have been stopped by proper cut-off walls built into the sandstone, and by properly bonding and compacting the earth in the fill.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

Most of the photographs accompanying Mr. Johnson's report are not reproduced.

The failure of this reservoir caused great damage to the Union Pacific Railroad and telegraph lines and to many farms, although fortunately there was no loss of life.

The Julesburg Irrigation District secured the services of Mr. George T. Prince, consulting engineer, for the purpose of studying the mode of failure, determining the probable cause, and planning the reconstruction in such a way that a recurrence of this disaster should be impossible. Mr. Prince's report and his recommendations for reconstruction are on file in the office of the State Engineer, and with the exception of the accompanying drawings are reproduced herein.

These recommendations for reconstruction were approved by the State Engineer after a personal examination on the ground in company with Mr. Prince.

PRELIMINARY REPORT ON JULESBURG RESERVOIR.

Following is my preliminary report upon the conditions as I find them at the Julesburg Reservoir and my recommendations relative to repairing the break in the dam which recently failed, and precautionary measures to be taken to guard against similar disasters in the future.

CAUSE OF FAILURE.

As is well evidenced by the exposed rock foundation, the stratification under the failed dam was exceedingly porous and dangerous for the purposes of holding water. As water accumulated in the reservoir it readily found a passage through the upper surface of the underlying rock above the dam, which had been stripped of earth in order to obtain filling material for the embankment. This water was eventually forced, under the reservoir head, through the rock foundation underlying the dam.

Some of it escaped through "seep" holes below the toe of the lower slope, which resulted in washing out much of the fine sand and lighter material contained in the rock bed. Not enough water, however, was thus liberated by these vents or "seep" holes to prevent the gradual accumulation of pressure throughout the underlying rock mass, which pressure increased as the material was washed out, and the interstices became filled with water, until such time when the upward pressure applied throughout the rock mass, at depth of 30 feet or more below the base of the dam, exceeded the weight of the overlying rock.

The point of least resistance was at the toe of the lower slope, and it was at this point where the rock mass was lifted from its bed and a torrent of water from the reservoir carried it down stream, much as a chip of wood is floated on the crest of a wave.

That this occurred is evidenced by the large boulders of soft magnesian rock that were carried by the flood for a long distance below the dam. Some of these boulders contain more than 20 cubic yards; had they been rolled over and over they would have been broken to bits; they must have floated like chips by the first flush of water, which made a stream fully 15 to 20 feet in depth in the middle and sloping up the easy grades on either side, with varying width of from 600 to 1,000 feet, as indicated by the drift which was deposited along both slopes by the high water.

Soundings of the water filled hole at the point of failure indicate a depth at the center line of the dam of from 4 to 5 feet; about 50 feet further down stream, to the south, the depth is about 8 feet, and about 50 feet still further south the depth increases to 20 feet. A profile is here inserted, showing the approximate condition along a line passing through the center of the break.

It will be noted from this profile how much deeper the rock has been torn out at the toe of the lower slope.

It might be argued that this deeper excavation would result from the scouring effect of the flood as it issued from the mouth of the break, but to the writer this does not seem probable. Since the rock formation at that depth is in layers of about 3 feet in thickness and with few vertical seams, there would be but little tendency for the water to do more than pass over these rock surfaces, located more than 30 feet below the base of the dam.

Had the flood of water fallen upon this rock mass it would have worn and washed it, but it would not have lifted the rock from its bed and carried it to such distances, in such large masses.

The writer believes that in no other way than that of an upheaval could the results have been effected.

This upheaval of the bottom of the lower slope was immediately followed by the flood which swept everything before it, with a power that was sufficient to carry bodily these blocks of magnesia stone, some of which, as stated, measure over 20 cubic yards in bulk.

The reason why the rock was excavated to a greater depth at the toe of the lower slope is, as already noted, because it was the point of least resistance to the upward pressure. Under the major part of the dam, the super-incumbent load was enough to overcome the lifting pressure of the water, until the lower part of the slope had been lifted, when the main part of the dam at once collapsed and completed the breach.

At a depth of 35 feet below the base of the dam, the upward pressure, at the time of failure, approximated 32 pounds per square inch, whereas the weight of the over-lying stone did not exceed 27 pounds per square inch, hence the upheaval.

The above explanation of the cause of failure has been thus fully discussed, in order to make clear the reason for the following:

RECOMMENDATIONS.

It is recommended that a number of test pits, about 4 feet in diameter, be sunk along the bottom of the inner slope of the dam, separated about 100 feet and excavated to a depth of 25 feet below the surface. In other words, the pits abreast of the break will be sunk to a lower elevation than at either side of the break where the original surface remains undisturbed. Sink these pits along that portion of the dam having a height of 20 feet or more above the natural surface, separated as above remarked, 100 feet.

These pits should be numbered and a careful record should be kept of each, describing the character of the excavation encountered at each foot below the surface.

Samples of the various kinds of excavated material should be taken from each pit and each sample placed in a separate box and properly labeled as to the number of pit from which taken, and the depth below the surface.

From an inspection of the samples and of the record, which should be signed by Mr. Davis or Mr. Hornbein, or both, it will be possible to determine the depth to which it will be necessary to sink the curtain wall below described.

CURTAIN WALL.

It is recommended that a tight, continuous curtain be sunk along the inner toe of the dam, to such depth as will pass through all loose, insecure strata, and penetrate well into the solid rock.

This curtain could consist of steel sheet piling or of a concrete wall, preferably of the former construction. Economical considerations would determine which method of construction should be selected, and as an aid in this selection, it is suggested that careful records be kept of the cost of sinking these pits, from which to better know the probable expense of excavating a trench for a concrete curtain wall.

Steel piling, if used, would be extra heavy, having a web of half an inch in thickness and weighing 40 pounds per linear foot, and of 12 inches width.

Should concrete be used, the wall should not be less than 24 inches in thickness and sunk to a depth sufficient to secure a firm foundation, as indicated by the test pits, and thus shut off possible percolation under the base of the dam.

SLOPES.

The State Engineer has suggested that the inner slope of the reconstructed dam shall be two (2) to one (1), and the lower slope three (3) to one (1), and the writer endorses the suggestion.

The inner slope shall be lined with a concrete facing, six (6) inches in thickness, as below specified.

PREPARATION OF FOUNDATION BEFORE REFILLING.

As suggested by the State Engineer, it is advisable to pump out all standing water and remove all mud and slime from the rock surface over the entire area to be covered by the dam, before depositing any of the earth filling.

Two methods may be employed in removing this—viz.:

First. Pump out the water and let the material dry out sufficiently to be worked by drags or "fresnos."

Second. Stir up the mud by agitation and thereby render it sufficiently liquid to pass through a centrifugal pump. The writer has handled some very heavy, thick fluid by means of a centrifugal pump. It might perhaps be better to try the second method, before resorting to the first, as it would be quite inexpensive, and it is believed that it will prove effective.

METHOD TO BE PURSUED IN REFILLING.

It is recommended that the center line of the trench for the concrete curtain wall be located 130 feet (horizontally) above the core wall now being constructed across the break. (See remarks under the caption, "Caution," page 8.)

Beginning at this wall as the line of the inner toe, construct a bank 15 feet in height, on a slope of 2 to 1, allowing for a crest width of 117.5 feet, and a lower slope of 3½ to 1, thus making the base of the dam 200 feet between the inner and lower toes.

It is desirable to make the bank on the inner slope about 18 inches full (horizontally) in order to secure a firm foundation for the concrete lining when laid, and hence it would be well to locate the inner toe 131.5 feet above or north of the core wall. This would make the base of this smaller dam 201.5 feet in width.

The earth filling for this dam should be placed in layers not to exceed 8 inches in thickness, and sufficient water should be applied to keep the earth well moistened so as to make a uniform and compact mass. It is suggested that this smaller dam be constructed from the east side of the break toward the west side, and leave an opening of about 30 feet in width on the western end of the break in order to allow the passage of any flood water that may occur due to cloudbursts.

On the completion of this 15-foot dam as thus outlined, its inner face should be dressed down to true lines, which would require the removal of about 18 inches (horizontally) of earth, and this finished surface will form the foundation upon which the concrete lining shall be laid.

The length measured on the slope of this 15-foot bank would be about 34 feet, and the concrete should be laid in blocks upon this slope as below specified.

Upon the top of this 15-foot bank, another bank 15 feet high will be constructed, having its inner toe 10 feet inside of the top of the first bank, that is, a berme shall be left on the top of the first or lower 15-foot dam. This second 15-foot dam shall be carried up likewise, with slopes of 2 to 1 on the inner side, and 3½ to 1 on the lower side, with a crest width of 25 feet.

In order that all new material deposited upon bank already formed be thoroughly incorporated with the same, it is recommended that the bank upon which new material is to be deposited shall be plowed below the slope for a distance of at least 5 feet (horizontally), and the new material should be well moistened and packed in layers not to exceed 8 inches in thickness.

The inner slope of this second 15-foot dam shall be made full as has been recommended for the lower portion of the dam, and this additional material upon the completion of the dam to a height of 30 feet, shall be removed from the slope to a finished surface upon which the concrete lining shall be placed.

The bottom of the western end of the second or upper 15-foot lift, shall not be carried to nearer than 10 feet to the top of the western end of the first or lower lift.

When the upper lift is completed, with the exception of the gap at the western end, it is then recommended that the gap at the western end be quickly and expeditiously filled, in layers not more than 8 inches in thickness, well moistened and packed, and this material shall be placed in this gap as quickly as possible.

The berme on the inner side of the top of the lower section being maintained to the west, and the new bank shall be thoroughly incorporated and bonded into both sides of the break.

The second or upper section shall then be constructed westwardly across the gap to the west side of the break, and the new material shall be thoroughly incorporated and bonded into the old bank.

When this has been accomplished there will be a dam across the entire break 30 feet in height, having a crest width of 25 feet, with slopes on the inner side of 2 to 1, and a horizontal berme 10 feet wide at the top of the first 15-foot section. The outer slope will be 3½ to 1.

Thus, this 30-foot bank will have a base 200 feet wide and the concrete facing can now be completed for the entire length of the bank thus spanning the break, and covering the entire inner surface of the two 15-foot lifts, and also of the 10-foot berme above referred to.

It is suggested that a second berme be left on the top of the 30-foot bank, that is, the toe of the remainder of the dam be set back 10 feet from the top of the 30-foot bank, and the slope continued from this line 2 to 1 to the parapet wall, an added height of about 24 feet. In filling the holes at the toe of the outer slope, which are deeper than near the center of the dam, it is desirable to use a large percentage of stone with the earth fill, so as to furnish a stable foundation to guard against the possibility of the toe sliding in consequence of excess water. This stone filling should be carried up above the surface of the ground, forming a dry rubble wall across the break, and extending about 2 feet above the surface of the ground.

CAUTION.

It must be borne in mind that in referring to a height of a lift as being 15 feet and 30 feet, and an added 24 feet, reference is made only to the natural surface, and when the inner toe of the slope, or curtain wall, is specified as being 130 feet (horizontally) north of the core-wall, it is meant that this distance applies to the original surface of the ground, and for all depths below the original surface, the toe or curtain wall will be 130 feet plus twice the depth of excavation below the natural surface from said core-wall.

The construction of the main portion of the dam can now be prosecuted; the inner slopes being 2 to 1, and the outer slope 3 to 1. Leave a berme of 10 feet in width along the inner top of the 30-foot dam. All new material that is placed upon the bank already formed must be thoroughly bonded and incorporated into the former work, and all filling shall be placed in layers not to exceed 8 inches, to be well moistened and packed by the passage of the wagons.

The crest width of the completed dam shall be 20 feet and shall be surmounted by a parapet wall preferably connected with the concrete facing constructed on the inner face of the dam.

METHOD OF PLACING CONCRETE LINING.

The concrete used in the lining of the inner face of the dam, and in the curtain wall and parapet wall, shall be composed of one part by weight of Portland cement, 3 parts by weight of clean, sharp sand, and 5 parts by weight of crushed stone, quality and firmness to be approved by the writer. This stone to be crushed to particles that shall not measure, in any dimension, over 1½ inch, except for that concrete which is to be used in the curtain wall. The stones for this may measure as much as 3 inches in any dimension. It is possible that gravel of suitable quality may more advantageously be used than the crushed stone, and in that event the mixture should be about one part cement to 4 or 5 parts of gravel, dependent on the character of the latter.

The concrete should be mixed in a mechanical mixer, and in manner conforming to best practice. Probably it is unnecessary to specify this in detail, as your Mr. Davis is informed regarding such matters.

The concrete facing should be placed in blocks measuring 10 feet (horizontally); and not to exceed 20 feet on the slope.

In the case of the two 15-foot lifts above referred to, two (2) blocks of 17 feet, measured on the slope, would cover the slope of each lift. These blocks should be placed in alternate sections; that is, two blocks constructed with a space between them for another block; two thicknesses of tar felt shall be placed in all joints between the blocks. The object of this is to prevent the new cement from bonding with old cement, it being desired to prevent such bonding in order that the joint may be kept open to take care of expansion and contraction due to the changes in the temperature of the cement.

All matters of detail will be supplied by the writer as occasion requires.

The upper surface of the cement facing shall consist of mortar composed of one part of cement to 2 parts of sand thoroughly mixed and moistened, which shall be applied to the top of the concrete block while it is yet fresh and plastic, and this mortar shall be carefully worked with finishing tools in manner to produce a smooth, even surface, the object of which is to protect, in large measure, the concrete surface against the action of frost.

COMPLETION OF CORE WALL.

As to the concrete core-wall which has been commenced, the writer is not insistent upon its completion. Its construction would add an element of strength against sliding, but apart from this, there is nothing of benefit to be expected. It certainly will do no harm to complete it, if it is desired to realize some benefit from that portion already constructed.

EXAMINATION OF THE EMBANKMENT IMMEDIATELY EAST OF THE ONE WHICH FAILED.

As explained upon my recent visit to this reservoir, it is suggested that test pits be sunk along the outer toe of the embankment immediately east of the one which failed.

These pits should be located about 25 feet outside of the outer toe, separated about 100 feet and excavated to a depth of 25 feet below the surface of the ground.

The object of these pits is to furnish information as to the character of the sub-stratification upon which to determine if this embankment needs fortifying with a curtain wall in manner similar to that above recommended for the broken bank.

These pits should extend along that portion of the embankment having a height of 20 feet or more.

As it is possible that this embankment may require treatment similar to that recommended for the broken bank, it is important that these test pits be excavated without delay, if it is desired to store water the coming season.

FURTHER ADVICE AND REPORTS.

Upon receipt of your advice that test pits have been made and records and samples ready for inspection, the writer will arrange to go to the reservoir and advise regarding the depth and lengths of the proposed curtain wall, and concerning any other details that may require further explanation.

Will you, therefore, kindly advise when and where the writer will meet you for further attention regarding this work. There is one other recommendation of which I have spoken to you, which is, to sink pits about 4 feet in diameter along the lower toe, abreast of the break and separated about 100 feet.

These pits should be sunk to a depth of about 25 feet below the surface, and should extend along the bank that is 20 feet or more in height. They had better be placed about 25 feet from the lower toe. The object of these pits is to prevent the possible accumulation of pressure in the rock formation under the toe of the dam and so avert any tendency of an upheaval should the sub-soil become sur-charged with water.

Respectfully submitted,
(Signed) GEO. T. PRINCE,
Consulting Engineer.

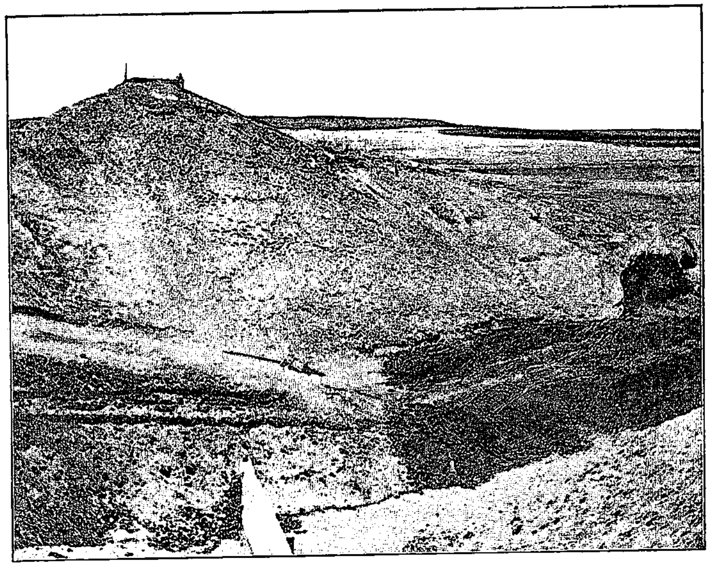
Recommendations herein contained are hereby approved by me.

(Signed) CHARLES W. COMSTOCK,
State Engineer.

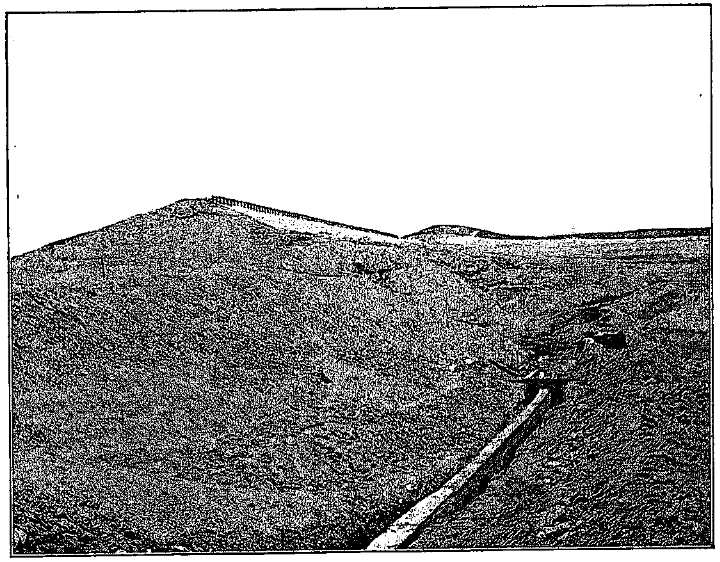
It will be noted that Mr. Johnson's statement of the cause of the failure differs from that expressed by Mr. Prince. It is impossible at this time to determine which of the theories expressed by these gentlemen is correct.

However, the method of reconstruction proposed by Mr. Prince, and actually carried out, is such that no repetition of the disaster could take place, no matter which of the explanations offered is the true one. The reconstruction was carried out under the direction of Mr. George T. Prince, as consulting engineer for the Julesburg Irrigation District, and under the continuous supervision of Mr. Julius Hornbein, State Inspector.

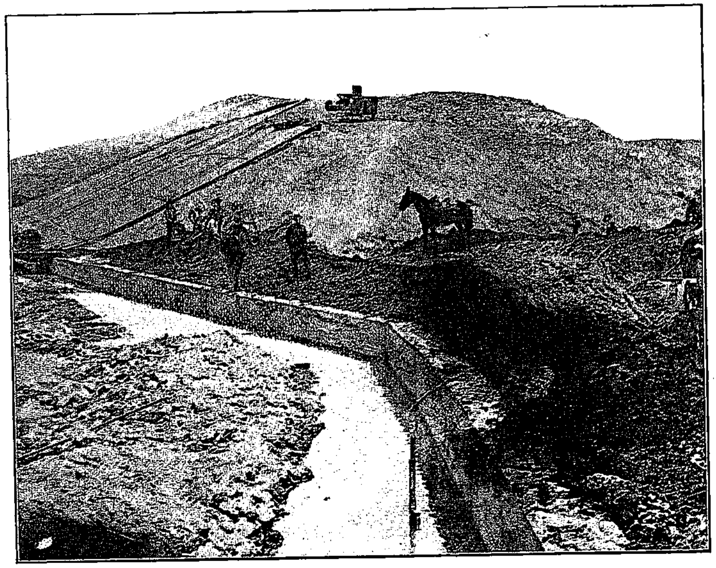
Mr. Prince's final report on the completion of the work is reproduced herein, omitting, however, the drawings and most of the photographs, with which the report is profusely illustrated.



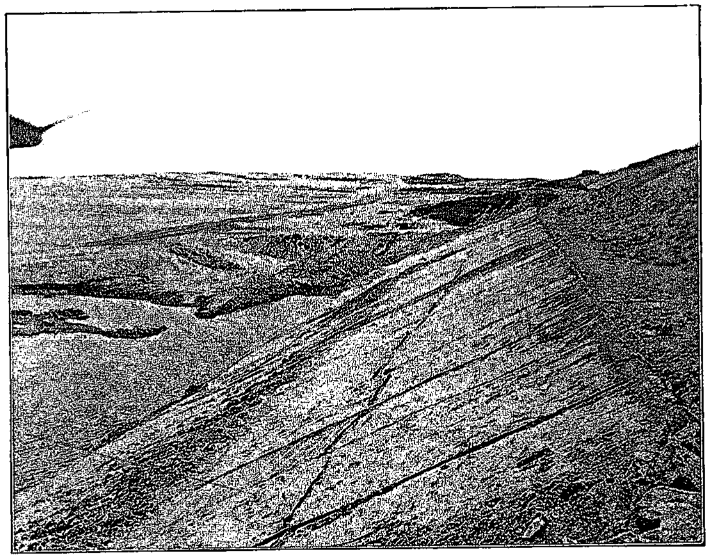
RECONSTRUCTION OF JULESBURG DAM.
Part of concrete cut-off wall.



RECONSTRUCTION OF JULESBURG DAM.
Concrete toe wall completed.



RECONSTRUCTION OF JULESBURG DAM.
Concrete toe wall and slope pavement.



RECONSTRUCTION OF JULESBURG DAM.
Concrete slope pavement below berme.

DESCRIPTION OF PHOTOGRAPHS SUBMITTED WITH REPORT OF RECONSTRUCTION OF "JUMBO DAM" OF THE JULESBURG RESERVOIR.

No. 1. Looking north into the reservoir, showing the east end of the break.

No. 2. Looking north into the reservoir, showing the loose character of the rock under the dam site.

No. 3. Looking south from the lower toe of the dam, showing the water hole formed below the dam by the flood.

No. 4. Showing some of the rocks carried three-quarters of a mile below the dam by the force of the flood; some of the rocks measured 30 cubic yards in volume.

No. 5. Looking west across the break, showing core wall in process of construction.

No. 6. Looking at eastern end of trench for core wall.

Nos. 7-8. Core wall before removal of forms.

No. 9. Teams taking earth from floor of reservoir.

No. 10. Looking from point below dam toward eastern end of break.

No. 11. Embankment in process of construction.

No. 12. Plowing in order to obtain good bond.

Nos. 13 to 19, inclusive. Showing various stages of embankment during progress of construction.

No. 20. Showing portion of core wall not yet buried.

Nos. 21 to 24, inclusive. Showing trench for curtain wall.

Nos. 25, 27. Curtain wall completed.

Nos. 26, 28, 29, 30, 31, 32. Showing concrete facing.

No. 33. Looking at lower slope of reconstructed dam.

No. 34. Looking along top of reconstructed embankment.

No. 35. Showing face of undisturbed concrete lining east of break.

No. 36. Looking at concrete facing completed to elevation of berme.

No. 37. Type of concrete parapet wall to be constructed along the top of reconstructed embankment.

State Engineer, Denver, Colorado. September 12, 1910.

Dear Sir—Herewith is submitted for your information and record, a statement descriptive of the methods and character of the construction employed in rebuilding the dam of the Julesburg reservoir, more familiarly known as the Jumbo Dam, which failed during the night of March 11, 1910.

This is one of six dams forming the Julesburg reservoir, which is the property of The Julesburg Irrigation District.

The reservoir is located in sections 7, 8, 17, 18 and 19, township 11 north, range 48 west, and in sections 12, 13, 14 and 24, township 11 north, range 47 west, 6th P. M.

You have a copy of a report which the writer made to Mr. E. D. White, claim agent of the Union Pacific Railroad Company, dated March 30, 1910, in which the conditions existing before and after the break of this dam are presented in detail.

The report is illustrated by photographs obtained soon after the break occurred, and statement is therein made as to the probable cause of the failure. With that report in hand you will better understand the steps which have been adopted in reconstructing the broken dam as herein outlined.

As a means of determining the extent and depth of the washout and the amount of yardage required to reconstruct the dam, a surveying party was put to work soon after the break occurred, cross-sectioning the break and the dam on either side of the same.

The rush of water which carried out the dam had washed a deep hole extending from the center of the dam section for several hundred feet below the outer toe, and having a width of from 100 to 150 feet. This hole was filled with water, and soundings showed the depth of water to be from 4 to 18 feet. Photographs are appended to this report which show the extent and character of the break.

LOCATION OF PRIMARY CAUSE OF FAILURE.

The soundings and other examinations of conditions existing immediately after the failure of the dam, indicated to the writer that the exact location of the first stage of the failure, which resulted in the destruction of the dam, was at the lower toe of the embankment and about 35 feet below the original surface of the ground or base of the dam.

The underlying rock stratification was found to be of a very open and porous character, so much so as to admit of the passage of water from the reservoir, under the base of the dam through this rock formation. This running water had gradually washed out the sand filling contained in the pockets and cavities of the rock mass, and had reached such a depth that there resulted a hydrostatic pressure of sufficient amount to lift the overlying mass of rock and earth. The failure naturally occurred at the point of least resistance to upheaval, or at the toe of the lower slope.

Working upon this theory of the cause of the failure, it was determined to construct a wall of concrete to such depth into the rock bed as to effectually shut off and prevent any amount of percolation of water under the site of the reconstructed dam.

CONCRETE CORE WALL.

The first step taken was the construction of a core wall across the break, located vertically beneath and parallel with the parapet wall constructed along the inside edge of the crest of the dam. The core wall was made 15 inches wide on top and 4 feet at the surface of the rock.

The inner or reservoir face is vertical and the lower face is battered.

The elevation at the top of the wall varies from 6 to 12 feet above the surface of the rock bed, into which the wall penetrates not less than 4 feet, and somewhat deeper for short stretches.

The length of this wall is about 275 feet and it was extended well into the rock foundation at either end of the break.

The work of reconstruction was under the personal direction of the superintendent of the Julesburg Irrigation District, Mr. Bert Davis. Mr. Julius Hornbein, representing the interests of the State, was employed as inspector.

The concrete used throughout the reconstruction was composed of a mixture somewhat richer than 1 part of Portland cement to 5 parts of a very satisfactory grade of bank gravel.

The construction of the core wall was begun prior to engagement of the writer in connection with the reconstruction of the dam, the major part being built during said engagement.

CURTAIN WALL.

As shown upon the accompanying prints, a trench was excavated along the toe of the inner slope, through the overlying earth into the rock to a depth of from 6 to 18 feet, to such depth as to extend through and below all loose, porous stratification. This trench was then filled with concrete of good quality, having a thickness of 2 feet, and it forms a foundation to which the concrete facing, below mentioned, is bonded.

This curtain wall is extended to the east and west of the break, as shown upon the prints, side curtains being built, to which the new concrete facing is also bonded.

On either side of the break, where the curtain wall is not bonded to the concrete facing, at least 6 feet of compact earth filling overlies the top of the curtain wall and furnishes a practically water-tight blanket to prevent the downward percolation of water back of the curtain wall.

EARTH EMBANKMENT.

The filling placed in the earth embankment was mostly obtained from the floor of the reservoir. It was of good material and being in a damp state made an excellent, compact dam. The material was leveled into layers approximately 8 inches in thickness, after being dumped from the wagons.

The inner slope of the embankment is 2 horizontal to 1 vertical, and the lower slope 3 horizontal to 1 vertical.

The crest width is 20 feet. It will be noticed from the accompanying prints that a berme 10 feet in width was constructed on the inner slope. It was deemed best to provide this reinforcing feature upon this slope to better resist any sliding tendency of such a long concrete facing.

ROCK FILLING AT TOE OF LOWER SLOPE.

A large amount of rock was placed along the toe of the lower slope, thus displacing any mud or soft material deposited upon the rock bottom and so providing against a possible tendency for the toe to slide out into the water hole formed below the reconstructed embankment.

CONCRETE FACING.

A concrete facing has been placed along the lower portion of the inner slope of the dam, to the elevation of the berme. This facing has a minimum thickness of 6 inches and is laid in blocks generally 10 feet long longitudinally with the dam and 15 feet long on the slope.

The joints between contiguous blocks were constructed on a broken line and were then filled with two thicknesses of tar felt.

The concrete, which was of a mixture as above stated, when placed was well tamped and trowelled and for several days after being laid was kept moist by sprinkling.

It is proposed to complete concreting the berme and upper part of the slope, as shown upon the prints, within the next month.

PARAPET WALL.

Along the inner edge of the crest, there will be constructed a concrete parapet wall about 3 feet in height, of type shown by accompanying photographs.

CROSS-SECTIONS, PLANS, PHOTOGRAPHS.

The accompanying cross-sections, plans and photographs explain themselves and illustrate in detail the extent of the break and the methods employed in the reconstruction, as above outlined.

PITS ALONG THE LOWER TOE OF EMBANKMENT.

As a further preventive against a possible repetition of the conditions causing the failure of this dam, there have been sunk along the toe of the lower slope of the embankment, pits about 4 feet in diameter and about 23 feet below the ground level. These pits are located about 100 feet apart and are excavated along the bank where it is at least 20 feet high.

By excavating these pits, the nature of the sub-soil was ascertained to be of firm, compact sandstone. The pits will further provide relief against the possible accumulation of water pressure below the toe of the embankment, in the event that water again finds a passage under the dam, a condition which is believed by the writer to be impossible to any considerable extent.

Similar pits have been sunk along the lower toe of another embankment of this reservoir, located about a quarter of a mile to the east of the reconstructed dam. These pits also showed a firm condition of the underlying rock stratification and it is believed that there will be no further trouble as regards the stability of this reservoir.

Respectfully submitted,

(Signed) GEO. T. PRINCE,
Consulting Engineer.

After the completion of the reconstruction work careful examination was made by the State Engineer in person, and the work formally accepted in writing under date of November 3, 1910, in accordance with the provisions of section 3205, Revised Statutes of Colorado, 1908.

Prior to the original construction of this dam a drawing showing the cross-section at the outlet and the detail of the outlet construction was filed in the State Engineer's office and is endorsed "February, 1905, Julesburg Reservoir Dam. Held for amplification." This drawing does not bear the name of any engineer, or any one representing the owners or any other interested parties, and there is nothing to indicate that it was ever approved by the State Engineer.

There are two sets of specifications on file, neither bearing any date and one unsigned, the other signed by L. L. Stimson, engineer in charge, and approved by D. A. Camfield, owner of the Julesburg reservoir. There is no evidence of the approval of these specifications, and the files of the State Engineer's office contain no comment on them other than the letter of Mr. T. W. Jaycox, at that time Deputy State Engineer, which is quoted in Mr. Johnson's report.

The failure at Julesburg, together with that at the Empire reservoir and the trouble at Riverside, show not only that the provisions of the law by which the State Engineer is given control over the construction of dams and reservoirs are necessary, but that the State Engineer should have the power to initiate through the Attorney General's office proceedings to compel compliance with this law and to enforce severe penalties for non-compliance.

JACKSON LAKE.

No recent failure of Jackson lake has occurred, but as it is one of the larger reservoirs in the Platte River valley, and as it is so situated that much damage would result if a failure should occur, a report on its present condition is worth while.

The files of the State Engineer's office contain a number of drawings pertaining to the Jackson lake construction, but no complete plans showing all the details of the work, and no specifications. None of these drawings bear any mark of approval by the State Engineer. Only one of them bears any date or the name of any engineer. This one is a drawing of the supplementary outlet for the reservoir, designed by C. R. Hedke, engineer, and bearing date May, 1905.

In the fall of 1904 a leak through or under the main dam developed to such an extent that a new dam was built below the old one in such a way as to enclose the leak and to connect with the old dam on either side of it. The old dam actually failed while this new work was in progress, but in such a way that no great damage was done.

Following the break at Julesburg reservoir the Union Pacific Railroad Company engaged Mr. Geo. T. Prince, consulting engineer, to make an examination of all reservoirs in the Platte valley whose failures might result in damage to the railroad. Jackson lake was one of these, and through the courtesy of the railroad officials a copy of Mr. Prince's report was placed in the files of the State Engineer's office. It is here reproduced, with the omission of most of the photographs.

LIST OF PHOTOGRAPHS ACCOMPANYING REPORT ON THE CONDITION OF JACKSON LAKE RESERVOIR, MORGAN COUNTY, COLO.

No. 1—Looking west along the embankment.

No. 2—Looking west along the embankment.

No. 3—Looking west along the embankment.

No. 4—Looking south, down outlet ditch.

No. 5—Looking east, across mouth of inlet ditch.

No. 6—Looking east, along embankment at west end of reservoir.

No. 7—Looking north across the reservoir.

No. 8—Looking south, down a seepage ditch, flowing about 5 cubic feet per second.

No. 9—Showing two seep-holes, along the lower slope of dam; there are many such holes scattered along the length of the dam.

No. 10—Showing a seep-hole.

No. 11—Looking south from the regulating gates on the main dam, across the basin formed by the secondary dam.

Denver, Colorado, April 28, 1910.

Mr. R. L. Huntley, Chief Engineer Union Pacific R. R. Co., Omaha, Nebraska.

Dear Sir—I herewith submit report of my observations, conclusions and recommendations, relative to Jackson Lake reservoir, requested in your letter of April 8, 1910. (No. A. 11383.)

This reservoir is located in Morgan county, Colorado, about two miles north and east of Orchard, Colorado, in Sections 10, 13, 14, 15, 16, 21, 22, 23, 24, 26, 27, Tp. 5 N., R. 60 W. of the 6th P. M.

The reservoir was constructed in 1903. A dam about 2¾ miles long extends along the southern portion of the reservoir, and impounds a body of water which covers 2,640 acres at high water.

As originally constructed the inner slope was four (4) horizontal to one (1) vertical and was paved with a very light stone covering. The wave action quickly destroyed this paving and cut into the embankment. The difficulty was remedied by cutting down the slope and paving with a sheet of concrete, as below described.

Water is conducted to the reservoir from the South Platte river, through a ditch about 11 miles long, and is conveyed from the reservoir back to the river through an outlet ditch approximately two miles long. This water is again taken from the river through the Upper Platte and Beaver and the Lower Platte and Beaver ditches, by which it is distributed for use upon lands located on the south side of the river, mainly lying between Fort Morgan and Brush.

Storage Capacity—The reservoir has a storage capacity, when full, of 1,727,154,000 cubic feet, equal to 39,650 acre feet.

Height of Dam—The height of the dam above the natural surface varies from five (5) to twenty (20) feet.

Slopes—The outer or lower slope approximates throughout the length of the dam two and one-half (2½) horizontal to one (1) vertical, and the inner slope is one and one-half (1½) horizontal to one (1) vertical; in places it is slightly steeper than this.

The inner face is paved with a concrete facing, varying in thickness from 4 inches to 6 inches. Wire reinforcement was placed at the center of this facing, which has quite effectually provided for temperature stresses.

Parapet Wall—A parapet wall extends along the top of the concrete facing, having a width of 6 inches and a height of 22 inches.

Outlet Conduit—The outlet conduit is located about 1,500 feet east of the western terminus of the dam, near the southwestern corner of the reservoir.

Regulating Valves—Three regulating valves, or sluice gates, control the flow of water from the reservoir. These gates are placed in a concrete chamber, located in the center of the dam. This chamber is similar to that described in connection with the Riverside reservoir. The gates are operated by revolving a fixed nut through which the threaded stem of the gates operates.

Three years ago the seepage immediately west of these gates was so excessive as to cause alarm, and to avoid disaster a secondary embankment was built, in the form of a horseshoe, the two legs of which bond with the main dam at points about 50 feet on either side of the gate chamber and extending about 200 feet below said chamber, thus forming an oblong basin about 100 feet by 200 feet, along the line of the outlet ditch. In the embankment, at the lower end of the basin, a second set of three sluice gates was placed.

Before this protection was completed the main dam broke, but fortunately the filling in the embankment contained sufficient gravel to slide under the action of the escaping water and so effectually shut off further flow of water.

PRESENT CONDITIONS AND RECOMMENDATIONS.

Embankment—The material of which the embankment is constructed is good and has made a hard, compact structure, and the bank is in good condition.

Headgates—As above noted the headgates have already caused trouble and they should be relocated at the inlet end of the outlet conduit.

Too many reservoirs have been built in this part of the country, in which the regulating gates are placed in or near the center of the dam. The plan is radically wrong and ought not to be allowed. The present State Engineer is trying to correct this evil and should be encouraged and supported in his policy.

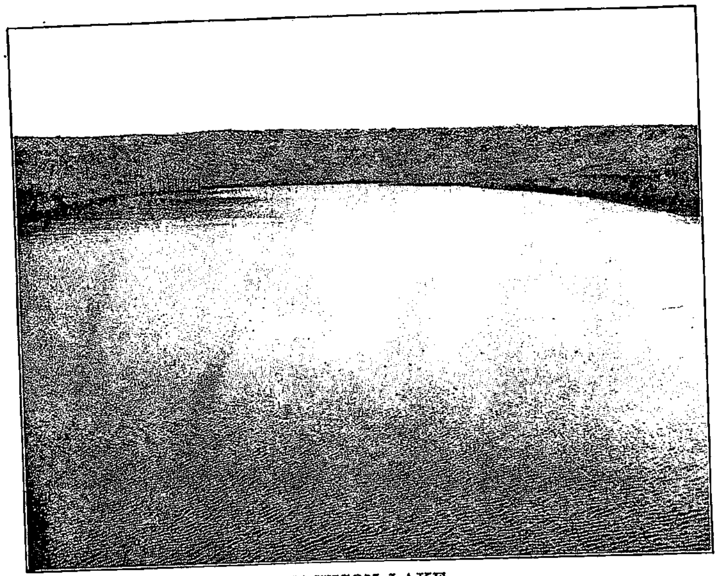
Cement Facing—The cement facing seems to be in good condition; the concrete of which it consists was apparently made of good materials and properly mixed and placed.

I think it is placed upon too steep a slope, but there are but few weak places apparent, and these are being given good attention.

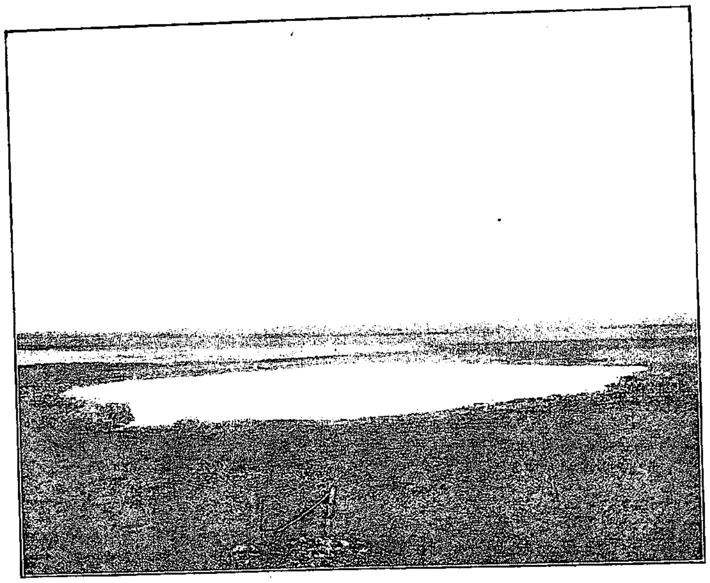
Toe Wall—There is a considerable amount of seepage from the reservoir. So far as I am able to learn there was no "cut-off" or toe wall constructed along the inner toe or center of the dam. Unless some precautionary measures are taken, seepage is sure to result, and this continued over an extended period is very apt to soften the sub-soil to such an extent as to cause serious trouble. It is recommended that a wall be constructed along the toe or bottom of the concrete face, having a thickness of 15 inches and extending at least 4 feet below the toe of the slope.

Parapet Wall—This is one of the weak points in this construction, being but 6 inches thick and 22 inches high; in many places it shows checks and cracks.

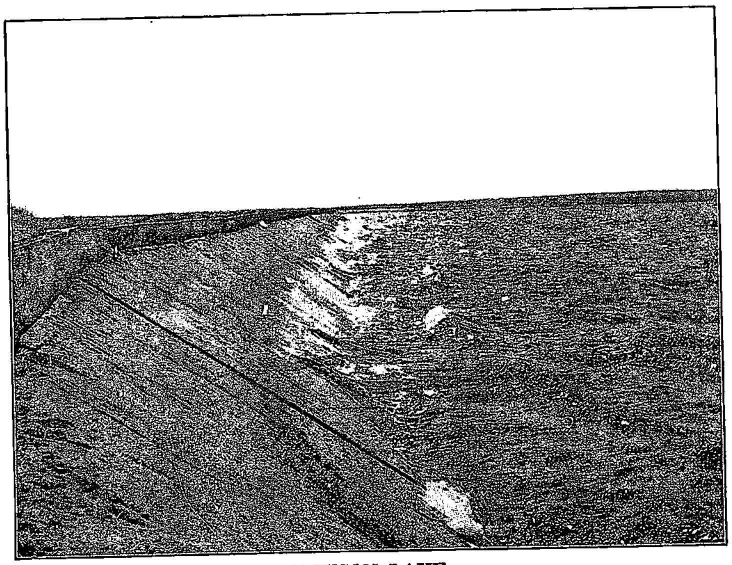
The wave action at this reservoir is excessive at times, as the lake has a stretch of about two miles, over which the north winds have an unobstructed sweep. It is recommended that a parapet wall be constructed having a thickness of 12 inches and a height of 3 feet, the same to be well bonded into the slope facing.



JACKSON LAKE.
Looking south from outlet across basin formed by secondary dam. April, 1910.



JACKSON LAKE.
Seepage below dam. April, 1910.



JACKSON LAKE.
Looking west along the embankment. April, 1910.

Freeboard—The writer is informed that the water in the reservoir is at all times at least 10 feet below the crest of the parapet wall and this is a safeguard that should be carefully observed. It is stated that during the past month water was carried clear over the top of the embankment during violent windstorms.

With the high-water mark unchanged and the parapet wall strengthened and raised as above suggested, conditions would be very much improved.

Respectfully submitted,

(Signed) GEO. T. PRINCE.

TROUT LAKE.

Early in September of 1909 the Trout Lake and Middle reservoir dams of the Telluride Power Company, in San Miguel county, Colorado, failed, with a resultant property damage which was appalling. By the most remarkable good fortune no loss of life resulted.

On September 18, 1909, Mr. J. W. Johnson, Deputy State Engineer, made an examination of these reservoirs, and his report is reproduced herein.

At the urgent solicitation of a number of interested parties the State Engineer made a personal examination on the ground on October 2, 1909. This report is also reproduced in full, with the exception of some of the sketches and photographs.

These two reports contain all the information which could be obtained by observation on the ground or by interview with reliable persons.

LIST OF PHOTOGRAPHS ACCOMPANYING REPORTS ON THE CONDITION OF TROUT LAKE AND MIDDLE RESERVOIR DAMS.

No. 1—First or west spillway of Trout lake.
No. 2—Second spillway, Trout lake.
No. 3—Showing break in dam. Trout lake.
No. 4—Showing break in dam. Trout lake, west of No. 3.
No. 5—General view of break and dam, Trout lake, showing riprap on inner slope.
No. 6—View of inner slope, Middle reservoir, showing outlet and plank facing.
No. 7—Inner face Middle reservoir dam, showing broken end of facing.
No. 8—General view of inner face and break, Middle reservoir.
No. 9—Down-stream face of Middle reservoir dam, showing break and construction.
No. 1—Lake Hope, July 17, 1909.
No. 2—Up-stream face of Middle reservoir dam, July 17, 1909.
No. 3—Down-stream face of Middle reservoir dam, July 17, 1909.
No. 4—Middle reservoir and Trout lake from Lake Hope, July 17, 1909.
No. 5—Trout lake from west end of dam, July 17, 1909.
No. 6—Break in Middle reservoir dam, taken October 2, 1909.
No. 7—Up-stream face of Middle reservoir dam, October 2, 1909.
No. 8—Down-stream face of Middle reservoir dam, near break. Taken October 2, 1909.
No. 9—Up-stream face of Trout lake dam, showing location of break. Taken October 2, 1909.
No. 10—Eastern side of break in Trout lake dam. Taken October 2, 1909.
No. 11—Eastern side of break in Trout lake dam. Taken October 2, 1909.
No. 12—Up-stream face of Middle reservoir dam, October 2, 1909.
No. 13—Break in Trout lake dam, taken October 2, 1909.
No. 14—Ames Power Station, July 17, 1909.
No. 15—Interior Ames Power Station, July 17, 1909.
No. 16—Ilium Power Station, July 17, 1909.
No. 17—Interior Ilium Power Station, July 17, 1909.
No. 18—Ilium Power Station, September 5, 1909.

State Engineer, Denver, Colorado.

January 22, 1910.

Dear Sir—According to instructions I made a trip of inspection to the two dams of the Telluride Power Company, on September 18, 1909, located in the canon above Ophir, Colorado, and make the following report.

The upper dam is a log crib, 30 feet high, filled with rock and earth. The crest is 20 feet wide. Up-stream edge of crest is 6 feet higher than down-stream edge. Up-stream face covered with two layers of 1-inch plank on an average slope of 1 to 1. Down-stream slope ¼ to 1. The planking on up-stream face is not level, south end being lower than north end.

On Sunday, September 5, a break occurred which washed out about 60 feet of the extreme south end of this dam. This part of the dam is completely washed away, and water has cut below the original surface of old stream bed to a depth of three or four feet.

The spillway was located on south end of dam and has been entirely washed out.

The lower dam is about a mile and one-half below the upper dam on the same stream. It is an earthen dam about twenty-five feet high at highest point. Crest about 6 feet wide on top. Up-stream slope 2 to 1, riprapped with rock and a portion at east end with log crib.

There are two board flume spillways at west end, one 4.3 feet by 4 feet and the other 7 feet by 4 feet. The first spillway is 7 feet wide at intake end, but is choked to 4.3 feet a short distance beyond. (See photos.) Both of these spillways were prepared for the use of flash boards, but contained none at the time of my visit.

Wave breakers, consisting of two floating logs about four feet apart and connected by plank cross pieces spiked to each log, were used to retard or lessen the action of water on crest of dam. At the time of high water these wave breakers were washed up onto the crest of dam and in one or two instances over the crest.

The break in the upper dam and the sudden outflow of the water stored in that reservoir raised the elevation of the lower reservoir above the crest of dam. This water flowing over the crest washed about three feet of material off of it for a length of approximately four hundred feet and weakened the dam around the outlet. This weak spot gave way on the following day and a section of the dam was washed out. This section was about 50 feet on top and extended lower than the old natural surface by about 10 feet.

This dam was in fair condition with the exception of seepage, which had been previously noted in the center of dam, and which extended to a height of from 7 to 10 feet above outlet.

This was reported by Deputy G. N. Houston in his report to State Engineer T. W. Jaycox on October 3, 1908, and was estimated by him to be ½ second-foot.

The spillways were entirely inadequate to carry off the water fast enough, thus allowing the rise in lake elevation as mentioned above.

The upper dam was constructed of material which was not as impervious to water as it should have been. This dam was provided with a 12-foot spillway, 45 inches deep.

Deputy Houston reported considerable seepage throughout the entire dam. One leak at the north end was estimated to be one second-foot.

The highest water mark that I could find at the time of my visit was 18 inches below the top of plank facing near the center of dam. This would indicate that water had risen to a point very near the top of the plank facing at the south end. There is one place about twenty feet north of north edge of break where the dam has sunk about two feet. This sunken place is about five feet wide and extends entirely across crest of dam at right angles to its length. (See photo.) This place appears to have been caused by settling of the top after being undermined at some point lower down. The top of crest remaining does not show any damage caused by water overflowing.

Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

REPORT ON THE MIDDLE RESERVOIR AND TROUT LAKE DAMS OF THE TELLURIDE POWER COMPANY, SAN MIGUEL COUNTY, COLORADO.

Early in September of 1909, the dams of the Middle reservoir and the Trout Lake reservoir of the Telluride Power Company, on the Lake fork of the San Miguel river, in San Miguel county, Colorado, failed, discharging a large volume of water into the river within a short time, and causing a great deal of damage to property located below.

On October 2, 1909, I made a personal examination of these reservoir sites and what remained of the dams, and collected such information as could be obtained from reliable sources concerning the history of these reservoirs.

The reservoir system of the Telluride Power Company consists of a chain of three lakes located on the headwaters of the Lake fork of the San Miguel river. The upper one, known as Lake Hope, has an altitude of about 11,700 feet, and is within about one-half mile of the divide between the San Miguel and the Animas drainage. This is a natural lake, to which an artificial outlet has been constructed in such a way as to be able to draw the water below its natural level if it is found necessary.

I did not visit this lake, and the information concerning it was given me by Mr. S. A. Bailey, of the Telluride Power Company.

Photograph No. 1, hereto attached, is a view of the surface of Lake Hope, taken on July 17, 1909.

About two miles down the stream from Lake Hope, and at an elevation of 10,000 feet above sea level, is located the Middle reservoir. This reservoir was formed by constructing a log-crib dam, filled with earth and rock, the length being about 200 feet on the crest and the height about 32 feet.

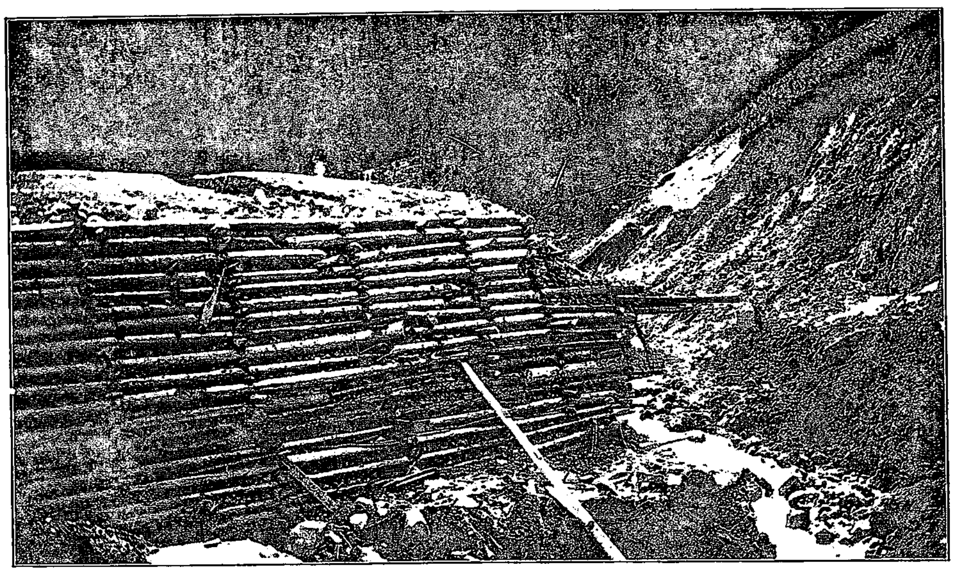
Photograph No. 2 is a view of the up-stream face of this dam, and photograph No. 3 a view of the down-stream face.

The reservoir so formed had an area at high water mark of 5 acres, and a capacity of 30,000,000 cubic feet, or 690 acre-feet. This dam is located a few hundred feet above the trestle by which the Rio Grande Southern Railroad crosses the Lake fork of the San Miguel river.

Trout lake is located about a mile and one-half below the Middle reservoir, at an elevation of about 9,700 feet above sea level. This was a small natural lake, whose area and capacity had been increased by the construction of a low earthen dam at its natural outlet. Its area at high water is 138 acres. Its approximate low-water area is 70 acres, and its storage capacity between low-water and high-water lines was 80 million cubic feet, or about 1,840 acre feet.

All of these figures as to areas and capacities were furnished me by Mr. S. A. Bailey, of the Telluride Power Company. The elevations were taken from the Telluride Topographical Sheet, prepared by the United States Geological Survey.

MIDDLE RESERVOIR OF TELLURIDE POWER COMPANY.
Upper face of dam from break. October 2, 1909.



MIDDLE RESERVOIR OF TELLURIDE POWER COMPANY.
Lower side of broken dam. September 18, 1909.

Photograph No. 4 is a view taken from near the outlet of Lake Hope, and shows, just below Lake Hope, the dam of the Middle reservoir, which was nearly empty at that time, and, in the distance, Trout lake.

Photograph No. 5 is a view of Trout lake, taken from a point near the west end of the dam.

I am informed that both the Middle reservoir and Trout lake dams were constructed about 1894. The law requiring that reservoir plans should be submitted to the State Engineer, and the work to be done under his supervision, was not passed until 1899. The records of this office, therefore, do not contain any plans, or specifications, or records of construction of either of these dams.

The construction of the Middle reservoir dam is shown on the attached blue print, which was prepared from measurements made at the time of my visit. The dimensions given apply especially to the section where the break occurred.

The slope of the inner face is not the same at all points of the length of the dam, but is steeper at the end farthest from the break. The direction of the crest of the dam is northeast and southwest. The break occurred at the southwestern end, where the spillway was located. There is nothing remaining to give any idea of the dimensions or construction of the spillway, but photographs Nos. 2 and 3, hereto attached, show its location and general character.

From a report of Mr. G. N. Houston, Deputy State Engineer, who visited the dam on October 2, 1908, I find that the spillway consisted of a flume constructed across the crest of the dam at the southwestern end, this flume being 12 feet wide and its floor 45 inches below the upper edge of the planking on the face of the dam. Mr. Houston reported that this spillway contained flash boards 3 feet high at the time of his visit, thus raising possible high water line to within 9 inches of the crest of the dam.

The outlet to this reservoir is a wooden box about 2 feet square 67 feet horizontally from the northeastern end of the plank facing. This is closed at its inner end by a sluice gate operated from the top of a wooden tower built in the reservoir. The vertical distance from the bottom of the outlet to the upper edge of the plank facing is 32.5 feet.

Photographs 6, 7 and 8 show the general appearance of the break, and will give some idea of the construction of the dam. Nos. 6 and 7 show the location of the outlet and the method of control just described. No. 8 shows a portion of the down-stream face of the dam, immediately adjoining the break. The width of the break at the level of the bottom of the dam is 60 feet.

This dam is essentially an earthen dam, with its upper and lower faces protected by logs running longitudinally, these logs being held in place by others running transversely back into the earth and rock fill, the two sets of logs being fastened together at their intersections by iron drift bolts one-half inch in diameter. These logs were of various sizes; I measured some which were as large as 18 inches in diameter, and saw a considerable number which did not appear to be more than 8 inches in diameter, though I did not measure them.

The tranverse logs vary from about 6 to 15 feet in length, and serve to anchor the face logs in place. I did not see any of these transverse logs which extended clear through the dam from face to back.

The dam is founded on the alluvial material which fills the bottom of the narrow valley to an unknown depth. At the break this material has been washed out to a depth of about 10 feet below the base of the dam, as shown by photograph No. 8, and as indicated on the attached blue print.

The upper edge of the plank facing is not horizontal. The northeastern end is highest, and the slope is fairly uniform to the point where the break occurs, 127 feet from the northeastern end. At this point the upper edge of the plank facing is 4.1 feet lower than at the northeastern end.

There is no evidence that the water has run over the top of that portion of the dam which remains, except at one place. Forty feet northeast of the break there is a channel 6 feet wide and 2 feet deep extending across the top of the dam. The upper end of this is connected by a channel running longitudinally just back of the face logs with the broken end of the dam. The water appears to have run over the edge of the plank facing at some point in the portion since washed out, then found its way toward the northeast along a channel back of the face and cut the transverse channel above described across the crest of the dam.

I saw nothing else to indicate that the water had run over the top of that portion of the dam which still stands.

The highest water mark which I could find, either on the dam or on the vegetation within the reservoir area, was just level with the top edge of the plank facing at the point where the break occurred. This is 1.5 feet below the edge of the plank facing at the outlet.

The drainage area above the Middle reservoir is 6 square miles, or 3840 acres. This was measured from the Telluride Topographical Sheet of the United States Geological Survey. A run-off of 2.16 inches from this area would be sufficient to entirely fill the reservoir. Since almost the entire drainage area is barren and rocky, and the slopes precipitous, it is probable that the water would run off nearly as fast as it fell. To raise the surface of the reservoir from the level of the bottom of the spillway to the low point of the crest of the dam, 45 inches above, would have required 191 acre-feet, or a run-off of 0.6 inches over the entire drainage area. To raise the water surface from the elevation of the top of the flash boards, as they were reported by Deputy G. N. Houston, would have required a run-off of 0.12 inches from the entire drainage area.

So far as it is possible to judge from what remains of the dam, and information as to its condition before the break, obtained from reliable sources, it would appear that a heavy discharge of water from the spillway washed away the loose material just below the dam, back to a point so near the toe of the dam that the weight of the dam itself, and the pressure of the water behind it, forced the loose material in front of the toe to cave, and thus undermined the foundation of the dam.

TROUT LAKE.

The Trout Lake dam is an earthen dam about 600 feet long, about 19 feet high at the highest point above the natural surface, from 4 to 6 feet in width at the crest, and about 70 feet width of base at the highest point. Its inner slope is protected by a rip-rap of loose rock of all sizes up to about one cubic foot, simply dumped in place and not laid after the fashion of stone paving. The general character of this rip-rap can be seen by reference to photograph No. 9. The material of the dam is very dense, clay-like material, which seems to be semi-elastic.

The direction of the crest of this dam is nearly due east and west. At the western end of this dam are two flumes which were used as spillways. The one at the extreme western end was 4 feet wide, while 42 feet to the east of it is another which is 7½ feet wide for some distance below the entrance, and then narrows up to a width of about 4 feet. The floors of both of these flumes are 4.6 feet below the original crest of the dam.

The outlet was in that portion of the dam which gave way, and no remnant of it remains. It is, therefore, impossible to determine its character.

Photograph No. 5 shows the location of the tower from which the sluice gate was controlled. I was told by people who were present during the flood, before the dam gave way, that the water flowed approximately 2 feet deep over nearly the entire length of the crest of the dam. There is every evidence of this in the present condition of the crest and of the down-stream slope of this dam. For a length of 494 feet, beginning at a point 91 feet east of the west end of the dam, a depth of from 1½ to 3 feet has been cut from the crest by the action of the water overflowing, and the down-stream slope is worn into terraces by the same agency. This can be seen in photographs Nos. 10 and 11.

At the western end of the eroded portion of the crest the depth cut below the original crest is 1.5 feet, while at the eastern end it is 2.0 feet.

The break in this dam is a cut with nearly vertical sides, 83 feet wide on top, and 33½ feet deep from the present crest of the dam to the bottom of the cut. The western end of this break is 325 feet from the western end of the dam.

Photographs Nos. 10 and 11 are views of the eastern end of the break, and show quite clearly the line between the artificial embankment and the original surface of the ground. The cut made by the escaping water extends not only to the base of the dam, but about 16 feet below it.

The drainage area above the Trout Lake dam is 14 square miles, taken from the Telluride Topographical Sheet of the United States Geological Survey. This includes the 6 square miles above the Middle reservoir. To raise the surface of Trout lake from the level of the bottom of the spillway to the former crest of the dam would have required a run-off of about 0.84 inches over this entire drainage area.

The people living in the vicinity of these reservoirs are all agreed that one of the dams broke on one day and the other on the following day. There is, however, some difference in the statements made as to which dam broke first. Some persons told me that the upper dam broke first, and the Trout Lake dam on the following day. Other people, apparently quite as credible, and just as disinterested, told me that the lower dam broke first and the upper dam the next day.

The contents of the Middle reservoir were 690 acre-feet of water. The area of Trout lake at its normal high-water line, that is, the bottom of the spillway, is 138 acres. If no account is taken of the increase in area as the high-water line rises, the contents of the Middle reservoir, discharged suddenly into Trout lake, would be sufficient to raise the elevation of the lake surface just 5 feet. This would have been just one-half foot higher than the crest of the dam, as it originally stood.

Since the parties who were in the neighborhood of these reservoirs during the flood period seem to be agreed that the water flowed at least 2 feet deep over the crest of the Trout Lake dam, it seems probable that the Middle Reservoir dam must have given way first, and that its contents, combined with the run-off from the heavy precipitation over this drainage area, produced the rise necessary to top the dam by the reported two feet. Although the crest and outer slope of the dam are badly eroded by the action of the water, the really remarkable thing is that the entire dam was not washed away by the action of so heavy a flood as is reported to have washed over it. The fact that it was not destroyed by this action indicates that it is an exceptionally good piece of earth work.

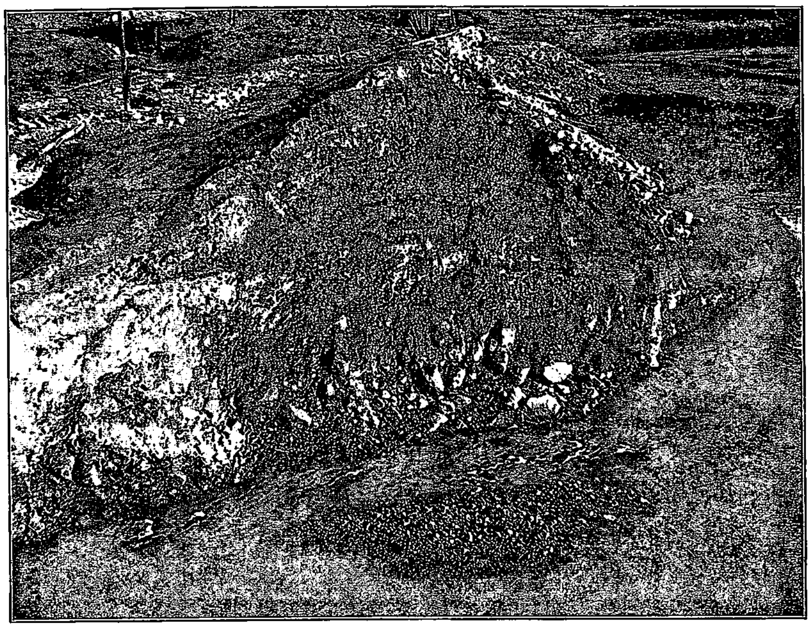
The break in the dam was in all probability due to some defect in the construction of the outlet, which permitted the water discharged from the reservoir to wash away the earth under the dam, and thus make an opening through, which would be rapidly enlarged by the water discharged under pressure from a full reservoir. This is only surmise, as I had never visited the reservoir previous to the destruction of the dam, and there is nothing left of the outlet structure itself.

(Signed) CHARLES W. COMSTOCK,
State Engineer.

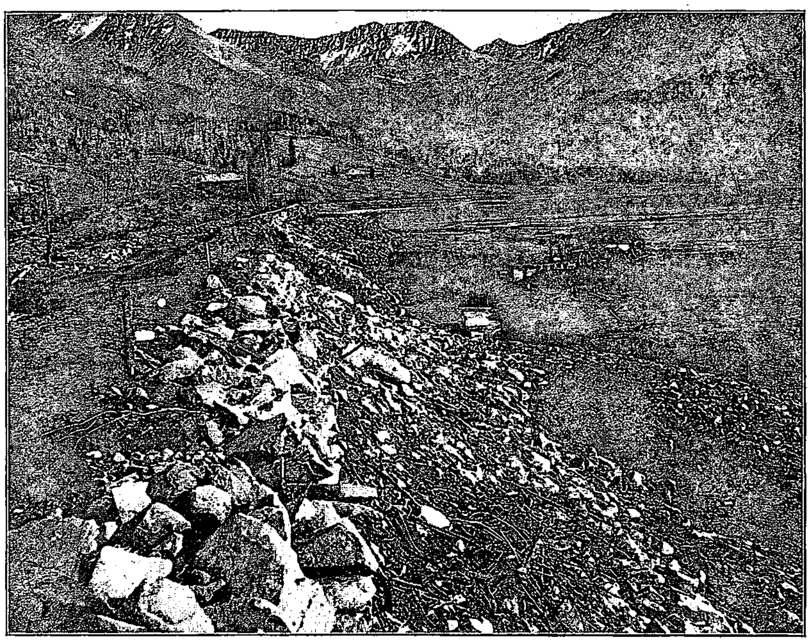
January 27, 1910.

These dams were built about 1894, and the law providing for the supervision of reservoir construction by the State Engineer was not passed until 1899. There are, therefore, no plans, specifications or other documents in the files of the State Engineer's office relating to the construction of these reservoirs.

The dam of the Middle reservoir has not yet been reconstructed. In April, 1910, the engineers of the Telluride Power Company prepared plans and specifications for the reconstruction of the Trout Lake dam, which plans and specifications were approved by the State Engineer on May 6, 1910.



TROUT LAKE.
East side of break from top of dam at west side. October 2, 1909.



TROUT LAKE.
Upper face of dam, showing location of break. October 2, 1909.

A peculiar feature of the reconstructed Trout Lake dam is the spillway, and as the failure of the old dam was due to insufficient spillway capacity, if indeed any spillway could have carried the flood which passed over the crest of the dam, an account of the new spillway will not be out of place.

The dam before the failure had a freeboard of 4½ feet above the bottom of the spillway, and the spillway was so arranged that it might be stopped with flash boards so as to decrease this freeboard. The dam as reconstructed has a freeboard of 7 feet above the bottom of the spillway. The spillway is provided with automatic gates by which the water surface may be raised four feet, thus decreasing the freeboard to three feet. These gates are so constructed, however, that they will open automatically when the water rises more than four feet above the bottom of the spillway. The spillway will then immediately begin to discharge at the rate of 520 cubic feet per second. If there is an inflow of 1,000 cubic feet per second to the lake it will require 17.50 hours to raise the lake level from four feet to six feet above the spillway bottom. When the water surface reaches an elevation of 6.2 feet above the bottom of the spillway the discharge will be 1,000 cubic feet per second and the freeboard 0.8 feet.

With the present spillway construction an inflow of 1,000 cubic feet per second can never overtop the dam, and this inflow would have to continue for nearly 18 hours to bring the water level to within a foot of the crest of the dam. It is believed that the margin of safety in the reconstructed dam is as great as is practicable at this location.

The reconstruction work was carried out during the summer of 1910, under the supervision of Mr. Geo. M. Post, State Inspector. Mr. Post's report, omitting most of the photographs, is reproduced herein.

State Engineer, Denver, Colorado. September 27, 1910.

Dear Sir—I submit herewith my report of the reconstruction of The Telluride Power Company's dam at Trout lake.

The dam was overtopped by a flood a year ago. A portion of it, about 150 feet, was entirely washed out. The balance was eroded to a depth of from three to eight feet. The back of the eroded portion was left in a series of benches, which made the task of bonding the new fill to the old a comparatively easy one.

See photo No. 1 for these benches. See No. 7 for a picture of the cut made by the washing out of the bank.

Filling up to grade of the eroded portion was undertaken first. The bank was plowed down in benches, thoroughly wet, and the new material deposited in horizontal eight-inch layers, rolled by the wheeled scrapers which brought in the earth from the borrow pits. The earth for the fill was taken from a bed of blue clay forming part of the bed of the lake.

See No. 4 for method of placing. No. 1 A for the borrow pit. Nos. 3 and 5 show the east and west ends of the dam, respectively. No. 6 shows riprap being placed at west end.

While the work of bringing these portions of the dam to grade was going on, the deep cut made by the flood was being prepared for the new fill. (No. 7 shows the cut and the cars and track provided for handling the excavated material.)

Excavation was carried down to the solid cement gravel underlying the cut, all pockets of sand and loose stone being removed and all debris cleaned out, and the excavation for outlet pipe made at the same time. (See Nos. 7, 8 and 9.) The 42-inch steel field-riveted pipe was then placed and encased in 8 inches of concrete cover. (See Nos. 10, 11, 12, 13 and 14.) Along this concrete casing, at 40-foot intervals, were built collars.

During this work the water from the lake was carried in a temporary flume along the east side of the cut. Upon completion of the pipe and the concrete well (shown in No. 12) the water was turned into the pipe, and the flume taken down to allow completion of the cleaning up of the cut.

Core wall trenches were cut as shown in Nos. 9 and 10, also a larger one in the bottom of the cut, an unsatisfactory picture of which is shown in No. 10.

The bottom trench was 8 feet wide and 6 feet deep, extending down into the solid cement gravel mentioned before. All material filled into these trenches was carefully hand-tamped, as was all earth around the concrete pipe casing and well.

Filling was commenced by cutting down the bank of clay immediately in front of the dam. (See No. 7. This shows the bank about 15 feet high. Background Nos. 12 and 13 show the clay being drawn in.)

A rock-filled log crib was built 200 feet below the concrete well, and the cut was filled completely between the well and the crib up to an elevation twenty feet below the crest of the dam. (No. 14 shows fill being made into the crib.) Material for the lower 100 feet was obtained outside the dam and was very largely small rocks and gravel.

(Photo No. 16 shows back of dam rising above the fill made as mentioned in last paragraph. No. 20 shows the back of the completed fill. No. 23 shows lower side of crib and flume covering outlet pipe.)

The main fill was made in layers six to ten inches thick, with the center kept always a little lower than the sides. Where new earth was placed against old, it was carefully hand-tamped.

The clay from the lake bed pits became very soft, so earth from a pit outside the lake was mixed with it to stiffen the fill sufficiently to permit teams to travel over it. A great deal of trouble and delay was caused by horses getting mired down, until the drier material was used. This drier material was a heavy mixture of yellow clay and fine gravel, in the proportions of 65 per cent. clay and 35 per cent. gravel. Using this with the blue clay from the lake bed, in the proportion of 1 to 4, rendered the fill firm enough to prevent miring the teams, and, in my opinion, made a better bank.

A result of the use of the soft material was the bulging of the front toe of the dam just under the riprapping. (See photo 22.) A space 50 feet long and 8 feet wide was pushed outward three feet and bulged up vertically 4 feet. This was remedied by putting a "blanket" four feet thick over the whole front of the new fill and about 40 feet wide. (See photo 21, foreground.)

Riprap, 18 to 24 inches thick, was placed everywhere new fill was made, care being taken to make good connections where new riprap joined the old. (No. 21 shows the character of this work.)

The spillway was constructed in the most careful and substantial manner. Instead of the 8x8 inch sills called for by the plans, 12x12 inch and 6x16 inch sills were laid. The outside walls were reinforced with solid lagging, and the earth carefully hand-tamped against them. Heavy cross braces of 12x12 inch timbers were placed. (See photo No. 19.)

The three flash boards were set to trip when the water should reach elevation of 3, 3½ and 4 feet, respectively, above the floor of the spillway, which is 7 feet below the crest of the dam.

The spillway flume is 12 feet wide by 5 feet high and 200 feet long, to carry overflow waters well away from the dam and down into the canon below. The flume is on a 10 per cent. grade.

The greatest height of fill is 45 feet, from the bottom of the core wall trench to crest of the dam. The earth was brought to the fill, for the most part, in wheeled scrapers, which served to roll the fill very effectively.

The cost was about 75 cents per cubic yard of earth in the fill. This includes stripping borrow pits, excavating and placing, superintendence and inspection.

All concrete was made with Ideal Portland cement. The gravel used was taken from the bed of the creek below the dam. With rock larger than two inches removed from the gravel, the proportion of sand in it was such that the concrete mix was in the neighborhood of 1 cement, 2 sand and 4 gravel. It was all hand-mixed in two-sack batches.

A gate tower was constructed upon the concrete well, and a Chapman gate valve installed. The valve stem is placed inside a six-inch steel pipe filled with oil.

Respectfully submitted,

(Signed) GEO. M. POST,
State Inspector.

TURKEY CREEK RESERVOIR.

On July 12, 1910, a serious break occurred in the dam of the Turkey Creek reservoir, at that time under construction in Pueblo county, Colorado. This break did not result from any defect in the design or construction of the dam but was due entirely to the misfortune of being overtopped by a flood before the structure reached the spillway level. It was believed that the flood season had passed and the large outlets which had been specially provided to pass flood flows during construction had been closed so that some water might be stored before the dam was entirely completed.

Plans and specifications for the construction of this dam were prepared by Mr. T. W. Jaycox, consulting engineer, and were approved by the State Engineer onJuly 29, 1909.

On July 15, 1910, Mr. J. W. Johnson, Deputy State Engineer, made an examination of this dam and his report is herein reproduced.

August 1, 1910.

State Engineer, Denver, Colorado.

Dear Sir—On July 15, 1910, I made a trip of inspection to the dam of the Turkey Creek reservoir, near Pueblo, Colorado, accompanied by Mr. J. C. Teller, the owner, and Mr. T. W. Jaycox, consulting engineer, and desire to make the following report:

The Turkey Creek Reservoir dam is being constructed across the natural channel of Turkey creek, and will have a height, when completed, of 106 feet. The dam is constructed of earth with two 6 foot concrete outlets, the inner slope being paved with 4 inches of concrete.

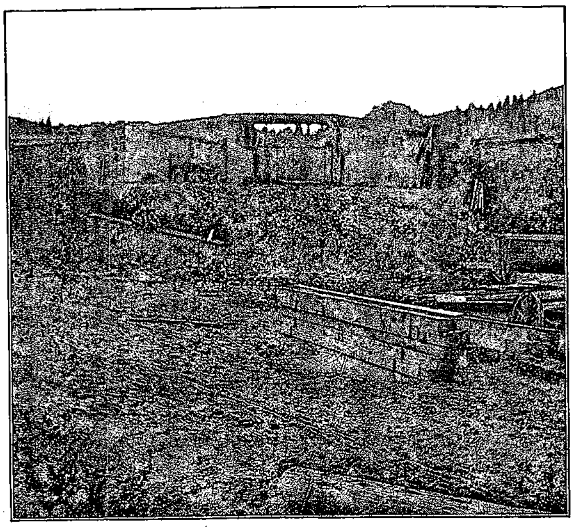
Plans and specifications for this work are on file in the State Engineer's office, and were approved on July 29, 1909.

On July 12, 1910, the top of dam was at an elevation of 60 feet above bottom of outlet tubes. Prior to this time one of the outlet tubes had been closed by means of a concrete wall and outlet gate placed in position at the intake end of other outlet tube. This was done with a view to storing water in the lower part of reservoir, and it was thought to be too late for cloudbursts of any size.

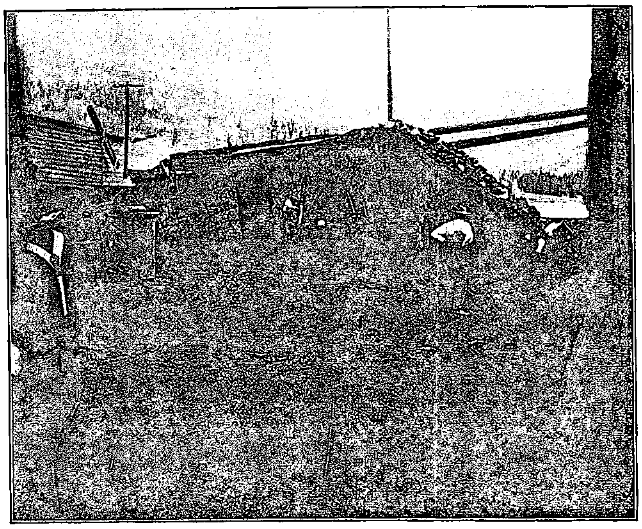
A runway had been established from the mesa on the east end of dam and earth was being brought onto the dam from borrow pits at that end. On this account the top line of dam was inclined from west to east, the east end being higher.

On July 12, 1910, a heavy rainstorm, which lasted several hours, occurred in the drainage basin of this reservoir. The water rose very rapidly against the dam, and at 12 o'clock p. m. on July 12, 1910, burst through the west end of reservoir. This break was about 100 feet wide on top and extended down to bed rock at a width of about 25 feet.

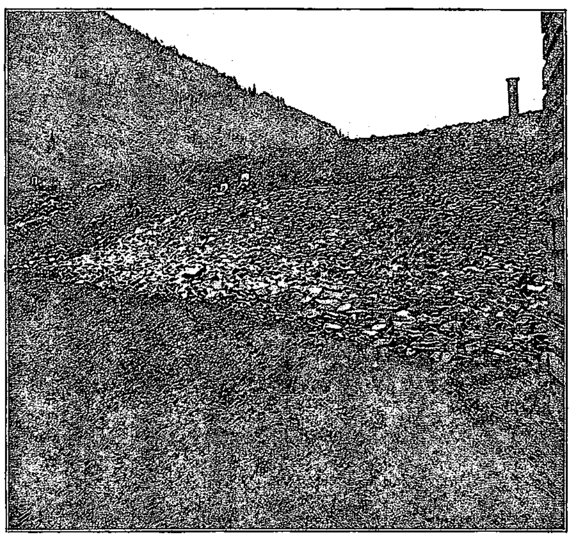
The water in reservoir reached to within at least five feet of the top of dam at west end. At the time of my trip the high-water mark was five feet below the end of break, which was the high end. Due to the manner of



RECONSTRUCTION OF TROUT LAKE DAM.
Inner end of new spillway.



RECONSTRUCTION OF TROUT LAKE DAM.
Trenches at east side of break for bonding old material and new.



RECONSTRUCTION OF TROUT LAKE DAM.
New rip rap on inner face.

construction previously mentioned, the west end was lower than the east and it was impossible to obtain any data as to the exact elevation and width of dam at the point where break occurred.

I am inclined to believe that the water rose almost to the top of dam at that point and gradually soaked through the newly deposited earth, starting a leak which immediately increased and caused the break.

The outlet gates were closed when water started to rise and an attempt was made to open them when it was noticed how rapidly the water was rising. This attempt was not successful as was discovered after water went out through the break.

The top of concrete paving on water slope was at an elevation of about 40 feet above outlet. Water rose above this point and soaked the fill behind paving and was necessarily under a pressure due to head of water in reservoir.

When break occurred the water level in reservoir was lowered rapidly and the pressure behind concrete was evidently not decreased correspondingly.

The entire facing was destroyed and moved from its position on the slope, almost all of it having slipped into lower portion of reservoir and closed the intake end of outlet tubes.

The cut-off walls and lower portion of concrete toe-wall were intact, showing that break did not occur primarily along line of original ground and earth fill. Respectfully submitted,

(Signed) J. W. JOHNSON,
Deputy State Engineer.

The Turkey Creek reservoir is formed by the construction across Turkey creek of an earth dam having a maximum height of 106 feet, a length on the crest of 770 feet and a length on the bottom of about 500 feet. As these lengths indicate, the hills which form the abutments of the dam are very steep, and near the top the dam abuts against rock cliffs at both ends. The embankment has a width on the crest of 22 feet, an inside slope of 1½ to 1 and an outside slope of 3 to 1.

The inner slope is protected by a reinforced concrete pavement 4 inches thick, anchored to the earthwork by concrete plugs 6 inches in diameter and 2 feet long, spaced 12 feet apart. This concrete pavement is connected with a concrete toe-wall which is carried to bed rock across the creek bottom. Concrete cut-off walls were also provided where the embankment abuts against the rock cliffs at either end.

The outlet consists of two concrete tunnels constructed in a trench in the natural ground entirely below the artificial embankment. Each of these tunnels is 7 feet wide and 6 feet 4 inches high. They were expected to have sufficient capacity to pass any flood which might occur on the creek during construction. One of them was eventually sealed up by a concrete wall at the inner end and the other provided with two 30-inch pipe inlets equipped with gate valves. The sealed tunnel was used as a means of access to the valves, thus dispensing with the necessity for constructing a valve tower.

A spillway for the reservoir was provided over a rock cliff at some distance from the dam.

This work was carried out under the supervision of Mr. L. A. Sumner as resident engineer, and Mr. T. W. Jaycox, as consulting engineer.

Mr. Sumner made frequent reports on progress and character of work to the State Engineer's office, and a resident inspector representing the State was not considered necessary.

The design provides for a dam which will be amply strong, and it is believed that the work has been well executed. Once the work is completed there need be no fear of any failure.

OTHER DAMS.

No actual failures other than those above described have been brought to the attention of this office. Examinations have, however, been made of a number of smaller reservoirs, either upon the request of the owners or upon the complaint of parties whose property would be damaged by a failure, as provided in Section 3209, Revised Statutes of Colorado, 1908.

Following is a list of such examinations, omitting, however, the reports of the engineers who made them. These reports are on file in the State Engineer's office and are not reproduced as they refer chiefly to minor defects which have been remedied in accordance with the recommendations in the reports.

The La Jara Meadows reservoir, examined on April 21, 1909, by Mr. G. N. Houston, Deputy State Engineer.

Ish Lake, near Longmont, Colorado, examined on April 28, 1909, by Mr. G. N. Houston, Deputy State Engineer, and later by the State Engineer, and after completion of repairs by Mr. A. F. Hewitt, Deputy State Engineer.

The reservoir of the Colorado Consolidated Lumber Company, on the South Fork of the Grand river in Grand county, Colorado, examined by Mr. A. F. Hewitt, Deputy State Engineer, on June 3 and 4, 1909.

The Bartels reservoir, at Evans, Colorado, examined by Mr. J. W. Johnson, Deputy State Engineer, on June 15, 1909.

Sylvan Lake, San Miguel county, Colorado, examined by Mr. J. W. Johnson, Deputy State Engineer, on April 8, 1910.

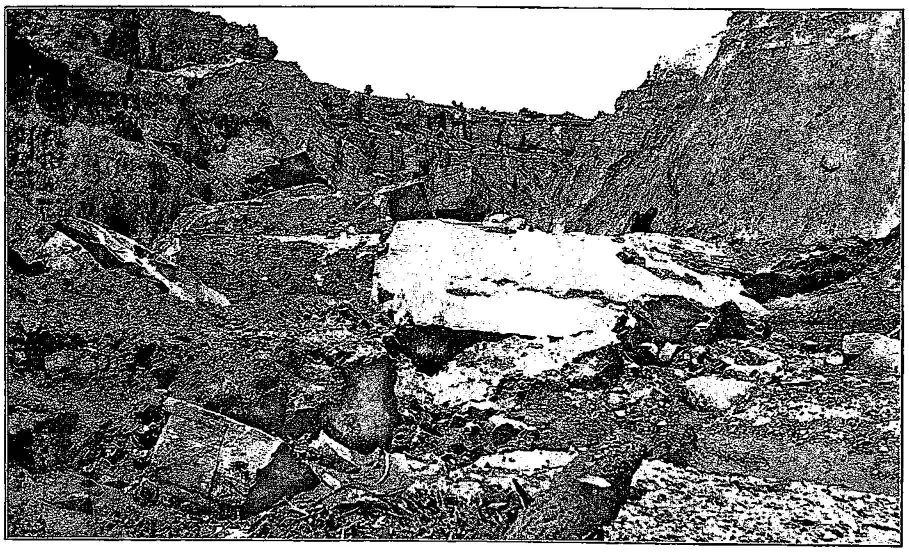
The reservoirs of the Agate Land & Stock Company, in Elbert county, Colorado, examined by Mr. Geo. T. Prince, consulting engineer, in May, 1910.

Fountain Valley Reservoir No. 2, examined by Messrs. J. W. Johnson and A. F. Hewitt, Deputy State Engineers, in May and June, 1910.

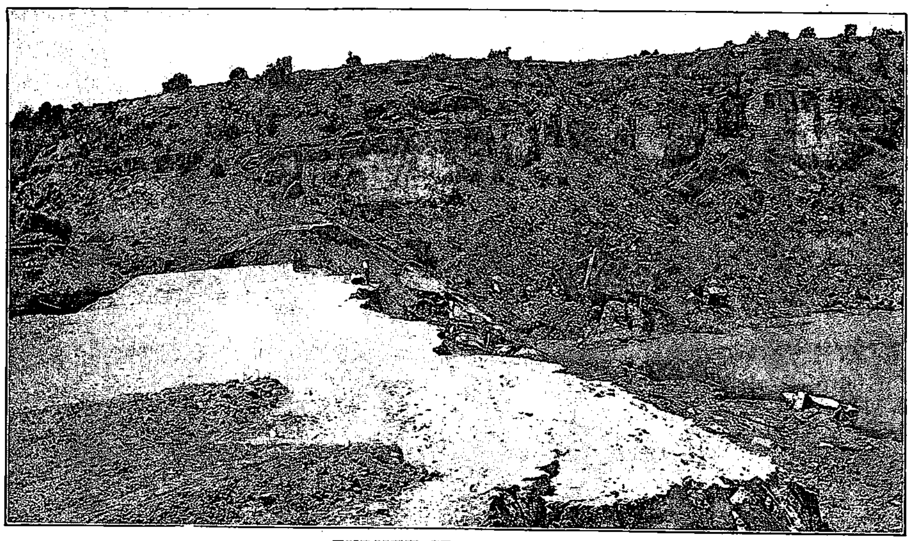
The Bauer reservoir, the Upper Milwood reservoir, the Summit reservoir and the Webber reservoir, all located near Mancos, Colorado, and examined by Mr. A. F. Hewitt, Deputy State Engineer, in the latter part of July, 1910.

The Bootleg reservoir, near Brighton, Colorado, examined by Mr. A. F. Hewitt, Deputy State Engineer, on November 1, 1910.

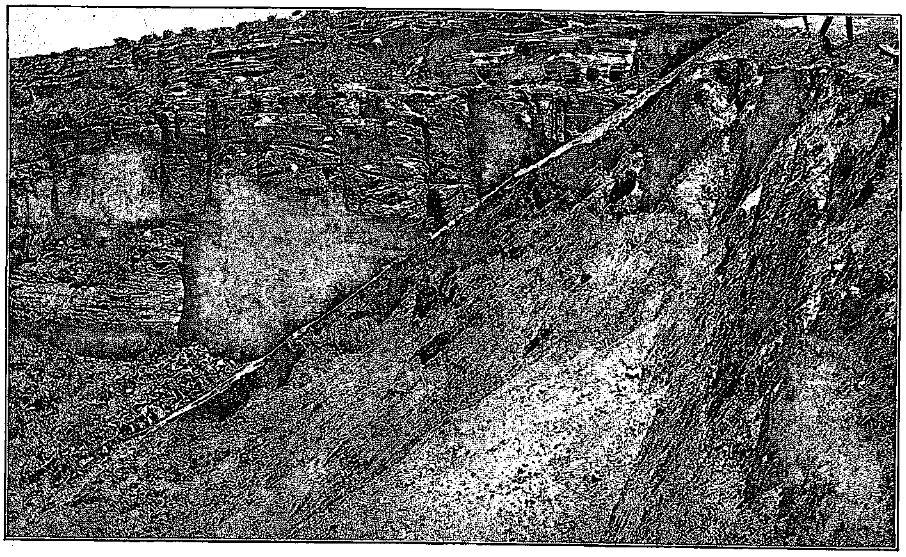
In some of these instances the complaints were found to be unjustified and in some others some minor repairs were suggested to and carried out by the owners. It is not thought necessary to report here the details of these smaller matters.



TURKEY CREEK DAM.
Looking through break. July 15, 1910.



TURKEY CREEK DAM.
Looking west along top of embankment. Showing location of break. July 15, 1910.



TURKEY CREEK DAM.
Looking east along inner face. Remains of concrete paving visible at bottom of slope. July 15, 1910.

CHAPTER IX.

RESERVOIRS UNDER CONSTRUCTION AND PLANS APPROVED.

STANDLEY LAKE.

This is a part of the system now under construction by the Denver Reservoir Irrigation Company. Plans for the construction of the dam were prepared by The Arnold Company, engineers, of Chicago, and approved by the State Engineer on February 17, 1909.

The dam is an earth embankment having a maximum height of 113 feet above the natural ground surface and a length of about 9,000 feet on the crest. The greatest depth of water against the dam will be 108 feet. This embankment is worthy of note as having the greatest depth of water back of it of any earth dam now in existence, although a number are proposed, and at least one is under construction, which will be subject to a greater head than this one.

The Standley Lake embankment will have a width of 20 feet on the crest and slopes on the inside and outside of 2 to 1. On the inside the slope is flattened to 3 to 1 for about the lower 40 feet. On the outside there is a banquette 30 feet high and about 100 feet wide against the toe. It is planned to protect the inner slope with a reinforced concrete pavement which will have a thickness of 10 inches for the lower one-fourth of the slope, 8 inches for the next one-fourth, 6 inches for the third, and 4 inches at the top.

A continuous line of steel sheet piling is driven to bed rock immediately under the crest of the dam. It is believed that this will effectually cut off any underflow.

A line of drainage wells, 100 feet apart, was placed under the embankment some distance back from the lower toe to catch and dispose of any water which may seep through the dam. This will no doubt prevent any saturation of the lower slope. The original plans contemplated the construction of a puddle core by maintaining a pond of water in an open trench along the axis of the dam, into which the material should be dumped, so that it might be thoroughly consolidated and become practically impervious to water. This method of construction was actually carried out up to about elevation 30 above the base of the dam. It was then found that the character of the earth used was such that the excess of water did not readily drain away and that the puddle core was a mass of jelly-like consistency which would not contribute anything to the stability of the structure. This system was therefore abandoned and the method of placing the material in this central portion in thin layers by teams and slip scrapers was substituted. This was found to give an effective consolidation of material without the disadvantage attendant upon the use of an excessive amount of water, and was continued until work on the structure was stopped.

At the present time the dam is completed up to elevation 70, with the exception of the paving on the inside slope, and about one-half of the material above elevation 70 has been placed, bringing the outer portion of the dam to the final elevation of 113.

The outlet system for this reservoir consists of four lines of 48-inch cast-iron pipe placed in a trench excavated in bed-rock underlying the dam. These pipes are provided with gate valves at the outer end for convenience of control, and emergency valves at the inner end to be used in case of accident.

The drainage area tributary to the reservoir is not large and the supply to the reservoir will be under complete control, since it will come through feeder canals with headgates which may be opened or closed at will. For this reason no great spillway capacity is necessary. However, a spillway 300 feet wide, with its bottom 5 feet below the crest of the dam, and so placed as to discharge clear of the toe of the dam itself, has been provided.

The construction of this dam from May 1, 1909, until work was suspended was under the constant supervision of Mr. Parker D. Shepperd, State Inspector. Mr. Shepperd's detailed reports are on file in the State Engineer's office. The work so far has been carried out strictly in accordance with the plans and specifications and with good engineering practice. Special care has been taken by this office to insure absolutely reliable work on every portion of this structure because of the large amount of valuable property and the considerable number of human beings which would be damaged by any failure.

The work is believed to be sound and reliable in every respect, and absolutely free from any danger of failure.

BARKER DAM.

This dam was built across Boulder creek, a few miles from the town of Nederland, in Boulder county, Colorado. It is the property of the Central Colorado Power Company and was designed by that company's engineers under the direction of Mr. A. S. Crane, of New York, as consulting engineer. The dam is a concrete structure of the standard section universally accepted by engineers as the correct one for masonry dams. Its maximum height is about 170 feet and its length on the crest 660 feet.

The plans were approved by the State Engineer on February 20, 1909.

During the season of 1909 the work was under the supervision of Mr. J. J. Wilson, as State Inspector, and during the season of 1910 under Mr. F. L. Easton, as State Inspector.

In addition to the State supervision, the Central Colorado Power Company maintained a constant and careful engineering inspection and the contractors seemed also to have a pride in doing good work. The result is a structure which is not only safe and substantial in every way, but a credit to everyone connected with it as well.

The dam was finally completed in August, 1910.

NORTH POUDRE RESERVOIR NO. 15.

This reservoir is located in Water District No. 3 in the valley of the Cache la Poudre river. It is the property of the North Poudre Irrigation Company, and is formed by an earth dam having a maximum height of 45 feet and a length on the crest of 3,500 feet. The embankment is 14 feet wide on top, has an inside slope of 3 to 1 and an outside slope of 2 to 1.

The outlet is of reinforced concrete constructed in a trench below the surface of the natural ground. The depth of water above the bottom of the outlet will be 38 feet, leaving a freeboard of 7 feet.

The plans were prepared by Mr. E. C. McAnelly, engineer, and approved by the State Engineer on June 25, 1909.

The State Engineer made a personal examination of this structure in June, 1910, at which time the work was complete except for the riprapping on the inner slope.

TURKEY CREEK RESERVOIR.

The plans for this work were approved by the State Engineer on July 29, 1909. As the work is elsewhere described in this report, no further reference will be made to it here.

HALLIGAN DAM.

This dam is the property of the North Poudre Irrigation Company, and is located near the town of Livermore, on the north fork of the Cache la Poudre river, in Larimer county, Colorado.

It is worthy of note because of the boldness of its design. It is a concrete structure 80 feet high and 333 feet long on the crest. It is constructed on a curve, the radius on the back being 324 feet. Because of this curved plan and the rock abutments, reliance has been placed upon arch action of the structure and the area of the cross section very greatly diminished on this account.

The central portion of the dam for a length of 110 feet has been constructed to serve as a spillway, the sill of this spillway being 10 feet below the crest of the dam.

The structure was designed by Mr. G. N. Houston, consulting engineer, of Denver, and approved by the State Engineer, after careful study and many consultations with the designer, on August 10, 1909.

The work was constructed under the supervision of Mr. Chas. E. Shimer, State Inspector, who reported that it conforms in all respects to the requirements of the plans and specifications.

On June 12, 1910, the State Engineer made a personal inspection of the completed structure, and on June 22 addressed a letter to the North Poudre Irrigation Company, formally accepting the work as satisfactory to the State, in compliance with section 3205, Revised Statutes of Colorado, 1908.

SCHAEFFER DAM.

This is an earth dam constructed across Beaver Creek, in the northeastern part of Fremont county, Colorado, by the Beaver Land & Irrigation Company.

The dam has a maximum height of 100 feet above the bottom of the outlet and a length on the crest of 1,100 feet. Its average height is about 90 feet for the middle 500 feet of its length. The width on the crest is 15 feet, the outside slope is 2 to 1 and the inside 3 to 1. A freeboard of 10 feet is provided. A concrete cut-off wall is provided in the middle portion of the length and a timber cut-off wall for the remainder.

The outlet is a concrete tunnel 4 feet wide, 5 feet high, constructed on bed rock. The gate well is also of concrete and is placed in the middle of the embankment.

Plans and specifications for the construction of this dam by the hydraulic fill process were prepared by Mr. O. K. Parker, chief engineer, in November, 1908, and were approved by the State Engineer in March, 1909.

Under this system of construction both the inside and outside slopes were to be provided with a pavement of hand laid rock. The dam was actually constructed to a height of between 20 and 30 feet by this process. It was then observed that the material deposited in the center of the dam was extremely retentive of water and did not consolidate, being, in fact, more nearly liquid than solid throughout the entire mass.

