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IRRIGATION INVESTIGATIONS IN IDAHO IN 1906.

By Elias Nelson.

The irrigation investigations begun in southern Idaho in 1905* were continued in 1906 with the writer in charge. The lines of work undertaken were:

1. Soil moisture investigations.
2. Duty of water measurements.
3. Gathering of data on cost of preparing land for irrigation and methods and cost of applying water and producing crops.
4. Seepage investigations.
5. Determination of amount of evaporation from a water surface.

Except for some duty of water measurements made near Idaho Falls in the upper Snake River Valley the investigations were confined to the Twin Falls tract which lies in the extreme south Central part of the great Snake River Plains. The elevation of this tract is from 3500 to 4100 feet while that of the farming lands about Idaho Falls is 4750. The temperatures and rainfall in 1906 at two points on the tract and at Idaho Falls are given in the following table.

Monthly Precipitation and Temperature in 1906.

Twin Falls.

	Precipitation	Temperature		
		Maximum	Minimum	Mean
January	.11	47	3	26.4
February	.11	54	11	34.2
March	1.99	63	-3	34.6
April	.24	85	22	48.6
May	1.58	86	31	60.5
June	2.72	95	36	59.5

*"Irrigation from Snake River, Idaho," by H. G. Raschbacher. Circular No. 65, Office of Experiment Stations, contains much general information not given in this report.

	Precipitation	Temperature		
		Maximum	Minimum	Mean
July	.09	101	44	73.6
August	.10	100	40	70.2
September	.11	92	29	62.7
October	.06	85	14	50.8
November	1.00	69	- 4	34.4
December	1.72	57	- 8	33.3
Total	9.82			
		BUHL.		
June	2.18	94	37	60.8
July	—	101	54	77.2
August	.31	100	46	72
September	.34	92	32	64.8
October	.04	88	19	52.6
November	.92	68	0	41.5
December	.07	56	- 2	35.2
		IDAHO FALLS.		
January	1.07	42	-15	20.3
February	1.05	44	- 1	27.9
March	2.87	58	-26	27.2
April	1.10	78	22	45.2
May	2.99	84	26	52.5
June	1.94	85	31	55.8
July	.27	93	43	67.3
August	.83	95	37	64.1
September	.31	85	26	57.0
October	.32	82	16	48.4
November	.62	63	- 5	32.0
December	1.01	51	- 3	31.0
Total	14.38			

The Twin Falls tract is typical of those parts of the Snake River Plains in Idaho where the soil is a fine wind-deposited dust. In certain localities it is somewhat sandy, but aside from such local variations the character of the soil is very similar from Hagerman to American Falls. In the upper Snake River Valley the same general type of soil

is found but alluvial deposits of sand and gravel occur along the tributary streams. The soil in the vacinity of Idaho Falls and Blackfoot ranges from a heavy clay to a sandy loam and is more or less uniformly underlaid by sand or gravel at varying depths. Toward the extreme northwestern part of the Twin Falls tract the soil gradually merges into the lacustral soil formation which extends northwest into Canyon county. On the Rock Creek bottom just below the High Line canal some alluvial deposits of gravel occur. Except for the two exceptions noted the soil on the tract with but little variation is a fine volcanic dust. It is homogenous throughout its entire depth over the greater part of the tract. In the western part a white lime formation occurs at a depth of from one and half to three feet. In depth the soil varies from two to fifteen feet or more. In the second or third foot there is a very firm layer of soil differing only in its compactness from the soil above and below. From Murtaugh to Kimberly the soil contains a little fine sand and is not so heavy as west of Rock Creek. Along the north border of the tract opposite to Twin Falls is a narrow strip of land several miles long which is quite sandy and very similar to certain parts of the Minidoka tract.

SOIL MOISTURE INVESTIGATIONS.

Since the amount of available moisture that any soil may hold is one of the chief determinants of the quantity of water to apply, some investigations were undertaken with the hope that the data secured would shed some light on the proper and rational use of water. Determination of the moisture contents were made on fields near Twin Falls, chiefly on the Experiment Farm, all of which was second-year land.

The samples of soil were taken by means of a soil auger and placed in Mason jars which were then sealed to prevent any loss of moisture. The soil was then dried in

an improvised oven at a temperature of 112-118 degrees C. The weighing before and after drying were made on accurate scales at the Sprague Pharmacy. The tests were not made at regular times, but only at intervals between field work. Some valuable results, however, were secured.

MAXIMUM CAPACITY.

The Twin Falls soil when saturated contains 24.72 per cent. water by weight, and 43.69 by volume. These are the averages for the first three feet. One per cent. of water in one cubic foot of soil weighs 1.10 lbs. and is equivalent to .21 inch in depth. Each cubic foot when saturated contains 27.27 lbs. of water which is equal to 5.24 inches in depth. A cubic foot of soil when water free weighs 83.04 lbs. and when saturated 110.3 lbs. In the tables and discussions that follow the moisture content is expressed in the terms of the per cent. of the wet weight.

EXTENT TO WHICH THE SOIL MAY DRY OUT.

The least amount of moisture found was on unbroken land which had never been irrigated. The first foot contained 3.56 per cent.; the second 5.80 per cent. and the third 4.49 per cent., or a total for the three feet of 2.92 inches. The first two inches of surface soil contained but 1.76 per cent. These samples were to all appearances perfectly dry.

MOISTURE CONTENTS OF UNRECLAIMED LAND.

Below a depth of two feet the rainfall has but a very slight effect on the moisture contents. At greater depths the soil is always dry. The following table shows the variation during the season.

Date	Per Cent.			Total inches
	1st. foot.	2nd. foot.	3rd. foot.	
April 19	9.37	12.5	5.47	5.78
May 11	9.37	12.05	5.44	5.68
July 6	7.17	8.45	5.32	4.42
Aug. 23	3.56	5.80	4.49	2.92
Sept.27	4.00	6.02	5.32	3.25

The loss from April 19 to August 23 was 5.81 per cent., 6.75 per cent., and .98 per cent. respectively for each foot or a total of 2.86 inches. The rainfall during this period was 4.53 inches thus making a total of 7.39 inches evaporated in 96 days. If we assume that 2.92 inches, the amount contained August 23, represents the lowest amount at any time during the year, then with an average annual precipitation of 11 inches the average fall and winter precipitation must be about 6.47 inches of which 3.61 inches may be lost by the middle of April and but 2.86 inches or 44.20 per cent. retained. The fact that the soil in its virgin state contains such small amounts of moisture should emphasize the advisability of irrigation before planting.

MOISTURE CONTENTS IN SPRING.

On April 19 the condition of the soil on second year land was as follows:

	1st. foot Per cent.	2nd foot Per cent.
Fall Plowing	13.86	19.19
Spring Plowin	13.38	17.86
Alfalfa Field	12.80	16.46

The differences are what we should expect to find. The alfalfa ground having a firm, unstirred surface had lost more water by surface evaporation than the plowed ground. That plowed in the fall contained more moisture than the spring plowed.

RELATION OF IRRIGATION TO MOISTURE CONTENTS.

The moisture contents on three fields on the Experiment Farm at different times during the season are given in the following table.

Moisture Contents of Irrigated Land.

