OKLAHOMA

AGRICULTURAL EXPERIMENT STATION.

Bulletin No. 29--September, 1897.

A STUDY OF WATERS FOR IRRIGATION.

THE IRRIGATION PLANT.

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JOHN FIELDS.

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STILLWATER, OKLAHOMA.

OKLAHOMA

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Irrigation Waters of Oklahoma.

Between June 12th and 22d, 1897, twenty-five samples of water were collected in the northern, western and central portions of the Territory for the purpose of determining their fitness for irrigation. Detailed information concerning source of the samples and analytical data will be found at the close of this bulletin.

The materials dissolved in irrigation water are left in the soil when the water evaporates. It is not possible to say with certainty that a given water is unfit for irrigation unless it contains a large amount of dissolved matter. This is especially true in Oklahoma, where the heavy spring rains do much toward washing the soluble salts out of the soil and carrying them away. For this reason, accumulation of alkali salts in any considerable amount would not be expected to come from the use of waters which would be unfit for use in regions having a smaller annual rainfall.

The following conclusions are not based on experimental data, but are deduced from careful comparisons of our conditions with those existing where experiments have been made.

The samples examined naturally fall into three classes—river, well, and pond waters. They will be discussed in this order.

I—RIVER WATERS.

1. The waters of the Black Bear, the Salt Fork of the Arkansas, and the Cimarron are unfit to be used for irrigation. The first contains too much black alkali to be used with safety; the others are too salty.

2. The water of the North Fork of the Canadian may be classed as doubtful, and probably unfit, since it contains a considerable amount of the salts which go to form white alkali.

3. The waters of the Red Rock, the Arkansas above the Salt Fork, the Shakaska, Deer Creek, and the Canadian at Taloga, are considered to be safe irrigation waters. It is not thought that their use would tend to cause a material increase in the amount of alkali in the soil.

It is to be understood that these conclusions are but tentative, they being based upon but a small number of samples taken, not during a period of drought, but when the streams were flowing their average volume of water. It is expected that more work will be done on these waters whenever practicable, and no extensive irrigation schemes should be undertaken until more extended data are secured.

Sample No.	SOURCE	Lbs. in 100,000 lbs.		Lbs. in 1 acre-inch.	
		White Alkali	Black Alkali	White Alkali	Black Alkali
739	Black Bear	13.5	14.1	30.5	31.9
740	Red Rock	6.7	2.2	15.1	5.0
741	Salt Fork of Ark	875.6	0.9	1978.9	2.0
742	Arkansas	30.6	0.5	69.2	1.1
743	Shakaska	15.5	0.7	35.0	1.6
744	Deer Creek	39.9	2.2	90.2	5.0
751	Cimarron	737.4	1.1	1666.5	2.5
753	N. Fork of Cana.	81.8	2.6	184.9	5.9
755	Canadian	33.4	0.9	75.5	2.0
756	N. Fork of Cana.	82.5	1.2	186.5	3.8
763	Cimarron	638.1	0.9	1442.1	2.0

One acre-inch is the amount of water equal to a rainfall of one inch on an acre.

By "white alkali" is meant the sum of the salts commonly included in this term, viz: Calcium sulfate and chlorid, magnesium sulfate and chlorid, and sodium sulfate and chlorid.

By "black alkali" is meant sodium carbonate.

II—WELL WATERS.

Sample No.	SOURCE	Lbs. in 100,000 lbs.		Lbs. in 1 acre-inch.	
		White Alkali	Black Alkali	White Alkali	Black Alkali
746	30 ft. deep, 1 mile east Pond Creek	106.3	10.1	240.2	22.8
747	At railroad station, Pond Creek	108.2	11.5	244.5	26.0
749	9 miles east, 6½ north of Cleo	30.6	2.6	69.2	5.9
750	16 feet, town well of Cleo	11.1	1.4	25.1	3.2
752	22 feet deep at Leslie postoffice	50.0	2.2	113.0	5.0
754	90 feet, 13 miles east, 1 south of Taloga	3.3	2.6	7.5	5.9
757	At Hotel at Omega	157.7	3.6	356.4	8.1
758	30 feet deep, at Kingfisher	60.1	1.7	135.8	3.8
759	30 feet, 6 east, 2½ south of Kingfisher	50.0	2.2	113.0	5.0
760	25 feet deep at Downs	8.4	13.2	19.0	29.8
762	50 feet deep at Langston	32.2	5.3	72.8	12.0
764	24 feet deep near Stillwater	5.3	20.7	12.0	47.0

The waters of wells present a problem different from that of the rivers. Good, bad, and no water have frequently been found within a few rods, and, except in a most general way, analyses of well water are of value only for the well from which the sample was taken. For this reason discussion is impossible; all that can be said at present is that:

1. The water from wells represented by samples 749, 750, 754, and 762 are considered safe for irrigation under conditions existing in Oklahoma.

2. That represented by samples 752, 758, and 759 can probably be used without ill effects.

3. That represented by samples 746, 747, 757, 760, and 764 is most probably unfit for irrigation and would be expected to cause troublesome alkali in a few years.

Considering mineral contamination only, well water that is suitable for irrigation is safe for domestic use.