New specifications for completing the structure were prepared by Mr. Geo. G. Anderson, consulting engineer, and approved by the State Engineer on November 5, 1909. The specifications provided for the replacement of the semi-liquid material by dry earth and the completion of the dam to the height and dimensions originally planned with earth deposited by wagons and sprinkled and rolled in thin layers. Under this system of construction the hand-laid pavement on the outer slope was not necessary, but the inner slope was carefully rip-rapped to the top.

A spillway 100 feet wide is provided beyond the east end of the dam, and the discharge from the spillway is led away from the toe of the embankment by a canal constructed for that purpose.

The work was examined by the State Engineer while the construction was in progress, and was considered eminently satisfactory.

The construction was under the supervision of Mr. Winfield Holbrook, resident engineer, who made frequent reports to the State Engineer's office concerning the progress and character of the work.

At this writing the structure is nearly complete.

WILD HORSE RESERVOIR.

This is a small reservoir, located in Weld county, Colorado. A dam having a maximum height of 22.5 feet has been in existence for some time. Plans for raising it 5 feet were prepared by Mr. Glen A. Izett, engineer, and approved by the State Engineer, on September 19, 1909.

As enlarged the embankment has a maximum height of 27.5 feet, width on crest of 16 feet, an outside slope of 2 to 1 and an inside slope of 4 to 1. The inner slope is protected by a rip-rap of hand placed stone. The dam is 1,150 feet long on the crest and the freeboard is 5 feet.

MILTON LAKE.

This is one of the reservoirs of the Farmers Reservoir & Irrigation Company, which is closely connected with the Denver Reservoir Irrigation Company. This lake is formed by an earth dam with a maximum height of 52 feet, a crest width of 16 feet, an inside slope of 2½ to 1 and an outside slope of 2 to 1.

The inner slope is to be protected by reinforced concrete paving 4 inches thick abutting against a concrete toe-wall which in its turn encloses the top of a line of Wakefield sheet piling driven to an impervious substratum. A freeboard of 5 feet has been provided for.

The outlet consists of two lines of 48-inch cast iron pipe entirely surrounded by concrete and resting on a pile foundation throughout its length. Gate valves are provided at the lower end of these pipes for the normal control of the discharge. Special valves are provided at the inner end for use in emergency.

Plans for the construction of this dam were prepared by The Arnold Company, engineers, of Chicago, and approved by the State Engineer on November 23, 1909.

This office has never been advised whether actual construction has been begun.

DUNSTAN RESERVOIR.

This is a small reservoir formed by the construction of an earth dam across Second creek, a tributary of the Williams river in Routt county, Colorado.

The dam has a maximum height of 25 feet at the center and a length on the crest of 315 feet. The crest width is 10 feet, the outer slope 2 to 1 and the inner slope 3 to 1. A freeboard of 5 feet is provided, with a spillway 20 feet wide just beyond one end of the dam.

The outlet consists of an 8-inch cast iron pipe laid on concrete foundation and provided with concrete cut-off walls. Plans were prepared by the Routt County Engineering Co., and approved by the State Engineer on November 20, 1909.

GRASS VALLEY RESERVOIR.

This reservoir will be formed by an earth dam now under construction in what is known as Harvey Gap, a few miles northwest of Silt, Garfield county.

Twice in the past ten years has a dam been constructed on this site; each time the dam has failed. There is no record of plans or specifications of either of the dams previously constructed, but judging from information available from people living in that neighborhood the structures were of inadequate dimensions and the work was improperly done.

The dam now under construction will have a height of about 70 feet above the bottom of the reservoir at the inner toe, and is about 680 feet long on the crest. The hills against which the embankment abuts at either end are very steep and the dam has nearly its maximum height throughout its length.

The section has a width of 20 feet on the crest, a slope 2 to 1 on the outside and 3 to 1 on the inside. The freeboard provided is 16 feet.

Because of the considerable pond of water retained by what remained of the old dam it was impossible to construct a cut-off wall. The inner toe of the embankment is protected by a loose rock fill 8 feet wide on top and with side slopes of about 1 to 1. Against this the earth embankment rests. The inner slope of the embankment is protected by a carefully laid rip-rap of loose rock which is 3 feet thick where it joins the rock fill at the toe and tapers in a length of 40 feet to a thickness of 18 inches, which it retains to the top of the dam.

A spillway 100 feet wide has been cut in the solid rock at the western end of the dam. The outlet is through a tunnel in the rock passing under the western end of the dam and lined with concrete. This tunnel is 4 feet wide and 5½ feet high inside of the lining.

The discharge is controlled by a gate valve in a cast iron pipe passing through the bottom of a dry well built of concrete. The lower half of this well is built in an excavation in the natural earth. The upper half is surrounded by the artificial embankment.

The design was prepared only after borings had been made and all conditions carefully studied, and is most excellently adapted to the site.

Personal inspection of the work was made by the State Engineer in the spring of 1910.

The structure was designed by Mr. A. G. Allan, chief engineer of the Antlers Orchard Development Company, owner of the reservoir, and the work has been done under his immediate supervision.

Plans were approved by the State Engineer on November 15, 1909.

Reports from Mr. Allan at frequent intervals were accepted by the State Engineer's office in lieu of supervision by a State Inspector.

Work was discontinued about November 1, because of freezing weather. At that time about two-thirds of the structure had been completed.

HIGHLAND DITCH COMPANY'S RESERVOIR NO. 2.

It was desired to construct a new outlet to this reservoir, which has been in use for some years.

Plans were prepared by Mr. R. E. Richardson, engineer, Longmont, Colorado, for a reinforced concrete outlet and gate tower.

The outlet is 3 feet wide and 3 feet high and its bottom is 30 feet below the crest of the embankment. The total length of the structure is 160 feet.

Plans were approved by the State Engineer on December 16, 1909.

ISH LAKE.

Ish lake is located near Longmont. The embankment, which has a maximum height of 42 feet, has been in use for several years, but has never been riprapped on the inner face.

The dam is 18 feet wide on the crest, the outer slope is 2 to 1 and the inner slope 3 to 1.

Plans and specifications for the construction of a riprap one foot thick were prepared by Mr. M. D. Whipple, of Berthoud, Colorado, and were approved by the State Engineer on December 22, 1909.

On April 29, 1910, Mr. A. F. Hewitt, Deputy State Engineer, examined the work and found it complete and satisfactory.

MARION RESERVOIR.

This reservoir is formed by a rock-filled log crib dam 40 feet high throughout almost the entire length and 310 feet long on the crest. It is located in the southeastern part of Custer county.

The dam is 10 feet wide on the crest, 51 feet at the base, has an inner slope of 1 to 1, and is practically vertical on the down-stream face.

Along the inner toe a line of sheet piling consisting of three rows of 2-inch plank breaking joints is driven to an impervious substratum. The inner face of the dam is covered by two layers of 2-inch plank, laid so as to break joints.

The outlet is a 10-inch iron pipe laid in a trench in the natural earth and protected by a specially constructed log crib. A valve at the inner end is operated from a trestle connected with the crest of the dam. A freeboard of five feet is provided and a spillway flume 30 feet wide is constructed across the crest of the dam and continued to a point 100 feet below the structure, so as to avoid the possibility of the dam being undermined.

Plans for this dam were prepared by Mr. Jay Lonergan, engineer, and approved by the State Engineer on December 30, 1909.

MC INTYRE RESERVOIR.

This reservoir is located in Morgan county. The dam is an earth embankment having a maximum height of 29 feet and a length on the crest of 880 feet. The embankment has a crest width of 16 feet, an inner slope of 3 to 1 and an outer slope of 2 to 1. The freeboard is 5 feet.

The outlet consists of one line of 24-inch vitrified pipe, entirely surrounded by reinforced concrete 10 inches thick and provided with four concrete cut-off walls. This outlet is constructed in a trench in the natural earth. The inner slope is protected by a riprap 12 inches thick of hand-placed rock.

Plans were prepared by Mr. Glen A. Izett, engineer, and approved by the State Engineer on January 8, 1910.

BADGER RESERVOIR.

This reservoir is formed by a dam across Badger creek, in Morgan county, Colorado. The dam is of earth and has a maximum height of 50 feet. The embankment is 3,542 feet long on the crest. The inside slope is 2 to 1 above high-water mark and 4 to 1 below it. The outside slope is 1½ to 1 above the high-water mark and 2 to 1 below it. The freeboard is 8 feet, and the width on the crest 12 feet.

A spillway 200 feet wide has been constructed beyond one end of the dam. This spillway is 500 feet long from grade to grade, and water discharging over it is returned to the creek below the dam without coming in contact with the toe of the embankment.

The outlet is of riveted steel pipe built of No. 10 sheet steel, with an inside diameter of 30 inches. This pipe is entirely surrounded by concrete. It is 204 feet long. The gate is placed immediately under the crest of the dam and is operated through a wet well. This well, like the outlet conduit, is constructed of riveted steel pipe surrounded by concrete.

Plans were prepared by Mr. J. E. Youngquist, engineer, in February, 1909, and were approved by the State Engineer on March 17, 1909. The structure was built without any inspection by a representative of the State.

On May 29, 1910, Mr. J. W. Johnson, Deputy State Engineer, made an examination of this dam at the request of the directors of the Badger Irrigation District. He reported that the work had been done in accordance with approved plans and specifications, and recommended its formal acceptance by the State.

WILLIAMS-M'CREERY RESERVOIR.

This reservoir is being constructed by the San Arroyo Irrigation District in Morgan county, Colorado. It is formed by an earth dam having a maximum height of 46 feet, a width of 10 feet on the crest, an inside slope of 3 to 1 above the high water line, and 4 to 1 below, and an outside slope of 1½ to 1 above high water line and 2 to 1 below. The freeboard is 8 feet.

The outlet consists of two lines of 24-inch standard cast-iron pipe provided with concrete cut-off walls extending 6 feet each side of the pipe, 3 feet below and 2 feet above, and spaced one to each pipe length. These walls are 2 feet thick. Gate valves for the control of the dis charge are placed at the outer end of the conduit and emergency valves for use in case of accident are provided at the inner end.

Plans were prepared by Mr. J. E. Youngquist in December, 1909, and approved by the State Engineer on February 3, 1910.

The work has been built under the constant supervision of Mr. Walter E. Robi, State Inspector, and at the date of this report is nearly complete.

SANCHEZ RESERVOIR.

This reservoir will be formed by the construction of a dam across the Rio Ventero in Costilla county. The reservoir will contain about 104,000 acre-feet, and is part of the system under construction by The Costilla Estates Development Company for the reclamation of a large area of land on that estate.

The main dam is of earth, with a maximum height of 117 feet above the ground surface, and 130 feet above the bottom of the outlet. The dam is 1,660 feet long on the crest, and has its maximum height for a length of only about 200 feet.

The crest of the embankment is 20 feet wide, the inside slope is 3 to 1 and the outside 2 to 1.

About one-third of the dam next to the down-stream toe will be constructed of loose rock and porous material, while the remainder will be composed of selected material sprinkled and rolled in layers not exceeding 9 inches in thickness. The inner slope will be protected with a hand-laid rock pavement 1 foot thick on a 1 foot layer of gravel. The freeboard is 10 feet, and a spillway 250 feet long is constructed near one end of the dam.

Along the axis of the dam a trench has been carried to bed rock, and a concrete cut-off wall constructed from bed rock to a height at least 2 feet above the natural surface of the ground. The trench on either side of this concrete wall has been refilled with selected and carefully puddled material.

The outlet is a concrete tunnel 8 feet wide, 12½ feet high and 676 feet long. A very elaborate and carefully designed gate tower, with an inside diameter of 15 feet and with a height from bottom of foundation to floor of gate house of 145 feet, has been constructed at the inner end of this conduit. This tower has been provided with a large number of valves arranged according to a system devised with great care and permits not only of an absolute control of the discharge from the reservoir, but of complete access to all valves and parts of the mechanism at all times, whether the reservoir be full or empty. This outlet system is without any doubt by far the best yet constructed anywhere in the west.

In addition to this main dam it has been necessary to construct a dyke at one place where the rim of the Sanchez Reservoir is low. This dyke has a maximum height of 30 feet and a length on the crest of 4,040 feet. Its crest width, inside and outside slopes and method of construction, are the same as for the main dam except that no provision has been made for the use of loose rock and porous material on the lower slope.

The plans and specifications for the construction of this reservoir have been rationally worked out, and are the most complete and best adapted to the conditions which have yet come into the State Engineer's office. The work is under the immediate supervision of Mr. W. D. Waltman, Resident Engineer, and of Messrs. O. V. P. Stout and Geo. G. Anderson, consulting engineers.

The plans and specifications were approved by the State Engineer on February 1, 1910.

In September of 1910 the State Engineer made a personal examination of the work and found that it was being carried out in every detail as provided by the plans and specifications. At that time the gate tower and the outlet conduit were nearly complete, the cut-off trench under the main dam had been finished, and perhaps one-third of the work on the dyke had been done. Reports are received at frequent intervals from the resident engineer and from the consulting engineers, and it is thought unnecessary to keep a state inspector on the work.

TWO BUTTES RESERVOIR.

This reservoir is under construction by The Two Buttes Irrigation & Reservoir Company in Prowers county, Colorado. This company is under contract with the State to irrigate some 22,000 acres of land which has been segregated under the Carey act, and the dam here described is a portion of the system being constructed for that purpose.

This dam is of earth and has a maximum height of 106 feet above the bed of the creek. It retains this maximum height, however, for a length of only about 50 feet, while, except for a length of 400 feet in the middle of the dam, the height at no place exceeds 40 feet. The length on the crest is 1,600 feet. The crest width is 20 feet, the inside slope is 1½ to 1 above high water line, 2 to 1 from the high water line down to a point 68 feet vertically below it, and 3 to 1 from there to the bottom. The outside slope is 1½ to 1 above high water line and 3 to 1 below it. The inner toe of the dam and the entire outside slope were constructed of loose rock and coarse material. The remainder is built of selected material carefully placed.

Cut-off trenches are carried to bed rock, and in them concrete cut-off walls constructed to some distance above the natural surface of the ground. The trenches on both sides of these concrete walls are filled with selected material carefully puddled in place. Along the greater portion of the length of the dam only one cut-off wall is built. At the south end, however, three walls spaced about 40 feet apart, have been constructed. The inner slope is protected by a reinforced concrete pavement 5 inches thick.

The outlet is through a tunnel in the rock which is entirely removed from any contact with the artificial embankment. This tunnel is 12 feet wide and 7 feet high. The dam has a freeboard of 10 feet and a spillway 300 feet wide has been provided at the south end of the dam.

Plans were prepared and the work constructed under the supervision of Mr. C. W. Beach, chief engineer, and Messrs. Field, Fellows & Hinderlider, consulting engineers. Plans and specifications were approved by the State Engineer on February 23, 1910.

The construction work has been continuously inspected from the beginning by Mr. J. J. Wilson, State Inspector. Mr. Wilson's reports are to the effect that the plans and specifications have been carefully followed, and that all work has been done in a careful manner and in accordance with sound engineering principles.

Under the terms of the contract between The Two Buttes Irrigation & Reservoir Company and the State of Colorado it became necessary to determine when the dam was three-fourths completed. For this purpose the work was examined on September 24, 1910, by Mr. A. F. Hewitt, Deputy State Engineer, in company with Mr J. J. Wilson, State Inspector of the Two Buttes dam, and Mr. C. W. Beach, chief engineer of The Two Buttes Irrigation & Reservoir Company. At that time Mr. Hewitt and Mr. Wilson reported to this office that the outlet works had been entirely completed and that three-fourths of the volume of material in the dam had been placed. At this writing the structure is almost entirely completed.

MARSHALL LAKE.

This lake, which was constructed a number of years ago, is located in Boulder county a few miles north of Denver. Several different organizations had a hand in its original construction and the work was badly handled. One slide of a large volume of material took place during construction and since the completion of the embankment there has always been some motion resulting in the development of a number of cracks.

Part of the plan of The Denver Reservoir Irrigation Company was to raise this embankment and increase the capacity of the lake by about 5,000 acre-feet. An examination of the dam made by the engineers of this company together with the State Engineer showed that it would be necessary to construct a system of drains to remove the water from the old embankment, and to construct an entirely new outlet system. A considerable amount of preliminary work was done and a drain constructed near the lower toe of the dam.

A tentative plan for reconstruction and raising was prepared by The Arnold Company, engineers, and submitted to the State Engineer in January, 1910. This plan was, however, not approved, and as The Denver Reservoir Irrigation Company was not prepared to go ahead with the work, nothing further was done.

RIO GRANDE RESERVOIR.

This reservoir is being formed by the construction of a dam across the Rio Grande river near what is known as Thirty Mile bridge, approximately 35 miles above Creede, in Hinsdale county. The reservoir will have a capacity of about 43,000 acre-feet and is being constructed by the San Luis Valley Irrigation District. The dam is a combination of rock fill and earth fill. The maximum height is 100 feet. The down stream portion of the dam is composed of a loose rock fill having an outside slope of 1¼ to 1, an inside slope of 1 to 1 and a crest width of 15 feet. Above this is an earth fill resting against the rock and having an inside slope of 4 to 1, with a horizontal crest of 15 feet in addition to the crest of the rock fill, thus making the crest width of the entire dam 30 feet. The length of the dam on the crest is 452 feet.

The inside slope of the earth work will be protected by a rip-rap of hand placed rock. Two cut-off trenches 140 feet apart, each with a width of 10 feet on the bottom and 20 feet on top, will be constructed entirely across the valley under the earthen part of the dam.

A spillway 30 feet wide on the bottom and with its sill 17 feet below the crest of the dam will be constructed in the solid rock beyond the end of the dam. This spillway channel has a heavy grade and it is calculated that a depth of water of 2 feet in it in conjunction with the outlet tunnel will discharge the heaviest floods in the river. This leaves the dam a freeboard of 15 feet above the highest possible water mark. The outlet is through a tunnel in the solid rock entirely away from the dam. This tunnel has a width of 15 feet and a height of 11 feet.

About the middle of the length of the tunnel a shaft has been constructed and through this shaft the gate stems pass to the surface above the reservoir level. There are two complete systems of gates, either one of which may be used to control the flow through the tunnel. Each system consists of five gates 8 feet high by 3 feet wide in the clear. The detail of the construction and operation of these gates has been so carefully worked out that it is not possible to imagine any combination of circumstances under which the water would not be at all times under complete control.

Plans and specifications for the construction of this reservoir were prepared by Mr. J. C. Ulrich, consulting engineer, of Denver, and were approved by the State Engineer on May 31, 1910.

In September, 1910, the State Engineer made a personal examination of the work and found it in a highly satisfactory condition. At that time the outlet tunnel had been completed and the steel framework for the gate system was being installed. The dam site was being thoroughly cleared and the cut-off trenches were in course of construction.

The work was under the direction of Mr. O. P. Pennock, resident engineer, and Mr. J. C. Ulrich, consulting engineer. No state inspector was considered necessary during the past season. Work has now been entirely suspended for the winter, but will be actively undertaken again in the spring.

MESITA RESERVOIR.

This is part of the irrigation system of The Costilla Estates Development Company, in Costilla county. The reservoir is formed by the construction of an earth dam 2,900 feet long on the crest and with a maximum height of 48 feet. The dam has a crest width of 15 feet, an inside slope of 3 to 1 and an outside slope of 2 to 1. The inner slope is protected by a hand-laid rock pavement 12 inches thick, carried to a vertical height of 2 feet above the high-water line. The dam has a freeboard of 5 feet and a spillway 50 feet wide has been constructed beyond one end of the dam.

The outlet is a reinforced concrete tunnel 3 feet wide and 4 feet 6 inches high. Its total length is 217 feet. A sluice gate has been provided at the inner end and is operated from a steel tower constructed near the inner toe of the dam.

Plans were prepared by the engineers of the Costilla Estates Development Company and approved by the State Engineer on June 7, 1910.

KIT CARSON RESERVOIR.

This reservoir is located a few miles from the town of Kit Carson, in Cheyenne county, and is the property of the Big Sandy Irrigation District.

The dam is of earth with a maximum height of 35 feet and is 13,500 feet long on the crest. The embankment is 16 feet wide on the crest, has an inside slope of 1½ to 1 and outside slope of 3 to 1. The inner slope is protected by a reinforced concrete pavement 5 inches thick, capped by a coping wall 6 inches thick extending 2 feet above the top of the embankment.

A spillway 400 feet wide has been provided beyond the end of the dam and has its sill 8 feet below the crest of the embankment. The outlet consists of 2 lines of 36-inch standard cast-iron pipe set on concrete cross walls 2 feet thick and spaced 12 feet apart. These cross walls extend 3 feet above and below and on each side of the pipe and form an effective cut-off against any leakage along the conduit. These pipes pass through the bottom of a concrete well located about half way between the inner toe and the crest of the embankment. Gate valves for the control of the discharge are located in the bottom of this well and are accessible at all times. An open concrete-lined canal 11 feet wide and 27 feet long connects the body of the reservoir with the inlet end of the conduit.

Plans and specifications for this work were prepared by Baker & Thompson, of Greeley, and were approved by the State Engineer on November 16, 1909. This office has not been advised of the final completion of the work.

ADOBE CREEK RESERVOIR.

This reservoir is the property of the Fort Lyon Canal Company and is located in Bent and Kiowa counties, about 10 miles north of the town of Las Animas. It is formed by a large natural depression, around a portion of which at the low points of the rim an embankment not exceeding 10 feet in maximum height has been constructed. This embankment has a width on the crest of 30 feet, an inside slope of 4 to 1 and an outside slope of 2 to 1. It is proposed to protect the inner slope by a concrete pavement 6 inches thick. The freeboard provided is 5 feet.

The outlet consists of four lines of 36-inch double-strength vitrified pipe entirely surrounded by concrete and provided with three concrete cut-off walls. A gate well of the ordinary wet type has been provided in the middle of the embankment and provision has been made for emergency gates at the inner end of the conduit. The entire length of the outlet structure is 238 feet.

Plans were prepared by Mr. B. F. Powell, engineer, and approved by the State Engineer on June 30, 1910.

SPRING RUN RESERVOIR NO. 2.

This reservoir is located near Stratton Park, just outside of the city of Colorado Springs. The dam is of earth, with a maximum height of 40 feet and a length on the crest of 770 feet. The width on the crest is 12 feet, the inside slope is 1 to 1 above the high-water line and 2 to 1 below. The outside slope is 2 to 1.

The inner slope of the embankment was constructed with special care and carefully puddled. It is protected by a reinforced concrete paving 5 inches thick abutting against a concrete toe wall 3 feet deep. The freeboard provided is 5 feet. A small spillway is constructed around one end of the dam. The outlet is a 12-inch cast-iron pipe laid on a concrete foundation entirely below the natural surface of the ground. It is provided with 5 concrete cut-off walls. A reinforced concrete gate tower is constructed about half way between the crest of the embankment and the inner toe, and communicates with the body of the reservoir by an open concrete channel.

The plans and specifications were prepared by Mr. E. C. van Diest, engineer, and approved by the State Engineer on August 8, 1910.

FINNEY-GILDERBLOOM RESERVOIR.

This reservoir is located on Mud Springs creek, near Hayden, Routt county.

The dam is of earth, with a maximum height of 54 feet and a length on the crest of 288 feet. The width on the crest is 10 feet, the inside slope is 3 to 1 and the outside slope 2 to 1. A trench 6 feet wide on the bottom and with side slopes of 1 to 1 is constructed along the inner toe of the dam and extended to bed rock. This is filled with selected material puddled in place.

A spillway 20 feet wide on the bottom is constructed around one end of the dam. The freeboard is 5 feet. The outlet is a tunnel through the rock and is partly lined with concrete. The cross-section of the tunnel is 3 feet in width by 4 feet in height inside the lining.

Plans were prepared by The Routt County Engineering Company and approved by the State Engineer on August 18, 1910.

LOST PARK RESERVOIR.

This is a natural reservoir formed by a landslide which blocked up the canon through which Goose creek flows, at a point about 8 miles west of Lake Cheesman, in Park County.

The dam formed by this landslide is by no means water-tight, but it is believed that it can be made so by filling the interstices between the boulders with concrete. To this end a shaft was sunk 190 feet through this slide, and the work of cleaning out the loose material between the boulders and replacing it by concrete was begun. The plan by which it is expected to accomplish this result was prepared by Messrs. A. J. Tanner, Jr., and E. J. Riethmann, and was approved by the State Engineer on August 18, 1910.

Of necessity, the exact procedure will depend upon what develops as the work progresses, but as the worst that can happen in event of failure is leakage of the water through the slide, and not a break which would precipitate a large body of water at one time into the channel of the creek, it is considered that the State has no very active interest in this construction. If the work of making this slide tight is a success it is intended to construct a concrete dam about 50 feet high on top of it, so that the total height from the creek bed to the top of the dam will be 240 feet.

BUCKEYE RESERVOIR.

This reservoir is under construction in the Paradox valley in Montrose county. The dam will be of earth, have a maximum height of 80 feet and a length of 764 feet on the crest. The embankment will have a crest width of 20 feet and inside and outside slopes of 3 to 1. A loose rock fill with a height of 25 feet will be constructed along the lower toe. A freeboard of 8 feet has been provided and a spillway 22 feet wide has been arranged around one end of the dam.

The inner slope will be protected with a rock paving 18 inches thick. The outlet will be a concrete tunnel, 7 feet inside diameter and 12 inches thick, constructed below the surface of the ground. Details of the outlet gates have not yet been prepared.

It is proposed to construct this dam by the hydraulic fill process, and work has been actually begun by this method. This method of construction does not meet with the unqualified approval of the State Engineer's office, but because of the scarcity of teams, the small supply of feed available in the valley, even if teams were brought in, and the distance from the railroad, the hydraulic method seemed to be the only one financially possible.

The plans were prepared under the direction of Mr. I. W. McConnell, former supervising engineer of the United States Reclamation Service, and known to be an extremely able and careful engineer. For these reasons the following conditional approval was endorsed on the plans: "Approved provided condition of work is found satisfactory from time to time during construction. The State Engineer may refuse to permit storage until satisfied that the structure is safe and substantial. August 23, 1910."

At the date of this report the structure has reached a height of only 12 to 15 feet and work has been discontinued for the winter. A careful inspection of it by a representative of the State Engineer's office will be made in the spring before any further work is done.

ALBION LAKE.

This reservoir will form a part of the water system of the city of Boulder and is located about 18 miles nearly due west of that city. The dam will be of concrete of standard section, with a maximum height of 60 feet. It is curved in plan and has a length on the crest of 860 feet.

The outlet system is so arranged that water can be drawn from the reservoir at different elevations. This is important in reservoirs for domestic water supply, since it frequently happens that the water is clearer at intermediate depths than at either the top or the bottom.

Plans and specifications which are very elaborate and carefully worked out in detail were prepared by Mr. M. S. Ketchum, consulting engineer, by direction of Mr. Fred R. Dungan, city engineer of Boulder, and were approved by the State Engineer on August 10, 1910.

No construction work other than the preparation of the dam site has been undertaken up to this time. It is expected that active work will be begun in the spring.

AGRICULTURAL RESERVOIR NO. 3.

This reservoir is located in Water District No. 7, in Jefferson county. The dam is of earth of a maximum height of 18 feet and a length on the crest of 1,200 feet. The crest width is 12 feet, the outside slope is 2 to 1 and the inside slope 3 to 1. The inner slope is protected with 12 inches of rock rip-rap. A trench 4 feet wide and three feet deep was excavated along the axis of the dam and refilled with puddled material. The puddle-wall thus constructed was carried to a height of 4 feet above the surface of the ground. This formed an effective cut-off against leakage under the embankment.

The dam has a freeboard of 4 feet and a spillway 100 feet wide on the bottom has been provided. The outlet consists of one line of 12-inch standard cast iron pipe laid on a concrete foundation. This is provided with a gate valve at the lower end, and with an emergency gate at the inner end.

The plans were prepared by Mr. Geo. R. Baker, engineer, of Denver, and approved by the State Engineer on September 19, 1910.

Some work has been done on this reservoir but the State Engineer's office has not been advised whether the dam has been completed.

OMER RESERVOIR.

This reservoir will be formed by the construction of an earthen dam across the channel of the Apishapa river in Otero county.

The dam will have a length of 580 feet on the crest and a maximum height of 115 feet. The crest width will be 16 feet, the inner slope 2 to 1 and the outer slope 3 to 1. About one-third of the volume of the embankment next to the down-stream slope will be constructed of coarse and porous material. The remainder will be of the best available material carefully placed and compacted. The up-stream face will be provided with a pavement of reinforced concrete 5 inches thick finished at the top with a crest wall 2 feet high by 18 inches thick. The pavement will abut against a mass of loose rock at the bottom and will make a water tight joint with the top of a line of sheet piling driven to bed-rock at the toe of the dam. The freeboard provided is 10 feet.

The spillway is entirely removed from the dam. The outlet will be through a tunnel in the solid rock far below the earth embankment. A shaft will be constructed about the middle of the length of this tunnel and through this the valve stems will pass. The tunnel will be lined with concrete and will be 10 feet wide by 8 feet high inside the lining. The water will be carried through the bottom of the gate shaft by three lines of 48-inch pipe, each provided with a standard gate valve. The shaft will be dry and the valves accessible at all times, regardless of the stage of water in the reservoir.

At one place on the rim of the reservoir it will be necessary to construct a dyke 2,000 feet long on the crest, with a maximum height of 10 feet. The dyke will be of the same crest width as the main dam with slopes on both sides of 1½ to 1. The inner slope will be protected by a rock rip-rap. When the reservoir is full water will just wash the toe of this dyke at about the middle of its length.

The spillway, which is about 200 feet wide, is located near one end of the dyke.

This reservoir will be constructed by the Omer Irrigation District. Plans and specifications were prepared by the Field, Fellows & Hinderlider Engineering Company, and were approved by the State Engineer on September 22, 1910. Actual construction work has not yet begun.

CAMP VIGIL RESERVOIR.

This is a small reservoir located on Little Fountain creek in El Paso county. The dam is 185 feet long on the crest and has a maximum height of 16 feet. This is a rock fill dam built on bed-rock. The crest is 10 feet wide and the inside and outside slopes are each 1½ to 1. The inside slope is protected by an apron of logs and brush on top of which earth is piled to a slope of 2 to 1 on the inside. The freeboard is only 2 feet and the spillway is a flume 20 feet wide built across the middle of the dam. The outlet conduit is a wooden box 2 feet by 1 foot surrounded by concrete, and provided with a concrete bulk head and a cast iron sluice gate at the inner end.

Plans were prepared by Sawyer & Garstin, engineers, of Colorado Springs, and approved by the State Engineer on September 24, 1910.

MEYER DAM.

This dam will be constructed near the head waters of the Huerfano river in Huerfano county. It will be a rock fill dam 240 feet long on the crest, with a maximum height of 75 feet. The width on the crest will be 15 feet, inside slope 1 to 1 and outside slope 1½ to 1.

The inner slope will be constructed by laying up a dry rubble wall 3 feet thick, chinking the openings with spalls and grouting with cement. On top of this will be laid a concrete face 12 inches thick at the bottom and 6 inches thick at the top.

The outer slope will be made of selected large stone, carefully laid. A freeboard of 8.5 feet has been provided and a spillway 40 feet wide will be cut in the solid rock at one end of the dam.

The concrete face on the inner slope will be carried at least 2 feet into bed rock underlying the dam. The outlet will consist of two lines of 24-inch steel riveted pipe entirely surrounded by a 12-inch thickness of concrete. Sluice gates are provided at the inner end of this outlet.

Plans and specifications were prepared by Danford & Sanderson, engineers, and approved by the State Engineer on October 8, 1910.

CLOVER BASIN RESERVOIR.

This reservoir is located in Water District No. 5, in Boulder county. It is formed by the construction of an earth dam 670 feet long on the crest, with a maximum height of 30 feet. The embankment is 15 feet wide on the crest, has an inside slope of 2½ to 1 and an outside slope of 2 to 1. The coarser material will be placed on the down-stream slope and the most impervious material on the inner slope. The inner slope is protected by a loose rock rip-rap 9 inches thick. The freeboard is 5 feet and a spillway 50 feet wide discharges entirely away from the embankment.

The outlet conduit consists of a 20-inch standard cast-iron pipe entirely surrounded by 6 inches of concrete, and provided with concrete cut-off walls. A gate valve is placed at the lower end of the conduit and an emergency valve is provided at the inner end. Plans were prepared by Mr. R. E. Richardson, engineer, of Longmont, and approved by the State Engineer on October 26, 1910.

LOOKOUT MOUNTAIN RESERVOIR.

The structure here referred to is an enlargement of a dam located on Lookout Mountain above Golden, and forming part of the domestic water system of that city. The original embankment had a height of 32 feet, measured vertically under the crest. The enlarged embankment will have a height of 58 feet and a length of 460 feet on the crest. The crest width will be 10 feet, the inside slope will be 1 to 1 above the high water line and 3 to 1 below. The outside slope will be 2 to 1.

A concrete abutment 13 feet high and with a base of 26 feet will be built at the outer toe. On the outer slope loose rock and porous material will be placed. The space between that and the old dam will be filled with the best obtainable material puddled or rolled in place. The freeboard is 4 feet.

As there is no appreciable drainage area tributary to the reservoir, and as the reservoir can only be filled through a pipe line, the flow of which is entirely under control, no spillway is provided.

A number of springs of water are known to exist on the dam site and these will be taken care of by several lines of 4-inch drain tile, which will discharge into a main drain of 8-inch tile.

The outlet will be a 10-inch standard cast-iron pipe provided with a gate valve at the lower end.

Plans were prepared by Mr. Wm. F. Allison, engineer for the city of Golden, and approved by the State Engineer on November 9, 1910. Work will be begun immediately if the weather permits.

CUCHARAS VALLEY RESERVOIR NO. 5.

This reservoir is the property of the Pueblo-Rocky Ford Irrigation Company, and is located on the Cucharas river, in Huerfano county. The dam will be rock fill, having a maximum height of 125 feet and a length on the crest of 550 feet. The crest width is 20 feet, the outside slope 1½ to 1 and the inside slope 1 to 1. The inner slope will be protected by a reinforced concrete pavement 18 inches thick. This will bond with a toe wall 2 feet thick at the surface of the ground and increasing to 8 feet at the bed-rock. Special provision is made in the specifications for a method of construction which will insure the complete filling of all the interstices in the rock fill. A freeboard of 20 feet is provided. A spillway is cut in the solid rock at each end of the dam. That at the eastern end is 100 feet wide; the one at the western end is 250 feet wide. It is calculated that these spillways will discharge the largest flow of the Cucharas river with a depth of water not exceeding 15 feet, thus leaving 5 feet between the extreme flood level of the reservoir and the crest of the dam.

The outlet consists of 3 lines of 48-inch standard cast-iron pipe resting on a concrete foundation, which in turn rests on bed-rock. These pipes are entirely surrounded by concrete. Concrete cut-off walls will be provided, their number and position to be determined by conditions at the dam site when the work begins. Each line of pipe in the outlet is provided with a standard gate valve at the lower end.

Plans were prepared under the direction of Mr. W. J. Lester, chief engineer, and Mr. Wm. H. Rosecrans, consulting engineer, and were approved by the State Engineer on November 10, 1910.

AKRON RESERVOIR.

This is a small reservoir to be constructed by the Chicago, Burlington & Quincy Railroad near the town of Akron, in Washington county. The dam is of earth with a maximum height of 22 feet and a length on the crest of 680 feet. The crest width is 10 feet, the outside slope 2 to 1 and the inside slope 4 to 1. The freeboard provided is 3 feet and a spillway 30 feet wide will be constructed around one end of the dam. The inside slope will be rip-rapped. A trench 2 feet deep and 3 feet wide on the bottom will be excavated along the axis of the dam and refilled with selected material. In addition to this the entire dam site will be plowed so as to make a thorough bond between the natural earth and the artificial embankment.

The outlet consists of a single line of 6-inch standard cast-iron pipe provided with wooden cut-off collars 6 feet square.

Plans were prepared by F. T. Darrow, engineer maintenance of way, Chicago, Burlington & Quincy Railroad, and approved by the State Engineer on November 29, 1910.

POINT OF ROCKS RESERVOIR.

This reservoir is the property of the North Sterling Irrigation District and is located on Cedar creek, in Logan county, about 13 miles north of the town of Sterling.

Plans and specifications have never been filed in the office of the State Engineer, as required by law, and detailed information is, therefore, wanting.

The State Engineer made an examination of the work in May, 1910, at which time the embankment had reached an elevation about 15 feet above the ground level. The maximum height of the dam is understood to be about 86 feet. The inside slope is 1½ to 1, the outside slope is 2½ to 1 for a vertical distance of 25 feet from the crest and 3 to 1 from there on down.

The inner slope will be protected with a reinforced concrete pavement which abuts against a concrete toe-wall carried to bed-rock for the greater part of the length of the dam. Across the creek bottom steel sheet piling is driven in lieu of a concrete toe-wall. Special care has been taken to compact that portion of the embankment next to the inner slope by thoroughly soaking it with water. It was hoped by this means to avoid subsequent settlement which would crack the concrete pavement.

The outlet is of reinforced concrete with sluice gates located in a wet well in the middle of the embankment. The lower portion of the embankment was built by depositing the earth in 3 foot lifts. Test pits developed the fact that the lower two-thirds of every lift was porous and open. As a result the system was changed so that the earth was deposited from wagons in windrows and afterwards spread and rolled in lifts not exceeding one foot.

Since May of 1910 the work has been under the constant supervision of Mr. Chas. E. Shimer, State Inspector, who has made frequent reports to the State Engineer's office.

Mr. P. J. Preston is engineer for the North Sterling Irrigation District, and is in charge of the work. There is a small drainage area directly tributary to this reservoir, but most of the water supply will be brought through a feeder canal from the South Platte river.

TERRACE RESERVOIR.

This reservoir is located on the Alamosa river about 25 miles from the town of La Jara. Work on the main dam was begun a number of years ago and has been carried on intermittently ever since. In the spring of 1909 arrangements were made to push the work vigorously, and the construction was put in the hands of Mr. John E. Field, consulting engineer.

This dam, which when finished will be the highest earth dam in the world (227 feet), has been and is being constructed by the hydraulic fill process. When work was begun in 1909 a total volume of a little more than 300,000 cubic yards had been placed and the elevation of the top of the work was about 390 feet above datum.

During the seasons of 1909 and 1910 a little more than 200,000 cubic yards of additional material have been deposited, and the present top of the structure is about elevation 450. To finish the dam a further volume of material of about 300,000 yards will be necessary. This, when placed, will bring the elevation of the crest to 531.

Besides the main dam it will be necessary to construct an auxiliary dyke containing about 150,000 cubic yards of earth. The present storage capacity of the reservoir is slightly under 8,000 acre-feet. The storage capacity when finished will be about 27,000 acre-feet.

ANTERO RESERVOIR.

This reservoir has been under construction for the past three seasons, in accordance with plans approved by the State Engineer several years ago. The work done during 1909 and the early part of 1910, up to the completion of the earth work, was under the supervision of Mr. A. J. Tanner, Jr., State Inspector.

On May 4, 1910, Mr. J. W. Johnson, Deputy State Engineer, in company with Mr. T. W. Jaycox, consulting engineer for the Antero & Lost Park Reservoir Company, visited the dam and reported that the earth work had been completed in accordance with plans on file in the State Engineer's office, but that no riprap had at that time been placed.

Water was stored to a depth of about 15 feet during the winter and spring of 1910, and discharged during the latter part of the dry season of 1910 to supply the Highline canal. On September 10, 1910, the Antero & Lost Park Reservoir Company reported that the work of placing the concrete paving on the inner face would begin immediately. The State Engineer's office has not been advised whether this work has been completed.

MOUNT PISGAH RESERVOIR.

This reservoir has been constructed during the seasons of 1909-1910 by the Park Center Land & Water Company, near the head waters of Four Mile creek, in Teller county.

No plans or specifications for this work have been filed in the State Engineer's office, as required by law. In the spring of 1910 complaint was made by persons owning property below the reservoir that the construction work was not being well done and that their property would be endangered if water was stored behind the dam.

In response to this complaint Mr. A. F. Hewitt, Deputy State Engineer, made an examination of the work on March 11, 1910. He reported that the precautions ordinarily considered necessary in the construction of an earth dam were apparently being entirely disregarded, and that the work was by no means well done.

A demand from the State Engineer's office for the submission of plans and specifications was not productive of any result for a considerable length of time. After a considerable amount of correspondence a plan for a dam of dimensions considered insufficient by the State Engineer was presented. Approval of this was refused and modifications were suggested. No other plans were, however, submitted. The work was finally completed, along lines which were not and cannot be approved, and a formal acceptance on the part of the State Engineer was requested by the owners. Such an acceptance has not been given and is clearly impossible under the circumstances.

Storage in this reservoir has not as yet been permitted, and can be permitted, if at all, only on a tentative basis.

CLEAR CREEK RESERVOIR.

This reservoir, which is the property of the Otero Irrigation District, is located near the mouth of Clear creek, a stream which flows into the Arkansas river about three miles below the town of Granite in Chaffee county. It has a capacity of 9,400 acre-feet and is formed by the construction across Clear creek of an earth dam having a maximum height of eighty feet and a length on the crest of 1,858 feet.

The embankment is twenty feet wide on the crest and has an inside slope of 3 to 1 and an outside slope of 2 to 1. The inner slope is protected by a riprap twelve inches thick of stones laid by hand on a four-inch bed of gravel. A puddle trench five feet wide on the bottom, ten feet on top and about five feet deep has been constructed near the toe of the inner slope.

The outlet consists of two lines of 30-inch standard cast-iron pipe provided with concrete cut-off walls, and with standard gate valves located near the toe of the outer slope. Concrete channels lead the water to and from these pipe lines.

The freeboard is ten feet. A spillway 125 feet wide is constructed beyond the southern end of the dam and discharges into a ravine which leads the overflow to the Arkansas river some distance below the mouth of Clear creek.

There is a smaller dam about four hundred feet north of the main dam, protecting a low point in the rim of the reservoir. This small dam does not exceed twenty feet in height and is 647 feet long on the crest. It has the same crest width, inside and outside slopes and rip-rap protection as the large dam.

Plans for this reservoir were prepared by Mr. George G. Anderson, consulting engineer, and were approved by the State Engineer on June 15, 1908. The work was executed under Mr. Anderson's direction with Mr. Winfield Holbrook as resident engineer.

On October 7, 1909, the State Engineer made an examination of the completed work, and on October 28, 1909, addressed to the Otero Irrigation District a letter formally approving and accepting the reservoir as provided by section 3205, Revised Statutes of Colorado, 1908.

CHAPTER X.

MATERIALS USED IN EARTH DAMS.

In view of the considerable number of failures of structures of this type during the past two years, and further, in view of the fact that the proper design of the section of an earth dam depends on the properties of the material of which the embankment is to be composed, an attempt has been made to investigate material from some of the failed structures as well as the material in some of the new work now under way.

On March 15, 1910, the State Engineer selected from the then upper surface of the Terrace Dam in Conejos county, two samples of the material which had been deposited by the hydraulic process. One of these samples, herein designated as No. 1, was of coarser material at some distance from the center of the dam. The other, designated as No. 2, was the finest material to be found, and was taken from very near the axis of the dam. It was the last material to be deposited from suspension before the water used as a carrier was discharged through the wasteways.

The No. 1 sample was submitted to a mechanical analysis by means of screens varying in fineness from 8 to 100 meshes per lineal inch. The result is as follows:

	Per Cent.
On 8-mesh	13.50
Through 8-mesh and on 10-mesh	7.15
Through 10-mesh and on 20-mesh	15.10
Through 20-mesh and on 30-mesh	11.95
Through 30-mesh and on 40-mesh	11.10
Through 40-mesh and on 50-mesh	16.60
Through 50-mesh and on 60-mesh	5.55
Through 60-mesh and on 80-mesh	6.35
Through 80-mesh and on 100-mesh	1.20
Through 100-mesh	11.50
	100.00

The No. 2 sample was submitted to a similar analysis, with the following result:

	Per Cent.
Through 60-mesh and on 80-mesh	4.00
Through 80-mesh and on 100-mesh	1.20
Through 100-mesh	94.80
	100.00

The No. 2 sample was further submitted to a proximate analysis by chemical methods with a view to determining the relative proportions of clay, sand and other ingredients. The result of this was as follows:

	Per Cent.
Quartz and feldspar	74.50
Argillaceous matter	15.00
Iron oxide	6.40
Calcium carbonate	2.40
Loss by ignition	1.60
	99.90

The impervious properties of an earth fill are largely dependent upon the percentage of clay contents and in this instance the percentage is very small.

The earth which is being used for the construction of the Terrace Dam is the result of disintegration of diorite and other rocks composed largely of quartz and soda-lime feldspars. As these feldspars do not kaolinize as readily as potash feldspars the percentage of clay in soils resulting from the disintegration of such rocks is much less than where the soil is formed from granite rocks.

It is barely possible, also, that a larger proportion of clay than of sand has been carried away by the water, since the clay particles are probably much finer, on the average, than the sand grains. However, since 95% of this material passes the 100 mesh screen, it seems probable that the material deposited must contain nearly the same proportions of clay and sand as it did before being washed by the hydraulic transportation process.

The No. 1 sample was not submitted to chemical analysis, as it was of much coarser character, mechanically, and clearly contained less clay than the No. 2 sample.

In April of 1910 three samples were taken from different portions of the Trout Lake Dam, which had failed during the previous fall, by a representative of the Telluride Power Company, and were sent to this office for examination. The samples were too small for proper screen analyses, but they were submitted to chemical examination, with the following results:

Sample from top of dam:

	Per Cent.
Quartz and feldspar	47.50
Argillaceous matter	31.70
Iron	6.51
Calcium carbonate	1.70
Sulphur	2.88
Water and organic matter	8.58
	98.87

Sample from middle of break in dam:

	Per Cent.
Quartz and feldspar	50.10
Argillaceous matter	31.10
Iron	5.67
Calcium carbonate	1.80
Sulphur	1.10
Water and organic matter	8.20
	97.97

Sample from outer slope of dam:

	Per Cent.
Quartz and feldspar	41.30
Argillaceous matter	28.70
Iron	4.90
Calcium carbonate	15.18
Sulphur	1.62
Water and organic matter	6.70
	98.40

This material is a heavy, sticky, semi-elastic clay, which, when properly compacted, must be absolutely impervious to water, except under very high heads. It is the result of the disintegration of granitic rocks whose feldspars are readily converted into kaolin. It is a nearly ideal material for the construction of an earth dam, considered simply from the standpoint of impermeability. It is, however, difficult to handle, difficult to consolidate, and under high pressures would probably act more like a viscous liquid than like a solid.

Early in May of 1910, two samples of material were taken by the State Engineer from the borrow pits at the Point of Rocks Dam. One of these, herein designated as No. 1, was taken from a point about 500 feet west of the dam, and opposite Station 34. The material from this point was considered by Mr. Preston, the engineer in charge, to contain the largest proportion of sand of any material at that time being used in the construction of the dam.

The screen analysis gave the following result:

	Per Cent.
Coarser than 10-mesh	3.03
Through 10-mesh and on 100-mesh	3.03
Through 100-mesh	93.94
	100.00

The chemical examination resulted as follows:

	Per Cent.
Quartz and feldspar	48.70
Argillaceous matter	28.10
Iron sesquioxide	7.40
Lime	5.30
Loss by ignition	10.60
	100.10
Sulphur	0.685

An experiment was also conducted to determine the quantity of water which would percolate through a given thickness of this material in a given time. For this purpose a constant level apparatus, consisting of a glass cylinder 1.4375 inches diameter and 11 inches between overflow and discharge openings, was arranged. In this a column of earth 5½ inches high was placed, and so arranged as to prevent percolation of water between the earth and the sides of the cylinder. This column of earth was kept covered with a constant depth of 5½ inches of water for 24 hours, and the amount of water percolating through in that time was noted. The volume was found to be 980 cubic centimetres.

The second sample from the Point of Rocks Dam, designated herein as No. 2, was taken from a point about 400 feet west of the dam and opposite Station 41. The borrow pit at this point was considered by the engineer in charge to contain the heaviest clay percentage on the work.

The screen analysis gave the following result:

	Per Cent.
On 20-mesh	3.226
Through 20-mesh and on 40-mesh	6.451
Through 40-mesh and on 100-mesh	3.226
Through 100-mesh	87.097
	100.00

The chemical analysis was as follows:

	Per Cent.
Quartz and feldspar	42.30
Argillaceous matter	30.70
Iron sesquioxide	9.00
Lime	5.90
Loss by ignition	10.60
	98.50
Sulphur	0.55

A percolation test, conducted in the same way as in the case of the No. 1 sample, showed a volume of water passing of 1,805 cubic centimetres in 24 hours. It will be noted that the No. 2 sample, which to the eye and to the feel as it came from the borrow pit appeared to be nearly pure clay, contains only about 2½ per cent. more argillaceous matter than the No. 1 sample, which, as examined on the ground, seemed to be nearly pure sand. It will be noted, also, that the sample containing the higher percentage of clay permitted the percolation of nearly twice as much water under given conditions and in a given time, as the other one. This, however, is to be explained by the larger percentage of fine material contained in the No. 1 sample. It will be noted that only 6 per cent. of the No. 1 sample failed to pass a 100-mesh screen, while 13 per cent. of the No. 2 would not pass this screen. It is also probable that the No. 1 sample contained a considerable percentage of particles, probably not exceeding 1-500 of an inch in diameter.

In May of 1910 Mr. Julius Hornbein, State Inspector of the Julesburg Reservoir, took two samples from the Julesburg embankment after the break and sent them to this office. Sample No. 1 was taken from the bottom of the hole gouged by the water in the rock immediately underlying the embankment. Sample No. 2 was taken from a point on the east side of the break, about half way between the top and bottom of the dam.

A screen analysis of sample No. 1 was as follows:

	Per Cent.
On 10-mesh	5.00
Through 10-mesh and on 20-mesh	3.75
Through 30-mesh and on 40-mesh	3.75
Through 50-mesh and on 60-mesh	3.75
Through 60-mesh and on 80-mesh	2.50
Through 100-mesh	81.25
	100.00

The chemical analysis gave the following:

	Per Cent.
Quartz and feldspar	54.50
Argillaceous matter	24.20
Iron sesquioxide	2.50
Lime	4.20
Loss by ignition	12.50
	97.90

The percolation test, conducted in the same way as described for the Point of Rocks samples, showed a volume of water of 180 cubic centimetres passing in 24 hours.

Sample No. 2 gave the following screen analysis:

	Per Cent.
On 10-mesh	5.50
Through 10-mesh and on 20-mesh	13.90
Through 20-mesh and on 30-mesh	5.50
Through 30-mesh and on 40-mesh	4.20
Through 40-mesh and on 50-mesh	5.60
Through 50-mesh and on 60-mesh	4.20
Through 60-mesh and on 80-mesh	2.80
Through 100-mesh	58.30
	100.00

The chemical analysis was as follows:

	Per Cent.
Quartz and feldspar	60.80
Argillaceous matter	23.60
Iron sesquioxide	2.50
Lime	1.60
Loss by ignition	9.80
	98.30

The percolation test showed a volume of 430 cubic centimetres passing in 24 hours. In this instance it will be observed that the No. 2 sample permitted the percolation of nearly 2½ times as much water under given conditions as the No. 1 sample.

Two facts probably contribute to this difference. The No. 2 sample contains about 61 per cent. of sand as against 54.5 per cent. for the No. 1. Further, 81 per cent. of the No. 1 sample was fine enough to pass a 100-mesh screen, while only 58 per cent. of the No. 2 sample could pass this screen.

In comparing the percolation tests on these samples with those on the samples from Point of Rocks, it will be noted that the Julesburg material is much more impervious than the Point of Rocks material, although the Point of Rocks material shows a larger percentage passing the 100-mesh screen. The explanation would probably be found by a further mechanical analysis of the material finer than 100-mesh.

Mr. Allen Hazen, for many years chemist of the Lawrence Experiment Station, made large numbers of tests to determine the volume of water which would pass through sands of various mechanical compositions. As a result of these tests, he devised the following formula:

$$v = cd^2 \frac{h}{l} \frac{t+10}{60}$$

In this formula, v is the velocity in metrés per day through the whole area of the sand bed; c is a numerical coefficient whose value ranges between 450 and 1,200; d is the effective diameter of the sand grains in millimetres; h is the head of water, and l the thickness of the sand bed; t is the temperature of the water in degrees Fahrenheit.

By effective diameter of the grains, Mr. Hazen means the diameter of a sphere which is smaller than 90 per cent. of the grains and larger than 10 per cent.

Applying this formula to the result obtained from the percolation tests on the No. 1 sample at Point of Rocks, the effective diameter of the grains is found to be 0.04 millimetres, or less than 0.002 inches. If this formula be applied to the No. 2 sample at Julesburg, the effective diameter is found to be 0.0027 millimetres, or about 0.0001 inches. In these calculations the temperature has been assumed to be 70 degrees Fahrenheit, and the numerical coefficient has been taken as 450. There is, of course, some question as to the propriety of applying Mr. Hazen's formula to material so much finer than that used in his experiments. There seems to be little question, however, that the degree of impermeability of earthen embankments depends upon the diameter of the smallest particles contained in the earth.

The percentage of clay has an important bearing on the fitness of material for use in this way since clay must be depended upon to bond all the particles together into one mass. In its absence the fine sand particles are readily removed by any mechanical agency, as is illustrated, for example, at Riverside, where considerable volumes of material have been removed from the embankment by the wind alone.

CHAPTER XI.

INTERNAL IMPROVEMENTS.

BRIDGES.

In the design and construction of all bridges during the past two years, the following specifications have been strictly adhered to. These specifications were drawn with great care after thorough consideration of every point involved, and are believed to represent good practice in their respective kinds of construction. The results obtained have been in all cases satisfactory, and are believed to justify the standards adopted.

GENERAL SPECIFICATIONS FOR STEEL BRIDGE SUPERSTRUCTURE.

LOADS—

Bridges shall be designed to carry loads as specified below: Dead load shall be the estimated weight of the steel and floor system. A live load consisting of 70 pounds per square foot of floor surface over entire bridge. A moving load of 15 tons on two axles, 14 feet centers, 8 feet gauge, two-thirds of total weight on rear axle.

Wind pressure shall be assumed, acting in either direction horizontally at 300 pounds per lineal foot on the loaded chord, and 150 pounds per lineal foot on the unloaded chord.

STRESSES—

The allowable tensile stress shall not exceed 15,000 pounds per square inch on net sections.

The allowable compressive stress shall not exceed

$$\frac{15000}{1+\frac{1}{13500}\frac{L^2}{R^2}}$$

pounds per square inch. In this formula, L equals length of member, and R equals least radius of gyration.

When combined stress, due to dead and live loads and wind acting simultaneously, does not exceed by more than 20 per cent. the allowable stress for dead and live loads only, the section of the member need not be increased to provide for the stress due to the wind. If the combined stress, due to dead and live loads and wind acting simultaneously, does exceed by more than 20 per cent. the allowable stress for dead and live loads only, then the section of the member shall be increased to meet this condition.

Rivets shall have a shearing stress not to exceed 7,500 pounds per square inch, and a bearing stress not to exceed 15,000 pounds per square inch. In field connections the number of rivets shall be increased 25 per cent.

The contractor shall furnish the engineer complete copies of mill orders, and no material shall be rolled, nor work done, before the engineer has been notified where the orders have been placed, so that he may arrange for the inspection.

The contractor shall furnish all facilities for inspecting and testing the weight and quality of all material at the mill where it is to be manufactured. He shall furnish a suitable testing machine for testing the specimens, as well as prepare the pieces for the machine, free of cost.

The contractor shall put together and set up in the shop the entire bridge, or such parts as the inspector may deem necessary, to determine whether all parts are properly manufactured.

When an inspector is furnished by the engineer to inspect material at the mills, he shall have full access at all times to all parts of mills where material to be inspected by him is being manufactured.

The inspector shall stamp each piece accepted with a private mark. Any piece not so marked may be rejected at any time, and at any stage of the work. If the inspector, through an oversight or otherwise, has accepted work or material which is defective or contrary to the specifications, this material, no matter in what stage of completion, may be rejected by the engineer.

Complete copies of shipping invoices shall be furnished to the engineer with each statement.

MATERIALS AND WORKMANSHIP—

All riveted work shall be punched accurately with holes 1-16 of an inch larger than the size of the rivet, and when the pieces forming one built member are put together, the holes must be truly opposite; no drifting to distort the metal will be allowed; if a hole must be enlarged to admit the rivet, it must be reamed.

The size of rivets called for on the plans shall be understood to mean the actual size of the cold rivet before driving.

All holes for field rivets in floorbeams and stringer connections and splices in tension members shall be accurately drilled to an iron templet or reamed while the connecting parts are temporarily put together. The outside burrs on reamed holes shall be removed.

The rivet heads must be of approved hemispherical shape, and of a uniform size for the same size rivets throughout the work. They must be full and neatly finished throughout the work, and concentric with the rivet hole.

All rivets when driven must completely fill the holes, and heads be in full contact with the surface, or countersunk when so required.

Whenever possible, all rivets shall be machine driven. Power riveters shall be direct acting machines, worked by steam, hydraulic pressure or compressed air.

Rivets marked loose by the inspector must be cut out and replaced. Calking or setting up cold will not be permitted.

The pitch of rivets in the direction of the stress shall not exceed 6 inches nor sixteen times the thickness of thinnest outside plate connected.

In a direction at right angles to the stress, the pitch of rivets shall not exceed 50 times the thickness of the thinnest outside plates, except in the case of cover plates for chords and end posts.

At the ends of compression members the pitch shall not exceed four diameters of the rivet for a length equal to twice the least transverse dimension of the member.

The minimum distance between centers of rivet holes shall be three diameters of the rivet, but the distance shall preferably be not less than three inches for rivets not less than ¾ inch diameter.

The distance from the edge of any piece to the center of the rivet hole must be not less than twice the diameter of the rivet in the direction of the stress, nor one and one-half times that diameter in a direction at right angles to the stress, nor shall this distance exceed eight times the thickness of the plate.

All segments of compression members connected by latticing only shall have tie plates placed as near as practicable to the ends of the members. These plates shall have a length not less than their width, and shall, in general, have the same thickness as the lattice bars.

Lattice bars shall have neatly rounded ends, unless otherwise ordered.

Bolts must not be used to transmit shearing stresses unless marked on the plans or ordered in writing by the State Engineer. When so marked or ordered, the holes must be reamed and the bolts turned to a driving fit.

The several pieces forming one built member must fit closely together, and when riveted shall be free from twists, bends or open joints.

All portions of the work exposed to view shall be neatly finished.

All surfaces in contact shall be painted before they are put together.

All abutting surfaces in compression members shall be truly faced to even bearings, so that they shall be in perfect contact throughout.

The ends of riveted floor girders shall be faced true and square.

All workmanship shall be first-class in every particular.

STEEL—

All steel must be made by the Open Hearth process, and if by acid process, shall contain not more than .06 per cent. of phosphorus, and if by basic process, not more than .04 per cent. of phosphorus.

No steel shall contain more than .05 per cent. sulphur, and in no case shall the sulphur and phosphorus aggregate more than .09 per cent.

Steel must be uniform in character for each specified kind.

The finished bars, plates and shapes must be free from injurious seams, flaws or cracks, and have a clean, smooth finish.

The tensile strength, limit of elasticity and ductility shall be determined from a standard test-piece, cut from the finished material, of at least ½ square inch cross section. All broken samples must show a silky fracture of uniform color.

Material which is to be used without annealing or further treatment, is to be tested in the condition in which it comes from the rolls. When material is to be annealed or otherwise treated before use, the specimen representing such material is to be similarly treated before testing.

Each finished piece of steel shall be stamped with the blow number identifying the melt.

Rolled steel shall be of two grades, Rivet and Structural.

Rivet steel shall have preferably an ultimate tensile strength of 50,000 pounds per square inch, and structural steel an ultimate tensile strength of 58,000 pounds per square inch. Material which does not vary more than 4,000 pounds from these requirements shall be considered to comply with these specifications.

The elastic limit shall, in all cases, be at least one-half of the ultimate strength.

The percentage of elongation at rupture shall be not less than 1,500,000 divided by the ultimate tensile strength, measured in a length of 8 inches, which length shall include the fracture.

Steel of either grade shall stand bending cold through an angle of 180 degrees flat on itself without any sign of fracture.

Punched rivet holes, pitched two diameters from a sheared edge, must stand drifting until the diameter is one-third larger than the original hole, without cracking the metal.

The slabs for rolling plates shall be rolled from ingots of at least twice their cross section.

A variation in cross-section or weight of rolled material of more than 2½ per cent. from that specified may be cause for rejection.

Steel castings shall be made of Open Hearth steel, and shall meet the same requirements as to chemical composition as specified for rolled steel.

Specimens cut from steel castings shall show an ultimate tensile strength of not less than 65,000 pounds per square inch, and an elongation of at least 15 per cent.

The fracture shall be silky or very finely granular. Specimens must stand bending cold through an angle of 90 degrees around a diameter of three times their thickness without any sign of fracture.

Should machined surfaces of steel castings show blow holes aggregating more than .01 per cent of the surface, or should any blow hole exceed ⅛ of an inch in any dimension, the casting may be rejected.

Except where chilled iron is specified, all iron castings shall be of a tough, gray iron, free from injurious cold shuts or blow holes, true to pattern, and of workmanlike finish. Test bars one inch square, loaded in middle between supports 12 inches apart, shall bear 2,500 pounds or over, and deflect 0.15 inches before rupture.

PAINTING—

All paint used shall be of the brands known as Carbonizing Coating, made by the Goheen Mfg. Co., of Canton, Ohio, or Crysolite, made by the Semet-Solvay Company, of Syracuse, New York.

Before leaving the shops, all parts of the structure shall receive one coat of paint, well worked into the joints.

After being erected, all exposed parts of the structure shall receive a second coat of paint. Two coats of paint after erection may be required in case any part of the structure shall become so badly scarred or scratched from handling or transporting as, in the judgment of the engineer, to need them.

All surfaces shall be thoroughly cleaned of dirt, oil, grease, rust or scale before applying any of the coatings.

All surfaces which will be inaccessible after erection, shall receive two shop coats of paint. In case of surfaces in contact as in riveted work, one coat on each surface will be sufficient. All machined surfaces shall receive a coat of white lead and tallow before leaving the shop.

All surfaces shall be dry when the paint is applied.

ERECTION—

Bolts shall be placed in not less than 70 per cent. of the rivet holes in each connection before the bridge is swung clear of the falsework.

No rivets shall be driven in any portion of the field connections until the bridge has been swung clear of the falsework and is carrying its own weight.

GENERAL SPECIFICATIONS FOR CONCRETE BRIDGES AND FOUNDATIONS.

FOUNDATIONS—

All foundations shall be as shown on plans, and conform to the dimensions marked thereon.

The elevations marked on plans are as nearly exact as may be determined from present data, and are the elevations to which it is desired to build piers and abutments.

After commencing construction work it may be found advisable to change these elevations, in which case the amount of concrete added to the amount shown on plans shall be figured and work done under an order for "Extra Work or Materials."

CEMENT—

The cement to be used must be established brands of high-grade Portland cement. Samples may be selected by the State Engineer, or his representatives, from any package of cement received by the contractor, and physical or chemical tests made on the same. Any package whose sample fails to meet the requirements of the Standard Specifications for cement, adopted August 15, 1908, by the American Society for Testing Materials, may be rejected, and in that case will be at once removed from the premises.

Should the cement in 10 per cent. of the packages in any lot prove defective, the entire lot may be rejected, and will then be immediately removed from the premises.

CONCRETE—

Concrete will be composed of cement, sand and broken stone or gravel, mixed in the proportions and in the manner hereinafter specified.

The sand will be clean, sharp and coarse, and free from clay or organic matter or other injurious material.

The broken stone shall be clean and hard, free from long, thin scales and dust.

The gravel shall be of assorted sizes, screened or washed, entirely free from clay, loam or foreign matter, and be free from scale, slime or humus.

The ingredients will first be thoroughly mixed dry, then the necessary water used and the mixing continued until a uniform mass is obtained. The method of mixing shall meet the approval of the State Engineer. Every care will be taken to avoid an excess of water.

All concrete will be mixed in the proportions of one part Portland cement, two and one-half parts sand, and five parts broken stone or screened gravel, all parts to be by volume.

The broken stone or gravel will be such that any piece will pass through a two-inch ring.

Concrete will be immediately deposited in forms in layers of six or eight inches, and be thoroughly rammed until all voids are filled and the water flushes to the surface. No concrete shall be laid which has stood a longer time than twenty minutes after mixing.

CASING—

The concrete shall be deposited in timber forms of proper strength, rigid, and of proper dimensions for the work.

The fresh concrete when placed in forms shall be worked back from face in a manner satisfactory to the State Engineer, to insure a sufficient amount of mortar against inside face of forms, so that no mark or imperfections shall be left on the work.

CONCRETE FACING—

After the forms for concrete have been removed, all exposed surfaces shall be wet, and a thin mortar, composed of one part cement and two parts sand, shall be applied with a brush. The surface shall then be thoroughly rubbed with a piece of grindstone, removing all board marks and inequalities and filling all pores, producing a lather on the surface of the concrete, and before this has time to dry it shall be gone over with a brush dipped in water, producing a smooth finish of uniform color.

CENTERING—

The falsework or centering will be constructed in a rigid and substantial manner. The lagging will be dressed to a uniform thickness, or plastered or otherwise prepared, so that when laid it will present a smooth surface.

In the construction of the falsework, or centering, the necessary allowance will be made for settlement, deflection of arch after removal of centers and for permanent camber.

The center will be framed for a rise of arch greater than the rise marked on the drawings by an amount equal to one eight-hundreth part of the span, and will not be struck until at least four weeks after the completion of the arch.

Care will be taken to prevent distortion of the arch as the work progresses, by proper construction of the centering.

STEEL—

Steel rods shall be imbedded in the concrete of the arch, abutments and floor system as shown on the drawings.

All steel will be free from paint and oil, and all scale and rust will be removed before bedding in the concrete.

Test pieces will be furnished the engineer at any time for testing purposes.

Steel shall be of exact sizes as shown on drawings, and shall be twisted, or Johnson bars, or an equivalent which shall be approved by the engineer in writing.

FILL—

The abutments will be filled to the level of the roadway and sidewalks with sand, earth or other suitable materials, thoroughly compacted by ramming or rolling.

GENERAL SPECIFICATIONS FOR PILE-TRESTLE HIGHWAY BRIDGES.

TIMBER—

All timber shall be of good quality, and with the exception of the piles, which shall be of white oak, it shall be of the kind known as white oak or long leaf yellow pine, all of grade known as No. 1 commercial. It must be free from wind-shakes, wanes, black, loose or unsound knots, sap, worm-holes and all description of decay, or any other defect which would impair its strength or durability. Under no circumstances will any timber cut from dead logs be allowed to be placed in any portion of the structure, but all timber must be cut from live trees.

SUBSTRUCTURE—

There shall be .... pile bents; the bents will be 20 feet center to center, the piles to be not less than 24 feet long. The end bents shall be at such points as may be designated by the State Engineer, and all others shall be centered on a line between the centers of the end bents. All bents shall be at right angles to the axis of the bridge.

PILES—

The piles shall be cut from good, live trees of white oak. They must be sound and perfectly free from wind-shakes, wanes, large, loose, black or decayed knots, cracks, worm-holes and all description of decay, and they shall be stripped of all bark.

The piles shall be not less than 12 inches in diameter at the large end, and not less than 8 inches in diameter at the tips for piles 24 feet or under, nor less than 6 inches for piles 36 feet long. The piles shall be so nearly straight that a right line, taken in any radial direction and running parallel to a right line joining the centers of the ends of the pile, shall show that the pile is at no point over one-third of its diameter at such point out of a straight line. All piles must show an even and gradual taper from end to end, and the tips are to be pointed in a workmanlike manner. Should it develop that the piles encounter boulders or any other material which is liable to split or injure them, the ends are to be protected by cast or wrought iron shoes.

A cast iron follower head shall be used in driving all piles. Piles shall in all cases be driven to a penetration of not more than five (5) inches for ten (10) blows of a two thousand (2,000) pound hammer falling twenty (20) feet, or an equivalent computed by the formula:

$$P = \frac{2\,Wh}{s+1}$$

In which P = twenty-six (26) tons,
W = weight of hammer in tons,
h = height of fall in feet,
s = average penetration per blow for ten blows, in inches.

The hammer shall weigh not less than two thousand (2,000) pounds. No piles shall be driven less than ten (10) feet below the level of the ground.

All piles must be cut off at tops, after they are driven, to an exact line and parallel to grade of floor of bridge, so that the caps will bear evenly on all the piles of the group, without special framing or shimming up.

All piles injured in driving or that are driven out of place, shall either be cut off or withdrawn, as the State Engineer or his representatives may elect, and others shall be driven in their places.

The heads of all piles shall be adzed off at the tops, parallel to the axis of the cap, at an angle of 45 degrees, so as to be flush with the sides of the caps. All piles must be adzed off at any point where they come in contact with a brace, sufficiently to give a good bearing for brace.

The caps shall set squarely on top of the piles and shall be 10x12 inches by 16 feet, sized to 11 inches over piles. They shall be fastened to the piles by having one drift bolt to each pile; the drift bolt shall be ⅞ inch diameter by 24 inches long, and be driven on the axis of the cap and in the center of the head of the pile.

Each bent shall be supported with two sway braces, one on each side of the piles, and each brace shall run in an opposite direction to its mate on the pile. The braces shall be of 3x10-inch material and long enough to extend from the top of the cap at one end of the bent to the surface of the ground at the other end of the bent, and pass by the pile so that the end of the brace will coincide with outside of the pile, the end of the brace to be cut parallel to outside vertical edge of pile. The upper end of the brace must be cut flush with the top of the cap. All bracing timbers are to be attached to the piles and caps, wherever they come in contact with one another, with two ¾-inch diameter bolts.

SUPERSTRUCTURE—

The deck shall consist of .... panels; each panel will be 20 feet, center to center, in length; the width shall be 16 feet.

All posts, braces, stringers, guard-rails and all other timber shall be of the full size, as shown on the plans.

No variations from such sizes will be allowed except upon the written consent of the State Engineer.

FLOOR SYSTEM AND RAIL.

STRINGERS—

The stringers underneath the roadway shall consist of seven lines of 4x18-inch plank 22 feet long, and two outside lines of 4x17½-inch plank 20 feet long; the outside stringers shall make butt joints over centers of caps of trestles; intermediate stringers shall make lap joints over the caps, and be spiked together with 8-inch wire spikes. There shall be three lines of 2x4-inch bridging to each panel, 6 feet 8 inches apart.

The intermediate stringers shall be sized to 17½ inches over caps. Each intermediate stringer shall be fastened, at lower end, to the cap by a dowel pin of ¾x8-inch round iron, set half in cap and half in stringer in a 11-16 inch diameter hole in center of cap. Each outside stringer shall be fastened at each end to cap by a dowel pin of ¾x8-inch round iron, set one-half in cap and one-half in stringer, and two inches each side of center of cap.

There shall be 4-inch plank not less than 8 inches nor more than 12 inches wide, of even thickness, and trimmed to even lengths of 16 feet, used for flooring. It shall be laid at right angles to the axis of the bridge, with closed joints.

The floor planks shall be spiked at each crossing of the stringers, with two 8-inch wire spikes to each plank.

On each side of the roadway at the ends of the planks there shall be a 4x6-inch felloe guard resting on 4x6x 12-inch blocks, blocks to be spaced 5 feet center to center as shown on plans.

These guards shall be bolted to the floor system with ⅝-inch hook-bolts, the bolts passing through the guards, blocking and floor, and hooking under the outside stringer as shown on plans.

There shall be a wooden handrail on each side of the roadway. The posts shall be 4x6 inches of such a length as to place the top of the rail 3 feet 2 inches above the top surface of the floor.

The posts shall be bolted to the outside stringers with two ½-inch machine bolts, having two O. G. cast iron washers each. The posts shall be spaced 6 feet 8 inches center to center. Along the top of the posts there shall be a 2x4-inch scantling, placed vertically, and a 2x6-inch plank, placed horizontally, covering the tops of posts and upper edge of the scantling. There shall be a 2x10-inch hub-guard placed half way between the scantling and the top of the guard rail. These guards and rail tops shall be substantially nailed to the posts with 60-penny wire nails. Over the top of the rail at each post, and reaching down on either side an equal distance, there shall be a strip of strap iron ⅛x⅞x24 inches nailed on each side with two 8-penny nails.

All lumber above the floor shall be dressed by planing on all sides.

Two wing walls shall be constructed at each end of bridge. Each wing wall shall have three piles driven on a line at 45 degrees to center line of bridge, and four feet between centers. Piles in wing walls and last bent shall be backed with 4x12-inch plank from the elevation of bridge floor to an elevation of two feet below surface of ground, as shown on plans.

FRAMING—

All framing must be done to a close fit, and in a thorough and workmanlike manner. No blocking or shimming of any kind will be permitted in making joints, nor will any open joints be accepted anywhere on the work.

All joints, ends of piles and all surfaces of timber which are to be placed in direct contact with other timbers, must be thoroughly painted with a coat of such standard paint as may be selected by the State Engineer, at the time the surfaces of such parts are exposed and when the paint can be applied direct.

METAL WORK—

All bolts, nuts, washers and drift bolts must be practically perfect in every respect. All nuts and heads of bolts must have heavy O. G. washers between them and the timbers. All washers are to be made of a good quality of cast iron and must be sufficiently large and thick to provide properly for distributing the pressure due to the greatest allowable tension in the bolts over the area of the washers. They must be finished in a neat and workmanlike manner, and must be free from airholes, cracks, cinders and other defects. All holes for all bolts are to be bored 1-16 inch less in diameter than that of the bolts which are to be used in them.

ARAPAHOE COUNTY BRIDGE.

House Bill No. 120, Session Laws 1909, appropriated $5,000.00 from the General Fund for the construction of a bridge in the town of Englewood over Little Dry creek.

The State Engineer, the Mayor of Englewood and the chairman of the Board of County Commissioners of Arapahoe county constitute the Board of Construction.

Plans for this bridge were drawn by the State Engineer, but as only a small portion of the money appropriated became available no bids were asked for and no construction work has been started.

BENT COUNTY BRIDGE.

Senate Bill No. 289, chapter 19, Session Laws 1907, and page 83, Fourteenth Biennial Report of the State Engineer.

The Board of County Commissioners of Bent county desired to build a one-span bridge instead of the two-span bridge which had been contracted for. By mutual agreement between the contractor and the Board of Construction the existing contract was canceled and plans were drawn for a 190-foot steel span to be erected upon tubular piers which were built by the Pueblo Bridge Company under contract with the Board of County Commissioners and under the supervision of the State Engineer.

The bridge was advertised and bids were received on June 26, 1909, as follows:

Bidder.	Price, Complete.	Price for Furnishing Material.	Price for Erecting.	Date to be Completed.
National Construction Company	$7,695.00	....	....	November 30, 1909
W. M. Porter	8,030.00	$6,110.00	$1,920.00	October 15, 1909
Hughes & Hammond	7,500.00	5,500.00	2,300.00	October 15, 1909
Pueblo Bridge Company	6,795.00	....	....	4 mos. after signing contract
M. F. Levy Construction Company	7,390.00	....	1,680.00	October 10, 1909
Kansas City Bridge Company	7,300.00	....	2,100.00	November 1, 1909
Midland Bridge Company	7,400.00	5,640.00	1,950.00	5 mos. after signing contract
M. J. Patterson Contracting Company	6,296.00	....	....	November 1, 1909
Penn Bridge Company	....	4,937.00	....	90 days from contract.
R. P. & J. T. Garrett	....	5,194.00	....	November 1, 1909

McClintic-Marshall Construction Company, fabricating and delivering metal alone, $4,590.00, 8 weeks after signing contract.

Contract was awarded to the M. J. Patterson Contracting Company.

The steel was manufactured by Hansel-Elcock Company, of Chicago, and inspected by Hildreth & Company, of New York.

The county commissioners of Bent county appropriated an amount equal to the difference between the contract price and the amount in the State appropriation, less incidental expenses. This amounted to $2,392.58.

Final payment was made to contractor April 28, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$4,000.00
Expended prior to December 1, 1908	$ 9.00	
Las Animas Leader, advertising	3.99	
C. W. Comstock, expenses	6.70	
Bent County Democrat, advertising	2.31	
J. Hornbein, inspector	2.05	
Colorado Blue Print Company	4.36	
Engineering News, advertising	15.60	
M. H. Griffith, typewriting	5.00	
Rocky Mountain News, advertising	2.75	
Hildreth & Co., Inspecting Engineers	44.82	
M. J. Patterson Contracting Company, contract	3,903.42	
	$4,000.00	$4,000.00

CHAFFEE COUNTY BRIDGE.

House Bill No. 350, chapter 14, Session Laws 1909, appropriated $1,500.00 for the construction of a State wagon bridge across the Arkansas river at Granite, in Chaffee county. The State Engineer and the chairman of the Board of County Commissioners of Chaffee county constituted the Board of Construction.

Plans were prepared for two 30-foot steel and concrete spans, with concrete pier and abutments. On June 11, 1910, bids were received as follows:

Bidder.	Price.	Date to be Completed.
F. A. Maxwell	$3,240.00	September 1, 1910
Midland Bridge Company	4,087.00	February 1, 1911
Missouri Valley Bridge Company	4,019.00	October 10, 1910
M. F. Levy Construction Company	4,100.00	December 1, 1910
Pueblo Bridge Company	3,894.00	October 15, 1910
James Collier	4,350.00	October 1, 1910

As the lowest bid was so much in excess of the State appropriation that the county was not able to pay the difference, all bids were rejected and new bids requested for the concrete pier and abutments. On September 10, 1910, bids for this work were received as follows:

Bidder.	Price.	Additional Concrete, Per Cu. Yd.	Date to be Completed
Pueblo Bridge Company	$2,200.00	$17.50	Dec. 15, 1910
Missouri Valley Bridge & Iron Co	2,422.00	15.00	Mch. 10, 1911

The Board of County Commissioners of Chaffee County appropriated an amount equal to the difference between the contract price and the State appropriation, less incidental expenses, and the contract was awarded to the Pueblo Bridge Company.

This work was done under the supervision of Clyde Jay, of Salida, inspector, and was completed and final payment made on November 25, 1910. The county paid $915.93 as its portion of the cost.

FINANCIAL STATEMENT.

Appropriated by State		$1,500.00
L. D. Smith, typewriting	$ 7.50	
Chaffee County Democrat, advertising	4.29	
Rocky Mountain News, advertising	4.44	
Geo. M. Post, surveying	24.70	
Clyde H. Jay, inspecting	175.00	
Pueblo Bridge Company, contract	1,284.07	
	$1,500.00	$1,500.00

CONEJOS COUNTY BRIDGE.

House Bill No. 55, chapter 16, Session Laws 1909, appropriated $2,500.00 for the construction of a wagon bridge across the Conejos river in Conejos county.

The State Engineer and the Board of County Commissioners of Conejos county constituted the Board of Construction. Plans and specifications were prepared by the State Engineer for an 80-foot reinforced concrete arch bridge. The bridge was advertised and bids received on October 22, 1910, as follows:

Bidder.	Price.	Date to be Completed.
Commonwealth Construction Company	$4,835.00	Dec. 15, 1910
Missouri Valley Bridge Company	4,883.00	Apr. 22, 1911
M. F. Levy Construction Company	4,200.00	Apr. 15, 1911

The Board of County Commissioners of Conejos County made an appropriation to pay the amount in excess of the State appropriation, less incidental expenses. Contract was awarded to the M. F. Levy Construction Company.

On account of cold weather construction work has not been commenced.

FINANCIAL STATEMENT.

Appropriated by State		$2,500.00
L. D. Smith, typewriting	$ 7.50	
Rocky Mountain News, advertising	1.52	
Balance in fund	2,490.98	
	$2,500.00	$2,500.00

CONEJOS-COSTILLA COUNTIES BRIDGE.

Senate Bill No. 140, chapter 17, Session Laws 1909, appropriated $6,700.00 for the construction of a State wagon bridge across the Rio Grande between the counties of Conejos and Costilla, at the town of Alamosa.

The State Engineer and the chairmen of the Boards of County Commissioners of Conejos and Costilla counties constituted the Board of Construction.

The Board of Construction decided to let contracts for the substructure and superstructure separately.

Plans and specifications were prepared by the State Engineer for concrete pier and abutment, and for one 203-foot steel span and 200 feet of pile trestle.

The concrete pier and abutment were advertised and bids received on February 14, 1910, as follows:

Bidder.	Price.	Extra Concrete, Per Cu. Yd.	Date to be Completed.
Pueblo Bridge Company	$5,000.00	$25.00	June 1, 1910
M. F. Levy Construction Company	4,950.00	20.00	May 25, 1910

Piles omitted to be credited to State at $5.00 each.

Contract was awarded to the M. F. Levy Construction Company.

After work commenced the Board of Construction ordered concrete wing walls placed on the abutment at prices stated in bid. This contract was completed and accepted and final payment made to contractor on November 14, 1910.

The State paid $2,000.00 on this contract and the counties the balance.

On July 9, 1910, the following bids were received for the superstructure:

Bidder.	Price.	Date to be Completed.
M. F. Levy Construction Company	$17,962.00	Jan. 20, 1911
Midland Bridge Company	18,975.00	Apr. 1, 1911
Western Bridge & Construction Company	18,973.00	Dec. 15, 1910

These bids were rejected and new bids received on July 23, 1910, as follows:

Bidder.	Price.	Date to be Completed.
National Construction Company	$12,200.00	Jan. 15, 1911
M. F. Levy Construction Company	17,962.00	Jan. 1, 1911

Contract was awarded to the National Construction Company. The steel is being fabricated at the Koken Iron Works, St. Louis, Missouri, under inspection of Hildreth & Company, of New York.

FINANCIAL STATEMENT.

Appropriated by State		$6,700.00
A. F. Hewitt, salary and expenses	$ 12.50	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	4.83	
Independent Journal, advertising	4.29	
F. L. Easton, inspector	455.09	
San Luis Hotel, inspector's expense, board	15.00	
Hilda Griffin, inspector's expense, rent	12.50	
M. F. Levy, contract	2,000.00	
Balance in fund	4,188.29	
	$6,700.00	$6,700.00

COSTILLA COUNTY BRIDGE.

Senate Bill No. 84, chapter 18, Session Laws 1909, appropriated $2,000.00 for the construction of a highway bridge across the Culebra river at a point near the town of San Luis in Costilla county.

The State Engineer and the Board of County Commissioners of Costilla county constituted the Board of Construction. Plans and specifications were prepared by the State Engineer for a 60-foot reinforced concrete arch bridge and work was advertised.

Bids were received on August 20, 1910, as follows:

Bidder.	Price.	Date to be Completed.
Missouri Valley Bridge Company	$5,328.00	Nov. 20, 1910
Midland Bridge Company	7,398.00	Mch. 1, 1911
Cuno Engineering & Construction Company	6,977.00	Nov. 20, 1910
M. F. Levy Construction Company	4,700.00	Jan. 1, 1911

The Board of County Commissioners of Costilla County passed a resolution appropriating an amount equal to the difference between cost of bridge and State appropriation, less incidental expenses.

Contract was awarded to M. F. Levy Construction Company. On account of delays it was cold weather before contractor was ready to commence this work. The Board of Construction decided to postpone commencement of this work until warm weather in spring of 1911 on this account.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
L. D. Smith, typewriting	$ 7.50	
Rocky Mountain News, advertising	1.60	
Balance in fund	1,990.90	
	$2,000.00	$2,000.00

CLEAR CREEK COUNTY BRIDGE.

Senate Bill No. 165, chapter 15, Session Laws 1909, appropriated $2,000.00 for the construction of a State wagon bridge across the South Fork of Clear creek near Empire Pass in Clear Creek county. The State Engineer and the chairman of the Board of County Commissioners of Clear Creek county constituted the Board of Construction.

The State Engineer prepared plans and specifications for a 36-foot concrete and steel span. The bridge was advertised, and on March 19, 1910, bids were received as follows:

Bidder.	Price.	Extra Concrete. Per Cu. Yd.	Date to be Completed.
Missouri Valley Bridge & Iron Company	$ 1,995.00	$ 11.50	Sept. 1, 1910
Gate City Construction Company	2,130.74	7.50	May 1, 1910
Frank A. Maxwell	1,920.00	8.80	July 1, 1910
M. F. Levy Construction Company	1,925.00	18.00	July 1, 1910
C. G. Sheely Construction Company	2,241.00	18.00	Sept. 1, 1910

The contract was awarded to F. A. Maxwell of Georgetown, Colorado, who completed the bridge, and same was accepted and final payment made on November 21, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
A. F. Hewitt, salary and expenses	$ 5.10	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	2.09	
Georgetown Courier, advertising	2.70	
Frank A. Maxwell, contract	1,920.00	
Balance in fund	62.61	
	$2,000.00	$2,000.00

DELTA COUNTY BRIDGE.

House Bill No. 85, chapter 19, Session Laws 1909, appropriated $3,750.00 for the construction of a State bridge across the Gunnison river near the Roubideaux switch on the Denver and Rio Grande railroad, about four miles west of Delta in Delta county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Delta county constituted the Board of Construction. Plans and specifications were prepared by the State Engineer for a 190-foot steel span with concrete pier and abutment and 160 feet of pile trestle.

This work was advertised and bidders were requested to make bids for the substructure and superstructure separately, or for the bridge complete. Bids were received on November 12, 1910, as follows:

Bidder.	Price.	Extra Piles Each.	Extra Concrete Per Cu. Yd.	Date to be Completed.
Pueblo Bridge Company	$13,500.00	$15.00	$20.00	Mch. 1, 1911
Beach Manufacturing Company	13,785.00	15.00	12.00	Nov. 12, 1911

The Beach Manufacturing Company made a bid of $2,100.00 for the substructure alone.

The Board of Construction decided to make some changes in this work and the Pueblo Bridge Company modified its bid and made a price of $11,550.00.

Contract was awarded to the Pueblo Bridge Company. Construction work has not been started at this time.

FINANCIAL STATEMENT.

Appropriated by State		$3,750.00
A. F. Hewitt, salary and expenses	$ 8.20	
J. W. Johnson, salary and expenses	14.75	
L. D. Smith, typewriting	7.50	
Rocky Mountain News, advertising	3.19	
Delta County Tribune, advertising	3.20	
Balance in fund	3,713.16	
	$3,750.00	$3,750.00

DOUGLAS COUNTY BRIDGE.

House Bill No. 526, chapter 20, Session Laws 1909, appropriated $2,250.00 for the construction of a State bridge across East Plum creek near Larkspur in Douglas county.

The State Engineer and the chairman of the Board of County Commissioners of Douglas county constituted the Board of Construction.

Plans and specifications for a 32-foot concrete and steel bridge were prepared by the State Engineer and work advertised. Bids were received on June 11, 1910, as follows:

Bidder.	Price.	Extra Concrete Per Cu.Yd.	Date to be Completed.
F. A. Maxwell	$1,690.00	$15.00	Sept. 1, 1910
C. G. Sheely Construction Company	1,591.00	11.75	Sept. 1, 1910
Midland Bridge Company	2,043.50	20.00	Feb. 1, 1911
Missouri Valley Bridge Company	2,008.00	16.00	Oct. 10, 1910
M. F. Levy Construction Company	2,050.00	20.00	Nov. 1, 1910
S. E. Nelson	1,690.00	10.50	Aug. 5, 1910
Gordon Newell	1,892.00	20.00	Sept. 1, 1910
James Collier	1,895.00	12.50	Sept. 1, 1910
Geo. P. Moore	1,675.00	17.50	Sept. 15, 1910

Contract was awarded to C. G. Sheely Construction Company.

After construction work was about completed some extra work was requested by the Board of County Commissioners, and an order was given the contractor to do this work at the agreed price of $200.00.

The bridge was completed and accepted and final payment made on November 3, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,250.00
L. D. Smith, typewriting	$ 7.50	
Geo. M. Post, salary and expenses inspecting	11.30	
Rocky Mountain News, advertising	2.20	
Record Journal, advertising	1.98	
Geo. P. Moore, surveying	13,55	
C. G. Sheely Construction Company, contract	1,591.00	
C. G. Sheely Construction Company, extra work	200.00	
Geo. P. Stewart, surveying	8.00	
Balance in fund	414.47	
	$2,250.00	$2,250.00

EAGLE COUNTY BRIDGE, CATAMOUNT CREEK.

Senate Bill No. 152, chapter 21, Session Laws 1909, appropriated $1,000.00 for the construction of a highway bridge across the Grand river near the mouth of Catamount creek in Eagle county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Eagle county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for two 70-foot wooden spans, supported by crib pier and abutments.

This bridge was advertised and bids received June 4, 1910, as follows:

Bidder.	Price.	Date to be Completed.
Missouri Valley Bridge and Iron Company	$3,821.00	Oct. 1, 1910
Pueblo Bridge Company	$3,750.00	Oct. 1, 1910

The Board of Construction decided to make some changes in the plans, with a view to getting a lower price. This was done, and the Pueblo Bridge Company lowered its price to $2,900.00. The Board of County Commissioners appropriated the necessary extra money and contract was awarded the Pueblo Bridge Company.

The bridge is reported complete at this date. Eagle county will pay $1,952.19 on this work.

FINANCIAL STATEMENT.

Appropriated by State		$1,000.00
L. D. Smith, typewriting	$ 7.50	
Rocky Mountain News, advertising	2.09	
Eagle County Enterprise, advertising	2.20	
Julius Hornbein, inspector	40.40	
Balance in fund	947.81	
	$1,000.00	$1,000.00

EAGLE COUNTY BRIDGE AT WILMOT RANCH.

Senate Bill No. 50, chapter 14, Session Laws 1907, appropriated $3,000.00, and House Bill No. 174, chapter 22, Session Laws 1909, appropriated $2,500.00 for the construction of a steel highway bridge across the Grand river, near the Wilmot ranch, in Eagle county. See page 102, Fourteenth Biennial Report of the State Engineer.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Eagle county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 120-foot steel span with concrete abutments. Work was advertised and on April 9, 1910, bids were received as follows:

Bidder.	Price.	Extra Concrete Per Cubic Yard.	Date to be Completed.
Pueblo Bridge Company	$9,000.00	$ 9.50	Sept. 15, 1910.
Midland Bridge Company	9,525.00	10.50	Nov. 1, 1910.
Missouri Valley Bridge and Iron Company	9,221.00	10.00	Oct. 9, 1910.
M. F. Levy Construction Company	9,800.00	18.00	Oct. 1, 1910.

After changing to tubular piers and making some other minor changes, the Pueblo Bridge Company made a bid of $7,050.00 which was accepted and contract awarded.

The County Commissioners of Eagle county appropriated the money necessary in excess of the State appropriation.

Steel work for this bridge is under construction at the works of the Toledo-Massilon Bridge Company, of Toledo, Ohio.

FINANCIAL STATEMENT.

Appropriated by State		$5,500.00
Expended prior to December 1, 1908	$ 23.20	
M. H. Griffith, typewriting	$ 7.50	
Rocky Mountain News, advertising	1.98	
Eagle Valley Enterprise, advertising	2.85	
Balance in fund	5,464.47	
	$5,500.00	$5,500.00

GARFIELD COUNTY BRIDGE AT LACY.

House Bill No. 37, Chapter 24, Session Laws 1909, appropriated $6,000.00 for the construction of a steel highway bridge across the Grand river, near the station of Lacy, on the Denver & Rio Grande Railroad.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Garfield county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 203-foot truss and 64-foot plate girder steel bridge with concrete pier and abutments. Work was advertised and bids received on May 28, 1910, as follows:

Bidder.	Price.	Extra Concrete Per Cubic Yard.	Date to Be Completed.
C. G. Sheely Construction Company	$23,750.00	$24.35	Dec. 1, 1910
Missouri Valley Bridge and Iron Company	28,200.00	24.00	Dec. 1, 1910
Midland Bridge Company	28,060.00	20.00	Jan. 1, 1911
Pueblo Bridge Company	25,150.00	25.00	Dec. 1, 1910
C. H. Williams	25,400.00	26.00	Mch. 1, 1911

Contract was awarded to the C. G. Sheely Construction Company. The County Commissioners of Garfield county appropriated a sum of money equal to the difference between the contract price and the amount remaining in the State appropriation after deducting incidental expenses.

Concrete work was completed under the supervision of James Brennan as inspector. Steel work was fabricated by the Minneapolis Steel & Machinery Company, of Minneapolis, Minn., under inspection of Hildreth & Company, of New York. The steel is now at the bridge site and is being erected.

FINANCIAL STATEMENT.

Appropriated by State		$6,000.00
A. F. Hewitt, salary and expenses	$ 8.05	
J. W. Johnson, salary and expenses	13.55	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	3.85	
Avalanche, advertising	5.85	
Geo. M. Post, inspecting	22.50	
James Brennan, inspecting concrete	117.00	
Balance in fund	5,821.70	
	$6,000.00	$6,000.00

GARFIELD COUNTY BRIDGE AT UNA.

Senate Bill No. 411, Chapter 23, Session Laws 1909, appropriated $4,000.00 for the construction of a steel highway bridge across the Grand river near the station of Una, on the Denver & Rio Grande Railroad, in Garfield county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Garfield county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 203-foot truss and 64-foot plate girder steel bridge, with concrete pier and abutments.

The bridge was advertised and bids received on May 28, 1910, as follows:

Bidder.	Price.	Extra Concrete Per Cubic Yard.	Date to Be Completed.
C. G. Sheely Construction Company	$24,000.00	$24.35	Nov. 1, 1910
Missouri Valley Bridge and Iron Company	28,350.00	24.00	Dec. 1, 1910
Midland Bridge Company	28,060.00	20.00	Jan. 1, 1911
Pueblo Bridge Company	25,150.00	25.00	Dec. 31, 1910
C. H. Williams	26,000.00	26.00	Apr. 1, 1911

The contract was awarded to C. G. Sheely Construction Company, after the Board of County Commissioners of Garfield county had appropriated a sum of money equal to the difference between the contract price and the amount left in the State appropriation after deducting incidental expenses.

The concrete work was done under the supervision of James Brennan, and has been completed.

The steel work was fabricated by the Minneapolis Steel & Machinery Company, of Minneapolis, Minn., under the inspection of Hildreth & Company, of New York, and is now in process of erection.