Plat	Date	1st foot per cent.	2nd foot per cent.	3rd foot per cent.
Alfalfa	April 19	12.80	16.46	
Alfalfa, 1 day before irrigation	May 3	7.61	15.14	17.82
Alfalfa, 1 day after irrigation	May 5	19.67	20.95	20.11
Alfalfa, 7 days after irrigation	May 11	11.69	17.42	18.78
Alfalfa, 1 day before irrigation	July 8	8.45	15.62	
Alfalfa, 1 day after irrigation	July 10	20.51	21.87	
Alfalfa, 7 days after irrigation	July 16	12.50	16.94	
Oats, before planting	Apr. 19	13.38	17.86	
Oats,	May 11	8.05	16.06	17.42
Oats, first irrigation	July 10	14.56	18.09	
Oats, day of harvesting	July 28	7.17	14.26	
Wheat, 1 day before irrigation	July 10	8.49	15.62	
Wheat, 7 days after irrigation	July 18	11.13	16.07	
Wheat, day of harvesting	Aug. 1	4.92	11.17	10.38
Wheat,	Aug. 23	5.80	14.70	13.82
Wheat,	Sep. 27	7.61	16.50	15.58

To illustrate the amount and the rate of loss of water from the soil after irrigation, let us take the instance of the alfalfa field on May 4th. On that date 12.65 inches of

water were applied. Since the maximum capacity of three feet of soil is 15.73 inches and since the contents before irrigation was 8.58 inches, then no more than 7.15 inches could have been absorbed by the three feet of soil. The facts in regard to the loss are as follows:

	1st foot per cent.	2nd foot per cent.	3rd foot per cent	Total inches
Loss in one day	5.08	3.77	4.61	2.89
Loss in seven days	13.03	7.30	5.94	5.60
Retained at end of one day	12.03	5.81	2.29	4.26
Retained at end of seven days	4.08	2.28	.96	1.55

As compared with the amount absorbed:

Loss in one day	29.69	39.35	66.81
Loss in seven days	76.15	76.20	86.08

As compared with total capacity:

Loss in one day	16.38	15.25	18.64
Loss in seven days	52.71	29.52	24.03

The rate of loss during the first day after irrigation was greater than the average per day for the week. Hence, the soil looses water most rapidly when it contains the most and it must therefore follow that the greater the amount applied the greater is, not only the loss, but also the rate of loss.

In one week about ¾ of the amount which the three feet of soil could absorb and supposedly did absorb, was lost from the first and second feet and ⅞ from the third. As compared with the total capacity about ½ was lost from the first foot,one-third from the second, and ¼ from the third. It should be borne in mind that much of the water which passed into the deeper soil served a useful purpose

since some must have been brought up later by capillarity. Furthermore, even the roots of small grain penetrate beyond a depth of three feet.

Since three feet of soil could absorb but 7.15 inches of water, the remaining 5.5 inches must comprise what was lost by percolation, what wasted off the field and what was evaporation during irrigation. The waste did not exceed 10 per cent. and the evaporation could have been but a fraction of an inch so we may safely assume that at least 4 inches were lost by percolation. The loss from the first foot of 5.08 per cent. in one day and 13.03 per cent. in one week was more than evaporation and transpiration combined could have disposed of. Hence, there must have been continued downward percolation even from the first foot of soil. More than 4 and perhaps as much as 6 inches must therefore have passed into the deeper soil.

Reference to the table shows an almost identical amount of loss after the irrigations of the alfalfa field on July 9 and the wheat field on July 11. It is a noteworthy fact that there is a very little difference between the moisture contents of the second and third feet of soil before irrigation and one week after, as shown by three separate tests. Excess water thus drains away quickly and as surface evaporation and transpiration of plants remove moisture, capillarity brings more up from below so that there appears to be a tendency of the subsoil to maintain a moisture contents which varies but little and this remains close to 16 per cent. or nearly 60 per cent. of its maximum capacity. It was only on places where the crops had drawn heavily upon the soil moisture that the percentage fell much below the amount noted. On the oat plat it fell to 14.26 per cent. in the second foot by harvest time; on the wheat plot 11.17 per cent. It should not be inferred that capillarity is rapid enough to meet the needs of a vigorously growing crop of small grain though there is an abundance of moisture in the deeper soil.

MOISTURE CONTENTS OF STUBBLE FIELD AFTER HARVEST.

As may be seen from the figures in the table on pages three and four there was a considerable gain on the wheat plat after the harvest, though no water was applied. During 57 days, from August 1st to Sept. 27th, the gain amounted to 2.80 inches. This amount, however, cannot be all that capillarity brought up from the deeper soil for considerable must have been evaporated. During these 57 days the rainfall was .21 inches, an amount that without a doubt was all lost by surface evaporation.

AVAILABLE MOISTURE.

The determination of moisture contents on various plats show that the soil may hold by capillarity as much as 10.01 inches in three feet. The contents of the wheat field referred to above was 5.59 inches at the time of harvesting. If this amount be taken as representing the average amount of moisture that a crop of wheat leaves in the ground, then the soil may hold in three feet of soil 4.42 inches of water available to crops. Theoretically then, where the soil is deep, this is the amount of water that should be applied at one irrigation as far as the first three feet of soil is concerned. However, since some water must be supplied for the deeper soil and since evaporation from the soil is considerable for a few days after irrigation more than this must obviously be applied. It would seem that six inches is ample for second-year land. Data of water measurement made on the tract shows that less water than that was used in some cases. Where there is a total of 7 to 9 inches of water in the first three feet, or 12 to 15 per cent. in the second and third feet, six inches would be more than necessary.

POUNDS OF WATER REQUIRED FOR ONE POUND DRY MATTER.

Having determined the moisture contents in spring and

at the time of harvest, and knowing the yield of grain and straw per acre, the number of inches of rainfall, the quantity of water used in irrigation and the amount of waste, it has been possible to calculate the number of pounds of water the crop of wheat required for one pound of dry matter. This was found to be 671 pounds. Only three feet, however, were taken into account. The amount of water used was large, being a total of 27 inches in two irrigations 28 per cent. of which wasted off the plat. Considerable water must have percolated into the deeper soil, so that the amount that capillarity brought up and that which the crop drew from below must have been less than that which seeped away beyond a depth of three feet. In view of these considerations the total amount actually used was probably not more than 671 pounds for one pound of dry matter.

MOISTURE CONTENTS ON BARE FALLOW.

The oat stubble field on which the following determinations were made was cropped and irrigated for the first time the previous season but laid idle during 1906.

Date	1st foot per cent.	2nd foot per cent.	3rd foot per cent.
July 6	8.10	15.18	15.62
Aug. 23	5.80	16.06	16.06
Sep. 27	5.58	14.26	13.42

There was thus considerable loss in the first foot while the difference in the second and third feet might easily have been due to local variation. It is rather remarkable that this field should have contained so much moisture in view of the fact that there was no check to evaporation.

DUTY OF WATER.

Measurements of the amount of water used in irrigation were made chiefly on the Twin Falls tract. Some, however,

were undertaken in the vicinity of Idaho Falls where the land has been under cultivation for many years. All these measurements were secured through the hearty co-operation of farmers who kept a record of the amount applied. Weirs were used whenever it was possible to comply with the conditions that accuracy requires while rating flumes were placed in those ditches where there were not sufficient fall for a weir. On the Twin Falls tract data were secured both on first and second year land. In the following account of the measurements the amount of water applied is expressed in terms of inches in depth over the area irrigated.