FINANCIAL STATEMENT.

Appropriated by State		$4,000.00
A. F. Hewitt, salary and expenses	$ 8.55	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	3.96	
Avalanche, advertising	3.00	
Julius Hornbein, salary and expenses, inspecting	6.00	
James Brennan, inspector	111.00	
Balance in fund	3,859.99	
	$4,000.00	$4,000.00

LINCOLN COUNTY BRIDGE.

House Bill No. 35, Chapter 25, Session Laws 1909, appropriated $3,000.00 for the construction of a State wagon bridge across Big Sandy creek, about one-half mile east of Boyero in Lincoln county.

The State Engineer and the Board of County Commissioners of Lincoln county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 180-foot pile trestle, composed of nine panels, each twenty feet in length. The bridge was advertised and bids were received on September 4, 1909, as follows:

Bidder.	Price.	Date to be Completed.
M. F. Levy Construction Company	$1,642.00	Dec. 1, 1909
J. W. Cochran	2,250.00	Dec. 15, 1909
Tressler & Fisher	2,484.00	Nov. 20, 1909

Contract was awarded to the M. F. Levy Construction Company. The County Commissioners afterwards requested that the bridge be lengthened by 60 feet and a wing wall constructed on the east bank of the river.

The M. F. Levy Construction Company agreed to do this for the sum of $850.00 and the work was ordered by the Board of Construction on February 11, 1910.

The bridge was completed, accepted and payment made on April 19, 1910. The County Commissioners requested that the bridge be painted. This matter was taken up by the Board of Construction and Mr. Levy made them a price of $100.00 for doing this work. The matter has not been finally decided by the Board of Construction and is still pending.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
M. H. Griffith, typewriting	$ 7.50	
Range Ledger, advertising	1.54	
Rocky Mountain News, advertising	1.20	
A. F. Hewitt, salary and expenses	33.90	
David Beechtel, inspector	220.00	
Sadie Jackson, board for inspector	34.75	
M. F. Levy Construction Company, contract	1,642.00	
M. F. Levy Construction Company, extra work	850.00	
Balance in fund	209.11	
	$3,000.00	$3,000.00

MESA COUNTY BRIDGE.

Senate Bill No. 264, chapter 26, Session Laws 1909, appropriated $6,480.00 for the construction of a highway bridge across the Grand river at the end of Main street near the city of Grand Junction in Mesa county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Mesa county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for concrete piers and abutments for a bridge of six spans with a total length of 1,083 feet.

Concrete work was advertised and bids were received on February 28, 1910, as follows:

Bidder.	Price.	Extra Concrete Per Cu. Yd.	Extra Piles Each.	Date to be Completed.
M. J. Patterson Contracting Company	$63,000.00	$10.00	$5.00	Nov. 1, 1910
M. F. Levy Construction Company	70,000.00	No Bid	6.50	Dec. 10, 1910

As these prices were considered to be too high the bids were rejected. Since rejecting bids no definite action has been taken by the Board of Construction.

FINANCIAL STATEMENT.

Appropriated by State		$6,480.00
A. F. Hewitt, salary and expenses	$ 20.30	
J. W. Johnson, salary and expenses	20.90	
J H. Fisk, surveyor	24.00	
J. J. Lumsden, tools and supplies for test pits	228.01	
M. H. Griffith, typewriting	7.50	
Engineering Record, advertising	10.80	
Engineering—Contracting, advertising	11.60	
Daily Sentinel, advertising	3.00	
Balance in fund	6,153.89	
	$6,480.00	$6,480.00

MORGAN COUNTY BRIDGE.

House Bill No. 168, chapter 27, Session Laws 1909, appropriated $2,500.00 for the construction of a State bridge across the Platte river about two miles east of the town of Weldon in Morgan county. The State Engineer and the chairman of the Board of County Commissioners of Morgan county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 340-foot pile trestle bridge composed of 17 panels of 20 feet each. The bridge was advertised and bids received on April 30, 1910, as follows:

Bidder.	Price.	Date to be Completed.
Missouri Valley Bridge Company	$4,390.00	Oct. 1, 1910
M. F. Levy Construction Company	3,900.00	Nov. 1, 1910
C. G. Sheely Construction Company	3,475.00	Sept. 1, 1910
E. S. Baty	3,412.35	Sept. 1, 1910
J. F. Ewing	4,500.00	Sept. 1, 1910
Midland Bridge Company	3,000.00	Sept. 1, 1910

The County Commissioners of Morgan county appropriated the necessary amount in excess of the state appropriation and contract was awarded to the Midland Bridge Company, of Kansas City, Missouri.

The construction work was done under inspection by Julius Hornbein of the State Engineer's office. Bridge was accepted and final payment made on November 9, 1910. Morgan county paid $1,048.05 as its portion of the contract.

FINANCIAL STATEMENT.

Appropriated by State		$2,500.00
M. H. Griffith, typewriting	$ 7.50	
Rocky Mountain News, advertising	2.20	
Morgan County Herald, advertising	3.00	
Julius Hornbein, inspector	535.35	
Midland Bridge Company, contract	1,951.95	
	$2,500.00	$2,500.00

OURAY COUNTY BRIDGE.

Senate Bill No. 45, Chapter 28, Session Laws 1909, appropriated $3,480.00 for the construction of a steel wagon bridge and approaches across the Uncompahgre river, about one-half mile east of the town of Ridgway in Ouray county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Ouray county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 120-foot steel span. Work was advertised and bids received on April 9, 1910, as follows:

Bidder.	Price.	Date to be Completed.
Midland Bridge Company	$10,650.00	Nov. 1, 1910
Missouri Valley Bridge and Iron Company	10,462.00	Oct. 9, 1910
M. F. Levy Construction Company	10,198.00	Sept. 20, 1910
Pueblo Bridge Company	10,750.00	Sept. 15, 1910

As bids were considered to be too high they were rejected and plans prepared for concrete abutments for the old wooden bridge now at that point. On September 10, 1910, bids were received as follows:

Bidder.	Price.	Extra Concrete Per Cubic Yard.	Date to be Completed.
M. F. Levy Construction Company	$3,400.00	No bid.	Apr. 1, 1911
Missouri Valley Bridge and Iron Company	2,680.00	$14.50	Mch. 10, 1911

Contract was awarded to the Missouri Valley Bridge and Iron Company, of Leavenworth, Kan. The Missouri Valley Bridge and Iron Company submitted plans for a 66-foot light steel span, with tubular piers, and 20-foot steel approaches, for the sum of $3,800.00. The Board of Construction has the question of this change under advisement, no decision having been arrived at as yet.

FINANCIAL STATEMENT.

Appropriated by State		$3,480.00
A. F. Hewitt, salary and expenses	$ 11.15	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	3.85	
Ouray Plaindealer, advertising	4.46	
J. C. Ingersoll, County Surveyor	30.00	
Balance in fund	3,423.04	
	$3,480.00	$3,480.00

PARK COUNTY BRIDGE.

House Bill No. 224, Chapter 29, Session Laws 1909, appropriated $3,000.00 for the construction of a steel bridge across the Middle Fork of the South Platte river at a point near London Junction, in Park County.

The State Engineer and the chairman of the Board of County Commissioners of Park county constituted the Board of Construction. Plans and specifications were prepared by the State Engineer for a 32-foot concrete and steel bridge. Work was advertised and bids received on April 30, 1910, as follows:

Bidder.	Price.	Extra Concrete Per Cubic Yard.	Date to be Completed.
Midland Bridge Company	$1,932.00	$15.00	Dec. 1, 1910
F. A. Maxwell	1,875.00	10.00	Aug. 1, 1910
R. P. McDonald	2,390.00	25.00	June 25, 1910
M. F. Levy Construction Company	1,662.00	18.00	Sept. 1, 1910
Missouri Valley Bridge and Iron Company	1,968.00	......	Oct. 1, 1910
Geo. P. Moore	1,965.00	25.00	Aug. 30, 1910

Contract was awarded to M. F. Levy Construction Company, of Denver. Work was done under inspection of J. E. Dollison, of Alma, Colo. The Board of Construction decided to construct the earth approaches at each end of the bridge, and an agreement was made with the M. F. Levy Construction Company to do this work at actual cost plus 15 per cent. Work was completed and final payment made on November 10, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
M. H. Griffith, typewriting	$ 7.50	
Rocky Mountain News, advertising	2.00	
J. E. Dollison, inspector	129.00	
M. F. Levy Construction Company, contract	1,662.00	
M. F. Levy Construction Company, extra work	1,199.50	
	$3,000.00	$3,000.00

PITKIN COUNTY BRIDGE.

Senate Bill No. 354, Chapter 30, Session Laws 1909, appropriated $3,480.00, and House Bill No. 508, Chapter 31, Session Laws 1909, appropriated $2,250.00 for the construction of a steel bridge across the canon of Maroon creek, near Red Butte, about one mile west of the city of Aspen in Pitkin county.

House Bill No. 86, Chapter 22, Session Laws 1907, (page 128, Fourteenth Biennial Report of the State Engineer), also appropriated $4,000.00 for this same bridge.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Pitkin county constituted the Board of Construction.

The survey of the canon at the proposed crossing was made by the County Surveyor of Pitkin county. Plans and specifications were prepared by the State Engineer for a 171-foot steel arch, with two 66-foot side spans and with deck roadway. This type was chosen because the roadway must be 75 feet above the bottom of the canon. Bridge was advertised and bids received on August 6, 1910, as follows:

Midland Bridge Company	$15,588.00
A. Hughes Construction Company	18,530.00
M. J. Patterson Contracting Company	15,490.00
National Construction Company	17,650.00
Missouri Valley Bridge and Iron Company	14,700.00

As the prices bid were all in excess of the total of the three appropriations, and the county was not able to make up the amount required, it was proposed to build the steel work alone, omitting the floor, the hand railing and its brackets, and the small masonry abutments at the ends of the bridge. This would reduce the price about $2,000.00.

This suggestion was submitted to the Attorney General, who advised the Board of Construction that it would not be proper to proceed according to plan proposed. Bids were then rejected and no further steps have been taken by the Board of Construction.

FINANCIAL STATEMENT.

Appropriated by State		$9,730.00
Expended prior to December 1, 1908	$ 6.00	
A. F. Hewitt, salary and expenses	19.35	
L. D. Smith, typewriting	7.50	
Aspen Democrat-Times, advertising	1.98	
Rocky Mountain News, advertising	1.98	
Balance in fund	9,693.19	
	$9,730.00	$9,730.00

PUEBLO COUNTY BRIDGE.

Senate Bill No. 50, Chapter 32, Session Laws 1909, appropriated $5,000.00 for the construction of a State bridge of steel across the Arkansas river, near Orchard Grove in Pueblo county.

The State Engineer, the chairman of the Board of County Commissioners of Pueblo county and the chairman of the road and bridge committee of Pueblo county constituted the Board of Construction. The survey of the proposed crossing was made by C. C. Knight, County Surveyor of Pueblo county.

Plans and specifications were prepared by the State Engineer for a bridge with trusses continuous over two spans of 133 feet each. Before this work was advertised, the City Council of the city of Pueblo decided to build a new bridge over the Arkansas river on Union avenue, in the city of Pueblo, and move the old Union avenue bridge to Victoria avenue.

The County Commissioners made a contract with the city of Pueblo to buy the old Victoria avenue bridge for use as part of the bridge at Orchard Grove. The old Victoria avenue bridge has a span of 151 feet.

New plans and specifications are being prepared for the Orchard Grove bridge, using the old 151-foot span and a new 100-foot span, with concrete pier and abutments.

FINANCIAL STATEMENT.

Appropriated by State		$5,000.00
J. W. Johnson, salary and expenses	$ 10.25	
Balance in fund	4,989.75	
	$5,000.00	$5,000.00

RIO BLANCO COUNTY BRIDGE.

House Bill No. 62, Chapter 33, Session Laws 1909, appropriated $3,750.00 for the construction of a steel highway bridge across the White river, about three and one-half miles below the town of Meeker in Rio Blanco county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Rio Blanco county constituted the Board of Construction.

Plans and specifications were prepared by the State Engineer for a 100-foot steel span, with concrete abutments. Work was advertised and bids received on March 26, 1910, as follows:

Bidder.	Price.	Date to be Completed.
M. J. Patterson Contracting Company	$13,490.00	Oct. 1, 1910
Missouri Valley Bridge and Iron Company	14,337.00	Nov. 1, 1910
C. G. Sheely Construction Company	13,990.00	Oct. 1, 1910

As the lowest bid was greatly in excess of the State appropriation, the Board of Construction asked the M. J. Patterson Contracting Company to submit a plan for this bridge at a lower price.

The contractor submitted a design for this bridge, consisting of a 100-foot steel span and concrete abutments for which he made a price of $5,250.00. The Board of County Commissioners of Rio Blanco county appropriated the necessary extra money, and contract was awarded to the M. J. Patterson Contracting Company.

Construction work has been started, and abutments are complete. Steel for the span has been delivered but has not yet been erected.

FINANCIAL STATEMENT.

Appropriated by State		$3,750.00
J. W. Johnson, salary and expenses	$ 43.25	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	1.98	
Balance in fund	3,697.27	
	$3,750.00	$3,750.00

SUMMIT COUNTY BRIDGE.

House Bill No. 201, Chapter 34, Session Laws 1909, appropriated $3,500.00 for the construction of a bridge across the Blue river, about one and one-half miles north of the town of Dillon in Summit county.

The State Engineer and the chairman of the Board of County Commissioners of Summit county constituted the Board of Construction. Plans and specifications were prepared by the State Engineer for an 80-foot steel span, with concrete abutments. Work was advertised and bids received on April 16, 1910, as follows:

Bidder	Price.	Extra Concrete Per Cubic Yard.	Date to be Completed
Missouri Valley Bridge and Iron Company	$6,396.00	$12.00	....
Midland Bridge Company	6,475.00	14.50	Nov. 1, 1910
M. F. Levy Construction Company	7,200.00	18.00	Oct. 1, 1910
M. J. Patterson Contracting Company	6,297.00	9.00	Nov. 1, 1910

The Board of Construction decided to change the plans, using wooden floor joists and sliding bed plate instead of rollers, and the M. J. Patterson Contracting Company lowered its bid to $5,747.00.

As it was impossible for the county to appropriate any money for this bridge, all bids were rejected. No action has since been taken by the Board of Construction.

FINANCIAL STATEMENT.

Appropriated by State		$3,500.00
M. H. Griffith, typewriting	$ 7.50	
Rocky Mountain News, advertising	2.10	
Summit County Journal and Breckenridge Bulletin, advertising	3.61	
Balance in fund	3,486.79	
	$3,500.00	$3,500.00

TELLER COUNTY BRIDGE.

Senate Bill No. 417, Chapter 35, Session Laws 1909, appropriated $2,000.00 for the construction of a bridge over Coal creek, on a public highway in Teller county.

The State Engineer and the Board of County Commissioners of Teller county constituted the Board of Construction.

Plans were prepared by the State Engineer for a 32-foot steel and concrete bridge. Work was advertised and bids were received on September 20, 1910, as follows:

Bidder	Price.	Extra Concrete Per Cubic Yard.	Date to be Completed
Pueblo Bridge Company	$1,890.00	$18.00	Dec. 20, 1910
C. G. Sheely Construction Company	1,974.00	19.50	Dec. 31, 1910
M. F. Levy Construction Company	$2,000.00	19.00	Apr. 1, 1911

Contract was awarded the Pueblo Bridge Company. Construction work was inspected by Julius Hornbein, of the State Engineer's office. The bridge is now nearly completed.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
J. S. Gorman, team	$ 6.00	
Claude Stotts, County Surveyor	18.00	
L. D. Smith, typewriting	7.50	
Teller County News, advertising	1.98	
Rocky Mountain News, advertising	2.09	
Geo. M. Post, surveying	35.25	
The Windsor Livery	6.00	
Julius Hornbein, inspector	87.75	
Balance in fund	1,835.43	
	$2,000.00	$2,000.00

ROADS.

BOULEVARD—DENVER TO COLORADO SPRINGS.

Senate Bill No. 488, chapter 11, Session Laws 1909, appropriated $2,000.00 and transferred the balance remaining in the fund created by appropriation, Senate Bill No. 288, of the Sixteenth General Assembly, for the construction of a driveway from the south side of the limits of the City and County of Denver to the north side of the limits of Colorado Springs.

The Board of Construction consisted of the Governor, the State Engineer, the Mayor and the City Engineer of Denver.

After consultation with the Board of County Commissioners of El Paso county, the Board of Construction entered into an agreement with the County Commissioners to let a contract for the grading of certain sections of this road in El Paso county, the Board of Construction and Board of County Commissioners of El Paso county each to pay one-half of the contract price.

On April 23, 1910, the following bids were received and contract awarded to W. T. Rodney of Colorado Springs:

Bidder.	Price.	Date to be Completed.
H. R. Daniels	$10,453.57	....
T. B. Schooler	14,000.00	....
W. T. Rodney	9,268.29	Nov. 30, 1910

This work was divided into seven sections, the last six of which are completed at the present time.

The Board of Construction then decided to let a contract for furnishing teams and outfit to do certain work between the north line of El Paso county and the south line of Denver county. Only one bid was received on July 23, 1910, and contract awarded to J. A. Osner at the following prices:

Bidder.		Price.	
J. A. Osner.	Teams and drivers	$4.50	Per day of 8 hours.
	Laborers	2.00	
	Tools	4.00	

This outfit was put in charge of a superintendent for the Board of Construction and work done as directed by him.

FINANCIAL STATEMENT.

Appropriated by State		$ 2,000.00
From Platte Canon Boulevard Fund, Senate Bill No. 288, 1907		14,689.28
J. W. Johnson, salary and expenses	$ 6.60	
M. H. Griffith, typewriting	7.50	
Denver Republican, advertising	4.73	
Denver Post, advertising	2.31	
El Paso County Democrat, advertising	2.31	
W. P. Woodside, surveying etc.	686.75	
Denver Times, advertising	2.31	
Rocky Mountain News, advertising	1.84	
W. T. Rodney, contract	3,152.35	
J. A. Osner, contract	5,018.19	
T. C. Allen, superintendent	145.80	
J. C. Van Horn, superintendent	32.50	
Balance in fund	7,626.09	
	$16,689.28	$16,689.28

BOULEVARD—DENVER TO GOLDEN.

Senate Bill No. 156, chapter 12, Session Laws 1909, appropriated $5,000.00 for the purpose of constructing a permanent driveway or boulevard between the west limits of the City and County of Denver and the city of Golden in Jefferson county.

The Governor, the State Engineer, the Mayor of the city of Denver and the Board of County Commissioners of Jefferson county constituted the Board of Construction.

After viewing the three main roads between Denver and Golden, the Board of Construction decided to improve the road known as the North Golden road.

The County Commissioners of Jefferson county appropriated $5,000.00 and private parties living along the road donated $6,000.00 in money and $3,000.00 in work towards the construction of the road.

After the survey was made, the Board of Construction advertised the work and requested bids for grading and surfacing, either with gravel or crushed basalt. On February 19, 1910, bids were received as follows:

	F. A. Maxwell.	W. E. Russell & John Dunhill.
Excavation	$ .38	$ .35 per cubic yard.
Borrow	.27	.25 per cubic yard.
Pipe	1.00	.90 per lineal foot.
Bridges	10.00	1.70 per lineal foot.
Flooring	75.00	45.00 per M. B. M.
Gravel	1.30	.70 per cubic yard.
Basalt	1.00	2.70 per cubic yard.
Gravel, hauling and dumping	.30	.85 per cubic yard.
Basalt, hauling and dumping	3.00	1.75 per cubic yard.
Spreading and rolling	.05	.09 per square yard.
Concrete rip rap	.30	.25 per square foot.
Completion of work	Aug. 1, 1910	....

As these prices were greatly in excess of the money available, the Board of Construction decided to use the money in the State appropriation for grading only and the contractors were given the opportunity of withdrawing their bids or revising them. Mr. Maxwell withdrew his bid entirely. Messrs. Russell and Dunhill allowed their bid on grading work to remain as stated above. Contract for the grading was awarded to them and it was stipulated that the work should commence at the east end of the road. This grading work was completed and work accepted and final payment made on September 19, 1910. Some extra work was done on this road which was paid for by the State Highway Commission. The County Commissioners of Jefferson county took charge of the money appropriated by the county and private subscriptions and commenced the work of surfacing at the town of Golden. This work is practically complete at the present time.

FINANCIAL STATEMENT.

Appropriated by State		$5,000.00
George Tritch Hardware Company	$ 1.35	
Max Grossman, salary	2.50	
R. H. Croke, salary	17.50	
C. R. Enos, salary	23.75	
J. J. Lonergan, salary	3.00	
H. F. Stiles, salary	5.00	
J. Hornbein, salary and expenses	233.90	
G. P. Moore, salary	17.25	
Hallack & Howard, stakes	6.50	
J. W. Johnson, salary and expenses	6.60	
M. H. Griffith, typewriting	7.50	
Peoples Press, advertising	7.86	
Pueblo Star-Journal, advertising	3.80	
J. E. Maloney, constructing engineer	18.10	
E. E. Montgomery, salary	121.00	
Russell and Dunhill, contract	4,524.39	
	$5,000.00	$5,000.00

BOULDER-GRAND COUNTIES ROAD.

House Bill No. 163, chapter 56, Session Laws 1905; page 140, Fourteenth Biennial Report of the State Engineer.

C. L. Stewart of Boulder, the contractor, completed his contract about October 15, 1910, and was paid the amount due on the contract, $100.00.

FINANCIAL STATEMENT.

Appropriated by State		$5,000.00
Expended prior to December 1, 1908	$ 4,782.80	
C. L. Stewart, contract	100.00	
Balance in fund	117.20	
	$5,000.00	$5,000.00

CHAFFEE COUNTY ROAD—PONCHA PASS.

House Bill No. 163, Chapter 90, Session Laws 1909, appropriated $750.00 for repairing and grading the Salida-Villa Grove road, between the town of Poncha and Poncha Pass. The Board of Construction consisted of the State Engineer and the Board of County Commissioners of Chaffee county.

The Board decided where repairs were most necessary and asked for bids for this work. Only one bid was received, and contract was awarded to John Godec, on May 5, 1910, for $725.00.

The contractor completed his work and was paid on October 24, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$ 750.00
Geo. M. Post, inspector	$ 16.50	
John Godec, contract	725.00	
Balance in fund	8.50	
	$ 750.00	$ 750.00

CHAFFEE-EAGLE COUNTIES ROAD.

Senate Bill No. 347, Chapter 53, Session Laws 1903, and page 113, Fourteenth Biennial Report of the State Engineer.

The contractor, Zenas Crawford, completed this work about September 15, 1910, and was paid in full.

FINANCIAL STATEMENT.

Balance in fund on December 1, 1908		$1,074.00
Zenas Crawford, contract	$1,040.00	
A. F. Hewitt, salary and expenses	15.65	
Balance in fund	18.35	
	$1,074.00	$1,074.00

CLEAR CREEK COUNTY ROAD—GREEN LAKE.

Senate Bill No. 444, Chapter 91, Session Laws 1909, appropriated $2,730.00 for constructing a wagon road in a southerly direction from Green Lake in Clear Creek county. The Board of Construction consisted of the State Engineer and the Board of County Commissioners of Clear Creek county.

Plans and specifications were prepared and bids were requested upon the first 3,000 feet of road. This was all new work, and connected with an old road at Station 30.

On November 6, 1909, the following bids were received:

Bidder.	Price.	Date to be Completed.
Oscar B. Wing	$2,400.00	June 1, 1910
F. A. Maxwell	2,100.00	July 1, 1910

Contract was awarded to F. A. Maxwell, of Georgetown, and his contract completed about July 22, 1910.

The Board then decided to let a contract for repairing and widening the old road from the end of the new work. On October 10, 1910, the following bids were received:

Bidder.	Price.	Date to be Completed.
M. A. Clark	$550.00	Nov. 30, 1910
P. T. Stevens	600.00	Jan. 15, 1911

Contract was awarded to M. A. Clark, of Georgetown, who completed the work to Station 100, the end of the contract, about November 20, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,730.00
A. F. Hewitt, salary and expenses	$ 7.55	
Rocky Mountain News, advertising	2.46	
M. H. Griffith, typewriting	7.50	
Georgetown Courier, advertising	3.52	
Frank A. Maxwell, contract	2,100.00	
Amount pledged M. A. Clark	550.00	
Balance in fund	58.97	
	$2,730.00	$2,730.00

DOLORES COUNTY ROAD—COKE OVENS TO DUNTON.

House Bill No. 449, chapter 93, Session Laws 1909, appropriated $2,000.00 for completing the construction of a wagon road from Coke Ovens to Dunton, in Dolores county. The Board of Construction consisted of the State Engineer and the chairman of the Board of County Commissioners of Dolores county.

Bids were requested for September 11, 1909, and one bid received from Henry Alerton, who agreed to complete the work for the sum of $2,000.00. As this was the amount in the appropriation, the Board of County Commissioners appropriated $100.00 to meet the incidental expenses.

The contract was awarded to Henry Alerton, who completed his contract about October 26, 1910. The County Commissioners paid $24.01 out of their $100.00 appropriation.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
A. F. Hewitt, salary and expenses	$ 11.00	
M. H. Griffith, typewriting	7.50	
Rico Item, advertising	1.80	
Rocky Mountain News, advertising	.96	
O. L. Nelson, expenses	2.75	
Henry Alerton, contract	1,975.99	
	$2,000.00	$2,000.00

EAGLE COUNTY ROAD.

House Bill No. 479, chapter 94, Session Laws 1909, appropriated $7,500.00 for repairing the Eagle county portion of the State road from Denver to Grand Junction. The work was done under the supervision of the State Engineer and the Board of County Commissioners of Eagle county.

The Board decided upon three sections where work was most necessary and received the following bids on October 8, 1910:

Bidder.	Section.	Price.	Date to be Completed.
Frank S. Smith	1	$3,160.00	Jan. 1, 1911
Matt Murray	1	2,825.00	Dec. 5, 1910
Joe Johnson	2	700.00	Jan. 1, 1911
A. R. Gerard	3	1,657.60	June 1, 1911

Contracts were awarded to Matt Murray on section 1, Joe Johnson on section 2, and A. R. Gerard on section 3. None of the contracts have been completed at present.

FINANCIAL STATEMENT.

Appropriated by State		$7,500.00
L. D. Smith, typewriting	$ 7.50	
Rocky Mountain News, advertising	1.87	
Eagle Valley Enterprise, advertising	6.93	
Amount pledged by contract	5,182.60	
Balance in fund	2,301.10	
	$7,500.00	$7,500.00

EL PASO AND FREMONT COUNTIES ROAD.

Senate Bill No. 362, chapter 95, Session Laws 1909, appropriated $4,120.00 from the Internal Improvement Fund and $5,000.00 from the General Fund, and House Bill No. 472, chapter 96, Session Laws 1909, appropriated $4,000.00 from the Internal Improvement Fund for the construction and repair of a public highway from the city of Colorado Springs, in El Paso county, to the city of Canon City, in Fremont county.

The State Engineer, the chairmen of the Boards of County Commissioners of El Paso and Fremont counties and the County Surveyors of El Paso and Fremont counties constituted the Board of Construction.

The Board of Construction met as required and ordered the County Surveyors to make surveys of the most feasible routes in their respective counties. The Board accepted the surveys as made, and the work was commenced by the Board of Penitentiary Commissioners.

A camp was established near the line between El Paso and Fremont counties, and practically all of the work has been done in El Paso county. After the State funds were exhausted the County Commissioners of El Paso county appropriated money from their county funds to complete the road to a connection with the old public wagon road.

All moneys from this fund were paid on vouchers drawn by the Penitentiary Commissioners.

GILPIN COUNTY ROAD—TOLLAND TO AMERICAN CITY AND APEX.

House Bill No. 452, chapter 97, Session Laws 1909, appropriated $3,250.00 for completing and repairing the wagon road from the town of Tolland through American City, Apex, Elk Park, Mammoth, Kingston and Yankee to the town of Alice, and connecting with the public wagon road running towards Central City, in Gilpin county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Gilpin county constituted the Board of Construction.

This work was started at the end of road constructed under appropriation made by House Bill No. 378, Session Laws 1907. Bids were received on February 26, 1910, to the amount of $3,100.00, as follows:

Bidder.	Stations.	Distance.	Price.	Date to be Completed.
George W. Pyle	89 to 110	15,120 ft.	$3,100.00	....
Hendry Johnson	89 to A72	11,320 ft.	$3,100.00	Aug. 1, 1910
Elmer Eldred and Oscar Williams	89 to 50	8,920 ft.	$3,100.00	July 15, 1910

Mr. Geo. W. Pyle, of Apex, was awarded the contract, and his work was completed and accepted July 22, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,250.00
M. H. Griffith, typewriting	$ 7.50	
Rocky Mountain News, advertising	1.20	
Gilpin Observer, advertising	3.74	
G. M. Post, inspector, salary and expenses	27.90	
Geo. W. Pyle, contract	3,100.00	
Balance turned back into Internal Improvement Fund	109.66	
	$3,250.00	$3,250.00

GILPIN COUNTY ROAD—MOON GULCH.

House Bill No. 514, Chapter 98, Session Laws 1909, appropriated $1,500.00 for constructing a wagon road from Rollinsville up Moon Gulch to the junction with the present road running toward Central City, in Gilpin county.

The Governor, the State Engineer and the chairman of the Board of County Commissioners of Gilpin county constituted the Board of Construction.

Plans and specifications were prepared and bids requested in the sum of $1,400.00.

On October 1, 1910, the following bids were received:

Bidder.	Stations.	Distance.	Price.	Date to be Completed.
P. C. McNevins Henry Eatwell Frank Strosser	0 to 26 in Section 6	6,217.9 ft.	$1,400.00	....
Geo. W. Pyle Otto Blake	0 to 10 in Moon Gulch.	4,610.2 ft.	$1,400.00	June 15, 1911

Contract was awarded to P. C. McNevins et al., and the work was partially completed by November 30, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$1,500.00
Geo. M. Post, surveying and inspection	$ 85.00	
L. D. Smith, typewriting	7.50	
Rocky Mountain News, advertising	1.44	
Weekly Register Call, advertising	1.98	
Amount due on contract	1,400.00	
Balance in fund	4.08	
	$1,500.00	$1,500.00

GRAND COUNTY ROAD NO. 1 —GRANBY TO GRAND LAKE.

Senate Bill No. 43, chapter 99, Session Laws 1909, appropriated $2,610.00 for improving the wagon road between the towns of Granby and Grand Lake in Grand county.

The State Engineer and the Board of County Commissioners of Grand county constituted the Board of Construction.

The survey of route, plans and specifications were prepared by the State Engineer and proposals advertised for July 10, 1909. Only one bid was received. R. W. McQueary, of Grand county, proposed to complete the work for $2,575.00. This proposal was accepted and contract awarded. The contract was completed and accepted on October 21, 1909.

FINANCIAL STATEMENT.

Appropriated by State		$2,610.00
A. F. Hewitt, salary and expenses	$ 26.70	
C. O. Nuckolls, assistant	5.25	
Middle Park Times, advertising	1.21	
Rocky Mountain News, advertising	1.04	
R. W. McQueary, contract	2,575.00	
Balance turned back into Internal Improvement Fund	.80	
	$2,610.00	$2,610.00

GRAND COUNTY ROAD NO. 2 —WILLOW CREEK PASS.

Senate Bill No. 86, chapter 100, Session Laws 1909, appropriated $2,610.00 for improving the wagon road from Windy Gap in Grand county to the dividing line between Grand and Larimer counties at the summit of Willow Creek pass.

The State Engineer and the Board of County Commissioners of Grand county constituted the Board of Construction.

The survey was made and plans and specifications prepared by the State Engineer.

The work was advertised and bids requested for July 10, 1909. No bids were received at that time and R. W. McQueary was requested by the Board of Construction to submit a proposal. Mr. McQueary submitted a price of $2,500.00, which was accepted and contract awarded on October 13, 1909.

This contract was completed and the road accepted on September 20, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,610.00
A. F. Hewitt, salary and expenses	$ 63.60	
C. O. Nuckolls, assistant	4.50	
Middle Park Times, advertising	1.32	
Rocky Mountain News, advertising	1.12	
R. W. McQueary, contract	2,500.00	
Balance turned back into Internal Improvement Fund	39.46	
	$2,610.00	$2,610.00

GUNNISON COUNTY ROAD—ANTHRACITE CREEK.

House Bill No. 209, chapter 101, Session Laws 1909, appropriated $2,200.00 for the construction of a wagon road from the terminus of the wagon road already constructed down Anthracite creek towards its confluence with Coal creek in Gunnison county.

The work was done under the supervision of the State Engineer and the chairman of the Board of County Commissioners of Gunnison county.

House Bill No. 97, chapter 60, Session Laws 1903, appropriated $4,000.00 for this work and the road was constructed to Station 190; page 109, Fourteenth Biennial Report of the State Engineer.

Plans and specifications were prepared from the survey made under State Engineer Carpenter and work advertised.

Bids were received on October 16, 1909, as follows:

Bidder.	Stations.	Price.	Date to be Completed.
Frank Kunze	190 to 260	$2,000.00	Aug. 1, 1910
Kasper Pressler	190 to 270	$2,000.00	Aug. 1, 1910
Kasper Pressler	190 to 380	$2,000.00	Aug. 1, 1910

The bid submitted by Kasper Pressler from Station 190 to Station 380 was not based on the specifications prepared by the State Engineer, and was rejected. Contract was awarded Kasper Pressler for work between Stations 190 and 270 to conform to the specifications of the State Engineer.

On July 11, 1910, the contractor notified the State Engineer that he would complete his work by July 21, 1910. The road was inspected by O. L. Nelson from this office on August 10, 1910, and by the Board of Construction on September 28, 1910.

It was found that the road did not conform to the specifications and was not accepted. A partial payment, however, was made to contractor on November 28, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,200.00
A. F. Hewitt, salary and expenses	$ 9.75	
M. H. Griffith, typewriting	7.50	
News Champion, advertising	1.43	
O. L. Nelson, expenses	19.40	
Kasper Pressler, contract	1,500.00	
Amount due contractor	500.00	
Balance in fund	161.92	
	$2,200.00	$2,200.00

HINSDALE COUNTY ROAD—LAKE CITY TO CREEDE.

House Bill No. 202, Chapter 102, Session Laws 1909, appropriated $3,000.00 for the construction and repair of the State wagon road between Lake City in Hinsdale county, and Creede in Mineral county.

The State Engineer and the Boards of County Commissioners of Hinsdale and Mineral counties constituted the Board of Construction.

The survey of the proposed route was made by R. M. Taylor, County Surveyor of Hinsdale county. Plans and specifications were prepared by the State Engineer, and bids were advertised for and received on March 19, 1910, as follows:

Bidder.	Station.	Price.	Date to be Completed.
F. S. Williams and J. F. Swank	0 to 150	$2,700.00	Sept. 15, 1910
L. F. Chapman	Complete.	$3,250.00	Oct. 15, 1910

As the bid of L. F. Chapman was in excess of the State appropriation, and the counties were unwilling to appropriate any money from their funds, it was rejected and contract awarded to Williams and Swank. Contract was completed and work accepted October 12, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
A. F. Hewitt, salary and expenses	$ 16.25	
R. M. Taylor, surveying	259.50	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	1.20	
The Phonograph, advertising	4.95	
Creede Candle, advertising	4.95	
F. S. Williams and John F. Swank, contract	2,700.00	
Balance in fund	5.65	
	$3,000.00	$3,000.00

LAKE COUNTY ROAD—CRYSTAL LAKE TO EMPIRE GULCH.

House Bill No. 11, Chapter 103, Session Laws 1909, appropriated $3,800.00 for the construction of a State wagon road from Crystal Lake to the head of Empire gulch, in Lake county.

The State Engineer, the County Surveyor of Lake county and the chairman of the Board of County Commissioners of Lake county constituted the Board of Construction.

The survey of the route was made by the County Surveyor of Lake county. Plans and specifications were prepared by the State Engineer and work advertised for bids to be submitted on July 2, 1910. No bids were received at that time, but on August 13, 1910, the following bids were received:

Bidder.	Price.	Date to be completed.
Louis Solem	$3,300.00	August 15, 1911
Peter Connell	3.50 per ft.	No time stated.

As the road was 5,773 feet long, the bid of Solem was low, and contract was awarded him. This contract has not been completed on account of the weather.

FINANCIAL STATEMENT.

Appropriated by State		$3,800.00
Fred J. McNair, surveying	$ 162.00	
A. F. Hewitt, salary and expenses	42.90	
L. D. Smith, typewriting	7.50	
Herald Democrat, advertising	5.48	
Amount pledged by contract with Louis Solem	3,300.00	
Balance in fund	282.12	
	$3,800.00	$3,800.00

LARIMER COUNTY ROAD.

Senate Bill No. 247, Chapter 104, Session Laws 1909, appropriated $3,480.00 for the purpose of repairing the wagon road between the towns of Fort Collins and Loveland, in Larimer county.

The State Engineer and the Board of County Commissioners of Larimer county constituted the Board of Construction.

The County Commissioners and County Surveyor of Larimer county decided where repairs were most necessary, and the County Surveyor made the survey of the same.

Plans and specifications were prepared by the State Engineer, and work was advertised for July 23, 1910. The following bids were received:

Bidder.		Price.	Date to be Completed.
W. A. Tucker	Rock	$1.00 per cu. yd.	....
	Earth	.30 per cu. yd.	
James Ross	Rock	$ .90 per cu. yd.	
	Earth	.25 per cu. yd.	Dec. 1, 1910

The contract was awarded to James Ross, and the road is still in process of construction.

FINANCIAL STATEMENT.

Appropriated by State		$3,480.00
Rocky Mountain News, advertising	$ 2.20	
Fort Collins Review, advertising	4.40	
L. D. Smith, typewriting	7.50	
James Ross, partial payment on contract	368.50	
Balance in fund	3,097.40	
	$3,480.00	$3,480.00

MINERAL COUNTY ROAD AND FLUME.

House Bill No. 203, Chapter 105, Session Laws 1909, appropriated $4,500.00 for the construction of a road and to complete the building of a flume to carry the waters of Willow Creek in Mineral county along the route as fully described in Section 1, House Bill No. 160, of the Session Laws of 1907, on page 156.

The State Engineer, the chairman of the Board of County Commissioners of Mineral county, and the County Surveyor of Mineral county constituted the Board of Construction.

A portion of this work had been constructed by State Engineer Jaycox, under House Bill No. 160, Session Laws 1907, and is reported on page 117, Fourteenth Biennial Report of the State Engineer.

A survey of the work necessary to complete this road and flume was made by S. B. Collins, County Surveyor of Mineral county, and plans and specifications drawn by him and approved by the State Engineer.

The work was advertised for September 10, 1910, and bids were received as follows:

Sections.	M. H. Steele & M. H. Grafford	Z. J. Wilson.	W. S. Kennell & H. D. Barnhart.
1	$1,000.00	$561.00	$ 975.00
2	475.00	172.00	505.81
3	645.00	64.00	512.31
4	500.00	58.00	429.97
5	6.00 per ft.	838.00	1,377.50
6	1.75 per ft.	334.00	350.30 plank bottom.
6	No price.	314.00	358.00 log bottom.
Flooring.	1.85 per ft.	2.11 per ft.	1.85 per ft. plank.
Flooring.	No price.	1.81 per ft.	1.89 per ft. log.
Date of Completion	No date.	Dec. 31, 1910.	No date.

Contract was awarded to Z. J. Wilson, low bidder, who commenced construction work at once. The work was completed and accepted on November 30, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$4,500.00
Rocky Mountain News, advertising	$ 1.36	
Creede Candle, advertising	2.70	
Z. J. Wilson, partial payment on contract	1,059.20	
Balance in fund	3,436.74	
	$4,500.00	$4,500.00

MONTROSE COUNTY ROAD.

Senate Bill No. 296, chapter 103, Session Laws 1907, and page 122, Fourteenth Biennial Report of the State Engineer.

Napoleon Leap completed his contract and was paid the amount of his contract on August 24, 1909. At that time he was ordered to do some extra work under his contract to the amount of $53.00.

This extra work was completed and payment was made on September 8, 1909.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
Expended prior to December 1, 1908	$1,892.88	
Napoleon Leap, contract	1,050.00	
Napoleon Leap, extra work	53.00	
Balance in fund	4.12	
	$3,000.00	$3,000.00

MONTROSE COUNTY ROAD—MEXICAN GULCH.

House Bill No. 434, chapter 107, Session Laws 1909, appropriated $1,500.00 for the purpose of improving the public wagon road on Spring Creek Mesa at Mexican gulch in Montrose county.

The State Engineer and the chairman of the Board of County Commissioners of Montrose county constituted the Board of Construction. The survey of the route was made by the County Surveyor of Montrose county.

Plans and specifications were prepared by the State Engineer and work advertised. On April 30, 1910, the following bid was received:

Bidder	Price	Date to be Completed
Frank H. Hill	$5,500.00	40 days after commencement.

By a letter of June 25, 1910, Mr. Hill reduced his bid to $4,200.00.

As this amount was in excess of the State appropriation the following amounts were donated towards this work:

State Highway Commission	$ 700.00	
County Commissioners Montrose county	1,500.00	
Private citizens by Frank F. Frasier, trustee	500.00	
Total		$2,700.00

Some incidental expenses were incurred by the board of construction which reduced the State appropriation by $26.10, this amount being paid by the Board of County Commissioners in excess of their $1,500.00 appropriation.

The completed work was inspected on November 11, 1910, by the chairman of the Board of County Commissioners and the County Surveyor of Montrose county and accepted by the Board of Construction.

FINANCIAL STATEMENT.

Appropriated by State		$1,500.00
J. W. Johnson, salary and expenses	$ 16.20	
M. H. Griffith, typewriting	7.50	
Montrose Enterprise, advertising	2.40	
Frank H. Hill, contractor, partial payment	1,000.00	
Balance in fund	473.90	
	$1,500.00	$1,500.00

MONTROSE-SAN MIGUEL COUNTIES ROAD.

Senate Bill No. 325, chapter 118, Session Laws 1909, appropriated $3,480.00 for the purpose of constructing and repairing the public wagon road across Naturita canon in Montrose county to Cedar in San Miguel county.

The State Engineer and the Board of County Commissioners of Montrose county constituted the Board of Construction.

The survey of this road was made by M. J. Winter of Nucla, Colorado. Plans and specifications were prepared by the State Engineer. On September 25, 1909, bids were received as follows:

Bidder.	Price.	Date to be Completed.
G. W. Hamilton Uri Hotchkiss A. C. Guy and E. M. Schnur	$3,300.00	May 3, 1910
J. Meyer & Son	3,400.00	June 1, 1910

Contract was awarded to Messrs. Hamilton et al. and work was done under the supervision of Mr. Winter. Upon report by Mr. Winter, the work was accepted and final payment made to contractors on July 12, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,480.00
M. H. Griffith, typewriting	$ 7.50	
Montrose Enterprise, advertising	1.54	
Rocky Mountain News, advertising	1.20	
Western Empire, advertising	1.54	
G. W. Hamilton et al., contract	3,300.00	
Balance turned back into Internal Improvement Fund	168.22	
	$3,480.00	$3,480.00

MONTEZUMA COUNTY ROAD—MENEFEE SIDING TO RUSH'S BASIN.

House Bill No. 198, chapter 106, Session Laws 1909, appropriated $2,000.00 for the purpose of constructing and repairing a public wagon road from Menefee Siding on the Rio Grande Southern Railway to Rush's Basin at the head of the East Mancos river in Montezuma county.

The State Engineer and the chairman of the Board of County Commissioners of Montezuma county constituted the Board of Construction.

The survey of the proposed road was made by R. H. Toll. Plans and specifications were prepared by the State Engineer and work advertised. On September 11, 1909, the following bid was received:

Bidder.	Price.	Date to be Completed.
Fielding & Spencer	$4,000.00	Dec. 30, 1909

This bid was rejected as there was not enough money in the appropriation and Montezuma county could not appropriate the necessary amount.

On account of cold weather new bids were not requested until July 30, 1910, when the following bids were received:

Bidder.	Station.	Price.
J. B. Moore	0 to 118	$1,700.00
Leon Ashback	0 to 100	1,800.00
T. A. Fielding	0 to 109	1,800.00

The contract was awarded to J. B. Moore. The work was completed and accepted on November 28, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
A. F. Hewitt, salary and expenses	$ 8.10	
M. H. Griffith, typewriting	7.50	
R. H. Toll, surveying	127.00	
T. A. Fielding, surveying	7.50	
Rocky Mountain News, advertising	.96	
J. B. Moore, contract	1,700.00	
Balance in fund	148.94	
	$2,000.00	$2,000.00

MONTEZUMA-DOLORES COUNTIES ROAD.

Senate Bill No. 47, chapter 97, Session Laws 1907, and page 121, Fourteenth Biennial Report of the State Engineer.

C. W. Virden, contractor for the Montezuma county portion of this road, completed his contract and was paid in full on January 26, 1909.

Messrs. Treadway and Millard completed the Dolores river and Bear Creek bridges and final payment was made on September 15, 1909.

On March 20, 1909, the following bid was received for the construction of the Dolores county portion of this road:

Bidder	Price	Date to be Completed
J. W. Ridlen	$965.00	August 1, 1909.

Contract was awarded Ridlen, who completed his work and final payment was made on June 30, 1909.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
Expended prior to December 1, 1908	$ 61.02	
C. W. Virden, contract	980.00	
Rocky Mountain News, advertising	1.20	
Treadway and Millard, contract	990.68	
Rico Item, advertising	2.10	
J. W. Ridlen, contract	965.00	
	$3,000.00	$3,000.00

OTERO COUNTY ROAD—ROCKY FORD TO FOWLER.

Senate Bill No. 49, chapter 108, Session Laws 1909, appropriated $3,480.00 and House Bill No. 109, chapter 109, Session Laws 1909, appropriated $2,250.00 for the purpose of constructing and improving the State wagon road from the town of Rocky Ford to the town of Fowler in Otero county.

The State Engineer and the Board of County Commissioners of Otero county constituted the Board of Construction.

The survey of the road was made by Mark Denson, County Surveyor of Otero county. Plans and specifications were prepared by the State Engineer and work advertised. On July 16, 1910, bids were received as follows:

Bidder.	Price per Cu. Yd.	Date to be Completed.
W. H. Hackworth	11.5c	Dec. 1, 1910
A. M. McElroy	14.2c	....
W. A. Smith	13.6c	....
A. A. Brashear	15.25c	Oct. 15, 1910
L. C. Swink	11.5c	Dec. 1, 1910
McDowell Cons. Co.	15.0c	Oct. 1, 1910
Thomas Mishou	15.75c	Nov. 10, 1910

The bids of W. H. Hackworth and L. C. Swink were identical, but Mr. Hackworth asked to be allowed to withdraw his bid. This was granted and contract awarded to L. C. Swink. The construction work was done under the supervision of Mr. Denson. Work was completed and same accepted on November 30, 1910.

FINANCIAL STATEMENT.

Appropriated by State, Senate Bill No. 49, 1909		$3,480.00
Appropriated by State, House Bill No. 109, 1909		2,250.00
Rocky Mountain News, advertising	$ 2.30	
L. C. Swink, partial payment on contract	2,937.72	
Mark Denson, surveying	479.50	
Balance in fund	2,310.48	
	$5,730.00	$5,730.00

PUEBLO COUNTY ROAD NO. 1.

House Bill No. 556, chapter 113, Session Laws 1909, appropriated $2,000.00 for the purpose of repairing a road and bridge in Pueblo county near Rock Creek canon, extending north from the Arkansas river a distance of about three miles.

The State Engineer and the Board of County Commissioners of Pueblo county constituted the Board of Construction.

The survey of the road was made by C. C. Knight, County Surveyor of Pueblo county. Plans and specifications were prepared by the State Engineer. Work was advertised and bids were received on January 15, 1910, as follows:

Bidder.	Price.	Date to be Completed.
John Stamm	$1,900.00	June 1, 1910

Only one bid was received and contract was awarded to John Stamm. Work was completed and accepted on June 28, 1910, and final payment to contractor made on July 11, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
J. W. Johnson, salary and expenses	$ 18.95	
C. C. Knight, surveying	58.00	
M. H. Griffith, typewriting	7.50	
Pueblo Star-Journal, advertising	1.87	
John Stamm, contract	1,900.00	
Balance turned back into Internal Improvement Fund	13.68	
	$2,000.00	$2,000.00

PROWERS-BENT COUNTIES ROAD.

House Bill No. 292, chapter 111, Session Laws 1909, appropriated $3,750.00 for the purpose of improving a wagon road in Prowers and Bent counties, one-half of this amount to be expended in each county, provided the Boards of County Commissioners of these counties shall appropriate an amount sufficient to provide for the proper drainage of the work in their respective counties.

The State Engineer and the chairmen of the Boards of County Commissioners of Bent and Prowers counties constituted the Board of Construction.

The County Surveyor of each county made a survey of that portion of the road lying in his county. Plans and specifications were prepared by the State Engineer and work advertised. Bids were requested for November 27, 1909, but none were received. Bids were again requested for June 25, 1910. As the bids received on this later date did not conform to published request they were rejected and date for new bids set for August 27, 1910. Bids were then received as follows:

Bidder.	Bent County for $1,800.00.	Prowers County for $1,800.00.	Date to be Completed.
K. E. Banta	Station 0 to 500	....	Dec. 1, 1910
John C. Ford	....	Station 0 to 167	....
J. C. Inskeep	Station 0 to 464	....	Jan. 1, 1911

Separate contracts were made to K. E. Banta for the Bent county portion and to J. C. Ford for the Prowers county portion, each county paying for the necessary drainage on its respective portion of work.

On November 29, 1910, the Prowers county portion of the work was practically complete.

The Bent County portion of the work is incomplete and no payment has been made to contractor.

FINANCIAL STATEMENT.

Appropriated by State		$3,750.00
M. H. Griffith, typewriting	$ 7.50	
Lamar Sparks, advertising	4.53	
Geo. M. Post, inspector	15.05	
Balance in fund	3,722.92	
	$3,750.00	$3,750.00

PUEBLO COUNTY ROAD NO. 2.

House Bill No. 586, chapter 114, Session Laws 1909, appropriated $1,000.00 for the purpose of repairing a wagon road in Pueblo county near the town of Boone.

The State Engineer and the Board of County Commissioners of Pueblo county constituted the Board of Construction. The survey of this road was made by C. C. Knight, County Surveyor of Pueblo county. Plans and specifications were prepared by the State Engineer, work advertised, and on December 4, 1909, the following bid received:

Bidder.	Price.	Date to be Completed.
John Stamm	$925.00	May 1, 1910

Contract was awarded to John Stamm, who completed the work June 28, 1910, and final payment was made July 20, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$1,000.00
C. C. Knight, surveying	$ 49.05	
M. H. Griffith, typewriting	7.50	
Pueblo Star-Journal, advertising	1.76	
John Stamm, contract	925.00	
Balance turned back into Internal Improvement Fund	16.69	
	$1,000.00	$1,000.00

PITKIN-EAGLE-ROUTT COUNTIES ROAD—ASPEN TO YAMPA.

House Bill No. 442, chapter 91, Session Laws 1907, and page 135, Fourteenth Biennial Report of the State Engineer.

C. M. McGaughey, the contractor, completed his work, and same was accepted by the Board of Construction on September 14, 1910, and final payment was made on September 22, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
Expended prior to December 1, 1908	$ 74.57	
C. M. McGaughey, contract	1,850.00	
Balance turned back into Internal Improvement Fund	75.43	
	$2,000.00	$2,000.00

PITKIN COUNTY ROAD NO. 3—LINCOLN GULCH TO LAKE CREEK.

House Bill No. 65, chapter 105, Session Laws 1907, and page 127, Fourteenth Biennial Report of the State Engineer.

Work was advertised upon route surveyed by State Engineer Jaycox, and on October 2, 1909, bids were received as follows:

Bidder.	Stations.	Price.	Date to be Completed.
Louis Solem	93 to 200	$2,700.00	Oct. 1, 1910
W. P. Noble	0 to 40	2,700.00	Sept. 1, 1910

The contract was awarded to Louis Solem. The work was completed, accepted and final payment made on October 24, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
Expended prior to December 1, 1908	$ 66.74	
M. H. Griffith, typewriting	7.50	
Leadville Publishing Company, advertising	1.76	
Rocky Mountain News, advertising	1.28	
Louis Solem, contract	2,700.00	
M. Christman, expenses	30.00	
Balance in fund	192.72	
	$3,000.00	$3,000.00

PUEBLO-CUSTER COUNTIES ROAD.

Senate Bill No. 95, chapter 115, Session Laws 1909, appropriated $1,800.00 for repairing the Squirrel Creek road from near the town of Beulah in Pueblo county westerly along Squirrel creek into Custer county.

The State Engineer and the Boards of County Commissioners of Pueblo and Custer counties constituted the Board of Construction. The survey of the road was made by C. C. Knight, County Surveyor of Pueblo county, and his fee for services paid by the county commissioners as provided in the appropriation bill. Plans and specifications were prepared by the State Engineer and work was advertised and bids requested for April 30, 1910. As no bids were received the Board of Construction decided that the work in each county should be done under the supervision of the respective Boards of County Commissioners by day labor. The Board also decided that one-half of the appropriation should be spent in each county. The work on the Pueblo county portion was completed and payment made to Charles S. Glascoe, chairman of the Board of County Commissioners of Pueblo county, on November 19, 1910.

The Custer county portion was practically complete on November 30, 1910. Payment for Pueblo county portion was made on signed statements of expense made by the Boards of County Commissioners.

FINANCIAL STATEMENT.

Appropriated by State		$1,800.00
M. H. Griffith, typewriting	$ 7.50	
Wet Mountain Tribune, advertising	3.23	
Pueblo Star-Journal, advertising	3.99	
C. S. Glascoe, Ch. Bd. Co. Comms. Pueblo Co	900.00	
Balance in fund	885.28	
	$1,800.00	$1,800.00

SAN JUAN COUNTY ROAD—SILVERTON TO CREEDE.

House Bill No. 129, Chapter 117, Session Laws 1909, appropriated $3,750.00 for the purpose of improving and repairing the State wagon road between the town of Silverton in San Juan county, and the town of Creede in Mineral county, passing through the northern part of Hinsdale county.

The State Engineer and the chairmen of the Boards of County Commissioners of San Juan, Mineral and Hinsdale counties constituted the Board of Construction.

The survey to determine needed repairs was made by Mr. Finney Jones, County Surveyor of San Juan county. Plans and specifications were prepared by the State Engineer and work advertised. On March 19, 1910, bids were received as follows:

Bidder.	Price.	Date to be Completed.
Albert Z. Watson	$3,750.00	August 1, 1910.
J. V. Lorenzen	3,650.00	August 15, 1910.

Contract was awarded to J. V. Lorenzen, who completed the work, and same was accepted and payment made to contractor on August 11, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$3,750.00
A. F. Hewitt, salary and expenses	$ 19.00	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	1.54	
Creede Candle, advertising	5.25	
Phonograph, advertising	2.70	
Silverton Standard, advertising	6.00	
J. V. Lorenzen, contract	3,650.00	
Balance in fund	58.01	
	$3,750.00	$3,750.00

SAN MIGUEL COUNTY ROAD—OPHIR TO VANCE JUNCTION.

House Bill No. 505, Chapter 119, Session Laws 1909, appropriated $2,250.00 for the purpose of constructing and repairing a wagon road from Ophir Station, on the Rio Grande Southern Railroad, to Vance Junction, in San Miguel county.

The State Engineer and the chairman of the Board of County Commissioners of San Miguel county constituted the Board of Construction.

The road was surveyed by Ben W. Purdy, County Surveyor of San Miguel county. Plans and specifications were prepared by the State Engineer and work advertised. On February 26, 1910, bids were received as follows:

Bidder	Price.	Date to be Completed.
August Anderson— Upper Section entire and Lower Section, 0 to 28+73.7	$2,100.00	July 10, 1910.

Contract was awarded to August Anderson, who completed the work, and same was accepted on August 11, 1910. Final payment was made to contractor on August 26, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$2,250.00
A. F. Hewitt, salary and expenses	$ 19.00	
M. H. Griffith, typewriting	7.50	
Telluride Journal, advertising	2.66	
Rocky Mountain News, advertising	1.12	
San Miguel Examiner, advertising	2.10	
August Anderson, contract	2,100.00	
Ben W. Purdy, surveying	32.00	
Balance in fund	85.62	
	$2,250.00	$2,250.00

SAGUACHE COUNTY ROAD.

Senate Bill No. 250, Chapter 116, Session Laws 1909, appropriated $3,000.00 for the purpose of constructing and repairing the Gun Barrel Road, in Saguache county. The State Engineer and the chairman of the Board of County Commissioners of Saguache county constituted the Board of Construction.

The survey to determine needed repairs was made by A. H. Smith, County Surveyor of Saguache county. Plans and specifications were prepared by the State Engineer and work advertised. On January 15, 1910, bids were received as follows:

Bidder	Price.	Date to be Completed.
Lewis J. Chapman	$3,150.00	June 1, 1910
James J. Navins	3,600.00	Aug. 1, 1910 County to furnish all material and construct all bridges and culverts.
James J. Navins	2,700.00	Aug. 1, 1910 Sta. 0 to 317. County to furnish all material and construct all bridges and culverts.

As the lowest price was in excess of the State appropriation, the county of Saguache appropriated $300.00 for this work, and contract was awarded to Lewis J. Chapman.

The contractor completed his work, which was accepted on September 13, 1910. The county of Saguache paid the contractor $193.99.

FINANCIAL STATEMENT.

Appropriated by State		$3,000.00
A. F. Hewitt, salary and expenses	$ 11.75	
M. H. Griffith, typewriting	7.50	
Saguache Crescent, advertising	3.90	
Rocky Mountain News, advertising	1.54	
Lewis J. Chapman, contract	2,956.01	
O. L. Nelson, inspecting	19.30	
	$3,000.00	$3,000.00

YUMA COUNTY ROAD.

House Bill No. 227, Chapter 120, Session Laws 1909, appropriated $2,000.00 for the purpose of repairing a wagon road connecting the two divides on either side of the Arickaree river with the main road from Vernon to Idalia, in Yuma county.

The State Engineer and the chairman of the Board of County Commissioners of Yuma county constituted the Board of Construction.

The survey to determine needed repairs was made by the County Surveyor of Yuma county. Plans and specifications were prepared by the State Engineer and work advertised. Bids were received on November 13, 1909, as follows:

Bidder.	Price.	Date to be Completed.
William E. Jordan	$1,375.00	Dec. 30, 1909
Joseph A. Rolow	$1,400.00	Dec. 30, 1909

Contract was awarded to William E. Jordan. Mr. Jordan completed his contract, work was accepted on May 14, 1910, and payment made on May 21, 1910. Some more work being considered necessary, the Board of Construction made an order on Mr. Jordan to do said work, the agreed price being $262.00. This extra work has not yet been satisfactorily completed.

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
A. F. Hewitt, salary and expenses	$ 42.20	
Hendrie & Crenshaw, automobile hire	12.00	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	1.28	
Wray Gazette, advertising	3.04	
Wm. E. Jordan, contract	1,375.00	
W. J. Walsh, surveying	112.00	
Pledged to contractor for extra work	262.00	
Balance in fund	184.98	
	$2,000.00	$2,000.00

SANTA FE TRAIL.

Senate Bill No. 91, Chapter 70, Session Laws 1907, and page 76, Fourteenth Biennial Report of the State Engineer.

The following is an extract taken from the State Year Book of the Daughters of the American Revolution of Colorado, 1908-1909, by Mrs. John Campbell:

"Twenty-seven markers have been set with the funds furnished by the State, the Santa Fe Railroad, the Denver & Rio Grande Railroad, Trinidad, and many citizens along the route; other markers will be placed by Chapters.

"A stone marks the State line and Santa Fe Trail on the east; five miles away, at Holly Warm Springs, is a marker given by the Zebulon Pike Chapter, set under the supervision of Mr. W. M. Wiley. Another of this Chapter's stones is at Amity, set under the care of Colonel Thomas Holland, of the Salvation Army. Next come four stones, made by order of the conference and paid for from its funds in 1906, set in August, 1907, with the help of Otero county, State Treasurer Bent and L. Wirt Markham.

"A Zebulon Pike Chapter marker stands on the site of New Fort Bent, called Fort Lyon and Fort Wise. Two of the markers placed by the Zebulon Pike Chapter were donated by its Regent, Mrs. Frances W. Goddard. Westward, to a point near Las Animas, the State continued setting stones about five miles apart, leaving a place near the last-mentioned city for the Pueblo Chapter Marker. Old Fort Bent is to be marked by Mr. A. E. Reynolds, the present owner of the land on which it stood.

"King's Ferry, La Junta, is the location of the Arkansas Valley monument, a large one, bearing the Daughters of the American Revolution shield. Here the trail turns to the south, and the State stones, at regulation distances, mark the road to El Moro, where the Colorado Chapter unveiled its fine granite marker. The chief stone on the trail was unveiled at Trinidad. Leaving Trinidad, the trail begins to cross the mountains to Raton Pass. Markers are set at the usual distance, and one will mark the border of the State, when the United States Congress has decided where that is.

"Four stones have been set on the southern trail, which crosses the corner of the State in Baca county, near the Cimarron river."

FINANCIAL STATEMENT.

Appropriated by State		$2,000.00
Expended prior to December 1, 1908	$ 559.28	
Will R. Murphy, salary and expenses	167.23	
Terry Trujillo, livery	26.50	
Biscoe & Hewitt	55.00	
C. F. Bryner, photos of markers	2.00	
Denver Marble and Granite Company	307.20	
W. B. Wheaton, berth	5.00	
Colorado Telephone Company	1.20	
Bradford Publishing Company	18.00	
Clason Map Company	3.50	
Charles Bobenreith, setting markers	75.28	
La Junta Lumber Company	3.00	
Smith-Brooks Publishing Company	9.00	
C. H. Davis, setting markers	131.45	
M. F. Mickley, map	2.50	
Balance in fund	633.86	
	$2,000.00	$2,000.00

KIOWA COUNTY ARTESIAN WELL.

House Bill No. 23, Chapter 7, Session Laws 1909, appropriated $5,000.00 for the sinking of an artesian well at a point to be determined by the Board of Supervision in Kiowa county.

The State Engineer and the Board of County Commissioners of Kiowa county constituted the Board of Supervision.

The Board of Supervision located the well in the Northwest quarter of section 31, township 18 south, range 51 west of the sixth principal meridian, near Haswell, in Kiowa county.

Deed for this land was filed with the State Land Board. Specifications were prepared by the State Engineer, and bids requested for February 26, 1910. One bid was received, as follows:

Bidder.	Price.
A. M. Dillow	$10.04 per foot

This price was considered to be excessive, and was rejected by the Board of Supervision. After considerable delay, the Board of Supervision received a bid from E. R. Good, who agreed to drive and case the well for $5.00 per foot. Where casing is considered unnecessary, its cost is to be deducted from contract price.

Contract was awarded to Mr. Good, on the 16th day of November, 1910.

FINANCIAL STATEMENT.

Appropriated by State		$5,000.00
A. F. Hewitt, salary and expenses	$ 21.49	
M. H. Griffith, typewriting	7.50	
Pueblo Star-Journal, advertising	3.23	
Kiowa County Press, advertising	3.04	
Engineering—Contracting, advertising	13.80	
Balance in fund	4,950.94	
	$5,000.00	$5,000.00

MONTEZUMA COUNTY ARTESIAN WELL.

Senate Bill No. 44, Chapter 8, Session Laws 1909, appropriated $3,850.00 for sinking an artesian well at some point in township 35 north, range 16 west, New Mexico principal meridian, near the town of Cortez, in Montezuma county.

The State Engineer and the chairman of the Board of County Commissioners of Montezuma county constituted the Board of Supervision.

The well was located in the northeast quarter of section 18, township 35 north, range 16 west of the New Mexico principal meridian, and deed to land was filed with the State Board of Land Commissioners.

Specifications were prepared by the State Engineer and, bids requested for October 23, 1909. No bids were received. This well has been re-advertised twice, but only one bid has been received and that required a payment of $5,000.00 when machinery was landed at Cortez and could not be considered.

FINANCIAL STATEMENT.

Appropriated by State		$3,850.00
A. F. Hewitt, salary and expenses	$ 13.50	
M. H. Griffith, typewriting	7.50	
Rocky Mountain News, advertising	2.70	
Durango Democrat, advertising	2.09	
Mancos Times-Tribune, advertising	4.38	
Pueblo Star-Journal, advertising	1.54	
Engineering—Contracting, advertising	14.40	
Balance in fund	3,803.89	
	$3,850.00	$3,850.00

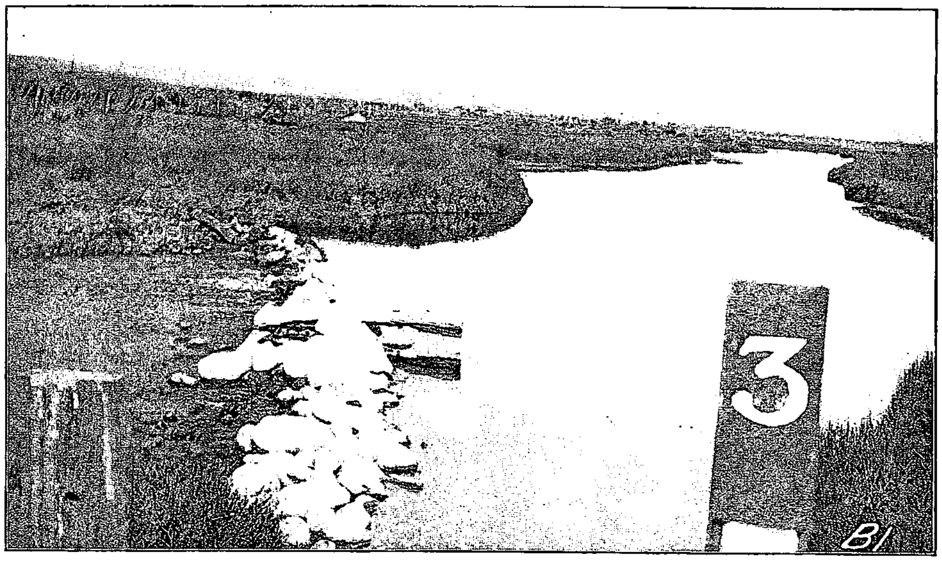
WALSENBURG DITCH.

House Bill No. 284, chapter 56, Session Laws 1907, and page 113, Fourteenth Biennial Report of the State Engineer.

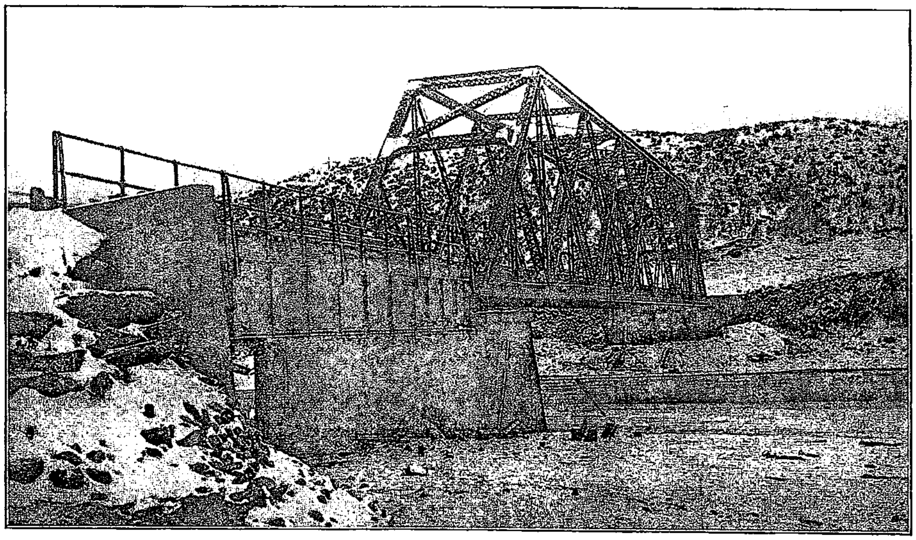
Contract was awarded Jones & Stewart of Walsenburg. The ditch was accepted and final payment made to contractors on September 17, 1909.

FINANCIAL STATEMENT.

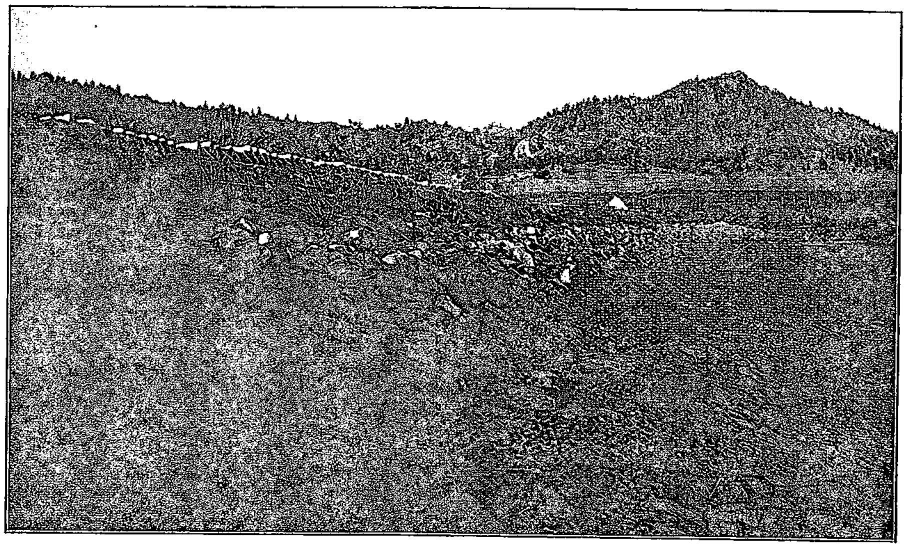
Appropriated by State		$2,000.00
Expended prior to December 1, 1908	$ 7.46	
J. W. Johnson, salary and expenses	16.00	
Jones & Stewart, contract	1,825.00	
Balance returned to Internal Improvement Fund	151.54	
	$2,000.00	$2,000.00



B1—Photograph taken July 11, 1910, showing stage of river, relative height of river bank, and diversion dam at the headgate of the Pierce Ditch. As shown by the reference number (3) this is a view at the same headgate that is shown in photograph A3.



BRIDGE ACROSS THE GRAND RIVER AT UNA, GARFIELD COUNTY.
208-foot truss span and 64-foot girder span.



LAKE LIDDERDALE.
Rip rap on inner face. August 22, 1909.

CHAPTER XII.

RUNNING RESERVOIR WATER IN NATURAL STREAMS.

Section 3203, Revised Statutes of Colorado, 1908, is as follows:

"The owners of any reservoir may conduct the water therefrom into and along any of the natural streams of the State, but not so as to raise the waters thereof above ordinary high water mark, and may take the same out again at any point desired, without regard to the prior rights of others to water from said stream; but due allowance shall be made for evaporation and seepage, the amount to be determined by the commissioners of irrigation of the district; or, if there are no such commissioners, then by the county commissioners of the county in which the water shall be taken out for use."

This section, it will be observed, provides for the determination of the allowance to be made for evaporation and seepage in these reservoir runs by the commissioners of irrigation of the district, or failing these, by the county commissioners of the county in which the water shall be taken out for use.

Section 3225, however, which was enacted at a later date and provides for an exchange of water between ditches and reservoirs, places the duty of determining this loss on the State Engineer's office.

For a number of years reservoir water has been run comparatively short distances in natural streams with only a nominal deduction for loss or none at all, but with no complaint of damage done to appropriators from the stream.

About the year 1896 the Twin Lakes reservoir was constructed above Granite, in Lake county. The water stored in this reservoir was intended to be used in the Bob Creek canal, whose headgate is about 18 miles below Pueblo. The water had thus to be conducted about 160 miles along the channel of the Arkansas river, but since the runs of water were quite large, varying from 300 to 500 cubic feet per second, the allowance to be made for loss became a very serious question, not only to the reservoir owners but to appropriators of water along the river. The determination of this loss was put in the hands of the State Engineer at that time. The office had neither funds nor facilities for making the necessary measurements and was unable to obtain a satisfactory solution of the problem. Mr. John E. Field, at that time State Engineer, succeeded, however, in effecting a compromise between the adverse interests and in securing an agreement of all parties concerned to an allowance of 10 per cent. for loss on runs from the Twin Lakes reservoir. This figure has been in use ever since. There are many people who believe it to have been the result of an actual investigation instead of a simple stipulation by the parties concerned.

When the Clear Creek reservoir of the Otero Irrigation District, near Granite, was completed in 1909, the same question was again presented, and since this reservoir is not far from Twin Lakes and both use the same portion of the channel of the Arkansas river for about the same distance, such runs as have been made from the Clear Creek reservoir have been made with a 10 per cent. allowance for loss. Water users along the Arkansas river have, however, become somewhat restless over this matter and show some disposition to object to the continuation of this arbitrary allowance. The appropriators from the river profess to believe that the allowance is insufficient. The reservoir owners claim that it is, if anything, too large.

It is a question of only a short time before there will be an actual revolt against the continuation of this practice, and a demand that the actual loss be determined by careful and systematic measurements. There is no question but that it is the duty of the State to do this. So far, however, neither funds nor assistance sufficient for this purpose have been provided in the State Engineer's office.

During the fall and winter of 1909 the Antero reservoir, which had then nearly completed the earth work of its dam on the South Fork of the South Platte above Hartsel in Park county, stored about 12,000 acre-feet of water. This water the owners wished to run through the channel of the South Platte river to the headgate of the High Line canal, a distance of about 75 miles. The first notification of their wish to make this run was received in this office the latter part of May, 1910, accompanied by the request that the State Engineer should fix the allowance to be made for loss. In the absence of any other basis for fixing this loss than the practice on the Arkansas river, they were advised that an allowance of 10 per cent. would be made.

The run was started from the Antero reservoir on June 2, 1910, and on June 3, the reservoir was discharging 217 cubic feet per second. The water commissioner of District No. 8, in which the headgate of the High Line canal is situated, was instructed to be on the lookout and to see that the water was turned into the High Line canal as soon as it reached the headgate. There was no doubt in the mind of anyone that the increase in the flow of the river would be immediately noticeable. It was not, however, until June 6th that there was any appreciable increase in the flow of the river at South Platte. From June 6th to June 7th the discharge of the South Fork of the South Platte at South Platte increased from 275 cubic feet per second to 400 cubic feet per second; from the 7th to the 8th it decreased to 340; from the 8th to the 9th to 315; from the 9th to the 10th to 295, increasing again to 315 on the 11th. This temporary increase of 125 cubic feet per second from the 6th to the 7th, followed immediately by a continuous decrease from the 7th to the 10th, was the only effect on the discharge of the South Fork of the South Platte at South Platte which could be traced to the run of Antero reservoir water. Had the High Line canal been permitted to take 195 cubic feet per second from the river at this time it would mean that the flow of the river at all points below would have been decreased by about that amount, and ditches which had been receiving water, and which were entitled to receive water, would have been deprived of it to that extent.

The Antero & Lost Park Reservoir Company were no less embarrassed than the State Engineer's office. However, their view as to the proper procedure differed from that of the State Engineer, and as an agreement could not be reached they applied to the District Court of Denver county for an injunction to restrain the water officers from interfering with the High Line headgate during the continuance of this run. The injunction was issued and at the final hearing the court settled the controversy over this particular run by issuing an order stating the rate of flow to be permitted into the headgate of the High Line canal and the number of days it should be allowed to continue. The order of the court was strictly adhered to, with the result of inflicting a loss of 26 per cent. on the reservoir company on this particular run.

The water discharged from the Antero reservoir during this run was subjected to a practically continuous measurement at four different points. The first was at the inlet to Cheesman lake from the South Fork of the South Platte where the Denver Union Water Company maintains a gauge and makes systematic readings; the second was over the spillway from Lake Cheesman where the Denver Union Water Company also maintains systematic readings; the third was on a staff gauge on the South Fork of the South Platte, just above the junction with the North Fork, where a station is maintained by the State and the United States Geological Survey in co-operation, and the staff gauge is read twice each day; the fourth is at a point a short distance below the junction of the two forks of the South Platte where the State maintains an automatic self-recording gauge.

A graphical record of the volume of water passing each of these stations is shown on the accompanying diagram covering the period from May 1, 1910, to June 11, 1910. In addition to these four records, the record of inflow to Lake Cheesman from Goose creek and the discharge of the North Fork of the South Platte at South Platte have been added. The total amount of water discharged from the Antero reservoir during this run was approximately 8,000 acre-feet. The run ended June 17, 1910.

A good deal of bitter personal feeling was engendered by the controversy over this run, and although the court settled this particular controversy nothing was thereby added to the general knowledge of the subject in question, and no basis was established for the control of future runs.

At this juncture the Attorney General suggested that the next run from the Antero reservoir should be supervised by a commission of which one member should be appointed by the Antero & Lost Park Reservoir Company, one member chosen by the water users on the South Platte whose interests would be affected if proper allowances were not made, and one member from the State Engineer's office.

There still remained in the Antero reservoir approximately 4,000 acre-feet of water which the company desired to run to the headgate of the High Line canal. Adopting the Attorney's General's suggestion, the Antero & Lost Park Reservoir Company chose its chief engineer, Mr. Geo. A. Starbird, to represent it on this commission; the ditch owners taking water from the Platte river chose Mr. Ben A. Johnson, Superintendent of the Farmer's High Line Canal in District No. 7, as its member, and the State Engineer's office appointed Mr. Geo. J. Lyon, professor of civil engineering at Colorado College, and sometime hydrographer of the United States Geological Survey.

The water remaining in the Antero reservoir was run down the river under the supervision of these gentlemen. The reports of Messrs. Lyon and Johnson are herein reproduced in full. Mr. Starbird, by direction of his company, withdrew from the commission while the report was in preparation, and the State Engineer's office was advised that the reservoir company would refuse to sign the report or to be bound in any way by its findings.

About the time the work of this commission commenced, ditch owners taking water from the South Fork of the South Platte and its tributaries in South Park, retained the services of Mr. A. J. McCune to represent their interests, and Mr. McCune accompanied the commission in the course of its field work and consulted with its members during the preparation of the report. Mr. McCune prepared a report to his clients covering this run, and by his courtesy this office has been furnished with a copy of it. It is herein reproduced in full.

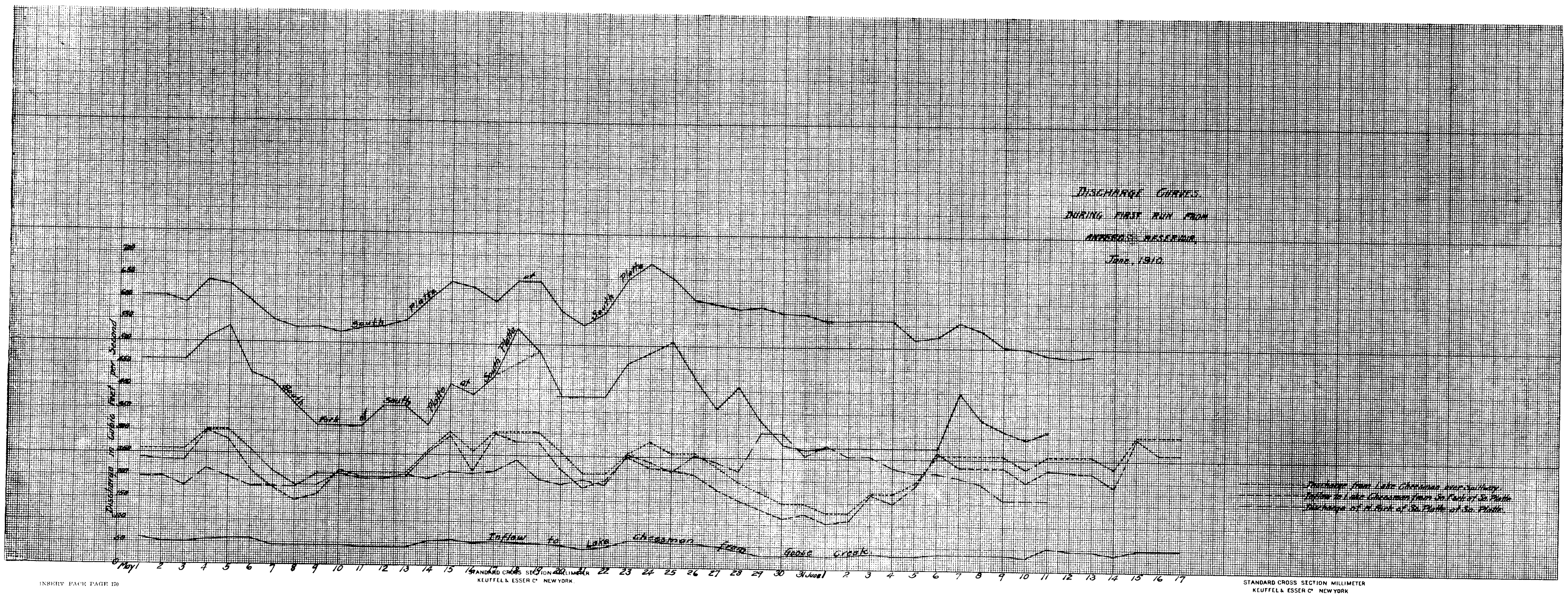
REPORT OF MR. GEORGE J. LYON ON A RUN OF WATER FROM THE ANTERO RESERVOIR TO THE HEADGATE OF THE HIGH LINE CANAL.

On July 1, 1910, a commission was appointed by the State Engineer for the purpose of supervising a run of water from the Antero Reservoir to the headgate of the English High Line canal. This commission consisted of Mr. George A. Starbird, representing the Antero and Lost Park Reservoir Company; Mr. Ben A. Johnson, representing Clear Creek Valley Protective Association, and Consolidated Ditches Association of the South Platte river, and Mr. George J. Lyon, Special Deputy State Engineer.

The commission was instructed to determine, by means of an examination in the field, as well as from consideration of existing records, the loss in transit from the Antero reservoir to the English High Line canal.

The Antero reservoir lies in South Park, about six miles above Hartsel, Colorado. The headgate of the English High Line canal is situated about nine miles below the station of South Platte.

The course of the water from the Antero reservoir is through the South Fork of South Platte river, in South Park, through Eleven-Mile canon and Lake George, and through Cheesman lake to South Platte, and thence through the South Platte river to the headgate, a total distance of seventy-five miles.



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From the reservoir to Eleven-Mile canon, through South Park, the river channel winds back and forth through the meadows. (See Photograph B-6). The distance, as the river flows, is about twenty-three miles, and the fall between these points is about forty-six feet.

The fall is more rapid through the Eleven-Mile canon to Lake George, the river dropping about 500 feet in seven miles.

Beyond Lake George the river flows again through a narrower valley, with some fall, for about four miles, where it enters a narrow canon. The course through the valley is reasonably straight.

After running about eighteen miles through this canon, the river enters Cheesman lake. Below Cheesman lake, the course is entirely within a canon as far as the headgate of High Line canal.

In addition to storage water from the Antero reservoir, the river receives the waters of the Middle Fork at a point about three miles below Hartsel; Twin creeks, at the upper end of Lake George; Tarryall creek, at a point about seven miles north of Lake George; Horse creek, at Decker's, and the North Fork at South Platte Station, on the Colorado & Southern railroad.

Cheesman lake receives the waters of Goose creek and of Turkey creek. Numerous springs also contribute water in this distance.

The river furnishes water to all ditches between Antero reservoir and Eleven-Mile canon. These ditches are as follows:

NAME OF DITCH	NO. OF PRIORITY	DATE OF APPROPRIATION	CU. FT. PER SEC. DECREED
Weed	42	May 1, 1875	20.00
Foster	66	July, 1876	42.00
Hot Springs	75	May 15, 1877	28.00
Main or Hotel	95	April 5, 1879	29.00
Rogers North	99	May 15, 1879	34.00
Rogers	114	May 10, 1880	42.74
Pierce	124	June, 1880	55.00
Love and Rayner	139	May 8, 1881	8.10
Rogers South	160	May 15, 1882	84.00
Harrington South	177	Sept. 15, 1882	43.00
Unidentified			

The determination of the loss in transit presents a very complex problem in itself. These difficulties were further complicated by the fact that the distances between controlling points along the stream from the view point of the problem in hand were considerable, and the country very difficult. The region covered by investigation was in part unknown to the commission. In order to become familiar with local conditions, the commission decided to first make a general reconnaissance.

Messrs. Johnson and Lyon arrived at Hartsel on the afternoon of July 10, and were met by representatives of the Antero Reservoir Company, Mr. Starbird arriving on the night train. These representatives called the attention of the commission to the fact that proceedings had been commenced in the District Court at Denver, before Judge Whitford, seeking to restrain all persons controlling ditches below the Antero Reservoir from interfering with the investigation. They also advised the commission that certain headgates were open unlawfully, and that their company would run no water from the reservoir until all ditches which were not entitled to water under the orders previously issued by the Irrigation Division Engineer were shut down. Photographs were then taken at the headgate of the Hotel ditch, and at the Hot Springs ditch. (See photographs A 1 and A 2.)

On July 11, the commission examined the headgates of several ditches, proceeding as far as Freshwater, on the Colorado Midland railroad.

The examination of headgates and ditches was continued on July 12. The condition of a number of the headgates is shown in photographs Nos. A 3, A 4, A 5, A 6, B 2, B 7.

The conditions shown in these views are typical. Of all the headgates visited none were arranged to effectively block the passage of water if any were flowing in the river. In some cases preparations were being made to divert into the ditches any water from the river that might come down; that is to say, the ditches, in the conditions shown, would have diverted any water released from the Antero reservoir. These ditches in general were shut down later by the Deputy Water Commissioner, on account of their inferior rights, and before any reservoir water was run. In a few cases a small head of water flowed in the ditches, owing to defective headgates. The quantity flowing was measured, and is taken account of in computing the loss in transit.

July 14 and 15 were spent in an attempt to reach Cheesman lake. The roads had been washed out a few days before so that Cheesman lake was not reached that day by the commission but an observer was sent forward to observe conditions at the lake.

Having made the reconnaissance it was decided to place observers at certain controlling points in order to make gaugings at times so chosen that the results would indicate fairly percentages of loss in transit. Observations were made accordingly at Colorado Midland R. R. Bridge No. 69B, just west of Hartsel and above the first diversion east of the reservoir; at a point above and also at one below Lake George; near the mouth of Tarryall creek and at the entrance to Cheesman lake. Observations were also made at South Platte station during the passage of water below Cheesman lake.

An occasional photograph was taken to show the relative elevation of the stream and the meadows before the reservoir water was turned out. Such are Nos. B1, B5, B6, B7. These views indicate that any attempt to make a run larger than the capacity of the channel would result in flooding the adjoining meadows and in excessive loss of water at least temporarily. During the run in question the water was maintained well within the channel with very few exceptions. For a short distance below the Antero reservoir where the channel is most tortuous, approximately 400 acres was flooded to the extent shown in photographs D5, C5, C6, C7.

On July 16, the discharge from the Antero reservoir read 0.65 ft. on the State Engineer's staff gauge in the rating flume. At 9:00 a. m. the reservoir gates were raised until the water in the flume stood at 1.20 ft. on the staff gauge, and a meter measurement was made showing a discharge of 163 second-feet. At noon the valves were raised still more until the staff gauge read 1.45 ft. with the intention of running approximately 230 second-feet.

At 8:00 a. m, this first water arrived at Bridge 69B, just above the first diversion. It was apparent that the quantity being discharged from the reservoir was more than the channel would accommodate.

It was decided by Mr. Starbird, on the morning of the 17th to reduce the discharge. Water in the flume was reduced to 1.30 ft. on the staff gauge, corresponding to 185 second-feet on the rating table. Thereafter, as long as enough head was available in the reservoir the gauge was maintained at 1.30 ft.

This quantity was carried by the channel with little flooding beyond the first three miles below Antero. This discharge was accumulated in Cheesman lake and later turned out in a large enough quantity to be useful to the High Line canal. The water was stored in Cheesman lake until July 28.

In order to secure the agreement of all members of the commission to the results of gaugings, a number of gaugings were made by all three members. This method seemed advisable in order to insure a feeling that all parties interested would receive fair treatment in the investigation. It soon became apparent that if the ground were to be properly covered the members must divide the work among them, and that hydrographers must be stationed at the controlling points continuously. Men were therefore stationed at such points. Good results were obtained for three consecutive days at the end of which time a succession of heavy rains introduced into the problem such decided uncertainties that the simultaneous gaugings were abandoned.

From the data obtained between Antero reservoir and Lake Cheesman two sets of computations were made.

In the first set percentages of loss were obtained for sections of the route having similar characteristics. These results are not included in this report.

In the second set the percentage of loss is based on the difference between the discharge from Antero reservoir and the flow into Lake Cheesman from the Platte river. These results are shown below.

	JULY 26	JULY 27	JULY 28
Discharged from Antero Reservoir, cu. ft. per sec	168.00	165.00	145.00
Contributed by Middle Fork, cu. ft. per sec	27.00	20.00	37.00
Contributed by ditches and springs, cu. ft. per sec	4.50	4.00	3.50
Contributed by Tarryall Creek, cu. ft. per sec	4.50	4.50	4.50
Total to be accounted for	204.00	193.50	190.00
Ditches en route were consuming	15.00	15.00	15.00
Entering Cheesman Lake, July 27, 28 and 29	151.00	146.00	161.00
Total to be accounted for	166.00	161.00	176.00
Loss, cu. ft. per sec	38.00	32.50	14.00
Loss, per cent	18.60	16.80	7.40

All of these results are of the same relative weight. We accept the average as the loss for this section, namely, 14.3 per cent.

In computing the results shown above an effort was made to use gaugings so arranged as to time that the gaugings represent measurements made at different points along the stream upon practically the same water.

In this connection it is the opinion of all members of the commission that, after uniform flow had been established in the channels, 185 second-feet would consume in transit from

Antero Reservoir to Hartsel	9 hours
Hartsel to Lake George	16 hours
Lake George to Cheesman Lake	12 hours
Cheesman Lake to South Platte	10 hours
South Platte to High Line headgate	5 hours
Total	52 hours

These computations of loss were made by Messrs. Lyon and Johnson owing to the inability of Mr. Starbird to be present. They were fortunate in having the advice of Mr. A. J. McCune, formerly State Engineer.

The data on which the results are based are consistent if meager, and the results represent the conditions fairly as far as the data go.

After these results had been obtained, the representative of the Antero Reservoir Company was instructed by his company to withdraw from the commission.

We believe that it is within the scope of this investigation to call attention to certain existing conditions.

With few exceptions it was most difficult to identify the headgates visited. We recommend that there should be displayed upon each headgate the number of the priority of the ditch or ditches served from it. It would be better if the name of the ditch as well as the number were displayed. This could be done at trifling cost. Much time would be saved in administering water rights.

By far the greater number of headgates visited were useless. These should be placed in a reasonable state of repair before another irrigation season.

In view of the increasing importance of irrigation along the Platte and especially in view of the fact that with the Antero reservoir running water annually, controversies will frequently arise, steps should be taken to determine accurately at the important controlling points the discharge of the Platte.

To accomplish this we recommend that gauging stations be maintained at these points. And it is our opinion that at these points concrete weirs should be constructed, and that careful readings should be taken in addition to having at each weir an automatic register that would show gauge heights at all times.

We find that the discharge from the Antero reservoir is not measured accurately as a simple function of the gauge height alone. Instead, the discharge varies with the height of water in the reservoir, the same reading on the staff gauge representing different discharges for different heights in the reservoir. This may be corrected in part by lengthening the flume and at the same time removing the cause of the pondage in front of the flume. We understand that the company contemplates straightening the channel below the dam. Such improvement would better the conditions of measuring at the flume.

Automatic registers should be installed at all of the inlet and outlet weirs at Cheesman lake and they should be carefully maintained.

The storage of the Antero Company's water at Cheesman lake was conducted by representatives of the Denver Union Water Company. Their method was as follows: The height of water in their reservoir was noted at the time the Antero water was supposed to arrive. The water level was also noted at the close of the run. There was then placed to the credit of the Antero company the volume of water represented by the difference of these water levels deducting what was supposed to be the average daily flow of the contributing streams. In this way the Antero Company gained any additional temporary flow that comes from the showers prevailing at the end of the run into Cheesman lake. No account was taken one way or the other of the evaporation from the surface of the lake.

Tables Nos. 1 to 13, inclusive, show the data resulting from this investigation and on which the computations were based.

TABLE I.

South Fork of South Platte River at Bridge 69B, Colorado Midland R. R.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 15	0.20	8.69	Weather clear.
July 22	1.63		
July 23	1.59		
July 24	1.58		
July 25	1.54		
July 26	1.49	142.76	At 7:00 p. m. weather clear.
July 27	1.50	159.50	Weather clear.
July 28	1.44	124.15	At 7:30 p. m. weather clear.
July 30	2.00	232.67	10:10 a. m. to 11:15 a. m. after rain.

A succession of heavy showers interfered with the proposed series of gaugings after July 28.

TABLE II.
Middle Fork of Little South Platte River.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 16	0.54	24.77	Weather clear.
July 17	0.67	47.59	9:00 a. m.
July 18	0.58	33.00	Measured by F. Cogswell in afternoon.
July 19	0.79	.....	9:00 a. m.
July 21	0.92	.....	4:00 p. m.
July 22	0.85	66.77	2:00 p. m.
July 23	0.76	62.42	9:15 a. m.
July 24	0.65	.....	.....
July 25	0.64	.....	.....
July 26	0.52	26.66	.....
July 27	0.52	20.41	.....
July 28	.....	37.18	9:45 a. m.
July 29	.....	.....	Heavy rain. Flooded.
July 30	.....	263.89	.....

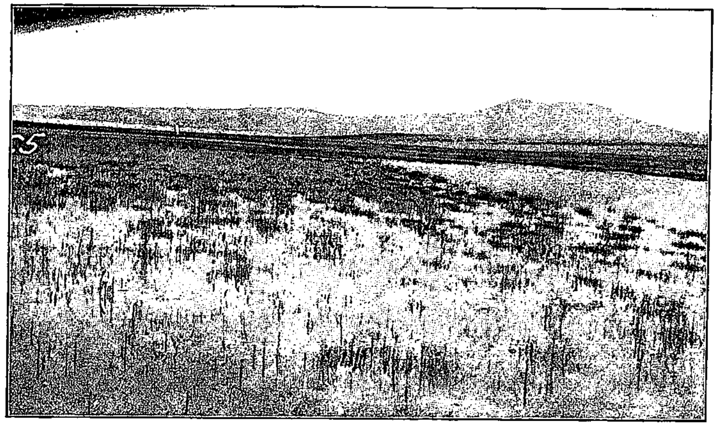
Rain after July 28.