MEASUREMENT NO. 1.

Farm of A. McPherson at Twin Falls, Idaho; forty acres alfalfa on first-year land.

First irrigation.	June 29-July 3	5.20
Second "	July 30-Aug. 13	6.62
Third "	Aug. 24-Sept. 6	7.79
Total applied		19.61
Rain fall		4.73
Total received		24.34

Average head of water used, 1 sec. ft.

This field was irrigated by the furrow system, there being spouts in all the head ditches to regulate the flow. A head of one second foot of water supplied 193. furrows. Each furrow thus received a stream equal to .00518 of a second foot or .259 of a Miner's inch and from one to three furrows were supplied by each spout. For furrows 40 rods long and 24 inches apart a run of from 24 to 30 hours was required.

It will be observed that there was but little variation in the amount applied at each of the three irrigations. Such uniformity is possible with the furrow system for the water is under complete control and evenly distributed. Besides these 40 acres there were 120 more on which the same system was in operation.

This land was cleaned and leveled in the spring and disced twice lapping one half each time preparatory to seeding. Three irrigations were all that the land received during the season, the last application of water supplying sufficient moisture to carry the alfalfa through the winter.

This measurement may be considered as a fair test of the minimum amount of water that will start alfalfa successfully on new land when sown without a nurse crop.

MEASUREMENT NO. 2.

Farm of W. S. Star near Kimberly, Idaho; 22.52 acres of spring wheat on first-year land.

First irrigation	June 19-27 (estimated)	9.00
Second irrigation	July 7-12	6.53
Third irrigation	July 20-27	8.50
Total applied		24.03
Rainfall		4.73
Total received		28.76

Average head of water used 1.5 sec. ft.
Yield, 36 bu. per acre.

This field was marked out to aid in the irrigation but spouts were not used to regulate the flow. Constant attention was therefore necessary. More water wasted than necessary, for there was plenty, and Mr. Star stated that with careful work he could have prevented much of the waste and considerable less water would have sufficed. This test gives a fair idea of the amount used for small grain on new land on the tract in 1906.

Mr. Star had a field of oats sown on new land June 15. This was irrigated five times and yielded at the rate of 5 bushels per acre. Barley sown in April on second-year land was irrigated twice and produced 60 bushels per acre.

MEASUREMENT NO. 3.

Farm of Nels Lind near Filer, Idaho; 5.52 acres oats on first-year land.

First irrigation, July 4-6.....15.91
Second irrigation, August 1-3.....13.33
Total applied.....29.24
Rainfall..... 4.73
Total received.....33.97
Average head of water used, 1.4 sec. ft.
Yield 35.7 bu. per acre.

This field was plowed in the fall. It was not marked out for irrigation.

MEASUREMENT NO. 4.

Farm of Nels Lind near Filer, Idaho; 7.07 acres barley on first-year land.

First irrigation, May 8-10..... 4.73
Second irrigation, June 10-12..... 5.56
Third irrigation, July 2-3..... 3.35
Total applied.....13.64
Rainfall 4.63
Total received.....18.27
Average head of water used, 1 sec. ft.
Yield, 43 bu. per acre.

The method employed was the furrow system without spouts. The land was broken in the fall.

MEASUREMENT NO. 5.

Farm of Smith & McMasters near Hanson, Idaho; 36.79 acres of oats on second-year land.

First irrigation, June 26-July 2..... 5.53
Second irrigation, July 11-18.....10.73
Third irrigation, July 30-Aug. 5..... 7.98
Total applied.....24.24
Rainfall 4.73
Total received.....28.97
Average head of water used, 2.3 sec. ft.
Yield, 56.3 bu. per acre.

The records were kept by Mr. Nick Smith. The field was plowed in the fall. It was marked out for irrigation but spout were not used to regulate the flow.

MEASUREMENT NO. 6.

Farm of Nels Lind near Filer, Idaho; 18.59 acres spring wheat on second-year land.

First irrigation, May 27-June 1..... 5.38
Second irrigation, July 26-Aug. 1..... 8.07
Total applied.....13.45
Total rainfall..... 4.63
Total received.....18.08
Average head of water used, 2 sec. ft.
Yield, 38.52 bu. per acre.

This land was broken in June, 1905, and seeded to alfalfa which did not catch. It was irrigated twice that season. Much moisture was thus stored in the soil and this reduced the requirement for water the following season. The seed was drilled in without any further plowing. The method used in irrigation was that of flooding from field ditches, 50 to 60 feet apart.

MEASUREMENT NO. 7.

Farm of F. L. Johnson, Murtaugh, Idaho; 5.92 acres of oats.

First irrigation, June 25-29 (estimated) 8.00
Second irrigation, July 19-21..... 7.92
Total applied.....15.92
Rainfall 4.73
Total received 20.65
Average head of water used, 1.2 sec. ft.
Yield, 44 bu. per acre.

A part of this field was second-year land and part first-year. Furrows were used in the irrigation.

MEASUREMENT NO. 8.

Farm of W. F. Owens, Jr., Ammon, near Idaho Falls Bingham Co., Idaho; 21.06 acres alfalfa.

First irrigation, June 1-3 (estimated)	3.48
Second irrigation, June 21-23	3.11
Third irrigation, Aug. 7-10	3.85
Total applied	10.44
Rainfall	6.34
Total received	16.78

Average head of water used, 1.17 sec. ft.
Yield per acre, 4 tons.

The soil is a heavy clay and the method used was flooding. Owing to the heavy rainfall in May and the cold backward spring the yield was much below the average. The early growth was stopped by the unfavorable weather and the new which sprung up later was thick but short and the yield therefore small.

MEASUREMENT NO. 9

Farm of W. F. Owens, Jr., Ammon, near Idaho Falls, Bingham Co., Idaho; 20.8 acres wheat.

First irrigation, July 5-7	3.42
Second irrigation, Aug. 2-5	3.96
Total applied	7.38
Rainfall	6.03
Total received	13.41

Average head of water used, 1.17 sec. ft.
Yield, 34.25 bu. per acre.

Mr. Owens has a clay soil, as heavy as any in this section.. The method used in irrigating the grain was flooding. The amount of water used was small, but the rainfall during the season unusually heavy. The average irrigator in this district uses more water than was applied in this instance.

MEASUREMENT NO. 10.

Farm of Arthur Ball near Idaho Falls, Bingham Co., Idaho; 14 acres sugar beets.

First irrigation, July 28-Aug. 1.....10.00
Second irrigation, Aug. 9-12..... 6.21
Third irrigation, Sept. 7-9..... 6.72
Total applied.....22.93
Rainfall.....6.34
Total received.....29.27
Average head of water used, 1,75 sec. ft.
Yield, 15.92 tons per acre.

Mr. Ball's place lies close to the foot hills under the highest canal in the vicinity of Ammon. The soil here is sandy, a type of soil generally admitted to be better suited to sugar beet growing than the clays of this district. Since there had been much rainfall the beets were not irrigated until late. In average seasons Mr. Ball irrigates five times. The beets were cultivated three times before the first irrigation. It was 2 to 3 inches to moisture on July 23. In 1905 the same field yielded 22 tons of beets per acre.

DISCUSSION OF RESULTS OF DUTY OF WATER MEASUREMENTS.