TABLE III.
Twin Creeks Flowing into Lake George.

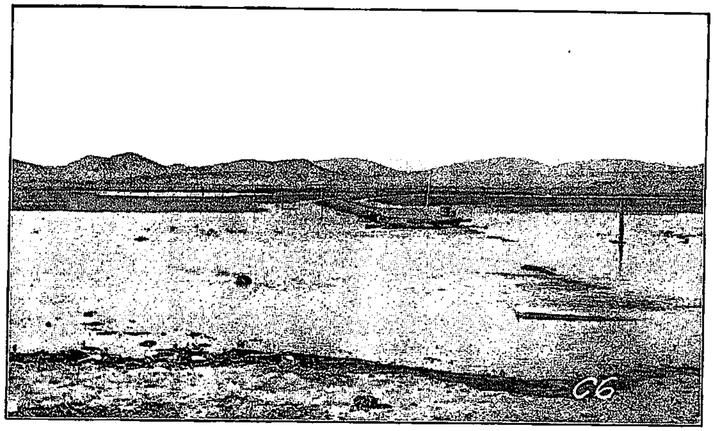
DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 21	0	1.93	Weather clear. This represents the normal flow during the period of the run up to the showers.
July 25	0.50	11.70	After a heavy shower.

TABLE IV.
South Fork of South Platte River Above Lake George.

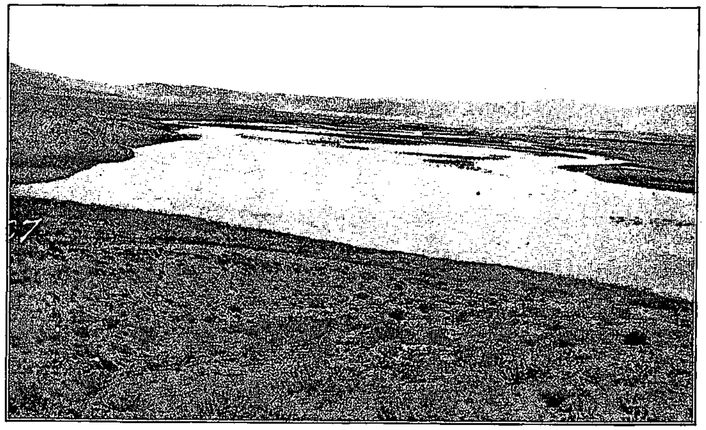
DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 17	.....	38.16	At Howbert 5:30 to 6 30 p. m. by Mr. A. J. McCune.
July 18	1.03	.....	.....
July 19	0.96	.....	Ra'n 5 30 p. m ; gauge stood at about 1 50 on night of July 19.
July 20	1.17	.....	Rain 6:00 p. m.; gauge stood at about 1.60 on night of July 20.
July 21	1.13	.....	.....
Ju y 23	1.10	.....	.....
July 24	1.08	.....	.....
Ju'y 25	1.02	211.45	.....
July 26	0.95	167.05	10:30 a. m. to 12 m.
July 27	0.90	146.99	.....
July 28	0.91	151.84	.....
July 29	1.78	.....	.....



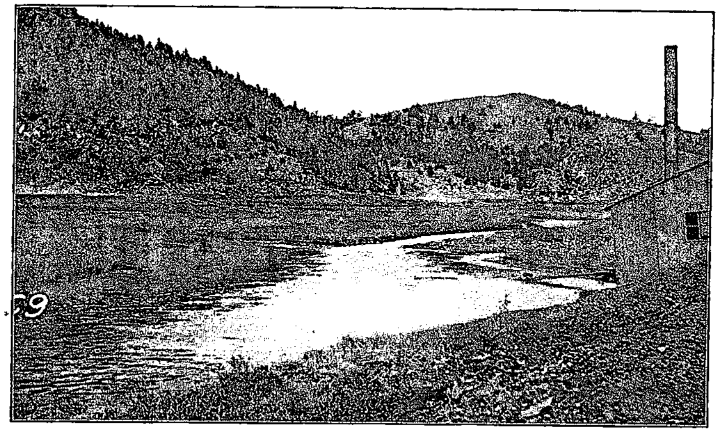
C5—Photograph taken July 17, 1910, showing meadows west of Antero road, near Antero bridge. These flooded meadows show a possible source of loss of the Antero water.



C6—Photograph taken July 17, 1910, showing flooded meadows downstream from Antero Dam and just south of Superintendent Cooper's house.



C7—Photograph taken July 17, 1910, showing South Platte about three miles east of Antero Reservoir.



C9—Photograph taken July, 1910, at the pump house at Hartsel, Colorado Midland R. R. Shows the relative level of water flowing in the channel of the Platte for a discharge of approximately 185 second feet from Antero Reservoir. This relative level was maintained during the run in order to avoid the excessive loss of water which would occur if the adjoining meadows were flooded.

TABLE V.

Elevation of Surface of Lake George Referred to a Point on Valve Frame of West Outlet Gate. All Elevations Are *Negative.*

DATE, 1910	ELEVATION	REMARKS
July 17	3.69	
July 18	3.55	
July 19	3.23	*Rain at 5:30 p. m.
July 20	3.17	*Rain at 6:30 p. m.
July 21	3.20	
July 23	3.60	
July 24	3.25	
July 25	3.34	
July 26	3.44	
July 27	3.50	
July 28	3.51	

*The outlet gates were opened by the owners to protect the dam against a possible overflow. Thus a variable flow was permitted to enter Cheesman Lake.

TABLE VI.

South Fork of South Platte River Below Lake George.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 17	0.19		
July 18	1.33		
July 19	1.56		Rain 5 30 p. m.
July 20	1.65		Rain 6:00 p. m.
July 21	1.72		
July 23	1.06		
July 24	1.33	194.62	
July 25	1.33	192.28	
July 26	1.29		
July 27	1.22	157.42	1:30 to 3:00 p. m.
July 28	1.21	157.55	2:45 to 4:00 p. m.

TABLE VII.

Tarryall Creek.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 21	1.00	8.66	2:30 p. m.
July 25	0.95	5.55	
July 27	0.83	4.44	

Measurements by Mr. A. J. McCune.

TABLE VIII.
Inflow to Lake Cheesman.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 16	0.57	14.30	11:15 a. m.
July 19	2.21	131.30	4:10 p. m. Water arrived between noon and 4:10 p. m.
July 20	2.64	258.80	2:55 p. m.
July 21	2.64	258.80	5:15 p. m.
July 22	.....	217.90	6:00 a. m. to 8:00 p. m. Mean discharge.
July 23	.....	183.90	6:00 a. m. to 8:00 p. m. Mean discharge.
July 24	.....	174.60	6:00 a. m. to 8:00 p. m. Mean discharge.
July 25	.....	161.80	6:00 a. m. to 8:00 p. m. Mean discharge.
July 26	.....	147.40	6:00 a. m. to 8:00 p. m. Mean discharge.
July 27	.....	132.50	6:00 a. m. to 8:00 p. m. Mean discharge.
July 28	.....	128.90	6:00 a. m. to 8:00 p. m. Heavy rains all night after 7:35 p. m.
July 29	.....	227.50	Rained hard all night.
July 30	.....	620.60	Showers all day.
July 31	.....	706.00	.....
Aug. 1	.....	566.00	Rained all day.
Aug. 2	.....	399.44	.....

TABLE IX.
Inlet Flume to Antero Reservoir.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 17	0.40	15.90	By Lyon, Johnson and Starbird.
July 18	0.50*	36.30	Gauge, 0.55; discharge, 40.0.
July 22	0.40	.....	.....
July 23	0.32	.....	.....
July 24	0.34	.....	.....
July 25	0.32	.....	.....
July 26	0.30	.....	.....
July 27	0.31	.....	.....
July 28	0.32	8.53	4:30 p. m.
July 29	0.39	14.70	8:30 a. m. to 9 00 a. m.
July 30	0.65	.....	Gauge in Lake, 4.50.
July 31	0.76	72.69	.....

*Mr. McCune, who made these measurements, read the depth of the water instead of the gauge height. This depth is equivalent to a gauge height of 0.55.

TABLE X.
Outlet Flume from Antero Reservoir.

DATE, 1910	GAUGE HEIGHT	DISCHARGE	REMARKS
July 17	1.30	185.00	
July 18	1.30	182.46	
July 19	1.30	185.00	
July 20	1.30	185.00	
July 21	1.30	185.00	
July 22	1.30	181.66	
July 23	1.30	178.33	
July 24	1.30	175.00	
July 25	1.30	171.66	
July 26	1.30	168.33	
July 27	1.30	165.12	
July 28	1.22	99.48	2:50 p. m.
July 29	1.21	72.03	6:00 a. m. Discharge 129.60 at 11:45 p. m.; 144.60 at 3:00 p. m.; 72.03 at 6:00 a. m.
July 30	1.35	126.67	
July 31		72.69	Last day of gauge reading.

TABLE XI.
Capacity of Antero Reservoir in Acre-Feet for Each Foot in Depth.

CONTOURS	ACRE-FEET	CONTOURS	ACRE-FEET
0– 1	55.	5– 6	559.
1– 2	116.	6– 7	673.
2– 3	194.	7– 8	790.
3– 4	297.	8– 9	998.
4– 5	431.	9–10	1227.

TABLE XII.
Gauge Heights at Antero Reservoir as Reported by Mr. Cooper to State Engineer's Office.

DATE, 1910	GAUGE HEIGHT	REMARKS
July 15	9.15	
July 16	9.10	
July 17	8.80	
July 18	8.50	
July 19	8.12	
July 20	7.75	
July 21	7.35	
July 22	6.90	
July 23	6.50	
July 24	6.00	
July 25	5.40	
July 26	4.85	
July 27	4.20	
July 28	3.40	
July 29	3.50	
July 30	4.70	At 10:00 a. m.; 4.50 at 8:00 p. m.

TABLE XII—Concluded.
Gauge Heights at Antero Reservoir as Reported by Mr. Cooper to State Engineer's Office.

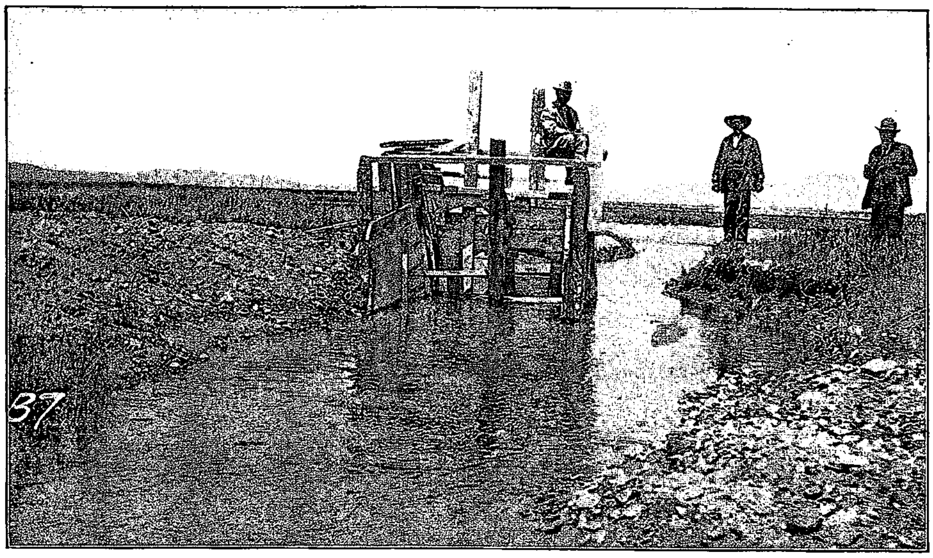
DATE, 1910	GAUGE HEIGHT	REMARKS
July 31	5.00	
Aug. 1	4.40	
Aug. 2	4.20	
Aug. 3	3.60	
Aug. 4	2.80	
Aug. 5	2.60	
Aug. 6	2.30	
Aug. 7	2.10	
Aug. 8	1.90	
Aug. 9	1.50	

TABLE XIII.
Water Drawn from Antero Reservoir in Cubic Feet Per Second Per 24 Hours.

DATE, 1910	CUBIC FEET PER SECOND	REMARKS
July 16	93	12 hours at 185.
July 17	185	
July 18	185	
July 19	185	
July 20	185	
July 21	185	
July 22	188	
July 23	178	
July 24	175	
July 25	172	
July 26	168	
July 27	165	
July 28	99	
July 29	113	130 for 3 hrs.; 145 for 6 hrs.; 72 for 6 hrs.; 127 for 9 hrs.
July 30	127	
July 31	73	
Aug. 1	208	
Aug. 2	208	
Aug. 3	208	
Aug. 4	192	
Aug. 5	185	
Aug. 6	174	Interpolated between 5th and 7th.
Aug. 7	163	
Aug. 8	163	
Aug. 9	163	
Total	4,124	Cu. ft. per sec. for 24 hrs.

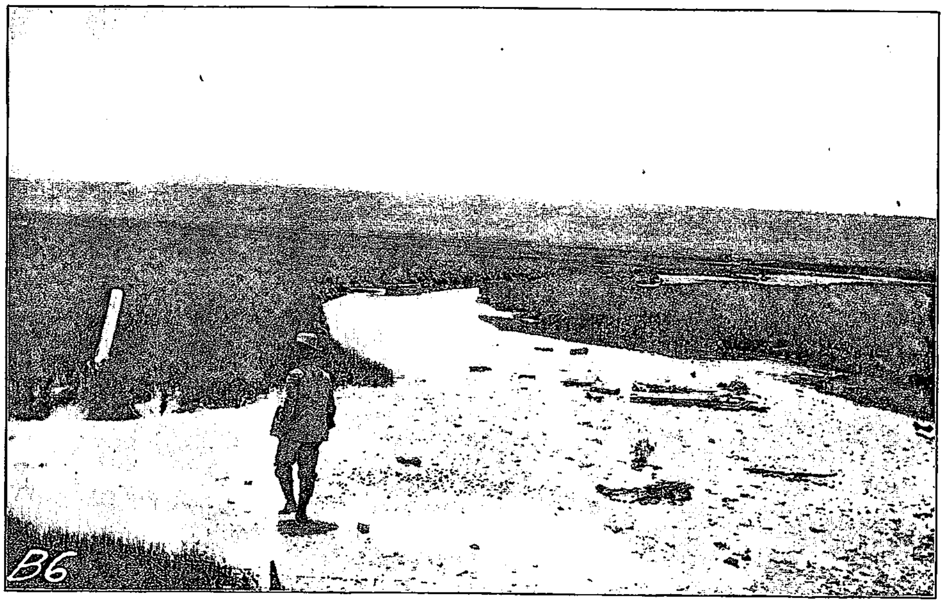
Respectfully submitted,
(Signed) GEORGE J. LYON,
Special Deputy State Engineer.

Denver, Colorado, October 20, 1910.



HEADGATE ON SPINNEY RANCH.

B7—Photograph taken July 12, 1910. Located about 800 feet south of Colorado Midland R. R. Bridge No. 60 A. This headgate was in very bad condition. There were no bottom boards. An open channel, 5 feet wide, alongside the headgate allowed any water in the stream to flow into the ditch up to the capacity of the ditch.



B6—Photograph taken July 12, 1910, from Bridge 60 A, Colorado Midland R. R., looking downstream. This view also shows the relative elevations of river and meadows.

REPORT OF MR. BEN A. JOHNSON ON A RUN OF WATER FROM THE ANTERO RESERVOIR TO THE HEADGATE OF THE HIGH LINE CANAL.

1. Committee composed of Prof. George J. Lyon, representing the State of Colorado; George A. Starbird, representing the Antero Reservoir Company; Ben A. Johnson, representing the Clear Creek Valley Protective Association, and the Consolidated Ditches Association.

2. Committee met at Antero reservoir, July 10, 1910.

3. I left Denver by automobile at 12 o'clock, July 9; traveled to Manitou Park the same day; stayed at Manitou Park night of July 9, starting out for Hartsel, Colo., on the morning of the 10th, having Messrs. Dehay and Hammen with me; these gentlemen were to help get records. Met Professor Lyon and Mr. Starbird the afternoon of July 10, at Hartsel.

4. The Antero Reservoir Company had notified us that they wished to start water from Antero reservoir on Tuesday morning, July 12, 1910, but when Mr. Starbird arrived, on the 10th, at Hartsel, he informed us that he would not have water turned out from Antero reservoir until the State officers had closed all the ditch headgates, from Hartsel, Colo., to Eleven-Mile canon. After calling up the State Engineer, by 'phone, and learning from him that the State did not intend to do this, Mr. Starbird got in communication with his company in Denver, and his company finally made some arrangements with the State Engineer, so that the commissioner of district No. 23, assisted by several deputies, started out to close the ditch headgates above spoken of. In the meantime, the Antero people had succeeded in getting an injunction from Judge Whitford's court, in Denver county, restraining the ditch owners, from the point at Hartsel to the head of Eleven-Mile canon, from interfering with the commissioner of district 23, or the investigating committee; but as so few of the ditches had any headgates at all, about three days were consumed trying to get the headgates closed, so as not to take any part of the Antero water when it was turned down the river.

5. The water was turned out of Antero reservoir on July 16, beginning at 9 a. m., and having 233 second-feet turned out at 12:30. Then the committee proceeded to take measurements at various places on South Platte river, to determine flow of same before the Antero water arrived at these various points.

6. We were very much handicapped in getting these measurements accurately, as Mr. Cogswell, Division Engineer, and Water Commissioner Wright were shutting down the various ditches on the Middle Fork of the Platte, and South Platte, which caused the river to fluctuate very much; consequently, we agreed among the members of the committee that men to keep gaugings at the mouth of the Middle Fork, at Lake George, and at Cheesman Reservoir inlet were necessary. Consequently, a Mr. Brown was stationed at Hartsel, and to read gauge at the mouth of the Middle Fork river. Mr. Dehay was stationed at Lake George, to read gauge there at inlet and outlet of Lake George, also at Tarryall Creek, which comes into the South Platte at four miles below Lake George; the committee proceeding together to make gaugings and put in gauge rods at these various places.

Committee went up the river from Hartsel to Antero reservoir, on the morning of July 17. The water was overflowing the banks on either side, causing water to be from one-fourth to one-half mile in width the entire distance from reservoir to Hartsel. So Mr. Starbird concluded that a smaller head of water would not overflow so much, and he ordered the water diminished to 185 second-feet from Antero reservoir. This amount still overflowed this portion of the river, causing the river to be anywhere from 200 to 600 feet wide.

The water reached Hartsel at 8:00 a. m., July 17, and reached Lake George about 8:00 a. m., July 18, and arrived at Cheesman lake about 3:00 p. m. on the same day.

It was decided and agreed to by all the members of the committee, that an accurate account of the water flowing into Lake Cheesman be kept, and that the Antero Reservoir Company be allowed to hold their water in said Cheesman lake for four or five days, which arrangement was satisfactory to The Denver Union Water Company. The committee desired this, as it would give us the opportunity to check up our data so as to have the total loss ascertained before the Antero people had run too much out from Lake Cheesman. But heavy rains set in the entire length of the Platte, several cloud bursts occurring—namely, one in Antero reservoir, and one near Lake George—so that the High Line ditch was entitled to a direct river run. The Antero Company ordered the amount of water due them shut off at Lake Cheesman, after they had only drawn 200 second-feet for a period of four days, from Lake Cheesman.

On account of the heavy rains setting in during the time water was still in transit, the data we had obtained previous to this time are incomplete, as naturally a great deal of water had been lost in South Park by reason of sub-irrigation of the meadows, and on account of raising the water level of the river. I expected some of it to return, or at least the loss to become less, as the meadows became thoroughly soaked, but the unprecedented heavy rains occurring made it impossible to record any such return.

We found, according to the best records we were able to get, a loss of 22 per cent. from Antero reservoir to Lake Cheesman, but after the run had been made of all the water from Lake Antero, Mr. G. R. Baker, representing Mr. A. J. McCune; Mr. Brown, representing Professor Lyon; Mr. Hammen, who had been stationed at Lake Cheesman inlet during the run from Antero, and myself, made a trip up the river as far as Lake Cheesman, for the purpose of getting more definite data on the loss from Lake Cheesman to the High Line. We found that the gauge rod at the Cheesman inlet had been incorrectly read, for the following reason: that the gauge rod is fastened to a log, dirt and rock filled crib on the north side of the weir, and evidently the freezing during the winter had heaved the same enough to raise the gauge one-tenth—thus, when the gauge rod would read 3.60, it should have been 3.70. This, of course, made a great change in the total loss from Antero to Cheesman. Correcting this, it changes the loss from 22 per cent to 12 per cent, and according to the best data we have from Lake Cheesman to High Line headgate, we find this loss to be 2½ per cent, or a total of 14½ per cent for entire distance, Antero outlet to High Line headgate. This amount may not be absolutely correct, but it is as near as it could be determined under the conditions which existed during this run.

I feel, and would respectfully recommend, that the investigation be continued another year, and perhaps a more favorable time be taken, so that heavy rains will not interfere with measurements, so that the loss we have found can be corroborated. I do not make this recommendation from a selfish standpoint, as I would hesitate to serve on a like committee again, as several unpleasant things happened. One instance I beg to mention, that Professor Lyon and myself were accused by the Antero Reservoir Company of being unfair; and another thing, from a financial standpoint. I furnished my auto for the use of this committee, and anyone who has traveled through the mountains along the Platte river knows what this kind of a trip does to an automobile. I covered 1,165 miles with it during this investigation.

While we were waiting for the Antero Company to get the ditches below their reservoir, and above Eleven-Mile canon shut off, we investigated the conditions of the ditches in other portions of the park, as to whether they were only drawing water that they were entitled to, according to the dates of their decrees, as at this time, namely, July 16, there were only two ditches in the park entitled to draw water, and this on account of an order issued by Division Engineer Cogswell to all water commissioners in districts 2, 7, 8, 9, and 23, to shut down all ditches whose decrees dated later than 1864; consequently, only two ditches were entitled to water, namely, the Beery ditch and Trout Creek ditch, but we found all ditches, regardless of dates of decrees, drawing water; and in most cases the headgates were set above the water, so if more water should come in the stream, they would get more. Nearly all ditches have a dam across the stream from which they draw their supply, so that when water is low, they can and do draw all that may come to their headgates.

From the condition of the headgates of the ditches on that portion of the South Platte river, from Antero reservoir to Eleven-mile canon, and from observation of the water marks on the meadows, and from information gathered from ditch owners on this portion of the river, I feel at liberty to state that 125 second-feet of water was taken by these ditches, during the previous run by the Antero Reservoir Company, and should have been deducted from their allowance at the head of the High Line; and these same ditches were prepared to do the same this run, but were prevented by the injunction I have spoken of.

We were joined by Mr. A. J. McCune, Mr. Powless and Mr. Link, representing the South Park Ditches Association, on July 20, and these gentlemen rendered valuable aid and information which enabled the committee to get along over the country more rapidly, Mr. A. J. McCune remaining with the committee the entire time, and, being the former State Engineer, I considered his advice as to the measurements and modes of taking them, very helpful to the committee.

For anyone not familiar with conditions on the South Platte river, from Antero reservoir to the High Line ditch, a distance of some seventy-five miles, I will say that I consider it a very hard matter for any committee to ascertain the loss by evaporation and seepage of the Antero reservoir water, for the following reasons:

The frequency of heavy rains on the small tributaries of the river.

The fluctuations of the stream itself on account of some fourteen ditches that may turn on water at any time.

The Platte river passing through Lake George and Lake Cheesman.

The rough country that must be traversed to get to the various places where gaugings must be kept. As an illustration, I will give the following: The distance along the river from Lake George to Lake Cheesman is only some eighteen miles, but to get from one point to another, a distance of fifty-five miles must be traveled, starting from Lake George and going to Florissant, to Divide, to Woodland Park, to Manitou Park, to Pemberton, to Decker's, to Lake Cheesman.

I would recommend the following:

That a man, under the direction and control of the State Engineer's office, be stationed at reservoir to keep accurate measurements of all water coming into Lake Antero, during non-storage season. I make this recommendation for the following reason: The Antero Company was only taking measurements of the main channel of the South Platte. There is also a vast amount of water flowing into said reservoir from numerous springs, and also from return water from the meadows north and west of Antero reservoir. This, alone, amounted to 20 second-feet at the time when the committee was there, but the Antero Company only discharges the amount coming in from the main channel of the river, which was only 8 second-feet at this time. I think they should turn out all water running into the reservoir from all sources, the same as if the reservoir were not constructed.

A more careful account kept at inlet to Lake Cheesman, from the South Platte and Goose creek. The gauge at these points should be taken at least twice each day, and the amount flowing in, plus the evaporation of Lake Cheesman, turned out of same.

That the measuring flume at Antero outlet be reconstructed, so as to record the true amount of water flowing through the same at the different stages of height of water in reservoir. I make this last recommendation for the following reason: 185 second-feet flowing through the flume requires a depth of 1.3, but as it receded in the reservoir, the velocity of the water became less, and as the channel below the measuring weir is not deep or wide enough, the back water held the depth the same, 1.3, when there was only 122 second-feet flowing through the flume.

I feel that the committee is indebted to the Denver Union Water Company for the hospitality accorded, and the willingness of its officers in giving the committee any and all information desired; also, for transportation from one point to another on Lake Cheesman.

Committee found, by actual measurements taken at the various stations from Antero outlet to Cheesman lake, the following:

1. Committee determined that the amount discharging from Antero reservoir at this time, July 27, 1910, namely, 165.12 second-feet, required 52 hours in transit to Cheesman lake.

	S. ft.	
July 27, 1910, 8:30 a. m., discharge from Antero reservoir	165.12	
July 27, 1910, 12:00 m., contributed by Middle Fork	20.41	
July 27, 1910, 3:00 p. m., contributed by ditches and springs	7.00	
July 28, 1910, 8:00 a. m., contributed by Twin Creeks	1.96	
July 28, 1910, 6:00 p. m., contributed by Tarryall Creek	4.44	
Total		198.93
July 29, 1910, 12:30 a. m., measurement at South Platte Cheesman inlet	174.06	
Loss		24.87

Showing a loss of 24.87 s. ft. or 12.5%.

	S. ft.	
Sept. 1, 1910, 7:00 a. m., discharge at Cheesman	89.50	
Sept. 1, 1910, contributed by Wigwam Creek	3.84	
Sept. 1, 1910, contributed by Saw Mill Creek	0.75	
Sept. 1, 1910, contributed by Horse Creek	9.60	
Sept. 1, 1910, c ntributed by two springs between Horse Creek and South Platte station	0.75	
Total		104.44
	S. ft.	
Sept. 1, 1910, 5:00 p. m., measurement at South Platte station showed	121.15	

Or a gain of 16.71 s. ft. between Lake Cheesman outlet and South Platte station.

	S. ft.	
Sept. 2, 1910, measurement South Fork at South Platte station showed	121.15	
Sept. 2, 1910, measurement North Fork at South Platte station showed	62.90	
Total		184.05

Discharge from river below South Platte station:	S. ft.	
Sept. 2, 1910, discharge into D. U. Water Co.'s pipe line	8.00	
Sept. 2, 1910, discharge into High Line Ditch	41.57	
Sept. 2, 1910, passing by High Line in river	129.72	
Total		179.29

Showing a loss of 4.76 s. ft. or 2.5%. Making a total loss of 15.0% from Antero Reservoir to head-gate of High Line Ditch.

Respectfully submitted,
(Signed) BEN A. JOHNSON,

Denver, Colorado, October 20, 1910.

REPORT OF MR. A. J. M'CUNE ON A RUN OF WATER FROM THE ANTERO RESERVOIR TO THE HEADGATE OF THE HIGH LINE CANAL.

Mr. Charles E. Wilkin, Attorney at Law, Fairplay, Colorado.

Dear Sir:—I beg leave to submit the following report of my investigation of the water conditions on the South Fork of the South Platte river, as related to the use of water for irrigation:

On July 16, 1910, you engaged me to represent your clients, the South Park Ditch Association, in the running of water from the Antero reservoir to the intake of the High Line canal, and to determine the loss in transmission.

A commission had been appointed to superintend the running of this water, comprising one representative from the State Engineer's office, one from the Antero Reservoir Company, and one from the water users of the South Platte near Denver. Professor Lyon, of the State Engineer's office, G. A. Starbird, of the Antero Reservoir Company, and Ben A. Johnson, of the Clear Creek Valley Protective Association and the Consolidated Ditches Association, constituted the commission.

On July 17, I took the Midland train for Hartsel, arriving there at 4:20 p. m., and was met by Mr. C. P. Link and Mr. W. H. Powless, C. E., representing the South Park Association, who were to accompany me. It was learned that water had already been started from Antero reservoir on the 16th, at 12:30 p. m. We proceeded at once down the river, desiring to get a gauging of the stream at the lower end of the park, and before it had been influenced any by the water from the reservoir.

This measurement was taken just above the wagon bridge, on the county road, near Howbert. We found a good channel and other conditions favorable for an accurate measurement. The gauging was taken between 5 o'clock and 6 o'clock p. m., and the discharge was found to be 38.76 second-feet. We returned to Hartsel for the night.

Monday morning, the 18th, between 7 o'clock and 8 o'clock, we measured Middle Fork, near the Hartsel ranch house, at the station established by Professor Lyon and party, and found the discharge to be 47.59 second-feet.

We then proceeded up the valley, the first object being to determine the flow into Antero reservoir. At the rating flume, on the main stream above the reservoir, between 11:30 a. m. and 12:30 p. m., the discharge was found to be 36.30 second-feet. This rating flume is a concrete structure, and was built by the Antero Reservoir Company.

We also measured four spring branches which enter the reservoir northeasterly from the rating flume. These measurements were taken where the South Park railroad crosses them, and their combined discharge was found to be about 7 second-feet, making the total discharge into the reservoir on that date 43.30 second-feet.

We then went down to the Antero dam and measured the discharge from the reservoir. Our measurements indicated a flow of 182.46 second-feet. The water stood at 1.3 on the gauge rod. The table prepared by the Division Engineer, Mr. Cogswell, gave a discharge of 185 second-feet. Considering the fact that our facilities for gauging were not the best, our measurement was a very close check, being a difference of only 1-1/3 per cent. This measurement was taken between 3 o'clock and 4 o'clock p. m. The dam was in charge of Mr. Cooper, representing the Antero Company. It appearing that there was no check upon the readings made by him, and as it was impossible for one man to look after it as closely as the conditions seemed to demand, it was suggested by Mr. Link that the Association put a man on to check the readings of the gauge, and note any other conditions as they might arise. This was objected to by the Antero Company, but, after some conference over the 'phone with yourself and the manager of the company, it was agreed that a man be placed there under certain restrictions.

It was learned that Professor Lyon and Mr. Johnson had proceeded down the river towards Cheesman lake in advance of the reservoir water, establishing gauging stations and making measurements of the river and side streams. It appeared that the river would have to be divided into two divisions, viz., from Antero reservoir to Cheesman, and from Cheesman to the High Line canal, and that principal gauging stations ought to be at Lake George, Cheesman Lake and South Platte (junction of the North and South Forks). It was known that gauging stations had been maintained at South Platte for a number of years by the State, and that daily readings were kept. We could, therefore, expect to get good results of the discharge at that point. It was presumed, also, that a good record of the inflow and outflow at Cheesman lake would be kept at all times, and also it was expected that the water commissioner of district No. 8 would keep a record of the amount of water taken into the head of the High Line canal. It was soon decided that, with the limited force and time at the command of our party, we could not expect to get results that would be of much value, and, after consultation with Messrs. Link and Powless, it was decided to proceed at once down the river and join Professor Lyon and party, and, if agreeable to the commission, we would co-operate with them. We learned that they were working toward Cheesman lake. We passed Lake George about 6:30 p. m., and found the river rising from the reservoir water. Professor Lyon had established a station below the lake, and stationed an assistant there to read the gauge. We spent the night at Woodland Park, and July 19 took breakfast at Manitou Park, where we met Professor Lyon, and learned that the other members of the commission had gone to Denver, but would meet him that day at Decker Springs, some ten miles below Cheesman dam. We reached Decker Springs at 12:15 p. m., and Mr. Link communicated with the State Engineer, as a result of which Professor Lyon was instructed to co-operate with us and furnish me with what data they procured, the same as if I were a member of the commission. From this date I was consulted on all the work done by the commission. In the evening the other two members arrived, and a conference was held to plan future operations. It was decided that the whole party proceed to Cheesman dam and look over the situation. Professor Lyon had stationed an assistant there several days before to observe the gaugings on the weirs.

July 20 we reached Cheesman lake in the forenoon, and took the dimensions of the measuring weir below the outlet; and in the afternoon Mr. Thornburg, who has charge of the property, took us in his launch to the South Platte and Goose creek inlets. On our return from Goose creek, a heavy rainstorm was encountered, wetting the whole party to the skin. The conditions at Cheesman lake will be discussed later on in this report. We remained over night at the dam.

July 21st we drove to Decker's for breakfast. The Antero Company secured permission to hold the water coming down from their reservoir in Cheesman lake a few days before sending it down to their canal, as they were not quite ready to use it. After consultation, it was decided to return up the river and make some more gaugings. On the way up Starbird, Powless and I gauged Tarryall creek and found 8.66 second-feet. Mr. Link, Mr. Powless and I stayed over night at Fairplay, where Mr. Powless had to leave us on account of other business. On the headwaters of nearly all the streams there were local showers on this day.

July 22nd. Mr. Link and I returned to Hartsel, where we met the rest of the party. At 2 o'clock p. m. I gauged Middle fork at Hartsel Ranch Station. At 3 p. m. measured the Hotel ditch and held a conference with others of the party, and at 4:30 p. m. took the train for Denver.

July 25th most of the day was spent at the State Engineer's Office, the Water Company's office and the Antero Reservoir Company's office arranging for future work. It was agreed that we would return to South Park and get some more measurements on the stream from Lake George up.

July 26th I took the train at nine a. m. for Hartsel, accompanied by two members of the commission. Prof. Lyon joined us at Florissant. At 5:00 p. m. I gauged Middle fork at Hartsel ranch, assisted by Mr. Starbird. Lyon and Johnson spent the evening making up a table of gaugings.

July 27th. After a conference, it was agreed that Mr. Starbird and I should proceed to Cheesman lake and determine definitely conditions there, while Lyon and Johnson should gather what data were available from stations at Lake George and other points. I spent the forenoon working up notes and wiring and phoning to Denver to arrange for our trip to Cheesman lake. Lyon and Johnson worked on notes and at 3:00 p. m. all members of the party gauged the river above bridge 69 and took the train for Denver, reaching there at 1 o'clock a. m., July 28th. At 8:15 a. m. Starbird and I took the train for Cheesman lake via Buffalo. We reached the lake at five o'clock p. m., just ahead of a heavy rainstorm. Previous rains had filled the reservoir about six feet and water had been running over spillway. We went to the South Platte intake and got the records from the men stationed there by Prof. Lyon to take the readings. On our return to Buffalo a heavy rainstorm was encountered, washing out a large part of the road and bridges between Wellington lake and Buffalo, and making the trip very difficult. At Buffalo we found the railroad track washed out, delaying the trains and compelling us to remain over night.

July 30th. We reached Denver about nine o'clock a. m. These heavy rains swelled the river to as much as 1,500 second-feet, enabling all the ditches to draw water for some days. Consequently the Antero Company desired to hold the water stored in Cheesman lake until the flood waters subsided; therefore, further field work was temporarily suspended.

August 2nd I met the commission for the purpose of working up the results of our field work, but as some of the data had not been reported in by Prof. Lyon's assistants the commission adjourned.

August 9th. Prof. Lyon and Mr. Johnson met with me in my office to continue the work of compiling the data obtained on the river from the Antero reservoir to Cheesman lake. The Antero Reservoir Company had previously notified the State Engineer that they would take no further part in the work of the commission and would not be bound by any of its conclusions; consequently, Mr. Starbird's work on the same was ended.

August 26th Mr. Johnson notified me that he would be ready to begin field work on the river from Lake Cheesman to the High Line canal on Tuesday, August 30th. As it was not possible for me to go, I employed Mr. G. R. Baker, a competent civil and irrigation engineer, to take my place. The party consisted of Ben A. Johnson, Mr. Baker, Mr. Brown—representing Prof. Lyon, who was compelled to go East to begin his year's work—and Mr. Hammen, who had been stationed at Lake Cheesman during the run of water from Antero reservoir. Three days were consumed in this work. Gaugings were made on this trip at South Platte intake to Cheesman and below Cheesman at Wigwam creek, Saw Mill creek, South Platte above Decker's, Horse creek at Decker's, North and South Forks of river at South Platte, at the Denver Union Water Company's pipe line, High Line canal and on river below the High Line.

RESULTS.

Preliminary to the figures given, I wish to say that the results obtained from all the work and money expended are very unsatisfactory. A large number of gaugings were made and a series of readings were kept by three assistants, extending over a period from July 16th to August 9th; yet, on account of frequent heavy rains and the consequent fluctuations of all the streams and unfavorable conditions of the measuring stations, the tables of gaugings are quite conflicting.

Water was turned out of Antero reservoir at 12:30 p. m., July 16th, and, according to report of Mr. Hammen, reached Lake Cheesman at 4 o'clock p. m., the 18th, a period of 52 hours. After the river and Lake George were filled up, it took about 24 hours from Antero to Cheesman, according to Prof. Lyon's notes. We can take the tables and get all sorts of results. I have taken a date at which appear to be the most stable conditions and get the following result from Antero reservoir to Lake Cheesman:

July 27th:	Discharge from Antero	165.12	
	Contributed by Middle Fork	20.41	
	From springs and ditches	7.00	
	Twin creeks	1.96	
	Tarryall creek	4.44	
	Total inflow	198.93	sec. ft.
July 28th:	The gauge at the South Platte intake of Lake Cheesman stood all day from 6 a. m. at 2.30 indicating a discharge of	173.00	sec. ft.
	Making the loss	25.93	sec. ft.
	Or a fraction over 13 per cent.		

I will say that before Prof. Lyon left we made one table showing the loss between Antero and Cheesman to be 22 per cent., but Mr. Johnson, on his last trip to Lake Cheesman, discovered that the gauge rod had been incorrectly read. When this correction was made it reduced the loss to 12 per cent according to his calculations, and to 13 per cent according to mine.

Below Lake Cheesman a peculiar condition was discovered. The amount of water discharging from the lake on September 1st, according to their gauge, was 89.5 sec. ft. The only surface streams entering the river between there and Decker's are Wigwam creek and Saw Mill creek, which were discharging on that date 3.84 and 0.75 sec. ft., respectively, making a total of 94.09 sec. ft. entering the channel above Decker's; whereas, a gauge of the river just above Decker's showed a discharge of 110.76 sec. ft., an actual gain of 16.67 sec. ft. in about ten miles. This can only be accounted for by concluding either that the measurement is wrong at the Cheesman outlet or that there are some subterranean crevices that are discharging from the lake at some point below the outlet. The same condition existed, I presume, at our first visit to the dam, for on the afternoon of July 19th, while waiting at Decker's for Prof. Lyon's party to arrive, Mr. Link, Mr. Powless and I gauged the river at the same point and found a discharge of 112.80 sec. ft. The next day the manager of the dam said he was discharging less than one hundred feet. The only other tributary between this point and the junction of the North Fork is Horse creek, which on September 1st showed a discharge of 9.6 sec. ft. This 9.6 plus 110.80 gives 120.4 sec. ft., which should be the discharge at its junction with the North Fork, less whatever loss there might be; but a gauging at that station gave a discharge of 121.15 sec. ft., an actual gain of 0.75 feet. It is possible there are some sub-surface springs between those two points, or a slight error in gauging of less than 1 per cent. would make up for it. On this date the North Fork was discharging 62.9 sec. ft.

September 2nd the Denver Water Company's intake, the High Line canal and the river below the High Line were gauged and gave a discharge of 8.0, 41.57 and 129.72 sec. ft., respectively. The only table I can present on this division of the stream is as follows:

	Sec. Ft.	Sec. Ft.
Discharge of South Fork at South Platte	121.15	
Discharge of North Fork	62.90	
Total flow		184.05
Discharge into Denver Water Company's pipe line	8.00	
Discharge into High Line canal	41.57	
Discharge of river below High Line	129.72	
		179.29
Total loss		4.76

Or a little more than 2.5 per cent, which, added to 13 per cent from Antero to Cheesman, makes a total of 15.5 per cent from Antero to the High Line canal.

RECOMMENDATIONS.

As I have already stated, the results of this investigation are very unsatisfactory, but I do not know what better could have been done in the time given and under the conditions. Barring some little disagreement with the Antero reservoir people, the commission worked in unison, and conscientiously, to get at the actual facts. The most of the actual gauging was done by the three members of the commission, or myself; but the assistants employed by them were also experienced in stream gauging. The facts are that no one in interest, I believe, quite realized the magnitude of the work undertaken; or rather, that to arrive at results that may be relied upon as permanent, investigations should be made during the whole season, and in fact for several seasons. I therefore recommend that an effort be made to have the following things done.

1st. A thorough system of gauging of the ditches and of the South Fork and its tributaries during the irrigating season at least, and that this be kept up for several seasons.

2d. The building of several permanent rating stations at points that will best serve the needs, and also of good rating flumes and headgates in all the ditches. Engineering is considered by the layman an exact science, and the Engineer is put in an unpleasant position when sent out to get exact results, and after spending a lot of time and money, is able to report only a guess as to results.

3d. That a more careful and accurate account be kept of the flow into and from the Antero reservoir and Lake Cheesman, or other reservoirs, if any are built along the South Platte.

Concerning the carrying out of the above recommendations I have the following remarks to make: The unsatisfactory results of the work of this Commission emphasize the importance of having more thorough ditch and stream measurements extending over a series of years. In this case, after we were well under way with our measurements, heavy rains over different portions of the territory covered disarranged all our figures, and we were not prepared, nor had we time to repeat the operations this season. I am aware that the farmers look upon the expense of such work as a needless burden, but when trouble comes they are always willing to raise money to protect their rights. A question is never properly settled until it is settled rightly, and to settle these water problems such data are needed. As land and water are rapidly advancing in value, the farmers can well afford to have the work done. I am not in favor of multiplying public offices or of putting any unnecessary authority into the hands of State officials, but since all water-users of any one drainage are affected, to avoid duplication the work should be under the supervision of the State Engineer, or some person agreed upon by all the parties in interest. If this method of doing the work cannot be brought about, I suggest that your Association could procure a very large amount of data for about $1,200 per season. Your Association would not need the services of a high-priced man, except perhaps a few days in a consulting capacity. I think two competent gaugers could be procured, who with the use of motorcycles would cover the whole of your territory, from the upper ditches to the head of Eleven-Mile canon. These men ought to be procured for $150 per month, including expenses, say for four months, beginning the last of April and extending into August. The rating flumes for the ditches could be put in under their supervision by the farmers themselves, and the expense would be very light.

Concerning the permanent rating stations on the streams, if such were built, and Bristol self-registering machines installed, accurate record of the discharge could be obtained at a small cost. The State Engineer with the meager funds at his command is doing a large amount of work, but the territory he has to cover is too large to get results close enough upon which to settle controversies of a serious nature.

Concerning the accounting of the water entering and leaving the reservoirs: At the Antero the Commission found about twenty second-feet more water entering the lake than was going, and this at a time when there was a shortage for ditches below. At Lake Cheesman, the Commission believe that the inflow and outflow have not been correctly reported to the State Engineer's office. I think the supervision of the running of water into and out of all large reservoirs that are built on running streams should be in charge of a disinterested officer.

I join Mr. Johnson in stating that the Commission and myself were always courteously treated by the officers of the Denver Union Water Company, and we are indebted to them for hospitality accorded and their willingness at all times to furnish information desired, and for transportation to different points on Lake Cheesman.

Respectfully submitted,

Denver, Colorado, October 20, 1910. (Signed) A. J. McCUNE.

It will be observed that each of these reports urges the necessity for further and more elaborate investigations covering several seasons, so that the effects of all possible variations in conditions may be determined. In this recommendation the State Engineer heartily concurs.

The assumption, upon which previous practice has been based, that the loss is a constant percentage of the volume discharged from the reservoir is not only gratuitous, but probably erroneous. The percentage of loss will undoubtedly vary not only with the absolute volume discharged, but with the relation of this volume to the normal discharge of the stream, and with the stage of the stream itself. Many minor causes will probably affect the solution of the problem also, but if the effect of each of the three principal variables can be determined within reasonable limits a practical solution will have been reached.

In connection with the running of reservoir water in natural streams there is a second problem, much less generally recognized, but hardly less important than the question of loss. This is the determination of the form of the wave front. It is important to know how the discharge of the stream at the point of diversion of the reservoir water varies with the time, in order that the reservoir water may be diverted in proper amount at all times without, however, interfering with the distribution of the water belonging to the stream to the ditches entitled to it.

Even in a uniform channel the flood wave created by a reservoir discharge is rapidly attenuated, and this effect may be greatly magnified by the passage of the wave through large reservoirs en route. If diversion of reservoir water in excess of the increase over the normal flow is permitted, the distribution of the river water will be seriously disturbed. If, on the contrary, the diversion is less than the increase over the normal flow, the reservoir owner loses some water which he should rightfully receive. A doubt must always be resolved against the reservoir, since the condition upon which the use of a public stream for private purposes is permitted is that the rights of others must not thereby be injured.

The law authorizing this use of the channels of public streams imposes the restriction that "the waters thereof shall not be raised above ordinary high water mark." This perfectly proper provision is clearly intended for the protection of riparian owners. However, it complicates the administration of reservoir runs, somewhat, since it not infrequently happens that moderately high water on the upper reaches of the stream occurs at a time when the stream farther down is so low as to make a reservoir run desirable.

From these considerations, as well as from the facts brought out by the reports herein reproduced, it is evident that the problems connected with running reservoir water in natural streams are by no means as simple as has been generally supposed. Not only on the South Platte and its tributaries, but on the Arkansas, elaborate and detailed investigations are desirable, not to say necessary. It is believed that the series of automatic recording gauges now installed on the Arkansas will throw a good deal of light on the question, but it is probable that studies of greater refinement will be necessary. Water from the Twin Lakes and Clear Creek reservoirs must pass five recording gauges. Water from the Antero reservoir at the present time passes only one. It is hoped that at least four such gauges will be in position to record Antero water before the summer of 1911 is past.

CHAPTER XIII.

PRELIMINARY REPORT ON THE HYDROGRAPHY OF THE YAMPA BASIN,

BY

CHARLES L. CHATFIELD, HYDROGRAPHER, STATE ENGINEER'S OFFICE.

FOREWORD.

The following report is the result of a superficial examination of the basin, and is therefore preliminary, considering only its prominent features:

GENERAL.

The Yampa or Bear river and tributaries drain an area rudely rectangular of about 8,000 square miles, 125 miles long and 75 miles in width at extremes, lying mostly in Routt county, in the northwestern corner of Colorado. It forms a part of the Colorado Drainage. A portion of the headwaters of the Little Snake, a tributary from the north, lies just over the boundary in Wyoming.

Rising in that portion of the White River Plateau, known as the Flattops, in southeastern Routt county, the Yampa flows in a northerly direction for about fifty miles to Steamboat Springs, where the course changes abruptly to generally due west for 170 miles, by the stream, and 115 miles in a straight line to the Colorado-Utah line, a little ways over which it joins the Green river.

For the major portion of its course, from the head to State line, the Yampa river flows through a succession of broad valleys and deep, narrow canons, the largest and deepest of which the Yampa last enters in the lower end of Routt county, and through which it flows until its confluence with the Green. This canon appears to be a fissure running longitudinally through a range of mountains. These valleys are sub-divided into bottom lands, first and second mesas, the so-called bottom lands being up to two or three miles in width, while the total width, including mesas, is sometimes ten or twelve miles. A village is generally located in each of these valleys. In this manner Yampa is located near the head, on the river's northward sweep; Steamboat Springs at the point of flexure, and Hayden, Craig and Maybell on the westward sweep, Maybell being only about fifty miles in a straight line from the Colorado-Utah line.

Elk River Basin is a broad fertile valley up to about twenty miles above its mouth, being, however, almost bisected by a cross range of mountains.

Williams river flows through a narrow valley, all through its length being enclosed by precipitous walls of sand-stone and lime rock.

Principal tributaries to the Yampa are the Elk river from the northeastern portion of upper Basin, Williams river from the south, and Fortification creek, Elk Head creek and Little Snake river from the northeast and north.

TOPOGRAPHY.

At the head of the Yampa proper the ranges lie in a huge arch shape, the springing point on the north being the Elk Head mountains, and on the south the Flattops. On the east and northeast are the Gore and Park ranges.

Gore range forming southeast catchment area rises gradually to within two or three miles of the divide, when it rises abruptly in outcrops of metamorphic rocks to a general elevation of 10,000 feet, with four or five peaks from 10,200 to 10,800 feet in elevation.

The Park range, immediately joining to Gore on the north, is of the same character for some distance, but gradually becomes more rough and broken until it culminates in one of the most rugged and jagged and absolutely barren ranges in the Rockies, called the Sawtooth range, which lies at the head of the Elk river. This barren condition terminates in Hahn's peak, of an elevation of 10,906 feet. From that point on west through Elk Head mountains, the topography becomes less rough until only a few escarpments appear, and the maximum elevation is 10,000 feet.

On the south are the aforementioned Flattops, so named on account of their appearance. For miles the eye encounters rolling, grassy uplands, broken here and there by patches of timber below an elevation 11,000 feet. They have a general elevation of 11,500 feet, with peaks here and there over 12,000 feet in elevation. Dome peak is one of this group, towering to elevation of 12,498 feet. From the rim of this mesa on almost all sides erosion has caused a sheer drop in places of 800 feet, at the foot of which lie numerous lakes from a fraction of an acre to two or three thousand acres.

A curious feature of erosive action is the "Devil's Causeway," forming the dividing line between Williams river and head of the Yampa. The Flattops are in two principal areas connected by this dike of volcanic rock about 1,000 feet long converging at the center until it is only three or four feet wide, with a sheer drop of almost 1,000 feet.

From the Flattops west as on the north from Hahn's peak the range becomes less and less rough in character and lower, finally developing into a low range of rolling sandy, cedar and pinon covered hills and the much eroded Yampa plateau, whose features are principally broad terraces, deep, sandy arroyos and rocky escarpments, extending to the Colorado-Utah line. The principal streams fall in the manner shown in Table I.

GENERAL GEOLOGY.

Metamorphic rocks form the major portion of the Park and Gore ranges and also the upper Elk river area.

The Flattops and Elk Head mountains are eruptive rocks.

The remaining portion of the basin above Craig and a small portion through Axial basin or Milk creek is Cretaceous, with the exception of Fortification and Lower Elk Head basin and on the Yampa in the vicinity of Craig. This area is Post Cretaceous. Fortification and Elk Head creeks, principally Elk Head creek, show a marked loss of flow upon entering the Post Cretaceous area. The geological formation in Yampa basin and sub-basin above Craig apparently has very little deteriorating effect on runoff, although Elk river, whose upper area is principally metamorphic, is very prolific.

The lower Little Snake and lower Yampa, between Craig and Cross mountain, are entirely Tertiary. When any visible runoff occurs in this section except in the main streams it is from an excessive rainfall. This and also the entire disappearance of surface water in Little Snake river at various points when there is considerable at Dixon, Wyoming, is due to the very sandy character of the soil.

North slope of Escalante hills extending to Utah line, taking in the famous Ladore Canon of Green river is Silurian, while Cross Mt., Juniper Mt. and Yampa basin below Little Snake are Carboniferous.

Summarily it might be said that the formation above Williams river except Fortification and Lower Elk Head is not such that it should reduce runoff below average for altitude of area, forestation and topography.

NATURAL AND ARTIFICIAL STORAGE.

Although at various points along the headwaters are found lakes, they are for the most part small and of little consequence. Most of them lie at the base of the Flattops escarpment and vary from a fraction of an acre in area up to a thousand or so. The largest of these are the Lost lakes, at the head of Williams Fork.

A number of large reservoir sites are scattered over the Yampa basin. The ones of value are to be utilized by the irrigation companies planning developments; none yet, however, have been constructed. The most important are the reservoirs on Fish creek, Elk Head creek, Fortification creek, Slater Fork and on the Yampa at Juniper and Cross mountains, varying from a capacity of 30,000 to 400,000 acre feet or over. This latter at one time interested the Reclamation Service.

FORESTATION.

Following the more prolific water-shed or the arch of mountain catchment area is a distinct line of forestation. The acreage, character and density of forestation varies in the various basins from artificial as well as natural reasons.

All timbered areas of consequence are included in the Routt and White River National Forests. However, in lower Routt county on the Escalante hills there is an area of about 12 square miles of pine forest. It is small for the most part and knotty and not very well suited for lumber.

The forests consist mainly of lodge pole pine, spruce, Douglas and Alpine fir, also an area of considerable extent on which a growth of young forests of pines and quakenasps is growing.

On the ranges at the crest above timber line the barren, rocky productive watershed is first encountered; below this come the heavy forests dotted here and there with parks; below this belt are generally the young forests and still lower come the chaparral and sage-brush. This condition generally holds true.

Outside of reserves on lower divides the covering is cedar, pinon and juniper, while below these areas sage-brush land is found.

PRECIPITATION DATA.

Precipitation records of some duration have been secured at various points over Routt county but no records at a considerable elevation had been taken until 1909. On account of the absence of data of such character and the lack of continuous runoff data, it is impossible to obtain an accurate relationship between these data. However, all precipitation data of value are submitted in the following tables. Table III.

In addition to the rainfall data a record of snowfall depths during winter months has been obtained by the U. S. Weather Bureau and this is given in Table IV, submitted below.

IRRIGATION.

A number of large projects still in the embryonic stages plan to irrigate roundly 500,000 acres in Routt county. It is possible that others may be developed or the existing ones enlarged to cover a number of thousand acres in addition, as there are thousands of acres of excellent land capable of producing crops if it were possible to secure water for application.

Small grains can be grown successfully during a normal year without irrigation in portions of the upper basin, but the farther down the river the more sandy the soil, making the growing of a crop without irrigation speculative.

At the present time there are assessed in Routt county, which includes a portion of the Upper Little Snake and the Green River basins—the latter being located in the extreme northwestern corner of Routt county—43,320 acres of irrigated land, most of which lies along the main water courses. Some, however, is upland and derives its supply from small streams that augment the flow of the larger ones on all sides. There are also 16,784 acres of dry farm land and 225,027 acres of grazing land.

RUNOFF DATA.

The inception of records in the Yampa basin, outsideof some miscellaneous measurements, was on the Yampa at Craig in 1901 by the U. S. Geological Survey.

Table V is a list of all regular stations in this district.

A reference to the runoff data, Table VI, of the basin discloses the fact that the Elk River basin has not only the greatest runoff per square mile, but also the greatest runoff depth in inches, a mean total of which for four years' record, for the months May to October, inclusive, is almost 14 inches, while the nearest approach to this efficiency is the Yampa at Steamboat, with a mean total runoff depth in inches for the same period of about 12 inches.

The Elk, although it has a catchment area of about 72.5 per cent of the Yampa at Steamboat, has a runoff about 10 per cent greater. This may be accounted for in two or three ways. The more rugged character of the basin, less percentage of forestation on its upper part allowing more perfect drifting into gulches and ravines, a greater precipitation, less irrigation and for the most part greater fall to the mile. It may seem strange, but Steamboat Springs, 30 miles north of Yampa, nearer the Elk, at a lower elevation has an annual precipitation much in excess of the latter place.

Considering the Elk within itself, the stream at Kinney's ranch, 25 miles above the mouth and having an elevation 225 feet higher or 6875 feet above sea level, has about 50 per cent of the catchment area and carries 70 per cent of the total runoff of the basin.

These runoff data give a greater runoff depth in inches at Steamboat than at Yampa above. This might be explained by existence of the considerable area of Egeria park, Five Pine mesa, and also other park and mesa lands much of which is not very prolific, referring to runoff, and upon which small grains and hay are grown, necessitating the heavy use of water for irrigation. Above Yampa there is 30% more forested area than above Steamboat, thereby possibly increasing the loss by evaporation.

The Yampa at Craig and Williams river at Hamilton (mouth) compare very favorably as to runoff depth in inches, each having an average total for months April to October, inclusive, of about 7 inches. This does not mean that their runoff in acre-feet is the same, as the Yampa has an area about 5 times as great and also a total runoff of about the same relation.

An approximate estimate of the relation between rainfall and runoff in the Yampa Basin at the mouth of Williams river including that stream is 30%.

Illustrating how non-prolific that portion of the basin between mouth of Williams river and Maybell is the fall in average runoff depth in inches between those points. Above Williams river, as before stated, it amounted to about 7 inches for months April to October, inclusive, while at Maybell it is scarcely 4 inches.

The drainage area above the Pyramid station on Williams river comprises about 28% of the whole basin, while it contributes about 55% of the runoff, making it 50% more efficient than the remaining portion of the basin. The amphitheater-like arrangement at the headwaters is responsible for the efficiency.

Only a portion of a year's record was obtained on the Little Snake river at mouth near Maybell, but even this will show that the runoff over the basin is excessively low. Even at Dixon, Wyoming, above all the sandy wastes the runoff depth in inches is very low, amounting in 1910, May 27 to December 1, to 1.291 inches.

This is slightly low, as some water was diverted for irrigation purposes, making a total between 1.50″ and 2.00″.

This period does not include all of what was this year's high water period.

LITTLE SNAKE BASIN.

Little Snake river, although a tributary to Yampa, seems almost a separate basin on account of catchment area and the contrast in topography, geology, etc.

The stream's general course is west, paralleling the Colorado-Wyoming line, crossing and re-crossing it at intervals until it joins the Yampa at Lily Park, an open area of a few thousand acres just below Cross Mt. Canon and about 32 miles from Colorado-Utah line. Valley is narrow as far down as Dixon, Wyoming, where it broadens out, with broad high mesas and sandy deserts.

FORESTATION.

The upper catchment area on the east is quite well forested with lodge pole and spruce. Elk Head Mountains have about 75 square miles of forest of the same type, but on the north the growth a short distance from main range is cedar, pinon and juniper, also sand hills skirting both sides of stream have the same covering. Much land is classified as sage brush.

RUNOFF.

The runoff per square mile in this basin is low, due to the fact that only the upper basin is topographically favorable.

Gauging stations were established in 1910 on Little Snake river at Colorado-Wyoming line and on Slater Fork of Little Snake. Its tributaries, South Fork Little Snake, Slater Fork and Four Mile, draw from the north slopes of Elk Head Mountains. Battle Creek and Savery, the principal basins contributing from the north, derive their water from the main range. At its head the Little Snake basin is very broken and precipitous, terminating at the continental divide in a chain of rugged peaks of metamorphic rocks. Elk Head slope of Little Snake is similar to the Yampa slope but possibly a little more precipitous.

TOPOGRAPHY.

Its headwaters are contiguous to the Elk river's and also continue north into Wyoming. The north range decreases in elevation from main range west in long, rolling, gradual slopes until it finally terminates in a vast sandy desert, well eroded, in places showing outcrops of sandstone of Tertiary period. From the Little Snake to the Green river and almost to the Yampa river the same condition exists, varying somewhat in forms of erosion.

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TABLE I.

Fall and Distances Between Stations in Yampa Basin.

BASIN	STREAM	POINT	Elevation	Fall, Feet	Distance, Miles	Fall Ft. Per Mile
Yampa..........	Yampa.........	Head....................	11,800	....	....	....
		4.5 miles below Flat Tops.	10,000	1,800	4.5	400.0
		Yampa..................	7,750	2,250	14.0	161.0
		Steamboat..............	6,683	1,067	30.0	36.0
		Hayden..................	6,350	333	27.0	12.5
		Craig....................	6,250	100	18.0	5.6
		Maybell (Sta.)...........	5,920	330	62.0	5.3
		Mouth L. Snake.........	5,840	80	18.0	4.4
		Colo.-Utah Line.........	5,500	340	47.0	7.2
	Elk............	Head....................	10,000	....	....	....
		Diamond Park...........	7,500	2,500	10.5	250
		Kinney's................	6,875	625	8.5	74
		Trull (Mouth)...........	6,650	225	25.0	9
	Williams River..	Head....................	11,800	....	....	....
		Foot Flat Tops..........	10,000	1,800	3.0	600
		Pyramid................	7,425	2,575	16.0	161
		Pagoda..................	6,740	685	16.0	43
		Hamilton...............	6,400	340	15.0	23
		Mouth..................	6,200	200	9.0	22
	Little Snake....	Head....................	9,500	....	....	....
		Honnold.................	7,000	2,500	17.0	147
		Battle Creek............	6,650	350	14.0	25
		Slater..................	6,500	150	11.0	14
		Dixon..................	6,300	200	14.0	14
		....	5,875	425	86.0	5
		Mouth..................	5,550	325	27.0	12

NOTE.—Elevations at divide at heads of streams are the average elevations.

TABLE II.

Forested Areas in Yampa Basin, Within Boundaries of Routt and White River Reserves. Areas in Square Miles.

BASIN	FORESTED AREAS			Drainage Area	Per Cent.
	Lodgepole Pine, Spruce, Douglas and Alpine Fir	Young Forests and Quakenasp	Total		
Yampa above Yampa	48	....	48	52	92.5
Yampa above Steamboat	173	172	345	572	60
Elk River at Mouth	97	119	216	415	52
Yampa-Craig	338	384	722	1,730	42
Williams River	149	35	184	341	54
Yampa-Maybell	507	444	951	3,670	26
Tota'	507	444			

NOTE.—Forested areas are approximate. Forested areas in Little Snake not given. Below Reserves, only growth is Cedar, Pinon and Juniper.

TABLE III.
Precipitation Records, Yampa Basin.

STEAMBOAT SPRINGS—Routt County, Colorado—Elevation, 6,683 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1891	**0.07**	**0.22**	**1.30**	**1.26**	**2.13**	**0.24**	**1.36**	**1.54**	1.88	0.46	1.90	3.40	**15.76**	**1.31**
1892	2.00	3.20	0.66	1.20	2.00	1.00	T	0.10	0	1.60	0.50	**1.42**	**13.68**	**1.14**
1893	**0.33**	3.90	3.70	3.20	2.60	T	0.50	0.15	1.00	0.70	0.75	3.75	20.58	1.72
1894	5.50	2.40	1.60	2.10	1.00	0.10	0.70	**1.74**	0.90	1.70	**0.25**	**2.81**	**20.80**	**1.73**
1895	**3.81**	**2.10**	**2.54**	0.80	2.60	5.00	0.75	**1.52**	**1.23**	**1.59**	**2.48**	**1.72**	**26.14**	**2.18**
1896	**1.14**	0.60	0.80	0.70	**0.50**	**0.20**	**1.68**	**1.31**	2.02	0.25	1.81	0.65	**11.66**	**0.97**
1897	2.13	3.80	2.55	2.80	1.50	0.85	0.90	0.29	0.20	0.10	1.50	2.70	19.32	1.61
1898	0.36	0.47	0.83	0.63	1.54	**0.86**	0	0.92	0.40	1.10	1.80	1.47	**10.38**	**0.86**
1908	**1.00**	**1.12**	**1.57**	**2.15**	**2.17**	**1.11**	**1.57**	**1.11**	1.40	5.97	0.70	2.97	**22.84**	**1.90**
1909	3.81	3.07	2.07	2.75	1.45	1.32	1.08	1.56	2.31	0.74	2.18	2.83	25.17	2.10
1910	1.38	3.53	0.49	1.21	1.45	0.37	1.23	0.60	1.85	1.87	1.37	......	......	......
Totals	21.53	24.41	18.11	18.80	18.94	11.05	9.77	10.84	13.19	16.08	15.24	23.72	186.33	15.52
Mean	1.96	2.22	1.65	1.71	1.72	1.00	0.89	0.99	1.20	1.46	1.38	2.37	18.63	1.55

YAMPA—Three Miles Above, at Hughes Ranch—Elevation, 8,000 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1909	2.35	0.87	0.65	1.22	0.70	0.63	1.16	3.33	1.98	0.09	1.24	1.29	15.51	1.29
1910	0.63	0.70	0.26	0.40	1.26	0.38	1.62	1.19	1.71	0.95	0.89	......	......	......
Totals	2.98	1.57	0.91	1.62	1.96	1.01	2.78	4.52	3.69	1.04	2.13	......	......	......
Mean	1.49	0.78	0.46	0.81	0.98	0.50	1.39	2.26	1.84	0.52	1.06	1.29	13.38	1.12

COLUMBINE—Elevation, 8,766 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1909	**5.25**	**4.30**	**2.90**	**3.85**	**2.03**	**1.85**	1.51	**2.18**	**3.24**	0.25	2.24	5.57	**35.17**	**2.93**
1910	2.80	3.47	1.13	1.42	4.10	**0.48**	**1.58**	1.53	1.19	1.13	0.90	......	......	......
Totals	8.05	8.77	4.03	5.27	6.13	2.33	3.09	3.71	4.43	1.38	3.14	......	......	......
Mean	4.02	4.38	2.02	2.64	3.06	1.16	1.54	1.86	2.22	0.69	1.57	5.57	30.73	2.52

DUNKLEY—Elevation, 7,175 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1906	2.33	1.41	3.82	3.92	1.99	0.58	2.46	1.69	1.84	0.57	1.74	1.24	23.59	1.97
1907	1.25	1.32	1.63	2.32	**3.33**	**0.72**	**2.33**	**3.32**	1.68	**1.21**	**0.02**	**2.41**	**21.54**	**1.71**
1908	2.21	2.49	0.77	1.35	2.18	0.77	2.89	1.50	1.63	2.40	1.08	1.71	20.98	1.75
1909	1.54	1.14	**0.35**	2.72	**0.42**	**0.84**	0.26	1.30	1.69	**0.40**	**1.20**	**1.73**	**13.59**	**1.13**
Totals	7.33	6.36	6.57	10.31	7.92	2.91	7.94	7.81	6.84	4.58	4.04	7.09	79.70	6.56
Mean	1.83	1.57	1.64	2.58	1.98	0.73	1.98	1.95	1.71	1.14	1.01	1.80	19.92	1.64

NOTE.—All black-faced values are estimated.

PAGODA—Routt County, Colorado—Elevation, 6,500 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1891	0.06	0.19	**1.10**	1.07	1.80	0.20	1.15	1.30	2.46	0.14	1.47	2.40	**13.34**	**1.11**
1892	2.70	1.90	2.50	1.86	2.40	0.57	0.77	0.35	0	2.10	1.20	1.90	18.25	1.52
1893	0.35	3.40	4.60	1.66	2.50	0.30	0.58	2.62	1.95	1.35	1.40	1.75	22.46	1.87
1894	1.85	3.00	1.65	2.75	0.39	1.12	0.95	1.70	2.03	1.90	0.25	2.75	20.34	1.70
1895	3.00	1.65	2.00	1.15	2.15	2.40	1.50	1.20	0.97	1.25	1.95	1.35	20.57	1.72
1896	1.70	1.55	2.40	0.70	0.75	0.30	2.50	1.95	3.17	0.11	1.30	0.95	17.38	1.45
1897	1.70	4.35	4.92	3.50	1.85	1.55	2.51	1.87	1.00	1.75	1.10	3.03	29.13	2.43
1898	1.75	0.80	1.65	0.92	2.80	1.57	1.48	1.68	0.05	2.85	2.05	1.32	18.92	1.58
1899	2.04	4.95	2.78	1.51	0.42	1.82	0.95	1.80	0.50	5.25	0.10	1.93	24.05	2.00
1900	0.30	2.61	0.55	2.10	0.47	0.70	0.15	0.49	1.04	2.35	0.85	0.71	12.32	1.03
1901	0.74	2.05	2.41	3.05	1.58	2.34	0.32	2.56	0.20	0.77	0.60	1.59	18.21	1.52
1902	**0.65**	**0.90**	**1.45**	**0.92**	1.08	0.41	1.59	T	1.52	0.82	1.39	2.38	**13.11**	**1.09**
1903	0.99	1.91	0.82	3.13	1.03	0.68	0.55	1.45	**4.80**	**1.67**	0.46	0.57	**18.06**	**1.50**
1904	1.48	1.26	2.48	0.82	1.03	1.30	0.50	3.00	0.96	**0.90**	0	0.93	**14.66**	**1.22**
1905	0.99	1.27	2.81	2.23	1.27	0.22	1.92	0.47	1.77	0.89	0.72	0.80	15.36	1.28
1906	1.23	0.52	3.11	2.88	1.88	0.49	1.88	1.10	2.72	0.69	1.09	0.43	18.02	1.50
1907	1.14	0.88	1.33	1.68	**2.57**	0.57	1.85	2.64	1.95	0.50	T	1.92	**17.21**	**1.43**
1908	**0.76**	0.85	1.19	1.63	1.64	0.84	1.19	0.84	1.82	3.93	**1.10**	1.50	**17.29**	**1.44**
1909	1.39	1.48	0.51	3.10	0.62	1.23	1.68	2.57	2.48	0.59	1.77	2.54	**19.96**	**1.66**
1910	**1.98**	2.35	1.30	1.03	1.72	0.40	1.89	1.50	1.77	1.60	0.63	......	......	......
Totals	26.80	37.87	37.56	37.69	29.95	19.01	25.91	31.09	33.16	31.41	19.43	30.75	348.64	29.05
Mean	1.34	1.89	1.88	1.88	1.50	0.95	1.30	1.56	1.16	1.57	0.97	1.62	18.35	1.53

NOTE.—All black-faced values are estimated.

LAY, Routt County—Elevation, 6,190 Feet.

Year	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Annual	Mean
1890	**1.20**	**1.59**	1.38	0.85	0.25	0.01	0.40	**1.50**	**0.40**	0.30	0.45	0.36	**8.69**	**0.72**
1891	0.55	1.15	1.05	0.51	0.69	**0.20**	**1.00**	**1.35**	**2.20**	0	0.36	1.44	**10.20**	**0.85**
1892	1.57	0.99	2.22	0.98	1.37	0.72	0.30	0.42	T	**1.50**	0.98	1.07	**12.12**	**1.01**
1893	0.45	2.15	3.25	1.34	1.38	0.06	0.55	2.00	1.40	0.62	1.41	1.28	15.89	1.32
1894	1.12	1.29	1.10	1.94	0.17	0.79	0.90	0.10	1.00	1.20	T	1.60	11.21	0.93
1895	1.22	0.89	1.12	0.35	1.77	**1.10**	1.66	0.54	1.44	0.57	2.57	1.40	**14.63**	**1.22**
1896	0.95	1.80	1.05	0.40	0.66	0.04	3.06	1.26	2.75	0.25	1.47	0.35	14.04	1.17
1897	0.77	2.85	5.01	1.83	0.75	0.73	**2.50**	0.87	1.62	**1.24**	**0.90**	**1.80**	**20.87**	**1.74**
1899	**0.75**	**2.00**	**2.40**	**1.40**	**0.20**	**2.00**	**0.90**	**1.75**	**0.40**	**4.30**	0.28	1.19	**17.57**	**1.46**
1900	0.40	0.73	0.43	0.93	0.27	1.89	0.20	0.34	0.59	1.29	0.33	0.20	7.60	0.63
1901	0.70	1.09	0.89	1.48	2.66	0.60	0.85	0.94	0.08	0.29	0.36	1.23	11.17	0.93
1902	0.43	0.64	2.21	0.84	0.76	0.34	0.46	0.12	1.28	0.27	0.72	0.72	8.79	0.73
1903	1.03	0.97	1.61	0.83	1.87	0.23	**0.80**	0.16	3.26	0.70	0.34	0	**11.80**	0.98
1904	0.68	0.44	1.45	0.59	1.78	0.85	0.65	1.89	0.81	0.18	0.00	0.85	10.17	0.85
1905	0.62	1.94	1.92	1.64	2.44	0.13	0.67	0.36	2.22	0.33	1.26	0.60	14.13	1.09
1906	1.29	1.42	1.48	2.34	2.64	0.35	0.45	1.33	1.91	1.21	0.55	0.63	15.60	1.30
1907	1.66	0.94	0.51	1.27	1.73	0.65	1.14	1.04	1.73	0.34	1.14	0.75	11.90	0.99
1908	0.42	0.49	1.15	0.66	1.81	0.94	0.80	1.44	0.63	2.31	0.20	1.25	12.10	1.01
1909	1.70	0.97	0.93	1.67	0.56	1.03	1.04	1.71	1.68	1.13	1.79	1.15	15.36	1.28
1910	1.56	0.75	0.38	1.16	0.20	0.97	0.22	2.01	2.81	1.32	1.32	......	......	......
Totals	19.07	25.09	31.54	23.45	23.96	13.63	18.55	21.13	28.21	17.35	16.43	17.57	243.84	20.21
Mean	0.95	1.25	1.58	1.18	1.20	0.68	0.93	1.06	1.41	0.87	0.82	0.92	12.83	1.06

NOTE.—All black-faced values are estimated.

CRAIG, Routt County—Elevation, 6,250 Feet.
Collected by Great Northern Irrigation & Power Co.

Date 1910	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Period
1									0.05	0.28			
2									1.17				
3													
4							0.15		0.01				
5							0.06						
6													
7													
8													
9													
10							0.05		0.01				
11								0.06	0.01				
12									0.05				
13								0.08	0.33				
14								0.04					
15											0.30		
16						0.13				1.95			
17									0.08				
18							0.12		0.45				
19							0.01	0.01					
20								0.02					
21													
22									0.26		0.45		
23													
24													
25													
26											0.04		
27							0.57	0.05					
28						0.61	0.27						
29													
30						0.18							
31							0.07						
Total						0.92	1.31	0.26	2.42	2.23	0.79		7.93

NOTE.—U. S. Weather Bureau established a station at Craig in Nov., 1910.

CALIFORNIA PARK—Near Headwaters of Elk Head Creek Reservoir Site—Elevation, 7,500 Feet.
Collected by Great Northern Irrigation & Power Co.

Date 1910	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Total Period
1													
2													
3									1.45	0.16			
4									0.10				
5													
6													
7													
8													
9													
10									0.20				
11								0.10					
12													
13									0.65				
14													
15							0.10						
16							0.30		0.09				
17							0.10			1.60			
18													
19													
20									0.10				
21													
22													
23													
24													
25													
26													
27							0.70						
28							0.30						
29							0.40						
30													
31							0.15						
Total							2.05	0.10	2.59	1.76			6.50

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TABLE IV.

Depth of Snow in Inches on Ground at end of Month.

ROUTT COUNTY, COLORADO.

10 inches of snow equals 1 inch of water.

STATION	Elev.	Year	JANUARY		FEBRUARY		MARCH		DECEMBER	
			Station	Timber Line	Station	Timber Line	Station	Timber Line	Station	†Timber Line
Big Fish..........	8,100	1910	36	....	43	....	24	....	....	....
Columbine..........	8,766	1903	....	....	....	....	44	....	....	....
		1904	....	....	....	....	....	....	16	....
		1905	....	....	....	....	....	....	22	39
		1906	36	60	42	72	52	78	24	40
		1907	42	72	42	78	40	72	20	....
		1908	28	30	32	48	32	48	38	54
		1909	54	72	84	....	90	108	33	....
		1910	41	....	53	....	....	....	....	....
Egeria..........	9,100	1909	....	....	....	....	....	....	25	....
		1910	30	....	33	....	....	....	....	....
Fish*..........	10,000	1909	....	....	....	....	....	....	24	....
		1910	36	....	....	....	....	....	....	....
Hahns Peak..........		1908	....	....	....	....	....	....	36	....
		1909	42	54	60	72	48	60	....	....
		1910	....	....	....	....	....	....	....	....
Hunt*..........	9,000	1909	....	....	....	....	....	....	27	....
		1910	35	....	43	....	....	....	....	....
Milk*..........	8,900	1910	46	....	50	....	42	....	....	....
Oak*..........	9,200	1909	....	....	....	....	....	....	33	....
		1910	46	....	....	....	....	....	....	....
Soda*..........	8,400	1910	....	....	24	....	....	....	....	....
Steamboat..........	6,683	1903	....	....	....	....	24	....	....	....
		1904	....	....	....	....	....	....	12	....
		1905	....	....	....	....	....	....	8	18
		1906	24	48	20	36	10	60	12	24
		1907	20	30	15	36	6	48	12	24
		1908	20	36	24	40	6	48	20	48
		1909	24	60	42	120	20	66	12	....
		1910	18	....	30	....	0	....	....	....

*Stations near head of basin same name. †Timberline depths are mostly estimates.

TABLE IV.—Concluded.

Depth of Snow in Inches on Ground at End of Month.

ROUTT COUNTY, COLORADO.

10 inches of snow equals 1 inch of water.

STATION	Elev.	Year	JANUARY		FEBRUARY		MARCH		DECEMBER	
			Station	Timber Line	Station	Timber Line	Station	Timber Line	Station	Timber Line
Williams River..........	6,800	1909	....	....	....	....	....	....	8	....
(Pagoda)		1910	11	....	34	....	6	....	....	....
Williams River..........	8,500	1909	....	....	....	....	....	....	11	....
(Head West Fork)		1910	18	....	8	....	4	....	....	....
Yampa..................	8,200	1903	....	....	....	....	10	60	....	....
		1904	....	....	....	....	....	....	3	12
		1905	....	....	....	....	....	....	6	10
		1906	....	....	12	55	12	60	3	5
		1907	7	24	5	36	0	72	4	24
		1908	16	36	10	42	6	42	16	36
		1909	....	....	36	48	24	48	14	....
		1910	31	....	35	....	....	....	....	....
Yampa..................	8,500	1909	....	....	....	....	....	....	24	....
(Ranger Station)		1910	31	....	35	....	....	....	....	....

TABLE V.

List of Gauging Stations in Yampa Basin, Routt Co., Colo.

Stations in order from heads of streams down.

BASIN	STREAM	STATION	Established By Whom	Established Date	Re-established By Whom	Re-established Date	REMARKS
Yampa....	Yampa..........	Yampa................	State..............	1910	....	....	....
	Yampa..........	Steamboat............	U. S. G. S..........	1904	State......	Mch. 1910	....
	Soda Creek.......	Steamboat............	State..............	1910	....	....	Co-op. with Borroughs Ditch Co.
	Elk River.........	Clark................	Elk R. Canal Co......	1910	....	....	....
	Elk River.........	Trull................	U. S. G. S..........	1904	State......	1910	....
	Trout Creek.......	Pinnacle.............	State..............	1910	....	....	Co op. with Williams R. High Line Canal Co.
	Fish Creek........	Dunkley..............	State..............	1910	....	....	Co-op. with Williams R. High Line Canal Co.
	Elk Head Creek...	Sec. 8, T 8 N, R 88 W, Californ'a Park........	G. N. Irr. & P. Co....	1910	....	....	Gt. Northern Irr. & P. Co.
	N. Fk. Elk Head...	Sec. 8, T 8 N, R 88 W, California Park........	G. N. Irr. & P. Co....	1910	....	....	Gt. Northern Irr. & P. Co.
	Elk Head Creek...	Craig................	U. S. G. S..........	1906	State......	1910	....
	Little Bear Creek..	Sec. 23, T 8 N, R 88 W, Skiles, above mouth....	G. N. Irr. & P. Co....	1910	....	....	Gt. Northern Irr. & P. Co.
	Fortification......	Sec. 23, T 8 N, R 88 W, Chapmans, above mouth of Little Bear..........	G. N. Irr. & P. Co....	1910	....	....	Gt. Northern Irr. & P. Co.
	Fortification......	Craig................	U. S. G. S..........	1906	State......	1910	....
	Yampa..........	Craig................	U. S. G. S..........	1901	State......	1910	....
	Williams River...	Pyramid..............	State..............	1910	....	....	Co-op. with Williams R. High Line Canal Co
	Williams River...	Hamilton.............	U. S. G. S..........	1904	State......	1910	....
	Milk Creek........	Axial................	U. S. G. S..........	1904	....	....	....
	Yampa..........	Maybell..............	U. S. G. S..........	1904	State......	1910	....
	Slater Fork.......	Slater...............	State..............	1910	....	....	....
	Little Snake......	Dixon, Wyo...........	State..............	1910	....	....	....
	Little Snake......	Maybell..............	U. S. G. S..........	1904	....	....	....

TABLE VI.

Run-Off Tables, Yampa Basin.

ELK HEAD CREEK AT CRAIG—Drainage Area, 249 Square Miles.
Estimated Discharges.

MONTH	Discharge in Second-Feet Maximum	Minimum	Mean	Total in Acre-feet	Run-Off Second-feet per square mile	Depth in inches
1906 May..........................	1,080	267	840	51,600	3.374	....
June..........................	629	27	257	15,300	1.032	....
July..........................	29	4	13.5	830	0.0542	....
August........................	3.6	2.6	3.0	184	0.0120	....
September 1-7.................	2.8	2.7	2.8	38.9	0.0112	....
Total period..............	....	....	....	68,000	....	....

TABLE VI.—Continued.
Run-Off Tables, Yampa Basin.

ELK RIVER AT TRULL—Drainage Area, 415 Square Miles.
Estimated Discharges.

MONTH		Discharge in Second-Feet			Total in Acre-feet	Run Off	
		Maximum	Minimum	Mean		Second-feet per square mile	Depth in inches
1904	May 2-31	3,485	1,502	2,185	130,000	5.263	5.872
	June	2,430	1,206	1,749	104,000	4.214	4.701
	July	1,129	260	539	33,140	1.299	1.498
	August	294	97	185	11,380	0.446	0.514
	September	213	80	110	6,545	0.265	0.296
	October	184	97	137	8,424	0.330	0.380
	Total period				293,600		
1905	May 7-31	2,938	940	1,841	91,290	4.436	4.125
	June	3,410	1,520	2,303	137,000	5.549	6.191
	July	3,032	250	667	41,010	1.607	1.853
	August	312	80	146	8,977	0.352	0.406
	September 1-9	111	73	87.9	6,569	0.212	0.071
	Total period				279,800		
1906	May	4,280	870	2,630	162,000	6.338	7.307
	June	3,860	1,480	2,590	154,000	6.241	6.963
	July	1,950	295	1,010	62,100	2.434	2.806
	August 1-16	355	175	241	7,650	0.581	0.334
	Total period				386,000		

FORTIFICATION CREEK AT CRAIG—Drainage Area, 256 Square Miles.

1905	June	435	40	176	10,500		
1906	May 2-31	427	97	267	15,900		
	June	272	0	117	6,960		

LITTLE SNAKE RIVER NEAR MAYBELL—Drainage Area, 4,456 Square Miles.

1904	June 9 30	2,140	760	1,730	59,780		
	July	715	63	306	18,820		
	August 1-14	153	43	61.1	1,777		

MILK CREEK AT AXIAL—Drainage Area, 75 Square Miles.

1904	April 20-30	236	104	178	3,883		
	May	218	76	157	9,654		
	June	143	10	55	3,273		
	July	8	2	3.6	221		
	August	87	1	6.7	412		
	September	17	1	4.8	286		
	October	23	2	6.6	406		
	Total period				18,140		

TABLE VI.—Continued.
Run-Off Tables, Yampa Basin.

MILK CREEK AT AXIAL—Drainage Area, 75 Square Miles.
Estimated Discharges.

MONTH	DISCHARGE IN SECOND-FEET Maximum	Minimum	Mean	Total in Acre-feet	RUN-OFF Second-feet per square mile	Depth in inches
1905 April	123	12	35.9	2,136	....	....
May	276	97	184	11,310	....	....
June	206	4	70.4	4,189	....	....
July	7	2	3.5	215	....	....
August 1-16	10	4	5.7	181	....	....
Total period	....	....	....	18,030	....	....

WILLIAMS RIVER AT HAMILTON—Drainage Area, 341 Square Miles.

MONTH	Maximum	Minimum	Mean	Total in Acre-feet	Second-feet per square mile	Depth in inches
1904 May	1,370	685	1,003	61,670	2.942	3.391
June	970	345	667	39,690	1.956	2.183
July	330	75	166	10,210	0.487	0.562
August	148	59	87	5,349	0.255	0.294
September	148	21	60	3,570	0.176	0.196
October	95	39	61	3,751	0.176	0.203
Total period	....	....	....	126,000	....	....
1905 April	336	70	135	8,033	0.396	0.442
May	1,675	255	737	45,320	2.161	2.491
June	1,550	231	745	44,330	2.185	2.438
July	212	58	115	7,071	0.337	0.388
August	126	23	46.6	2,865	0.137	0.158
September	62	23	36.6	2,178	0.107	0.119
October	102	30	43.6	2,681	0.128	0.148
Total period	....	....	....	112,500	....	....
1906 April	634	89	218	13,000	0.639	0.713
May	2,580	260	1,340	82,400	3.930	4.531
June	1,730	514	1,120	66,600	3.284	3.664
July	480	75	230	14,100	0.674	0.777
August	126	54	78.4	4,820	0.230	0.265
September	158	35	74.0	4,400	0.217	0.242
October	75	28	53.2	3,270	0.156	0.180
Total period	....	....	....	189,000	....	....

YAMPA RIVER AT CRAIG—Drainage Area, 1,730 Square Miles.

MONTH	Maximum	Minimum	Mean	Total in Acre-feet	Second-feet per square mile	Depth in inches
1901 May 25-31	7,086	6,285	6,684	92,800	3.863	1.006
June	6,285	2,203	4,283	254,856	2.476	2.762
July	1,917	321	745	45,808	0.431	0.497
August	423	198	301	18,508	0.174	0.201
September	276	136	190	11,306	0.110	0.123
October	235	136	181	11,129	0.105	0.121
Total period	....	....	....	434,407	....	....

TABLE VI.—Continued.
Run-Off Tables, Yampa Basin.

YAMPA AT CRAIG—Drainage Area, 1,730 Square Miles.
Estimated Discharges.

MONTH	Discharge in Second-Feet: Maximum	Discharge in Second-Feet: Minimum	Discharge in Second-Feet: Mean	Total in Acre-feet	Run-Off: Second-feet per square mile	Run-Off: Depth in inches
1902 April	4,195	370	1,797	106,929	1.039	1.160
May	8,728	3,320	6,722	413,320	3.886	4.480
June	8,522	825	3,969	236,172	2.294	2.559
July	1,081	198	479	29,452	0.277	0.3194
August	165	90	115	7,071	0.066	0.076
Total period	....	....	....	792,944	....	....
1904 May	7,554	3,475	5,281	324,700	3.05	3.519
June	5,820	1,960	4,011	238,700	2.32	2.586
July	1,816	310	731	44,950	0.423	0.487
August	375	238	299	18,380	0.173	0.199
September	291	163	201	11,960	0.116	0.130
October	291	163	230	14,140	0.133	0.153
Total period	....	....	....	652,800	....	....
1905 April	3,380	510	1,579	93,960	0.913	1.019
May	8,000	1,920	4,177	256,800	2.414	2.783
June	9,000	2,425	5,713	339,900	3.302	3.684
July	2,360	370	1,002	61,610	0.579	0.668
August	570	100	333	20,480	0.192	0.221
September	230	100	124	7,379	0.072	0.080
October	230	125	163	10,020	0.094	0.108
Total period	....	....	....	790,100	....	....
1906 April	4,460	808	2,100	125,000	1.214	1.355
May	9,680	2,550	6,180	380,000	3.572	4.118
June	8,800	2,480	5,620	334,000	3.248	3.624
July	2,700	450	1,470	90,400	0.850	0.980
August	535	215	359	22,100	0.208	0.232
September	425	200	283	16,800	0.164	0.177
October	350	265	285	17,500	0.165	0.190
Total period	....	....	....	986,000	....	....

YAMPA AT MAYBELL, Drainage Area, 3,670 Square Miles.

MONTH	Maximum	Minimum	Mean	Total in Acre-feet	Second-feet per square mile	Depth in inches
1904 April 17-30	5,570	2,700	3,931	109,200	1.071	0.560
May	7,730	3,650	5,232	321,700	1.426	1.644
June	6,610	2,235	4,559	271,300	1.242	1.386
July	2,110	340	942	57,920	0.257	0.296
August	450	250	260	22,140	0.071	0.082
September	428	195	271	16,130	0.074	0.083
October	405	195	301	18,510	0.082	0.095
Total period	....	....	....	816,900	....	....

TABLE VI.—Concluded.

Run-Off Tables, Yampa Basin.

YAMPA AT MAYBELL—Drainage Area, 3,670 Square Miles.
Estimated Discharges.

MONTH	Discharge in Second-Feet: Maximum	Minimum	Mean	Total in Acre-feet	Run-Off: Second-feet per square mile	Depth in inches
1905 April	3,665	655	1,825	108,600	0.497	0.554
May	9,325	2,920	5,581	343,200	1.52	1.75
June	10,850	2,695	6,768	402,700	1.84	2.05
July	2,015	450	968	59,520	0.264	0.304
August	880	145	303	18,630	0.083	0.096
September	250	130	185	11,010	0.050	0.056
October	290	145	188	11,560	0.051	0.059
Total period	....	....	....	955,200	....	....

YAMPA AT STEAMBOAT—Drainage Area, 525 Square Miles.

MONTH	Maximum	Minimum	Mean	Total in Acre-feet	Second-feet per square mile	Depth in inches
1904 May 3-31	3,400	1,000	1,967	113,100	3.747	4.042
June	2,430	818	1,575	93,720	3.000	3.347
July	870	142	278	17,090	0.530	0.611
August	232	146	166	10,210	0.316	0.364
September	185	146	153	9,104	0.291	0.325
October	200	142	166	10,210	0.316	0.364
Total period	....	....	....	253,400	....	....
1905 April	775	250	418	24,870	0.796	0.888
May	2,320	462	1,405	86,390	2.676	3.085
June	4,240	550	2,435	144,900	4.638	5.175
July	840	86	254	15,620	0.484	0.558
August	173	51	92.5	5,688	0.176	0.203
September	104	55	73.1	4,350	0.139	0.155
October	104	75	88.2	5,423	0.168	0.194
Total period	....	....	....	287,200	....	....
1906 April	2,030	260	813	48,400	1.548	1.727
May	4,020	745	2,220	136,000	4.229	4.876
June	4,560	901	2,500	149,000	4.762	5.317
July	805	140	398	24,500	0.758	0.874
August	280	116	166	10,200	0.316	0.364
September	240	125	171	10,200	0.325	0.363
October	177	146	159	9,780	0.303	0.349
Total period	....	....	....	388,000	....	....

CHAPTER XIV.

HYDROGRAPHIC DATA.

ARKANSAS RIVER DRAINAGE.

ARKANSAS RIVER AT GRANITE.

This station is located near Granite and below the mouth of Lake creek. The discharge is affected at this point by Twin Lakes reservoir and a ditch which takes water from Lake creek for placer mine near Granite. The water for the placer mine is emptied into the Arkansas river below the station.

The equipment, owned by the State, consists of an automatic gauge which is located about 500 feet above the D. & R. G. depot, and a cable and car. The cable is located about one-third mile above the depot. For checking the automatic gauge there is a 4″x4″ slope gauge rod.

The bed of the stream is composed of small boulders and is permanent. The banks are principally debris from old placer claims and are not liable to overflow, except in extremely high water.

This station has been maintained entirely by the State.

The observer is Geo. Morrison, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT GRANITE, COLORADO.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 7	Thos. Grieve	68	82	1.83	1.70	150
May 6	C. L. Chatfield	77	203	5.09	3.04	1033
May 28	Thos. Grieve	74	180	4.47	2.83**	804
Aug. 5	Grieve & Christiansen	71	108	2.47	2.00	267
Aug. 8	A. A. Weiland	72	119	2.98	2.25	355
Sept. 19	*Thos Grieve	66	65.9	1.76	1.58	116
Oct. 28	*Thos. Grieve	57	58.5	1.27	1.32	74.1

*Measurements by wading.

**Twin Lakes stopped run during this measurement. Area and velocity would indicate that gauge height was about 2.83.

NOTE.—On Aug. 5 graduations on gauge were found to be incorrect and gauge was re-graduated commencing at 4.50 ft. mark. Gauge hts. until Aug. 5 were corrected on sliding scale.

DISCHARGE OF ARKANSAS RIVER AT GRANITE FOR 1910.
Drainage Area, 425 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	595	1,745	1,090	372	595	150	180	....	
2	....	....	....	....	638	1,550	1,090	345	595	150	150	....	
3	....	....	....	....	728	1,550	1,035	322	300	150	150	....	
4	....	....	....	....	925	1,550	1,035	278	120	120	150	....	
5	....	....	....	....	925	1,550	980	198	120	120	165	....	
6	....	....	....	180	1,035	1,490	980	180	110	120	85	....	
7	....	....	....	165	1,035	1,430	345	150	100	120	92	....	
8	....	....	....	198	925	1,200	345	165	92	110	85	....	
9	....	....	....	255	1,090	1,200	520	165	100	120	85	....	
10	....	....	....	278	1,200	1,200	455	198	92	70	85	....	
11	....	....	....	278	1,200	1,200	372	215	100	70	85	....	
12	....	....	....	278	1,255	1,090	300	235	100	92	85	....	
13	....	....	....	278	1,550	1,090	300	198	100	70	78	....	
14	....	....	....	235	1,200	1,090	300	198	85	100	85	....	
15	....	....	....	235	980	1,090	345	150	85	92	78	....	
16	....	....	....	215	680	1,200	322	135	110	120	78	....	

DISCHARGE OF ARKANSAS RIVER AT GRANITE FOR 1910—Concluded.

Drainage Area, 425 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
17	....	....	....	215	638	1,090	278	135	120	100	70	....	
18	....	....	....	215	595	822	278	180	135	92	78	....	
19	....	....	....	235	520	775	300	198	120	120	78	....	
20	....	....	....	595	595	822	300	198	120	85	70	....	
21	....	....	....	870	638	980	428	180	180	135	78	....	
22	....	....	....	870	1,255	980	428	165	135	215	85	....	
23	....	....	....	520	1,200	1,090	345	165	150	85	70	....	
24	....	....	....	488	1,090	1,090	300	150	120	85	70	....	
25	....	....	....	925	1,035	1,090	278	135	120	85	78	....	
26	....	....	....	728	870	1,090	255	135	215	85	85	....	
27	....	....	....	400	1,035	1,200	235	135	322	78	85	....	
28	....	....	....	980	1,090	1,090	255	135	180	78	78	....	
29	....	....	....	345	925	1,035	372	180	120	78	78	....	
30	....	....	....	455	1,490	1,035	520	455	150	78	78	....	
31	....	....	....	....	1,745	....	345	558	....	92	....	....	
Total	....	....	....	10,436	30,682	35,414	14,731	6,608	4,991	3,265	2,797	....	
Mean	....	....	....	417	990	1,180	475	213	166	105	93	....	456
Maximum	....	....	....	925	1,745	1,745	1,090	558	595	215	180	....	1,745
Minimum	....	....	....	165	520	775	235	135	85	70	70	....	70
Run-off, per square mile	....	....	....	0.981	2.329	2.776	1.118	0.501	0.391	0.247	0.219	....	1.073
Run-off, depth, inches	....	....	....	0.912	2.685	3.097	1.289	0.578	0.436	0.285	0.244	....	9.256
Run-off, acre-feet	....	....	....	20,678	60,873	70,215	29,207	13,097	9,878	6,456	5,534	....	215,938
Acre-feet per square mile	....	....	....	48.64	143.20	165.18	68.74	30.80	23.27	15.19	13.03	....	508.05

ARKANSAS RIVER AT SALIDA.

This station is located at Salida, and is operated by the State.

The equipment consists of an automatic gauge with a 2″x4″ slope gauge for checking.

Measurements are made from the concrete bridge above gauge at high water and wading at low water.

The bed of the stream is composed of small and large sized boulders and is fairly permanent.

The observer is Howard Sneddon, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT SALIDA.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Nov. 3	Grieve & Chatfield	....	174	3.14	1.60	547
	Dec. 15	C. L. Chatfield	....	102	2.38	0.70	243
1910	Jan. 19	*Thos. Grieve	66	104	2.12	0.70	221
	Feb. 26	*Thos. Grieve	66	100	2.26	0.70	226
	May 5	Thos. Grieve	81	226	5.61	2.75	1269
	May 25	Thos. Grieve	83	259	6.20	2.92	1605
	Aug. 4	Grieve & Christiansen	69	140	3.41	1.35	478
	Sept. 18	*Thos. Grieve	67.5	103	2.59	0.76	267

*Measurements by wading.

DISCHARGE OF ARKANSAS RIVER AT SALIDA FOR 1909.
Drainage Area, 1,160 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1												325	
2												340	
3												340	
4												292	
5												250	
6												275	
7												275	
8												275	
9												275	
10												292	
11											358	262	
12											358	262	
13											340	275	
14											340	262	
15											325	250	
16											340	238	
17											340	250	
18											340	225	
19											340	212	
20											358	212	
21											358	225	
22											340	250	
23											340	262	
24											340	262	
25											325	250	
26											340	250	
27											340	262	
28											325	250	
29											340	250	
30											340	250	
31												250	
Tota											6,827	8,148	
Mean											341	263	294
Maximum											358	340	358
Minimum											325	212	212
Run-off, per square mile											0.294	0.227	0.253
Run-off, depth, inches											0.219	0.262	0.481
Run-off, acre feet											13,527	16,171	29,698
Acre-feet per square mile											11.66	13.94	25.60

DISCHARGE OF ARKANSAS RIVER AT SALIDA FOR 1910.

Drainage Area, 1,160 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	275	238	238	415	1,375	2,200	1,535	480	555	325	280	....	
2	275	225	250	478	1,115	2,300	1,445	455	758	250	265	....	
3	250	212	250	478	880	2,555	1,315	435	758	250	265	....	
4	238	200	262	435	1,225	2,450	1,315	480	435	238	265	....	
5	200	200	275	395	1,262	2,450	1,272	555	395	238	280	....	
6	190	200	292	340	1,310	2,665	1,190	505	358	225	280	....	
7	190	212	292	325	1,360	2,450	822	415	340	238	265	....	
8	225	212	310	325	1,410	2,200	665	395	325	250	265	....	
9	225	200	310	375	1,450	2,003	665	415	310	280	265	....	
10	238	200	250	415	1,820	1,813	725	415	215	250	250	....	
11	238	200	238	435	2,000	1,718	635	415	185	225	250	....	
12	238	212	238	435	2,240	1,625	555	415	195	238	250	....	
13	212	200	238	455	2,280	1,718	555	415	195	238	265	....	
14	225	225	238	435	1,840	1,860	530	415	205	238	250	....	
15	238	212	250	375	1,500	1,908	580	395	195	250	265	....	
16	250	200	250	375	1,160	2,003	580	340	215	265	250	....	
17	250	200	250	395	1,070	1,908	455	340	225	295	238	....	
18	225	212	262	375	1,010	1,670	358	375	265	265	238	....	
19	238	212	275	375	920	1,765	415	435	325	295	250	....	
20	225	225	310	415	900	1,813	415	455	325	280	238	....	
21	238	225	310	455	1,040	1,670	505	415	340	265	238	....	
22	250	225	340	455	1,670	1,535	505	395	395	415	250	....	
23	250	225	375	478	1,720	1,718	455	435	325	325	250	....	
24	250	225	358	500	1,740	1,670	435	415	325	280	250	....	
25	250	250	358	600	1,580	1,625	415	375	310	265	250	....	
26	212	238	375	760	1,445	1,580	375	375	295	265	250	....	
27	212	212	340	945	1,445	1,625	325	375	435	250	238	....	
28	212	212	358	1,150	1,670	1,625	375	395	435	250	225	....	
29	238	....	358	1,640	2,050	1,535	555	325	280	250	238	....	
30	212	....	325	1,562	2,608	1,490	725	375	325	250	225	....	
31	225	....	375	....	2,255	....	580	505	....	265	....	....	
Total	7,194	6,009	9,150	16,596	47,350	57,147	21,277	12,935	10,244	8,213	7,588	....	
Mean	232	215	295	553	1,527	1,905	686	417	341	265	253	....	610
Maximum	275	250	375	1,640	2,608	2,665	1,535	555	758	415	280	....	2,665
Minimum	190	200	238	325	880	1,490	325	325	185	225	225	....	185
Run off, per square mile	0.200	0.185	0.254	0.477	1.316	1.642	0.591	0.359	0.294	0.228	0.218	....	0.526
Run-off, depth, inches	0.231	0.193	0.293	0.532	1.517	1.832	0.684	0.414	0.328	0.263	0.243	....	6.530
Run-off, acre-feet	14,265	11,940	18,139	32,906	93,891	114,962	42,180	25,640	20,291	16,294	15,055	....	405,563
Acre-feet per square mile	12.30	10.29	15.64	28.42	80.94	99.05	56.36	22.10	17.49	14.05	12.98	....	349.62

ARKANSAS RIVER AT CANON CITY.

This station is located at the Hot Springs hotel about one mile above Canon City and below the mouth of Grape creek.

The equipment consists of a cable and car, an automatic gauge and chain gauge. The automatic gauge is owned by the State. The cable and car and expenses of erecting same were paid for by the State. The chain gauge is the property of the United States Geological Survey.

The bed of the stream is composed of sand and gravel and shifts at high water. Both banks are high and not liable to overflow.

The observer is S. R. McKissick, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT CANON CITY.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 6......	*W. B. Freeman..........................	....	152	2.55	3.40	388
June 10......	Geo. J. Lyon..........................	....	423	6.78	6.15	2870
June 28......	W. B. Freeman..........................	....	443	6.76	6.40	3000
July 21......	G. H. Russell..........................	....	289	5.29	5.00	1526
Aug. 9......	T. Grieve..........................	....	232	3.79	4.30	882
Aug. 21......	G. H. Russell..........................	....	223	4.85	4.65	1081
Sept. 1......	C. L. Chatfield..........................	....	212	6.18	4.75	1309
Sept. 16......	C. L. Chatfield..........................	....	284	4.62	5.10	1310
Sept. 18......	G. H. Russell..........................	....	235	5.20	4.95	1220
Oct. 11......	Thos. Grieve..........................	....	196	3.76	4.30	730
Oct. 14......	G. H. Russell..........................	....	192	3.60	4.20	689
Nov. 4......	Grieve & Chatfield..........................	....	188	3.36	4.13	631
Nov. 23......	G. H. Russell..........................	....	180	3.10	4.10	559
Dec. 15......	C. L. Chatfield..........................	....	143	2.99	3.95	427
Dec. 21......	*G. H. Russell..........................	45	81	3.41	3.65	276
1910 Jan. 19......	Thos. Grieve..........................	86	132	3.04	3.90	402
Feb. 23......	Thos. Grieve..........................	95	158	3.14	4.04	496
Feb. 26......	G. H. Russell & Grieve..........................	96	159	3.00	4.00	477
Apr. 4......	G. H. Russell..........................	97	168	3.25	4.32	611
Apr. 10......	Thos. Grieve..........................	97	180	3.11	4.18	559
Apr. 30......	Lyon & Lamb..........................	107	359	6.02	5.82	2362
May 5......	Thos. Grieve..........................	104	286	5.37	5.35	1537
May 29......	Thos. Grieve..........................	107	347	6.08	5.82	2111
June 10......	R. H. Bolster & G. Lyon..........................	104	336	5.28	5.57	1774
June 23......	G. H. Russell..........................	103	300	5.00	5.28	1500
July 22......	G. H. Russell..........................	95	158	3.29	4.15	520
Aug. 3......	Grieve & Christiansen..........................	93	151	3.79	4.10	572
Aug. 12......	G. H. Russell..........................	99	122	3.71	3.95	453
Aug. 17......	G. H. Russell..........................	....	107	3.36	3.71	360
Aug. 17......	G. H. Russell..........................	....	105	3.27	3.70	343
Sept. 16......	G. H. Russell..........................	80	92	2.71	3.62	249
Sept. 20......	Thos. Grieve..........................	92	121	2.85	3.86	345
Oct. 1......	S. T. Harding..........................	92	129	3.16	3.83	407
Oct. 28......	S. T. Harding..........................	72	107	3.21	3.70	344
Nov. 24......	†Padgett & Miles..........................	76	104	2.74	3.70	284

*Measurements at different section. †Measurement by wading.

DISCHARGE OF ARKANSAS RIVER AT CANON CITY FOR 1909.
Drainage Area, 3,060 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1..........	......	......	......	......	292	1,178	3,002	1,223	1,360	620	552	552	
2..........	......	......	......	......	236	1,132	3,190	1,223	1,330	620	585	552	
3..........	......	......	......	......	254	1,088	3,190	1,045	1,170	620	622	585	
4..........	......	......	......	......	273	1,735	3,585	811	1,200	620	552	552	
5..........	......	......	......	......	311	2,321	3,855	848	1,930	620	492	395	
6..........	......	......	......	......	370	2,382	3,320	777	2,960	640	492	450	
7..........	......	......	......	......	410	2,628	2,566	777	2,450	740	465	450	
8..........	......	......	......	......	452	2,815	2,566	848	2,480	770	440	450	
9..........	......	......	......	......	497	2,628	2,382	848	2,400	800	465	450	

DISCHARGE OF ARKANSAS RIVER AT CANON CITY FOR 1909—Concluded.
Drainage Area, 3,060 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
10	....	....	....	....	544	2,752	2,200	811	2,150	710	465	510	
11	....	....	....	....	711	3,002	2,080	848	1,750	698	465	480	
12	....	....	....	....	711	3,128	1,791	743	1,550	698	465	422	
13	....	....	....	....	680	3,385	1,573	848	1,730	660	465	450	
14	....	....	....	....	680	3,065	1,368	811	1,560	622	492	450	
15	....	....	....	....	680	2,628	1,368	1,045	1,440	585	492	422	
16	....	....	....	....	622	2,566	1,368	810	1,310	585	520	395	
17	....	....	....	....	680	2,752	1,318	1,790	1,240	585	492	395	
18	....	....	....	....	680	3,518	1,270	6,380	1,130	585	492	300	
19	....	....	....	....	743	4,058	1,223	1,320	1,050	585	552	255	
20	....	....	....	410	848	4,328	1,178	1,010	1,010	552	552	255	
21	....	....	....	350	923	3,518	1,368	1,310	940	520	585	300	
22	....	....	....	311	923	3,002	1,847	1,060	840	585	552	322	
23	....	....	....	292	1,045	2,878	1,573	830	800	622	585	422	
24	....	....	....	273	1,045	4,462	1,735	850	800	660	585	422	
25	....	....	....	273	1,045	3,585	1,962	1,090	800	660	585	370	
26	....	....	....	273	962	3,255	1,680	940	770	660	585	278	
27	....	....	....	292	1,045	3,255	1,735	950	740	622	552	345	
28	....	....	....	311	1,223	3,128	1,626	880	710	585	520	345	
29	....	....	....	330	1,368	3,128	1,626	1,020	675	585	520	345	
30	....	....	....	311	1,318	3,190	1,468	1,060	650	585	585	345	
31	....	....	....	....	1,178	....	1,270	1,280	....	552	....	370	
Total	....	....	....	3,426	22,749	86,490	62,283	36,086	40,925	19,551	15,771	12,634	
Mean	....	....	....	311	734	2,883	2,009	1,164	1,364	631	526	408	1,171
Maximum	....	....	....	410	1,368	4,462	3,855	6,380	2,960	800	622	585	6,380
Minimum	....	....	....	273	236	1,088	1,178	743	650	520	440	255	236
Run-off per square mile	....	....	....	0.102	0.240	0.942	0.657	0.380	0.446	0.206	0.172	0.133	0.383
Run-off, depth, inches	....	....	....	0.042	0.277	1.051	0.757	0.438	0.498	0.238	0.192	0.153	3.646
Run-off, acre-feet	....	....	....	6,800	45,130	171,550	123,540	71,580	81,170	38,800	31,300	25,090	594,960
Acre-feet per square mile	....	....	....	2.22	14.75	56.06	40.38	23.39	26.52	12.68	10.23	8.20	194.43

DISCHARGE OF ARKANSAS RIVER AT CANON CITY FOR 1910.
Drainage Area, 3,060 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	655	370	370	692	1,840	3,260	1,220	680	600	465	290	....	
2	730	345	480	618	1,660	3,025	1,220	580	630	410	410	....	
3	480	322	450	692	1,270	3,100	1,170	620	630	330	410	....	
4	370	300	480	692	1,270	3,025	1,170	830	560	330	380	....	
5	395	300	510	618	1,490	2,800	1,122	740	330	290	380	....	
6	300	322	655	510	1,490	2,650	1,075	740	330	315	380	....	
7	278	345	618	480	1,435	2,430	932	520	330	315	305	....	
8	345	370	618	510	1,490	2,155	627	470	255	310	305	....	
9	422	322	580	545	1,545	1,960	595	490	230	310	305	....	
10	480	345	545	545	1,840	1,840	595	490	230	330	280	....	
11	450	345	480	580	2,155	1,720	562	470	210	290	300	....	
12	480	370	480	618	2,360	1,660	530	470	210	270	300	....	
13	450	370	422	692	2,725	1,660	438	490	210	300	280	....	
14	450	395	480	810	2,500	1,780	385	470	225	260	280	....	

DISCHARGE OF ARKANSAS RIVER AT CANON CITY FOR 1910—Concluded.
Drainage Area, 3,060 Square Miles.

DAY	Jan.	Feb?	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov	Dec.	Period
15	510	395	480	692	2,155	1,720	360	470	245	290	295	....	
16	480	235	480	692	1,720	1,720	360	390	245	290	295	....	
17	510	215	480	655	1,490	1,840	360	370	245	370	295	....	
18	422	278	510	618	1,325	1,490	325	390	275	390	270	....	
19	395	395	545	580	1,220	1,325	360	410	400	365	270	....	
20	422	395	545	618	1,170	1,270	410	430	375	490	280	....	
21	395	395	618	655	1,220	1,325	410	405	300	360	240	....	
22	422	450	618	692	1,960	1,270	498	380	315	360	260	....	
23	450	480	655	692	2,025	1,325	500	380	330	605	270	....	
24	480	395	655	730	1,840	1,435	450	400	275	355	270	....	
25	450	422	655	810	1,660	1,380	420	370	335	355	315	....	
26	345	450	618	990	1,545	1,380	340	370	345	355	265	....	
27	345	345	655	1,190	1,720	1,380	300	370	385	350	265	....	
28	322	370	580	1,535	1,840	1,380	320	345	470	345	245	....	
29	370	....	655	2,265	2,025	1,270	1,260	345	460	300	245	....	
30	370	....	580	2,335	2,950	1,220	820	320	355	275	245	....	
31	345	....	618	....	3,340	....	880	490	....	255	....	....	
Total	13,318	1,0041	17,115	24,351	56,275	55,795	20,014	14,695	10,335	10,635	8,930	....	
Mean	430	359	552	812	1,815	1,850	646	474	345	343	298	....	723
Maximum	730	480	655	2,335	3,340	3,260	1,260	830	630	605	410	....	3,340
Minimum	278	215	370	480	1,170	1,220	300	320	210	255	240	....	210
Run-off per square mile	0.140	0.117	0.180	0.265	0.593	0.608	0.211	0.155	0.113	0.112	0.097	....	0.236
Run-off, depth, inches	0.161	0.123	0.208	0.296	0.682	0.678	0.243	0.179	0.126	0.129	0.108	....	2.933
Run-off, acre-feet	26,440	19,940	33,940	48,320	111,630	110,680	39,720	29,150	20,530	21,090	17,730	....	479,170
Acre-feet per square mile	8.64	6.52	11.09	15.79	36.48	36.17	12.98	9.53	6.71	6.89	5.79	....	156.57

ARKANSAS RIVER AT PUEBLO.

This station is located at Main Street bridge, Pueblo, and is maintained jointly by the United States Geological Survey and the State.

The equipment consists of an automatic gauge owned by the State and a chain gauge owned by the United States Geological Survey. Measurements are made from the Main Street bridge.

The bed of the stream is composed of sand and gravel and shifts generally at high water.

The observer is D. J. Cox, who is paid $5.00 per month for reading the chain gauge and 25 cents for each trip to the automatic gauge.

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT PUEBLO.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 5	*W. B. Freeman	....	66	1.67	1.74	106
May 23	Geo. J. Lyon	....	282	3.76	3.20	1051
June 5	Geo. J. Lyon	....	432	5.35	3.95	2313
June 10	W. B. Freeman	....	439	5.63	4.35	2473
June 24	W. B. Freeman	....	477	5.46	4.64	2608
July 16	Thos. Grieve	....	312	4.09	3.38	1275
July 22	Geo. J. Lyon and G. H. Russell	....	306	4.47	3.56	1369
July 23	Thos. Grieve	....	331	4.16	3.52	1372
July 30	Thos. Grieve	....	346	4.57	3.65	1581
Aug. 7	Thos. Grieve	....	196	2.80	2.63	548
Aug. 25	G. H. Russell	....	266	3.68	3.18	980

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT PUEBLO—Concluded.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Sept. 16	C. L. Chatfield		366	4.65	3.72	1712
	Sept. 17	G. H. Russell		347	4.57	3.60	1587
	Oct. 7	Thos. Grieve		262	3.63	3.00	949
	Oct. 15	Thos. Grieve		221	3.14	2.76	696
	Oct. 18	G. H. Russell		213	3.22	2.70	685
	Nov. 5	*C. L. Chatfield		168	2.94	2.49	494
	Nov. 24	G. H. Russell		187	3.18	2.65	595
	Dec. 16	C. L. Chatfield		181	3.13	2.52	567
	Dec. 21	†G. H. Russell		128	2.10	2.55	268
1910	Jan. 20	*Thos. Grieve	71.5	147	3.26	2.55	478
	Feb. 25	G. H. Russell	113	178	3.23	2.65	575
	Mch. 3	Thos. Grieve	150	228	3.66	2.88	835
	Mch. 16	*Thos. Grieve	69	104	3.38	2.24	351
	Mch. 22	Thos. Grieve	150	164	3.39	2.55	556
	Mch. 31	*C. L. Chatfield	75	124	3.86	2.45	478
	Apr. 5	G. H. Russell	136	181	3.34	2.58	606
	Apr. 28	A. A. Weiland	151	275	4.44	3.28	1220
	Apr. 29	Lyon & Lamb	150.5	338.7	4.58	3.62	1555
	Apr. 30	A. A. Weiland	151	422	5.13	4.07	2169
	May 14	A. A. Weiland	151	445	5.61	4.50	2495
	May 31	A. A. Weiland	151	511	5.91	4.86	3016
	June 9	R. H. Bolster and G. J. Lyon	151	377	4.67	3.93	1761
	June 23	G. H. Russell	150	310	3.89	3.46	1256
	July 23	G. H. Russell	74	161	2.46	2.40	396
	Aug. 16	G. H. Russell	70	136	2.37	2.20	322
	Aug. 30	*A. A. Weiland	62			1.99	194
	Sept. 16	G. H. Russell	64	98	1.89	1.90	185
	Oct. 4	S. T. Harding	64	88.5	1.81	1.91	160
	Nov. 23	Padgett & Miles	122	129	2.43	2.15	313

*Measurements made at different sections. †Slush and anchor ice.

DICHARGE OF ARKANSAS RIVER AT PUEBLO FOR 1909.

Drainage Area, 4,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					290	1,150	2,630	1,150	1,275	865	580	580	
2					220	1,095	2,770	1,150	1,330	820	580	580	
3					200	1,095	2,630	1,150	1,220	820	580	580	
4					160	1,370	2,700	805	2,360	820	660	660	
5					142	2,510	3,000	805	2,500	820	545	510	
6					160	3,230	3,910	680	3,250	820	510	510	
7					200	3,010	2,550	640	3,025	910	580	510	
8					290	3,070	2,270	640	3,730	1,010	580	545	
9					340	2,850	2,065	940	3,570	1,010	510	580	
10					370	2,400	2,000	760	3,250	910	510	660	
11					565	2,810	1,805	760	2,220	910	510	660	
12					640	2,940	1,550	760	2,090	910	545	580	
13					680	2,920	1,370	760	2,220	910	580	660	
14					680	3,420	1,370	1,040	2,155	820	580	580	
15					680	2,170	1,150	1,260	1,895	780	580	580	

DISCHARGE OF ARKANSAS RIVER AT PUEBLO FOR 1909.—Concluded.
Drainage Area, 4,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
16	....	....	....	....	600	2,220	1,260	805	1,635	740	580	580	
17	....	....	....	....	530	2,130	1,430	1,095	1,635	660	580	580	
18	....	....	....	....	530	2,750	1,205	5,520	1,510	660	580	230	
19	....	....	....	....	600	4,000	1,095	2,915	1,510	660	580	250	
20	....	....	....	340	720	4,160	1,040	2,065	1,390	660	580	420	
21	....	....	....	340	990	3,940	940	1,260	1,275	620	620	580	
22	....	....	....	340	1,040	2,600	1,610	2,765	1,220	580	660	700	
23	....	....	....	400	1,040	2,360	1,490	760	1,220	660	620	1,110	
24	....	....	....	370	1,150	2,850	2,990	680	1,220	660	580	1,330	
25	....	....	....	340	1,040	3,650	2,000	850	1,220	660	510	1,450	
26	....	....	....	200	940	2,920	1,740	865	1,010	580	510	960	
27	....	....	....	200	940	2,630	1,550	910	1,010	580	510	1,060	
28	....	....	....	220	1,040	2,700	1,610	910	960	580	545	1,220	
29	....	....	....	240	1,260	2,770	1,675	910	910	580	580	1,060	
30	....	....	....	265	1,315	2,700	1,490	1,060	865	580	580	1,110	
31	....	....	....	....	1,205	....	1,040	1,060	....	580	....	1,220	
Total	....	....	....	3,255	20,557	80,420	57,935	37,730	54,680	23,175	17,045	22,635	
Mean	....	....	....	296	663	2,681	1,869	1,217	1,823	748	568	730	1,240
Maximum	....	....	....	400	1,315	4,160	3,910	5,520	3,730	1,010	660	1,450	5,520
Minimum	....	....	....	200	142	1,095	940	640	865	580	510	230	142
Run-off per square mile	....	....	....	0.064	0.144	0.583	0.406	0.265	0.396	0.163	0.123	0.159	0.270
Run-off, depth, inches	....	....	....	0.026	0.166	0.650	0.468	0.306	0.442	0.187	0.137	0.183	2.565
Run-off, acre-feet	....	....	....	6,456	40,766	159,530	114,923	74,830	108,479	45,993	33,798	44,885	629,660
Acre-feet per square mile	....	....	....	1.40	8.86	34.68	24.99	16.27	23.58	10.00	7.35	9.76	136.89

DISCHARGE OF ARKANSAS RIVER AT PUEBLO FOR 1910.
Drainage Area, 4,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	2,240	515	488	590	1,740	3,110	1,400	450	450	200	315	....	
2	1,040	395	555	590	1,565	2,972	1,140	515	548	200	315	....	
3	688	422	630	710	1,345	2,838	1,140	340	548	180	315	....	
4	515	395	555	710	1,140	2,770	1,190	1,565	515	160	290	....	
5	650	340	670	630	1,345	2,568	1,040	1,040	315	160	315	....	
6	650	450	840	488	1,455	2,568	1,040	768	200	142	340	....	
7	855	422	710	520	1,240	2,305	990	580	240	142	315	....	
8	1,040	368	670	455	1,455	2,045	725	515	200	160	290	....	
9	1,290	422	670	390	1,400	1,800	515	422	125	125	125	....	
10	1,565	395	520	555	1,800	1,680	615	482	142	142	142	....	
11	1,740	368	455	590	1,980	1,510	515	482	142	220	220	....	
12	1,680	395	360	520	2,045	1,565	3,390	422	108	200	200	....	
13	1,510	395	300	710	2,500	1,680	990	580	142	200	265	....	
14	1,090	395	390	710	2,568	1,620	422	515	340	220	290	....	
15	900	450	422	590	2,305	1,680	315	515	125	200	315	....	
16	900	368	360	555	1,800	1,740	340	315	160	240	368	....	
17	855	200	390	520	1,565	1,920	290	220	142	240	340	....	
18	615	340	390	590	1,400	1,740	315	290	125	315	340	....	
19	650	368	300	555	1,345	1,345	290	142	200	290	340	....	
20	580	395	488	590	1,345	1,240	290	240	340	340	340	....	

DISCHARGE OF ARKANSAS RIVER AT PUEBLO FOR 1910—Concluded.

Drainage Area, 4,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
21	580	395	590	555	1,400	1,290	290	395	240	368	340	....	
22	650	395	520	710	1,860	1,290	340	265	240	340	290	....	
23	650	450	630	710	2,045	1,240	340	265	265	368	290	....	
24	580	580	670	630	1,860	1,400	368	265	180	395	265	....	
25	580	725	555	795	1,740	1,400	340	240	200	368	240	....	
26	548	580	630	930	1,740	1,510	240	265	180	368	290	....	
27	450	450	670	978	1,400	1,400	240	220	160	368	290	....	
28	515	482	520	1,230	1,740	1,455	200	200	240	340	290	....	
29	482	....	590	1,560	1,860	1,400	768	220	265	340	240	....	
30	482	....	590	2,112	2,305	1,290	1,980	200	200	340	220	....	
31	482	....	488	....	3,040	....	810	200	....	315	....	....	
Total	27,052	11,855	16,616	21,778	54,328	54,371	22,868	13,133	7,277	7,986	8,535	....	
Mean	873	423	536	726	1,752	1,812	738	424	243	258	284	....	736
Maximum	2,240	725	840	2,112	3,040	3,110	3,390	1,565	548	395	368	....	3,390
Minimum	450	200	300	390	1,140	1,240	200	142	108	125	125	....	125
Run-off per square mile	0.190	0.092	0.116	0.158	0.381	0.394	0.160	0.092	0.053	0.056	0.062	....	0.160
Run-off, depth, inches	0.219	0.096	0.134	0.176	0.439	0.440	0.184	0.106	0.059	0.065	0.069	....	1.987
Run-off, acre-feet	53,680	23,490	32,960	43,200	107,720	107,820	45,320	26,070	14,460	15,860	16,900	....	487,480
Acre-feet per square mile	11.67	5.11	7.16	9.39	23.42	23.44	9.85	5.67	3.14	3.45	3.67	....	105.97

ARKANSAS RIVER AT NEPESTA.

This station is located at the dam of the Oxford Farmers Canal Company, about 1½ miles above Nepesta.

The equipment consists of a pile dam, staff gauge and automatic gauge. Both gauges have their zeros at the same elevation as the crest of the dam. The automatic gauge, which is the property of the State, was installed on August 23, 1910.

The bed of the stream is sandy and shifting at the dam and at the highway bridge at Nepesta where measurements are made at high water.

The observer is Matt West, headgate keeper for the Oxford Farmers Canal Company, and his services are furnished the State gratis.

DISCHARGE MEASUREMENTS OF ARKANSAS RIVER AT NEPESTA.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	July 14	Thos Grieve	....	341	3.44	1.10	1172
	Aug. 8	Thos. Grieve	....	....	....	0.80	589
	Sept. 15	C. L. Chatfield	....	446	4.57	1.59	2042
	Nov. 6	C. L. Chatfield and Thos. Grieve	....	176	2.31	0.75	404
1910	Jan. 24	*Thos Grieve	134	338	3.17	....	1071
	Mch. 2	Thos. Grieve	159	175	3.28	0.80	574
	Apr. 9	Thos. Grieve	152	....	....	0.60	422
	Apr. 30	C. L. Chatfield	....	398	4.22	1.50	1681
	Sept. 1	A. A. Weiland	47	38.4	2.35	0.44	90

*Ice gorge at Oxford Farmers Dam.

ARKANSAS RIVER AT HOLLY.

This station is located on a pile highway bridge about ¼ mile from Holly and is maintained jointly by the United States Geological Survey and the State.

The equipment consists of a chain gauge which is owned by the United States Geological Survey. Measurements are made from the bridge at high water.

The bed of the stream is composed of sand and gravel, and very shifting.

Owing to the poor conditions it is difficult to construct a rating curve for this station.

The observer is S. W. Jones, who is paid $5.00 per month.

DISCARGE MEASUREMENTS OF ARKANSAS RIVER AT HOLLY.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Apr. 17	Geo. J. Lyon		9.7	0.56	0.13	5.4
	May 8	Geo. J. Lyon		8.6	1.45	0.20	12.5
	May 30	Geo. J. Lyon	22	6.4	0.85	0.15	5.4
	July 10	Geo. J. Lyon		243	1.68	1.47	409
	Aug. 13	Geo. J. Lyon		8.6	0.83	0.30	7.1
	Aug. 26	G. H. Russell		225	2.22	1.90	500
	Sept. 6	C. L. Chatfield		266	2.65	1.90	706
	Nov. 10	C. L. Chatfield		54	1.67	1.25	90
	Dec. 31	G. H. Russell		207	2.08	2.20	431
1910	Jan. 22	*Thos. Grieve		274	2.50		684
	Feb. 28	Thos. G ieve		410	2.56	2.80	1048
	Apr. 28	C. L. Chatfield		43	1.26	1.45	54
	Apr. 30	G. H. Russell	60	26	1.23	1.31	32
	May 9	G. H. Russell	29.5	6.8	0.97	1.05	6.6
	Sept. 2	Geo. J. Lyon	38.5	9.2	0.81		7.5
	Nov. 1	†Thos. Grieve				1.10	10.0

*Channel fil ed with floating ice. †Estimated.

GRAPE CREEK NEAR CANON CITY.

This station was maintained by the United States Geological Survey in co-operation with the Colorado Southern Irrigation Company during 1909, and was discontinued in 1910 although measurements are still made.

It is located about 2 miles from Canon City and about one mile above the mouth of the creek.

The equipment consisted of a cable with car and a Friez automatic gauge. This gauge was removed in 1910.

The bed of the stream is composed of sand and gravel and shifts considerably. The banks are both high and not liable to overflow. The current is very swift at high stages.

DISCHARGE MEASUREMENTS OF GRAPE CREEK NEAR CANON CITY.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 6	W. B. Freeman	24	11	2.10	0.60	23
	July 21	G. H. Russell	18.5	11.0	2.85	1.00	31.0
	Aug. 21	G. H. Russell	15.5	7.2	3.01	0.90	21.7
	Sept. 18	G. H. Russell	23.0	29	8.00	3.00	232
	Oct. 14	G. H. Russell	14.0	9.8	3.16	1.20	30.9
	Nov. 4	Thos. Grieve and C. L. Chatfield	16.5	12.4	3.14	1.08	38.9
	Nov. 24	G. H. Russell	24	25.5	4.25	2.15	121
	Dec. 22	G. H. Russell	10.0	12.0	1.58	1.20	19.0

DISCHARGE MEASUREMENTS OF GRAPE CREEK NEAR CANON CITY.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Feb. 26......	G. H. Russell and Geo. J. Lyon............	15.5	12	3.17	1.45	38
Apr. 30......	Lyon & Lamb..........................	18.5	23.7	5.22	1.60	124
July 23......	G. H. Russell...........................	....	11.0	2.00	1.10	22
Aug. 17......	G. H. Russell...........................	13	7.0	2.86	1.32	20
Apr. 5......	G. H. Rus ell...........................	14.5	14	3.29	1.30	46
Aug. 11......	G. J. Lyon.............................	26	11	2.09	1.38	23
Sept. 17......	G. H. Russell...........................	18	7.5	2.10	....	28
Oct. 4......	S. T. Harding..........................	23	9.8	2.54	....	24.9
Oct. 28......	S. T. Harding..........................	22	8.91	2.70	*1.00	25.4
Nov. 24......	Padgett & Miles........................	17	5.8	2.60	....	15

*Approximately.

PURGATOIRE RIVER AT TRINIDAD.

This station, maintained by the United States Geological Survey, in co-operation with the State of Colorado, is located at the Animas Street bridge at Trinidad.

The equipment, which is owned by the United States Geological Survey, consists of a chain gauge on bridge footway.

The bed of the stream is composed of sand and boulders, and is extremely shifting. The current is swift at high stages. Banks overflow in extreme high water.

The observer is H. D. Albertson, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF PURGATOIRE RIVER AT TRINIDAD.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 1......	Geo. J. Lyon...........................	33	27.4	1.71	3.10	47
May 22......	Geo. J. Lyon...........................	55	50.4	3.00	4.70	151
June 28......	Geo. J. Lyon...........................	49.5	48.3	3.46	4.80	167
July 23......	G. H. Russell...........................	55	59.3	3.04	3.60	181
Aug. 24......	G. H. Russell...........................	....	88	4.54	4.55	402
Sept. 8......	C. L. Chatfield.........................	48	80	4.66	4.45	373
Sept. 16......	G. H. Russell...........................	....	55	2.88	3.80	152
Oct. 20......	G. H. Russell...........................	....	30	1.67	3.40	50
Oct. 29......	W. B. Freeman..........................	....	25.8	1.45	3.35	37.3
Nov. 25......	G. H. Russell...........................	....	28	1.21	3.35	34
Dec. 9......	G. H. Russell...........................	....	33	0.87	3.65	29
1910 Jan. 26......	*G. H. Russell..........................	18	9.8	0.45	3.35	4.4
Feb. 8......	*G. H. Russell..........................	25.5	25	0.43	3.90	10.7
Mch. 2......	*G. H. Russell..........................	12	12	2.25	5.10	27
Mch. 3......	*G. H. Russell..........................	11	11.5	2.30	5.10	26.5
Mch. 3......	*G. H. Russell..........................	11	11.5	2.35	5.10	27
Mch. 18......	*G. H. Russell..........................	12	14	2.86	5.30	40
Apr. 29......	G. H. Russell...........................	56	75	4.08	4.70	306
May 25......	W. B. Freeman..........................	48	55	2.73	4.28	150
June 23......	G. H. Russell...........................	32.5	35	1.94	3.81	68
July 26......	J. B. Stewart...........................	27.5	17.2	1.28	3.20	22.1
Aug. 4......	W. B. Freeman..........................	23.3	26.8	1.79	3.52	48.0
Aug. 16......	W. B. Freeman..........................	32	17.6	1.85	3.50	32.6
Oct. 4......	G. H. Russell...........................	29	10.3	0.94	3.25	9.7
Oct. 23......	G. H. Russell...........................	32.5	17	1.50	3.50	25.5

*Gauge height distorted by dam below.

DISCHARGE OF PURGATOIRE RIVER AT TRINIDAD FOR 1909.
Drainage Area, 742 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	...	...	...	...	...	...	...	...	128	73	30	...	
2	...	...	...	...	...	...	...	...	128	73	30	...	
3	...	...	...	...	...	...	...	...	140	63	30	...	
4	...	...	...	...	...	...	...	...	183	63	30	...	
5	...	...	...	...	...	...	...	...	980	63	30	...	
6	...	...	...	...	...	...	...	...	980	63	30	...	
7	...	...	...	...	...	...	...	...	900	63	30	...	
8	...	...	...	...	...	...	...	...	330	63	30	...	
9	...	...	...	...	...	...	...	...	1,850	63	30	...	
10	...	...	...	...	...	...	...	...	213	63	30	...	
11	...	...	...	...	...	...	...	...	310	63	30	...	
12	...	...	...	...	...	...	...	...	330	54	30	...	
13	...	...	...	...	...	...	...	...	290	54	45	...	
14	...	...	...	...	...	...	...	...	213	45	45	...	
15	...	...	...	...	...	...	...	...	168	45	45	...	
16	...	...	...	...	...	...	...	...	140	45	45	...	
17	...	...	...	...	...	...	...	...	128	45	45	...	
18	...	...	...	...	...	...	...	...	128	45	45	...	
19	...	...	...	...	...	...	...	...	103	45	45	...	
20	...	...	...	...	...	...	...	380	128	45	45	...	
21	...	...	...	...	...	...	...	183	128	45	45	...	
22	...	...	...	...	...	...	...	183	115	45	45	...	
23	...	...	...	...	...	...	...	153	103	45	38	...	
24	...	...	...	...	...	...	...	550	93	45	38	...	
25	...	...	...	...	...	...	...	213	83	38	38	...	
26	...	...	...	...	...	...	...	520	83	38	30	...	
27	...	...	...	...	...	...	...	183	83	38	30	...	
28	...	...	...	...	...	...	...	153	83	38	30	...	
29	...	...	...	...	...	...	...	153	83	30	38	...	
30	...	...	...	...	...	...	...	128	73	30	38	...	
31	...	...	...	...	...	...	...	140	...	30	...	...	
Total	...	...	...	...	...	...	...	2,939	8,697	1,558	1,090	...	
Mean	...	...	...	...	...	...	...	245	290	50	36	...	139
Maximum	...	...	...	...	...	...	...	550	1,850	73	45	...	1,850
Minimum	...	...	...	...	...	...	...	128	73	30	30	...	30
Run-off per square mile	...	...	...	...	...	...	...	0.330	0.391	0.067	0.049	...	0.187
Run-off, depth, inches	...	...	...	...	...	...	...	0.147	0.436	0.077	0.055	...	0.715
Run-off, acre-feet	...	...	...	...	...	...	...	5,832	17,256	3,074	2,142	...	28,304
Acre feet per square mile	...	...	...	...	...	...	...	7.85	23.27	4.12	2.92	...	38.16

DISCHARGE OF PURGATOIRE RIVER AT TRINIDAD FOR 1910.
Drainage Area, 742 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	9	10	31	40	280	242	87	70	44	10	20	....	
2	9	10	27	40	280	242	97	64	44	10	20	....	
3	9	9	32	35	650	225	87	57	39	10	20	....	
4	9	10	31	40	650	225	80	80	29	10	20	....	
5	9	11	32	45	242	195	80	87	29	8	20	....	
6	9	11	32	35	242	210	57	87	29	8	20	....	
7	9	11	31	31	260	210	50	125	29	8	20	....	
8	9	11	31	31	242	195	45	87	24	6	20	....	
9	9	11	31	31	260	180	38	80	24	6	20	....	
10	9	10	31	40	260	165	38	105	24	6	20	....	
11	9	11	31	90	260	154	38	87	20	6	16	....	
12	9	9	31	150	260	154	38	238	16	5	16	....	
13	8	9	31	210	320	142	125	105	24	5	16	....	
14	8	9	31	300	408	142	97	125	24	5	16	....	
15	9	9	31	225	362	131	64	97	20	5	16	....	
16	10	9	31	225	300	131	38	39	44	5	16	....	
17	10	9	40	180	300	120	33	16	24	5	16	....	
18	10	9	40	165	242	109	25	13	20	5	16	....	
19	10	9	40	165	210	109	17	34	20	16	16	....	
20	10	9	40	225	210	109	17	16	24	34	16	....	
21	10	8	40	260	195	109	64	16	29	29	16	....	
22	10	8	42	225	225	80	57	16	44	29	16	....	
23	10	9	45	180	225	65	38	50	29	29	16	....	
24	10	9	45	165	225	65	425	44	20	29	20	....	
25	10	15	45	195	408	65	28	50	20	29	20	....	
26	9	15	45	195	408	65	25	44	16	154	20	....	
27	9	15	45	210	195	58	20	44	13	29	20	....	
28	9	15	40	260	195	58	13	65	10	29	20	....	
29	10	....	40	340	195	131	20	50	8	24	16	....	
30	10	....	32	300	210	58	315	50	8	20	16	....	
31	10	....	31	....	225	....	238	50	....	20	....	....	
Total	290	290	1,105	4,833	8,944	4,144	2,394	2,091	748	594	540	....	
Mean	9	10	36	161	289	138	77	67	25	19	18	....	77.8
Maximum	10	15	45	340	650	242	425	238	44	154	20	....	650
Minimum	8	8	31	31	195	58	13	13	8	5	16	....	5
Run-off per square mile	0.013	0.014	0.048	0.217	0.389	0.186	0.104	0.091	0.034	0.026	0.024	....	0.105
Run-off, depth, inches	0.015	0.014	0.055	0.242	0.448	0.208	0.120	0.105	0.038	0.030	0.026	....	1.301
Run-off, acre-feet	553	555	2,214	9,580	17,770	8,212	4,735	4,120	1,488	1,168	1,071	....	51,466
Acre-feet per square mile	0.74	0.75	2.98	12.91	23.95	11.07	6.38	5.55	2.00	1.57	1.44	....	69.34

MISCELLANEOUS MEASUREMENTS IN ARKANSAS RIVER BASIN.

DATE	HYDROGRAPHER	STREAM	LOCALITY	Discharge
1909 Aug. 1	Thos. Grieve	Arkansas River	Las Animas	117
Aug. 3	Thos. Grieve	Arkansas River	Las Animas	53
Nov. 10	C. L. Chatfield	Arkansas River	Las Animas	119
July 31	Thos. Grieve	Purgatory River	Las Animas	131
Aug. 3	Thos. Grieve	Purgatory River	Las Animas	107
Nov. 10	C. L. Chatfield	Purgatory River	Las Animas	26
Sept. 15	C. L. Chatfield	Purgatory River	Higbee	482
1910 Jan. 23	Thos. Grieve	Arkansas River	La Junta	635
June 23	A. A. Weiland	Arkansas River	La Junta	550
Aug. 30	A. A. Weiland	Arkansas River	Boone	286
June 12	A. A. Weiland	Clear Creek	Geibfried's Ranch	236
Apr. 2	A. A. Weiland	East Four Mile Creek	At junction with West Four Mile Creek	10.9
Apr. 12	Thos. Grieve	Four Mile or Oil Creek	At mouth	21
Sept. 20	Thos. Grieve	Four Mile or Oil Creek	At mouth	28
Oct. 31	Thos. Grieve	Four Mile or Oil Creek	At mouth	51
May 5	A. A. Weiland	Lake Creek	Twin Lakes	116
July 19	A. A. Weiland	Lake Creek	Twin Lakes	69
May 31	A. A. Weiland	Four Mile or Oil Creek	Headgate Long Gulch Ditch	15
May 31	A. A. Weiland	Four Mile or Oil Creek	End of Garden Park	16.5
Apr. 22	A. A. Weiland	St. Charles River	Lime	148

GRAND RIVER DRAINAGE.

GRAND LAKE OUTLET AT GRAND LAKE.

This station was established July 31, 1904, and is maintained at present by co-operation between United States Geological Survey, United States Forest Service and the State.

It is located at foot bridge across outlet right at the lake. Measurements at high water are made from foot bridge, at low water by wading about ¼ mile below. Gauge is staff, spiked to one of crib piers.

Gauge height represents height of lake level.

Observer is United States Forester T. O. Smith, whose services are gratis.

DISCHARGE MEASUREMENTS OF GRAND LAKE OUTLET AT GRAND LAKE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 3	C. L. Chatfield	17	12	1.67	1.60	20
Aug. 10	W. B. Freeman	95	118	1.02	2.20	120
1910 July 4	W. B. Freeman	64	136	1.50	2.49	204
Sept. 20	S. T. Harding	128	107	1.00	2.21	111

DISCHARGE OF GRAND LAKE OUTLET AT GRAND LAKE FOR 1909.
Drainage Area, 62 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	9.2	11.0	7.5	9.2	16	170	1,042	156	97				
2	9.2	11.0	7.5	9.2	20	170	1,042	143	97				
3	9.2	11.0	7.5	9.2	20	214	1,042	143	87				
4	9.2	11.0	7.5	9.2	20	372	1,014	143	87				
5	9.2	11.0	7.5	9.2	24	555	1,126	131	87				
6	9.2	9.2	7.5	9.2	34	762	930	119	87				
7	11.0	9.2	7.5	9.2	46	818	790	119	97				
8	11.0	9.2	7.5	9.2	53	902	708	119	156				
9	11.0	9.2	7.5	9.2	60	874	605	119	170				
10	11.0	9.2	6.0	9.2	77	818	555	119	143				
11	9.2	9.2	6.0	9.2	77	735	506	143	119				
12	9.2	9.2	6.0	9.2	87	605	459	143	97				
13	9.2	9.2	6.0	9.2	87	605	414	156	97				
14	9.2	9.2	6.0	9.2	87	656	352	156	87				
15	11.0	11.0	6.0	9.2	87	656	333	143	87				
16	11.0	11.0	6.0	9.2	77	708	297	119	87				
17	11.0	11.0	6.0	11.0	77	846	297	119	77				
18	11.0	11.0	6.0	11.0	97	1,042	297	170	68				
19	11.0	11.0	6.0	13.5	119	1,212	297	170	68				
20	11.0	11.0	6.0	13.5	170	1,212	297	143	60				
21	11.0	11.0	6.0	13.5	246	1,014	297	119	53				
22	13.5	9.2	6.0	13.5	297	986	297	119	53				
23	13.5	9.2	7.5	13.5	297	958	280	97	53				
24	13.5	9.2	9.2	13.5	297	1,042	297	119	46				
25	13.5	9.2	9.2	13.5	230	1,098	297	119	46				
26	13.5	9.2	9.2	13.5	184	1,014	280	119	46				
27	13.5	9.2	9.2	13.5	170	1,042	263	97	40				
28	11.0	9.2	9.2	16.0	170	986	230	97	40				
29	11.0		9.2	16.0	230	1,042	199	97	40				
30	11.0		9.2	16.0	230	986	184	87	40				
31	11.0		9.2		199		170	87					
Total	338.0	279.2	226.6	338.7	3,885	24,100	15,197	3,930	2,412				
Mean	10.9	10.0	7.3	11.3	125	803	490	127	80				186
Maximum	13.5	11.0	9.2	16.0	297	1,212	1,126	170	170				1,212
Minimum	9.2	9.2	6.0	9.2	16	170	170	87	40				6
Run-off per quare mile	0.176	0.161	0.118	0.182	2.016	12.952	7.903	2.048	1.290				3.000
Run-off, depth, inches	0.203	0.168	0.136	0.203	2.324	14.450	9.111	2.361	1.439				30.395
Run-off, acre-feet	670	555	449	672	7,686	47,782	30,129	7,809	4,760				100,512
Acre feet per square mile	10.82	8.94	7.26	10.83	123.96	770.70	485.93	125.93	76.76				1,621.13

NORTH FORK GRAND RIVER NEAR GRAND LAKE.

This station was established July 29, 1904, by the United States Geological Survey. The records at present are obtained through co-operation between United States Geological Survey, Forest Service and State.

This station is located on stage road Granby to Grand Lake, about 3 miles from Grand Lake. Gauge is a staff spiked to right abutment.

Channel is rocky and permanent.

Observer is United States Forester T. O. Smith, whose services are gratis.

DISCHARGE MEASUREMENTS OF NORTH FORK GRAND RIVER, NEAR GRAND LAKE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 3......	*C. L. Chatfield..........................	40	59	0.76	3.60	45
Aug. 9......	Freeman & Woolsey..........................	44	42	2.10	3.97	88
1910 July 4......	R. H. Bolster..........................	39	86	1.35	4.05	116
July 4......	*W. B. Freeman..........................	49	47	2.10	4.05	99
Sept. 8......	S. T. Harding..........................	38	67.4	0.84	3.80	57
Sept. 21......	S. T. Hard ng..........................	40	75	1.25	4.07	94

*Wading.

DISCHARGE OF NORTH FORK OF GRAND RIVER NEAR GRAND LAKE FOR 1909.

Drainage Area, 125 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1..........	19	19	16	19	50	345	895	140	80	....	....	....	
2..........	19	19	16	19	65	390	960	140	80	....	....	....	
3..........	19	16	19	19	80	480	960	125	72	....	....	....	
4..........	19	16	19	19	95	615	1,170	112	72	....	....	....	
5..........	19	16	19	19	110	675	1,170	112	72	....	....	....	
6..........	19	16	19	19	125	960	960	100	72	....	....	....	
7..........	19	16	19	19	140	960	830	100	72	....	....	....	
8..........	19	16	19	19	160	960	765	100	155	....	....	....	
9..........	19	19	19	19	172	960	705	90	140	....	....	....	
10..........	19	19	22	19	190	895	480	90	100	....	....	....	
11..........	19	19	22	19	210	765	390	90	90	....	....	....	
12..........	19	19	22	19	225	735	390	100	80	....	....	....	
13..........	19	16	22	19	245	735	345	100	65	....	....	....	
14..........	22	16	19	19	260	765	322	90	65	....	....	....	
15..........	22	16	19	19	242	765	300	80	65	....	....	....	
16..........	19	16	19	22	300	765	280	100	65	....	....	....	
17..........	19	19	19	22	260	960	260	125	65	....	....	....	
18..........	16	19	19	22	322	1,170	260	225	65	....	....	....	
19..........	16	19	19	22	390	1,475	260	125	65	....	....	....	
20..........	16	19	19	19	480	1,555	260	100	65	....	....	....	....
21..........	16	19	19	19	530	1,245	260	90	58	....	....	....	
22..........	19	19	19	19	480	1,170	242	80	58	....	....	....	
23..........	19	16	19	19	480	1,170	242	80	50	....	....	....	
24..........	19	16	19	22	412	1,245	300	72	50	....	....	....	
25..........	19	16	34	22	345	1,170	225	72	50	....	....	....	
26..........	19	16	34	22	300	1,170	208	72	50	....	....	....	
27..........	19	19	16	22	322	1,030	190	72	44	....	....	....	
28..........	19	22	16	38	368	1,030	155	65	44	....	....	....	
29..........	22	....	16	38	480	895	155	65	44	....	....	....	
30..........	22	....	19	50	368	895	140	65	44	....	....	....	
31..........	22	....	19	....	345	....	140	80	....	....	....	....	
Total..........	592	493	616	663	8,551	27,950	14,219	3,057	2,090	....	....	....	
Mean..........	19	18	20	22	276	932	459	99	70	....	....	....	213
Maximum..........	22	22	34	50	530	1,555	1,170	225	155	....	....	....	1,555
Minimum..........	16	16	16	19	50	345	140	65	44	....	....	....	16
Run-off per square mile..........	0.153	0.141	0.159	0.177	2.208	7.456	3.672	0.792	0.560	....	....	....	1.704
Run-off, depth, inches..........	0.176	0.147	0.183	0.198	2.546	8.319	4.233	0.913	0.625	....	....	....	17.340
Run-off, acre-feet..........	1,174	977	1,224	1,315	16,971	55,458	28,223	6 087	4,165	....	....	....	115,594
Acre-feet per square mile..........	9.41	7.83	9.78	10.53	135.76	443.66	225.78	48.70	33.32	....	....	....	924.77

GRAND RIVER NEAR GRANBY.

This station is maintained in co-operation with the United States Geological Survey, which pays the salary of the observer. It is located about five miles from Granby on road to Grand Lake.

The equipment consists of two staff gauges and cable and car. This equipment is owned by the Central Colorado Power Company.

The bed of the stream is composed of sand and boulders. The current is swift at high water.

The observer is J. P. Switzer.

DISCHARGE MEASUREMENTS OF GRAND RIVER NEAR GRANBY.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Mch. 10	C. L. Chatfield	25	30	1.10	2.40	33
	May 4	C. L. Chatfield	95	145	1.78	2.10	259
	May 7	C. L. Chatfield	98	153	2.52	2.55	386
	May 8	C. L. Chatfield	100	144	2.38	2.46	343
	June 17	W. H. Sne'son and C. L. Chatfield	111	411	6.30	4.65	2586
	Aug. 9	W. B. Freeman and R. H. Woolsey	90	170	2.15	2.41	366
	Oct. 14	R. H. Woo'sey	85	104	1.17	1.67	122
1910	Feb' 22	*H. A. Howe	24	19	1.71	3.10	32.9
	Mch. 11	H. A. Howe	25	26	2.18	3.20	56.6
	May 7	H. A. Howe	100	176	2.54	2.60	448
	June 4	H. A. Howe	109	349	5.35	4.20	1868
	July 5	Bolster & Freeman	100	197	1.83	2.77	557
	July 30	C. L. Cha field	99	157	2.10	2.40	333
	Sept. 19	C. L. Chatfield	96	140	1.72	2.16	241
	Oct. 7	Chatfield & Hezma'ha'ch	89.5	92	1.21	1.68	111
	Oct. 8	Chatfield & Hezmalhalch	89.5	99	1.11	1.68	110

*Ice conditions.

DISCHARGE OF GRAND RIVER NEAR GRANBY FOR 1909.

Drainage Area, 484 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	50	40	40	60	145	815	3,250	432	270	125	62	55	
2	50	40	40	60	145	850	3,075	432	290	125	62	55	
3	50	40	40	65	158	1,000	3,250	432	270	125	62	55	
4	50	40	35	65	218	1,270	3,075	405	270	125	62	55	
5	50	40	35	70	310	1,880	2,650	355	252	125	62	55	
6	50	40	35	70	405	2,320	2,400	380	270	125	62	55	
7	50	40	33	70	432	2,735	1,950	380	432	125	62	55	
8	50	40	33	75	490	2,905	1,810	405	432	105	62	55	
9	50	40	33	75	460	2,820	1,675	355	405	105	62	55	
10	50	40	33	80	460	2,480	1,550	380	380	105	62	55	
11	50	40	33	80	550	2,170	1,325	355	332	105	62	55	
12	50	40	33	80	580	2,020	1,170	432	310	105	62	55	
13	50	40	33	85	612	2,095	1,125	460	332	105	70	55	
14	50	40	33	85	550	2,020	962	432	310	105	70	55	
15	50	40	33	90	580	2,020	925	405	270	105	70	55	
16	45	35	35	90	580	2,095	925	460	235	105	70	55	
17	45	35	35	90	645	2,400	888	432	218	105	70	55	
18	45	35	35	90	678	2,990	850	580	200	105	70	55	
19	45	35	35	90	745	3,710	850	490	200	105	70	55	
20	45	35	35	90	925	4,000	850	432	200	85	70	55	
21	45	35	40	95	1,000	3,250	850	432	170	85	70	50	
22	45	35	40	70	1,125	3,250	780	405	145	85	70	50	

DISCHARGE OF GRAND RIVER NEAR GRANBY FOR 1909—Concluded.
Drainage Area, 484 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
23	45	35	45	115	1,270	3,250	710	380	145	85	70	50	
24	45	35	45	95	1,080	3,250	780	332	145	85	70	50	
25	45	35	50	95	925	3,430	745	310	145	78	70	50	
26	45	40	50	115	780	3,075	745	310	125	78	70	50	
27	45	40	55	125	710	3,160	745	270	125	78	70	50	
28	45	40	55	135	780	3,075	612	270	125	78	70	50	
29	45	....	60	158	1,040	2,735	550	270	125	78	70	50	
30	45	....	60	170	888	3 250	520	270	125	70	70	50	
31	45	....	65	....	780	....	432	270	....	70	....	50	
Total	1,470	1,070	1,262	2,733	20,046	76,320	42,024	11,953	7,253	3,082	2,004	1,650	
Mean	47	38	41	91	647	2,544	1,356	381	242	99	67	53	468
Maximum	50	40	65	170	1,270	4,000	3,250	580	432	125	70	55	4,000
Minimum	45	35	33	60	145	815	432	270	125	70	62	50	33
Run-off per square mile	0.097	0.079	0.085	0.188	1.337	5.256	2.802	0.787	0.500	0.205	0.138	0.110	0.967
Run-off, depth, inches	0.112	0.082	0.098	0.210	1.541	5.864	3.230	0.907	0.558	0.236	0.154	0.127	13.119
Run-off, acre-feet	2,890	2,110	2,521	5,415	39,782	151,378	83,377	23,427	14,400	6,087	3,987	3,259	338,633
Acre-feet per square mile	5.96	4.39	5.23	11.19	82.21	312.74	172.29	48.39	29.75	12.60	8.21	6.76	699.72

DISCHARGE OF GRAND RIVER NEAR GRANBY FOR 1910.
Drainage Area, 484 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	158	710	2,320	645	310	115	170	105	....	
2	....	....	....	170	710	2,245	645	310	135	145	105	....	
3	....	....	....	170	612	1,950	645	270	170	145	105	....	
4	....	....	....	158	550	1,810	580	270	185	145	85	....	
5	....	....	....	158	520	1,435	520	252	218	145	85	....	
6	....	....	....	170	612	1,270	490	235	218	125	85	....	
7	....	....	....	185	745	1,325	460	235	200	125	85	....	
8	....	....	....	200	780	1,125	405	200	200	125	85	....	
9	....	....	....	235	888	1,080	405	200	170	125	85	....	
10	....	....	....	270	962	1,000	355	185	170	125	105	....	
11	....	....	....	270	1,040	1,040	355	170	170	125	105	....	
12	....	....	....	270	1,080	1,125	310	170	200	125	105	....	
13	....	....	....	270	1,040	1,080	310	170	200	125	105	....	
14	....	....	....	270	962	1,080	270	170	200	125	85	....	
15	....	....	....	200	850	1,080	270	170	235	125	85	....	
16	....	....	....	200	925	1,080	270	170	235	125	85	....	
17	....	....	....	252	815	1,080	270	170	200	125	85	....	
18	....	....	....	270	710	962	235	170	200	125	85	....	
19	....	....	....	310	645	925	235	170	200	125	85	....	
20	....	....	....	290	678	925	200	170	200	125	85	....	
21	....	....	....	235	710	815	200	158	235	125	85	....	
22	....	....	....	290	780	780	235	145	235	125	85	....	
23	....	....	....	310	710	780	200	145	235	125	85	....	
24	....	....	....	355	850	710	170	125	235	125	85	....	
25	....	....	....	432	780	710	170	125	218	125	85	....	
26	....	....	....	490	962	710	170	125	185	125	85	....	
27	....	....	....	612	1,220	710	170	105	185	125	[illegible]	....	

DISCHARGE OF GRAND RIVER NEAR GRANBY FOR 1910—Concluded.
Drainage Area, 484 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
28	....	....	....	710	1 080	780	170	105	185	125	85	....	
29	....	....	....	710	1,490	780	235	105	170	125	85	....	
30	....	....	....	780	1,675	710	355	105	170	125	85	....	
31	....	....	....	....	2,095	....	290	105	....	125	....	....	
Total	....	....	....	9,400	28,186	33,392	10,240	5,515	5,909	4,000	2,670	....	
Mean	....	....	....	313	909	1,113	330	178	197	129	89	....	407
Maximum	....	....	....	780	2,095	2,320	645	310	235	170	105	....	2,320
Minimum	....	....	....	158	520	710	170	105	115	125	85	....	85
Run off per square mile	....	....	....	0.647	1.878	2.300	0.682	0.368	0.407	0.267	0.184	....	0.841
Run off, depth, inches	....	....	....	0.722	2.163	2.566	0.786	0.424	0.454	0.308	0.205	....	7.628
Run-off, acre-feet	....	....	....	18,625	55,892	66,229	20,291	10,945	11,722	7,932	5,296	....	196,932
Acre-feet per square mile	....	....	....	38.50	115.48	136.86	41.94	22.63	24.22	16.42	10.95	....	407.00

GRAND RIVER AT SULPHUR SPRINGS.

This station is located on steel road bridge between Denver, Northwestern & Pacific station and town. Station first established July 27, 1904.

Co-operative station between United States Geological Survey, United States Forest Service and State.

Equipment—Measurements from bridge during open season and wading ½ mile below. Gauge is chain type.

Observer is United States Forester, services gratis.

DISCHARGE MEASUREMENTS OF GRAND RIVER AT SULPHUR SPRINGS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Mch. 10	C. L. Chatfield		72	1.42	2.55	102
	Apr. 29	C. L. Chatfield		194	2.80	2.40	543
	May 8	C. L. Chatfield		278	3.88	3.20	1080
	June 17	C. L. Chatfield and W. H. Snelson, Jr		902	5.71	6.17	5142
	Aug. 8	Freeman & Woolsey		226		2.70	608
1910	July 2	Bolster & Freeman	118	258	3.50	3.09	904
	July 29	C. L. Chatfield	110.6	185	2.56	2.45	474
	Sept. 17	C. L. Chatfield	103.6	142	2.03	2.10	288
	Oct. 8	C. L. Chatfield and C. C. Hezmalhalch	104.6	124	1.68	1.80	208

DISCHARGE OF GRAND RIVER AT SULPHUR SPRINGS FOR 1909.

Drainage Area, 946 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	109	85	125	470	388	1,885	5,350	1,010	560	....	....	....	
2	109	85	125	470	415	1,985	5,350	1,010	560	....	....	....	
3	109	85	135	552	470	2,450	5,150	940	560	....	....	....	
4	109	85	125	552	552	3,210	4,950	910	560	....	....	....	
5	109	85	125	415	580	3,760	5 050	875	500	....	....	....	
6	109	85	102	525	950	4,550	4,750	760	500	....	....	....	
7	109	85	102	498	918	5,750	4,150	690	500	....	....	....	
8	109	85	102	442	852	5,950	3,480	690	500	....	....	....	
9	109	85	125	470	885	6,050	2,960	592	500	....	....	....	
10	109	85	102	442	1,165	5,950	2,660	625	445	....	....	....	
11	109	85	85	360	1,288	5,450	2,590	690	445	....	....	....	
12	109	85	85	310	1,330	5,150	2,520	760	500	....	....	....	
13	109	85	85	265	1 165	5,950	2,145	760	445	....	....	....	
14	109	85	85	288	1 165	4,350	1,835	760	445	....	....	....	
15	109	85	102	310	1,165	3,855	1,450	725	418	....	....	....	
16	100	100	102	310	1,165	3,855	1,400	795	445	....	....	....	
17	100	100	102	360	1,245	5 250	1,355	868	445	....	....	....	
18	100	100	102	360	1,415	5,450	1,355	980	445	....	....	....	
19	100	100	125	360	1,595	5,650	1,400	1,060	418	....	....	....	
20	100	100	150	415	1,885	5,650	1,310	980	445	....	....	....	
21	100	100	180	415	2,260	5,950	1,355	905	418	....	....	....	
22	100	100	230	470	2,260	5,750	1,310	830	390	....	....	....	
23	100	100	285	498	2,450	5,350	1,310	690	335	....	....	....	
24	100	100	285	498	2,590	5,450	1,275	625	362	....	....	....	
25	100	100	300	580	2,260	5,850	1,190	560	362	....	....	....	
26	100	110	300	635	1,690	6,550	1,160	560	335	....	....	....	
27	100	110	350	695	1,595	6,050	1,160	560	335	....	....	....	
28	100	110	350	695	1,785	5,750	1,160	592	335	....	....	....	
29	100	....	400	635	2,450	5,150	1,160	472	335	....	....	....	
30	100	....	400	635	2,090	5,250	1,080	472	335	....	....	....	
31	100	....	450	....	1,985	....	1,080	625	....	....	....	....	
Total	3,235	2,605	5,721	13,930	44,008	149,250	74,450	23,371	13,178	....	....	....	
Mean	104	93	185	464	1,420	4,975	2,402	754	439	....	....	....	1,208
Maximum	109	110	450	695	2,590	6,550	5,350	1,060	560	....	....	....	6,550
Minimum	100	85	85	265	388	1,885	1,080	472	335	....	....	....	85
Run-off per square mile	0.110	0.098	0.196	0.490	1.501	5.259	2.539	0.797	0.464	....	....	....	1.277
Run-off, depth, inches	0.127	0.102	0.226	0.547	1.730	5.868	2.927	0.919	0.518	....	....	....	12.964
Run-off, acre-feet	6,395	5,165	11,375	27,610	87,313	296,033	147,693	46,362	26,122	....	....	....	654,068
Acre-feet per square mile	6.76	5.50	12.05	29.16	92.29	312.93	156.12	49.01	27.61	....	....	....	691.43

DISCHARGE OF GRAND RIVER AT SULPHUR SPRINGS FOR 1910.
Drainage Area, 946 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1										225	180		
2										225	180		
3										225	162		
4										225	162		
5										225	162		
6										245	145		
7										200	162		
8										200	162		
9										190			
10										190			
11										180	162		
12										180	162		
13										180	164		
14										180	164		
15										180	164		
16										190	164		
17									290	201	164		
18									300	212	164		
19									320	225	164		
20									340	235	164		
21									360	245	164		
22									380	255	164		
23									390	265	164		
24									340	265	164		
25									265	244	164		
26									305	244	164		
27									280	235	164		
28									280	225	164		
29									255	215	164		
30									230	205	164		
31										195			
Total									9,300	6,696	4,925		
Mean									310	216	164		230
Maximum									390	265	180		390
Minimum									230	180	145		145
Run off per square mile									0.328	0.228	0.173		0.243
Run-off, depth, inches									0.366	0.263	0.193		0.822
Run off, acre-feet									18,446	13,281	9,759		41,486
Acre-feet per square mile									19.52	14.02	10.29		43.83

GRAND RIVER AT GORE CANON, NEAR KREMMLING.

This station is located about 3 miles west of Kremmling in Gore canon.

The equipment consists of a Friez automatic gauge, cable and car and slope gauge. The automatic gauge is the property of the State, and the cable and car and slope gauge are owned by the United States Geological Survey.

The bed of the stream is composed of sand and gravel, and shifts. Current is very sluggish at low water.

The observer is H. C. Rogers, who is paid by the Central Colorado Power Company.

The original records from gauge are sent to this office and blue prints are furnished to the United States Geological Survey, and the Central Colorado Power Company. Measurements have been made by the State hydrographers.

DISCHARGE MEASUREMENTS OF GRAND RIVER AT GORE CANON, NEAR KREMMLING.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 Mch. 12......	*C. L Chatfield..........................	100	138	1.89	0.80	260
Apr. 29......	C. L. Chatfield..........................	115	658	2.01	4.20	1,325
May 10......	C. L. Chatfield..........................	133	1,249	2.63	8.00	3,286
June 18......	C. L. Chatfield..........................	160	3,086	4.22	16.22	13,020
June 19......	C. L. Chatfie'd..........................	160	3,179	4.34	16.90	13,784
Aug. 7......	W. B. Freeman..........................	121	1,236	1.50	5.20	1,837
Oct. 10......	R. H. Woolsey..........................	105	105	1.36	2.50	749
Nov. 23......	R. H. Woolsey..........................	103	103	1.99	1.80	609
1910 Feb. 8......	*H. A. Howe..........................	100	165	2.20	0.8	363
Feb. 27......	*H. A. Howe..........................	100	161	2.24	1.20	361
Mch. 17......	H. A. Howe..........................	110	795	1.41	3.40	1,122
May 3......	H. A. Howe..........................	127	1,329	....	7.05	2,840
May 12......	H. A. Howe..........................	135	1,815	2.94	10.05	5,332
July 1......	W. B. Freeman..........................	123	1,407	1.71	6.30	2,402
July 28......	C. L. Chatfield..........................	112	746	0.99	2.35	737
Sept. 16......	C. L. Chatfield..........................	107	407	1.88	2.28	744
Oct. 11......	C. L. Chatfie'd and C. C. Hezmalha'ch......	104	224	2.20	1.42	494
Nov. 20......	C. L. Chatfield..........................	103	165	1.99	1.08	329

*Ice conditions.

DISCHARGE OF GRAND RIVER AT GORE CANON, NEAR KREMMLING, FOR 1909.

Drainage Area, 2,380 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	315	250	330	490	1,082	4,952	10,740	1,865	1,865	890	515	515	
2	315	280	340	502	1,012	5,048	10,545	1,865	1,795	875	528	528	
3	280	290	340	740	978	5,742	10,480	1,865	1,548	860	590	415	
4	250	290	315	665	1,360	7,255	10,805	1,750	1,460	860	620	428	
5	260	300	305	635	2,065	9,075	11,202	1,660	1,460	860	620	428	
6	275	300	305	565	2,615	10,935	10,545	1,592	1,660	830	565	302	
7	280	300	285	490	3,075	12,350	8,888	1,795	2,015	845	540	340	
8	280	315	280	490	2,915	13,470	7,370	1,728	2,278	908	540	415	
9	280	315	270	490	2,978	14,040	6,565	2,195	1,990	860	490	415	
10	260	330	250	540	3,405	13,680	6,010	1,940	1,818	845	465	490	
11	260	305	260	540	3,835	12,770	5,190	1,965	1,660	845	552	478	
12	280	330	260	528	4,180	11,742	4,635	2,015	1,460	815	515	502	
13	280	335	260	605	3,722	11,068	4,180	2,168	1,460	800	565	465	
14	280	335	260	565	3,510	11,068	3,872	2,040	1,460	800	515	402	
15	305	335	260	695	3,510	10,870	3,650	1,795	1,400	800	465	465	
16	315	335	270	1,030	3,722	10,480	3,475	1,795	1,380	770	465	452	
17	315	335	280	1,460	3,760	10,805	3,205	1,750	1,320	740	490	378	
18	275	330	280	1,592	4,060	12,080	3,108	3,075	1,280	740	465	378	
19	260	315	280	1,082	4,380	13,680	3,140	3,108	1,260	740	365	365	
20	260	305	270	1,048	5,095	15,200	3,205	3,108	1,260	725	428	390	
21	260	305	280	908	5,900	15,200	3,270	2,360	1,170	710	578	390	
22	260	280	280	755	6,285	14,040	2,945	2,040	1,118	680	635	390	
23	280	305	300	725	6,852	13,330	3,010	1,940	1,135	635	635	390	
24	260	305	315	860	6,795	12,980	3,302	1,728	1,135	650	590	390	
25	260	305	330	860	6,565	13,260	3,545	1,705	1,100	605	680	390	

DISCHARGE OF GRAND RIVER AT GORE CANON, NEAR KREMMLING, FOR 1909—Concluded.
Drainage Area, 2,380 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
26	250	315	300	1,100	4,815	13,120	2,915	1,615	960	578	578	400	
27	260	330	365	1,320	4,635	12,350	2,765	1,420	1,012	590	552	400	
28	315	330	400	1,615	5,038	11,810	2,585	1,400	960	578	478	400	
29	315	....	390	1,682	5,848	11,202	2,278	1,440	942	578	502	400	
30	315	....	402	1,340	6,340	10,870	2,140	1,380	908	552	502	400	
31	290	....	490	....	5,095	....	2,015	1,615	....	528	....	400	
Total	8,690	8,705	9,552	25,917	125,427	344,472	161,580	58,381	42,074	22,902	15,998	12,863	
Mean	280	311	308	864	4,046	11,482	5,212	1,883	1,402	739	533	415	2,292
Maximum	315	335	490	1,682	6,852	15,200	11,202	3,108	2,278	908	635	528	15,200
Minimum	250	250	250	490	978	4,952	2,015	1,380	908	528	365	302	250
Run-off per square mile	0.118	0.131	0.129	0.363	1.700	4.826	2.190	0.791	0.589	0.311	0.224	0.174	0.963
Run-off, depth, inches	0.136	0.136	0.149	0.405	1.960	5.385	2.525	0.912	0.657	0.358	0.250	0.201	13.074
Run-off, acre-feet	17,217	17,272	18,938	51,412	248,778	683,226	320,474	115,781	83,425	45,439	31,716	25,517	1,659,195
Acre-feet per square mile	7.26	7.28	7.93	21.60	104.53	287.18	134.66	48.64	35.05	19.12	13.33	10.70	697.28

DISCHARGE OF GRAND RIVER AT GORE CANON, NEAR KREMMLING, FOR 1910.
Drainage Area, 2,380 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	400	402	350	845	3,580	7,542	2,415	1,440	490	565	478	....	
2	400	402	361	875	3,270	7,140	2,090	1,360	478	552	478	....	
3	400	402	440	925	2,855	7,660	1,818	1,222	478	552	490	....	
4	400	390	450	815	2,615	7,370	1,728	1,135	540	540	478	....	
5	400	365	530	800	2,735	6,450	1,818	1,100	960	540	478	....	
6	410	363	560	815	2,735	5,690	1,840	1,135	925	528	478	....	
7	410	363	590	815	2,555	5,535	1,615	1,030	830	515	452	....	
8	410	363	620	875	2,442	5,190	1,400	908	740	515	452	....	
9	410	363	650	978	2,795	4,690	1,280	860	680	515	440	....	
10	410	363	680	1,135	3,650	4,100	1,170	815	620	502	440	....	
11	410	363	710	1,260	4,300	3,985	1,135	770	578	490	440	....	
12	410	370	710	1,340	4,905	3,985	1,085	755	590	490	440	....	
13	410	375	830	1,440	4,690	4,022	1,030	785	650	478	440	....	
14	428	375	875	1,502	4,340	3,948	1,012	770	710	478	428	....	
15	440	400	925	1,320	4,140	3,760	942	740	770	465	428	....	
16	440	380	978	1,100	3,722	3,650	942	710	740	478	440	....	
17	440	360	1,030	1,188	3,238	3,580	995	680	740	490	440	....	
18	440	335	1,100	1,100	3,302	3,075	1,048	665	740	540	440	....	
19	440	360	1,118	1,222	2,945	2,915	1,100	650	800	565	440	....	
20	428	360	1,152	1,460	2,885	2,915	1,082	620	908	578	440	....	
21	415	340	1,205	1,940	3,042	2,795	1,012	620	875	540	415	....	
22	440	365	1,340	1,865	2,978	2,585	995	605	925	502	415	....	
23	440	380	1,480	1,795	2,915	2,470	942	590	845	502	415	....	
24	440	380	1,340	1,840	2,825	2,360	875	590	785	502	428	....	
25	440	400	1,260	2,140	2,885	2,222	845	578	710	575	428	....	
26	402	385	1,118	2,585	3,205	2,015	770	552	665	528	415	....	
27	390	361	995	3,042	3,172	2,040	710	528	650	528	402	....	
28	402	340	978	3,510	3,685	2,040	815	528	620	502	378	....	
29	415	....	978	3,948	5,285	1,990	1,300	528	605	478	378	....	
30	415	....	725	4,022	6,565	2,360	1,865	528	578	478	390	....	
31	415	....	845	....	7,255	....	1,795	502	....	465	....	....	
Total	12,950	10,405	26,923	48,497	111,511	120,079	39,469	24,209	21,225	15,916	13,104	....	

DISCHARGE OF GRAND RIVER AT GORE CANON, NEAR KREMMLING, FOR 1910—Concluded.
Drainage Area, 2,330 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	418	372	868	1,617	3,597	4,003	1,273	784	708	513	437	....	1,330
Maximum	440	402	1,480	4,022	7,255	7,660	2,415	1,440	960	578	490	....	7,660
Minimum	390	335	350	800	2,615	1,990	710	502	478	465	378	....	335
Run-off per square mile	0.176	0.156	0.365	0.679	1.511	1.682	0.535	0.329	0.297	0.216	0.184	....	0.559
Run-off, depth, inches	0.203	0.162	0.421	0.758	1.742	1.876	0.617	0.379	0.331	0.249	0.205	....	6.943
Run-off, acre-feet	25,702	20,660	53,371	96,219	221,171	238,196	78,274	48,206	42,129	31,543	26,003	....	881,474
Acre-feet per square mile	10.82	8.66	22.44	40.40	92.91	100.09	32.90	20.23	17.67	13.28	10.95	....	370.35

GRAND RIVER AT GLENWOOD SPRINGS.

This station is maintained by the United States Geological Survey and Central Colorado Power Company. It is located at highway bridge at Glenwood Springs.

The equipment consists of a cable and car with stay and tag lines and a Friez automatic gauge. This gauge was installed in May, 1910.

The bed of the stream is composed of medium sized boulders and sand. The channel fills in during low stages and is scoured out at high water.

DISCHARGE MEASUREMENTS OF GRAND RIVER AT GLENWOOD SPRINGS.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 Jan. 13	C. L. Chatfield	180	407	1.54	3.78	628
Mch. 16	C. L. Chatfield	185	464	1.70	4.04	788
Apr. 20	C. L. Chatfield	195	710	2.72	5.28	1,925
June 21	C. L. Chatfield and Matthes	190	2,230	12.24	12.00	27,300
June 30	W. B. Freeman	222	1,900	9.74	9.45	18,500
July 13	W. H. Snelson, Jr.	220	1,304	5.78	7.12	7,532
July 24	W. B. Freeman	210	1,080	4.68	6.50	5,050
Aug. 5	W. H. Snelson, Jr.	205	843	3.13	5.10	2,640
Oct. 9	G. H. Russell	190	649	2.52	4.20	1,630
1910 Mch. 17	W. B. Freeman	192	659	2.41	4.16	1,586
Apr. 26	W. B. Freeman	215	1,130	4.55	6.22	5,140
Apr. 26	W. B. Freeman	215	1,140	4.65	6.20	5,300
May 17	Freeman & Matthe	218	1,330	4.75	6.75	6,320
June 11	Bol er & Lyon	215	1,275	5.73	7.17	7,300
July 8	G. H. Russell	202	812	3.06	5.73	2,490
Aug. 13	G. J. Lyon	186	628	2.37	....	1,488
Sept. 6	G. H. Russell	193	720	2.68	5.72	1,930
Sept. 21	G. H. Russell	186	694	2.64	5.73	1,830
Nov. 20	G. H. Russell	181	500	1.75	4.92	866
Nov. 28	C. L. Chatfield	185	479	1.68	5.09	803

DISCHARGE OF GRAND RIVER AT GLENWOOD SPRINGS FOR 1909.
Drainage Area, 4,520 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	690	575	602	980	2,440	7,500	18,100	2,970	2,800	1,750	1,140	1,000	
2	690	575	630	980	2,150	7,250	17,400	2,890	2,970	1,630	1,090	1,040	
3	690	575	690	1,070	2,010	8,470	17,000	2,820	2,730	1,690	1,090	1,090	
4	690	630	720	1,170	2,010	11,300	17,000	2,740	2,580	1,630	1,190	920	
5	720	690	1,020	1,170	2,750	17,600	18,100	2,590	2,500	1,630	1,190	672	
6	1,070	690	900	1,270	3,810	22,600	16,300	2,520	2,580	1,630	1,190	640	
7	980	690	900	1,120	4,220	28,300	13,200	2,590	3,020	1,570	1,190	705	
8	940	690	860	900	4,650	29,400	12,100	2,670	3,660	1,750	1,190	610	
9	860	690	820	900	4,430	31,200	10,200	2,590	3,470	1,630	1,090	810	
10	900	690	785	900	4,760	31,200	9,380	3,240	3,100	1,630	1,090	1,000	
11	820	690	750	900	5,360	28,000	8,080	2,900	2,780	1,570	1,140	845	
12	630	750	690	1,070	5,360	24,400	7,260	2,990	2,780	1,630	1,190	845	
13	630	750	690	1,070	5,360	24,400	6,960	3,150	2,550	1,510	1,190	845	
14	690	750	690	980	5,120	25,400	6,390	3,210	2,550	1,510	1,190	845	
15	1,020	750	750	980	5,120	24,700	6,110	2,960	2,530	1,510	1,000	810	
16	940	690	750	1,270	5,240	23,300	5,840	2,720	2,530	1,510	1,000	705	
17	820	720	820	1,740	5,360	24,400	5,580	2,720	2,450	1,460	845	672	
18	785	720	860	2,440	5,360	27,600	5,330	3,500	2,450	1,400	845	610	
19	785	720	860	2,750	6,000	32,000	5,330	4,520	2,250	1,400	920	520	
20	820	660	900	2,440	6,710	36,000	5,460	4,400	2,310	1,400	1,090	520	
21	820	660	940	2,150	7,000	37,200	5,330	3,390	2,250	1,400	1,190	520	
22	820	630	940	1,870	8,100	34,600	5,330	3,180	2,100	1,400	1,240	705	
23	980	630	1,070	1,740	9,350	32,000	5,090	2,850	2,070	1,290	1,190	740	
24	785	602	980	1,610	9,500	27,200	5,460	2,610	2,000	1,290	1,240	775	
25	690	630	980	1,680	8,500	26,500	5,840	2,760	2,000	1,290	1,190	775	
26	690	630	980	1,800	7,000	25,400	5,460	2,709	1,940	1,290	1,190	740	
27	630	575	980	2,150	7,150	24,400	4,750	2,400	1,870	1,140	1,090	775	
28	660	575	1,020	2,590	7,900	21,900	4,100	2,400	1,870	1,240	1,090	845	
29	575	....	1,070	2,920	9,350	19,800	3,590	2,410	1,800	1,240	1,000	775	
30	550	....	1,070	2,830	10,200	19,100	3,400	2,420	1,800	1,190	1,000	775	
31	525	....	980	....	8,350	....	3,140	2,500	....	1,190	....	810	
Tota'	23,895	18,627	26,697	47,430	180,620	734,220	262,610	90,310	74,290	45,400	33,280	23,939	
Mean	771	665	861	1,580	5,830	24,500	8,470	2,910	2,480	1,460	1,110	772	4,278
Maximum	1,070	750	1,070	2,910	10,200	37,200	18,100	4,520	3,660	1,750	1,240	1,090	37,200
Minimum	525	575	602	900	2,010	7,250	3,140	2,400	1,800	1,140	845	520	520
Run-off per square mile	0.171	0.147	0.190	0.350	1.290	5.420	1.874	0.644	0.549	0.323	0.246	0.171	0.946
Run-off, depth, inches	0.197	0.153	0.219	0.390	1.487	6.047	2.160	0.742	0.612	0.372	0.274	0.197	12.850
Run-off, acre-feet	47,407	36,932	52,941	94,016	358,473	1,457,851	520,800	178,920	147,570	89,772	66,050	47,468	3,098,209
Acre-feet per square mile	10.49	8.17	11.72	20.80	79.31	322.53	115.22	39.59	32.65	19.86	14.74	10.50	685.58

GRAND RIVER AT PALISADES.

This station is maintained by the United States Reclamation Service. It is located at the State bridge 2 miles above Palisades.

The equipment consists of a chain gauge and an auxiliary staff gauge, both owned by the United States Geological Survey.

The bed of the stream consists of large cobblestones and is permanent. Willows and brush along the left bank interfere with measurements at very high stages.

The gauge is read under the direction of the United States Reclamation Service.
Discharge Measurements of Grand River at Palisades.

DISCHARGE MEASUREMENTS OF GRAND RIVER AT PALISADES.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 6	S. O. Harper	315	1,530	5.05	15.65	7,746
	May 8	S. O. Harper	321	1,850	5.25	16.45	9,690
	May 11	D. L. Henderson	325	2,132	5.55	17.40	11,830
	May 19	D. L. Henderson	366	2,175	6.47	17.65	14,100
	May 22	S. O. Harper	381	2,565	7.15	18.75	18,300
	June 1	D. L. Henderson	370	2,240	6.88	18.05	15,400
	June 5	D. L. Henderson	390	3,032	8.76	20.15	26,600
	June 8	S. O. Harper	400	3,858	9.71	22.05	37,470
	June 11	D. L. Henderson	380	4,151	8.57	22.35	35,580
	June 21	D. L. Henderson	380	4,392	10.20	23.15	44,800
	June 29	Henderson, Harper & Freeman	383	3,821	7.67	21.45	29,300
	July 28	D. L. Henderson	330	1,824	4.01	15.70	7,300
	Aug. 5	D. L. Henderson	300	1,410	2.82	14.40	3,950
	Sept. 9	S. O. Harper	254	612	3.16	12.5	1,744
	Oct. 13	G. H. Russell	300	1,020	2.76	13.45	2,810
1910	Apr. 2	S. O. Harper	251	1,076	2.85	13.6	3,073
	Apr. 27	Freeman & Sovereign	328.5	2,050	5.20	16.60	10,670
	June 13	R. H. Bolster	360	2,414	5.72	17.7	13,800
	Aug. 5	Harper & Hoag	268	1,121	2.58	13.5	2,894
	Sept. 1	Harper & Henderson	256	734	2.08	12.50	1,528
	Sept. 23	Harper & Henderson	257	992	2.54	13.25	2,521

DISCHARGE OF GRAND RIVER AT PALISADES FOR 1909.

Drainage Area, 8,550 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	1,500	1,300	1,220	1,600	4,550	15,600	29,300	5,570	4,640	3,210	2,130	2,130	
2	1,500	1,300	1,450	1,600	4,080	14,600	27,600	5,140	5,360	3,130	2,130	2,000	
3	1,500	1,300	1,600	1,700	3,900	16,200	27,600	5,250	5,140	3,050	2,130	2,200	
4	1,500	1,300	2,000	1,880	4,080	20,300	28,800	5,040	4,840	2,890	2,130	1,940	
5	1,500	1,300	2,420	2,200	5,250	26,000	28,500	4,640	5,460	2,890	2,130	1,880	
6	1,500	1,300	2,340	2,130	7,660	32,500	27,700	4,450	6,460	2,890	2,130	1,880	
7	1,500	1,300	2,340	1,820	8,880	35,800	25,500	4,450	6,350	3,050	2,130	1,760	
8	1,500	1,300	1,700	1,700	9,810	39,700	21,300	4,640	7,290	3,050	2,130	1,760	
9	1,500	1,300	1,450	1,550	10,100	40,000	19,200	4,740	7,410	3,210	2,130	1,760	
10	1,500	1,300	1,450	1,550	10,800	39,000	16,400	5,250	6,350	3,130	2,130	1,760	
11	1,500	1,350	1,400	1,600	12,900	36,800	15,000	5,360	5,900	2,890	2,130	1,760	
12	1,500	1,350	1,300	1,700	13,200	34,600	13,600	5,360	6,120	2,890	2,130	1,760	
13	1,500	1,350	1,300	1,700	13,200	34,000	12,700	5,360	5,570	2,970	2,130	1,760	
14	1,500	1,350	1,500	1,700	12,000	33,400	11,100	5,460	5,460	2,970	2,130	1,760	
15	1,500	1,350	1,550	1,700	11,300	32,500	10,400	5,140	5,140	2,730	2,130	1,650	
16	1,450	1,300	1,600	1,940	11,300	31,900	10,300	4,840	4,840	2,810	2,130	1,650	
17	1,450	1,400	1,700	2,570	11,400	33,100	9,810	5,040	4,940	2,730	2,130	1,650	
18	1,450	1,350	1,700	3,640	12,500	34,300	8,880	5,460	4,840	2,730	2,130	1,650	
19	1,450	1,350	1,700	5,250	14,600	39,000	8,590	7,050	4,640	2,650	2,130	1,650	
20	1,450	1,350	1,760	5,680	16,400	43,000	8,880	7,170	4,360	2,340	2,130	1,650	
21	1,450	1,300	1,760	4,260	17,400	42,300	8,590	7,290	4,170	2,500	2,130	1,650	
22	1,450	1,260	1,650	3,640	19,200	42,300	8,180	6,120	3,900	2,570	2,270	1,650	
23	1,450	1,260	1,760	3,130	20,100	39,700	7,910	5,460	3,810	2,500	2,270	1,650	
24	1,450	1,260	1,820	2,970	20,800	38,700	8,450	5,040	3,720	2,420	2,270	1,650	
25	1,400	1,220	1,650	2,890	19,200	37,400	9,180	4,940	3,720	2,270	2,270	1,650	
26	1,300	1,220	1,600	3,210	17,400	36,800	8,880	4,940	3,550	2,270	2,730	1,650	
27	1,300	1,220	1,650	3,990	17,200	34,300	8,310	4,640	3,550	2,270	2,730	1,650	
28	1,200	1,220	1,650	4,640	18,500	34,300	7,530	4,350	3,460	2,270	2,270	1,650	
29	1,260	....	1,700	5,140	20,800	30,700	7,050	4,080	3,380	2,270	2,340	1,650	
30	1,300	....	1,760	4,840	19,900	29,000	6,460	4,350	3,210	2,270	2,340	1,650	
31	1,300	....	1,760	....	17,600	....	5,790	4,840	....	2,270	....	1,650	
Total	46,110	36,460	52,240	83,920	406,010	997,800	447,490	161,460	147,580	84,090	66,220	54,160	
Mean	1,490	1,300	1,690	2,800	13,100	33,300	14,400	5,210	4,920	2,710	2,210	1,750	7,070
Maximum	1,500	1,400	2,420	5,680	20,800	43,000	29,300	7,290	7,410	3,210	2,730	2,200	43,000
Minimum	1,260	1,220	1,220	1,550	3,900	14,600	5,790	4,080	3,210	2,270	2,130	1,650	1,220
Run-off per square mile	0.174	0.152	0.198	0.328	1.532	3.895	1.684	0.609	0.575	0.317	0.258	0.205	0.827
Run off, depth, inches	0.200	0.158	0.228	0.366	1.766	4.346	1.942	0.702	0.642	0.365	0.288	0.237	11.240
Run-off, acre-feet	91,600	72,200	104,000	167,000	806,000	1,980,000	885,000	320,000	293,000	167,000	132,000	108,000	5,125,800
Acre-feet per square mile	10.71	8.44	12.16	19.53	94.26	231.58	103.51	37.43	34.27	19.53	15.44	12.63	599.49

DISCHARGE OF GRAND RIVER AT PALISADES FOR 1910.
Drainage Area, 8,550 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	2,500	1,500	2,420	3,295	14,170	27,075	6,810	4,355	1,650	1,820	1,820	....	
2	2,300	1,500	2,810	3,295	12,500	25,700	6,695	4,170	1,650	2,130	1,705	....	
3	2,000	1,500	3,380	3,465	11,110	25,700	6,235	3,380	1,650	2,000	1,705	....	
4	2,000	1,500	3,900	3,380	9,650	25,700	5,680	3,210	2,890	1,940	1,760	....	
5	1,800	1,500	3,550	3,295	9,650	24,700	5,460	3,050	3,050	1,880	1,650	....	
6	1,800	1,500	3,900	3,295	10,130	22,450	5,460	3,050	2,890	1,940	1,650	....	
7	1,800	1,500	3,635	3,210	9,970	20,300	5,145	3,210	3,050	2,000	1,600	....	
8	1,600	1,500	3,550	3,210	9,650	18,950	4,840	2,970	2,650	1,940	1,705	....	
9	1,600	1,500	3,380	3,295	10,130	17,375	4,640	2,650	2,495	1,940	1,705	....	
10	1,600	1,500	3,210	3,720	12,860	15,350	4,355	2,420	2,345	2,000	1,760	....	
11	1,600	1,500	3,380	4,260	16,550	14,950	4,080	2,200	2,200	1,820	1,705	....	
12	1,600	1,500	3,380	4,740	17,828	14,950	3,810	2,810	1,940	1,705	1,760	....	
13	1,600	1,500	2,730	5,145	18,725	14,555	3,635	2,650	2,065	1,650	1,820	....	
14	1,600	1,500	2,970	5,460	17,375	13,980	3,380	2,650	2,570	1,650	1,760	....	
15	1,600	1,800	3,210	5,250	15,350	13,045	3,210	2,570	2,495	1,705	1,880	....	
16	1,600	1,800	2,730	4,740	14,170	11,965	3,050	2,495	2,130	2,730	1,820	....	
17	1,600	1,800	3,050	4,545	13,230	12,140	2,970	2,420	2,570	2,130	1,940	....	
18	1,600	1,800	3,295	4,260	11,790	11,280	2,890	2,200	2,570	2,200	1,940	....	
19	1,600	1,800	2,890	4,545	10,945	10,780	2,890	2,130	2,420	2,270	2,650	....	
20	1,600	1,800	3,050	5,250	10,615	10,290	2,890	2,000	2,420	2,345	2,200	....	
21	1,600	2,000	4,080	6,010	10,290	9,650	2,890	1,820	2,890	2,200	1,880	....	
22	1,600	2,000	4,640	6,930	10,290	9,030	2,730	1,880	2,810	2,065	1,705	....	
23	1,600	2,000	4,840	6,695	9,970	8,735	2,650	1,880	2,570	2,065	1,705	....	
24	1,600	2,000	4,840	6,695	9,650	8,175	2,495	1,880	2,570	1,940	1,705	....	
25	1,600	2,000	4,740	7,410	10,615	7,655	2,420	1,820	2,495	1,820	1,650	....	
26	1,500	2,000	4,740	8,880	11,110	7,170	2,270	1,760	2,270	1,820	1,760	....	
27	1,500	2,000	4,545	10,780	12,320	6,930	2,130	1,820	2,065	1,880	1,705	....	
28	1,500	2,065	3,900	12,500	13,790	6,580	2,890	1,820	2,000	1,820	1,650	....	
29	1,500	....	3,720	14,170	18,050	7,410	2,570	1,705	2,000	1,820	1,600	....	
30	1,500	....	3,550	15,350	21,950	6,810	3,380	1,650	1,880	1,705	1,500	....	
31	1,500	....	3,210	....	22,450	....	3,550	1,650	....	1,820	....	....	
Total	52,000	47,865	111,225	177,075	406,880	429,380	118,100	76,275	71,250	60,750	53,395	....	
Mean	1,677	1,709	3,588	5,902	13,126	14,313	3,810	2,460	2,375	1,960	1,780	....	4,803
Maximum	2,500	2,065	4,840	15,350	22,450	27,075	6,810	4,355	3,050	2,730	2,650	....	27,075
Minimum	1,500	1,500	2,420	3,210	9,650	6,580	2,130	1,650	1,650	1,650	1,500	....	1,500
Run-off per square mile	0.196	0.200	0.420	0.690	1.535	1.674	0.446	0.288	0.278	0.229	0.208	....	0.562
Run-off, depth, inches	0.226	0.208	0.484	0.770	1.770	1.868	0.514	0.332	0.310	0.264	0.232	....	6.978
Run-off, acre-feet	103,200	94,900	220,600	351,200	807,100	851,700	234,300	151,300	141,300	120,500	105,900	....	3,182,000
Acre-feet per square mile	12.06	11.10	25.80	41.08	94.40	99.61	27.40	17.70	16.53	14.09	12.39	....	372.16

WILLIAMS FORK RIVER NEAR SULPHUR SPRINGS.