On those farms on the Twin Falls tract where records of water used were kept the supply was ample and the irrigators used as much as they considered necessary. The average for the four fields of new land was 21.88 inches while that for the three fields of the second-year land 17.84 inches. We should expect that the land would require more water the first year than the second, yet these measurements do not show a very striking difference. The men on whose farms the records were kept are experienced irrigators and their judgment in the use of water is reliable. The soil on these farms is deep, very fine and uniform throughout and is typical of a vast area of land in south central Idaho.

The average amount of water used in the 18 irrigations

recorded was 7.84 inches each application. Four of the fields were irrigated three times and three fields but two times. The irrigation season for alfalfa would be 100 days or even more, while that for small grain should range from 50 to 75 days. Assuming the average irrigating season to be 75 days, water delivered at the rate of 1-eightieth second foot per acre would cover the land to a depth of 22.31 inches. If 7.84 inches should be applied each time this amount would be sufficient to irrigate nearly three times and 26 days and 9 hours would be required to irrigate once. If, however, the application be six inches which should be sufficient, the amount delivered in 75 days would be more than enough to irrigate three times and each irrigation would last 20 days and 6 hours.

The measurements of the Twin Falls tract are not directly comparable to those made near Idaho Falls, chiefly on account of different soil conditions. In that district the soil varies greatly, ranging from a sandy soil to a heavy clay, and gravel occurs more or less generally at varying depths beneath the surface. The old water rights here call for a Miner's inch or one-fifteenth of a second foot per acre. For alfalfa and small grain flooding is the general practice, a large head generally being used and the water spread over the fields quickly.

MEASUREMENT OF THE EXPERIMENT FARM OF THE TWIN FALLS LAND AND WATER CO.

Arrangements were made with Superintendent A. McPherson for records of the use of water on the experiment farm which comprised forty acres of second-year land. Mr. McPherson wished to divert for use on the farm the exact amount allowed by the company. To this end a weir was installed under the direction of the writer in the supply ditch and another one at the lowest point on the farm to measure the waste. The gate diverting the water from the main lateral was set so that it supplied a little in excess of the amount required, the stream being divided at a point a few hundred feet from the farm. The division was made in the follow-

ing manner. A flume was placed in the ditch and a vertical partition inserted into it. This partition had a horizontal slit, 1x25 inches cut through it. In the flume above the partition there was an overflow space and the adjustment was such that the water stood at a uniform height of 4 inches above the center of the slit. This proved quite satisfactory, there being but very slight variation in the discharge. The area of the opening being 25 square inches and the head 4 inches, a steady flow of 25 Miner's inches or one-half second foot, the amount allowed for forty acres, was diverted. The water passing through the slit flowed into a box for the weir measurement which served as a check. In connection with the weir was an automatic register. The weir at the lowest point on the farm also had an automatic register which was very necessary since the waste varied greatly. The foreman of the farm, Mr. C. E. Moyer, attended to the registers and made all necessary records. Since the farm contained many different crops, the head of water often had to be divided on the farm and used on more than one plat at a time. It was therefore impracticable to secure separate records for but a few plats and the following are the ones on which an account of the water used was kept.

ALFALFA, 14 ACRES.

First irrigation, May 2-15	12.65
Second irrigation, June 20-July 3	5.70
Third irrigation, July 31-Aug 15	10.69
Fourth irrigation, Sept. 1-15	10.83
Total applied	39.87
Rain fall	4.73
Total received	44.60
Head of water used, .5 sec. ft.	
Yield, 4 tons per acre.	

The first and fourth irrigations were continuous day and night; the second and third at night only as the water was used on other plats during the day. The waste was small and at no time did it amount to more than 28 per cent.

The amount applied was large and in excess of real needs as soil moisture tests showed. Several reasons may be given why the amount used was large, namely: a commencement of irrigation earlier than necessary which was an effort to be forehanded as it was feared that other crops would require the water later; the very slight fall of the land and consequent less rapid spreading of the water; the small head of water used and the frequent interruptions in the irrigations.

SPRING WHEAT, .49 ACRES.

First irrigation, June 21	13.10
Second irrigation, July 11	14.08
Total applied	27.18
Rainfall	4.63
Total received	31.81

Head of water used, .5 sec. ft.
Yield at rate of 63.6 bushels per acre.

The waste off the plat was 28 per cent. of the head of water used, or a total of 7.62 inches in depth for the two irrigations. A consideroble waste is unavoidable on such a small plat as this one, but in a larger field where the runoff may be collected and redistributed it is possible to reduce the waste to a very insignificant amount.

Mr. McPherson believes that as large a yield would have been secured had less water been used. Five other wheat plats were irrigated but once and these yielded at the rate of 47, 48, 55, 61, and 69 bushels per acre.

SUGAR BEETS, .49 ACRE.

Five irrigations, May to August	26.30
Rainfall	4.73
Total received	31.03

Yield at rate of 21.5 tons per acre.

ONIONS, .8 ACRE.

Five irrigations, May to August.....22.66
Rainfall.....4.73
Total received.....27.39
Yield at rate of 29.4 bushels per acre.

The total amount of water used on the farm during the season, May 2 to September 15, expressed in terms of inches in depth over the whole farm was as follows:

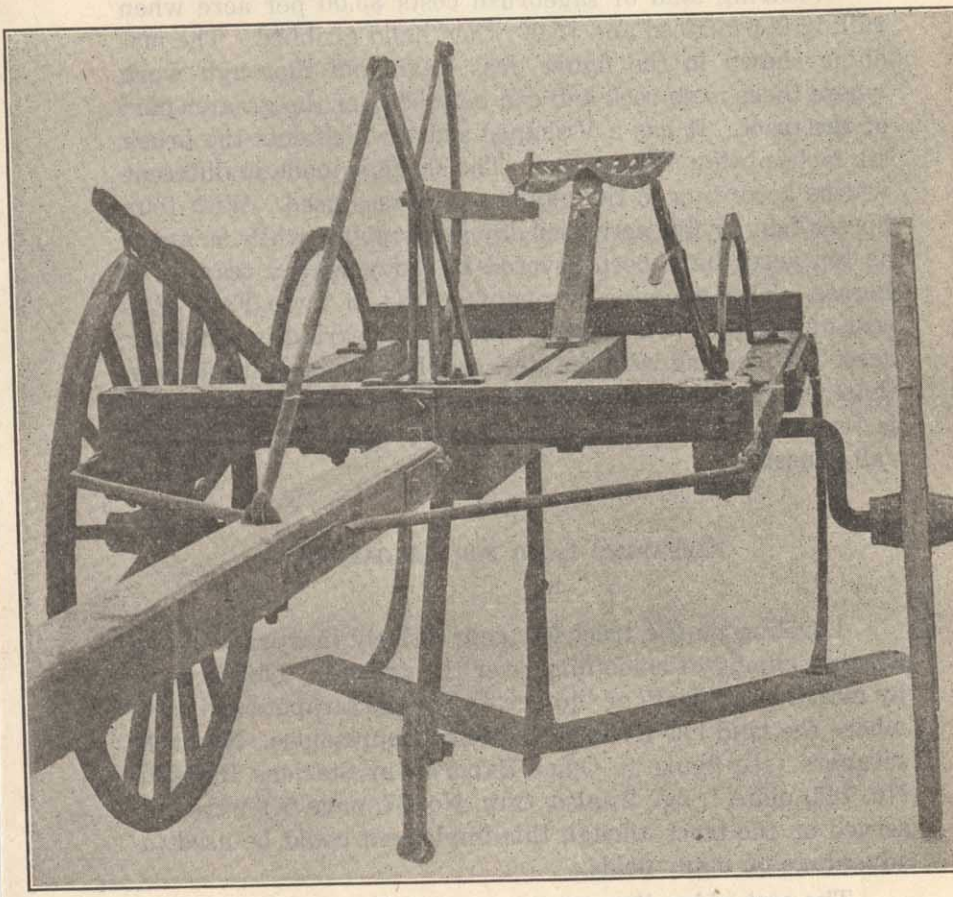
Month	Applied Inches	Rainfall Inches	Total Rec'd Inches
May	7.00	1.58	8.58
June	7.74	2.72	10.46
July	6.65	.09	6.74
August	6.27	.10	6.37
September	4.76	.11	4.87
Total	32.42	4.60	37.02