This station is on wagon bridge at Field's ranch about 9 miles southwest of Sulphur Springs and about four miles above the mouth of Williams Fork.

The equipment consists of a staff gauge fastened to wagon bridge from which measurements are made. This equipment is owned by the United States Geological Survey.

The bed of the stream is composed of small and medium sized boulders and appears to be permanent. The right bank overflows at very high stages.

The observer is F. A. Field, who is paid by the United States Geological Survey.

DISCHARGE MEASUREMENTS OF WILLIAMS FORK RIVER NEAR SULPHUR SPRINGS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Mch. 11	C. L. Chatfield	26	42	1.05	3.20	44
	Apr. 30	C. L. Chatfield	47	60	1.07	3.40	64
	May 9	C. L. Chatfield	49	82	1.85	3.76	152
	June 18	W. H. Snelson, Jr.	54	139	7.70	5.00	1,112
	Aug. 8	Howe, Woolsey & Freeman	48	91	1.59	3.62	145
	Oct. 14	R. H. Woolsey and M. S. Urquhart	44	72.4	1.45	3.47	105
1910	Feb. 11	H. A. Howe	22	39.9	1.19	2.95	47.5
	Mch. 4	H. A. Howe	24	45.7	1.18	3.05	53.8
	Mch. 31	H. A. Howe	26	47.9	1.24	3.25	59.4
	Apr. 25	H. A. Howe	42	81.8	1.73	3.60	141
	May 15	H. A. Howe	49	107.5	2.71	4.00	292
	July 2	Freeman & Bolster	47.8	96	2.03	3.75	195
	July 28	C. L. Chatfield	55	71	1.10	3.30	78
	Sept. 15	S. T. Harding	27	58.5	1.37	3.20	80.3
	Sept. 17	C. L. Chatfield	....	54	1.59	3.25	78
	Oct. 9	Chatfield & Hezmalhalch	42.5	55	1.17	3.18	64

DISCHARGE OF WILLIAMS FORK RIVER, NEAR SULPHUR SPRINGS, FOR 1909.
Drainage Area, 198 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	44	44	38	44	73	310	1,010	232	191	115	80	62	
2	44	44	38	58	64	380	962	210	172	102	80	55	
3	51	44	38	58	73	380	915	191	141	102	70	48	
4	51	38	44	51	104	530	1,060	172	141	102	70	42	
5	44	38	38	58	148	655	1,110	156	141	102	62	42	
6	44	32	44	58	148	750	868	156	156	102	55	42	
7	38	38	38	58	148	850	820	172	210	115	62	42	
8	38	32	38	58	164	955	775	156	172	115	55	42	
9	38	32	38	58	183	1,010	730	156	172	89	42	42	
10	32	32	44	74	202	900	730	156	210	115	48	42	
11	32	32	44	58	226	850	605	156	172	115	55	42	
12	32	32	44	58	250	850	530	156	141	102	80	42	
13	32	32	44	51	202	900	495	172	156	102	55	42	
14	38	32	44	51	202	850	460	141	156	102	55	42	
15	38	32	44	66	164	850	425	141	191	102	55	42	
16	38	32	44	64	202	915	392	128	172	89	42	42	
17	44	32	44	64	226	1,110	360	128	172	89	42	42	
18	44	32	44	64	280	1,265	360	128	156	89	42	42	
19	44	32	44	73	280	1,430	360	280	141	89	42	42	
20	44	32	44	64	310	1,430	360	191	141	89	89	42	
21	38	32	51	56	345	1,210	332	210	141	89	70	42	
22	38	32	44	56	380	1,210	305	172	141	89	70	42	
23	38	32	44	73	415	1,265	255	172	141	89	70	42	
24	32	32	44	64	380	1,265	305	172	141	89	80	42	
25	32	32	51	64	310	1,320	360	156	128	89	80	42	
26	38	38	44	73	250	1,265	360	141	128	80	70	42	
27	32	32	51	93	250	1,060	305	128	115	80	70	48	
28	32	38	58	93	345	1,060	280	141	115	80	42	48	
29	38	....	58	82	380	1,010	232	128	115	80	89	55	
30	38	....	58	73	280	1,060	232	141	115	80	70	48	
31	44	....	51	....	310	....	172	172	....	70	....	55	
Total	1,210	962	1,392	1,915	7,294	28,895	16,465	5,111	4,584	2,942	1,892	1,385	
Mean	39	34	45	64	235	963	531	165	153	95	63	45	203
Maximum	51	44	58	82	415	1,430	1,110	232	210	115	89	62	1,430
Minimum	32	32	38	44	64	310	172	128	115	70	42	42	32
Run-off per square mile	0.197	0.172	0.227	0.323	1.189	4.864	2.682	0.833	0.773	0.480	0.318	0.227	1.025
Run-off, depth, inches	0.227	0.179	0.262	0.360	1.368	5.426	3.092	0.960	0.862	0.553	0.355	0.261	13.905
Run-off, acre-feet	2,398	1,888	2,767	3,808	14,450	57,302	32,650	10,145	9,104	5,841	3,749	2,767	146,869
Acre-feet per square mile	12.11	9.58	13.97	19.23	72.98	289.66	164.90	51.24	45.98	29.50	18.93	13.97	742.05

DISCHARGE OF WILLIAMS FORK RIVER, NEAR SULPHUR SPRINGS, FOR 1910.
Drainage Area, 198 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	66	50	50	72	210	775	210	115	62	66	57	....	
2	62	50	50	72	210	688	172	115	62	66	57	....	
3	57	50	50	72	210	820	172	104	62	72	57	....	
4	57	50	54	72	191	820	172	86	108	72	54	....	
5	62	50	50	72	210	775	172	94	108	66	54	....	
6	66	50	50	72	210	730	196	94	119	66	54	....	
7	66	50	54	78	172	730	141	78	83	66	50	....	
8	66	50	54	78	255	730	128	72	76	66	57	....	
9	66	50	54	94	255	645	115	72	76	66	57	....	
10	62	50	54	94	332	645	104	66	71	62	62	....	
11	57	47	57	104	360	530	94	66	76	62	57	....	
12	57	50	57	104	425	530	94	72	83	62	57	....	
13	57	50	57	94	360	530	94	78	76	62	57	....	
14	57	50	62	86	392	530	86	66	83	62	62	....	
15	57	50	62	94	332	495	78	66	83	62	62	....	
16	57	47	62	72	305	460	78	66	76	66	62	....	
17	57	50	62	78	305	425	78	62	83	86	57	....	
18	57	47	62	86	255	392	78	57	108	86	54	....	
19	57	47	62	94	255	392	86	57	108	86	54	....	
20	57	50	62	115	232	392	86	57	119	86	57	....	
21	57	50	62	141	255	360	86	66	119	86	66	....	
22	57	50	62	141	255	332	78	66	108	78	57	....	
23	57	50	62	115	305	280	72	66	108	72	57	....	
24	57	50	62	128	305	280	66	62	108	72	57	....	
25	57	47	62	141	255	255	62	58	99	66	57	....	
26	57	47	62	172	280	232	57	58	99	66	57	....	
27	57	50	62	210	280	232	57	58	90	62	57	....	
28	57	50	62	255	360	210	115	62	90	54	66	....	
29	54	....	62	280	530	280	210	62	76	62	57	....	
30	54	....	62	255	605	255	210	58	76	57	57	....	
31	50	....	62	....	730	....	141	58	....	57	....	....	
Total	1,814	1,382	1,807	3,541	9,636	14,750	3,588	2,217	2,695	2,120	1,726	....	
Mean	59	49	58	118	311	492	116	72	90	68	57	....	136
Maximum	66	50	62	280	730	820	210	115	119	86	62	....	820
Minimum	50	47	50	72	172	210	57	57	62	54	50	....	47
Run-off per square mile	0.298	0.247	0.293	0.596	1.571	2.485	0.586	0.364	0.455	0.343	0.288	....	0.687
Run-off, depth, inches	0.344	0.257	0.338	0.665	1.811	2.772	0.676	0.420	0.508	0.395	0.321	....	8.507
Run-off, acre-feet	3,628	2,721	3,566	7,021	19,123	29,276	7,133	4,427	5,355	4,181	3,392	....	89,823
Acre-feet per square mile	18.32	13.72	18.02	35.46	96.60	147.87	36.03	22.38	27.07	21.09	17.14	....	453.70

FRASER RIVER NEAR GRANBY.

This station was established July 28, 1904. Records of 1909 obtained through co-operation between the Central Colorado Power Company and United States Geological Survey. Station abandoned September 30, 1909.

It is located on bridge 1 mile above Granby.

The bed of this river is rocky, fairly permanent, although small diversion drain a few feet below bridge interferes with low water results.

Measurements are made from bridge. Gauge of staff type.

The observer is J. W. Ostrander, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF FRASER RIVER NEAR GRANBY.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 Mch. 9......	*C. L. Chatfield..........................	44	29	1.52	5.08	44
Apr. 28......	*C. L. Chatfield..........................	45	61	3.70	5.30	226
May 6......	C. L. Chatfield..........................	69	148	3.12	5.54	462
June 16......	W. H. Snelson, Jr., C. L. Chatfield and G. H. Matthes..............................	61	213	4.99	6.35	1,075
Aug. 11......	W. B. Freeman and R. H. Woolsey........	56	125	2.06	5.15	257

*Ice.

DISCHARGE OF FRASER RIVER, NEAR GRANBY, FOR 1909.
Drainage Area, 220 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	326	122	153	153	108	585	1,515	225	185	....	....	....	
2	444	108	153	153	84	585	1,515	225	185	....	....	....	
3	444	108	153	153	108	692	1,515	225	185	....	....	....	
4	382	122	153	208	153	810	1,420	225	185	....	....	....	
5	382	153	153	153	515	1,105	1,285	225	225	....	....	....	
6	382	153	153	122	482	1,240	1,195	225	225	....	....	....	
7	382	153	228	95	385	1,330	1,105	225	225	....	....	....	
8	382	153	274	95	385	1,420	975	225	185	....	....	....	
9	382	153	138	72	450	1,420	810	225	185	....	....	....	
10	382	153	138	72	418	1,420	692	225	185	....	....	....	
11	170	153	170	72	482	1,420	550	248	185	....	....	....	
12	228	153	122	72	482	1,330	515	225	185	....	....	....	
13	228	153	122	72	450	1,195	515	225	185	....	....	....	
14	188	153	122	52	385	1,195	450	225	185	....	....	....	
15	274	122	153	52	355	1,240	450	225	185	....	....	....	
16	228	122	153	52	385	1,240	450	225	150	....	....	....	
17	188	122	153	52	385	1,375	450	225	150	....	....	....	
18	153	122	170	52	450	1,563	385	248	150	....	....	....	
19	153	122	208	108	620	1,658	385	385	150	....	....	....	
20	170	122	228	95	692	1,855	385	298	150	....	....	....	
21	153	122	228	108	730	1,855	385	270	150	....	....	....	
22	153	122	300	122	770	1,805	385	248	150	....	....	....	
23	153	122	326	122	810	1,805	450	225	150	....	....	....	
24	153	122	326	122	692	1,705	450	225	150	....	....	....	
25	228	122	326	122	620	1,705	385	225	150	....	....	....	
26	274	122	326	153	482	1,610	325	225	120	....	....	....	
27	188	122	251	153	482	1,705	325	185	120	....	....	....	
28	188	153	228	228	620	1,658	270	185	120	....	....	....	
29	153	....	188	208	692	1,610	270	185	120	....	....	....	
30	122	....	153	122	585	1,515	270	185	120	....	....	....	
31	122	....	153	....	515	....	225	185	....	....	....	....	
Total	7,755	3,729	6,002	3,415	14,772	41,651	20,302	7,122	4,995	....	....	....	

DISCHARGE OF FRASER RIVER, NEAR GRANBY, FOR 1909—Concluded.
Drainage Area, 220 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	250	133	194	114	477	1,388	655	230	166	....	....	....	402
Maximum	441	153	326	228	810	1,420	1,515	385	225	....	....	....	1,515
Minimum	122	108	122	52	84	585	225	185	120	....	....	....	52
Run-off per square mile	1.136	0.605	0.882	0.518	2.168	6.309	2.977	1.045	0.755	....	....	....	1.827
Run-off, depth, inches	1.310	0.630	1.017	0.578	2.500	7.039	3.432	1.205	0.842	....	....	....	18.553
Run-off, acre-feet	15,372	7,386	11,929	6,783	29,330	82,591	40,274	14,142	9,878	....	....	....	217,685
Acre-feet per square mile	69.87	33.57	54.23	30.83	133.32	375.41	183.06	64.28	44.90	....	....	....	989.47

MISCELLANEOUS MEASUREMENTS IN GRAND RIVER BASIN.

DATE	HYDROGRAPHER	STREAM	LOCALITY	DISCHARGE
1910 Mch. 10	C. L. Chatfield	Piney Creek	State Bridge	3
Mch. 10	C. L. Chatfield	Rock Creek	Near Crater	8
Mch. 10	C. L. Chatfield	Sheephorn Creek	At mouth	1
Mch. 10	C. L. Chatfield	Sheep Creek	Gore	4
Apr. 17	C. L. Chatfield	Sheep Creek	Gore	1
Mch. 10	C. L. Chatfield	Vasquez Creek	At Vasquez	2.5

PLATTE RIVER DRAINAGE.

NORTH FORK SOUTH PLATTE RIVER AT CASSELLS.

This station is maintained in co-operation with the United States Geological Survey. It is located at Cassells, on the South Park branch of the C. & S. R. R.

The equipment consists of a vertical staff gauge fastened to pier of wagon bridge from which measurements are made.

The bed of the stream consists of large and medium sized boulders. Both banks are liable to overflow at high water.

The observer is Lulu Cassell, whose salary is three dollars ($3.00) per month.

DISCHARGE MEASUREMENTS OF NORTH FORK SOUTH PLATTE RIVER AT CASSELL'S.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Jan. 1	*W. B. Freeman		12.3	1.55	1.10	19
	Jan. 3	*W. B. Freeman		12.2	1.47	1.07	18
	Jan. 27	*W. B. Freeman		9.0	1.67	1.28	15
	Jan. 28	*W. B. Freeman		7.4	1.89	1.10	14
	Jan. 29	*W. B. Freeman		9.6	1.42	1.40	13.6
	Jan. 29	*W. B. Freeman		15.3	1.21	1.55	18.5
	Feb. 28	*J. B. Stewart		10.6	1.10	1.50	11.6
	Feb. 28	*J. B. Stewart		12.7	0.90	1.50	11.3
	Mch. 1	*J. B. Stewart		9.3	1.16	1.40	10.8
	Apr. 11	*W. B. Freeman		14.4	1.62	0.90	23.4
	Apr. 12	*W. B. Freeman		24.3	2.08	1.10	50.0
	Apr. 12	*W. B. Freeman		13.3	1.07	0.90	14.2
	May 9	W. B. Freeman		61	1.80	1.48	110
	May 10	W. B. Freeman		45	2.23	1.50	96
	May 31	W. B. Freeman		57	3.30	1.79	188
	June 14	W. B. Freeman		84.5	4.67	2.30	395
	July 5	W. B. Freeman		92	5.71	2.60	525
	Aug. 2	W. B. Freeman		52	2.83	1.70	147
	Aug. 16	W. B. Freeman		54	3.35	1.78	181
	Aug. 18	W. B. Freeman and Emma Archuleta		73	3.65	2.03	259
	Sept. 2	W. B. Freeman and Emma Archuleta		56	3.00	1.80	173
	Dec. 5	W. B. Freeman		52	0.75	3.35	39
	Dec. 7	W. B. Freeman		34	1.26	2.45	43
1910	Jan. 30	*W. B. Freeman	15.3	28	1.21	1.90	34
	Feb. 1	*W. B. Freeman	14.5	21.4	1.27	1.50	27.2
	Feb. 1	*W. B. Freeman	13.5	22.6	1.33	1.55	30
	Feb. 25	*W. B. Freeman	13	19.1	1.19	1.50	22.8
	Feb. 25	*W. B. Freeman	14	20.5	1.13	1.65	23.2
	Mch. 28	W. B. Freeman	36.3	30	2.03	1.20	61
	Mch. 30	W. B. Freeman	22	16.6	1.47	1.00	24.4
	Mch. 30	W. B. Freeman	39.5	32	2.42	1.45	71
	May 11	W. B. Freeman	48	46.0	2.74	1.57	126
	May 11	W. B. Freeman	48	45.0	2.58	1.57	116
	May 30	W. B. Freeman	29	66.0	2.67	1.75	176
	July 18	W. B. Freeman	18.5	24.0	2.50	1.41	60
	Aug. 27	W. B. Freeman	23.5	20.1	1.80	1.17	36.2
	Aug. 28	W. B. Freeman	27.7	43.0	0.71	1.17	30.4
	Sept. 18	W. B. Freeman	24.0	21.6	1.66	1.21	35.8
	Sept. 18	W. B. Freeman	15.1	12.2	2.67	1.21	32.5
	Nov. 18	W. B. Freeman	26	18.3	1.57	1.25	28.8

*Ice conditions.

DISCHARGE OF NORTH FORK SOUTH PLATTE RIVER AT CASSELLS FOR 1909.

Drainage Area, 100 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	19	15	11	14	54	184	499	169	184	141	79	47	
2	19	15	12	15	54	184	474	154	169	141	70	54	
3	19	15	12	16	54	270	499	154	169	154	88	88	
4	16	15	10	17	79	400	524	154	184	154	79	54	
5	16	15	10	18	108	499	474	141	250	141	70	43	
6	15	15	10	19	88	376	474	128	290	128	70	43	
7	15	15	10	23	1,108	449	474	141	449	128	54	43	
8	15	15	10	23	118	578	400	128	400	128	54	40	
9	15	15	10	23	108	424	632	169	376	108	54	40	
10	15	14	12	23	108	424	499	154	376	128	70	40	
11	15	14	12	23	141	424	499	154	354	128	70	40	
12	15	14	12	20	128	400	354	154	332	128	70	40	
13	16	14	12	14	118	400	332	154	354	118	79	40	
14	19	14	12	14	128	400	332	154	290	108	168	40	
15	16	14	12	20	108	376	290	184	290	108	154	40	
16	19	14	12	28	128	354	290	184	270	108	128	40	
17	16	14	12	98	141	424	250	270	290	128	169	40	
18	16	14	12	62	184	605	250	250	270	118	141	40	
19	16	14	12	62	169	605	250	400	290	98	88	40	
20	16	13	12	40	184	632	270	270	270	88	70	40	
21	16	13	12	47	184	578	250	232	290	88	70	40	
22	15	13	12	34	232	578	311	270	250	88	47	40	
23	15	13	12	23	214	524	290	250	232	79	40	40	
24	16	13	12	28	184	551	270	270	214	88	40	40	
25	15	13	13	40	154	578	290	214	214	70	40	40	
26	16	13	13	40	154	474	250	184	184	70	40	40	
27	15	12	13	70	169	474	250	169	184	79	47	40	
28	14	12	13	88	184	474	214	214	184	70	40	40	
29	16	....	13	70	199	474	290	184	184	62	62	40	
30	16	....	13	54	184	524	214	199	154	62	54	40	
31	16	....	14	....	184	....	169	184	....	62	....	40	
Total	498	376	358	1,066	4,350	13,637	10,864	6,036	7,947	3,299	2,245	1,270	
Mean	16	13	12	36	140	455	350	188	265	106	75	41	142
Maximum	19	15	14	98	232	632	632	400	449	154	169	88	632
Minimum	14	12	10	14	54	184	169	128	154	62	40	40	10
Run-off, per square mile	0.16	0.13	0.12	0.36	1.40	4.55	3.50	1.88	2.65	1.06	0.75	0.41	1.42
Run-off, depth, inches	0.184	0.135	0.138	0.402	1.614	5.076	4.035	2.167	2.957	1.222	0.837	0.473	19.240
Run-off, acre-feet	984	722	738	2,142	8,608	27,074	21,521	11,560	15,769	6,518	4,463	2,521	102,620
Acre-feet per square mile	9.84	7.22	7.38	21.42	86.08	270.74	215.21	115.60	157.69	65.18	44.63	25.21	1026.20

DISCHARGE OF NORTH FORK SOUTH PLATTE RIVER AT CASSELLS FOR 1910.
Drainage Area, 100 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	35	30	25	40	118	214	82	77	23	33	23	....	
2	35	30	30	47	70	214	82	60	23	33	23	....	
3	35	30	30	47	88	214	80	56	23	28	23	....	
4	35	30	30	28	128	214	80	52	28	28	23	....	
5	35	30	30	40	118	214	70	48	23	33	19	....	
6	35	30	30	47	88	214	70	44	23	28	19	....	
7	35	30	30	47	108	214	68	40	23	33	28	....	
8	35	30	30	40	108	199	68	36	19	33	28	....	
9	35	30	30	40	128	169	68	36	23	33	23	....	
10	35	30	30	54	118	169	75	33	23	28	28	....	
11	35	30	30	54	128	153	66	33	23	28	23	....	
12	35	30	30	54	108	153	66	33	28	28	23	....	
13	35	30	30	62	128	166	66	33	33	33	19	....	
14	35	25	30	28	128	140	55	33	53	33	23	....	
15	35	25	34	28	128	150	55	33	40	33	15	....	
16	35	25	40	34	118	125	55	33	28	33	23	....	
17	35	25	40	40	128	137	55	33	33	53	15	....	
18	35	25	47	54	108	137	53	33	33	33	28	....	
19	35	25	40	54	128	112	53	33	46	33	33	....	
20	35	25	40	47	108	122	40	33	46	33	23	....	
21	35	25	47	40	141	122	46	33	46	33	40	....	
22	35	25	54	54	118	98	33	33	46	40	40	....	
23	35	25	47	54	108	108	46	33	40	33	33	....	
24	35	25	47	70	108	130	40	33	33	33	28	....	
25	35	25	40	88	128	118	40	33	33	28	33	....	
26	35	25	47	118	141	118	33	28	33	19	28	....	
27	35	25	54	128	141	106	33	28	33	23	23	....	
28	35	25	47	128	141	106	60	28	33	15	23	....	
29	35	....	47	154	199	104	97	28	33	19	23	....	
30	35	....	62	128	169	92	130	23	33	23	28	....	
31	35	....	40	....	199	....	77	23	....	23	....	....	
Total	1,085	765	1,188	1,847	3,875	4,532	1,942	1,125	957	939	761	....	
Mean	35	27	38	62	125	151	63	36	32	30	25	....	60
Maximum	35	30	62	154	199	214	130	77	53	53	40	....	214
Minimum	35	25	25	28	70	92	33	23	19	15	15	....	15
Run-off per square mile	0.350	0.273	0.383	0.616	1.250	1.511	0.627	0.363	0.319	0.303	0.254	....	0.569
Run-off, depth, inches	0.404	0.284	0.442	0.688	1.441	1.686	0.723	0.419	0.356	0.349	0.283	....	7.075
Run-off, acre-feet	2,152	1,500	2,337	3,689	7,686	8,985	3,874	2,214	1,904	1,845	1,488	....	37,674
Acre-feet per square mile	21.52	15.00	23.37	36.89	76.86	89.85	38.74	22.14	19.04	18.45	14.88	....	376.74

SOUTH PLATTE RIVER AT SOUTH PLATTE.

This station is located about 100 yards below the junction of the North and South Forks of the South Platte river and 200 yards below South Platte station, on the C. & S. R. R.

The equipment at this station, owned by the United States Geological Survey, consists of a cable of 120 feet span, with car and 4"x4" slope gauge rod. On March 14, 1910, an automatic gauge was installed by the State. Since that date readings have been taken from this gauge.

The bed of the stream at this point consists of sand and gravel, which shifts to some extent. Both banks are high and not liable to overflow. The current is swift at high stages and medium at low stages.

The observer at this station until November 1, was Miss E. H. Jardine. After November 1, A. Vermillion. Observers were paid $3.50 per month.

DISCHARGE MEASUREMENTS OF SOUTH PLATTE RIVER AT SOUTH PLATTE.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Feb. 9	*W. B. Freeman		35.9	1.33	1.55	47.6
	Mch. 11	J. B. Stewart		39	1.44	1.40	56
	Apr. 27	W. B. Freeman		125	2.10	2.16	262
	June 4	W. B. Freeman		206	3.68	3.35	758
	June 9	R. C. Miles and A. E. Lewis		323	4.82	4.10	1,558
	June 15	W. B. Freeman		284	4.03	3.90	1,025
	July 28	Geo. J. Lyon and G. H. Russell		190	3.31	3.20	629
	Aug. 14	G. H. Russell		186	3.86	3.28	698
	Sept. 27	G. H. Russell		237	4.32	4.40	1,022
	Oct. 16	J. B. Stewart	78	168	3.56	3.18	598
	Nov. 19	G. H. Russell		105	2.68	2.45	281
	Dec. 15	*G. H. Russell	58	67	2.70	2.15	181
1910	Jan. 24	G. H. Russell	42	64	3.18	2.18	203
	Feb. 15	G. H. Russell	42	59	2.62	1.90	152
	Mch. 10	Thos. Grieve	76	116	3.07	2.62	356
	Apr. 2	G. H. Russell	56	118	3.32	2.65	392
	Apr. 27	G. H. Russell	75	154	3.60	3.15	555
	May 9	W. B. Freeman	78.5	154	3.48	3.17	536
	June 5	R. C. Miles	75	146	3.81	3.30	556
	June 20	G. H. Russell	77	135	3.13	2.90	423
	July 19	G. H. Russell	40	64	2.41	1.95	154
	July 24	Grieve & Christiansen	74	80	2.40	2.05	192
	July 28	Lyon & Johnson		119	3.44	2.60	411
	Aug. 9	I. G. Ferguson and C. C. Hezmalhalch	80	125	3.11	2.82	388
	Aug. 11	G. H. Russell	76	160	4.05	3.40	648
	Aug. 25	G. H. Russell	75	82	2.39	2.10	196
	Sept. 24	Padgett & Miles	65	71	2.80	2.05	199
	Oct. 31	G. H. Russell	48.5	72	2.22	2.00	161
	Nov. 22	H. D. Padgett	55	57	1.96	1.80	112

*Ice Conditions.

DISCHARGE OF SOUTH PLATTE RIVER AT SOUTH PLATTE FOR 1909.

Drainage Area, 2,610 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	60	45	78	80	204	531	1,025	486	910	850	360	310	
2	60	45	80	80	204	554	998	464	930	860	360	310	
3	55	45	80	89	218	600	1,275	443	1,010	835	360	290	
4	55	45	90	89	218	725	1,410	443	1,090	820	360	260	
5	60	45	90	98	233	915	1,375	443	1,230	750	345	260	
6	60	40	90	98	218	942	1,900	464	1,430	735	345	190	
7	60	40	90	89	248	1,025	1,980	486	2,330	745	310	215	
8	60	40	90	80	312	998	1,625	508	2,420	755	275	215	
9	60	48	100	80	312	1,210	1,662	508	2,560	740	275	230	
10	60	40	90	118	296	1,085	1,145	508	2,560	725	290	240	
11	60	40	60	140	329	1,115	970	577	2,120	685	275	215	
12	60	40	75	140	329	1,055	832	650	1,910	650	290	200	
13	60	40	80	129	296	1,055	675	675	2,570	635	275	200	
14	60	50	80	140	312	1,055	625	650	2,770	620	260	190	
15	50	50	80	140	329	998	577	650	2,790	585	275	180	
16	50	50	80	190	402	1,025	554	650	2,580	570	245	180	
17	50	50	80	204	464	1,085	577	778	2,370	580	245	180	
18	50	50	80	233	464	1,085	581	1,340	2,190	580	310	180	
19	50	50	80	218	464	1,308	508	2,390	2,130	580	275	180	
20	50	50	80	218	486	1,340	554	2,670	1,720	580	275	180	
21	50	50	80	164	577	1,375	554	1,775	1,560	595	290	180	
22	50	60	80	177	625	1,480	554	1,220	1,450	505	325	180	
23	50	60	80	177	650	1,410	750	1,150	1,270	505	325	180	
24	50	60	98	164	675	1,308	860	1,080	1,170	480	325	180	
25	50	60	98	164	700	1,275	998	1,080	1,130	460	380	180	
26	50	60	98	177	675	1,178	915	1,010	1,030	420	380	180	
27	50	60	89	218	625	1,115	750	1,010	1,030	380	380	180	
28	50	78	98	264	600	1,085	650	910	980	400	380	180	
29	50	....	89	280	577	1,025	675	820	960	400	380	180	
30	50	....	80	233	554	1,025	625	815	920	400	310	180	
31	50	....	80	....	554	....	531	810	....	400	....	180	
Total	1,680	1,391	2,623	4,671	13,150	31,982	28,660	27,463	51,120	18,825	9,480	6,385	
Mean	54	50	85	156	424	1,032	925	886	1,704	607	316	206	537
Maximum	60	78	100	280	700	1,480	1,980	2,670	2,790	860	380	310	2,790
Minimum	50	40	75	80	204	531	508	443	910	380	245	180	60
Run-off per square mile	0.021	0.019	0.033	0.060	0.162	0.395	0.354	0.339	0.653	0.233	0.121	0.079	0.206
Run-off, depth, inches	0.024	0.021	0.038	0.067	0.186	0.440	0.408	0.391	0.728	0.269	0.135	0.091	2.798
Run-off, acre-feet	3,320	2,777	5,226	9,283	26,071	61,408	56,876	54,478	101,395	37,323	18,803	12,666	389,626
Acre-feet per square mile	1.27	1.06	2.00	3.56	9.99	23.52	21.79	20.87	38.84	14.30	7.20	4.85	14.92

DISCHARGE OF SOUTH PLATTE RIVER AT SOUTH PLATTE FOR 1910.
Drainage Area, 2,610 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	338	174	152	338	583	563	403	338	152	130	141	....	
2	278	200	174	353	583	563	403	543	163	130	130	....	
3	308	174	226	353	583	563	438	603	152	130	130	....	
4	252	152	226	308	623	563	420	543	163	130	130	....	
5	252	152	308	308	623	508	420	490	152	120	152	....	
6	308	152	338	293	563	508	403	508	130	120	141	....	
7	338	110	323	308	543	543	386	473	120	120	141	....	
8	368	110	353	308	526	526	353	403	120	130	163	....	
9	368	110	368	308	526	508	323	353	141	120	163	....	
10	308	100	683	308	526	490	200	563	141	120	163	....	
11	308	110	683	323	526	490	187	543	120	130	163	....	
12	338	110	623	338	543	508	174	583	120	120	163	....	
13	338	120	583	368	583	473	174	563	130	100	152	....	
14	293	130	583	420	623	508	174	508	130	110	141	....	
15	308	152	583	403	623	473	187	226	130	130	152	....	
16	252	174	583	353	603	508	187	200	130	152	152	....	
17	278	152	563	368	583	526	187	239	130	163	130	....	
18	308	163	583	368	663	508	187	265	130	141	141	....	
19	308	174	563	386	623	490	152	265	130	141	141	....	
20	338	200	583	403	543	438	163	265	130	152	120	....	
21	338	226	563	456	526	368	200	323	141	152	120	....	
22	323	239	543	438	563	386	226	338	163	163	130	....	
23	323	226	563	456	643	368	239	338	163	163	120	....	
24	338	226	543	473	663	353	226	338	163	152	141	....	
25	226	174	490	490	643	353	338	213	152	152	141	....	
26	226	200	473	490	583	308	323	163	152	141	120	....	
27	174	200	420	508	583	293	323	163	152	130	110	....	
28	200	174	386	526	583	278	338	163	152	130	81	....	
29	226	....	386	563	583	278	563	174	152	141	90	....	
30	200	....	338	583	563	386	543	152	152	130	81	....	
31	213	....	323	....	563	....	603	152	....	163	....	....	
Total	8,974	4,584	14,109	11,898	18,088	13,628	9,443	10,991	4,256	4,206	4,043	....	
Mean	289	164	455	397	583	454	305	354	142	136	135	....	312
Maximum	338	239	683	583	663	563	603	603	163	163	152	....	683
Minimum	174	100	152	293	526	278	152	152	120	100	81	....	81
Run-off per square mile	0.111	0.063	0.174	0.152	0.224	0.174	0.117	0.136	0.054	0.052	0.052	....	0.120
Run-off, depth, inches	0.128	0.065	0.201	0.169	0.258	0.194	0.135	0.157	0.060	0.060	0.058	....	1.485
Run-off, acre-feet	17,770	9,108	27,977	23,623	35,847	27,015	18,754	21,767	8,450	8,362	8,033	....	206,706
Acre-feet per square mile	6.81	3.49	10.72	9.05	13.74	10.35	7.18	8.34	3.24	3.20	3.08	....	79.20

SOUTH FORK SOUTH PLATTE RIVER AT SOUTH PLATTE.

This station, maintained in co-operation with the United States Geological Survey, is located about ¼ mile from South Platte station of the C. & S. R. R. and 600 feet above the junction of the North and South Forks of the South Platte river.

The equipment, which is the property of the United States Geological Survey, consists of a cable of 100 feet span, with car and a 4"x4" slope gauge rod.

The bed of the stream consists of boulders and gravel and is fairly permanent. Both banks are covered with trees and not liable to overflow.

The observers at this station were Miss E. H. Jardine and A. Vermillion, who were paid $3.50 per month.

DISCHARGE MEASUREMENTS OF SOUTH FORK SOUTH PLATTE RIVER AT SOUTH PLATTE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 Feb. 9	*W. B. Freeman		20.4	0.97	1.90	19.9
Mch. 11	*J. B. Stewart		28	1.18	0.81	33
Apr. 27	W. B. Freeman		39	1.72	1.15	67
June 4	W. B. Freeman		72	2.68	2.05	193
June 9	R. C. Miles and A. W. Lewis		150	3.97	3.25	597
June 26	R. C. Miles		169	3.66	3.30	621
July 28	G. H. Russell and Geo. J. Lyon		98.9	2.85	2.50	280
Aug. 14	G. H. Russell		103	3.67	2.60	382
Sept. 7	G. H. Russell		250	5.53	5.10	1,402
Sept. 27	G. H. Russell		148	4.01	4.00	593
Oct. 16	Jas. B. Stewart	64	94	3.18	2.80	299
Nov. 19	G. H. Russell		54	2.74	2.40	147
Dec. 15	*G. H. Russell	34	39	3.10	2.18	121
1910 Jan. 24	G. H. Russell	45	44	3.07	2.30	135
Feb. 15	G. H. Russell	25	30	2.47	1.90	74
Mch. 7	Thos Grieve	61	84	3.61	2.78	303
Apr. 2	G. H. Russell	65	90	3.02	2.65	272
Apr. 27	G. H. Russell	64	92	3.42	2.85	315
May 9	W. B. Freeman	69	106	3.16	2.80	335
June 4	R. C. Miles	61	97	3.75	2.95	364
June 20	G. H. Russell	61	83	3.43	2.75	285
July 19	G. H. Russell	41	39	2.10	1.90	82
July 24	Grieve & Christiansen	42	42	2.25	2.05	95
July 28	Lyon & Johnson		84.7	4.03	3.75	341
Aug. 9	Hezmalhalch & Ferguson	63.5	82.9	3.69	2.83	306
Aug. 11	G. H. Russell	65	135	4.31	3.33	582
Aug. 25	G. H. Russell	63	54	2.30	2.00	124
Sept. 24	Padgett & Miles	37	61	2.23	2.10	136
Oct. 31	G. H. Russell	39	60	1.90	2.05	114
Nov. 22	H. D. Padgett	36	35.5	1.73	1.80	61.6

*Ice conditions.

DISCHARGE OF SOUTH FORK SOUTH PLATTE RIVER AT SOUTH PLATTE FOR 1909.
Drainage Area, 2,160 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	30	50	20	56	68	172	565	164	418	418	179	158	
2	30	30	20	56	68	172	515	156	480	348	179	164	
3	30	25	30	56	68	190	515	156	575	333	179	145	
4	30	25	30	56	68	181	795	200	660	318	179	140	
5	30	25	30	53	68	210	1,140	210	850	288	179	130	
6	30	25	30	53	68	210	1,405	210	995	288	171	117	
7	35	20	30	50	68	285	1,565	235	1,448	288	152	117	
8	35	20	30	50	68	430	1,405	248	1,790	288	140	117	
9	50	20	30	50	68	235	1,215	235	1,895	288	140	121	
10	20	20	30	62	74	615	795	235	1,740	288	125	135	
11	20	20	30	68	71	675	565	285	1,495	253	125	130	
12	20	20	40	68	68	590	390	370	1,400	242	135	130	
13	20	20	50	68	68	565	272	370	1,895	222	135	125	
14	20	20	50	68	68	675	200	390	2,165	222	135	121	
15	20	20	50	68	82	565	172	390	2,220	222	145	117	
16	30	20	48	74	132	565	181	390	2,000	213	135	110	
17	30	20	46	68	124	565	235	390	1,790	213	125	110	
18	20	20	46	82	140	565	190	630	1,590	213	145	110	
19	20	40	50	82	156	735	172	1,448	1,315	213	140	110	
20	20	30	50	82	148	828	156	1,690	1,150	213	135	110	
21	20	30	50	74	190	892	181	995	995	253	152	110	
22	20	30	50	68	200	960	190	720	958	204	158	110	
23	20	30	50	68	210	860	285	630	850	204	164	117	
24	20	30	56	68	222	735	515	575	750	204	158	125	
25	20	30	56	68	235	675	735	500	690	187	158	135	
26	20	25	56	68	272	615	615	418	600	187	171	158	
27	20	20	62	68	235	565	450	418	575	187	171	158	
28	20	20	59	68	200	565	300	366	550	179	171	152	
29	15	....	56	74	190	540	260	303	500	179	158	145	
30	15	....	56	74	172	540	248	318	400	179	158	135	
31	25	....	56	....	172	....	200	348	....	179	....	125	
Total	755	705	1,347	1,968	4,041	15,975	16,427	13,993	34,739	7,513	4,597	3,987	
Mean	24	25	43	66	130	532	530	451	1,158	242	153	128	290
Maximum	50	50	62	82	272	960	795	1,690	2,220	418	179	164	2,220
Minimum	15	20	20	53	68	172	156	156	400	179	125	110	15
Run-off per square mile	0.011	0.012	0.020	0.030	0.060	0.247	0.245	0.209	0.536	0.112	0.071	0.060	0.135
Run-off, depth, inches	0.013	0.012	0.023	0.033	0.069	0.276	0.283	0.241	0.598	0.129	0.079	0.069	1.825
Run-off, acre-feet	1,497	1,398	2,672	3,904	8,016	31,690	32,585	27,750	68,904	14,901	9,120	7,908	210,345
Acre-feet per square mile	0.69	0.65	1.24	1.81	3.71	14.67	15.09	12.85	31.91	6.90	4.22	3.66	97.40

DISCHARGE OF SOUTH FORK SOUTH PLATTE RIVER AT SOUTH PLATTE FOR 1910.
Drainage Area, 2,160 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	155	145	106	245	445	280	202	155	116	106	88	....	
2	165	135	125	245	445	280	280	470	116	106	80	....	
3	145	125	145	262	445	280	355	605	106	106	73	....	
4	145	106	145	245	495	280	315	550	106	106	80	....	
5	145	106	215	245	522	280	315	445	106	88	106	....	
6	190	106	280	245	422	280	315	422	88	88	106	....	
7	215	88	245	106	400	378	315	400	80	88	106	....	
8	215	61	280	106	355	335	315	355	80	88	106	....	
9	245	61	298	106	315	315	178	335	97	97	116	....	
10	245	61	725	245	315	298	88	550	80	97	125	....	
11	165	67	695	262	315	315	88	665	88	97	125	....	
12	165	56	605	262	355	280	88	665	88	97	116	....	
13	165	61	550	280	355	298	88	665	88	97	106	....	
14	155	67	495	335	315	262	88	665	88	97	116	....	
15	165	88	495	315	400	298	88	445	88	97	116	....	
16	165	88	445	245	378	315	88	106	88	97	116	....	
17	190	97	470	262	422	315	106	230	106	106	106	....	
18	190	97	495	262	522	355	116	230	97	106	106	....	
19	215	106	495	262	470	355	106	230	88	106	97	....	
20	202	125	495	280	378	280	125	315	88	106	88	....	
21	215	155	495	315	378	215	125	355	116	106	88	....	
22	215	145	495	335	400	245	135	355	125	135	80	....	
23	202	145	355	335	445	245	125	355	155	135	80	....	
24	165	125	355	335	495	245	125	355	135	135	73	....	
25	155	106	355	355	495	145	298	125	135	135	67	....	
26	135	106	315	355	445	145	298	116	135	135	80	....	
27	145	106	315	355	355	125	298	125	135	125	80	....	
28	145	106	280	355	400	135	315	116	135	125	61	....	
29	135	....	280	400	335	145	725	116	135	125	73	....	
30	145	....	245	400	280	145	315	106	135	125	73	....	
31	145	....	245	....	280	....	298	125	....	125	....	....	
Total	5,444	2,840	11,539	8,355	12,377	7,869	6,610	10,652	3,223	3,382	2,833	....	
Mean	176	101	372	278	399	262	213	344	107	109	94	....	225
Maximum	245	155	725	400	522	378	725	665	155	135	125	....	725
Minimum	135	61	106	106	280	125	88	106	88	88	61	....	61
Run-off per square mile	0.081	0.047	0.172	0.129	0.185	0.121	0.099	0.159	0.050	0.050	0.044	....	0.104
Run-off, depth, inches	0.093	0.049	0.198	0.144	0.214	0.135	0.114	0.183	0.056	0.058	0.049	....	1.293
Run-off, acre-feet	10,822	5,609	22,873	16,542	24,534	15,590	13,097	21,152	6,367	6,702	5,593	....	148,881
Acre-feet per square mile	5.01	2.55	10.59	7.66	11.36	7.22	6.06	9.79	2.95	3.10	2.59	....	68.88

SOUTH PLATTE RIVER AT DENVER.

This station, maintained by the State, is located where the Sixteenth Street viaduct crosses the South Platte river at Denver, and about 500 feet below Cherry creek.

The equipment, owned by the State, consists of an automatic gauge, with an auxiliary chain gauge for checking.

The bed of the stream is composed of sand and gravel which shifts considerably. The current is swift at high stages and sluggish at low stages.

The gauge at this station has been taken care of by employes of the State Engineer's office.

DISCHARGE MEASUREMENTS OF SOUTH PLATTE RIVER AT DENVER.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 28	F. Cogswell		183	2.48	1.90	453
	June 18	F. Cogswell		355	3.16	2.80	1,122
	June 29	F. Cogswell		260	2.58	2.10	670
	July 7	C. L. Chatfield, T. Grieve		512	4.39	3.73	2,246
	Aug. 21	C. L. Chatfield		445	4.07	3.40	1,814
	Sept. 11	F. Cogswell		567	4.53	4.00	2,568
	Nov. 10	F. Cogswell		118	1.85	1.02	220
	Dec. 30	Thos. Grieve, C. L. Chatfield	101	115	1.97	1.35	226
1910	Jan. 12	Thos. Grieve, C. L. Chatfield	91	120	2.14	1.30	256
	Feb. 14	Thos. Grieve	101.5	85	1.93	1.22	165
	Mch. 10	Thos. Grieve	134	269	2.64	2.35	711
	Apr. 8	F. Cogswell		145	2.49	1.62	361
	Apr. 23	F. Cogswell		162	2.38	1.63	386
	May 5	F. Cogswell		197	2.66	1.80	524
	May 17	F. Cogswell		195	2.70	1.87	526
	June 4	C. L. Chatfield and C. C. Hezmalhalch		174	2.94	1.95	512
	June 17	F. Cogswell		124	2.67	1.49	331
	July 7	F. Cogswell		74	1.61	0.90	119
	July 26	Thos. Grieve and E. O. Christiansen	53	77	2.38	1.20	183
	July 30	Thos. Grieve and E. O. Christiansen	173	324	3.95	3.18	1,281
	Aug. 22	F. Cogswell		815	2.06	1.10	168
	Aug. 31	F. Cogswell		53	1.62	0.80	86
	Sept. 17	F. Cogswell		59	1.72	0.95	101
	Oct. 6	Grieve & Hezmalhalch	45	53.4	1.63	0.90	87.2
	Oct. 5	F. Cogswell		64.5	1.81	1.00	117
	Nov. 11	Christiansen & Hezmalhalch	46	56.7	1.37	0.89	77.6

DISCHARGE OF SOUTH PLATTE RIVER AT DENVER FOR 1909.

Drainage Area, 3,840 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	......	......	......	......	......	......	......	360	640	895	285	285	
2	......	......	......	......	......	......	......	380	730	860	285	265	
3	......	......	......	......	......	......	......	255	760	790	300	265	
4	......	......	......	......	......	......	......	420	1,010	760	300	265	
5	......	......	......	......	......	......	1,930	510	1,590	730	320	180	
6	......	......	......	......	......	......	......	460	1,645	670	340	180	
7	......	......	......	......	......	......	2,235	440	2,170	670	270	180	
8	......	......	......	......	......	......	......	535	2,938	730	255	165	
9	......	......	......	......	......	......	......	730	3,010	730	228	195	
10	......	......	......	......	......	......	......	585	2,938	700	228	248	
11	......	......	......	......	......	......	......	640	2,575	670	215	248	
12	......	......	......	......	......	......	......	535	2,050	670	228	212	
13	......	......	......	......	......	......	......	585	2,300	640	300	212	
14	......	......	......	......	......	......	......	560	2,648	610	300	212	
15	......	......	......	......	......	......	......	535	2,720	585	270	195	
16	......	......	......	......	......	......	......	510	2,938	585	320	195	
17	......	......	......	......	......	......	......	610	2,938	535	320	180	
18	......	......	......	......	......	......	......	1,270	2,720	485	340	100	
19	......	......	......	......	......	......	215	2,575	2,170	485	400	70	
20	......	......	......	......	......	......	......	2,720	1,700	460	400	110	
21	......	......	......	......	......	......	182	1,810	1,480	440	400	165	
22	......	......	......	......	......	......	......	895	1,375	420	420	150	
23	......	......	......	......	......	......	420	860	1,270	440	380	150	
24	......	......	......	......	......	......	760	730	1,180	420	340	180	
25	......	......	......	......	......	......	790	610	1,180	440	340	165	
26	......	......	......	......	......	......	730	700	1,090	400	440	180	
27	......	......	......	......	......	......	560	700	1,050	400	320	195	
28	......	......	......	......	......	......	420	640	930	360	420	195	
29	......	......	......	......	......	......	610	670	930	320	360	165	
30	......	......	......	......	......	......	585	585	930	300	400	230	
31	......	......	......	......	......	......	380	610	......	285	......	265	
Total	......	......	......	......	......	......	9,817	24,025	53,605	17,480	9,724	6,002	
Mean	......	......	......	......	......	......	755	775	1,787	564	324	194	727
Maximum	......	......	......	......	......	......	2,235	2,720	3,010	895	440	285	3,010
Minimum	......	......	......	......	......	......	182	255	640	285	215	70	70
Run-off per square mile	......	......	......	......	......	......	......	......	......	......	......	......	......
Run-off, depth, inches	......	......	......	......	......	......	......	......	......	......	......	......	......
Run-off, acre-feet	......	......	......	......	......	......	19,470	47,653	106,324	34,679	19,279	11,929	239,334
Acre-feet per square mile	......	......	......	......	......	......	......	......	......	......	......	......	......

DISCHARGE OF SOUTH PLATTE RIVER AT DENVER FOR 1910.
Drainage Area, 3,840 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	678	295	258	400	500	408	295	422	90	128	65	....	
2	102	275	240	378	768	535	275	222	90	115	65	....	
3	422	222	258	378	645	535	275	422	102	115	65	....	
4	315	205	295	400	500	520	275	545	115	115	65	....	
5	205	222	295	378	500	470	258	495	128	102	65	....	
6	175	205	295	355	468	445	240	495	115	102	65	....	
7	222	205	335	335	358	470	175	495	90	102	65	....	
8	258	190	520	315	312	445	130	445	78	102	65	....	
9	222	160	622	315	290	422	90	422	78	102	65	....	
10	222	145	678	295	290	335	102	422	78	102	78	....	
11	222	160	765	275	408	258	115	595	115	90	78	....	
12	222	160	735	335	408	222	90	622	65	90	78	....	
13	205	160	622	445	468	240	90	622	78	90	78	....	
14	222	205	570	520	685	275	90	678	102	90	78	....	
15	222	190	545	520	768	275	90	545	78	102	78	....	
16	240	160	545	500	855	258	90	275	90	115	78	....	
17	258	102	545	358	535	295	82	275	90	115	90	....	
18	258	102	570	290	408	295	82	400	90	115	102	....	
19	275	160	595	335	435	295	82	378	200	128	90	....	
20	275	175	570	290	535	275	90	335	115	140	90	....	
21	258	175	595	335	570	222	90	315	115	170	78	....	
22	275	175	570	468	500	130	90	240	170	155	102	....	
23	295	175	570	380	500	145	90	240	245	155	128	....	
24	315	205	595	335	570	115	102	222	170	102	128	....	
25	355	222	570	380	570	145	175	190	170	115	155	....	
26	258	205	520	408	468	222	145	205	155	102	155	....	
27	240	222	470	380	380	222	102	275	140	90	115	....	
28	275	258	445	358	335	222	175	335	155	102	128	....	
29	295	....	445	358	358	190	400	145	140	90	102	....	
30	258	....	470	358	435	222	918	175	140	90	102	....	
31	258	....	422	....	435	....	495	145	....	78	....	....	
Total	8,302	5,335	15,530	11,177	15,257	9,108	5,798	11,597	3,587	3,409	2,696	....	
Mean	268	190	501	372	492	304	187	374	110	110	90	....	275
Maximum	678	295	765	520	855	535	918	678	245	170	155	....	918
Minimum	102	102	240	275	290	130	82	145	78	78	65	....	65
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	16,479	10,552	30,805	22,136	30,252	18,089	11,498	22,996	6,545	6,764	5,355	....	181,471
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

SOUTH PLATTE RIVER AT KERSEY.

This station, maintained in co-operation with the United States Geological Survey, is located on a pile bridge 1½ miles north of Kersey.

The equipment consists of two chain gauges which are owned by the United States Geological Survey.

The bed of the stream is composed of sand and gravel and is very shifting. The banks are liable to overflow at extreme high water. There are two channels at low water.

The observer is Mrs. J. C. Maisner, whose salary is $6.00 per month.

DISCHARGE MEASUREMENTS OF SOUTH PLATTE RIVER AT KERSEY.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
		CHANNEL NO. 1					
1909	May 24......	W. B. Freeman..........................	94	118	2.00	3.13	235
	June 10......	*R. C. Miles..........................	....	....	....	6.99	7,260
	July 10......	R. C. Miles and G. H. Russell.............	166	630	2.91	6.55	1,831
	July 26......	G. J. Lyon and G. H. Russell..............	78	133.5	1.51	3.14	202
	Sept. 1......	G. H. Russell and G. Campbell...........	50	46.8	1.23	2.44	57.2
	Sept. 24......	G. H. Russell..........................	104	297	2.66	5.10	790
	Oct. 22......	G. H. Russell..........................	84	208	2.22	4.00	463
	Nov. 12......	G. H. Russell..........................	86	156.5	2.36	3.58	370
	Dec. 13......	G. H. Russell..........................	115	215	2.12	5.15	455
		CHANNEL NO. 2					
	May 24......	W. B. Freeman..........................	134.5	247	2.08	3.25	516
	June 10......	*R. C. Miles..........................	....	....	....	6.96	....
	July 10......	R. C. Miles and G. H. Russell.............	305	1,152	3.51	6.52	4,043
	July 26......	G. J. Lyon and G. H. Russell..............	82	93.2	0.77	2.93	717
	Sept. 1......	G. H. Russell and G. Campbell............	30	72.1	1.87	2.65	135
	Sept. 24......	G. H. Russell..........................	104	560	2.54	2.54	1,420
	Oct. 22......	G. H. Russell..........................	133	254	2.49	3.75	633
	Nov. 12......	G. H. Russell..........................	131	259	2.16	3.70	558
	Dec. 13......	G. H. Russell..........................	165	350	1.91	5.30	670
		CHANNEL NO. 1					
1910	Feb. 10......	G. H. Russell..........................	69	123	2.42	3.30	298
	Mch. 21......	G. H. Russell..........................	83	178	2.48	3.75	442
	Apr. 25......	G. H. Russell..........................	45	42	1.74	2.37	73
	May 16......	G. H. Russell..........................	65	45	1.78	2.40	80
	June 9......	G. H. Russell..........................	45	30	1.63	2.10	49
	June 29......	C. E. Turner and R. C. Miles.............	44	34	1.79	2.15	61
	July 14......	G. H. Russell..........................	47	37	1.62	2.21	60
	Aug. 9......	G. H. Russell..........................	39	38	1.50	2.26	57
	Sept. 12......	G. H. Russell..........................	35	33	1.60	2.18	53
	Oct. 8......	Padgett & Miles........................	35	31.7	2.32	2.30	74
	Oct. 27......	G. H. Russell..........................	67	85	1.85	2.88	157
	Nov. 26......	Padgett & Miles........................	48	47.6	....	2.60	103
		CHANNEL NO. 2					
	Feb. 10......	G. H. Russell..........................	70	193	2.70	3.40	522
	Mch. 21......	G. H. Russell..........................	150	203	2.71	3.60	550
	Apr. 25......	G. H. Russell..........................	47	52	2.52	2.20	131
	May 16......	G. H. Russell..........................	54.5	56	2.32	2.30	130
	June 9......	G. H. Russell..........................	31	22	1.73	1.56	38
	June 29......	C. E. Turner and R. C. Miles.............	46	32	1.50	1.60	48
	July 14......	G. H. Russell..........................	27	28	1.74	1.78	47
	Aug. 9......	G. H. Russell..........................	38	30	1.77	1.90	53
	Oct. 8......	Padgett & Miles........................	41	39.2	1.77	2.10	69.3
	Oct. 27......	G. H. Russell..........................	56	130	2.07	2.87	269
	Sept. 12......	G. H. Russell..........................	38.5	25	1.60	1.89	40
	Nov. 26......	Padgett & Miles........................	45	65.3	....	2.70	183

*Water in only one channel.

DISCHARGE OF SOUTH PLATTE RIVER AT KERSEY FOR 1909.
Drainage Area, 9,500 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					1,370	815	2,720	200	192	1,450	895		
2					1,260	815	2,530	180	200	1,290	895		
3					1,330	865	2,140	180	225	1,220	955		
4					1,150	985	2,530	180	275	1,220	955		
5					1,180	1,120	4,820	180	525	1,220	955		
6					1,050	1,500	9,220	180	1,310	1,180	925		
7					1,150	4,010	8,900	160	1,480	1,260	955		
8					1,050	5,280	7,460	185	1,880	1,260	955		
9					1,050	7,140	6,520	200	1,880	1,180	895		
10					1,120	7,140	5,870	300	2,780	1,500	895		
11					985	7,620	4,750	325	2,820	1,290	895		
12					925	7,140	3,620	250	2,820	1,330	895		
13					742	5,600	2,100	250	2,820	1,370	895		
14					635	6,220	1,380	190	3,080	1,330	955		
15					548	6,060	1,150	190	3,460	1,630	1,020		
16					490	6,370	800	170	3,600	1,630	955		
17					460	6,060	700	170	4,000	1,630	1,020		
18					385	6,060	550	170	3,700	1,220	985		
19					435	6,840	500	210	3,500	1,150	985		
20					410	8,420	420	885	3,180	1,080	985		
21					448	9,380	380	1,060	2,980	1,080	1,050		
22				1,180	525	8,420	300	1,250	2,560	1,050	1,020		
23				1,180	635	6,990	250	880	2,470	985	1,080		
24				1,120	698	5,750	275	600	2,210	985	1,080		
25				1,080	1,020	5,750	280	500	2,210	1,020	1,020		
26				1,050	1,580	5,130	274	375	2,210	985	1,020		
27				1,050	1,330	4,680	245	325	1,840	1,020	1,020		
28				1,120	1,120	3,650	200	285	1,730	985	1,020		
29				1,220	955	2,720	190	260	1,630	955	1,020		
30				1,180	985	2,940	200	240	1,540	955	1,080		
31					865		200	200		895			
Total				10,180	27,880	151,470	71,474	10,730	64,707	37,355	29,280		
Mean				1,130	899	5,050	2,310	346	2,160	1,200	976		1,808
Maximum				1,220	1,580	9,380	9,220	1,250	4,000	1,630	1,080		9,380
Minimum				1,050	385	815	190	160	192	895	895		160
Run-off per square mile													
Run-off, depth, inches													
Run-off, acre-feet				20,200	55,300	300,000	142,000	21,300	129,000	73,800	58,100		799,700
Acre-feet per square mile													

DISCHARGE OF SOUTH PLATTE RIVER AT KERSEY FOR 1910.
Drainage Area, 9,500 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	893	786	174	121	102	83	98	103	583	....	
2	....	....	803	727	210	118	102	83	98	103	583	....	
3	....	....	893	672	340	90	102	83	98	156	566	....	
4	....	....	876	617	592	90	102	93	98	145	555	....	
5	....	....	893	707	419	88	102	93	98	145	555	....	
6	....	....	893	488	283	90	102	108	90	145	385	....	
7	....	....	893	488	229	90	102	103	90	145	411	....	
8	....	....	893	462	216	90	110	103	90	145	458	....	
9	....	....	917	407	185	130	105	98	95	160	470	....	
10	....	810	1,064	329	150	130	126	93	103	155	441	....	
11	....	810	1,136	329	108	130	152	98	103	166	430	....	
12	....	810	1,196	329	98	130	152	98	103	182	436	....	
13	....	834	1,176	407	128	90	140	103	103	214	448	....	
14	....	834	1,196	446	185	90	75	98	103	230	448	....	
15	....	834	1,150	475	239	90	75	98	103	263	448	....	
16	....	810	1,104	597	226	90	75	98	103	319	431	....	
17	....	869	1,060	602	226	90	75	103	109	400	401	....	
18	....	845	1,036	607	316	90	75	103	103	583	401	....	
19	....	828	1,036	462	185	90	88	103	103	576	401	....	
20	....	845	1,016	407	167	90	83	88	109	576	365	....	
21	....	845	1,036	105	158	90	83	83	115	561	376	....	
22	....	780	1,036	98	276	90	83	83	115	561	396	....	
23	....	757	1,016	90	323	90	83	88	137	610	339	....	
24	....	821	1,016	90	370	90	83	98	137	610	324	....	
25	....	886	992	180	270	90	83	98	103	745	290	....	
26	....	928	1,016	142	243	90	83	98	98	566	290	....	
27	....	893	928	128	199	90	83	98	98	573	329	....	
28	....	893	845	128	172	90	88	98	120	638	375	....	
29	....	....	810	121	194	94	88	98	126	638	371	....	
30	....	....	728	152	175	94	88	98	98	638	360	....	
31	....	....	858	....	125	....	83	98	....	621	....	....	
Total	....	15,932	30,495	11,578	7,181	2,925	2,973	2,968	3,147	11,672	12,666	....	
Mean	....	839.	984	386	232	97	96	96	105	376	422	....	345
Maximum	....	928	1,196	786	592	130	152	108	137	745	583	....	1,196
Minimum	....	757	728	90	98	88	75	83	90	103	290	....	75
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	....	31,638	60,504	22,960	14,265	5,772	5,903	5,903	6,248	23,119	25,111	....	201,432
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

SOUTH PLATTE RIVER AT JULESBURG.

This station is maintained in co-operation with the United States Geological Survey. It is located on a pile bridge about one mile south of Julesburg and about one mile from the Nebraska-Colorado line.

The equipment at this station consists of a chain gauge and two rod gauges nailed to pile bents. The equipment is the property of the United States Geological Survey.

The bed of the stream is sandy and very shifting. Although the banks are low, owing to the great width of the river at this point they are not liable to overflow. At low water the river flows in several small streams. At high water the river flows in two channels and at extreme high water in one channel.

The observer at this station is Jos. B. McSparian, whose pay is $5.00 per month.

DISCHARGE MEASUREMENTS OF SOUTH PLATTE RIVER AT JULESBURG.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Feb. 25	*W. B. Freeman		274	1.09	2.70	298
	Mch. 20	W. B. Freeman		376	2.02	2.25	760
	Apr. 23	W. B. Freeman		636	2.00	2.53	1,270
	May 24	W. B. Freeman		138	1.20	1.50	164
	June 17-18	Geo. J. Lyon		1,910	2.47	3.38	4,714
	June 26	Geo J. Lyon		1,915	2.39	3.36	4,583
	Sept. 2	G. H. Russell		167	1.65	1.20	276
	Sept. 25	G. H. Russell and C. Slicker		1,204	2.46	3.05	2,964
	Nov. 13	G. H. Russell		574	2.07	2.40	1,190
	Dec. 14	*G. H. Russell		380	2.10	3.20	800
1910	Feb. 11	*G. H. Russell	466	527	1.96	2.95	1,031
	Mch. 22	G. H. Russell	431	333	2.01	2.23	670
	Apr. 26	G. H. Russell	229	84	2.01	1.80	169
	May 17	G. H. Russell	98	31	1.10	1.40	34
	June 10	G. H. Russell	73	21.4	1.01	1.30	21.6
	July 15	G. H. Russell	34	6.2	0.89	1.20	5.4
	Aug. 10	G. H. Russell	50	12.5	0.91	1.30	11.4
	Sept. 13	G. H Russell	53	11	1.18	1.30	13.0
	Sept. 30	G. H. Russell	76	19.7	1.10	1.41	21.6
	Oct. 28	G. H. Russell	69	21	1.00	1.55	21
	Nov. 2	F. Cogswell	46	18.6	1.34	1.40	25
	Nov. 25	Padgett & Miles	43.5	17.4	1.26	1.40	22

*Ice conditions.

DISCHARGE OF SOUTH PLATTE RIVER AT JULESBURG FOR 1909.
Drainage Area, 20,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1				1,040	860	80	1,680		300	1,570	1,080		
2				1,020	890	76	1,080		300	1,500	1,040		
3				1,000	920	73	980		300	1,430	1,200		
4				980	950	70	905		300	1,360	1,370		
5				960	980	310	865		300	1,280	1,280		
6				940	910	550	830		800	1,190	1,250		
7				920	840	790	1,800		800	1,280	1,220		
8				905	770	1,030	2,760		800	1,280	1,190		
9				905	700	1,270	3,730		800	1,280	1,190		
10				905	640	1,510	5,420		800	1,140	1,190		
11				985	555	1,740	4,530		1,200	1,000	1,190		
12				1,070	470	1,980	3,640		1,200	855	1,190		
13				1,150	380	3,330	2,750		1,200	855	1,190		
14				1,230	380	4,680	2,160		1,570	882	1,260		
15				1,310	380	6,040	1,680		1,760	910	1,320		
16				1,400	325	5,430	1,170		1,960	942	1,390		
17				1,540	270	4,820	640		2,260	975	1,450		
18				1,400	210	4,540			2,430	1,050	1,510		
19				1,320	190	4,400			2,430	1,120	1,570		
20			765	1,240	170	4,250			2,620	1,190	1,570		
21			800	1,170	155	4,320			2,920	1,190	1,430		
22			835	1,170	150	4,390			3,230	1,190	1,280		
23			870	1,280	140	4,460			3,020	1,120	1,570		
24			905	1,130	130	4,540			3,020	1,160	1,470		
25			940	980	122	4,540			3,020	1,190	1,370		
26			980	830	114	4,540			2,620	1,190	1,400		
27			980	830	106	3,220			2,260	1,280	1,430		
28			1,030	830	98	2,980			1,960	1,280	1,470		
29			1,080	830	90	2,750			1,960	1,230	1,570		
30			1,060	830	87	2,160			1,570	1,180	1,570		
31					83					1,130			
Total			10,245	32,100	13,065	84,869	36,620		49,710	36,229	40,210		
Mean			931	1,070	421	2,829	2,154		1,657	1,169	1,340		1,443
Maximum			1,080	1,540	980	6,040	5,420		3,230	1,570	1,570		6,040
Minimum			765	830	83	70	640		300	855	1,040		70
Run-off per square mile													
Run-off, depth, inches													
Run-off, acre-feet			20,320	63,670	25,920	168,350	72,640		98,600	71,870	79,760		601,130
Acre-feet per square mile													

DISCHARGE OF SOUTH PLATTE RIVER AT JULESBURG FOR 1910.
Drainage Area, 20,600 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	635	82	10	2	32	24	32	32	....	
2	....	....	....	585	82	10	2	42	24	32	32	....	
3	....	....	....	430	68	5	2	32	24	32	32	....	
4	....	....	970	490	68	5	2	32	24	32	32	....	
5	....	....	850	565	82	5	2	24	24	32	32	....	
6	....	....	850	480	82	10	2	32	32	32	32	....	
7	....	....	850	440	82	10	2	24	32	32	32	....	
8	....	....	970	430	82	5	2	24	24	32	32	....	
9	....	....	745	400	68	5	2	24	24	32	32	....	
10	....	....	745	390	68	10	2	24	24	32	32	....	
11	....	....	6,000	380	53	5	2	24	24	32	32	....	
12	....	....	850	350	42	5	2	15	24	32	32	....	
13	....	....	850	320	42	5	4	24	15	32	32	....	
14	....	....	970	335	32	5	4	24	15	32	32	....	
15	....	....	850	355	32	10	2	24	15	32	15	....	
16	....	....	745	345	32	5	2	24	15	32	15	....	
17	....	....	745	295	15	5	2	24	15	32	15	....	
18	....	....	745	250	15	5	2	24	15	32	15	....	
19	....	....	640	245	24	2	2	24	15	32	15	....	
20	....	....	640	225	24	2	2	24	15	32	15	....	
21	....	....	640	200	15	2	2	24	15	32	15	....	
22	....	....	640	210	15	2	10	24	15	32	15	....	
23	....	....	640	200	15	2	15	24	32	32	15	....	
24	....	....	635	145	15	2	15	24	32	32	15	....	
25	....	....	545	110	24	2	15	32	32	32	15	....	
26	....	....	460	82	24	2	15	24	32	32	15	....	
27	....	....	530	82	15	2	15	24	32	32	15	....	
28	....	....	610	100	15	2	24	32	24	32	15	....	
29	....	....	565	82	15	2	32	24	32	32	32	....	
30	....	....	600	82	15	2	32	24	32	32	32	....	
31	....	....	640	....	24	....	32	24	....	32	....	....	
Total	....	....	25,520	9,238	1,267	144	251	801	702	992	722	....	
Mean	....	....	823	308	41	4.8	8.1	25.8	23.4	32	24.1	....	119
Maximum	....	....	6,000	635	82	10	32	42	32	32	32	....	6,000
Minimum	....	....	460	82	15	2	2	15	15	32	15	....	2
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	....	....	50,604	18,327	2,521	286	498	1,586	1,392	1,968	1,434	....	78,616
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

GENEVA CREEK NEAR GRANT.

This station is maintained by the United States Geological Survey. It is located at Sullivan's ranch, about 2 miles above Grant.

The equipment consists of a staff gauge only.

The bed of the stream is rough, being composed of large and medium sized boulders, and is permanent.

The observer is J. Bruce Mather, who is paid by the United States Geological Survey.

DISCHARGE MEASUREMENTS OF GENEVA CREEK NEAR GRANT.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 Jan. 2	W. B. Freeman	12.1	7.6	1.67	....	12.7
Jan. 28	W. B. Freeman	12	9.4	1.27	....	11.9
Feb. 28	Jas. B. Stewart	11	7.7	1.22	....	9.4
Apr. 12	W. B. Freeman	14	12.6	1.79	....	22.6
May 10	W. B. Freeman	19.8	17.8	3.09	3.70	55
May 30	W. B. Freeman	43	41.4	2.97	1.07	123
June 13	W. B. Freeman	225	48	6.18	1.85	297
July 5	W. B. Freeman	225	52	6.25	1.85	325
Aug. 2	W. B. Freeman	42	43	2.56	1.20	110
Aug. 16	W. B. Freeman	38	41	2.71	1.20	114
Sept. 4	W. B. Freeman	43.5	41	3.00	1.20	123
Oct. 18	Jas. B. Stewart	....	31	2.13	0.90	66
Dec. 6	*W. B. Freeman	21	44.5	0.62	1.88	27.5
1910 Jan. 31	*W. B. Freeman	16.5	17.4	0.91	0.52	15.9
Feb. 25	*W. B. Freeman	12.3	14	0.93	0.50	13
Mch. 29	*W. B. Freeman	20.5	15.8	1.25	0.50	19.7
May 10	W. B. Freeman	41.0	31	2.38	1.00	73
May 24	W. B. Freeman	42	35	2.77	1.10	97
July 18	W. B. Freeman	30	23.6	1.49	0.71	35.2
Aug. 29	W. B. Freeman	27	17.4	1.23	0.57	21.4
Sept. 19	W. B. Freeman	23.5	20.2	0.75	0.62	15.3
Nov. 19	W. B Freeman	20	20.2	0.75	0.62	15.3

*Ice conditions.

DISCHARGE OF GENEVA CREEK, NEAR GRANT, FOR 1909.
Drainage Area, 49 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1						151	295	136	136	136			
2						184	258	126	126	126			
3						232	295	116	116	107			
4						295	346	107	116	98			
5						333	333	126	182	98			
6						320	333	116	170	98			
7						333	308	107	230	98			
8						404	282	107	206	81			
9						295	420	107	206	66			
10						282	308	116	206	81			
11						258	255	170	182	90			
12						295	242	136	206	81			
13						320	230	126	206	74			
14						308	230	126	206	74			
15						258	230	126	182	74			
16						308	194	136	182	74			
17						333	170	182	182	74			
18						374	158	194	182	66			
19						389	170	206	158	66			
20						436	170	182	158	66			
21						374	182	182	158	66			
22						320	206	182	136	66			
23						346	230	170	136	59			
24						374	218	182	136	59			
25						346	182	147	136	52			
26						320	182	136	126	52			
27						320	182	136	158	52			
28						308	182	136	170	40			
29						320	206	136	170	52			
30						320	170	147	158	46			
31							147	158		46			
Total						9,456	7,314	4,460	5,022	2,318			
Mean						315	236	144	167	75			187
Maximum						436	420	206	230	136			436
Minimum						151	147	107	116	46			46
Run-off per square mile						6.433	4.815	2.936	3.416	1.526			3.811
Run-off, depth, inches						7.177	5.551	3.385	3.812	1.759			21.684
Run-off, acre-feet						18,744	14,511	8,854	9,937	4,612			56,658
Acre-feet per square mile						382.53	296.14	180.70	202.80	94.12			1,156.29

DISCHARGE OF GENEVA CREEK, NEAR GRANT, FOR 1910.

Drainage Area, 49 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	20	16	13	20	76	134	60	68	20	....	....	....	
2	20	16	13	20	76	134	60	60	20	....	....	....	
3	20	16	13	20	76	134	60	46	24	....	....	....	
4	20	16	13	20	85	134	60	46	20	....	....	....	
5	20	16	13	20	85	94	60	46	20	....	....	....	
6	20	16	13	20	76	114	53	46	20	....	....	....	
7	20	16	13	20	85	94	46	40	20	....	....	....	
8	20	16	13	20	94	94	46	34	15	....	....	....	
9	20	16	13	24	94	94	46	40	15	....	....	....	
10	20	16	13	24	94	94	53	40	15	....	....	....	
11	18	16	17	29	94	85	46	34	15	....	....	....	
12	18	16	17	34	94	94	46	34	20	....	....	....	
13	18	16	17	40	94	94	40	34	20	....	....	....	
14	18	16	17	40	104	94	34	34	29	....	....	....	
15	18	16	17	40	76	94	34	34	34	....	....	....	
16	18	13	17	40	94	94	34	29	24	....	....	....	
17	18	13	17	40	60	76	34	24	20	....	....	....	
18	18	13	17	40	76	76	34	24	24	....	....	....	
19	18	13	17	34	76	76	34	24	24	....	....	....	
20	18	13	17	34	60	76	34	24	24	....	....	....	
21	16	13	20	34	60	76	34	29	24	....	....	....	
22	16	13	20	34	60	68	34	29	24	....	....	....	
23	16	13	20	34	76	60	34	24	24	....	....	....	
24	16	13	20	40	76	68	29	24	24	....	....	....	
25	16	13	20	40	60	76	29	24	24	....	....	....	
26	16	13	20	46	60	76	29	24	24	....	....	....	
27	16	13	20	68	76	76	29	24	24	....	....	....	
28	16	13	20	76	94	68	34	24	20	....	....	....	
29	16	....	20	76	94	68	29	24	20	....	....	....	
30	16	....	20	76	114	60	53	20	20	....	....	....	
31	16	....	20	....	124	....	76	20	....	....	....	....	
Total	556	409	520	1,123	2,563	2,675	1,324	1,027	651	....	....	....	
Mean	18	15	17	37	83	89	43	33	22	....	....	....	40
Maximum	20	16	20	76	124	134	60	68	29	....	....	....	134
Minimum	16	13	13	20	60	60	29	20	15	....	....	....	13
Run-off per square mile	0.366	0.298	0.342	0.762	1.687	1.820	0.872	0.676	0.441	....	....	....	0.811
Run-off, depth, inches	0.422	0.310	0.394	0.850	1.945	2.031	1.005	0.779	0.492	....	....	....	8.228
Run-off, acre-feet	1,107	833	1,045	2,202	5,103	5,296	2,644	2,029	1,309	....	....	....	21,568
Acre-feet per square mile	22.59	17.00	21.33	44.94	104.14	108.08	53.96	41.40	26.71	....	....	....	440.15

CLEAR CREEK AT FORKSCREEK.

This station, located about 50 feet from the Colorado & Southern depot at Forkscreek, is maintained by the United States Geological Survey in co-operation with the State.

The equipment consists of a foot bridge and a chain gauge. The gauge is the property of the United States Geological Survey.

The bed of the stream is composed of small cobbles and boulders and silts up during low water.

The observer is C. W. Hoisington, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF CLEAR CREEK AT FORKSCREEK.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	June 2	R. C. Miles and A. T. Lewis	43	78	6.17	5.72	480
	June 16	R. C. Miles and A. T. Lewis	45	143	7.48	6.70	1,070
	July 29	G. H. Russell	39	123	4.43	5.35	545
	Aug. 12	G. H. Russell	24	96	4.62	5.18	444
	Sept. 9	G. H. Russell	28	109	4.69	5.25	512
	Nov. 15	*G. H. Russell	24	41	1.61	3.95	66
1910	Jan. 20	†G. H. Russell	24	25	1.60	4.42	40
	Feb. 14	†G. H. Russell	15	38	2.33	4.90	48
	Mch. 26	G. H. Russell	22.5	49	1.45	4.32	71
	May 21	G. H. Russell	20	82	3.38	4.85	277
	May 21	G. H. Russell	30	82	3.47	4.85	285
	June 13	G. H. Russell	40	107	4.62	5.45	495
	June 23	Miles & Padgett	27	72	2.51	4.65	181
	June 25	Miles and C. E. Turner	30	102	3.91	5.20	399
	Aug. 12	G. H. Russell	21	50	3.22	5.10	161
	Sept. 5	H. D. Padgett	19	43.8	3.08	5.00	135
	Oct. 1	H. D. Padgett	22	33.6	2.68	5.81	90
	Oct. 29	G. H. Russell	18	29	2.34	5.65	68

*Wading measurement. †Ice conditions.

DISCHARGE OF CLEAR CREEK AT FORKSCREEK FOR 1909.
Drainage Area, 345 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					190	440	1,020	472	334	140	65		
2					210	420	995	472	334	128	65		
3					230	565	1,020	426	380	140	65		
4					210	670	1,250	380	426	140	65		
5					230	775	1,090	380	472	140	65		
6					270	980	1,110	380	518	128	65		
7					290	915	1,020	472	564	128	65		
8					310	950	990	518	564	116	65		
9					270	960	960	472	518	116	65		
10					290	970	910	472	495	116	65		
11					290	975	790	472	472	116	65		
12					270	980	760	472	541	116	65		
13					290	1,040	710	472	564	100	65		
14					310	1,050	660	426	518	75	65		
15					270	1,060	615	426	518	70	65		
16					270	1,070	615	380	472	65	65		
17					310	1,130	580	449	472	65	65		
18					250	1,210	590	588	472	65	65		
19					370	1,280	600	612	449	65	65		
20					440	1,320	610	564	449	65	65		
21				160	440	1,160	610	518	426	65	65		
22				130	485	1,080	590	495	426	65	65		
23				130	530	1,030	635	472	380	65	65		
24				130	530	1,100	700	472	380	65	65		
25				130	485	1,130	630	449	357	65	65		
26				145	485	1,030	610	426	357	65	65		
27				210	485	1,000	610	380	334	65	65		
28				245	530	1,000	565	380	334	65	65		
29				230	530	1,070	520	380	313	65	65		
30				210	460	1,020	495	334	313	65	65		
31					440		495	334		65			
Total				1,720	11,070	29,360	23,355	13,945	13,152	2,744	1,950		
Mean				172	357	979	753	450	438	89	65		434
Maximum				245	530	1,320	1,250	612	564	140	65		1,320
Minimum				130	190	420	495	334	313	65	65		65
Run-off per square mile				0.499	1.035	2.838	2.182	1.304	1.270	0.258	0.188		1.259
Run-off, depth, inches				0.186	1.193	3.166	2.515	1.504	1.417	0.297	0.210		10.488
Run-off, acre-feet				3,411	21,951	58,255	46,300	27,669	26,063	5,472	3,868		192,989
Acre-feet per square mile				9.88	63.62	168.85	134.20	80.20	75.55	15.86	11.21		559.37

DISCHARGE OF CLEAR CREEK AT FORKSCREEK FOR 1910.
Drainage Area, 345 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	40	45	55	30	215	672	355	500	90	85	60	....	
2	40	45	60	48	198	718	355	480	90	85	60	....	
3	40	45	60	58	198	628	320	420	90	85	60	....	
4	40	45	60	5	232	672	320	630	118	85	60	....	
5	40	45	60	9	198	628	320	390	133	85	50	....	
6	40	45	65	13	215	582	285	330	133	85	50	....	
7	40	45	70	30	198	538	268	275	133	85	50	....	
8	40	45	75	38	215	495	250	260	100	85	50	....	
9	40	50	70	58	232	495	250	225	100	85	50	....	
10	40	50	65	48	338	475	232	195	100	85	50	....	
11	40	50	60	58	375	495	232	180	100	85	50	....	
12	40	50	65	70	375	495	250	150	75	85	50	....	
13	40	50	83	83	338	515	232	133	75	85	50	....	
14	40	50	48	58	338	515	215	133	75	70	50	....	
15	40	50	18	83	302	538	215	133	60	70	50	....	
16	40	50	9	70	302	515	180	133	60	70	50	....	
17	40	50	23	58	268	475	250	100	60	60	50	....	
18	40	50	48	48	302	475	232	100	290	60	50	....	
19	40	50	30	48	268	435	215	100	500	50	50	....	... ...
20	40	50	58	83	268	435	285	100	390	85	50	....	
21	40	50	58	113	268	435	232	100	320	85	50	....	
22	40	50	70	98	302	435	215	100	290	70	50	....	
23	40	50	58	113	285	395	180	100	240	70	50	....	
24	45	50	83	113	285	435	145	90	200	60	50	....	
25	45	50	70	145	285	415	145	90	175	60	50	....	
26	45	55	83	162	285	415	145	90	140	50	50	....	
27	45	55	38	250	285	415	120	90	115	50	50	....	
28	45	55	48	250	355	395	433	90	80	50	50	....	
29	45	....	48	285	455	435	455	90	75	60	50	....	
30	45	....	38	302	628	415	473	90	75	60	50	....	
31	45	....	30	....	650	....	438	90	....	60	....	....	
Total	1,280	1,375	1,706	2,827	9,458	14,986	8,251	5,987	4,482	2,245	1,540	....	
Mean	41	49	55	94	305	500	266	193	149	72	51	....	162
Maximum	45	55	83	302	650	718	473	630	500	85	60	....	718
Minimum	40	45	9	5	198	395	120	90	60	50	50	....	5
Run-off per square mile	0.119	0.142	0.130	0.272	0.884	1.449	0.771	0.559	0.432	0.209	0.160	....	0.466
Run-off, depth, inches	0.137	0.148	0.150	0.303	1.019	1.617	0.889	0.645	0.482	0.241	0.179	....	5.810
Run-off, acre-feet	2,521	2,721	3,382	5,474	18,754	29,752	16,356	11,867	8,866	4,427	3,035	....	107,155
Acre-feet per square mile	7.31	7.89	9.83	15.87	54.36	86.25	47.42	34.40	25.70	12.83	8.80	....	310.66

SOUTH BOULDER CREEK AT ELDORADO SPRINGS.

This station is maintained by the State, and is located at Eldorado Springs resort, three miles west of Marshall.

Measurements are made by wading at low stages and from wagon bridge at high water. The gauge is a 4"x4" slope gauge.

The bed of the stream is composed of gravel and small boulders. The bed changes at high stages.

The observer is B. E. Chesebro, who is paid $3.00 per month.

DISCHARGE MEASUREMENTS OF SOUTH BOULDER CREEK AT ELDORADO SPRINGS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Apr. 17	D. R. I. Co.				1.98	145
	June 17	D. R. I. Co.				2.60	470
	Aug. 13	C. L. Chatfield		26.5	3.24	1.66	85.8
	Sept. 28	C. L. Chatfield		21.0	2.52	1.60	53.0
	Oct. 19	C. L. Chatfield		13.6	1.42	1.24	19.3
	Dec. 11	C. L. Chatfield		13.2	1.40	1.20	18.5
	Aug. 6	D. R. I. Co.				1.62	87.0
	July 27	D. R. I. Co.				1.87	123.0
		D. R. I. Co.				2.60	396
1910	June 13	C. C. Hezmalhalch	38	39.8	3.04	1.95	121
	July 27	C. C. Hezmalhalch	28	12.6	1.83	1.90	23.1
	Aug. 14	C. C. Hezmalhalch	24.5	17.4	1.90	1.40	33
	Sept. 30	C. L. Chatfield	21.5	13.0	0.66	1.05	6.6
	Feb. 1	C. L. Chatfield	21	9.24	1.12	1.10	10.4

Measurements by wading.

DISCHARGE OF SOUTH BOULDER CREEK AT ELDORADO SPRINGS FOR 1909.
Drainage Area, 125 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	13	12	12	32	152	326	445	92	67	54	20	24	
2	13	13	13	42	141	303	445	92	67	54	24	20	
3	13	12	13	62	130	326	515	84	67	48	24	17	
4	13	12	16	68	152	326	635	84	80	48	24	6	
5	12	10	20	62	240	380	595	75	105	48	24	3	
6	10	10	20	42	280	595	555	75	95	48	17	6	
7	13	10	13	62	280	635	445	75	268	48	20	11	
8	13	10	10	62	280	685	380	110	196	48	20	17	
9	13	10	10	62	206	735	303	110	155	37	17	24	
10	12	10	13	62	223	595	260	101	155	42	24	20	
11	10	10	13	84	240	595	240	130	112	42	17	17	
12	10	10	13	68	260	595	223	176	120	42	24	17	
13	10	10	13	75	240	555	206	110	152	42	20	17	
14	13	10	13	75	240	515	176	92	120	37	14	17	
15	13	10	13	92	206	515	164	92	120	32	11	17	
16	13	12	10	130	223	515	152	83	110	32	11	17	
17	13	12	13	176	223	595	152	90	110	32	17	14	
18	13	13	16	176	240	785	152	107	100	32	32	11	
19	13	13	16	152	260	910	152	173	90	32	28	8	
20	13	12	20	130	303	910	164	135	90	32	28	8	
21	13	10	20	130	326	685	164	125	74	32	32	6	
22	13	12	20	110	303	785	152	105	74	32	24	6	
23	13	12	20	110	326	595	152	95	74	28	24	8	
24	8	12	28	110	326	555	164	95	74	28	24	11	
25	10	12	28	110	326	595	152	85	74	28	20	11	
26	13	12	28	141	326	595	130	85	61	28	17	11	
27	13	12	28	176	280	515	130	76	54	24	17	11	
28	13	12	28	206	326	515	110	76	54	24	11	11	
29	5	....	28	206	326	445	110	76	54	24	28	11	
30	7	....	28	164	303	445	110	67	54	24	24	11	
31	12	....	28	....	303	....	110	67	....	24	....	11	
Total	366	315	564	3,177	7,990	17,126	7,843	3,038	3,026	1,126	637	399	
Mean	12	11	18	106	258	571	253	98	101	36	21	13	125
Maximum	13	13	28	206	326	910	635	176	268	54	32	24	910
Minimum	5	10	10	32	130	303	110	67	54	24	11	3	3
Run-off per square mile	0.096	0.088	0.144	0.848	2.064	4.568	2.024	0.784	0.808	0.288	0.168	0.104	1.000
Run-off, depth, inches	0.111	0.102	0.166	0.978	2.380	5.267	2.334	0.904	0.932	0.332	0.194	0.120	13.820
Run-off, acre-feet	738	611	1,107	6,307	15,864	33,977	15,556	6,026	6,010	2,214	1,250	799	90,459
Acre-feet per square mile	5.90	4.89	8.86	50.46	126.92	271.81	124.44	48.21	48.08	17.71	10.00	6.39	723.67

DISCHARGE OF SOUTH BOULDER CREEK AT ELDORADO SPRINGS FOR 1910.

Drainage Area, 125 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	14	11	11	24	88	173	72	43	11	8	11	....	
2	17	11	11	24	80	173	72	43	11	8	11	....	
3	17	11	11	24	80	188	72	33	11	8	11	....	
4	14	11	11	20	80	173	72	43	11	6	11	....	
5	11	8	11	20	88	148	64	38	17	11	8	....	
6	8	8	11	20	72	148	57	33	14	11	11	....	
7	6	8	11	24	72	148	57	28	11	11	11	....	
8	4	6	17	20	72	148	50	28	11	11	11	....	
9	3	6	20	20	88	126	43	28	11	11	8	....	
10	3	6	14	24	106	126	50	28	11	11	11	....	
11	3	6	14	24	106	116	43	24	11	8	8	....	
12	4	6	11	24	126	126	43	20	11	8	11	....	
13	4	6	14	28	106	126	38	33	11	8	11	....	
14	3	11	17	20	116	126	38	33	17	8	8	....	
15	4	6	20	20	106	116	33	24	11	11	11	....	
16	6	6	20	14	106	106	33	24	11	11	11	....	
17	6	6	20	14	106	106	57	24	11	11	11	....	
18	8	6	20	17	106	106	57	24	17	11	11	....	
19	11	6	24	24	88	97	57	20	17	17	8	....	
20	11	6	24	33	88	88	50	20	11	14	6	....	
21	11	8	33	57	106	88	43	17	11	11	3	....	
22	11	8	38	43	106	88	43	17	11	14	11	....	
23	11	6	43	33	126	88	38	17	17	17	11	....	
24	11	8	28	33	106	88	33	17	11	14	14	....	
25	11	11	43	43	106	97	28	14	11	14	11	....	
26	11	11	33	57	106	88	24	14	11	14	8	....	
27	11	11	33	72	106	88	24	11	11	14	8	....	
28	11	11	24	88	126	80	43	11	11	4	4	....	
29	11	....	14	88	137	88	57	11	8	14	4	....	
30	11	....	24	97	160	88	88	11	8	8	4	....	
31	11	....	24	....	173	....	57	11	....	11	....	....	
Total	278	225	649	1,049	3,238	3,545	1,536	742	357	352	278	....	
Mean	9	8	21	35	104	118	50	24	12	11	9	....	37
Maximum	17	11	43	97	173	188	88	43	17	17	14	....	188
Minimum	13	6	11	14	72	88	24	11	8	6	4	....	3
Run-off per square mile	0.072	0.064	0.168	0.280	0.832	0.944	0.400	0.192	0.096	0.088	0.072	....	0.294
Run-off, depth, inches	0.083	0.066	0.193	0.312	0.959	1.054	0.461	0.221	0.107	0.101	0.080	....	3.637
Run-off, acre-feet	553	444	1,291	2,083	6,395	7,021	3,074	1,476	714	676	536	....	24,263
Acre-feet per square mile	4.42	3.55	10.33	16.66	51.16	56.17	24.59	11.81	5.71	5.41	4.29	....	194.10

BOULDER CREEK AT ORODELL.

This station is maintained by the Central Colorado Power Company and the State. It is located just below the mouth of Four Mile creek and at Orodell station on the Denver, Boulder & Western R. R.

The equipment is owned by the Central Colorado Power Company and consists of a car and cable of 75 feet span and a Friez automatic gauge with 2"x5" slope gauge as an auxiliary.

Measurements are made at this station by State hydrographers. The expenses of looking after the gauge are paid by the Central Colorado Power Company.

The bed of the stream is composed of sand and boulders and shifts at high stages. Both banks are high and not liable to overflow.

DISCHARGE MEASUREMENTS OF BOULDER CREEK AT ORODELL.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Jan. 8	C. L. Chatfield	14	9.80	0.98	0.52	9.56
	Jan. 9	C. L. Chatfield	....	10.90	1.12	0.58	12.20
	Jan. 22	C. L. Chatfield	....	10.52	0.62	0.48	6.30
	Jan. 23	C. L. Chatfield	....	10.72	0.68	0.51	7.28
	Feb. 8	C. L. Chatfield	....	10.02	0.67	0.57	6.73
	Feb. 9	C. L. Chatfield	....	9.26	0.60	0.40	5.64
	Feb. 16	C. L. Chatfield	....	9.30	0.84	0.64	7.82
	Feb 17	C. L. Chatfield	....	7.70	0.93	0.53	7.18
	Feb. 26	C. L Chatfield	....	17.54	0.57	1.60	10.05
	Mch. 8	C. L. Chatfield	12	11.02	0.50	1.62	6.47
	Apr. 3	C. L. Chatfield	33	19.01	1.59	1.88	30.31
	Apr. 15	C. L. Chatfield	38	25	1.87	2.08	47
	Apr. 27	C. L. Chatfield	38	41	2.66	2.42	110
1910	Jan. 11	*C. L. Chatfield	7	4.51	1.63	0.30	7.36
	Feb. 1	*C. L. Chatfield	7.5	4.4	1.48	0.30	6.50
	Feb. 21	*C. L. Chatfield	7.7	4.1	1.49	0.25	6.10
	Mch. 12	C. L. Chatfield and L. Elliott	18.5	10.72	0.77	1.60	8.27
	Apr. 21	Thos. Grieve	34	29.1	2.25	2.25	65.4
	June 13	Thos. Grieve	48	61.8	2.97	2.85	184
	July 9	Thos. Grieve	34	46.0	2.46	2.50	113
	July 16	Thos. Grieve	33.5	35.7	2.14	2.30	76.6
	July 27	C. C. Hezmalhalch	36.0	37.65	1.92	2.30	74.0
	Aug. 13	C. C. Hezmalhalch	34	29.2	1.72	2.15	50.0
	Sept. 13	Thos. Grieve	28	18.3	1.43	1.93	26.1
	Sept. 30	†C. L. Chatfield	27	19	1.34	1.89	25.6
	Nov. 8	Thos. Grieve	23.5	12.6	1.16	1.68	14.7
	Nov. 30	Thos. Grieve	15	4.7	0.52	1.30	2.4

*Measurements at temporary station at Power House. †Measurements from cable.

DISCHARGE OF BOULDER CREEK AT ORODELL FOR 1909.

Drainage Area, 108 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	10	7	8	17	91	176	608	164	115	50	8	7	
2	9	6	7	19	80	186	609	155	102	43	16	7	
3	9	6	8	37	80	237	595	154	91	38	16	6	
4	9	6	10	47	102	315	590	147	133	37	15	7	
5	9	6	10	44	137	370	622	138	153	41	19	7	
6	11	6	9	36	152	430	618	137	147	44	20	7	
7	12	6	9	31	158	471	564	144	193	44	22	8	
8	10	5	11	29	159	510	507	189	163	41	18	9	
9	10	5	14	34	131	493	479	181	150	36	18	9	
10	11	5	14	39	142	477	449	167	146	36	19	10	
11	12	6	11	46	175	428	407	272	132	36	13	10	
12	13	7	12	45	178	416	392	242	142	36	20	10	
13	10	7	12	45	143	393	341	234	153	36	16	10	
14	11	7	9	49	141	389	307	230	146	36	21	10	
15	10	12	7	64	129	384	298	204	144	36	22	10	
16	8	8	7	90	150	410	284	188	137	36	32	10	
17	7	9	8	107	151	469	257	229	139	37	28	10	
18	7	11	8	119	169	510	240	268	138	36	39	10	
19	7	15	8	114	180	632	257	230	121	36	25	10	
20	7	13	7	104	222	698	279	228	104	34	22	9	
21	8	19	7	89	229	654	315	197	81	31	24	9	
22	7	17	7	76	237	640	308	196	83	32	22	9	
23	7	22	11	68	256	612	282	184	81	29	22	9	
24	7	16	17	71	221	621	301	187	76	29	22	9	
25	6	12	17	79	205	628	271	175	68	25	14	9	
26	8	16	20	97	194	593	253	155	65	22	6	9	
27	9	17	20	118	216	580	256	145	56	22	5	9	
28	9	10	16	136	255	566	242	148	53	23	3	9	
29	9	....	17	135	266	573	219	138	53	23	11	8	
30	8	....	16	110	213	609	196	184	52	20	10	8	
31	8	....	14	....	195	....	178	118	....	12	....	8	
Total	278	282	349	2,095	5,357	14,465	11,524	5,678	3,407	1,073	548	272	
Mean	9.0	10.0	11.3	70	173	482	372	183	114	35	18	8.8	124
Maximum	13	22	20	136	266	698	622	272	193	50	39	10	698
Minimum	6	5	7	17	80	176	178	118	52	12	3	6	3
Run-off per square mile	0.083	0.093	0.105	0.648	1.602	4.463	3.444	1.694	1.056	0.324	0.167	0.081	1.148
Run-off, depth, inches	0.096	0.097	0.121	0.723	1.847	4.980	3.971	1.953	1.178	0.374	0.186	0.094	15.620
Run-off, acre-feet	553	555	695	4,165	10,637	28,681	22,873	11,252	6,783	2,152	1,012	541	89,899
Acre-feet per square mile	5.12	5.14	6.44	38.57	98.44	265.57	211.80	104.19	62.80	19.93	9.37	5.01	832.38

DISCHARGE OF BOULDER CREEK AT ORODELL FOR 1910.
Drainage Area, 108 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	8	7	9	24	92	254	174	83	33	16	13	....	
2	8	7	9	24	83	266	196	83	24	16	9	....	
3	8	7	9	33	21	278	152	83	24	16	9	....	
4	8	7	9	24	51	266	152	83	24	16	11	....	
5	8	7	9	24	66	254	142	112	38	16	9	....	
6	8	7	9	28	58	230	132	102	38	16	9	....	
7	8	7	11	28	74	230	112	102	38	16	6	....	
8	8	7	11	18	122	218	112	83	38	16	13	....	
9	8	7	13	8	122	185	112	83	44	18	16	....	
10	8	7	9	8	152	185	102	66	38	16	9	....	
11	7	7	9	11	185	174	102	58	28	13	9	....	
12	7	7	9	18	185	174	102	66	28	13	11	....	
13	7	7	11	18	174	174	102	58	28	13	11	....	
14	7	7	11	51	174	174	83	58	33	13	5	....	
15	7	7	11	51	163	163	66	51	33	9	6	....	
16	7	6	13	51	174	163	66	51	33	11	8	....	
17	7	6	13	44	122	152	74	51	33	16	5	....	
18	7	6	16	28	51	152	83	44	33	24	6	....	
19	7	6	18	33	40	152	112	44	24	11	6	....	
20	7	6	24	38	28	152	112	51	24	9	6	....	
21	7	6	28	66	28	152	92	44	21	13	8	....	
22	7	6	33	51	28	152	92	38	24	16	9	....	
23	7	6	44	38	28	152	112	66	24	16	9	....	
24	7	6	38	44	24	152	92	58	18	16	11	....	
25	7	6	38	66	38	152	83	51	18	18	9	....	
26	7	6	33	38	51	152	83	38	16	18	6	....	
27	7	6	24	83	112	152	74	33	18	16	6	....	
28	7	6	24	66	163	142	92	24	18	16	5	....	
29	7	....	24	112	218	142	92	24	18	13	4	....	
30	7	....	16	142	242	163	92	24	18	13	4	....	
31	7	....	24	....	254	....	83	33	....	16	....	....	
Total	227	183	559	1,268	3,323	5,506	3,275	1,845	829	465	248	....	
Mean	7.3	6.5	18.0	42	107	184	106	60	27.6	15.0	8.3	....	53.1
Maximum	8	7	44	142	254	278	196	112	44	24	16	....	278
Minimum	7	6	9	8	21	142	66	24	16	9	4	....	4
Run-off per square mile	0.068	0.060	0.167	0.389	0.991	1.667	0.981	0.556	0.256	0.139	0.077	....	0.492
Run-off, depth, inches	0.078	0.062	0.192	0.434	1.142	1.860	1.131	0.641	0.286	0.160	0.086	....	6.072
Run-off, acre-feet	449	361	1,107	2,499	6,579	10,949	6,518	3,689	1,642	922	[illegible]	....	35,200
Acre-feet per square mile	4.16	3.34	10.25	23.14	60.92	101.38	60.36	34.16	15.20	8.54	[illegible]	.....	326.02

ST. VRAIN CREEK AT LYONS.

This station, maintained by the State, is located about one-half mile below Lyons and 100 yards below the North and South Forks of the St. Vrain creek.

The equipment at this station consists of a car and cable of 50 feet span. The gauge is 4"x4" slope gauge rod. The equipment is owned by the State.

The stream is swift except at low stages. The bed of the stream is composed of medium sized boulders and is permanent. The right bank is low and overflows at high stages. Several ditches take water above this station. The intakes of the Longmont and Lyons water works are also above this station.

The observer is Wm. Siglinger, who receives $3.00 per month.

DISCHARGE MEASUREMENTS OF ST. VRAIN CREEK AT LYONS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	July 14......	C. L. Chatfield...........................	....	93	3.40	3.15	316
	Aug. 9......	C. L. Chatfield...........................	....	80	2.36	2.87	189
	Sept. 27......	C. L. Chatfield...........................	....	54	1.00	2.20	54
	Oct. 22......	C. L. Chatfield...........................	....	48	0.73	2.08	35.1
	Dec. 2......	Chatfield & Grieve......................	....	18.2	0.82	1.85	15.9
1910	Feb. 2......	C. L. Chatfield...........................	21	17	0.88	1.84	15*
	Mch. 21......	C. L. Chatfield...........................	35	46	0.83	2.10	38*
	Mch. 22......	C. L. Chatfield...........................	35	49	0.79	2.115	39
	Mch. 23......	C. L. Chatfield...........................	35	50	0.90	2.17	45*
	June 11......	Thos. Grieve and C. C Hezmalhalch	39	81.4	2.83	3.10	230
	June 28......	C. C. Hezmalhalch........................	36	66.0	2.20	2.75	145
	Aug. 15......	C. C. Hezmalhalch........................	39	56.7	1.22	2.33	69.7*
	Sept. 29......	C. L. Chatfield...........................	37.5	51	0.96	2.18	49

*Measurements by wading.

DISCHARGE OF ST. VRAIN CREEK AT LYONS FOR 1909.
Drainage Area, 209 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	214	214	755	214	143	65	24	12	
2	....	....	....	....	168	342	805	196	143	65	29	20	
3	....	....	....	....	168	461	955	214	143	65	29	20	
4	....	....	....	....	196	558	1,005	196	182	65	29	12	
5	....	....	....	....	232	730	980	196	232	65	20	8	
6	....	....	....	....	318	730	1,005	168	214	73	20	12	
7	....	....	....	....	273	755	805	168	365	81	24	12	
8	....	....	....	....	273	730	730	196	318	65	29	29	
9	....	....	....	....	273	755	680	182	214	65	29	39	
10	....	....	....	....	232	755	656	168	182	65	29	34	
11	....	....	....	....	273	730	607	214	143	51	29	29	
12	....	....	....	....	273	730	534	273	143	51	20	24	
13	....	....	....	....	232	730	437	232	156	39	29	29	
14	....	....	....	....	232	730	342	232	132	29	24	24	
15	....	....	....	....	232	730	318	196	110	29	20	20	
16	....	....	....	....	252	705	342	182	99	39	20	12	
17	....	....	....	....	232	730	389	252	99	51	20	20	
18	....	....	....	....	232	805	389	273	81	65	39	20	
19	....	....	....	182	232	955	437	232	81	51	39	16	
20	....	....	....	232	365	955	389	232	73	45	34	20	
21	....	....	....	214	413	830	365	196	73	39	39	12	
22	....	....	....	196	437	805	365	168	73	34	34	16	
23	....	....	....	196	437	805	295	168	65	29	29	12	
24	....	....	....	214	461	805	252	196	65	29	29	20	
25	....	....	....	232	437	830	389	182	58	20	29	16	
26	....	....	....	273	365	755	342	143	51	24	29	20	
27	....	....	....	295	365	780	342	143	51	20	20	16	
28	....	....	....	365	389	755	295	143	51	20	20	20	
29	....	....	....	365	413	780	273	143	45	29	20	16	
30	....	....	....	273	318	805	232	120	45	29	20	20	
31	....	....	....	....	318	....	214	120	....	24	....	24	
Total	....	....	....	3,037	9,255	21,780	15,924	5,938	3,830	1,421	805	603	
Mean	....	....	....	253	298	726	514	191	128	46	27	20	244
Maximum	....	....	....	365	461	955	1,005	273	365	81	39	39	1,005
Minimum	....	....	....	182	168	214	214	120	45	20	20	8	8
Run-off per square mile	....	....	....	1.210	1.426	3.474	2.459	0.914	0.612	0.220	0.129	0.093	1.165
Run-off, depth, inches	....	....	....	0.540	1.644	3.876	2.835	1.054	0.683	0.254	0.144	0.107	11.137
Run-off, acre-feet	....	....	....	6,020	18,320	43,200	31,600	11,740	7,620	2,830	1,610	1,200	124,140
Acre-feet per square mile	....	....	....	28.83	87.66	206.70	151.20	56.18	36.46	13.54	7.70	5.74	594.01

DISCHARGE OF ST. VRAIN CREEK AT LYONS FOR 1910.

Drainage Area, 209 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	18	13	12	26	114	318	258	124	42	36	18	....	
2	18	12	10	26	96	353	202	134	42	36	22	....	
3	18	12	10	26	80	406	190	105	56	36	22	....	
4	18	16	13	31	105	336	190	105	88	36	16	....	
5	18	12	16	36	124	318	190	105	105	26	18	....	
6	16	12	18	56	96	288	166	88	96	22	18	....	
7	18	12	16	48	80	318	154	88	80	26	18	....	
8	18	12	18	42	88	273	144	88	80	26	18	....	
9	16	12	16	26	96	244	134	88	80	18	16	....	
10	16	11	11	26	144	216	134	72	64	22	16	....	
11	13	13	11	36	166	216	134	64	64	22	13	....	
12	16	12	13	31	178	216	124	64	64	18	16	....	
13	18	12	16	36	166	230	134	72	64	18	16	....	
14	18	12	16	31	166	230	134	80	80	18	16	....	
15	18	10	26	31	154	230	114	64	72	22	16	....	
16	18	13	26	26	134	230	114	56	64	22	13	....	
17	22	13	26	26	124	258	114	56	64	31	12	....	
18	18	13	26	22	114	216	114	72	72	26	13	....	
19	18	13	26	22	114	230	124	72	80	31	16	....	
20	18	11	31	26	124	230	190	72	80	36	12	....	
21	16	11	31	31	154	230	178	72	88	26	11	....	
22	18	13	42	26	124	202	144	80	80	31	16	....	
23	18	13	36	22	154	202	124	80	80	36	16	....	
24	18	16	36	26	154	190	105	72	64	26	16	....	
25	16	16	36	31	166	178	105	64	56	26	13	....	
26	13	13	36	42	178	190	105	56	56	26	13	....	
27	16	16	36	64	178	144	96	48	48	26	12	....	
28	13	16	36	80	230	144	114	56	42	16	11	....	
29	13	....	36	114	258	190	154	56	42	26	12	......	
30	13	....	22	124	288	202	190	48	36	22	16	....	
31	13	....	26	....	288	....	144	48	....	18	....	....	
Total	518	360	730	1,190	4,635	7,228	4,517	2,349	2,029	807	449	....	
Mean	17	13	24	40	150	241	146	76	68	26	15	....	74
Maximum	22	16	42	124	288	406	258	134	105	36	22	....	406
Minimum	13	10	10	22	80	144	96	48	36	16	11	....	10
Run-off per square mile	0.081	0.062	0.115	0.191	0.718	1.153	0.699	0.364	0.325	0.124	0.072	....	0.355
Run-off, depth, inches	0.093	0.064	0.133	0.213	0.828	1.286	0.805	0.420	0.363	0.143	0.080	....	4.428
Run-off, acre-feet	1,045	722	1,476	2,380	9,223	14,340	8,977	4,673	4,046	1,599	893	....	49,374
Acre-feet per square mile	5.00	3.45	7.06	11.39	44.13	68.62	42.95	22.36	19.36	7.65	4.27	......	236.25

BIG THOMPSON CREEK AT ARKINS.

This station, maintained by the State, is located about 10 miles from Loveland below the Handy dam.

The equipment consists of a staff gauge bolted to the downstream end of middle pier of wagon bridge. Measurements are made from the upstream side of wagon bridge.

The bed of the stream is composed of medium and large sized boulders and is permanent except in extremely high water.

The observer at this station is Minnie Gammon, who receives a salary of $3.00 per month.

DISCHARGE MEASUREMENTS OF BIG THOMPSON CREEK AT ARKINS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	July 13......	C. L. Chatfield...........................	....	149	3.18	2.80	473
	Aug. 6......	C. L. Chatfield...........................	....	104	2.29	1.90	238
	Sept. 25......	*C. L. Chatfield...........................	....	99	1.14	1.55	113
	Oct. 25......	*C. L. Chatfield...........................	....	58.8	0.51	1.10	29.8
	Oct. 25......	*C. L. Chatfield...........................	....	....	....	1.27	49.0
	Dec. 1......	*Chatfield & Grieve...........................	....	64.9	0.73	1.20	47.5
1910	Feb. 4......	‡C. L. Chatfield...........................	42	31	0.68	1.42	21
	Mch. 17......	*C. L. Chatfield...........................	42.5	49	0.55	1.10	27
	Apr. 20......	*Thos. Grieve...........................	36.5	38	0.89	1.10	34
	June 10......	Thos. Grieve and C. C. Hezmalhalch........	57.5	124	2.50	2.20	310
	June 25......	C. C. Hezmalhalch........................	57.5	111.3	2.37	2.00	265
	Aug. 16......	*C. C. Hezmalhalch........................	80	72	1.19	1.40	86
	Sept. 27......	*C. L. Chatfield...........................	61	75	0.85	1.30	64

†Computed by turning water out of Handy Ditch. ‡Measurement made through holes in ice. *Wading measurements.

DISCHARGE OF BIG THOMPSON CREEK AT ARKINS FOR 1909.
Drainage Area, 305 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					196	337	1,386	278	242	67	42	42	
2					182	360	1,386	296	226	76	50	28	
3					196	460	1,431	278	226	67	50	28	
4					242	850	1,565	242	196	58	50	28	
5					337	983	1,745	226	196	58	50	28	
6					382	1,207	1,476	196	259	58	58	28	
7					407	1,341	1,386	211	627	67	50	28	
8					382	1,476	1,162	259	460	67	50	28	
9					360	1,341	1,028	242	296	76	42	28	
10					316	1,207	983	242	296	76	42	28	
11					407	1,118	850	259	242	76	42	28	
12					407	938	760	259	226	76	35	28	
13					360	1,028	589	242	226	76	28	28	
14					360	1,028	520	259	211	76	28	28	
15					360	938	432	242	196	76	23	28	
16					360	938	460	226	168	58	23	28	
17				130	316	1,118	520	337	168	58	28	28	
18				130	296	1,341	488	627	155	58	58	28	
19				76	360	1,655	520	379	142	58	58	28	
20				50	520	1,745	551	337	142	50	42	28	
21				58	460	1,431	589	259	130	50	50	28	
22				67	432	1,341	520	226	118	50	42	28	
23				76	460	1,296	551	259	118	42	50	28	
24				76	488	1,431	589	259	118	35	28	28	
25				67	432	1,520	551	259	107	28	15	28	
26				130	360	1,476	488	211	96	28	15	28	
27				226	337	1,431	407	196	96	28	12	28	
28				278	432	1,476	432	211	96	28	8	28	
29				337	551	1,386	360	211	76	23	18	28	
30				242	407	1,386	337	226	76	23	42	28	
31					360		316	259		42		28	
Total				1,943	11,465	35,584	24,378	8,204	5,931	1,709	1,129	882	
Mean				139	370	1,186	786	265	198	55	38	28	352
Maximum				337	551	1,745	1,745	627	627	76	58	42	1,745
Minimum				50	182	337	316	196	76	23	8	28	8
Run-off per square mile				0.456	1.213	3.889	2.577	0.869	0.649	0.180	0.125	0.092	1.154
Run-off, depth, inches				0.237	1.399	4.339	2.971	1.002	0.724	0.208	0.140	0.106	11.126
Run-off, acre-feet				3,859	22,750	70,567	48,329	16,294	11,782	3,382	2,261	1,722	180,946
Acre-feet per square mile				12.65	74.59	231.37	158.46	53.42	38.63	11.09	7.41	5.65	593.27

DISCHARGE OF BIG THOMPSON CREEK AT ARKINS FOR 1910.
Drainage Area, 305 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	50	40	39	30	162	517	338	222	66	66	5	....	
2	50	40	30	17	135	555	288	192	57	66	39	....	
3	50	30	30	12	110	574	255	162	57	66	30	....	
4	40	20	30	12	148	555	255	110	162	57	30	....	
5	30	20	30	17	192	442	272	122	207	48	30	....	
6	25	20	30	17	148	460	288	110	135	48	30	....	
7	20	20	39	17	122	479	222	86	122	48	30	....	
8	25	20	39	24	110	460	255	76	110	48	39	....	
9	30	20	39	24	162	355	255	66	98	48	39	....	
10	25	20	39	30	222	304	177	66	86	48	39	....	
11	25	20	30	30	288	320	162	66	76	39	30	....	
12	25	20	30	39	304	408	135	86	110	39	30	....	
13	20	20	30	48	288	390	162	110	122	39	30	....	
14	20	20	30	39	272	425	162	135	122	48	30	....	
15	20	20	30	30	255	390	162	110	122	48	30	....	
16	20	20	30	30	222	408	148	86	110	48	30	....	
17	20	25	30	48	192	390	192	86	135	57	24	....	
18	20	25	30	30	162	355	192	76	135	57	24	....	
19	20	25	30	30	177	390	192	66	148	48	24	....	
20	20	25	30	39	207	372	222	66	162	57	12	....	
21	25	30	48	57	255	320	222	66	162	48	17	....	
22	25	30	48	57	222	320	192	86	162	57	30	....	
23	25	30	48	48	222	320	162	98	162	48	30	....	
24	25	35	66	48	222	320	135	98	110	48	30	....	
25	25	35	66	66	255	304	110	86	98	48	24	....	
26	20	[illegible]	66	86	255	255	110	66	98	39	17	....	
27	30	30	48	122	255	255	135	48	86	24	12	....	
28	40	35	48	148	320	255	255	48	86	8	17	....	
29	40	....	48	192	442	338	355	66	66	8	30	....	
30	40	....	24	192	517	425	408	66	66	8	24	....	
31	40	....	48	....	536	....	338	66	....	8	....	....	
Total	890	725	1,203	1,579	7,379	11,661	6,756	2,893	3,438	1,367	806	....	
Mean	29	26	39	53	238	389	218	93	115	44	27	....	116
Maximum	50	40	66	192	536	574	408	222	207	66	39	....	574
Minimum	20	20	24	12	110	255	110	48	57	8	5	....	5
Run-off per square mile	0.095	0.085	0.128	0.174	0.780	1.275	0.715	0.305	0.377	0.144	0.089	....	0.380
Run-off, depth, inches	0.110	0.089	0.147	0.194	0.899	1.423	0.825	0.352	0.421	0.166	0.099	....	4.725
Run-off, acre-feet	1,783	1,444	2,398	3,154	14,634	23,147	13,404	5,718	6,843	2,705	1,607	....	76,837
Acre-feet per square mile	5.85	4.74	7.86	10.34	47.98	75.90	43.95	18.75	22.44	8.87	5.27	....	251.95

CACHE LA POUDRE RIVER AT MOUTH OF CANON.

This station is located about twelve miles from Fort Collins, at the mouth of the canon, and below the headgates of the Poudre Valley canal.

The equipment at this station consists of an automatic gauge, together with a sloping gauge rod for checking, a cable of 115 feet span and car. This equipment is the property of the State.

The bed of the stream is composed of medium sized boulders and is permanent. The banks are walls of masonry, formerly part of a flume. The right bank is not liable to overflow, but water is liable to overflow the left bank at high stages. The current is swift at high stages, but sluggish at low stages.

The observer at this station is John E. Harris, who is paid $5.00 per month.

Discharges at this station do not show the correct run-off of the Cache la Poudre drainage, as some water is carried over the divide from the drainage areas of the Grand and Laramie rivers and Michigan creek.

DISCHARGE MEASUREMENTS OF CACHE LA POUDRE RIVER AT MOUTH OF CANON.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Feb. 3......	*C. L. Chatfield..........................	90	97	0.62	1.69	60
Mch. 18......	C. L. Chatfield..........................	94	160	0.61	1.11	98
Mch. 25......	C. L. Chatfield..........................	95	179	0.82	1.28	146
Apr. 19......	Thos. Grieve..........................	94	175	0.85	1.28	148
May 11......	Thos. Grieve..........................	98	305	3.05	2.65	936
June 9......	C. C. Hezmalhalch......................	98	334	3.61	2.88	1,206
June 25......	C. C. Hezmalhalch......................	100	294	2.78	2.55	818
June 28......	W. B. Freeman, R. C. Miles..............	97	247	2.01	2.02	496
July 15......	Thos. Grieve..........................	99	210	1.28	1.60	268
Aug. 5......	C. C. Hezmalhalch......................	100	195	1.00	1.42	196
Sept. 27......	C. L. Chatfield..........................	95	185	0.90	1.35	167
Dec. 5......	C. C. Hezmalhalch......................	....	131	0.33	0.97	43.6

*Ice conditions.

DISCHARGE OF CACHE LA POUDRE RIVER AT MOUTH OF CANON FOR 1910.
Drainage Area, 1,060 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	....	1,750	465	220	85	150	95	....	
2	....	....	....	....	....	1,810	438	202	85	202	120	....	
3	....	....	....	....	....	1,810	382	185	95	185	135	....	
4	....	....	....	....	....	1,810	355	135	120	185	95	....	
5	....	....	....	....	....	1,250	382	150	185	120	95	....	
6	....	....	....	....	....	1,150	382	168	135	108	108	....	
7	....	....	....	....	....	1,200	305	150	120	120	108	....	
8	....	....	....	....	355	1,100	305	120	85	135	150	....	
9	....	....	....	....	498	1,050	240	108	95	150	120	....	
10	....	....	....	....	632	1,000	282	120	120	168	95	....	
11	....	....	....	....	958	1,000	260	150	95	202	120	....	
12	....	....	....	....	1,000	958	240	150	120	202	135	....	
13	....	....	....	....	958	958	220	185	185	185	95	....	
14	....	....	....	....	872	1,000	220	168	202	150	85	....	
15	....	....	....	....	830	958	220	150	185	185	75	....	
16	....	....	....	....	745	872	220	135	168	240	75	....	
17	....	....	....	....	632	830	220	108	150	240	95	....	
18	....	....	....	....	670	830	282	108	202	185	95	....	
19	....	....	....	....	670	830	220	108	220	95	108	....	
20	....	....	....	....	670	830	260	95	240	108	85	....	
21	....	....	....	....	708	745	260	95	220	120	75	....	
22	....	....	....	....	670	708	240	108	202	120	85	....	
23	....	....	....	....	670	632	220	108	220	120	120	....	
24	....	....	....	....	708	595	202	85	220	120	75	....	
25	....	....	....	....	872	562	185	85	168	168	108	....	
26	....	....	....	....	872	465	168	85	150	135	108	....	
27	....	....	....	....	915	410	135	85	135	95	85	....	
28	....	....	....	....	1,150	382	150	95	120	95	95	....	
29	....	....	....	....	1,410	438	240	108	120	108	60	....	
30	....	....	....	....	1,465	530	355	95	120	120	68	....	
31	....	....	....	....	1,630	....	282	95	....	120	....	....	
Total	....	....	....	....	20,560	28,463	8,335	3,959	4,567	4,636	2,968	....	
Mean	....	....	....	....	857	949	269	128	152	154	99	....	355
Maximum	1,810	....	....	....	1,630	1,810	465	220	220	240	150	....	1,810
Minimum	60	....	....	....	355	382	135	85	85	95	60	....	60
Run-off per square mile	....	....	....	....	0.808	0.895	0.254	0.120	0.144	0.146	0.093	....	0.335
Run-off, depth, inches	2.583	....	....	....	0.721	0.999	0.293	0.138	0.160	0.168	0.104	....	2.583
Run-off, acre-feet	146,064	....	....	....	40,780	56,469	16,540	7,870	9,045	9,469	5,891	....	146,064
Acre-feet per square mile	137.78	....	....	....	38.47	53.27	15.60	7.42	8.53	8.93	5.56	....	137.78

MISCELLANEOUS MEASUREMENTS IN SOUTH PLATTE RIVER BASIN.

DATE	HYDROGRAPHER	STREAM	LOCALITY	Discharge
1909 July 16	C. L. Chatfield	Left Hand Creek	Altona	55
Aug. 9	C. L. Chatfield	Left Hand Creek	Altona	90
1910 Nov. 6	W. B. Freeman	Cache La Poudre River	Chambers Lake	14
Aug. 24	C. W. Hammen	Horse Creek	Deckers	13.6
Nov. 19	W. B. Freeman	No. Fk. So. Platte River	Grant	8.5
Aug. 27	W. B. Freeman	Smelter Creek	Grant	1.8
July 15	Lyon & Johnson	So. Fk. So. Platte River	Colo. Mid. R. R. Bridge, No. 69B	8.7
July 27	Lyon & Johnson	So Fk. So. Platte River	Colo Mid. R. R. Bridge, No. 69B	160
July 28	Brown & Knisely	So. Fk. So. Platte River	Colo. Mid. R. R. Bridge, No. 69B	124
July 30	Brown & Knisely	So. Fk. So. Platte River	Colo. Mid. R. R. Bridge, No. 69B	233
July 25	Lyon & Johnson	So. Fk. So. Platte River	Colo. Mid. R. R. Bridge, No. 41A	211
July 24	Lyon & Johnson	So. Fk. So. Platte River	Lake George	195
July 28	J. Burgess	So. Fk. So. Platte River	Above Lake George	152
July 26	Burgess & Deshayes	So. Fk. So. Platte River	Above Lake George	167
July 28	J. Burgess	So. Fk. So. Platte River	Below Lake George	158
July 17	Lyon & Johnson	So. Fk. So. Platte River	Antero Res. Intake	15.9
July 28	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Intake	8.5
July 29	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Intake	14.7
July 31	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Intake	73
July 27	Johnson & Starbird	So. Fk. So. Platte River	Antero Res. Outlet	166
July 28	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Outlet	99
July 29	Brown & Nicholas	So. Fk. So. Platte River	Antero Res. Outlet	72
July 29	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Outlet	130
July 29	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Outlet	145
July 31	Brown & Cooper	So. Fk. So. Platte River	Antero Res. Outlet	127
July 16	Lyon & Johnson	Middle Fk. So. Platte R.	½ mi. above jct. with So. Fork	24.8
July 25	Lyon & Burgess	Tarryall Creek	At mouth	5.6
July 21	Lyon & Johnson	Twin Creeks	At Lake George	1.9
July 25	Lyon & Johnson	Twin Creeks	At Lake George	11.8

LARAMIE RIVER AT GLENDEVEY.

This station is maintained by the State. It is located about one-eighth mile from Glendevey on road between Fort Collins and Walden.

The equipment consists of a staff gauge and automatic gauge. The latter was installed November 14, 1910.

The bed of the stream is composed of boulders and coarse gravel and is permanent. The current is swift at all stages.

The observer is D. L. Davy, whose salary is $5.00 per month. The automatic gauge is taken care of by Albert L. Fairhurst of the United States Forest Service.

DISCHARGE MEASUREMENTS OF LARAMIE RIVER AT GLENDEVEY.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Aug. 19	C. C. Hezmalhalch	38	42.7	0.70	1.90	29.7
Sept. 28	C. C. Hezmalhalch	38.5	40.2	0.64	1.90	26.0
Nov. 7	W. B. Freeman	33.3	30	0.93	1.86	28.0
Nov. 8	W. B. Freeman	31.2	24.4	0.59	1.69	14.3

DISCHARGE OF LARAMIE RIVER AT GLENDEVEY FOR 1910.
Drainage Area, 221 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									31	31	31		
2									36	31	31		
3									56	22	31		
4									76	42	31		
5									76	42	31		
6									42	42	31		
7									31	42	22		
8									31	36	26		
9									31	31	18		
10									56	31	22		
11									36	31	22		
12									31	31	22		
13									36	31	22		
14									56	31	18		
15									36	31	22		
16									31	31	22		
17									42	36	26		
18								31	49	49	15		
19								31	56	49	18		
20								31	49	42	15		
21								36	42	49	15		
22								31	42	56	18		
23								31	42	42	42		
24								31	42	42	42		
25								26	42	36	42		
26								31	42	31	36		
27								31	31	31	26		
28								31	31	31	42		
29								31	31	36	42		
30								31	31	31	42		
31								31		31			
Total								434	1,264	1,128	823		
Mean								31	42	36	27		35
Maximum								31	76	56	42		76
Minimum								26	31	22	15		15
Run-off per square mile								0.140	0.190	0.163	0.122		0.158
Run-off, depth, inches								0.073	0.213	0.189	0.138		0.617
Run-off, acre-feet								639	2,499	2,214	1,607		6,959
Acre-feet per square mile								2.89	11.31	10.02	7.27		31.49

RIO GRANDE DRAINAGE.

RIO GRANDE AT THIRTY-MILE BRIDGE, NEAR CREEDE.

This station is located 30 miles west of Creede at the thirty-mile bridge and below the dam site of the Farmers' Union reservoir.

The equipment consists of a chain gauge and cable and car which is the property of the Farmers' Union Irrigation Company.

The bed of the stream is composed of boulders and is permanent.

Gauge heights and measurements at this station are furnished this office gratis by Farmers' Union.

DISCHARGE MEASUREMENTS OF RIO GRANDE AT THIRTY-MILE BRIDGE NEAR CREEDE.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	June 19	W. B. Freeman, O. P. Pennock	60	255	5.66	5.90	1,443
	June 21	O. P. Pennock	59	232	5.27	5.50	1,223
	June 24	O. P. Pennock	58	222	4.72	5.30	1,048
	June 26	O. P. Pennock	57	196	4.64	5.05	910
	June 29	O. P. Pennock	56	195	4.53	4.90	883
	June 30	O. P. Pennock	55	191	4.22	4.78	806
	July 4	O. P. Pennock	55	194	4.33	4.75	840
	July 8	O. P. Pennock	54	159	3.11	4.12	494
	July 11	O. P. Pennock	52	135	2.71	3.70	366
	July 15	O. P. Pennock and N. C. Vandemoer	51	121	2.60	3.48	315
	July 18	O. P. Pennock and N. C. Vandemoer	51	111	2.17	3.20	241
	July 21	O. P. Pennock and N. C. Vandemoer	52	119	2.55	3.45	303
	July 22	O. P. Pennock and N. C. Vandemoer	53	155	3.43	4.12	531
	July 29	O. P. Pennock and N. C. Vandemoer	51	117	2.44	3.38	285
	Aug. 8	O. P. Pennock and N. C. Vandemoer	49	100	2.05	3.00	205
	Aug. 10	O. P. Pennock and N. C. Vandemoer	48	96	1.86	2.90	179
	Aug. 25	O. P. Pennock and N. C. Vandemoer	50	105	2.38	3.12	250
1910	June 21	O. P. Pennock and O. W. Evans		152	3.00	4.20	457
	June 24	O. P. Pennock and O. W. Evans		142	2.73	3.98	389
	June 27	O. P. Pennock and O. W. Evans		128	2.49	3.70	318
	July 18	O. P. Pennock and O. W. Evans		91	1.81	2.90	164
	July 20	O. P. Pennock and O. W. Evans		85	1.70	2.80	146
	July 21	O. P. Pennock and O. W. Evans		85	1.70	2.75	145
	July 22	O. P. Pennock and O. W. Evans		83	1.63	2.70	135
	July 26	O. P. Pennock and O. W. Evans		81	1.52	2.60	123
	Aug. 3	O. P. Pennock and O. W. Evans		81	1.69	2.70	137
	Aug. 16	O. P. Pennock and O. W. Evans		68	1.55	2.47	105
	Aug. 24	O. P. Pennock and O. W. Evans		64	1.50	2.39	96
	Aug. 26	O. P. Pennock and O. W. Evans		60	1.41	2.25	85
	Aug. 27	O. P. Pennock and O. W. Evans		60	1.37	2.21	82
	Sept. 8	O. P Pennock and O. W. Evans		59	1.36	2.17	80
	Sept. 12	I. G. Ferguson	37.4	51.4	1.09	2.17	55.7
	Sept. 12	I. G. Ferguson	35.2	44.7	1.27	2.17	56.8
	Sept. 12	I. G. Ferguson	34.8	44.8	1.27	2.17	56.9

DISCHARGE OF RIO GRANDE AT THIRTY-MILE BRIDGE, NEAR CREEDE, FOR 1909.
Drainage Area, 163 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1							789	230	316				
2							717	252	289				
3							717	220	289				
4							789	241	345				
5							861	220	1,607				
6							741	241	1,357				
7							648	210	1,040				
8							540	201	837				
9							520	201	694				
10							426	184	604				
11							409	241	561				
12							376	252	648				
13							345	230	561				
14							316	220	500				
15							302	210	444				
16							276	289	409				
17							264	220	376				
18						1,640	253	220	345				
19						1,448	241	241	316				
20						1,297	241	345	302				
21						1,210	330	289	276				
22						1,170	604	264	253				
23						1,131	345	276	241				
24						1,095	426	252	230				
25						1,013	330	230	220				
26						961	409	230	210				
27						886	444	264	201				
28						886	330	241	184				
29						936	289	345	177				
30						837	264	316	177				
31							241	316					
Total						14,510	13,783	7,691	14,009				
Mean						1,116	445	248	467				476
Maximum						1,640	861	345	1,607				1,640
Minimum						837	241	184	177				177
Run-off per square mile						6.847	2.728	1.522	2.865				2.921
Run-off, depth, inches						3.310	3.145	1.754	3.197				11.406
Run-off, acre-feet						28,780	27,338	15,255	27,786				99,159
Acre-feet per square mile						176.44	167.72	93.22	170.47				607.85

DISCHARGE OF RIO GRANDE AT THIRTY-MILE BRIDGE, NEAR CREEDE, FOR 1910.

Drainage Area, 163 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1							290	146	75	52	44		
2							266	123	65	60	44		
3							254	110	97	65	52		
4							242	146	86	60	60		
5							242	210	70	56	44		
6							220	146	60	48	37		
7							210	123	60	48	37		
8							200	116	56	48	31		
9							182	116	56	48	37		
10							164	116	52	48	37		
11							164	123	52	44	40		
12							155	123	56	48	40		
13							164	103	80	44	48		
14							155	103	70	52	60		
15							155	91	70	60	48		
16							146	86	70	146	44		
17							146	86	60	103	34		
18						439	138	80	65	91	37		
19						484	138	80	80	91	52		
20						484	130	80	86	75	34		
21						454	123	80	80	52	40		
22						424	123	75	86	70	44		
23						394	123	80	75	65	37		
24						366	116	80	65	65	44		
25						340	110	70	60	70	44		
26						314	103	65	60	75	40		
27						327	103	60	60	65	37		
28						454	130	60	56	52	37		
29						394	103	65	56	52	44		
30						302	220	60	52	44	40		
31							231	80		44			
Total						5,176	5,246	3,082	2,016	1,941	1,267		
Mean						398	169	99	67	63	42		113
Maximum						484	290	216	97	146	60		484
Minimum						302	103	60	52	44	31		31
Run-off per square mile						2.442	1.037	0.607	0.411	0.386	0.258		0.693
Run-off, depth, inches						1.181	1.197	0.703	0.460	0.443	0.289		4.273
Run-off, acre-feet						10,266	10,405	6,113	3,999	3,850	2,513		37,146
Acre-feet per square mile						62.98	63.84	37.50	24.48	23.62	15.42		227.84

RIO GRANDE AT WASON.

This station is maintained in co-operation with the United States Geological Survey and is located at Wason, on the Creede branch of the Denver & Rio Grande railroad.

The equipment consists of a chain gauge and automatic gauge. Measurements are made from a wagon bridge. The automatic gauge was installed September 23, 1910, and is the property of the State.

The bed of the stream is composed of small and medium sized boulders and changes at high water.

The observer is Henry H. Wason, who is paid 5.00 per month.

DISCHARGE MEASUREMENTS OF RIO GRANDE AT WASON.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 18......	W. B. Freeman..........................	115.5	485	5.77	3.44	2,800
	June 17......	O. P. Pennock, W. B. Freeman............	115.5	547	5.95	3.95	3,255
	June 20......	W. B. Freeman..........................	150	537	6.10	4.18	3,400
	Aug. 5......	G. H. Russell..........................	....	238	2.47	1.27	588
	Oct. 6......	G. H. Russell..........................	....	243	2.25	1.35	546
	Dec. 17......	*G. H. Russell..........................	....	146	1.60	0.88	233
1910	Jan. 25......	*J. B. Stewart..........................	69	122	1.39	....	169
	Feb. 21......	*Russell & Grieve..........................	65	93	1.64	....	152
	Apr. 14......	G. H. Russell..........................	100	217	2.53	1.10	548
	May 24......	G. H. Russell..........................	115.5	366	4.23	2.37	1,560
	June 26......	G. H. Russell and R. H. Bolster..........	....	274	2.88	1.51	788
	Aug. 2......	G. H. Russell..........................	....	187	2.12	0.80	396
	Aug. 13......	Grieve & Christiansen....................	100.5	191	1.90	0.78	363
	Sept. 1......	I. G. Ferguson..........................	109	168	1.64	0.55	277
	Sept. 23......	†I. G. Ferguson..........................	68	140	1.65	0.50	233
	Oct. 10......	E. O. Christiansen......................	90.5	143	1.48	0.30	210
	Oct. 20......	Christiansen & Hezmalhalch..............	110	169	1.72	0.60	290

*Ice conditions. †Wading.

DISCHARGE OF RIO GRANDE AT WASON, NEAR CREEDE, FOR 1909.
Drainage Area, 700 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1				175	780	1,660	1,938	585	715	470	398	150	
2				175	915	2,298	1,770	715	715	470	398	150	
3				175	955	3,840	1,880	650	812	470	398	150	
4				175	1,165	5,320	1,770	650	915	498	420	150	
5				175	1,715	6,185	2,175	650	2,115	525	398	150	
6				205	2,115	6,355	1,995	650	3,560	525	375	175	
7				205	1,255	5,050	1,660	618	3,150	470	398	175	
8				205	1,350	5,050	1,400	585	3,218	470	398	175	
9				285	2,298	4,818	1,255	585	3,150	470	375	175	
10				285	2,235	4,508	1,122	715	2,360	470	375	175	
11				285	2,235	4,355	1,080	650	1,995	470	375	175	
12				285	1,995	4,355	915	650	1,825	445	352	175	
13				285	2,298	4,355	915	650	1,450	445	352	175	
14				352	2,298	4,355	812	618	1,450	420	330	230	
15				375	2,422	4,058	780	650	1,255	445	285	230	
16				375	2 485	4,280	715	682	1,122	445	285	230	
17				375	2,680	3,985	650	618	1,035	445	262	230	
18				375	3,015	4,130	650	618	915	445	240	230	
19				1,555	3,015	3,912	650	650	845	420	240	230	
20				1,350	3,082	3,840	650	780	845	420	240	230	
21				955	3,150	3,560	1,080	748	780	420	205	230	
22				748	1,350	3,218	1,555	650	715	420	205	230	
23				812	2,115	3,150	1,608	715	715	420	205	230	
24				812	1,995	2,812	1,450	715	715	420	175	230	
25				812	2,175	2,615	955	650	650	420	175	230	
26				812	2,115	2,550	955	585	585	420	175	200	
27				780	2,745	2,360	995	585	525	420	175	200	
28				995	3,082	1,995	915	780	525	420	147	200	
29				915	2,880	2,115	780	780	525	398	147	200	
30				780	2,812	1,995	715	780	525	375	147	200	
31					2,485		650	748		375		200	
Total				16,093	67,212	113,129	36,440	20,705	39,707	13,746	8,650	6,110	
Mean				536	2,168	3,771	1,176	668	1,324	443	288	197	1,170
Maximum				1,555	3,150	6,355	1,938	780	3,560	525	420	230	6,355
Minimum				175	780	1,660	650	585	525	375	147	150	147
Run-off per square mile				0.766	3.097	5.387	1.679	0.954	1.891	0.633	0.412	0.280	1.672
Run-off, depth, inches				0.854	3.570	6.010	1.936	1.100	2.110	0.730	0.459	0.323	17.092
Run-off, acre-feet				31,920	133,313	224 388	72,278	41,068	78,758	27,265	17,157	12,113	638,260
Acre-feet per square mile				45.60	190.46	320.55	103.25	58.67	112.51	38.95	24.51	17.30	911.80

DISCHARGE OF RIO GRANDE AT WASON, NEAR CREEDE, FOR 1910.

Drainage Area, 700 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	200	170	222	618	1,502	4,355	748	445	240	....	....	....	
2	200	170	222	682	1,502	4,205	715	398	240	....	....	....	
3	200	170	222	555	1,660	3,015	650	375	240	....	....	....	
4	200	170	240	585	1,715	3,015	585	330	240	....	....	....	
5	200	170	240	555	1,770	3,150	585	420	240	....	....	....	
6	200	170	240	470	1,660	2,880	585	585	240	....	....	....	
7	200	170	240	470	1,938	2,550	525	420	240	....	....	....	
8	200	170	240	498	2,422	2,298	525	398	240	....	....	....	
9	200	150	262	525	3,560	2,422	470	375	262	....	....	....	
10	180	150	262	585	3,770	1,995	445	352	262	....	....	....	
11	180	150	285	650	3,352	2,115	445	375	262	....	....	....	
12	180	150	285	715	2,812	1,608	445	398	262	....	....	....	
13	180	150	308	682	2,422	1,660	420	352	262	....	....	....	
14	180	150	420	470	2,115	1,715	420	352	240	....	....	....	
15	180	150	525	498	1,938	1,608	375	330	240	....	....	....	
16	180	150	650	420	2,055	1,450	352	330	240	....	....	....	
17	180	150	650	445	2,175	1,302	375	285	240	....	....	....	
18	170	150	618	470	2,055	1,208	375	285	262	....	....	....	
19	170	150	618	585	2,175	1,124	398	285	240	....	....	....	
20	170	150	618	780	2,055	1,165	375	240	240	....	....	....	
21	170	150	650	915	2,175	1,080	352	285	240	....	....	....	
22	170	160	650	880	2,235	1,124	330	262	240	....	....	....	
23	170	160	618	1,080	2,175	955	330	240	240	....	....	....	
24	170	160	682	1,124	1,770	915	308	262	240	....	....	....	
25	170	180	682	1,255	1,938	812	308	240	240	....	....	....	
26	170	180	715	1,608	1,770	780	330	285	222	....	....	....	
27	170	180	715	1,880	1,555	845	285	240	205	....	....	....	
28	170	200	715	2,175	2,360	915	308	240	205	....	....	....	
29	170	....	780	2,422	2,745	915	285	240	205	....	....	....	
30	170	....	715	2,422	3,912	845	375	240	190	....	....	....	
31	170	....	715	....	4,430	....	555	240	....	....	....	....	
Total	5,620	4,530	15,004	27,019	71,718	54,026	13,576	10,104	7,159	....	....	....	
Mean	181	162	484	901	2,314	1,801	438	326	230	....	....	....	765
Maximum	200	200	780	2,422	4,430	4,355	748	445	262	....	....	....	4,430
Minimum	170	150	222	420	1,502	780	285	240	190	....	....	....	150
Run-off per square mile	0.259	0.231	0.691	1.287	3.306	2.573	0.626	0.466	0.341	....	....	....	1.092
Run-off, depth, inches	0.298	0.241	0.796	1.436	3.812	2.870	0.722	0.537	0.380	....	....	....	11.092
Run-off, acre-feet	11,129	8,997	29,760	53,613	142,280	107,180	26,932	20,045	14,221	....	....	....	414,157
Acre-feet per square mile	15.90	12.85	42.52	76.59	203.26	153.10	38.47	28.64	20.32	....	....	....	591.65

RIO GRANDE NEAR DEL NORTE.

This station, maintained in co-operation with the United States Geological Survey, is located at the State bridge, six miles west of Del Norte.

The equipment consists of a chain gauge and an automatic gauge. The chain gauge is the property of the United States Geological Survey, and the automatic gauge is owned by the State.

The bed of the stream is composed of small and medium sized boulders and changes to a slight extent. The current is swift at high stages and sluggish at low stages.

The observer is Jas. G. Duncan, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF RIO GRANDE NEAR DEL NORTE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909 May 17	W. B. Freeman		733	5.09	3.58	3,729
June 1	W. B. Freeman		878	5.65	4.27	4,960
Aug. 4	G. H. Russell		393	2.14	1.60	840
Oct. 1	G. H. Russell		383	1.96	1.40	752
1910 Jan. 25	*J. B. Stewart		200	1.57	0.60	314
Feb. 22	*G. H. Russell and Thos. Grieve	140	177	1.60	2.65	283
Mch. 17	Thos. Grieve	169	341	1.81	1.28	618
Apr. 8	Thos. Grieve	168	396	2.26	1.66	896
Apr. 15	G. H. Russell	176	402	2.29	1.60	918
May 23	G. H. Russell	174.4	584	4.13	2.79	2,410
June 27	G. H. Russell	168.2	430	2.51	1.87	1,080
July 31	G. H. Russell	166	367	2.01	1.41	736
Aug. 8	Grieve & Christiansen	159	325	1.70	1.18	551
Aug. 10	Grieve & Christiansen	159	317	1.68	1.15	532
Sept. 7	I. G. Ferguson	154	258	1.24	0.80	320
Oct. 18	Christiansen & Hezmalhalch	166	313	1.58	1.14	492

*Ice conditions.

DISCHARGE OF RIO GRANDE NEAR DEL NORTE FOR 1909.
Drainage Area, 1,400 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug	Sept.	Oct.	Nov.	Dec.	Period
1					1,060	2,415	2,730	835	1,110	700	425	398	
2					1,160	2,980	2,570	790	1,022	660	458	425	
3					1,560	4,145	2,570	835	1,022	660	490	425	
4					2,115	5,260	2,490	835	1,110	660	458	425	
5					2,980	6,230	2,490	880	1,500	928	425	425	
6					3,500	6,770	2,895	790	5,050	975	425	398	
7					3,770	6,550	2,490	790	4,945	975	425	398	
8					4,440	6,230	2,040	700	3,410	928	425	425	
9					3,235	6,110	1,820	700	2,650	790	425	425	
10					3,150	5,890	1,670	660	2,265	790	458	458	
11					3,320	5,680	1,440	745	2,040	745	425	458	
12					3,235	5,260	1,320	700	1,820	745	398	398	
13					3,320	5,470	1,160	790	2,115	700	398	425	
14					3,320	4,840	1,110	790	1,965	700	370	425	
15					2,895	4,840	1,060	745	1,820	660	370	425	
16					3,235	5,050	1,022	790	1,620	620	320	400	
17					3,590	4,945	975	790	1,500	620	295	350	
18					4,340	5,050	928	745	1,380	620	295	350	
19					4,540	4,945	880	745	1,260	588	345	350	
20					4,240	5,155	880	928	1,210	588	425	350	
21					3,590	4,945	880	1,022	1,110	588	490	340	
22					3,410	4,540	975	928	1,060	555	425	340	
23					3,235	4,440	1,380	928	1,022	555	425	340	
24					3,065	4,340	1,560	928	928	522	490	340	
25				975	2,810	4,050	1,320	1,060	880	522	490	320	
26				1,060	2,895	4,050	1,110	880	880	522	425	320	
27				1,380	3,590	3,500	1,380	928	835	490	425	320	
28				1,620	4,145	3,235	1,210	928	790	490	458	320	
29				1,560	3,320	2,980	1,022	1,320	745	490	425	320	
30				1,260	2,810	3,150	928	1,210	700	490	425	320	
31					2,730		880	1,160		458		320	
Total				7,855	98,605	143,045	47,185	26,875	49,764	20,334	12,533	11,733	
Mean				1,309	3,181	4,768	1,522	867	1,659	656	418	378	1,665
Maximum				1,620	4,540	6,770	2,730	1,320	5,050	975	490	458	6,770
Minimum				975	1,060	2,415	880	660	700	458	295	320	295
Run-off per square mile				0.935	2.272	3.406	1.087	0.619	1.185	0.468	0.298	0.270	1.189
Run-off, depth, inches				0.209	2.619	3.801	1.253	0.714	1.323	0.540	0.333	0.311	11.103
Run-off, acre-feet				15,580	195,580	283,725	93,590	53,306	98,705	40,332	24,859	23,272	828,949
Acre-feet per square mile				11.13	139.64	202.66	66.85	33.08	70.50	28.81	17.76	16.62	587.05

DISCHARGE OF RIO GRANDE NEAR DEL NORTE FOR 1910.
Drainage Area, 1,400 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	400	300	270	835	3,320	4,840	1,060	700	398	248	425	....	
2	400	300	270	928	2,980	4,640	928	588	398	202	398	....	
3	350	300	270	880	2,650	4,640	880	522	398	202	398	....	
4	350	300	270	745	2,490	4,440	835	458	398	225	370	....	
5	350	300	280	700	2,895	4,050	835	660	398	248	370	....	
6	350	300	290	790	2,570	3,770	790	700	345	270	320	....	
7	350	300	350	835	2,730	3,410	745	588	320	270	320	....	
8	350	300	400	928	3,065	3,150	700	522	295	270	320	....	
9	350	280	588	975	3,770	2,980	660	522	295	270	320	....	
10	350	280	555	928	4,440	2,810	620	522	248	270	320	....	
11	350	280	522	1,060	5,050	2,570	620	522	225	295	320	....	
12	350	280	458	1 160	5,260	2,490	620	620	225	270	320	....	
13	350	280	522	1,110	4,740	2,415	620	588	270	270	320	....	
14	350	280	522	1,060	4,440	2,340	620	555	320	270	345	....	
15	350	285	555	928	3,500	2,340	620	555	345	295	345	....	
16	350	285	555	790	3,410	2,340	555	490	370	345	295	....	
17	310	285	588	835	3,150	1,965	522	458	370	620	270	....	
18	310	285	620	880	3,065	1,750	522	425	345	490	270	....	
19	310	285	700	975	2,980	1,685	522	425	345	425	320	....	
20	310	285	700	1,260	2,980	1,620	490	425	370	398	295	....	
21	310	285	790	1,380	2,810	1,560	490	458	398	345	270	....	
22	310	285	880	1,380	2,490	1,500	458	458	370	345	295	....	
23	310	285	1,160	1,500	2,265	1,380	458	425	320	370	295	....	
24	310	280	1,160	1,820	2,190	1,260	490	458	248	398	295	....	
25	310	280	1,210	2,190	2,570	1,160	490	425	202	425	295	....	
26	310	280	1,160	2,490	2,650	1,110	458	398	202	425	295	....	
27	310	270	975	3,235	2,895	1,110	425	370	248	398	295	....	
28	310	270	880	3,320	3,680	1,060	398	370	295	398	248	....	
29	310	....	790	3,860	4,740	1,210	425	398	295	398	270	....	
30	310	....	620	3,860	5,050	1,160	490	398	295	398	248	....	
31	310	....	700	....	5,155	....	700	370	....	398	....	....	
Total	10,350	8,025	19,610	43,637	105,980	72,755	19,046	15,373	9,551	10,451	9 467	....	
Mean	334	287	633	1,455	3,419	2,425	614	496	318	337	316	....	971
Maximum	400	300	1,210	3,860	5,260	4,840	1,060	700	398	620	425	....	5,260
Minimum	310	270	270	700	2,190	1,060	398	370	202	202	248	....	202
Run-off per square mile	0.238	0.205	0.452	1.039	2.442	1.732	0.439	0.354	227	0.241	0.225	....	0.693
Run-off, depth, inches	0.275	0.214	0.521	1.159	2.815	1.932	0.506	0.408	0.253	0.278	0.251	....	8.612
Run-off, acre-feet	20,529	15,917	38,922	86,573	210,208	144,307	37,753	30,498	18,922	20,721	18,803	....	643,153
Acre-feet per square mile	14.66	11.37	27.80	61.85	150.15	103.08	26.97	21.78	13.52	14.80	13.43	....	459.41

RIO GRANDE NEAR LOBATOS.

This station, maintained in co-operation with the United States Geological Survey, is located at the State bridge, about six miles above the Colorado-New Mexico line.

The equipment consists of a chain gauge owned by the United States Geological Survey, and an automatic gauge owned by the State, which was installed November 8, 1910.

The bed of the stream is composed of sand and boulders. Both banks are high and rocky. The bed of the stream fills up at low stages.

The observer is Roman Mondragon, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF RIO GRANDE NEAR LOBATOS.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	Feb. 13	J. B. Stewart		150	2.62	2.24	393
	Mch. 26	J. B. Stewart		402	1.20	1.95	483
	May 16	W. B. Freeman		990	4.00	4.60	3,960
	June 22	W. B. Freeman		1,178	3.65	5.01	4,300
	Aug. 2	G. H. Russell		256	0.68	1.40	173
	Sept. 29	G. H. Russell		572	1.99	2.62	1,137
	Dec. 19	*G. H. Russell		258	1.08	2.28	280
1910	Jan. 27	*J. B. Stewart	212	323	1.35	1.85	438
	Feb. 23	G. H. Russell	214	273	1.34	2.70	366
	Apr. 9	W. B. Freeman and J. B. Stewart	239	596	2.03	2.68	1,213
	May 26	G. H. Russell	235	585	2.09	2.68	1,222
	June 24	G. H. Russell and R. H. Bolster	215	272	5.07	1.20	138
	July 15	J. B. Stewart	43.5	218	1.10	0.65	240
	Aug. 19	Ferguson & Christiansen	115	118	1.04	1.15	123
	Sept. 10	C. W. Comstock and E. O. Christiansen	95	69	0.60	0.75	42
	Oct. 13	J. B. Stewart	51	44	1.17	0.88	51
	Nov. 8	Mathias	125	159	1.32	1.40	212

*Ice conditions.

DISCHARGE OF RIO GRANDE NEAR LOBATOS FOR 1909.

Drainage Area, 7,700 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	250	250	350	530	1,665	2,480	1,730	205	1,730	1,000	460	660	
2	250	250	345	530	1,350	2,130	1,535	165	1,665	1,000	460	705	
3	250	250	400	530	1,350	2,130	1,290	165	1,730	950	530	615	
4	250	300	495	530	1,730	2,555	1,110	165	1,600	850	530	615	
5	250	300	530	530	2,270	3,220	1,110	135	1,730	800	530	600	
6	250	300	530	530	3,220	5,195	1,230	135	2,410	900	530	600	
7	250	350	530	530	4,150	5,945	1,230	120	3,530	1,055	530	600	
8	250	350	530	530	4,870	6,920	1,350	135	4,230	1,350	530	550	
9	250	350	530	530	5,030	7,370	1,110	150	4,390	1,350	530	550	
10	250	350	615	530	5,110	7,460	900	165	4,550	1,350	530	500	
11	250	350	530	530	4,870	7,190	800	205	4,070	1,230	530	500	
12	250	390	660	530	4,710	6,830	615	225	3,530	1,055	530	450	
13	250	390	615	495	4,550	6,380	460	205	3,140	1,055	615	450	
14	250	390	460	495	4,390	5,945	400	205	3,140	1,055	615	400	
15	300	390	530	800	4,550	5,610	295	205	2,920	1,000	615	400	
16	300	390	615	800	4,310	5,110	250	205	2,845	900	615	350	
17	300	390	615	800	3,605	4,390	205	205	2,630	900	530	350	
18	300	390	530	1,055	3,760	4,550	165	295	2,410	850	495	300	
19	300	390	530	2,270	4,310	4,710	165	345	2,270	750	460	280	
20	300	390	530	3,140	4,550	4,870	165	400	2,130	750	430	280	
21	250	390	530	3,220	4,710	4,790	110	460	1,925	705	570	280	
22	250	390	530	2,630	4,550	4,550	110	460	1,795	705	615	280	
23	225	350	530	2,200	3,840	4,310	110	1,000	1,600	705	615	270	
24	220	350	530	1,730	3,450	3,840	110	705	1,410	660	705	270	
25	200	350	530	1,470	2,920	3,530	120	750	1,410	615	705	250	
26	200	350	530	1,350	2,555	3,295	400	900	1,350	615	705	250	
27	200	350	530	1,230	2,480	2,990	530	900	1,230	615	705	250	
28	200	350	530	1,290	2,770	2,770	370	1,000	1,230	615	615	250	
29	200	....	530	1,535	3,140	2,480	295	1,170	1,170	530	615	250	
30	200	....	530	1,930	3,140	2,060	295	1,470	1,110	495	705	250	
31	200	....	495	....	2,630	....	250	1,600	....	495	....	250	
Total	7,645	9,790	16,265	34,800	110,535	135,605	18,815	14,450	70,880	26,905	17,150	12,605	
Mean	247	350	525	1,160	3,566	4,520	607	466	2,363	868	572	407	1,303
Maximum	300	390	660	3,220	5,110	7,460	1,730	1,600	4,550	1,350	705	705	7,460
Minimum	200	250	345	495	1,350	2,060	110	120	1,110	495	430	250	110
Run-off per square mile	0.032	0.045	0.068	0.151	0.463	0.587	0.079	0.060	0.307	0.113	0.074	0.053	0.169
Run-off, depth, inches	0.037	0.047	0.079	0.168	0.534	0.655	0.091	0.069	0.343	0.130	0.082	0.061	2.296
Run-off, acre-feet	15,187	19,438	32,281	69,020	219,269	268,960	37,323	28,653	140,590	53,371	34,036	25,025	943,153
Acre-feet per square mile	1.97	2.52	4.19	8.96	28.48	34.93	4.85	3.72	18.26	6.93	4.42	3.25	122.48

DISCHARGE OF RIO GRANDE NEAR LOBATOS FOR 1910.
Drainage Area, 7,700 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	450	350	450	1,230	5,360	3,300	85	30	45	45	205	....	
2	450	350	500	1,230	5,280	3,530	65	20	45	30	205	....	
3	450	350	705	1,230	4,710	3,300	65	20	45	30	205	....	
4	450	350	705	1,230	4,070	2,840	65	20	30	45	205	....	
5	450	350	800	1,230	3,840	2,560	45	30	30	45	165	....	
6	450	350	800	1,230	3,450	2,410	45	30	30	45	165	....	
7	450	350	950	1,230	3,300	2,130	30	30	30	45	165	....	
8	450	350	1,110	1,170	3,140	1,410	30	30	30	45	185	....	
9	450	350	1,110	1,230	3,220	1,170	30	30	45	45	165	....	
10	450	350	1,170	1,290	3,530	950	30	38	38	45	165	....	
11	450	350	1,230	1,290	4,070	850	30	55	38	45	165	....	
12	450	350	1,060	1,410	4,550	752	30	65	38	55	165	....	
13	450	350	1,060	1,730	4,950	752	30	85	38	45	185	....	
14	450	350	1,230	1,730	5,195	660	30	110	45	45	185	....	
15	450	350	1,230	1,730	5,110	572	30	135	45	65	185	....	
16	450	350	1,230	1,660	5,300	495	20	135	45	65	185	....	
17	450	360	1,230	1,600	4,790	400	20	122	45	65	205	....	
18	450	365	1,170	1,600	4,070	345	20	135	45	65	250	....	
19	450	370	1,230	1,470	2,770	250	20	135	45	85	272	....	
20	450	400	1,290	1,730	2 560	272	20	135	45	165	250	....	
21	450	400	1,350	1,860	2,480	205	20	110	65	165	250	....	
22	450	400	1,470	2,200	2,130	228	20	110	65	205	272	....	
23	450	400	1,470	2,200	1,920	185	20	110	55	250	272	....	
24	450	400	1,730	2,340	1,660	185	20	85	55	250	272	....	
25	450	400	1,990	2,770	1,410	165	20	85	45	250	295	....	
26	450	400	2,060	3,220	1,230	122	20	85	38	250	320	....	
27	440	400	1,990	3,840	1,410	85	20	85	45	250	295	....	
28	400	400	1,800	4,150	1,660	85	20	65	45	250	295	....	
29	400	....	1,730	4,790	1,920	85	20	65	45	250	295	....	
30	400	....	1,540	5,380	2,340	85	24	55	45	250	272	....	
31	400	....	1,350	....	3,060	....	75	55	....	250	....	....	
Total	13,740	10,295	38,740	61,000	104,485	30,378	1,019	2,300	1,300	3,655	6,715	....	
Mean	443	368	1,250	2,033	3,370	1,013	32	74	43	114	224	....	819
Maximum	450	400	2,060	5,380	5,360	3,530	85	135	65	250	320	....	5,380
Minimum	400	350	450	1,170	1,230	85	20	20	30	30	165	....	20
Run-off per square mile	0.058	0.048	0.162	0.264	0.438	0.132	0.004	0.010	0.006	0.015	0.029	....	0.106
Run-off, depth, inches	0.067	0.050	0.186	0.294	0.505	0.147	0.005	0.012	0.007	0.018	0.032	....	1.323
Run-off, acre-feet	27,239	20,438	76,860	120,969	207,213	60,278	1,968	4,550	2,559	7,010	13,329	....	542,413
Acre-feet per square mile	3.55	2.65	9.98	15.71	26.91	7.83	0.26	0.59	0.33	0.91	1.73	....	70.45

CLEAR CREEK AT TEXAS CLUB HOUSE, NEAR CREEDE.

This station, maintained by the State, is located at wagon bridge near the Texas Club House, about 20 miles from Creede, and about one-half mile above the junction with the Rio Grande.

The equipment consists of a 2"x4" staff gauge bolted to the left abutment of wagon bridge.

The bed of the stream is composed of small and medium sized boulders and is probably permanent.

The observer is Esther Workman, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF CLEAR CREEK, NEAR CREEDE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Aug. 12	E. O. Christiansen and Thos. Grieve	29.5	45.3	1.28	2.20	58.0
Sept. 12	I. G. Ferguson	34.8	38.4	0.99	2.06	38.2

DISCHARGE OF CLEAR CREEK, NEAR CREEDE, FOR 1910.

Drainage Area, 139 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									46	40			
2									46	40			
3									46	40			
4									46	40			
5									46	40			
6									40	40			
7									40	40			
8									40	40			
9									40	40			
10									40	40			
11									40	40			
12								58	40	40			
13								58	40	40			
14								58	46	40			
15								46	46	40			
16								46	46	46			
17								46	46				
18								46	46				
19								46	46				
20								46	46				
21								52	46				
22								46	46				
23								52	46				
24								52	46				
25								46	40				
26								46	40				
27								46	40				
28								46	40				
29								46	40				
30								46	40				
31								46					
Total								974	1,296	646			
Mean								49	43	40			44
Maximum								58	46	46			58
Minimum								46	40	40			40
Run-off per square mile								0.350	0.311	0.291			0.316
Run-off, depth, inches								0.260	0.347	0.173			0.780
Run-off, acre-feet								1,932	2,570	1,281			5,783
Acre-feet per square mile								13.89	18.49	9.22			41.60

SOUTH FORK RIO GRANDE AT SOUTH FORK.

This station is located at wagon bridge one-half mile west of South Fork station on the Denver & Rio Grande railroad.

The equipment consists of a 2"x4" slope gauge bolted to the down stream side of right abutment of bridge.

The bed of the stream is composed of boulders and is permanent. The current is sluggish at low stages.

Since its establishment as a permanent gauging station it has been maintained by the State. Measurements were made previously by the United States Geological Survey.

The observer is Lelia Singles, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF SOUTH FORK RIO GRANDE AT SOUTH FORK.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 17	W. B. Freeman	38	186	5.00	3.35	932
	June 21	W. B. Freeman	38	204	5.56	3.77	1,136
	Aug. 4	G. H. Russell	35	108	1.31	1.67	142
	Oct. 1	G. H. Russell	32	97.5	1.14	1.52	111
1910	Aug. 1	G. H. Russell	....	59	1.46	1.43	87
	Aug. 9	Grieve & Christiansen	38	98	0.72	1.42	71
	Sept. 22	I. G. Ferguson	44	65	.78	1.33	50
	Oct. 18	Christiansen & Hezmalhalch	31	44	1.53	1.40	67.2

DISCHARGE OF SOUTH FORK RIO GRANDE AT SOUTH FORK FOR 1910.
Drainage Area, 216 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									50	35	60		
2									50	42	42		
3									50	70	50		
4									50	50	50		
5									50	35	50		
6									50	35	50		
7									50	35	42		
8									42	35	50		
9								80	35	35	35		
10								90	35	35	35		
11								90	35	35	35		
12								170	35	35	35		
13								105	42	35	42		
14								120	35	35	35		
15								90	35	42	35		
16								70	50	70	50		
17								70	35	120	42		
18								70	35	70	60		
19								70	50	60	60		
20								80	50	70	50		
21								70	35	70	50		
22								90	50	90	70		
23								80	35	60	35		
24								80	35	70	50		
25								90	35	90	60		
26								60	35	170	80		
27								60	35	70	60		
28								50	35	50	50		
29								50	30	50	60		
30								50	30	50	60		
31								50		60			
Total								1,835	1,219	1,809	1,483		
Mean								80	41	58	49		56
Maximum								120	50	170	80		170
Minimum								50	30	35	35		30
Run-off per square mile								0.369	0.188	0.270	0.229		0.258
Run-off, depth, inches								0.316	0.210	0.311	0.256		1.093
Run-off, acre-feet								3,640	2,418	3,588	2,941		12,587
Acre-feet per square mile								16.85	11.19	16.61	13.61		58.26

SAN LUIS CREEK NEAR VILLA GROVE.

This station, maintained by the State, is located at Jay White's ranch, near Villa Grove.
The equipment consists of a vertical staff gauge bolted to abutment of wagon bridge.
The bed of the stream consists of sand and mud with a few boulders.
The gauge is read by Jay White, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF SAN LUIS CREEK NEAR VILLA GROVE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
Sept. 8	*I. G. Ferguson	7.0	2.2	0.41	0.20	0.9
Oct. 7	E. O. Christiansen	8.6	2.6	0.84	0.30	2.2

*Station established.

DISCHARGE OF SAN LUIS CREEK, NEAR VILLA GROVE, FOR 1910.

Drainage Area, 218 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1										2.2	0.9		
2										2.2	0.9		
3										2.2	0.9		
4										2.2	0.9		
5										2.2	0.9		
6										2.2	0.9		
7										2.2	0.9		
8									0.9	2.2	0.9		
9									0.9	2.2	0.9		
10									1.6	2.2	0.9		
11									2.2	2.2	0.9		
12									2.2	2.2	0.9		
13									2.2	2.2	0.9		
14									2.2	2.2	0.9		
15									2.2	2.2	2.2		
16									2.2	4.0	2.2		
17									2.2	4.0	2.2		
18									4.0	3.1	2.2		
19									2.2	2.2	2.2		
20									2.2	2.2	2.2		
21									4.0	1.6	2.2		
22									2.2	2.2	2.2		
23									2.2	2.2	2.2		
24									2.2	2.2	2.2		
25									2.2	2.2	2.2		
26									2.2	2.2	2.2		
27									2.2	2.2	2.2		
28									2.2	2.2	2.2		
29									2.2	1.6	2.2		
30									2.2	0.9	2.2		
31										0.9	1.6		
Total									51.0	68.9	47.2		
Mean									2.2	2.2	1.6		2
Maximum									4.0	4.0	2.2		4
Minimum									0.9	0.9	0.9		0.9
Run-off per square mile									0.010	0.010	0.007		0.009
Run-off, depth, inches									0.008	0.012	0.008		0.028
Run-off, acre-feet									101	137	94		332
Acre-feet per square mile									0.46	0.63	0.43		1.52

SAGUACHE RIVER AT SAGUACHE.

This station, maintained by the Stark-Hagadorn Irrigation Project, is located about 8 miles above Saguache.

The equipment consists of a foot bridge and Bristol automatic gauge owned by the Stark-Hagadorn Irrigation Project.

The bed of the stream consists of sand, gravel and small cobbles and is not liable to shift.

Blue prints of automatic gauge records are furnished this office gratis.

DISCHARGE MEASUREMENTS OF SAGUACHE RIVER AT SAGUACHE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
Sept. 3	I. G. Ferguson	24.0	26.8	1.85	1.10	49.5
Oct. 6	E. O. Christiansen	21.9	23	1.54	0.92	36.0

DISCHARGE OF SAGUACHE RIVER AT SAGUACHE FOR 1910.
Drainage Area, 595 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									50	42	38		
2									50	42	38		
3									46	42	38		
4									46	42	38		
5									46	42	42		
6									46	42			
7								54	42	42			
8								54	38	42			
9								54	38	42			
10								62	38	42			
11								58	38	34			
12								58	42	34			
13								58	50	42			
14								54	50	42			
15								50	46	38			
16								50	46	38			
17								50	42	42			
18								50	42	54			
19								50	42	50			
20								50	42	50			
21								50	42	50			
22								50	42	34			
23								54	50	38			
24								54	46	46			
25								50	42	46			
26								46	42	46			
27								42	42	42			
28								42	42	38			
29								50	42	38			
30								50	42	38			
31								50		38			
Total								1,290	1,312	1,298			

DISCHARGE OF SAGUACHE RIVER AT SAGUACHE FOR 1910—Concluded.

Drainage Area, 595 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	....	....	....	....	52	42	42	....	....	45
Maximum	....	....	....	....	....	....	....	58	50	50	....	....	58
Minimum	....	....	....	....	....	....	....	42	38	38	....	....	38
Run-off per square mile	....	....	....	....	....	....	....	0.087	0.071	0.070	....	....	0.076
Run-off, depth, inches	....	....	....	....	....	....	....	0.081	0.079	0.081	....	....	0.241
Run-off, acre-feet	....	....	....	....	....	....	....	2,559	2,602	2,574	....	....	7,735
Acre-feet per square mile	....	....	....	....	....	....	....	4.30	4.37	.433	....	....	13.00

CONEJOS RIVER NEAR MOGOTE.

This station, maintained in co-operation with the United States Geological Survey, is located 9 miles above Mogote and 16 miles above Antonito, the nearest railroad point.

The equipment consists of a chain gauge owned by the United States Geological Survey. Measurements are made from a private highway bridge.

The bed of the stream is composed of boulders and is considered permanent. The current is swift at high stages. The right bank overflows at high stages.

The observer is Francesque Jacob, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF CONEJOS RIVER NEAR MOGOTE.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1909	May 15	W. B. Freeman	....	314	3.40	2.35	1,068
	June 23	W. B. Freeman	....	369	4.62	2.80	1,706
	Aug. 3	G. H. Russell	....	153	1.78	1 00	272
	Sept. 30	G. H. Russell	....	92	1.34	0.65	123
	Nov. 13	Jas. B. Stewart	....	76	0.75	0.35	57
	Dec. 20	*G. H. Russell	....	33	2.24	....	74
1910	Jan. 26	J. B. Stewart	23	37	1.24	....	46
	Feb. 24	†G. H. Russell	30	32	1.66	....	53
	Apr. 10	Jas. B. Stewart	96.5	169	1.80	1.20	304
	May 27	G. H. Russell	104	258	4.31	2.25	1,112
	June 25	G. H. Russell and R. H. Bolster	....	176	2.00	1.30	352
	Aug. 5	G. H. Russell	....	152	2.24	1.20	340
	Aug. 18	Ferguson and Christiansen	72	83	1.67	0.63	139
	Sept. 9	E. O. Christiansen	49	45	1.58	0.30	71
	Sept. 23	E. O. Christiansen	51.5	40	1.56	0.32	63
	Oct. 22	Christiansen and Hezmalhalch	52	44	1.61	0.42	72

*Measurement 8 miles below Gauging Station. †Ice conditions. Measurement 2 miles above Mogote.

DISCHARGE OF CONEJOS RIVER NEAR MOGOTE FOR 1909.
Drainage Area, 282 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					378	1,230	1,120	222	388	120	95	60	
2					430	1,430	1,120	259	413	120	85	70	
3					653	1,895	1,065	259	413	120	75	70	
4					1,000	2,418	960	259	440	147	75	70	
5					1,575	2,942	910	278	910	190	75	70	
6					1,650	3,118	910	319	1,360	240	75	70	
7					1,730	2,942	865	341	1,300	240	75	70	
8					1,810	2,768	865	298	1,010	259	75	70	
9					1,170	2,680	780	278	740	190	75	70	
10					1,230	2,592	701	298	662	175	75	70	
11					1,230	2,418	662	240	592	175	75	70	
12					1,230	2,505	592	240	498	175	60	70	
13					1,230	2,330	498	319	528	175	60	70	
14					1,295	2,068	413	259	468	175	60	75	
15					1,230	1,895	388	240	468	175	60	75	
16					1,360	1,895	363	278	413	147	60	70	
17					1,500	1,895	341	240	363	147	60	70	
18					1,650	2,155	341	259	341	147	60	70	
19					1,810	1,980	341	240	319	147	60	70	
20					1,500	2,068	341	240	278	147	60	70	
21					1,500	2,068	319	240	278	120	60	70	
22					1,500	1,895	341	222	278	120	60	70	
23					1,170	1,650	341	298	278	120	60	70	
24					1,000	1,650	413	341	222	120	60	70	
25				353	900	1,575	388	413	222	120	60	70	
26				378	1,055	1,360	341	341	190	120	60	60	
27				458	1,230	1,295	319	413	190	120	60	60	
28				550	1,575	1,110	278	388	147	108	60	60	
29				518	1,360	1,110	278	740	147	95	60	60	
30				353	1,110	1,055	278	528	134	95	60	60	
31					1,110		222	440		95		60	
Total				2,610	39,171	59,992	17,094	9,730	13,990	4,644	1,995	2,110	
Mean				435	1,264	2,000	551	314	466	150	66	68	603
Maximum				550	1,810	3,118	1,120	740	1,360	259	95	75	3,118
Minimum				353	378	1,055	222	222	134	95	60	60	60
Run-off per square mile				1.542	4.445	7.091	1.955	1.113	1.652	0.531	0.235	0.241	2.138
Run-off, depth, inches				0.344	5.125	7.911	2.554	1.283	1.843	0.612	0.263	0.278	20.213
Run-off, acre-feet				5,177	77,694	118,992	33,905	19,299	27,749	9,211	3,957	4,185	300,169
Acre-feet per square mile				18.36	275.51	421.96	120.23	68.43	98.40	32.66	14.03	14.84	1,064.42

DISCHARGE OF CONEJOS RIVER NEAR MOGOTE FOR 1910.
Drainage Area, 282 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	60	40	50	222	1,180	1,630	278	190	95	47	75	....	
2	60	40	50	222	910	1,630	278	175	95	47	75	....	
3	60	40	50	222	910	1,560	240	161	75	47	75	....	
4	60	40	50	222	1,010	1,490	240	147	75	47	75	....	
5	50	40	60	222	1,120	1,360	240	298	75	47	75	....	
6	50	40	60	259	1,010	1,120	240	259	75	47	68	....	
7	50	40	60	259	960	1,010	222	175	68	47	68	....	
8	50	40	60	298	1,240	910	205	175	60	47	60	....	
9	50	40	60	298	1,360	865	190	175	60	47	60	....	
10	50	40	60	298	1,560	780	175	205	60	47	60	....	
11	50	50	70	298	1,770	740	175	298	60	47	60	....	
12	50	50	108	363	1,920	780	175	298	60	47	60	....	
13	45	50	120	363	1,770	701	190	259	60	47	60	....	
14	45	50	134	319	1,770	627	175	240	60	47	60	....	
15	45	50	161	298	1,490	627	175	190	60	47	60	....	
16	45	50	175	341	1,180	592	161	175	60	60	60	....	
17	45	50	190	341	1,120	560	147	147	60	75	54	....	
18	45	50	190	341	1,180	528	147	147	60	75	47	....	
19	45	50	190	363	960	468	147	147	60	95	47	....	
20	45	50	222	363	960	440	120	147	60	95	47	....	
21	45	50	298	440	910	440	120	120	60	85	47	....	
22	45	50	298	440	865	440	175	120	68	60	47	....	
23	45	50	363	440	740	440	161	161	60	60	47	....	
24	45	50	319	662	701	341	147	134	60	75	47	....	
25	45	50	341	960	740	363	147	120	60	75	47	....	
26	45	50	298	1,120	820	363	133	108	60	85	47	....	
27	45	50	240	1,120	1,010	341	120	95	60	95	54	....	
28	45	50	259	1,300	1,425	319	134	95	54	85	60	....	
29	45	....	259	1,360	1,630	319	120	95	47	75	60	....	
30	40	....	240	1,300	1,845	319	134	108	47	75	60	....	
31	40	....	222	....	1,700	....	222	95	....	75	....	....	
Total	1,485	1,300	5,257	15,054	37,760	21,103	5,533	5,259	1,914	1,950	1,762	....	
Mean	50	46	170	502	1,218	703	178	169	64	63	59	....	294
Maximum	60	50	363	1,360	1,845	1,630	278	298	95	95	75	....	1,845
Minimum	40	40	50	222	701	319	120	95	47	47	54	....	40
Run-off per square mile	0.177	0.163	0.603	1.780	4.319	2.494	0.633	0.600	0.226	0.228	0.208	....	1.044
Run-off, depth, inches	0.204	0.182	0.695	1.986	4.979	2.782	0.730	0.692	0.252	0.257	0.232	....	12.991
Run-off, acre -feet	2,945	2,578	10,427	29,871	74,896	41,831	10,945	10,391	3,808	3874	3,511	....	195,077
Acre-feet per square mile	10.44	9.14	36.98	105.93	265.58	148.34	38.81	36.85	13.50	13.74	12.45	....	691.76

CULEBRA RIVER AT SAN LUIS.

This station has been maintained by the Costilla Estates Development Company and is located at the county bridge in the town of San Luis.

Discharges have been furnished this office gratis and represent the mean discharge for the week beginning on the dates on which the discharges are noted.

The discharge for the week beginning September 3rd has been estimated.

DISCHARGE OF CULEBRA RIVER AT SAN LUIS FOR 1909.
Drainage Area, 260 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1												
2												
3												
4												31
5												
6												
7												
8												
9												
10												
11												20
12												
13												
14												
15												
16												
17												
18												33
19												
20												
21												
22												
23												
24												
25												30
26												
27											49	
28												
29												
30												
31												
Total											196	945
Mean											49	30
Maximum												
Minimum												
Run-off per square mile												0.127
Run-off, depth, inches												0.146
Run-off, acre-feet												1,845
Acre-feet per square mile												7.10

DISCHARGE OF CULEBRA RIVER AT SAN LUIS FOR 1910.
Drainage Area, 260 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	57									35.5			
2				95			52						
3									34				
4						185							
5		36	84								33.5		
6								53					
7					203								
8	40			95						34			
9							24						
10									39				
11						63							
12		37	98								40		
13								58					
14					255								
15	34			136						35			
16							15						
17									37				
18						58							
19		37	89								36		
20								25					
21					212								
22	34			185						40.5			
23							18						
24									31				
25						59							
26		37	107								32		
27								30					
28					165								
29	37			255						33			
30							30						
31													
Total	1,266	1,029	2,687	4,099	6,880	2,991	882	1,252	1,047	1,124	1,058		
Mean	41	37	87	136	222	100	28	40	35	37	35		73
Maximum													
Minimum													
Run-off per square mile	0.158	0.142	0.335	0.523	0.854	0.385	0.108	0.154	0.135	0.142	0.135		0.280
Run-off, depth, inches	0.182	0.148	0.386	0.583	0.984	0.430	0.125	0.177	0.150	0.163	0.150		3.478
Run-off, acre-feet	2,521	2,055	5,349	8,093	13,650	5,950	1,722	2,460	2,083	2,275	2,083		48,241
Acre-feet per square mile	9.70	7.90	20.57	31.12	52.49	22.88	6.62	9.46	8.01	8.75	8.01		185.51

MISCELLANEOUS MEASUREMENTS IN RIO GRANDE BASIN.

DATE		HYDROGRAPHER	STREAM	LOCALITY	Discharge
1910	Sept. 25	I. G. Ferguson	Rio Grande	Alamosa	9.4
	Sept. 10	I. G. Ferguson	Rito Arena	Kings Ranch near Liberty.	6.6
	Oct. 7	E. O. Christiansen	Rito Alto	Near mouth	Dry
	Oct. 7	E. O. Christiansen	San Isabella Creek	Near mouth	0.5
	Oct. 13	J. B. Stewart	Rio San Antonio	Near Lobatos	Dry
	Sept. 14	I. G. Ferguson	Rio Trinchera	At mouth	Dry
	Sept. 29	E. O. Christiansen	Rio Trinchera	At mouth	Dry
	Oct. 7	E. O. Christiansen	Wild Cherry Creek	At mouth	Dry
	Aug. 9	E. O. Christiansen	Alamosa River	At mouth	Dry
	Sept. 14	I. G. Ferguson	Alamosa River	At mouth	Dry
	Sept. 26	I. G. Ferguson	Alamosa River	Near Capulin	8.2
	Sept. 28	I. G. Ferguson	Alamosa River	At mouth	Dry
	Sept. 2	I. G. Ferguson	Carnero Creek	At mouth	0.8
	Oct. 5	E. O. Christiansen	Carnero Creek	¼ mile above Devil's Gate	5.0
	Apr. 9	W. B. Freeman	Costilla River	Eastdale	32
	Sept. 8	I. G. Ferguson	Cotton Creek	Near mouth	Dry
	Oct. 7	E. O. Christiansen	Cotton Creek	Near mouth	2
	Sept. 15	I. G. Ferguson	Conejos River	At Austin's Ranch above mouth	24
	Sept. 28	E. O. Christiansen	Conejos River	At Austin's Ranch above mouth	25
	Oct. 17	E. O. Christiansen	Conejos River	At Austin's Ranch above mouth	34
	Sept. 9	I. G. Ferguson	Deadman Creek	At Liberty	1.0
	Oct. 7	E. O. Christiansen	Garnero Creek	Near mouth	Dry
	Sept. 23	I. G. Ferguson	Goose Creek	Wagon Wheel Gap	22
	Oct. 20	E. O. Christiansen	Goose Creek	Wagon Wheel Gap	21
	Sept. 2	I. G. Ferguson	La Garita Creek	Near La Garita	0.8
	Oct. 5	E. O. Christiansen	La Garita Creek	Near La Garita	4.4
	Aug. 15	E. O. Christiansen	Rio La Jara	Hansen's Ranch above mouth	61
	Aug. 17	E. O. Christiansen	Rio La Jara	Hansen's Ranch above mouth	52
	Sept. 14	I. G. Ferguson	Rio La Jara	At mouth	3.1
	Sept. 28	E. O. Christiansen	Rio La Jara	Hansen's Ranch above mouth	4.4
	Oct. 17	E. O. Christiansen	Rio La Jara	Hansen's Ranch above mouth	11.4
	Aug. 16	E. O. Christiansen	Rio Grande	Near Alamosa	13
	Sept. 14	I. G. Ferguson	Rio Grande	Above mouth Rio La Jara	11.7
	Sept. 14	I. G. Ferguson	Rio Grande	Above mouth Alamosa R.	10.8
	Sept. 14	I. G. Ferguson	Rio Grande	Above mouth Rio Trinchera	15.6
	Sept. 12	I. G. Ferguson	Rio Grande	Above mouth Clear Creek.	85
	Sept. 15	I. G. Ferguson	Rio Grande	Above mouth Conejos R.	14.8
	Sept. 15	I. G. Ferguson	Rio Grande	5 miles below La Sauces	46.2
	Sept. 16	I. G. Ferguson	Rio Grande	2 miles above State Bridge at Lobatos	41
	Sept. 16	I. G. Ferguson	Rio Grande	Colo.-N. Mexico Line	41
	Sept. 20	I. G. Ferguson	Rio Grande	12 miles below Monte Vista	18.8
	Sept. 20	I. G. Ferguson	Rio Grande	6 miles below Monte Vista.	12.1
	Sept. 20	I. G. Ferguson	Rio Grande	At Monte Vista	63.8

MISCELLANEOUS MEASUREMENTS IN RIO GRANDE BASIN.

DATE	HYDROGRAPHER	STREAM	LOCALITY	Discharge
1910 Sept. 20......	I. G. Ferguson..........................	Rio Grande............	5 miles above Alamosa...	6.6
Sept. 21......	I. G. Ferguson..........................	Rio Grande............	Headgate Prairie Canal...	112
Sept. 21......	I. G. Ferguson..........................	Rio Grande............	¼ mile below Farmers Union Canal...........	166
Sept. 21......	I. G. Ferguson..........................	Rio Grande............	Below Headgate Rio Grande Canal..........	262

SAN JUAN AND DOLORES RIVERS DRAINAGE.

SAN JUAN RIVER AT ARBOLES.

This station, maintained by the State, is located about 1,000 feet west of Arboles and above its junction with the Piedra river.

The equipment consists of an inclined staff gauge and cable of 160 feet span with car. This equipment is the property of the State.

The bed of the stream is composed of cobbles and boulders and is probably permanent. The current has medium velocity at low stages.

The observer is L. E. Smack, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF SAN JUAN RIVER AT ARBOLES.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
Aug. 21......	I. G. Ferguson and E. O. Christiansen......	122	155	1.27	1.50	196
Sept. 22......	E. O. Christiansen......................	115.5	164	0.94	1.42	154

DISCHARGE OF SAN JUAN RIVER AT ARBOLES FOR 1910.

Drainage Area, 1,394 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									145	58	195		
2									145	58	145		
3									170	58	145		
4									170	145	145		
5									126	108	195		
6									145	82	170		
7									145	58	170		
8									126	50	145		
9									108	58	145		
10									108	58	145		
11									108	58	145		
12									95	58	145		
13									82	58	108		
14									95	58	108		
15									82	58	250		
16									82	284	170		
17									95	1,300	170		
18									95	600	145		
19									145	284	145		
20									195	284	145		
21								395	222	250	145		
22								195	195	222	126		
23								250	170	222	108		
24								250	108	195	108		
25								284	82	195	108		
26								195	82	195	145		
27								195	82	195	195		
28								126	82	170	195		
29								145	82	108	145		
30								145	58	108	145		
31								195		145			
Total								2,375	3,625	5,780	4,551		
Mean								216	121	186	152		160
Maximum								395	222	1,300	250		1,300
Minimum								126	58	50	108		50
Run-off per square mile								0.155	0.087	0.133	0.109		0.115
Run-off, depth, inches								0.063	0.097	0.153	0.122		0.435
Run-off, acre-feet								4,711	7,190	11,465	9,028		32 394
Acre-feet per square mile								3.38	5.16	8.22	6.48		23.24

PIEDRA RIVER AT ARBOLES.

This station was re-established by the State at the old United States Geological Survey gauging station in August, 1910, and is located on the Denver & Rio Grande railroad bridge near Arboles and above the junction with the San Juan river.

The equipment consists of a staff gauge fastened to right abutment of bridge and chain gauge attached to lower chord of downstream truss. Measurements are made from the bridge at high water.

The bed of the stream is composed of boulders and cobbles in mud and liable to shift in high water. The current has medium velocity at low stages. The banks are not liable to overflow.

The gauge is read by L. D. Smack, who is paid $3.00 per month.

DISCHARGE MEASUREMENTS OF PIEDRA RIVER AT ARBOLES.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Aug. 21	E. O. Christiansen and I. G. Ferguson	65	92	1.04	1.10	96
Sept. 21	E. O. Christiansen	64	112	0.80	1.04	90

DISCHARGE OF PIEDRA RIVER AT ARBOLES FOR 1910.

Drainage Area, 650 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									91	81	106		
2									86	86	111		
3									81	86	111		
4									86	101	116		
5									86	101	116		
6									81	91	116		
7									86	86	116		
8									81	86	111		
9									76	86	106		
10									76	86	106		
11									72	86	106		
12									67	86	106		
13									67	86	106		
14									67	86	106		
15									67	86	126		
16									67	142	121		
17									76	245	132		
18									76	191	126		
19									81	191	121		
20									91	191	116		
21								96	91	142	116		
22								96	96	137	116		
23								101	111	137	111		
24								106	96	137	106		
25								132	96	137	106		
26								116	86	137	106		
27								96	86	137	106		
28								91	86	126	106		
29								91	86	121	106		
30								91	76	116	91		
31								86		111			
Total								1,102	2,471	3,718	3,351		
Mean								100	82	120	112		104
Maximum								132	96	245	132		245
Minimum								86	67	81	91		67
Run-off per square mile								0.154	0.126	0.185	0.172		0.160
Run-off, depth, inches								0.063	0.141	0.214	0.192		0.610
Run-off, acre-feet								2,186	4,879	7,378	6,664		21,107
Acre-feet per square mile								3.36	7.51	11.35	10.25		32.47

LOS PINOS RIVER AT IGNACIO.

This station, maintained by the State, is located at wagon bridge near the Indian agency and one mile from Ignacio.

The equipment consists of a chain gauge attached to floor of bridge at Indian agency. Measurements are made from bridge at high water.

The bed of the stream is composed of gravel and cobbles, and shifts. Both banks are liable to overflow. The current is swift at high water.

The observer at this station is Mrs. C. J. Werner, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF LOS PINOS RIVER AT INDIAN AGENCY.

1910 Aug. 31	E. O. Christiansen, I. G. Ferguson	51	29	1.37	1.60	40
Sept. 20	E. O. Christiansen	48	41	1.32	1.70	54
Oct. 24	Christiansen & Hezmalhalch	56	77	2.01	2.35	160

DISCHARGE OF LOS PINOS RIVER AT IGNACIO FOR 1910.

Drainage Area, 450 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									43	51	126		
2									43	51	116		
3									47	56	116		
4									51	51	126		
5									47	47	116		
6									43	43	116		
7									43	47	116		
8									43	43	116		
9									36	43	98		
10									36	43	98		
11									36	43	106		
12									36	43	98		
13									36	43	98		
14									39	43	106		
15									36	43	126		
16									36	148	116		
17									36	440	126		
18									36	241	98		
19									39	226	98		
20									51	241	98		
21									51	160	98		
22									51	137	89		
23									51	148	98		
24									51	148	89		
25									51	148	98		
26									51	160	106		
27									43	160	106		
28									43	160	98		
29									47	160	98		
30									51	137	89		
31										137			
Total									1,303	3,641	3 183		
Mean									43	117	106		89
Maximum									51	440	126		440
Minimum									36	43	89		36
Run-off per square mile									0.096	0.260	0.236		0.198
Run-off, depth, inches									0.107	0.300	0.264		0.671
Run-off, acre-feet									2,559	7,194	6,307		16,060
Acre-feet per square mile									5.69	15.99	14.01		35.69

ANIMAS RIVER AT DURANGO.

This station is maintained by the State. It is located at the Rio Grande Southern R.R. bridge at Durango.

The equipment consists of a Bristol automatic gauge and chain gauge. This equipment is the property of the State.

The bed of the river is composed of cobbles and boulders, and shifts. Both banks are liable to overflow. The current is swift at all stages.

The observer is Henry Schunk, whose salary is $5.00 per month.

Owing to lack of range of gauge height between measurements daily discharges are omitted.

DISCHARGE MEASUREMENTS OF ANIMAS RIVER AT DURANGO.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Aug. 22......	I. G. Ferguson, E. O. Christiansen.........	105	190	1.67	1.55	316
Sept. 19......	E. O. Christiansen.......................	100	188	1.68	1.50	315
Nov. 3......	E. O. Christiansen and C. C. Hezmalhalch..	100	180	1.73	1.55	312

FLORIDA RIVER NEAR DURANGO.

This station is maintained by the State and was established September 18, 1910. It is located at wagon bridge at the Cash ranch about 7½ miles from Durango.

The equipment consists of a vertical staff gauge bolted to the downstream corner of the left abutment of the bridge. Measurements are made from the bridge at high water.

The bed of the stream is composed of large and small boulders and sand and is apparently permanent. The current is sluggish at low stages.

The observer is Thos. Cash, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF FLORIDA RIVER NEAR DURANGO.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Sept. 18......	E. O. Christiansen.......................	26	20	1.24	1.45	25
Oct. 25......	Christiansen & Hezmalhalch...............	28	27.2	1.44	1.70	49

DISCHARGE OF FLORIDA RIVER, NEAR DURANGO, FOR 1910.
Drainage Area, 136 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1										19	38		
2										22	38		
3										22	38		
4										22	38		
5										22	38		
6										22	34		
7										19	34		
8										19	34		
9										16	34		
10										16	34		
11										16	29		
12										16	29		
13										19	29		
14										22	29		
15										22	25		
16										49	29		
17										55	29		
18									22	49	38		
19									25	44	34		
20									29	38	29		
21									29	44	34		
22									38	49	38		
23									34	44	29		
24									29	44	29		
25									29	49	22		
26									22	49	22		
27									22	55	29		
28									22	44	29		
29									22	44	29		
30									19	44	29		
31										44			
Total									342	1,039	950		
Mean									263	34	32		32
Maximum									38	55	38		55
Minimum									19	16	22		16
Run-off per square mile									0.193	0.246	0.233		0.232
Run-off, depth, inches									0.093	0.284	0.260		0.637
Run-off, acre-feet									678	2,060	1,886		4,624
Acre-feet per square mile									4.98	15.22	13.87		34.07

WEST MANCOS RIVER NEAR MANCOS.

This station, maintained by the State, is located about 4 miles above the town of Mancos at Crane's ranch. The only equipment is a staff gauge bolted to a tree. Measurements are made by wading.

The bed of the stream is composed of large and small boulders and is liable to change in floods. Current has moderate velocity at low stages. The left bank probably overflows at high stages.

The observer is W. H. Crane, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF WEST MANCOS RIVER NEAR MANCOS.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Sept. 16	*E. O. Christiansen	18	9.2	1.02	0.62	9.3
Oct. 28	Christiansen & Hezmalhalch	21	11.8	1.03	0.72	12.1

*Station established.