During the 138 days, from May 2 to September 16, there were 30 days and 19 hours when water was not used or about one-fourth of the time. The amount not used is equal to a depth of 9.16 inches over the forty acres or enough to irrigate the whole farm once and half of it a second time.

WASTE WATER FROM EXPERIMENT FARM.

The record of the water wasting off the farm was kept for 7 weeks from July 7 to August 25.

Weeks Ending	Average Per Second Cu. Ft.	Per Cent.
July 14	.070	14.1
July 21	.111	22.2
July 28	.031	6.2
August 4	.044	8.1
August 11	.028	5.7
August 18	.072	14.5
August 25	.124	24.8
Average	.068	13.6



LABOR AND COST DATA AND IRRIGATION PRACTICE.

CLEARING.

Clearing land of sagebrush costs $3.00 per acre when railing is practiced and $5.00 when hand grubbed. The machine shown in the figure does clean and thorough work where there is no rock and can be used over the greater part of the tract. It has a V-shaped share which cuts the brush six inches below the surface. The share is made in different widths according to the number of horses used. With four horses four or five acres per day are grubbed while as many as ten acres have been covered in a day with a team of 8 horses. This machine is manufactured in Twin Falls at a cost of $125.00. The contract price for clearing is $5.00 per acre. The clearing with the steel grubber is more satisfactory than other methods since a part of the main root of the brush is removed and cleaner work is done than where the iron rail is used.

PREPARING LAND FOR IRRIGATION.

Leveling on the tract is comparatively inexpensive and consists chiefly of smoothing over the ground. This is done by means of a "float" or "joiner." Tongue scrapers are used where the land has to be moved to fill depressions. No buck scrapers (see figure in Office Experiment Stations Bulletin No. 145, plate 1, fig., 2; also, Circ. No. 67, page 5.) were observed on the tract, though this implement could be used to advantage on many fields.

The cost of leveling ranges upward from a minimum of 50 cents per acre depending on the nature of the ground.

METHODS OF APPLYING.

The method of applying water generally adopted on the

tract is the furrow system also known as the Yakima or the corrugation system. Ninety per cent. of the farmers on the tract use this method which seems to be very successful on the Twin Falls soil. Only a few farmers have gone to the expense of making irrigation automatic, that is, of placing lath tubes or "spouts" in the head ditches to regulate the flow of water into the furrows. This is an extra expense of $1.00 per acre, which, however, decreases the costs of applying water and makes irrigation on the whole more satisfactory.

The tool most generally used for making furrows is of the runner type. Some have no tongue and are therefore rather unsteady. Those with a tongue bolted solid on the platform are better. In others the tongue has some play and a lever is added to regulate the depth of the furrows. Only a few drum markers were seen on the tract.

COST OF APPLYING WATER.

The first irrigation on new land is the most difficult, and the most expensive, often costing $1.00 or more per acre. After the banks of the ditches have settled and become firm the average cost is 60 cents per acre. Where three men are needed to manage the irrigation in spring but one man is required later in the season. With the ditches in good order and the furrow system established one man can irrigate 100 acres of small grain or 150 acres of alfalfa. From 12 to 18 hours will be required for the irrigation and with a head of 2 second feet water may be running on from 6 to 10 acres at one time. Where the system is automatic but a part of the working hours of the day will be required to look after the irrigation but where not so arranged constant attention is necessary. Where spouts are not used one man generally irrigates four acres per day, but if the ditches are new he can attend to but two to three acres.

The average cost par acre of clearing, preparing land for irrigation, applying water and cost of production of two

of the leading crops may be summarized as follows. It is assumed that the automatic furrow system is used, and that the alfalfa is sown without a nurse crop.

Alfalfa—first year on new land.

Clearing	5.00
Plowing	2.50
Leveling	.50
Ditching	1.00
Seeding	2.50
Furrowing	.50
Spouts	1.00
Irrigating 3 times	2.00
Harvesting (1 ton)	2.30
Total	$17.30

Alfalfa—second year.

Repair ditches	25
Irrigating 3 times	1.50
Harvesting (6 tons)	10.80
Total	$12.55

Wheat on second-year land.

Plowing	2.50
Leveling	.50
Seeding	2.10
Furrowing	.50
Repairs of ditches	.25
Irrigating 2 times	1.20
Harvesting (45 bushels)	5.65
Total	$12.70

YIELDS OF CROPS IN 1906.

The productiveness of the land is all that can be desired as the following tabulation of yields will show. (For further information regarding agriculture on the Twin Falls tract see report of Superintendent A. McPherson for 1906.)

Yields per acre.

Crop	Average	Maximum	Price
Alfalfa, 1st year, tons	1	3	16.00
Alfalfa 2nd year, tons	6	9	16.00
Wheat, bushels	45	84	* 1.15
Oats, bushels	50	119	* 1.15
Corn, bushels	30	70	* 1.25
Potatoes, bushels	250	451	* .75
Onions, bushels	250	299	* 2.50
Sugar Beets, tons		21	4.50

*Price per cwt.

IRRIGATION PRACTICE IN BINGHAM COUNTY.

In this district flooding is the general practice and furrow irrigation is not employed for small grain or alfalfa. The fields are laid off into long strips 100 to 200 feet wide. These are termed "lands" and are separated by low levees which confine the water to each strip. The lands are graded so they are nearly level across. Usually they are laid off in comformity with the general slope of the land to lessen the cost of construction and in order that the surface soil may be disturbed as little as possible. Most of the land is underlaid by gravel thus ensuring good drainage but favoring a large loss by percolation. Since the soil is generally porous a large head is used and the water spread over the ground quickly. This method is well suited to the soil conditions obtaining over a large part of this district. The levees, however, become infected with noxious weeds which aside from being a nuisance make the fields appear rather unsightly. The lands often are too long. Some farmers mark out for irrigation but the furrows made are very shal-

low, so the irrigation is essentially flooding.

Alfalfa in the vicinity of Idaho Falls is cut twice and yields 3 to 5 tons per acre. It is generally irrigated three times before the first cutting and two times more before cut again. The first irrigation of this crop is early in May. Small grain is irrigated three times and sugar beets 4 to 5 times.

SEEPAGE MEASUREMENTS.

In measuring the seepage on the canals of the Twin Falls system the distance covered in a day was treated as a unit, a gaging being made at the starting point and another at the stopping place in the evening. The proceedure was from the head of each canal downward, every diversion and addition being measured. The trips down the Main canal and Low Line were made in a boat especially constructed for the purpose. Since we proceeded along with the flow of the water fluctuations in the volume had such occurred would not have affected the accuracy of the measurement. Down the High Line canal the trip was made with a team while along the laterals and coolees we went on foot in order that no diversion or addition of waste water might be missed. An account of the various measurements follows. The discharges at the different stations, the diversions and the loss are given in second feet.

MAIN CANAL.. FIRST SECTION.. MILNER TO DRY CREEK RESERVOIR. JUNE 9.

Inflow at station, 50½	971.707
Outflow at station, 461½	880.041
Loss	91.666
Length of section	7.79 miles
Loss per mile	11.767
Per cent. loss per mile	1.21
Loss per 10,000 sq. ft. of wetted surface	.218
Average width of water surface,	102.3 ft.
Average depth of water	5 ft.

Many rock cuts occur in this section of the canal. The soil throughout the length of the main canal is not as heavy as that along the other two larger canals. The Main canal has been in use since early in thespring of 1905.

MAIN CANAL. SECOND SECTION. DRY CREEK RESERVOIR. JUNE 11.

Inflow—		
Discharge at station 461½	875.984	
Dry Creek	16.150	
		892.134
Outflow—		
Discharge at station 546½	839.361	
Diversions	1.790	
		841.151
Loss		50.983
Per cent. loss	5.71	
Loss per 10,000 sq. ft. of wetted surface,	.01465	

To ascertain the loss by seepage and evaporation from the reservoir, gagings were made just above the point of inflow and just below the outlet. The loss for a given area of wetted surface is very much less than in the canals. The deposition of sediment in the reservoir is making the bottom less permeable and thus decreases the loss. Some loss by percolation through and under the dam along the north side is evidenced by standing water in the borrow pits below and by a few small trickling streams which arise at the base of the embankment.

MAIN CANAL. THIRD SECTION. DRY CREEK RESERVOIR TO WITHIN 3¼ MILES OF THE END OF CANAL. JUNE 12.

Inflow at station 546½		839.361
Outflow—		
Discharge at station 1179	684.164	
Diversions in section	53.692	
		737.856

Loss		101.505
Length of section	11.98 miles	
Loss per mile		8.472
Per cent. loss per mile		1.01
Loss per 10,000 sq. ft. of wetted surface		.174
Average width of water surface	92.05 ft	
Average depth of water	5.3 ft	

The channel in this section is almost entirely in soil there being but few rock cuts.

MAIN CANAL. FIRST SECTION. MILNER TO DRY CREEK RESERVOIR. AUGUST 6.

Inflow at station 50½		1690.998
Outflow—		
Discharge at station 461½	1495.027	
Diversion in section	1.301	
		1496.328
Loss		194.670
Length of section	7.79 miles	
Loss per mile		24.989
Per cent. loss per mile		1.48
Loss per 10,000 sq. ft. of wetted surface		.424
Average width of water surface	111.6 ft.	
Average depth of water	7.9 ft.	

At the time this measurement was taken the water was held high in the canal above the gates at Dry Creek. This had the effect of decreasing the velocity of the water so that the discharge at the end of the section was but 80.1 per cent of the calculated discharge for the particular depth of water then in the canal at that point. Had the flow of the water been uninterrupted the loss would have been a little less than 1.48 per cent.

MAIN CANAL. SECOND SECTION. DRY CREEK RESERVOIR TO SPILLWAY.

Inflow at station 544½		1447.589
Outflow—		
Discharge at station 973	1312.090	
Diversions	14.494	
		1326.584
Loss		121.005
Length of section	8.07 miles	
Loss per mile	14.994	
Per cent. loss per mile	1.04	
Loss per 10,000 sq. ft. of wetted surface	.294	
Average width of water surface	96.4 ft.	
Average depth of water	6.5 ft.	

This section is almost entirely in soil but a few rock cuts occur near the end of the section. It corresponds to the upper 8.07 miles of the third section in the series of measurements made in June. The flow in this section was normal.

MAIN CANAL. THIRD SECTION. SPILLWAY TO NEAR END OF CANAL. AUGUST 8.

Inflow at station 973		1312.090
Outflow—		
Discharge at station 1307½	1081.125	
Diversions	137.083	
		1218.208
Loss		93.882
Length of section	6.32 miles	
Loss per mile	14.855	
Per cent. loss per mile	1.13	
Loss per 10,000 sq. ft. of wetted surface	.291	
Average width of water surface	96.4 ft	
Average depth of water	6.6 ft	

At the upper station the flow was normal but at the lower end of the section the water was deeper and the velocity therefore less than if the gates at the end of the canal had not been lowered to hold the water high in the canal. Hence, the figures show a slightly greater loss than if the flow of the water had been normal.

LOW LINE CANAL. FIRST SECTION. STATION 359 TO STATION 697. JUNE 15, 1907.

Inflow—		
Discharge at upper station		336.291
Additions	6.777	
		343.068
Outflow—		
Discharge at lower station	271.185	
Diversions	37.059	
		308.244
Loss		34.824
Length of section	6.40 miles	
Loss per mile	5.440	
Per cent. loss per mile	1.58	
Loss per 10,000 sq. ft. of wetted surface	.187	
Average width of water surface	54.85 ft.	
Average depth of water	3.6 ft.	

Throughout this and the two following sections the soil is noticeably heavier than along the Main canal. Occasional rock cuts occur and for a great deal of the length of the canal the channel has been cut into or through the white line formation which is not uncommon along this canal and the High Line. Water was first run in this section in June, 1905. The additions were waste water.

LOW LINE CANAL. SECOND SECTION. STATION 697 TO STATION 1204½. JUNE 18.

Inflow at upper station	332.239

Outflow—		
Discharge at low station	133.876	
Diversions	147.595	
		281.595
Loss		50.654
Length of section	9.61 miles	
Loss per mile	5.271	
Per cent. loss per mile	1.59	
Loss per 10,000 sq, ft. of wetted surface,	.191	
Average width of water surface	52.2 ft.	
Average depth of water	3.3 ft.	

The upper part of this section was in use for the first time in June, 1905; the lower part not until April, 1906.

LOW LINE CANAL. THIRD SECTION. STATION 697 TO STATION 1534. JUNE 19.

Inflow at upper station		133.876
Outflow—		
Discharge at lower station	34.297	
Diversions	77.171	
		111.468
Loss		22.408
Length of section	6.24 miles	
Loss per mile	3.591	
Per cent. loss per mile	2.68	
Loss per 10,000 sq. ft. of wetted surface	.171	
Average width of water surface	37.9 ft.	
Average depth of water	1.8 ft.	

Water had been in this section since April 17 or about two months.

HIGH LINE CANAL. FIRST SECTION. END OF MAIN CANAL TO COTTONWOOD CREEK. JULY 2.

Inflow—		
Discharge at station 4½	224.607	
McMullen Creek	1.854	
		226.461
Outflow—		
Discharge at station 674½	177.925	
Diversions	13.340	
		191.265
Loss		35.196
Length of section	12.68 miles	
Loss per mile	2.776	
Per cent. loss per mile	1.22	
Loss per 10,000 sq. ft. of wetted surface	.108	
Average width of water surface	48.5 ft.	
Average depth of water	2.9 ft.	