DISCHARGE OF WEST MANCOS RIVER AT CRANE'S RANCH, NEAR MANCOS, FOR 1910.
Drainage Area, 46 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1										8.7	11.6		
2										8.7	11.6		
3										11.6	11.6		
4										11.6	14.7		
5										10.2	14.7		
6										8.7	14.7		
7										8.7	13.2		
8										8.7	11.6		
9										8.7	11.6		
10										8.7	11.6		
11										8.7	11.6		
12										8.7	11.6		
13										8.7	11.6		
14										8.7	11.6		
15										11.6	10.2		
16										27.4	10.2		
17										25.4	10.2		
18									8.7	18	10.2		
19									8.7	18	10.2		
20									8.7	14.7	10.2		
21									8.7	14.7	10.2		
22									8.7	13.2	10.2		
23									8.7	13.2	10.2		
24									8.7	13.2	10.2		
25									8.7	13.2	10.2		
26									8.7	13.2	10.2		
27									8.7	13.2	10.2		
28									8.7	11.6	10.2		
29									8.7	11.6	10.2		
30									8.7	11.6	10.2		
31										11.6			
Total									113	384	336		

DISCHARGE OF WEST MANCOS RIVER AT CRANE'S RANCH, NEAR MANCOS, FOR 1910—Concluded.
Drainage Area, 46 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	....	....	....	....	....	8.7	12.4	11.2	....	11.3
Maximum	....	....	....	....	....	....	....	....	8.7	27.4	14.7	....	27.4
Minimum	....	....	....	....	....	....	....	....	8.7	8.7	10.2	....	8.7
Run-off per square mile	....	....	....	....	....	....	....	....	0.189	0.270	0.243	....	0.246
Run-off, depth, inches	....	....	....	....	....	....	....	....	0.092	0.311	0.271	....	0.674
Run-off, acre-feet	....	....	....	....	....	....	....	....	224	762	666	....	1,652
Acre-feet per square mile	....	....	....	....	....	....	....	....	4.87	16.57	14.48	....	35.92

DOLORES RIVER AT DOLORES.

This station is maintained by the State. It is located about one-fourth mile southwest of the railroad station at Dolores.

The equipment consists of a staff gauge bolted to wing wall of left abutment of bridge and an automatic gauge which was installed November 1, 1910.

The bed of the stream consists of sand, cobbles and boulders and is probably permanent. The current is sluggish at low stages. The left bank is liable to overflow.

The observer is Beulah B. Hughes, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF DOLORES RIVER AT DOLORES.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Aug. 27	I. G. Ferguson, E. O. Christiansen	43.5	54	1.42	2.35	76
Sept. 14	E. O. Christiansen	43	63	1.61	2.49	101
Nov. 1	Christiansen & Hezmalhalch	46	61	1.62	2.48	98

DISCHARGE OF DOLORES RIVER AT DOLORES FOR 1910.
Drainage Area, 524 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1									84	69	102		
2									76	102	102		
3									93	102	102		
4									121	84	112		
5									102	84	112		
6									93	84	102		
7									84	69	93		
8									69	69	84		
9									69	69	93		
10									69	69	84		
11									69	69	93		
12									69	69	93		
13									76	69	84		
14									93	69	84		
15									84	84	93		
16									84	242	93		
17									84	291	93		
18									76	184	84		
19									84	184	93		
20									93	184	76		
21									131	121	62		
22									141	121	69		
23									93	121	84		
24									84	121	93		
25									84	121	93		
26									69	121	93		
27								69	69	121	84		
28								55	69	112	69		
29								69	69	102	69		
30								69	69	102	93		
31								84		102			
Total								346	2,550	3,511	2,681		
Mean								69	85	113	89		95
Maximum								84	141	291	112		291
Minimum								55	69	69	62		55
Run-off per square mile								0.132	0.162	0.216	0.170		0.181
Run-off, depth, inches								0.025	0.181	0.249	0.190		0.645
Run-off, acre-feet								686	5,058	6,964	5,318		18,026
Acre-feet per square mile								1.31	9.65	13.29	10.15		34.40

SAN MIGUEL RIVER AT PLACERVILLE.

This station is maintained by the State and is located about three-quarters of a mile below Placerville.

The equipment consists of a vertical staff gauge bolted to the left abutment of wagon bridge. Measurements are made from the bridge at high water.

The bed of the stream is composed of coarse gravel, cobbles and boulders and is permanent. The current is swift.

The observer is John E. Stanquist, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF SAN MIGUEL RIVER AT PLACERVILLE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Sept. 13......	E. O. Christiansen........................	31.5	61	3.00	1.05	183
Oct. 30......	Christiansen & Hezmalhalch...............	31	45	2.10	0.60	95

DISCHARGE OF SAN MIGUEL RIVER AT PLACERVILLE FOR 1910.
Drainage Area, 304 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1										95	103		
2										120	111		
3										103	111		
4										111	111		
5										95	103		
6										95	103		
7										95	103		
8										95	103		
9										95	103		
10										95	103		
11										95	103		
12										95	95		
13									171	95	95		
14									140	103	95		
15									140	103	95		
16									130	245	95		
17									111	194	88		
18									130	160	95		
19									120	150	95		
20									140	140	88		
21									140	130	88		
22									130	120	88		
23									120	130	95		
24									111	140	95		
25									111	130	88		
26									103	130	88		
27									111	130	80		
28									103	120	65		
29									95	111	80		
30									95	111	80		
31										111			
Total									2,201	3,742	2,845		
Mean									122	121	95		111
Maximum									171	245	111		245
Minimum									95	95	65		65
Run-off per square mile									0.401	0.398	0.312		0.365
Run-off, depth, inches									0.268	0.459	0.348		1.075
Run-off, acre-feet									4,366	7,423	5,643		17,432
Acre-feet per square mile									14.36	24.42	18.56		57.35

YAMPA AND WHITE RIVERS DRAINAGE.

YAMPA RIVER AT YAMPA.

This station is maintained by the State and is located at Yampa on bridge from town to Denver, Northwestern and Pacific railroad.

The equipment consists of a staff gauge spiked to upstream side of foot bridge. Measurements are made at wagon bridge about 200 feet above gauge.

The bed of the stream is composed of cobbles and boulders. The left bank is liable to overflow. The current is swift and flows at an angle with bridge.

The gauge is read by O. D. Sibbald, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF YAMPA RIVER AT YAMPA.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Mch. 10......	C. L. Chatfield..........................	14	12.7	1.69	....	21.5
May 17......	C. L. Chatfield..........................	15	22	3.68	2.00	81
July 9......	C. L. Chatfield..........................	7.5	3.71	0.54	0.90	2.00
July 26......	C. L. Chatfield..........................	....	1.00	1.10	0.70	1.10
Aug. 2......	C. L. Chatfield..........................	....	4.95	0.87	1.00	4.00
Sept. 16......	C. L. Chatfield..........................	19.5	14	1.50	1.50	21.0
Oct. 14......	C. L. Chatfield..........................	15.5	7.17	0.69	1.08	4.92
Nov. 17......	C. L. Chatfield..........................	22	13.7	1.68	1.47	23

DISCHARGE OF YAMPA RIVER AT YAMPA FOR 1910.
Drainage Area, 52 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	....	80	2.6	1.8	26	9	17	....	
2	....	....	....	....	....	92	1.8	3.5	22	11	17	....	
3	....	....	....	....	....	80	2.6	3.5	20	9	15	....	
4	....	....	....	....	....	62	3.5	3.5	22	9	17	....	
5	....	....	....	....	....	56	2.6	3.5	22	7.5	20	....	
6	....	....	....	....	....	62	1.8	9	22	9	17	....	
7	....	....	....	....	....	62	1.8	20	22	7.5	17	....	
8	....	....	....	....	....	62	1.2	20	22	6	17	....	
9	....	....	....	....	....	56	1.8	22	26	6	15	....	
10	....	....	....	....	....	62	1.8	22	29	7.5	17	....	
11	....	....	....	....	....	56	1.8	26	29	6	17	....	
12	....	....	....	....	....	62	1.2	22	34	9	17	....	
13	....	....	....	....	....	71	1.2	22	29	9	22	....	
14	....	....	....	....	....	80	0.7	22	29	11	22	....	
15	....	....	....	....	....	80	0.7	20	29	9	17	....	
16	....	....	....	....	....	80	0.7	22	29	13	17	....	
17	....	....	....	....	62	49	0.7	22	29	11	15	....	
18	....	....	....	....	62	56	0.7	22	34	13	13	....	
19	....	....	....	....	80	49	0.7	22	29	13	15	....	
20	....	....	....	....	104	38	0.7	26	34	15	13	....	
21	....	....	....	....	80	29	0.2	22	29	13	15	....	
22	....	....	....	....	104	26	0.2	22	26	13	13	....	
23	....	....	....	....	62	22	0.4	22	22	15	17	....	
24	....	....	....	....	62	20	0.2	22	22	13	17	....	
25	....	....	....	....	80	9	0.2	22	17	17	17	....	
26	....	....	....	....	71	4.8	0.2	20	17	17	20	....	

DISCHARGE OF YAMPA RIVER AT YAMPA FOR 1910—Concluded.
Drainage Area, 52 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
27	....	....	....	....	62	3.5	0.2	22	15	17	17	....	
28	....	....	....	....	71	3.5	0.4	22	15	17	22	....	
29	....	....	....	....	71	3.5	1.2	22	13	17	20	....	
30	....	....	....	....	62	3.5	1.8	22	9	17	17	....	
31	....	....	....	....	62	....	1.8	22	....	17	....	....	
Total	....	....	....	....	1,095	1,420	37.4	574.8	723	363.5	512	....	
Mean	....	....	....	....	73	47.3	1.2	18.5	24.1	11.7	17.1	....	23.9
Maximum	....	....	....	....	104	92	3.5	26	34	17	22	....	104
Minimum	....	....	....	....	62	3.5	0.2	1.8	9	6	13	....	0.2
Run-off, per square mile	....	....	....	....	1.404	0.910	0.023	0.356	0.463	0.225	0.329	....	0.460
Run-off, depth, inches	....	....	....	....	0.784	1.015	0.026	0.410	0.517	0.259	0.367	....	3.378
Run-off, acre-feet	....	....	....	....	2,172	2,814	74	1,138	1,434	719	1,018	....	9,369
Acre-feet per square mile	....	....	....	....	41.77	54.12	1.42	21.88	27.58	13.83	19.58	....	180.18

YAMPA RIVER AT STEAMBOAT SPRINGS.

This station is maintained by the State and is located at the lower steel bridge at Denver, Northwestern and Pacific railroad depot at Steamboat Springs.

The equipment consists of a chain gauge and automatic gauge. Measurements are made at steel bridge between the depot and town.

The bed of the stream is composed of cobbles and boulders and is permanent. The current is swift and is open most of the winter, due to hot springs flowing into river above. Both banks are high and not liable to overflow.

The observer is Dr. L. G. Blackmer, whose salary is $3.00 per month.

DISCHARGE MEASUREMENTS OF YAMPA RIVER AT STEAMBOAT SPRINGS.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Mch. 3	*†C. L. Chatfield	80	93	1.29	0.20	120
Mch. 8	C. L. Chatfield	105	163	1.96	0.80	319
Apr. 10	C. L. Chatfield	112	234	3.04	1.45	713
May 12	C. L. Chatfield	108	420	5.81	3.30	2,441
May 18	C. L. Chatfield	108	317	4.37	2.30	1,385
June 30	C. L. Chatfield	95	124	1.74	0.60	216
Aug. 3	C. L. Chatfield	82	88	1.20	0.15	106
Oct. 10	*Chatfield & Hezmalhalch	65	99	0.77	0.03	78
Dec. 10	‡C. L. Chatfield	82.5	95	1.23	0.22	117

*Wading. †Station established. ‡New Gauge 1.20.

DISCHARGE OF YAMPA RIVER AT STEAMBOAT SPRINGS FOR 1910.

Drainage Area, 572 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	120	675	1,050	2,560	239	130	93	93	143	....	
2	....	....	120	745	1,130	2,500	239	130	93	93	171	....	
3	....	....	120	605	1,300	2,440	239	105	93	73	221	....	
4	....	....	159	572	1,300	2,262	239	93	83	93	203	....	
5	....	....	198	640	1,475	2,035	221	105	73	57	157	....	
6	....	....	238	640	1,475	1,928	187	117	83	51	117	....	
7	....	....	278	675	1,660	1,770	203	130	83	65	157	....	
8	....	....	323	675	1,770	1,565	171	157	83	83	187	....	
9	....	....	347	710	1,875	1,300	117	171	83	117	157	....	
10	....	....	323	675	2,148	1,172	105	143	73	105	117	....	
11	....	....	259	675	2,380	1,090	93	143	93	105	105	....	
12	....	....	259	675	2,380	1,010	117	143	83	93	93	....	
13	....	....	301	640	2,148	932	105	157	65	93	117	....	
14	....	....	323	572	2,035	820	105	171	105	93	117	....	
15	....	....	347	540	1,980	710	93	171	130	105	117	....	
16	....	....	397	605	1,660	675	105	157	171	130	117	....	
17	....	....	397	605	1,520	675	93	157	187	143	117	....	
18	....	....	451	675	1,475	605	93	157	203	157	117	....	
19	....	....	510	745	1,565	510	93	143	203	130	130	....	
20	....	....	572	820	1,565	451	93	143	203	117	117	....	
21	....	....	640	858	1,475	423	105	143	221	93	117	....	
22	....	....	710	895	1,385	347	105	157	187	93	117	....	
23	....	....	820	970	1,385	301	105	171	157	130	117	....	
24	....	....	745	970	1,565	279	93	171	130	157	117	....	
25	....	....	710	932	1,770	259	83	117	130	203	117	....	
26	....	....	675	970	1,822	259	93	93	83	221	130	....	
27	....	....	675	970	1,875	259	83	105	65	117	130	....	
28	....	....	640	932	2,320	259	83	93	65	93	130	....	
29	....	....	540	970	2,500	239	117	93	65	93	130	....	
30	....	....	572	970	2,622	239	171	93	65	93	143	....	
31	....	....	640	....	2,685	....	157	93	....	130	....		
Total	....	....	13,409	22,601	55,295	29,874	4,145	4,152	3,451	3,419	4,025	....	
Mean	....	....	433	753	1,784	996	134	134	115	110	134	....	510
Maximum	....	....	820	970	2,685	2,560	239	171	221	221	221	....	2,685
Minimum	....	....	120	540	1,050	239	83	93	65	51	93	....	51
Run-off per square mile	....	....	0.757	1.316	3.119	1.741	0.234	0.234	0.201	0.192	0.234	....	0.892
Run-off, depth, inches	....	....	0.873	1.469	3.596	1.942	0.270	0.270	0.224	0.221	0.261	....	9.126
Run-off, acre-feet	....	....	26,624	44,807	109,694	59,266	8,239	8,239	6,843	6,764	7,974	....	278,450
Acre-feet per square mile	....	....	46.55	78.31	191.78	103.60	14.39	14.39	11.96	11.81	13.86	....	486.65

YAMPA RIVER AT CRAIG.

This station is maintained by the State. It is located about one mile south of Craig on a steel highway bridge on road to Hamilton.

The equipment consists of a staff gauge bolted to old pile at south end of bridge. Measurements are made from 3-span bridge 210 feet long.

The bed of the stream is composed of sand and gravel. Both banks are liable to overflow at high water. The current is swift at high water and sluggish at low stages.

The observer is W. E. Pratt, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF YAMPA RIVER AT CRAIG.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 15	C. L. Chatfield	152.4	962	2.97	4.85	2,857
May 21	C. L. Chatfield	162.4	1,113	3.05	5.30	3,392
June 10	C. L. Chatfield	151.5	1,030	2.89	4.90	2,980
Aug. 12	C. L. Chatfield		695	0.20	2.30	138
Sept. 4	*C. L. Chatfield	75	59	2.46	2.30	145
Oct. 24	*C. L. Chatfield	95	106	2.43	2.50	258

*Wading.

DISCHARGE OF YAMPA RIVER AT CRAIG FOR 1910.
Drainage Area, 1,730 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1				1,740	5,120	5,870	662	292	95	200	260		
2				1,860	4,505	5,435	620	230	145	200	292		
3				2,320	3,745	5,330	580	230	145	260	260		
4				2,250	3,480	5,015	580	200	145	360	260		
5				1,860	3,568	4,405	502	230	395	360	260		
6				1,620	3,655	4,210	360	145	330	292	260		
7				1,680	3,395	4,020	325	200	292	292	230		
8				1,800	3,310	3,480	292	200	230	260	200		
9				1,860	3,568	3,310	260	120	200	260	260		
10				2,182	4,405	2,755	200	145	172	230	260		
11				2,680	5,435	2,608	200	120	200	200	260		
12				2,908	5,650	2,462	172	172	172	230	260		
13				3,065	5,330	2,462	145	172	200	200	260		
14				3,310	5,120	2,390	120	172	230	172	260		
15				2,908	4,810	2,182	145	200	292	145	260		
16				2,182	4,405	1,922	172	172	360	200	260		
17				2,115	3,655	1,922	120	172	292	260	292		
18				2,462	3,395	1,800	145	145	325	360	325		
19				2,462	3,228	1,740	120	145	260	465	325		
20				3,310	3,395	1,505	120	172	260	360	325		
21				4,210	3,480	1,450	120	172	230	360	292		
22				3,745	3,145	1,340	120	172	230	292	292		
23				3,480	2,830	1,232	120	145	230	292	360		
24				3,835	2,985	1,180	120	145	260	325	395		
25				4,308	3,395	1,025	95	200	260	325	325		
26				4,605	3,928	835	72	145	230	325	325		
27				5,015	3,928	662	72	120	200	325	325		
28				5,330	4,505	662	120	120	200	325	292		
29				5,650	5,435	705	200	120	200	292	325		
30				5,542	5,650	705	292	95	200	292	325		
31					5,650		172	120		260			
Total				92,294	128,105	74,619	7,343	5,188	6,980	8,719	8,625		
Mean				3,076	4,132	2,487	237	167	233	281	288		1,360
Maximum				5,650	5,650	5,870	662	292	360	465	325		5,870
Minimum				1,740	2,830	662	72	95	95	145	260		72
Run-off per square mile				1.778	2.388	1.438	0.137	0.097	0.135	0.162	0.166		0.786
Run-off, depth, inches				1.984	2.753	1.605	0.158	0.112	0.151	0.187	0.185		7.135
Run-off, acre-feet				183,062	254,092	148,004	14,565	10,290	13,845	17,294	17,107		658,259
Acre-feet per square mile				105.82	146.87	85.55	8.42	5.95	8.00	10.00	9.89		380.50

YAMPA RIVER NEAR MAYBELL.

This station, maintained by the State, is located 9 miles below Maybell at the Thornburg bridge.

The equipment consists of a chain gauge located on bridge. Measurements are made from bridge.

The bed of the stream is composed of cobbles and gravel and is permanent. The current has a medium velocity. The left bank overflows at extreme high water.

The gauge is read by Peter E. Farrell, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF YAMPA RIVER NEAR MAYBELL.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 June 12......	C. L. Chatfield........................	....	1,038	3.00	3.90	3,119
Aug. 27......	C. L. Chatfield........................	80	66	2.41	0.40	159
Sept. 1......	C. L. Chatfield........................	77	63	2.18	0.35	137
Oct. 27......	C. L. Chatfield........................	120	117	2.72	0.85	319

DISCHARGE OF YAMPA RIVER NEAR MAYBELL FOR 1910.
Drainage Area, 3,670 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1							860	253	126	138	214		
2							820	197	138	126	234		
3							792	166	126	138	274		
4							755	151	116	126	234		
5							985	166	126	151	197		
6							942	180	151	166	180		
7							820	151	151	180	197		
8							685	138	166	151	214		
9							618	126	126	138	234		
10							496	116	126	126	214		
11							496	105	151	126	197		
12						4,340	415	126	138	138	180		
13						2,750	364	126	126	151	165		
14						2,180	318	138	151	151	197		
15						2,400	318	126	180	138	214		
16						2,690	389	151	166	151	234		
17						2,750	389	151	166	166	253		
18						2,572	340	138	180	214	274		
19						2,235	318	138	151	295	214		
20						2,125	295	126	197	318	197		
21						2,070	253	138	166	340	214		
22						1,850	234	126	197	468	234		
23						1,640	214	126	138	441	214		
24						1,492	180	126	151	318	253		
25						1,350	166	116	138	274	253		
26						1,350	151	126	166	295	274		
27						1,120	214	126	126	295	253		
28						1,120	234	138	166	274	234		
29						985	253	126	180	253	295		
30						985	318	138	214	234	340		
31							318	126		214			
Total						38,004	13,950	4,381	4,600	6,694	6,470		

DISCHARGE OF YAMPA RIVER NEAR MAYBELL FOR 1910—Concluded.
Drainage Area 3,670 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	....	....	2,000	450	141	153	216	216	....	431
Maximum	....	....	....	....	....	4,340	985	253	214	468	340	....	4,340
Minimum	....	....	....	....	....	985	151	105	116	126	165	....	105
Run-off per square mile	....	....	....	....	....	0.545	0.123	0.038	0.042	0.059	0.059	....	0.117
Run-off, depth inches	....	....	....	....	....	0.385	0.142	0.044	0.047	0.068	0.066	....	0.752
Run-off, acre-feet	....	....	....	....	....	75,372	27,669	8,670	9,104	13,281	12,853	....	146,949
Acre-feet per square mile	....	....	....	....	....	20.54	7.56	2.34	2.50	3.63	3.51	....	40.08

SODA CREEK AT STEAMBOAT SPRINGS.

This station is maintained by the State and located at road bridge on Main street, Steamboat Springs.

The equipment consists of a chain gauge on bridge from which measurements are made.

The bed of the stream is permanent and composed of cobbles. The current is swift and the left bank overflows at extreme stages.

The gauge was read gratis by J. E. Milner.

DISCHARGE MEASUREMENTS OF SODA CREEK AT STEAMBOAT SPRINGS.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 May 18	C. L. Chatfield	35	36	3.00	1.95	107
June 8	C. L. Chatfield	37	45	4.02	2.15	181
June 30	C. L. Chatfield	27	19	1.42	1.15	27
Aug. 3	C. L. Chatfield	....	3.25	0.37	0.62	1.20

NOTE.—Gunn Creek tributary to Soda Creek carries about one-third amount at Soda Creek Station.

DISCHARGE OF SODA CREEK AT STEAMBOAT SPRINGS FOR 1910.
Drainage Area, 47 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1							26	1.6	2	2	3.7		
2							24	1.2	2	2	3.7		
3							22	1.2	2	2	3.7		
4							20	1.2	2	2	3.7		
5							18	3.1	2	2	3.7		
6							16	3.1	2	2	3.7		
7							14	1.2	2	2	3.7		
8						262	12	1.2	2	2	3.7		
9						160	12	1.2	2	2	3.7		
10						98	13	1.2	2	2	3.7		
11						121	9	1.2	2	2	3.7		
12						98	11	5	2	2	3.5		
13						90	9	5	2	2	3.7		
14						82	7	1.2	2	2	3.7		
15						69	5	2	2	2	3.7		
16						64	5	2	2	2	3.5		
17						59	5	2	2	2	3.7		
18						59	5	2	2	2	4.0		
19						59	5	2	2	2	3.7		
20						64	4	2	2	2	3.7		
21						50	4	2	2	2	3.7		
22						50	4	2	2	2	3.7		
23						35	3.1	2	2	2	3.7		
24						42	3.1	2	2	2	3.7		
25						35	3.1	2	2	2	3.7		
26						38	3.1	2	2	2	3.7		
27						29	3.1	2	2	2	3.7		
28						23	2.5	2	2	2	3.7		
29						29	2.5	2	2	2	3.7		
30						26	2.0	2	2	2	3.7		
31							2.0	2		2			
Total						1,642	274.5	62	60	62	110.9		
Mean						71	8.9	2	2	2	3.7		12.6
Maximum						262	26	5	2	2	4		262
Minimum						23	2	1.2	2	2	3.5		2
Run-off per square mile						1.511	0.189	0.043	0.043	0.043	0.079		0.267
Run-off, depth, inches						1.293	0.218	0.050	0.048	0.050	0.088		1.747
Run-off, acre-feet						3,239	547	123	119	123	220		4,371
Acre-feet per square mile						68.93	11.62	2.64	2.56	2.64	4.70		93.09

TROUT CREEK AT PINNACLE.

This station, located ¼ mile above Pinnacle post office, is maintained in co-operation with the Williams River Highline Irrigation Company. This company pays the traveling expenses of hydrographer in making measurements at this point and the salary of the observer.

The equipment consists of a staff gauge driven into creek bed and braced to tree. Measurements are usually made by wading.

The bed of the stream is composed of gravel and boulders. The current is swift.

The observer is Mrs. D. M. Chapman, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF TROUT CREEK AT PINNACLE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 9	C. L. Chatfield	16	13.2	1.06	1.80	13.9
May 15	C. L. Chatfield	23.5	25	2.88	2.35	72
July 22	C. L. Chatfield	18	11.8	1.18	1.85	13.8
Aug. 9	C. L. Chatfield	18.5	12.2	1.12	1.90	13.8
Oct. 21	C. L. Chatfield	19.5	19.0	1.16	1.95	22.0

DISCHARGE OF TROUT CREEK AT PINNACLE FOR 1910.
Drainage Area, 27 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	......	......	......	......	55	316	42	18	12	12	4	......	
2	......	......	......	......	36	233	36	15	12	12	4	......	
3	......	......	......	......	42	264	36	15	18	12	2	......	
4	......	......	......	......	42	233	36	18	26	12	2	......	
5	......	......	......	......	36	233	31	18	18	12	2	......	
6	......	......	......	......	42	264	62	18	12	9	6	......	
7	......	......	......	......	48	264	55	18	12	6	9	......	
8	......	......	......	......	62	248	26	12	12	6	6	......	
9	......	......	......	12	71	218	26	15	9	6	6	......	
10	......	......	......	12	78	188	26	15	9	6	6	......	
11	......	......	......	18	132	173	26	18	12	6	6	......	
12	......	......	......	18	79	173	18	26	15	6	9	......	
13	......	......	......	18	62	173	18	22	22	6	12	......	
14	......	......	......	18	79	159	18	18	26	6	12	......	
15	......	......	......	18	79	145	18	18	22	6	12	......	
16	......	......	......	15	79	109	18	18	15	6	9	......	
17	......	......	......	15	62	98	18	18	12	6	12	......	
18	......	......	......	18	55	88	18	18	18	6	9	......	
19	......	......	......	22	62	88	18	18	15	6	12	......	
20	......	......	......	26	62	98	18	18	12	6	15	......	
21	......	......	......	26	62	79	15	18	12	6	18	......	
22	......	......	......	22	62	79	15	15	12	9	18	......	
23	......	......	......	22	62	62	15	12	12	9	12	......	
24	......	......	......	31	62	62	15	12	12	9	18	......	
25	......	......	......	48	70	62	12	12	12	9	12	......	
26	......	......	......	55	79	48	12	12	12	6	12	......	
27	......	......	......	55	98	48	12	12	12	6	12	......	
28	......	......	......	62	202	55	18	12	12	6	12	......	
29	......	......	......	62	233	48	26	12	12	12	12	......	
30	......	......	......	62	299	48	26	12	12	9	12	......	
31	......	......	......	......	354	......	22	12	......	6	......	......	
Total	......	......	......	655	2,846	4,356	752	495	429	240	293	......	
Mean	......	......	......	30	92	145	24	16	14	7.7	9.8	......	42.7
Maximum	......	......	......	62	354	316	42	26	26	18	36	......	354
Minimum	......	......	......	12	36	48	12	12	9	6	2	......	2
Run-off per square mile	......	......	......	1.111	3.407	5.370	0.889	0.592	0.518	0.285	0.370	......	1.582
Run-off, depth, inches	......	......	......	0.909	3.928	5.991	1.025	0.682	0.578	0.329	0.413	......	13.855
Run-off, acre-feet	......	......	......	1,299	5,657	8,628	1,476	984	833	474	0.583	......	19,934
Acre-feet per square mile	......	......	......	48.11	209.52	319.56	54.67	36.44	30.85	17.52	22.02	......	738.69

FISH CREEK AT DUNKLEY.

This station is maintained in co-operation with the Williams River Highline Irrigation Company, which pays the traveling expenses of the hydrographer in making measurements and the salary of the observer.

It is located on wagon bridge ¼ mile below Dunkley's ranch.

The equipment consists of a staff gauge driven into bed of stream and braced to bank.

The bed of the stream is composed of sand, gravel and mud and is permanent.

The observer is R. S. Bird, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF FISH CREEK AT DUNKLEY.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 8......	C. L. Chatfield..........................	10.5	8.0	2.31	2.60	18.5
May 15......	C. L. Chatfield..........................	16	23.5	2.17	4.02	51
July 21......	C. L. Chatfield..........................	....	1.24	0.97	1.80	1.20
Oct. 22......	C. L. Chatfield..........................	12	3.6	1.65	2.22	5.04

DISCHARGE OF FISH CREEK AT DUNKLEY FOR 1910.

Drainage Area, 29 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1..............................	....	....	....	....	70	33.5	6	3.2	2.2	3.2	6.7	....	
2..............................	....	....	....	....	65	31	5	3.2	2.2	4.9	5.5	....	
3..............................	....	....	....	....	68.5	26	6	3.2	3.2	5.5	5.5	....	
4..............................	....	....	....	....	84	23	7	3.2	6.7	4.3	5.5	....	
5..............................	....	....	....	....	68.5	19	6	3.2	6.1	4.9	5.5	....	
6..............................	....	....	....	....	70	16.5	4.5	2.7	4.3	4.3	4.3	....	
7..............................	....	....	....	....	58	16	4.5	3.2	3.2	4.9	5.5	....	
8..............................	....	....	....	19	67	15	4	3.2	3.2	3.8	5.5	....	
9..............................	....	....	....	20	65	16	4	2.2	3.2	5.5	6.7	....	
10..............................	....	....	....	24	82	15	4	3.2	2.2	5.5	5.5	....	
11..............................	....	....	....	28	128	14	2.5	2.7	2.2	5.5	5.5	....	
12..............................	....	....	....	31	131	11.5	2.5	3.2	3.2	5.5	5.5	....	
13..............................	....	....	....	30	121	12	2.5	2.2	3.2	5.5	5.5	....	
14..............................	....	....	....	28	102	12	3	2.2	3.2	5.5	6.7	....	
15..............................	....	....	....	21	76	11	2.5	3.2	3.2	5.5	5.5	....	
16..............................	....	....	....	19.5	43.5	10	2.2	3.2	3.2	7.4	5.5	....	
17..............................	....	....	....	21	43.5	10	2.7	2.2	3.2	8.0	6.7	....	
18..............................	....	....	....	28	38.5	10	2.2	2.2	3.2	6.7	4.9	....	
19..............................	....	....	....	35	47	9.5	2.2	2.2	4.3	5.5	6.7	....	
20..............................	....	....	....	61.5	35	9	2.2	2.2	3.2	5.5	6.7	....	
21..............................	....	....	....	63	33.5	8	2.2	3.2	3.2	4.3	5.5	....	
22..............................	....	....	....	43.5	37	8	2.2	2.7	3.2	3.2	5.5	....	
23..............................	....	....	....	48.5	35	8	2.2	2.2	2.7	4.3	5.5	....	
24..............................	....	....	....	63	35	7.5	2.2	2.2	3.2	3.8	5.5	....	
25..............................	....	....	....	82	35	7	2.2	2.2	3.2	4.3	5.5	....	
26..............................	....	....	....	111	40	6.5	2.2	2.2	3.2	4.3	5.5	....	
27..............................	....	....	....	121	35	6.5	2.2	2.7	3.2	3.2	5.5	....	
28..............................	....	....	....	121	45	7	4.3	2.2	3.2	4.3	6.1	....	
29..............................	....	....	....	131	37	7	6.7	2.7	3.2	4.3	6.7	....	
30..............................	....	....	....	84	36	7	8.6	2.2	3.2	6.7	5.5	....	
31..............................	....	....	....	....	33.5	....	3.2	2.2	....	6.1	....	....	
Total..........................	....	....	....	1,234	1,866	392	155.0	82.7	100	156	172	....	

DISCHARGE OF FISH CREEK AT DUNKLEY FOR 1910—Concluded.
Drainage Area, 29 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	54	60	13	5.0	2.7	3.3	5.1	5.7	....	18
Maximum	....	....	....	131	131	33.5	8.6	3.2	6.7	8	6.7	....	131
Minimum	....	....	....	19	33.5	6.5	2.2	2.2	2.2	3.2	4.3	....	2.2
Run-off per square mile	....	....	....	1.862	2.069	0.448	0.172	0.093	0.114	0.176	0.197	....	0.608
Run-off, depth, inches	....	....	....	1.593	2.385	0.500	0.198	0.107	0.127	0.203	0.220	....	5.333
Run-off, acre-feet	....	....	....	2,463	3,689	774	307	166	196	314	339	....	8,248
Acre-feet per square mile	....	....	....	84.94	127.22	26.66	10.58	5.72	6.78	10.82	11.72	....	284.44

ELK RIVER NEAR CLARK.

This station, established May 1, 1910, and maintained by the Elk River Canal Company, is located at Kinney's ranch about 19½ miles from Steamboat Springs and two miles from Clark post office.

Discharge measurements have been made by the State.

The equipment consists of a gauge similar to the standard chain gauge.

The bed of the stream is composed of boulders and results are defined as rough.

The observer is Geo. B. Kinney.

DISCHARGE MEASUREMENTS OF ELK RIVER NEAR CLARK.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sb. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 July 12......	C. L. Chatfield...........................	53	90	1.84	2.60	166
Nov. 15......	C. L. Chatfield...........................	48	52	1.15	1.90	57

DISCHARGE OF ELK RIVER NEAR CLARK FOR 1910.
Drainage Area, 213 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	1,865	1,640	300	125	36	57	57	....	
2	....	....	....	....	1,370	1,750	238	125	36	57	57	....	
3	....	....	....	....	1,250	1,985	212	125	36	57	57	....	
4	....	....	....	....	1,165	2,115	212	125	36	57	57	....	
5	....	....	....	....	1,435	1,535	212	125	36	57	57	....	
6	....	....	....	....	1,165	1,435	188	125	36	57	57	....	
7	....	....	....	....	1,005	1,640	188	125	36	57	57	....	
8	....	....	....	....	300	2,850	165	125	36	57	57	....	
9	....	....	....	....	300	725	165	93	36	57	57	....	
10	....	....	....	....	300	860	165	93	36	57	57	....	
11	....	....	....	....	505	725	165	93	36	57	57	....	
12	....	....	....	....	505	790	144	68	36	57	57	....	
13	....	....	....	....	505	725	144	68	36	57	57	....	
14	....	....	....	....	1,250	1,085	144	57	36	57	57	....	
15	....	....	....	....	665	725	125	57	36	57	57	....	
16	....	....	....	....	725	860	125	46	36	57	57	....	
17	....	....	....	....	725	610	144	57	36	57	57	....	
18	....	....	....	....	790	610	144	68	36	57	57	....	
19	....	....	....	....	725	555	144	68	36	57	57	....	
20	....	....	....	....	665	505	144	68	36	57	57	....	
21	....	....	....	....	610	460	144	57	36	57	57	....	
22	....	....	....	....	790	375	144	46	36	57	57	....	
23	....	....	....	....	860	375	125	57	36	57	57	....	
24	....	....	....	....	1,340	375	125	57	36	57	57	....	
25	....	....	....	....	1,435	335	125	68	36	57	57	....	
26	....	....	....	....	1,535	375	125	68	36	57	57	....	
27	....	....	....	....	1,640	375	125	57	36	57	57	....	
28	....	....	....	....	1,865	335	125	57	36	57	57	....	
29	....	....	....	....	1,985	375	125	46	36	57	57	....	
30	....	....	....	....	1,865	335	125	57	36	57	57	....	
31	....	....	....	....	1,750	....	125	68	....	57	....	....	
Total	....	....	....	....	32,860	27,440	4,881	2,414	1,080	1,767	1,710	....	
Mean	....	....	....	....	1,060	915	157	78	36	57	57	....	342
Maximum	....	....	....	....	1,985	2,850	300	125	36	57	57	....	2,850
Minimum	....	....	....	....	300	335	125	46	36	57	57	....	36
Run-off per square mile	....	....	....	....	4.976	4.298	0.733	0.366	0.169	0.268	0.268	....	1.606
Run-off, depth, inches	....	....	....	....	5.737	4.796	0.845	0.422	0.189	0.309	0.299	....	12.597
Run-off, acre-feet	....	....	....	....	65,177	54,446	9,654	4,796	2,142	3,505	3,392	....	143,112
Acre-feet per square mile	....	....	....	....	306.00	255.62	45.32	22.52	10.06	16.45	15.92	....	671.89

ELK RIVER AT TRULL.

This station is maintained by the State, and is located about two miles southeast of Trull, on road between Steamboat Springs and Hayden.

The equipment consists of a chain gauge. Measurements are made from steel bridge.

The bed of the stream is composed of boulders and cobbles. The current is very swift at high water.

The observer until November, 1910, was H. W. Laisy; after November, 1910, Fred O. Smith. The salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF ELK RIVER AT TRULL.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 11	C. L. Chatfield	115	267	3.65	7.00	976
May 12	C. L. Chatfield	115	454	5.03	8.50	2,284
June 7	C. L. Chatfield	115	378	4.33	7.88	1,636
July 11	C. L. Chatfield	85	109	1.99	5.55	216
Sept. 12	C. L. Chatfield	69	72	1.26	5.02	90
Nov. 12	C. L. Chatfield	68	70	1.16	5.05	81

DISCHARGE OF ELK RIVER AT TRULL FOR 1910.

Drainage Area, 415 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1				405	1,850	2,530	405	180	57	73	91		
2				560	1,565	2,405	382	165	61	73	91		
3				560	1,320	2,228	338	140	73	103	82		
4				405	1,360	2,060	315	115	315	91	82		
5				382	1,565	1,850	405	115	212	91	67		
6				455	1,360	1,750	315	115	140	82	67		
7				505	1,210	1,850	292	91	115	82	73		
8				560	1,245	1,750	250	91	91	82	73		
9				730	1,480	1,565	230	91	82	82	91		
10				910	1,955	1,360	195	82	73	82	82		
11				1,040	2,285	1,360	195	82	73	82	73		
12				1,245	2,285	1,400	165	91	103	73	73		
13				1,320	2,170	1,440	152	103	152	73	73		
14				1,320	1,850	1,320	165	103	195	73	73		
15				975	1,750	1,245	140	103	140	73	73		
16				790	1,400	1,175	140	91	115	73	73		
17				790	1,245	1,040	152	73	103	115	73		
18				1,040	1,175	1,008	152	73	103	128	73		
19				1,320	1,282	975	140	73	91	115	91		
20				1,565	1,320	910	165	67	91	91	61		
21				1,610	1,400	850	140	73	91	91	73		
22				1,282	1,140	790	140	73	91	91	91		
23				1,360	1,105	670	140	73	91	91	82		
24			480	1,655	1,245	615	115	61	91	91	91		
25			642	1,850	1,440	560	103	61	82	91	91		
26			670	1,955	1,750	505	115	61	82	91	73		
27			560	2,170	1,565	505	103	57	82	91	91		
28			505	2,405	2,115	505	165	61	82	91	73		
29			455	2,405	2,530	505	212	61	73	73	82		
30			315	2,170	2,530	505	195	61	73	82	82		
31			360		2,592		165	57		91			
Total			3,987	35,739	50,984	37,231	6,286	2,763	3,223	2,711	2,364		
Mean			498	1,191	1,645	1,241	203	89	107	87	79		576
Maximum			642	2,405	2,592	2,530	405	180	315	128	91		2,592
Minimum			315	382	1,105	505	103	57	57	73	73		57
Run-off per square mile			1.200	2.870	3.964	2.990	0.489	0.214	0.258	0.210	0.190		1.389
Run-off, depth, inches			0.357	3.202	4.570	3.336	0.564	0.247	0.288	0.242	0.212		13.018
Run-off, acre-feet			7,902	70,870	101,147	73,846	12,482	5,472	6,367	5,349	4,701		288,136
Acre-feet per square mile			19.04	170.78	243.74	177.92	30.07	13.16	15.35	12.91	11.31		644.28

ELK HEAD CREEK NEAR CRAIG.

The station is maintained by the State. It is located about six miles above Craig on road from Steamboat Springs to Craig.

The equipment consists of a chain gauge located on iron bridge from which measurements are made.

The bed of the stream is composed of sand and mud. The current is sluggish at low stages and obstructed by willows at high stages.

The observer is U. F. Harrison, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF ELK HEAD CREEK NEAR CRAIG.

DATE		HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910	Mch. 6	C. L. Chatfield	....	....	....	....	45
	Apr. 15	C. L. Chatfield	39	128	2.82	6.70	361
	May 26	C. L. Chatfield and R. E. Burke	37.5	76	2.68	5.93	204
	June 9	C. L. Chatfield	27	76	0.79	4.80	60
	Sept. 4	C. L. Chatfield	8	2.5	0.32	3.80	0.79
	Nov. 3	C. L. Chatfield	15	63	1.15	4.07	7.23

DISCHARGE OF ELK HEAD CREEK NEAR CRAIG FOR 1910.
Drainage Area, 249 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	700	163	3	4	0	6	10	....	
2	....	....	....	....	610	148	2	1	0	6	10	....	
3	....	....	....	....	483	127	1	3	1	6	10	....	
4	....	....	....	....	504	120	1	1	1	6	8	....	
5	....	....	....	....	578	100	1	1	0	10	6	....	
6	....	....	....	....	452	88	1	1	0	10	6	....	
7	....	....	....	....	462	75	1	1	1	6	3	....	
8	....	....	....	....	452	64	1	1	3	6	3	....	
9	....	....	....	....	462	59	1	1	1	6	3	....	
10	....	....	....	....	567	50	1	1	1	6	6	....	
11	....	....	....	....	599	54	0.5	1	1	6	6	....	
12	....	....	....	....	567	50	1	1	1	6	6	....	
13	....	....	....	....	472	30	1	1	3	6	6	....	
14	....	....	....	....	412	24	1	1	3	6	6	....	
15	....	....	....	....	342	21	1	0.5	2	6	6	....	
16	....	....	....	....	362	21	2	0.5	1	6	6	....	
17	....	....	....	332	312	18	1	0.5	3	18	10	....	
18	....	....	....	504	294	21	1	0.5	3	30	10	....	
19	....	....	....	578	229	21	3	0	3	21	10	....	
20	....	....	....	746	256	15	2	0.5	3	21	10	....	
21	....	....	....	1,019	303	6	2	0.5	3	18	10	....	
22	....	....	....	621	274	3	2	0.5	4.5	15	10	....	
23	....	....	....	567	238	3	2	0	3	12	10	....	
24	....	....	....	854	212	3	3	0	4.5	10	10	....	
25	....	....	....	954	238	1	2	0	6	10	10	....	
26	....	....	....	904	212	1	1	0	6	10	10	....	
27	....	....	....	1,006	195	1	1	0	6	10	10	....	
28	....	....	....	1,058	204	1	8	0	6	10	10	....	
29	....	....	....	980	195	6	27	0	6	10	6	....	
30	....	....	....	794	187	1	8	0	6	10	6	....	
31	....	....	....	....	179	....	4.5	0	....	10	....	....	
Total	....	....	....	10,917	11,522	1,295	87.0	22.5	82.0	319	233	....	
Mean	....	....	....	780	372	43	2.8	0.7	2.7	10	7.8	....	107
Maximum	....	....	....	1,058	700	163	27	4	6	30	10	....	1,058
Minimum	....	....	....	332	179	1	0.5	0	0	6	3	....	0
Run-off per square mile	....	....	....	3.133	1.494	0.173	0.011	0.003	0.011	0.040	0.031	....	0.430
Run-off, depth, inches	....	....	....	1.631	1.722	0.193	0.013	0.003	0.012	0.046	0.035	....	3.655
Run-off, acre-feet	....	....	....	21,660	22,873	2,559	172	43	161	615	464	....	48,547
Acre-feet per square mile	....	....	....	87.00	91.86	10.29	0.68	0.18	0.66	2.50	1.86	....	191.10

The following discharges on Elk Head creek at Hayes' ranch, North Fork Elk Head creek near Hayes' ranch, Little Bear creek near Skiles and Fortification creek above mouth of Little Bear creek, have been furnished by the Great Northern Irrigation & Power Company:

DISCHARGE OF LITTLE BEAR CREEK NEAR SKILES FOR 1910.

Drainage Area, ... Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	3.1	2.9	4.2	50	44	32	0	0	0	0	3.2	....	
2	3.1	3.3	4.6	47	62	30	0	0	0	0	3.2	....	
3	3.1	2.9	5.3	43	65	27	0	0	0	0	3.2	....	
4	3.1	2.9	6.6	50	62	30	0	0	0	0	3.2	....	
5	3.1	2.7	7.5	47	58	18	0	0	0	0.4	3.2	....	
6	3.1	2.5	33.0	43	62	24	0	0	0	0.4	3.2	....	
7	3.1	2.5	25.0	43	72	20	0	0	0	0.4	3.2	....	
8	3.1	2.7	34.0	43	62	18	0	0	0	0.4	3.2	....	
9	3.1	3.3	19.8	40	65	18	0	0	0	1.1	3.2	....	
10	3.3	3.3	24.0	57	82	18	0	0	0	1.1	3.2	....	
11	3.3	3.1	30.0	92	78	17	0	0	0	1.1	3.2	....	
12	3.1	3.1	37.0	105	72	14	0	0	0	1.1	4.1	....	
13	3.3	3.3	110.0	120	52	15	0	0	0	1.1	4.1	....	
14	3.3	3.1	80.0	33	52	16	0	0	0	1.1	4.1	....	
15	3.3	3.7	65.0	57	50	16	0	0	0	1.1	3.2	....	
16	3.7	3.3	72.0	55	48	17	0	0	0	1.1	3.2	....	
17	3.7	3.5	47.0	42	46	15	0	0	0	5.5	3.2	....	
18	2.9	3.3	47.0	82	50	13	0	0	0	24.1	3.2	....	
19	2.9	3.3	72.0	105	30	12	0	0	0	8.5	4.1	....	
20	2.2	3.3	72.0	128	32	10	0	0	0	1.1	3.2	....	
21	1.8	3.3	92.0	92	32	8	0	0	0	3.2	3.2	....	
22	2.9	3.1	180.0	125	30	0	0	0	0	3.2	3.2	....	
23	3.3	3.1	93.0	92	28	0	0	0	0	4.1	3.2	....	
24	3.7	3.7	47.0	150	30	0	0	0	0	4.1	4.1	....	
25	4.9	3.7	65.0	232	27	0	0	0	0	3.2	4.1	....	
26	3.1	2.7	64.0	150	30	0	0	0	0	4.1	4.1	....	
27	3.1	4.0	72.0	181	28	0	0	0	0	5.5	4.1	....	
28	2.2	4.9	44.0	181	33	0	0	0	0	4.1	3.2	....	
29	2.0	....	52.0	150	37	0	0	0	0	4.1	3.2	....	
30	2.7	....	50.0	105	36	0	0	0	0	3.2	2.1	....	
31	2.7	....	52.0	....	27	....	0	0	....	3.2	....	....	
Total	95.3	90.5	1,607	2,750	1,482	388	....	....	....	91.6	102.1	....	
Mean	3.1	3.2	52	92	48	13	0	0	0	3.0	3.4	....	20
Maximum	4.9	4.9	180	232	82	32	0	0	0	24.1	4.1	....	232
Minimum	1.8	2.5	4.2	33	27	0	0	0	0	0	2.1	....	0
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	191	178	3,197	5,474	2,951	774	0	0	0	184	202	....	13,151
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

DISCHARGE OF NORTH FORK ELK HEAD CREEK NEAR HAYES' RANCH FOR 1910.
Drainage Area, ... Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	1.5	1.5	1.6	38	117	39	0	0	0	1.3	1.5	....	
2	1.5	1.5	1.4	57	107	32	0	0	0	1.5	1.5	....	
3	1.5	1.5	1.6	42	90	27	0	0	2	1.8	0.9	....	
4	1.5	1.5	1.9	32	118	23	0	0	5	1.6	1.3	....	
5	1.5	1.5	3.1	23	91	19	0	0	7	1.5	0.8	....	
6	1.5	1.5	3.5	26	84	17	0	0	0	1.3	0.9	....	
7	1.5	1.5	9.7	38	83	18	0	0	0	1.6	2.3	....	
8	1.5	1.5	10.2	86	86	16	0	0	0	1.5	1.9	....	
9	1.5	1.5	9.9	115	115	14	0	0	0	0.9	1.5	....	
10	1.5	1.5	7.0	132	132	12	0	0	0	1.5	1.1	....	
11	1.5	1.5	6.5	141	143	11	0	0	0	1.1	0.8	....	
12	1.5	1.5	9.7	155	103	11	0	0	0	1.3	0.9	....	
13	1.5	1.4	10.6	155	85	11	0	0	0	1.3	0.9	....	
14	1.5	1.4	13.7	112	82	10	0	0	0	1.3	1.5	....	
15	1.5	1.6	27.0	71	75	10	0	0	0	1.3	1.5	....	
16	1.5	1.6	27.0	70	67	12	0	0	0	1.5	1.1	....	
17	1.5	1.4	40.9	107	50	10	0	0	0	3.6	1.3	....	
18	1.5	1.6	53.1	144	58	9	0	0	0	3.2	1.1	....	
19	1.5	1.6	78.8	174	53	7	0	0	0	3.6	1.5	....	
20	1.5	1.4	107.5	205	50	7	0	0	0	0.9	1.1	....	
21	1.5	1.4	137.1	165	57	7	0	0	0	2.5	2.1	....	
22	1.5	1.4	125.0	141	45	4	0	0	0	1.3	2.1	....	
23	1.5	1.4	118.0	162	50	2	0	0	0	1.5	1.8	....	
24	1.5	1.4	110.0	180	42	2	0	0	0	1.8	1.4	....	
25	1.5	1.6	98.0	195	39	2	0	0	0	2.7	1.1	....	
26	1.5	1.6	67.0	195	41	2	0	0	0	2.5	1.5	....	
27	1.5	1.6	45.0	207	43	2	2	0	0	1.5	4.1	....	
28	1.5	1.6	35.0	202	45	2	0	0	0	0.9	2.7	....	
29	1.5	....	27.0	165	41	0	0	0	0	2.3	3.6	....	
30	1.5	....	22.0	132	39	0	0	0	0	1.6	2.7	....	
31	1.5	....	25.0	....	41	....	0	0	....	1.5	....	....	
Total	46.5	42.0	1,234	3,667	2,272	338	2	....	14	53.7	48.5	....	
Mean	1.5	1.5	40	122	73	11	0.1	0	0.5	1.7	1.6	....	23
Maximum	1.5	1.6	137.1	207	143	39	2	0	7	3.6	4.1	....	207
Minimum	1.5	1.4	1.4	23	39	0	0	0	0	0.9	0.8	....	0
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	92	83	2,460	7,260	4,489	655	4	0	28	104	95	....	15,270
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

DISCHARGE OF ELK HEAD CREEK, AT HAYES' RANCH, ABOVE MOUTH OF NORTH FORK ELK HEAD CREEK, FOR 1910.

Drainage Area, ... Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	4.8	4.8	4.7	87	420	160	17	9.8	2.9	3.0	5.3	....	
2	4.8	4.7	4.7	113	341	160	14	8.0	3.1	6.9	4.4	....	
3	4.8	4.8	5.2	115	300	145	13	6.8	3.9	7.3	3.5	....	
4	4.8	4.8	6.7	90	341	128	12	5.6	16.0	4.7	4.7	....	
5	4.8	4.8	7.0	105	330	120	10	4.4	8.6	4.4	5.0	....	
6	4.8	4.8	7.6	91	290	113	9	3.7	3.9	3.8	4.4	....	
7	4.8	4.8	6.7	102	275	100	9	3.4	3.7	3.5	4.4	....	
8	4.8	4.8	7.6	135	273	92	8	3.1	3.5	3.2	4.4	....	
9	4.8	4.8	8.2	193	307	91	7	3.1	2.9	3.0	4.4	....	
10	4.8	4.8	9.2	237	355	50	6	3.3	3.1	3.2	4.1	....	
11	4.8	4.8	8.9	245	337	76	6	3.1	3.1	3.2	3.2	....	
12	4.8	4.8	13.1	295	305	75	6	3.3	2.7	3.2	4.7	....	
13	4.8	4.7	11.8	310	280	74	6	3.3	3.6	3.2	4.7	....	
14	4.8	5.2	19.6	277	296	70	5	3.5	4.0	3.2	4.4	....	
15	4.8	5.2	24.9	216	248	62	5	3.5	5.2	3.2	5.0	....	
16	4.8	4.7	23.1	193	235	63	5	3.1	3.9	3.8	5.0	....	
17	4.8	4.7	21.3	230	203	63	8	2.9	3.9	6.6	4.4	....	
18	4.8	5.2	24.0	277	207	55	8	2.7	4.0	9.5	4.4	....	
19	4.8	5.3	67.0	385	187	51	9	2.5	4.0	8.4	5.0	....	
20	4.8	4.7	82.0	595	193	38	6	2.3	4.0	2.5	4.4	....	
21	4.8	4.7	95.0	470	209	35	4	2.7	3.9	1.8	5.9	....	
22	4.8	4.7	113.0	375	195	27	4	2.9	3.9	1.5	6.3	....	
23	4.8	4.7	140.0	470	180	23	4	2.9	4.0	2.2	5.9	....	
24	4.8	4.7	151.0	515	173	22	3	2.0	3.8	3.2	5.4	....	
25	4.8	4.7	155.0	605	187	18	3	2.0	4.1	6.9	5.0	....	
26	4.8	4.7	188.0	610	171	17	3	2.3	4.2	6.9	4.1	....	
27	4.8	4.7	113.0	615	177	16	4	2.3	4.0	5.3	5.6	....	
28	4.8	4.7	103.0	620	180	15	9	2.7	4.0	5.0	7.3	....	
29	4.8	....	93.0	550	177	37	10	2.5	3.8	6.3	6.9	....	
30	4.8	....	85.0	471	170	34	12	2.5	3.6	4.7	5.6	....	
31	4.8	....	70.0	....	167	....	12	2.5	....	3.8	....	....	
Total	148.8	135.0	1,670	9,592	7,709	2,030	237	109	129	137	148	....	
Mean	4.8	4.8	54	320	249	68	7.6	3.5	4.3	4.4	4.9	....	66
Maximum	4.8	5.3	188	620	420	160	17	9.8	16.0	9.5	7.3	....	620
Minimum	4.8	4.7	4.7	87	167	15	3	2.0	2.7	1.5	3.2	....	2
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	295	267	3,320	19,041	15,310	4,046	467	215	256	270	292	....	43,809
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

DISCHARGE OF FORTIFICATION CREEK AT CHAPMAN'S RANCH, ABOVE MOUTH OF LITTLE BEAR CREEK, FOR 1910.
Drainage Area,....Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	3.6	2.9	3.5	38	75	29	0	0	0	0	2.1	....	
2	3.6	3.3	3.7	40	70	25	0	0	0	0	2.1	....	
3	3.6	2.7	4.0	42	68	24	0	0	0	0	2.1	....	
4	3.6	2.9	4.4	35	60	24	0	0	0	0	2.1	....	
5	3.6	2.5	12.1	32	62	23	0	0	0	0	2.1	....	
6	3.6	2.5	50.0	28	57	18	0	0	0	0.4	3.2	....	
7	3.6	2.2	111.0	27	65	15	0	0	0	0.4	3.2	....	
8	3.6	2.5	132.0	32	65	14	0	0	0	0.4	3.2	....	
9	3.6	2.5	205.0	44	58	16	0	0	0	0.4	3.2	....	
10	4.2	3.3	140.0	68	50	13	0	0	0	0.4	3.2	....	
11	4.0	3.3	60.0	68	78	13	0	0	0	0.4	4.2	....	
12	4.2	3.1	60.0	85	67	12	0	0	0	0.4	4.2	....	
13	4.2	3.3	140.0	132	68	12	0	0	0	0.4	4.2	....	
14	3.3	3.1	185.0	78	68	11	0	0	0	0.4	4.2	....	
15	4.2	3.7	190.0	55	55	9	0	0	0	0.4	4.2	....	
16	4.2	3.3	177.0	49	49	11	0	0	0	0.4	3.2	....	
17	4.6	3.3	173.0	57	47	11	0	0	0	1.5	4.2	....	
18	3.7	3.3	160.0	55	38	10	0	0	0	5.5	4.2	....	
19	3.3	2.9	177.0	75	37	8	0	0	0	4.1	3.2	....	
20	2.9	2.9	162.0	97	38	7	0	0	0	8.6	3.2	....	
21	2.7	2.9	168.0	103	40	6	0	0	0	3.2	3.2	....	
22	3.1	2.9	167.0	97	37	0	0	0	0	2.1	3.2	....	
23	3.5	2.9	147.0	78	34	0	0	0	0	3.2	3.2	....	
24	4.6	3.3	114.0	90	33	0	0	0	0	3.2	4.2	....	
25	4.2	3.3	85.0	101	33	0	0	0	0	4.1	4.2	....	
26	3.6	3.3	72.0	101	30	0	0	0	0	3.2	3.2	....	
27	2.5	3.5	53.0	68	32	0	0	0	0	3.2	3.2	....	
28	2.9	3.5	50.0	68	32	0	57	0	0	2.1	3.2	....	
29	2.3	....	42.0	97	31	0	193	0	0	3.2	2.1	....	
30	3.7	....	30.0	82	26	0	44	0	0	4.1	2.1	....	
31	3.3	....	40.0	....	23	0	29	0	0	3.2	2.1	....	
					33	....	0	0	....	2.1	....	....	
Total	111.6	85.1	3,118	2,022	1,527	311	323	0	0	61.0	97.3	....	
Mean	3.6	3.0	101	67	49	10.4	10.4	0	0	2.0	3.2	....	23
Maximum	4.6	3.7	205	132	78	29	193	0	0	8.6	4.2	....	205
Minimum	2.3	2.2	3.5	27	23	0	0	0	0	0	2.1	....	0
Run-off per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, depth, inches	....	....	....	....	....	....	....	....	....	....	....	....	....
Run-off, acre-feet	221	167	6,210	3,987	3,013	619	639	0	0	123	190	....	15,169
Acre-feet per square mile	....	....	....	....	....	....	....	....	....	....	....	....	....

FORTIFICATION CREEK AT CRAIG.

This station is maintained by the State and is located one-eighth of a mile east of Main street of Craig on road to Hayden.

The equipment consists of a chain gauge on steel highway bridge from which measurements are made.

The stream at this point has a shifting channel and is sluggish except at high water.

The observer is Mrs. E. L. Jameson, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF FORTIFICATION CREEK AT CRAIG.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Mch. 5	*C. L. Chatfield	51	100	1.77	7.25	177
Apr. 15	C. L. Chatfield	48.5	74	1.96	5.40	145
Mch. 10	*E. S. Foote and R. E. Burke	....	....	....	....	201
May 26	C. L. Chatfield and R. E. Burke	47	30	1.67	3.72	50
Mch. 13	E. S. Foote	50	....	....	....	411
June 10	C. L. Chatfield	....	....	....	....	0.5
June 29	C. L. Chatfield	....	....	....	....	0.3
Sept. 4	C. L. Chatfield	14	11.0	1.27	3.25	14
Nov. 3	C. L. Chatfield	7	2.8	0.40	2.60	2.94

*Ice.

DISCHARGE OF FORTIFICATION CREEK AT CRAIG FOR 1910.
Drainage Area, 256 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	95	136	30	0	0	0	0	4.5	....	
2	....	....	....	106	136	22	0	0	0	0	3.5	....	
3	....	....	....	109	100	25	0	0	0	0	4.5	....	
4	....	....	....	87	98	17	0	0	14	0	4.5	....	
5	....	....	178	76	100	10	0	0	13	0	4.5	....	
6	....	....	247	78	112	5	0	0	13	0	6.0	....	
7	....	....	306	78	90	1.5	0	0	13	0	4.0	....	
8	....	....	380	84	103	1.0	0	0	0	0	3.5	....	
9	....	....	312	122	92	1.0	0	0	0	0	3.0	....	
10	....	....	160	177	95	0.5	0	0	0	0	2.5	....	
11	....	....	120	173	115	0.5	0	0	0	0	2.5	....	
12	....	....	140	234	132	0.5	0	0	0	0	3.0	....	
13	....	....	411	181	92	0.5	0	0	0	0	4.0	....	
14	....	....	290	194	80	0.5	0	0	0	0	3.5	....	
15	....	....	245	106	76	0.5	0	0	0	6.8	4.0	....	
16	....	....	245	45	68	0.5	0	0	0	6	4.5	....	
17	....	....	315	76	60	0.5	0	0	0	9	3.5	....	
18	....	....	278	78	56	0.5	0	0	0	14	3.5	....	
19	....	....	315	132	47	0.5	0	0	0	15	3.5	....	
20	....	....	358	98	42	0.5	0	0	0	10	7.5	....	
21	....	....	452	185	47	0.3	0	0	0	7.5	6.0	....	
22	....	....	358	181	45	0.3	0	0	0	6	9.0	....	
23	....	....	507	190	47	0.3	0	0	0	6	4.5	....	
24	....	....	185	146	47	0.3	0	0	0	6	4.5	....	
25	....	....	185	169	49	0.3	0	0	0	6	4.5	....	
26	....	....	118	173	49	0.3	0	0	0	6	3.5	....	
27	....	....	112	177	45	0.3	0	0	0	6	5.2	....	
28	....	....	103	181	44	0.3	13	0	0	6.8	6.0	....	
29	....	....	95	177	41	0.3	38	0	0	6.8	4.5	....	
30	....	....	68	153	44	0.3	13	0	0	6.0	3.5	....	
31	....	....	84	....	41	....	0	0	....	6.0	....	....	
Total	....	....	6,567	4,061	2,329	121	64	0	53	129.9	131.2	....	

DISCHARGE OF FORTIFICATION CREEK AT CRAIG FOR 1910—Concluded.

Drainage Area, 256 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	243	135	75	4	2.1	0	1.8	4.2	4.4	....	49
Maximum	....	....	507	234	136	30	38	0	14	15	9.0	....	507
Minimum	....	....	68	45	41	0.3	0	0	0	0	3.5	....	0
Run-off per square mile	....	....	0.949	0.527	0.293	0.016	0.008	0	0.007	0.016	0.017	....	0.191
Run-off, depth, inches	....	....	0.953	0.588	0.338	0.018	0.009	0	0.008	0.018	0.020	....	1.952
Run-off, acre-feet	....	....	13,014	8,033	4,612	238	129	0	107	258	262	....	26,653
Acre-feet per square mile	....	....	50.82	31.36	18.02	0.94	0.50	0	0.42	1.01	1.02	....	104.09

WILLIAMS RIVER NEAR PYRAMID.

This station is maintained in co-operation with the Williams River Highline Irrigation Company. This company pays traveling expenses of hydrographer in making measurements and salary of the observer.

It is located at Dunstan's ranch, 3 miles below Pyramid P. O.

The equipment consists of a vertical staff gauge bolted to crib pier of foot bridge from which measurements are made.

The bed of the stream is composed of boulders and gravel. The left bank overflows at high water. The current is swift at all stages.

The observer is Edna B. Evans, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF WILLIAMS RIVER NEAR PYRAMID.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 14	C. L. Chatfield	26	50	2.64	1.80	132
May 16	C. L. Chatfield	38.5	79	3.96	2.80	3,130
Aug. 10	C. L. Chatfield	27.5	45	1.13	1.50	51
Oct. 23	C. L. Chatfield	27.5	42	0.95	1.43	40

DISCHARGE OF WILLIAMS RIVER NEAR PYRAMID FOR 1910.
Drainage Area, 98 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1					361	678	113	86	35	35	29		
2					338	751	113	73	35	35	29		
3					361	790	99	62	43	35	29		
4					361	678	99	73	43	35	35		
5					272	578	86	62	51	35	43		
6					252	643	113	51	51	35	29		
7					272	610	113	51	35	35	29		
8					272	548	99	51	35	35	29		
9					315	462	99	51	35	35	29		
10					518	436	99	51	35	35	29		
11					790	462	99	51	35	35	29		
12					678	436	73	51	51	35	29		
13					643	436	51	51	99	35	29		
14				128	436	436	51	51	51	35	23		
15				114	385	385	51	51	51	35	35		
16				99	338	361	51	51	73	35	29		
17				99	272	338	51	51	73	51	23		
18				128	294	338	86	51	51	51	29		
19				160	294	315	73	51	51	51	23		
20				195	294	315	73	51	51	29	29		
21				178	272	272	73	51	51	35	35		
22				160	252	232	73	51	35	43	29		
23				128	361	195	73	51	35	43	29		
24				160	385	178	73	51	35	43	29		
25				252	385	178	73	51	35	43	29		
26				272	410	195	73	51	35	43	23		
27				462	462	178	86	51	35	29	19		
28				518	548	178	113	51	35	23	35		
29				436	548	178	128	35	35	43	29		
30				272	678	128	99	43	35	35	23		
31					751		86	35		29			
Total				3,761	12,798	11,908	2,642	1,642	1,350	1,151	868		
Mean				221	413	397	85	53	45	37	29		156
Maximum				518	790	790	128	86	99	51	43		790
Minimum				99	252	128	51	35	35	23	19		19
Run-off per square mile				2.255	4.214	4.051	0.867	0.541	0.459	0.378	0.296		1.592
Run-off, depth, inches				1.426	4.856	4.520	1.000	0.624	0.512	0.436	0.330		13.706
Run-off, acre-feet				7,452	25,394	23,623	5,226	3,259	2,678	2,275	1,726		71,633
Acre-feet per square mile				76.04	259.12	241.05	53.33	33.26	27.31	23.24	17.61		730.96

WILLIAMS RIVER AT HAMILTON.

This station is maintained by the State. It is located on stage road between Craig and Meeker, about 14 miles from Craig.

The equipment consists of a standard chain gauge on steel highway bridge from which measurements are made.

The bed of the stream is composed of rocks and gravel and is shifting. Both banks are high and not liable to overflow. The current is swift at all stages.

The observer is Carrie A. Hamilton, whose salary is $4.00 per month.

DISCHARGE MEASUREMENTS OF WILLIAMS RIVER AT HAMILTON.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 Apr. 15......	C. L. Chatfield..........................	57.8	132	2.52	4.10	332
May 25......	C. L. Chatfield..........................	63	207	3.25	5.28	706
June 28......	C. L. Chatfield..........................	55.5	101	2.00	3.50	202
Aug. 12......	C. L. Chatfield..........................	30	33	1.54	2.65	51
Oct. 23......	C. L. Chatfield..........................	30	34.5	1.98	2.78	68.5

DISCHARGE OF WILLIAMS RIVER AT HAMILTON FOR 1910.

Drainage Area, 341 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1......	......	......	......	......	890	1,215	176	72	35	57	57	......	
2......	......	......	......	......	710	1,190	166	72	35	57	64	......	
3......	......	......	......	......	622	1,190	157	64	42	72	64	......	
4......	......	......	......	......	675	1,140	139	64	88	57	64	......	
5......	......	......	......	......	770	1,022	166	64	112	57	64	......	
6......	......	......	......	......	658	870	157	57	72	57	50	......	
7......	......	......	......	......	622	870	130	57	57	57	50	......	
8......	......	......	......	......	692	830	104	57	50	57	50	......	
9......	......	......	......	......	910	730	104	57	42	57	50	......	
10......	......	......	......	......	1,268	675	104	50	42	57	50	......	
11......	......	......	......	......	1,580	588	88	57	42	57	50	......	
12......	......	......	......	......	1,460	588	88	42	57	57	50	......	
13......	......	......	......	......	1,140	588	104	57	64	57	57	......	
14......	......	......	......	......	932	554	72	57	64	57	57	......	
15......	......	......	......	320	932	506	88	57	88	57	57	......	
16......	......	......	......	272	750	474	104	50	72	57	57	......	
17......	......	......	......	283	640	460	96	50	88	57	57	......	
18......	......	......	......	333	605	416	104	42	72	80	57	......	
19......	......	......	......	440	588	401	80	42	72	104	57	......	
20......	......	......	......	570	622	387	72	42	57	96	64	......	
21......	......	......	......	730	675	360	72	50	57	88	50	......	
22......	......	......	......	554	570	333	72	130	72	57	80	......	
23......	......	......	......	506	570	308	72	64	72	57	72	......	
24......	......	......	......	605	658	283	57	57	64	80	72	......	
25......	......	......	......	750	710	237	57	42	57	80	57	......	
26......	......	......	......	932	750	196	57	42	57	64	57	......	
27......	......	......	......	1,090	770	196	57	42	57	64	57	......	
28......	......	......	......	1,295	932	196	72	42	57	50	57	......	
29......	......	......	......	1,322	1,045	260	104	42	57	50	57	......	
30......	......	......	......	1,140	1,140	216	104	42	57	64	57	......	
31......	......	......	......	......	1,165	......	104	42	......	64	......	......	
Total......	......	......	......	11,142	26,051	17,279	3,127	1,705	1,858	1,982	1,742	......	
Mean......	......	......	......	696	840	576	101	55	62	64	58	......	282
Maximum......	......	......	......	1,322	1,580	1,215	176	130	112	104	64	......	1,580
Minimum......	......	......	......	272	570	196	57	42	35	50	50	......	35
Run-off per square mile......	......	......	......	2.041	2.463	1.689	0.296	0.161	0.182	0.188	0.170	......	0.827
Run-off, depth, inches......	......	......	......	1.214	2.840	1.885	0.341	0.186	0.203	0.217	0.190	......	7.076
Run-off, acre-feet......	......	......	......	22,088	51,650	34,274	6,210	3,382	3,689	3,935	3,451	......	128,679
Acre-feet per square mile......	......	......	......	64.77	151.44	100.51	18.20	9.90	10.83	11.56	10.12	......	377.33

SLATER CREEK AT SLATER.

This station, maintained by the State, is located at private bridge, 3 miles from Slater post office. The equipment consists of a staff gauge bolted to left abutment of bridge.

The bed of the stream is composed of cobbles and is permanent. The current is swift at high water. The gauge is read by H. V. Rowell, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF SLATER CREEK AT SLATER.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 July 15	*C. L. Chatfield	29	25.8	0.38	1.17	9.75
Sept. 6	*C. L. Chatfield	16	8.3	1.32	1.17	11.00
Nov. 7	*C. L. Chatfield	17.8	12.0	1.08	1.20	13.00
	†	30	110	1.60	3.00	153

*Measurements by wading. †Measurement by slope method.

DISCHARGE OF SLATER CREEK AT SLATER FOR 1910.
Drainage Area, 143 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1						143	22	14	8	10			
2						138	22	12	8	12			
3						133	22	12	8	20			
4						113	22	10	22				
5						103	22	12	17				
6						103	17	10	12				
7						94	17	8	10				
8						90	14	8	10				
9						81	14	8	10		17		
10						73	14	8	8		14		
11						69	12	8	8		14		
12						69	12	6	8		14		
13						69	12	8	8		14		
14						73	12	8	22		17		
15						61	10	8	12		17		
16						57	12	8	10		14		
17						61	10	6	10		14		
18						53	17	5	10		14		
19						46	14	5	12		14		
20						39	12	5	12		8		
21						39	12	8	12		17		
22						33	10	8	12		14		
23						33	10	8	12		14		
24						27	10	8	12		17		
25						27	4	8	12		17		
26						27	3	6	10		17		
27						22	4	6	10		14		
28					148	22	3	6	10		14		
29					148	22	27	6	10		17		
30					153	30	27	8	10		17		
31					143		12	8					
Total					592	1,950	431	249	335	42	339		

DISCHARGE OF SLATER CREEK AT SLATER FOR 1910—Concluded.
Drainage Area, 143 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	....	148	65	13	8	11	14	15	....	24
Maximum	....	....	....	....	153	143	27	14	22	20	17	....	153
Minimum	....	....	....	....	143	22	3	5	8	10	8	....	3
Run-off per square mile	....	....	....	....	1.035	0.454	0.091	0.056	0.077	0.098	0.105	....	0.166
Run-off, depth, inches	....	....	....	....	0.154	0.506	0.105	0.065	0.086	0.114	0.118	....	1.148
Run-off, acre-feet	....	....	....	....	1,174	3,868	855	494	664	861	916	....	8,832
Acre-feet per square mile	....	....	....	....	8.21	27.05	5.98	3.45	4.64	6.02	6.20	....	61.55

LITTLE SNAKE RIVER AT DIXON, WYOMING.

This station is located on steel bridge about one mile west of Dixon, Wyoming.

The equipment consists of a chain gauge located on steel bridge.

The bed of the stream is permanent and composed of boulders, gravel and a little mud. The current is swift and runs at angle with bridge. The left bank overflows at high water.

The observer is Nina Madsen, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF LITTLE SNAKE RIVER AT DIXON, WYOMING.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 May 28	C. L. Chatfield	122	6.49	2.98	4.55	1,940
July 16	*C. L. Chatfield	40	19.4	0.90	0.50	17.4
Sept. 6	*C. L. Chatfield	50	30	1.77	0.80	53.0
Nov. 8	*C. L. Chatfield	39	45	1.51	1.02	68.0

*By wading.

DISCHARGE OF LITTLE SNAKE RIVER AT DIXON FOR 1910.
Drainage Area, 1,294 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	....	1,905	149	47	17	35	61	....	
2	....	....	....	....	....	1,905	77	47	17	47	77	....	
3	....	....	....	....	....	1,740	61	35	17	61	69	....	
4	....	....	....	....	....	1,552	54	17	25	77	61	....	
5	....	....	....	....	....	1,365	61	17	69	77	61	....	
6	....	....	....	....	....	1,255	61	17	41	77	54	....	
7	....	....	....	....	....	1,150	54	17	25	77	77	....	
8	....	....	....	....	....	1,015	47	11	17	61	86	....	
9	....	....	....	....	....	890	35	11	17	54	77	....	
10	....	....	....	....	....	748	35	11	17	54	95	....	
11	....	....	....	....	....	670	30	11	17	54	77	....	
12	....	....	....	....	....	645	17	11	17	47	77	....	
13	....	....	....	....	....	645	14	11	17	61	77	....	
14	....	....	....	....	....	595	14	11	25	61	77	....	
15	....	....	....	....	....	502	11	11	47	61	77	....	
16	....	....	....	....	....	435	17	11	35	61	77	....	
17	....	....	....	....	....	525	11	11	35	95	86	....	
18	....	....	....	....	....	435	11	17	61	149	77	....	
19	....	....	....	....	....	370	14	14	69	137	77	....	
20	....	....	....	....	....	281	17	17	61	115	77	....	
21	....	....	....	....	....	233	17	17	47	77	54	....	
22	....	....	....	....	....	188	17	17	54	77	95	....	
23	....	....	....	....	....	126	14	17	54	86	95	....	
24	....	....	....	....	....	105	11	11	61	95	86	....	
25	....	....	....	....	....	105	17	9	54	95	95	....	
26	....	....	....	....	....	105	14	11	47	105	95	....	
27	....	....	....	....	1,590	95	11	9	47	115	69	....	
28	....	....	....	....	1,905	77	11	9	47	95	61	....	
29	....	....	....	....	2,032	126	30	17	47	77	95	....	
30	....	....	....	....	2,075	115	69	17	47	77	77	....	
31	....	....	....	....	1,990	....	61	17	....	86	....	....	
Total	....	....	....	....	9,592	19,903	1,062	506	1,151	2,446	2,319	....	
Mean	....	....	....	....	1,913	663	34	16	38	79	77	....	197
Maximum	....	....	....	....	2,075	1,905	149	47	69	149	95	....	2,075
Minimum	....	....	....	....	1,590	77	11	9	17	35	54	....	9
Run-off per square mile	....	....	....	....	1.806	0.624	0.032	0.015	0.036	0.074	0.072	....	0.185
Run-off, depth, inches	....	....	....	....	0.336	0.696	0.037	0.017	0.040	0.085	0.080	....	1.291
Run-off, acre-feet	....	....	....	....	19,025	39,477	2,106	1,004	2,283	4,852	4,582	....	73,329
Acre-feet per square mile	....	....	....	....	17.91	37.13	1.97	0.92	2.14	4.55	4.28	....	68.90

VERMILLION CREEK NEAR LADORE.

This station is maintained by the State and Ward & Montgomery of Denver. The traveling expenses of the hydrographer and salary of the observer are paid by Ward & Montgomery. It is located about 5 miles from Ladore.

The equipment consists of a staff gauge only.

The bed of the stream is composed of gravel held in place by outcrop of rock at gauge.

The observer is E. Bassett. As the stream is dry a considerable part of the time, the observer is paid by the number of readings taken.

DISCHARGE MEASUREMENTS OF VERMILLION CREEK NEAR LADORE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 July 28	C. L. Chatfield		563	6.65	6.85	3,750*
Aug. 29	C. L. Chatfield	5.5	0.90	0.77	—1.90	0.69
Aug. 31	C. L. Chatfield					1.05
Oct. 28	C. L. Chatfield					5.00
Oct. 29	C. L. Chatfield					4.50

*By Kutter's Formula. Flood

DISCHARGE OF VERMILLION CREEK NEAR LADORE FOR 1910.

Drainage Area, 1,017 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1							1	21	1	1.5	4.5		
2							1	5	1	1.5	4.5		
3							1	3	34	1.5	4.5		
4							1	3	375	1.5	4.5		
5							1	3	408	1.5	4.5		
6							1	1	128	1.5	4.5		
7							1	1	22	1.5	4.5		
8							1	1	3	1.5	4.5		
9							1	1	1.5	1.5	4.5		
10							1	1	1.5	20	4.5		
11							1	1	1.5	20	4		
12							1	1	1.5	20	4		
13							1	1	1.5	20	4		
14							1	1	1.5	20	4		
15							1	1	1.5	20	4		
16							1	1	1.5	417	4		
17							1	1	1.5	331	4		
18							1	1	1.5	156	4		
19							1	1	1.5	44	4		
20							1	1	1.5	9	4		
21							1	1	1.5	4	4		
22							1	1	1.5	4	4		
23							1	1	1.5	4	4		
24							1	1	1.5	4	4		
25							1	1	1.5	4	4		
26							1	1	1.5	4	181		
27							898	1	1.5	4	174		
28							2,680	1	1.5	4.5	132		
29							389	1	1.5	5.0	42		
30							161	1	1.5	5.0	3		
31							72	1		5.0			
Total							4,226	61	1,005	1,030	637		
Mean							136	2.0	33.5	33	21		45.5
Maximum							2,680	21	408	417	181		2,680
Minimum							1	1	1.5	1.5	3		1
Run-off per square mile							0.134	0.002	0.033	0.032	0.021		0.045
Run-off, depth, inches							0.154	0.002	0.037	0.037	0.023		0.253
Run-off, acre-feet							8,362	123	1,993	2,029	1,250		13,757
Acre-feet per square mile							8.24	0.12	1.96	1.97	1.25		13.54

BEAVER CREEK NEAR LADORE.

This station is located at Meyer's ranch about 16 miles from Ladore, and is maintained in co-operation with the Brown's Park Water Company. This company pays the traveling expenses of hydrographers and observer's salary.

The equipment consists of a vertical gauge rod and foot log.

The bed of the stream is rocky and shifting. The current is swift at high water.

The observer is Frank F. Meyer, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF BEAVER CREEK NEAR LADORE.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 June 17......	*C. L. Chatfield......	5	2.49	0.83	......	2.07
Aug. 30......	*C. L. Chatfield......	......	......	......	......	2.00
Oct. 29......	C. L. Chatfield......	3.5	1.49	0.81	0.60	1.20
	†......	......	36.9	12.4	4.05	455

*No water running below ditches at station. †Measurements by Slope method high water.

DISCHARGE OF BEAVER CREEK NEAR LADORE FOR 1910.
Drainage Area, 27 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	......	......	......	......	400	0	0	0	0.3	1	1.0	......	
2	......	......	......	......	350	0	0	0	0.3	1	1.2	......	
3	......	......	......	......	350	0	0	0	0.3	1	1.2	......	
4	......	......	......	......	300	0	0	0	0.3	1	1.2	......	
5	......	......	......	......	200	0	0	0	0.4	1	1.2	......	
6	......	......	......	......	200	0	0	0	0.5	1	1.2	......	
7	......	......	......	......	100	0	0	0	0.7	1	1.2	......	
8	......	......	......	......	50	0	0	0	0.7	1	1.2	......	
9	......	......	......	......	25	0	0	0	0.7	1	1.2	......	
10	......	......	......	......	10	0	0	0	0.7	1	2.3	......	
11	......	......	......	......	5	0	0	0	0.7	1	2.3	......	
12	......	......	......	......	5	0	0	0	1.0	1	2.3	......	
13	......	......	......	......	5	0	0	0	1	1	2.3	......	
14	......	......	......	......	3	0	0	0	1	1	2.3	......	
15	......	......	......	......	3	0	0	0	1	1	2.3	......	
16	......	......	......	......	2	0	0	0	1	1	2.3	......	
17	......	......	......	......	2	0	0	0	1	2.3	2.3	......	
18	......	......	......	......	2	0	0	0	1	2.3	2.3	......	
19	......	......	......	......	2	0	0	0	1	1.2	2.3	......	
20	......	......	......	......	2	0	0	0	1	1.2	2.3	......	
21	......	......	......	......	2	0	0	0	1	1.2	2.3	......	
22	......	......	......	......	1	0	0	0	1	1.2	2.3	......	
23	......	......	......	......	1	0	0	0	1	1.2	2.3	......	
24	......	......	......	455	1	0	0	0	1	1.2	2.3	......	
25	......	......	......	455	1	0	0	0	1	1.0	2.3	......	
26	......	......	......	455	0	0	0	0	1	1	2.3	......	
27	......	......	......	455	0	0	0	0	1	1	2.3	......	
28	......	......	......	455	0	0	0	0	1	1	2.3	......	
29	......	......	......	455	0	0	0	0	1	1	2.3	......	
30	......	......	......	455	0	0	0	0	1	1	3.0	......	
31	......	......	......	......	0	......	0	0	......	1	......	......	
Total	......	......	......	3,185	2,022	0	0	0	24.6	34.8	60.3	......	

DISCHARGE OF BEAVER CREEK NEAR LADORE FOR 1910—Concluded.
Drainage Area, 27 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	455	65	0	0	0	0.8	1.1	2.0	....	24.1
Maximum	....	....	....	455	400	0	0	0	1.0	2.3	3.0	....	455
Minimum	....	....	....	455	0	0	0	0	0.1	1.0	1.0	....	0
Run off per square mile	....	....	....	16.852	2.407	0	0	0	0.030	0.041	0.074	....	0.893
Run off, depth, inches	....	....	....	4.387	2.775	0	0	0	0.034	0.047	0.083	....	7.326
Run-off, acre-feet	....	....	....	6,317	3,997	0	0	0	47	68	119	....	10,548
Acre-feet per square mile	....	....	....	233.96	148.04	0	0	0	1.74	2.52	4.41	....	390.67

WHITE RIVER BASIN DESCRIPTION.

Rising in the White river plateau at an elevation of 11,000 to 12,000 feet, the White river flows in a general westerly direction until it joins the Green in Utah.

It heads in Trappers lake at an elevation of 9,500 feet and flows down a narrow valley until almost to Meeker, when the valley widens out into extensive bottom lands and mesas. A series of these mesas and bottom lands continue down to the State line, cut at intervals by low cross ranges.

The White river receives its most important tributary in the flow of South Fork of the White river at Buford, 23 miles above Meeker, and Beaver creek, the most important tributary from the north, just below.

Miller creek from the south, 15 miles above Meeker, drains the lower portion of the White river plateau.

To the Utah line on the north lie the Danforth hills and Yampa plateau, and on the south the Roan or Book plateau. Both of these divides are low, sandy and cedar covered and have very little runoff except from very heavy rains or cloudbursts.

At the head of the basin some very heavy forests occur. These follow roughly the White river plateau.

WHITE RIVER AT MEEKER.

This station, maintained by the State, is located at Van Cleave's ranch, about ½ mile southeast of Meeker.

The equipment consists of a staff gauge at right abutment of road bridge from which measurements are made, and an automatic gauge which was installed August 20, 1910.

The bed of the stream is composed of cobblestones and is permanent. The banks overflow at extreme high water. The current is swift.

The observer is Walter Van Cleave, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF WHITE RIVER AT MEEKER.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sb. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 May 22	C. L. Chatfield	....	278	3.89	4.15	1,082
June 22	C. L. Chatfield	....	267	4.01	4.10	1,074
Aug. 20	C. L. Chatfield	....	184	1.95	1.02	358
Aug. 22	C. L. Chatfield	....	188	2.08	1.10	391
Aug. 23	C. L. Chatfield	....	183	2.04	1.06	373
Nov. 26	C. L. Chatfield	....	178	2.02	1.00	360

DISCHARGE OF WHITE RIVER AT MEEKER FOR 1910.
Drainage Area, 634 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1						2,846	611	414	338	355	338		
2						2,756	556	371	355	355	338		
3						2,700	556	371	374	355	338		
4						2,700	531	328	458	355	355		
5						2,600	611	392	413	355	338		
6						2,600	556	328	374	338	322		
7					1,186	2,500	506	328	355	355	322		
8					1,100	2,400	460	328	355	338	322		
9					1,100	2,300	460	288	355	338	338		
10					1,100	2,200	460	288	355	338	322		
11					1,100	2,100	460	288	338	355	338		
12					1,100	2,000	460	328	338	338	338		
13					1,050	1,900	414	371	355	355	338		
14					1,050	1,800	414	374	392	355	322		
15					1,050	1,700	414	392	355	355	338		
16					1,050	1,600	414	374	355	374	338		
17					1,050	1,500	414	374	355	374	322		
18					1,004	1,400	414	374	355	374	338		
19					1,004	1,300	437	374	355	355	355		
20					1,004	1,200	392	374	338	338	292		
21					1,004	1,000	371	355	355	355	322		
22					1,004	881	328	355	338	355	338		
23					1,004	844	328	374	355	355	355		
24					1,091	806	328	355	355	355	338		
25					1,186	736	328	338	338	355	338		
26					1,406	671	308	355	338	355	338		
27					1,406	611	288	355	338	338	338		
28					1,676	611	437	355	338	338	338		
29					2,164	736	414	355	338	355	355		
30					2,328	671	437	355	338	338	338		
31					2,576		392	355		338			
Total					31,793	49,669	13,499	10,966	10,699	10,892	10,050		
Mean					1,272	1,656	435	354	357	351	335		662
Maximum					2,576	2,846	611	414	458	374	355		2,846
Minimum					1,004	611	308	288	338	338	292		288
Run-off per square mile					2.006	2.612	0.686	0.558	0.563	0.554	0.529		1.043
Run-off, depth, inches					1.865	2.914	0.791	0.643	0.628	0.639	0.590		8.070
Run-off, acre-feet					63,075	98,538	26,747	21,767	21,243	21,582	19,934		272,886
Acre-feet per square mile					99.47	155.43	42.18	34.31	33.50	34.06	31.48		430.43

SOUTH FORK WHITE RIVER NEAR BUFORD.

This is maintained by the State and is located on a private road bridge at Shepherd's ranch, about 7 miles above Buford.

The equipment consists of a staff gauge spiked to pier of bridge. Measurements are made from the wagon bridge at high stages.

The bed of the stream is composed of gravel and is fairly permanent. The current is swift at high water and has a good velocity at low stages. The left bank overflows at extreme stages.

The observer is Hugh Jones, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF SOUTH FORK WHITE RIVER NEAR BUFORD.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 June 24......	C. L. Chatfield..........................	59	93	1.34	0.40	125
Aug. 24......	C. L. Chatfield..........................	54	126	4.15	1.80	522
Nov. 25......	C. L. Chatfield..........................	59	81	1.11	0.20	90

NOTE.—Gauge heights refer to new gauge.

DISCHARGE OF SOUTH FORK WHITE RIVER NEAR BUFORD FOR 1910.

Drainage Area, 148 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1	....	....	....	....	....	2,295	397	200	128	108	108	....	
2	....	....	....	....	....	1,930	367	200	128	108	108	....	
3	....	....	....	....	....	2,175	337	200	128	108	108	....	
4	....	....	....	....	....	2,295	308	175	128	108	108	....	
5	....	....	....	....	....	1,930	337	175	128	108	108	....	
6	....	....	....	....	....	1,810	308	175	128	108	108	....	
7	....	....	....	....	....	1,750	280	175	128	108	108	....	
8	....	....	....	....	....	1,930	280	175	128	108	108	....	
9	....	....	....	....	....	1,380	252	175	128	108	108	....	
10	....	....	....	....	....	1,260	252	175	128	108	108	....	
11	....	....	....	....	....	1,260	252	175	128	108	108	....	
12	....	....	....	....	....	1,260	252	175	150	108	108	....	
13	....	....	....	....	....	1,200	225	175	150	108	108	....	
14	....	....	....	....	....	1,140	225	175	128	108	108	....	
15	....	....	....	....	....	1,140	225	175	128	108	108	....	
16	....	....	....	....	....	1,015	225	175	128	108	108	....	
17	....	....	....	....	....	955	225	175	128	108	108	....	
18	....	....	....	....	....	830	225	175	128	108	108	....	
19	....	....	....	....	....	765	225	175	128	128	108	....	
20	....	....	....	....	....	645	225	175	128	108	90	....	
21	....	....	....	....	....	525	225	150	128	108	90	....	
22	....	....	....	....	....	525	225	150	128	108	90	....	
23	....	....	....	....	....	465	200	150	128	108	90	....	
24	....	....	....	....	....	525	175	150	128	108	90	....	
25	....	....	....	....	....	522	175	128	108	108	90	....	
26	....	....	....	....	....	459	175	128	108	108	90	....	
27	....	....	....	....	....	428	175	128	108	108	90	....	
28	....	....	....	....	....	428	308	128	108	108	90	....	
29	....	....	....	....	....	428	225	128	108	108	90	....	
30	....	....	....	....	....	397	200	128	108	108	90	....	
31	....	....	....	....	....	....	200	128	....	108	....	....	
Total	....	....	....	....	....	33,667	7,705	5,071	3,764	3,368	3,042	....	
Mean	....	....	....	....	....	1,122	248	164	125	109	101	....	311
Maximum	....	....	....	....	....	2,295	397	200	150	128	108	....	2,295
Minimum	....	....	....	....	....	397	175	128	108	108	90	....	90
Run-off, per square mile	....	....	....	....	....	7.717	1.676	1.108	0.844	0.736	0.682	....	2.101
Run-off, depth, inches	....	....	....	....	....	8.610	1.932	1.278	0.942	0.848	0.761	....	14.371
Run-off, acre-feet	....	....	....	....	....	66,764	15,249	10,084	7,438	6,702	6,010	....	112,247
Acre-feet per square mile	....	....	....	....	....	451.21	103.03	68.14	50.26	45.28	40.61	....	758.53

NOTE.—Results before June 25 approximate.

NORTH FORK WHITE RIVER NEAR BUFORD.

This station is maintained by the State. It is located at Genier's ranch, about 1½ miles above Buford. The equipment consists of a staff gauge spiked to supports for foot bridge from which measurements are made.

The bed of the stream is permanent and is composed of cobbles and boulders with a little gravel. The current is swift and overflows the right bank at extreme high water.

The observer is Mrs. H. Genier, whose salary is $5.00 per month.

DISCHARGE MEASUREMENTS OF NORTH FORK WHITE RIVER NEAR BUFORD.

DATE	HYDROGRAPHER	Width Feet	Area of Section Sq. Ft.	Mean Velocity Ft. Per Sec.	Gauge Height Feet	Discharge Cu. Ft. Per Sec.
1910 May 24	C. L. Chatfield	68	152	4.32	2.00	656
June 23	C. L. Chatfield		127	3.98	1.60	505
Aug. 15	C. L. Chatfield	49	93	2.82	1.00	262
Nov. 26	C. L. Chatfield		79	2.63	0.80	208

DISCHARGE OF NORTH FORK WHITE RIVER NEAR BUFORD FOR 1910.

Drainage Area, 240 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
1						1,123	415	284	235	208	208		
2						1,123	415	266	235	222	208		
3						1,198	415	266	266	235	235		
4						1,223	415	266	376	235	235		
5						1,098	415	301	301	235	208		
6						1,098	415	284	301	222	208		
7						1,098	415	266	266	208	208		
8						1,048	376	266	235	208	208		
9						946	376	266	235	208	208		
10						896	376	250	235	208	208		
11						896	376	250	235	208	208		
12						896	376	301	235	208	208		
13						896	376	266	250	208	208		
14						801	338	266	250	208	208		
15						801	338	235	235	208	208		
16						755	338	235	235	208	208		
17						666	338	235	235	222	208		
18						666	338	235	235	235	208		
19						579	338	235	235	235	208		
20						579	338	235	235	235	222		
21						537	301	235	250	250	222		
22						537	301	235	250	235	208		
23						516	266	235	235	208	208		
24					710	496	266	235	235	222	208		
25					710	496	266	235	235	222	208		
26					732	476	266	235	235	208	208		
27					732	455	266	235	235	208	208		
28					848	455	266	235	235	208	208		
29					971	455	320	235	208	208	208		
30					998	435	301	235	208	208	185		
31					1,098		301	235		208			
Total					6,799	23,244	10,647	7,793	7,391	6,749	6,299		

DISCHARGE OF NORTH FORK WHITE RIVER NEAR BUFORD FOR 1910—Concluded.
Drainage Area, 240 Square Miles.

DAY	Jan.	Feb.	Mch.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Period
Mean	....	....	....	....	850	775	343	251	246	218	210	....	361
Maximum	....	....	....	....	1,098	1,223	415	301	301	250	235	....	1,223
Minimum	....	....	....	....	710	435	266	235	208	208	185	....	185
Run-off per square mile	....	....	....	....	3.542	3.229	1.429	1.046	1.025	0.908	0.874	....	1.504
Run-off, depth, inches	....	....	....	....	1.054	3.603	1.648	1.206	1.144	1.047	0.975	....	10.677
Run-off, acre-feet	....	....	....	....	13,486	46,104	21,118	15,457	14,660	13,414	12,466	....	136,705
Acre-feet per square mile	....	....	....	....	56.19	192.10	87.99	64.40	61.08	55.89	51.94	....	569.59

MISCELLANEOUS MEASUREMENTS IN YAMPA RIVER BASIN.

DATE	HYDROGRAPHER	STREAM	LOCALITY	Discharge
1910 Sept. 6	C. L. Chatfield	Battle Creek	Mouth	4
Nov. 9	C. L. Chatfield	Four Mile Creek	Mouth	2.8
July 16	C. L. Chatfield	Savery Creek	Mouth	6
Sept. 6	C. L. Chatfield	Savery Creek	Mouth	6
Nov. 7	C. L. Chatfield	Savery Creek	Mouth	28
Mch. 7	C. L. Chatfield	Yampa River	Hayden	281

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