Where the canal crosses the Rock Creek bottom and for some distance beyond the channel is wholly or in part in gravel. For the remainder of the length of the canal the soil is like that along the Low Line. Occasional rock cuts occur and the white line formation is frequently encountered. In this section a little visible seepage may be seen. Some emerges in several places near Rock Creek at some distance from the canal. There is a little seepage through gravel at McMullin Creek. At Cottonwood Creek where the channel has been cut through rock there is some visible loss.

Water was run down as far as the Stricker lateral for a short time in the fall of 1905, the distance being less than three miles. On May 13 the following spring water was turned in and allowed to run to near the end of the canal.

HIGH LINE CANAL. SECOND SECTION. COTTONWOOD CREEK TO CEDAR DRAW. JULY 3.

Inflow at station 674½		177.925
Outflow—		
Discharge at end of section	92.086	
Diversions	41.394	
		133.480
Loss		44.445
Length of section	16.94 miles	
Loss per mile	2.623	
Per cent. loss per mile	1.47	
Loss per 10,000 sq. ft. of wetted surface	.121	
Average width of water surface	41.15 ft.	
Average depth of water	2.7 ft.	

At the time of the measurement water had been in this section but 51 days.

HIGH LINE CANAL. THIRD SECTION. CEDAR DRAW TO NEAR END OF CANAL. JULY 6.

Inflow at station 1569		92.086
Outflow—		
Discharge at station 2192	29.905	
Diversions	45.430	
		75.335
Loss		16.751
Length of section	11.8 miles	
Loss per mile	1.421	
Average width of water surface	28.4 ft.	
Loss per 10,000 sq. ft. of wetted surface	.095	
Average depth of water	1.9 ft.	
Per cent. loss per mile	1.54	

Water had been in this section of the canal but 52 days.

LATERAL D. AUGUST 14.

Inflow—		
Discharge at upper station	64.965	
Additions of waste water	1.446	
		66.411
Outflow—		
Discharge at lower station	59.041	
Diversions	4.606	
		63.647
Loss		2.764
Length of section	1.57 miles	
Loss per mile	1.760	
Loss per cent. per mile.....	2.65	
Loss per 10,000 sq. ft. of wetted surface	.200	

This is one of the largest laterals on the tract and like most of them is short. It lies to the northeast of Hanson. The soil here is very deep and no rock or lime formation occurs in the channel of this ditch. The soil here is less heavy than in some other parts of the tract.

LATERAL Q. AUGUST 14.

Inflow—		
Discharge at upper station....	49.503	
Additions of waste water	.380	
		49.883
Outflow—		
Discharge at lower station	42.471	
Diversions	4.665	
		47.136
Loss		2.747
Length of section	1.66 miles	
Loss per mile	1.654	
Loss per cent. per mile.....	3.32	
Loss per 10,000 sq. ft. of wetted surface	.240	

This lateral lies northeast of Kimberly in a soil like that along lateral D.

LATERAL NO. 7. JULY 11.

Inflow—		
Discharge at upper station	28.759	
Additions of waste water	.546	
		29.305
Outflow—		
Discharge at lower station	15.818	
Diversions	10.042	
		25.860
Loss		3.445
Length of section	3.03 miles	
Loss per mile	1.136	
Loss per cent. per mile.....	3.88	
Loss per 10,000 sq. ft. of wetted surface	092	

The grade of this lateral is heavy in places so there is very little silting of the channel. This is the lateral that passes through the northeast corner of the town of Twin Falls.

PERRINE COOLEE. JUNE 26.

Inflow—		
Discharge at upper station	94.317	
Additions of waste water	3.120	
		97.437
Outflow—		
Discharge at lower station	56.652	
Diversions	38.009	
		94.661
Loss		2.776
Length of section	4.14 miles	
Loss per mile	.670	
Loss per cent. per mile.....	.69	
Loss per 10,000 sq. ft. of wetted surface	.040	

The section measured extends from a point 420 feet below the head of lateral No. 2 to bridge on Blue Lakes avenue. It is surprising that there was not a greater net loss. Considerable land along the coolee was irrigated during the season and seepage water from these fields no doubt reaches the coolee and offsets a part of the loss.

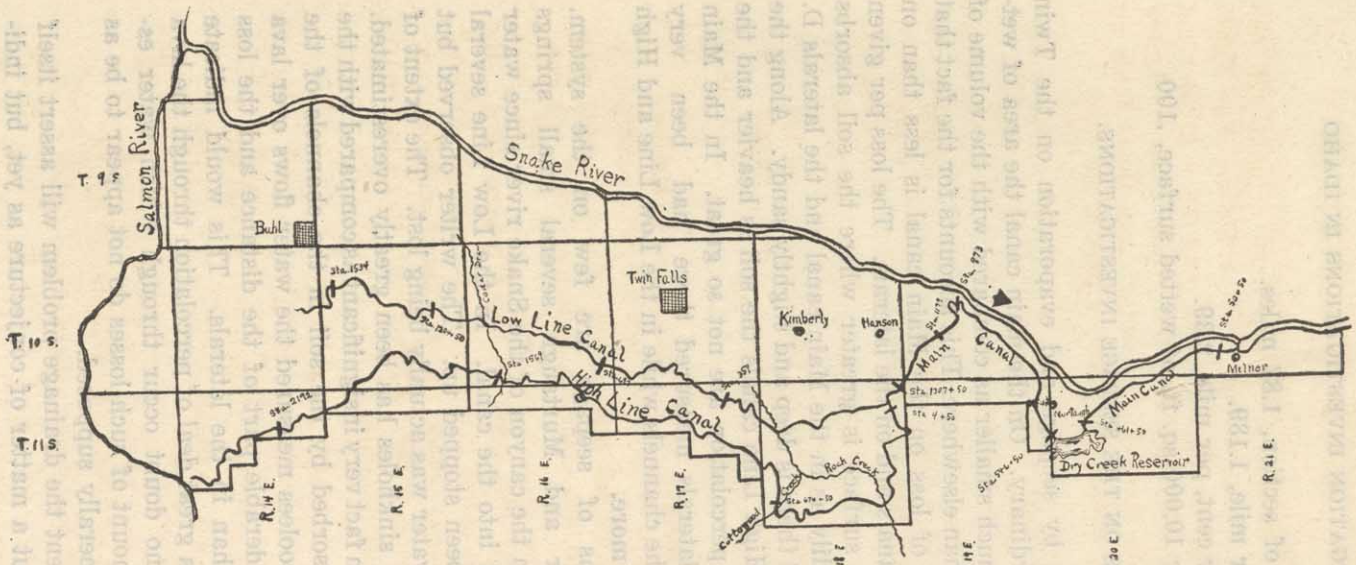
PERRINE COOLEE. AUGUST 15.

Inflow—		
Discharge at upper station	95.227	
Additions of waste water	1.449	
		96.667
Outflow—		
Discharge at lower station	58.319	
Diversions	39.931	
		98.250
Gain		1.574
Length of section	4.14 miles	
Gain per mile	.380	
Gain per cent. per mile.....	.39	
Gain per 10,000 sq. ft. of wetted surface	.022	

This section is the same as measured in June. By means of a current meter it is possible to measure within 2 per cent. of accuracy. Since the gain in this instance according to hte gaging is but 1.61 per cent. there may have been a loss rather than a gain.

J. COOLEE. AUGUST 28.

Inflow—		
Discharge at upper station,.....	44.907	
Additions (K. Coolee).....	2.799	
		47.706
Outflow—		
Discharge at Filer road crossing..	35.700	
Diversions.....	9.876	
		45.576
Loss.....		2.130



The Twin Falls tract showing canals and gaging stations.

Length of section, 1.87 miles.
Loss per mile, 1.139.
Loss per cent, per mile, 2.39.
Loss per 10,000 sq. ft. of wetted surface, .100

NOTES ON THE SEEPAGE INVESTIGATIONS.

The losses by seepage and evaporation on the Twin Falls are but ordinary. On the main canal the area of wetted surface is much smaller as compared with the volume of water carried than elsewhere. This accounts for the fact that the percentage of loss on the Main canal is less than on the other two canals and on the laterals. The loss per given area of wetted surface is greater where the soil absorbs water most readily as in the Main canal and the laterals D. and Q. The soil there is deep and slightly sandy. Along the Low Line and High Line canals the soil is heavier and the losses there by percolation are not so great. In the Main canal and the laterals measured there had been very little silting of the channels while in the Low Line and High Line there was more.

Visible signs of seepage are few on the system. Between Milner and Murtaugh several small springs have appeared in the canyon of the Snake river since water was first turned into the canal. In the Low Line several sinkholes have been stopped up. The writer observed but two where any water was actually being lost. The extent of the loss through sinkholes has been greatly overestimated. Such losses are in fact very insignificant as compared with the total amount absorbed by the soil in the channels of the canals. In the coolees measured the water flows over lava rock for a considerable part of the distance and the loss there was less than in the laterals. This would indicate that there is not a great deal of percolation through the lava rock. Fissures no doubt occur through which water escapes, but the amount of such losses do not appear to be as great as it is generally supposed.

To what extent the drainage problem will assert itself on the tract is but a matter of conjecture as yet, but indi-

cations are that with intelligent cultivation no serious dangers need be apprehended.

RATE OF ABSORPTION.

In the Main canal each square foot of wetted surface absorbed on the average .00002802 cubic feet per second or each acre 1.22 cubic feet per second. This water percolates through the soil of the channel at the rate of .05 inch per minute, 5.5 feet per day or 2021 feet per year. It is very probable that the movement is much slower at some distance from the canal. Where the soil is dry and has not been irrigated the progress of the seepage water is very slow.

EVAPORATION.

Records of evaporation from a water surface were kept at the Experiment Farm from April 16 to October 1. For this purpose a large tank, 30 inches deep, was sunk in the ground. The loss was as follows:

Evaporation From Water Surface at Twin Falls.

Period ending	Length of period days	Evaporation Depth in inches
April 23	7	1.41
April 30	7	1.24
May 12	12	1.84
May 19	7	1.76
May 27	8	.76
June 3	7	1.04
June 11	8	1.61
June 18	7	1.75
June 25	7	2.10
July 3	8	1.46
July 9	6	1.59

Period ending	Length of period days	Evaporation Depth in inches
July 16	7	2.10
July 26	10	3.30
July 30	4	1.20
Aug. 6	7	2.00
Aug. 13	7	1.80
Aug. 20	7	1.90
Aug. 27	7	1.00
Sept. 3	7	1.90
Sept. 10	7	1.90
Sept. 19	9	1.50
Sept. 25	6	1.50
Oct. 1	7	1.20
Total	169	37.86
Maximum per week		2.31
Minimum per week		.66
Mean per week		1.57

The evaporation here recorded is slightly greater than that which actually took place in the canals for the temperature of the water in the tank was somewhat higher. The least loss was during the rainy, cloudy days the latter part of May, and the greatest during the dry hot weather in July. The evaporation varies with the temperature, the humidity of the air and the velocity of the wind. It may be six times as great in a strong wind as when the air is still.

RELATIVE AMOUNT OF EVAPORATION AND SEEPAGE.

In the canals the loss by evaporation was very small as compared with the seepage while in the Dry Creek reservoir the difference was not so great. Taking the evaporation records secured on the Experiment Farm the loss by evaporation and seepage as percentages of the total loss has been calculated as follows:

	Evaporation Per cent.	Seepage Per cent.
Main Canal in June	1.09	98.91
Main Canal in Aug	.72	99.28
Low Line Canal in June	1.15	98.85
High Line Canal in July	1.92	98.08
Dry Creek Reservoir in June	14.74	85.26

SUMMARY.

1. The results set forth in this report hold good primarily for the fine volcanic soils of southern Idaho that are homogeneous throughout, several to many feet in depth and not underlaid by gravel or hardpan.

2. The precipitation for the year 1906 was 9.82 inches at Twin Falls and 14.38 inches at Idaho Falls.

3. The soil of the Twin Falls tract weighs 83.0 pounds when water free, 110.3 pounds when saturated and 100.6 pounds when containing the average amount of capillary water.

4. The maximum capacity of the soil for moisture is 24.72 per cent. by weight, 43.69 per cent. by volume or 5.24 inches per foot of depth.

5 In spring the soil on unbroken land at Twin Falls was moist only to a depth of 18 inches and contained 5.78 inches of water in the first three feet. In August it was dry throughout and contained but 2.92 inches of water in the first three feet.

6. Land irrigated the preceding season contained in spring 10.01 inches of water in the first three feet.

7. An alfalfa field contained 8.58 inches of water in the first three feet of soil one day before irrigation, 12.84 inches one day after and 10.13 inches seven days after.

8. In a wheat field there was a gain of 2.8 inches of water in three feet of soil in 57 days after date of harvesting.

9. It was found that irrigated land may hold by capillarity 10.01 inches of water in three feet. A crop of wheat, irrigated twice did not reduce the contents to less than 5.59 inches.

10. To produce one pound of dry matter in a crop of wheat 671 pounds of water were required.

11. The average duty of water on first-year land was 21.88 inches, on second-year land 17.84 inches. The average amount applied in one irrigation was 7.84 inches.

12. On the experiment farm of the Twin Falls Land and Water Company an amount of water equal to a depth of 32.42 inches over the whole 40-acre tract was applied in 138 days. Out of a total of 41.58 inches delivered according to the contract 9.16 inches were not used.

13. The waste water on the Experiment Farm averaged 13.6 per cent.

14. The Yakima or furrow system of irrigation is used by 90 per cent. of the farmers on the Twin Falls tract.

15. The furrows or corrugations are made 20 to 24 inches apart and the soil subs with a run of 40 rods in from 24 to 30 hours.

16. One man can irrigate 100 acres of small grain or 150 acres of alfalfa.

17. The first irrigation on new land costs about three times as much as the last one in the season.

18. The cost of clearing land and preparing it for irrigation and for seeding is $10.50. The second year the preparation costs $3.75.

19. The cost per acre of seeding, irrigating and harvesting alfalfa the first year is $7.10 with a yield of one ton. The second year the expense is $12.55 with a yield of 6 tons.

20. The cost per acre of seeding, irrigating and harvesting, wheat is $8.95 with a yield of 45 bushels.

21. The average yields are: wheat, 45 bu., oats, 50 bu.; potatoes, 250 bu.; corn 30 bu.; alfalfa, first year, 1 ton; second year, 6 tons.