III—POND WATERS,

Sample No.	SOURCE	Lbs. in 100,000 lbs.		Lbs. in 1 acre-inch.	
		White Alkali	Black Alkali	White Alkali	Black Alkali
745	1 mile east, ½ north Lamont	0.8	0.9	1.8	2.0
748	5 miles west of Pond Creek............	3.3	11.8	6.8	26.7
761	5 miles west, 1 south Langston............	0.9	0.9	2.0	2.0

The soil over which storm waters flow on their way to the storage pond contributes whatever of dissolved matter is contained in the water. In general, such waters will be found admirably fitted for irrigation, but ponds so situated as to catch the drainage from alkali soils may be expected to furnish water like sample 748, which contains too much black alkali to be used with certain safety. Samples 745 and 761 are very good irrigation waters, and may be taken as fairly representative of the pond waters of the Territory.

THE IRRIGATION PLANT.

Those who contemplate the erection of irrigation plants of any sort should study the question well. It is probable that many windmill plants will be put in during the next few years, and that if irrigation is to any extent a success in Oklahoma, wind and windmills will be largely used for elevating water.

Well matured and accurate plans of contemplated systems of irrigation will prevent disappointment and loss of invested capital.

The majority of the soil formations of the territory are of a texture favorable to the construction of ponds, ditches, etc., and to irrigation. In some localities, very light, sandy soils abound, and as these absorb a very large amount of water and allow it to pass through them readily, the problem of irrigating them is more complicated. More water will be required on a loose soil with an open subsoil than on a close textured one, hence a smaller area can be irrigated at a given cost.

In certain localities, the waters of rivers and creeks may be pumped to storage reservoirs for irrigation. In the greatest number of cases, this cannot be done and ground-water will be the only source of supply.

The Well is of prime importance. It should be large and roomy so that it does not get pumped out easily, and located on higher ground than the land to be irrigated. Shallow wells are preferable to deep ones for the reason that the shorter the distance the water must be lifted, the more water can be pumped with a given power (see p. 9). If it is impossible to procure water at a small depth, it will, of course, be necessary to go deeper, but it will be at the continued expense of power to lift the water to the required height.

In most cases, especially if the water has a marked taste, it would be advisable to write the Experiment Station concerning it, giving exact location, character of soil, depth of well, area to be irrigated, and crops to be grown. Directions will then be sent for taking a sample of the water to be forwarded to the Station where its quality as an irrigation water will be determined free of charge. Samples sent under any other conditions will not be analyzed as the results would be of no definite value.

The water of wells is not always fitted for irrigation as will be seen on referring to the results of analyses. Many wells yield waters which are so heavily charged with alkali that they cannot be used for irrigation. When water of this nature is applied to the soil, the pure water evaporates and the alkali is left behind. If this is sufficient in amount, the soil will in time become saturated with alkali, so that crops will not thrive. The occasional heavy rains will wash out of the soil a great deal of the alkali left from the evaporation of irrigation water. Just how much alkali may be in a water before its use is dangerous cannot be definitely stated but in a semi-humid region, on soils with good drainage, it is safe to use waters that would be totally unsuited for irrigation in an arid climate.

Having secured a well yielding a sufficient volume of water of good quality for irrigation, the next feature of importance is,

The Reservoir.—The size of the reservoir should be such that a large volume of water may be stored, equal at least to that furnished by the well during one week. In most cases, one, two, or at most three, thorough wettings of the soil will be all that are required to safely tide any crop over our short dry spells. But when water is needed, it is very much needed, and unless a very large supply is stored up, a portion of the crop cannot be irrigated, there frequently being but little wind during extremly dry weather.

In order to calculate the dimensions of a reservoir of a given capacity, only the following data are needed:

27,154 gallons of water equals one acre-inch, or a rainfall of one inch on one acre.

There are 231 cubic inches in one gallon and 1728 cubic inches in one cubic foot.

The square of the radius of a circle multiplied by 3.1416 equals the area.

Suppose it is desired to irrigate ten acres, one inch to the acre; or five acres, two inches; what must be the dimensions of a reservoir which, when full, will contain sufficient water for the purpose?

$10 \times 27{,}154 = 271{,}540$ gallons of water required.

$\frac{271{,}540 \times 231}{1728} = 36{,}300$ cubic feet which must be the capacity of the reservoir. It now remains to decide upon a shape for the pond. Round reservoirs are easiest built, expose less wall surface for seepage, and unless there are special considerations making it desirable to use some other form, should be built in preference to others. If the reservoir is constructed to hold water five feet deep, what must be its diameter?

$\frac{36{,}300}{5} = 7{,}260$ square feet as the area of the pond.

$\frac{7{,}260}{3.1416} = 2{,}311$ feet equals the square of half the diameter

The square root of 2,311 is a little more than 48; hence the diameter of the pond should be 96 feet, or approximately 100 feet. From this, the size of a reservoir of any capacity may be readily calculated.

The sod should be entirely removed from the place where the bank is to be, as otherwise the dirt will not pack firmly and there will be a loss of water. With a horse scraper, scrape up dirt from the outside of the pond, leveling and packing firmly as the work progresses, until the walls are of the required height. The bottom of the reservoir should not be lowered by scraping, as it is desirable to keep it as high as, or higher than, the surrounding land. The walls should be sloping, much wider at the bottom than at the top, with a gradual incline on the inside. If the wall is five feet high, it should at least be two feet wide on top and seventeen feet wide at the bottom. After leveling and packing the walls, water should be run into the pond and cattle driven around in it until the bottom and walls are thoroughly puddled. This is usually easily accomplished with Oklahoma soils. Some trouble may be experienced in sandy localities. In such cases, a few loads of clay tramped in will remedy the difficulty. The pond should be made water-tight. The water which seeps away requires an expenditure of energy to elevate, does no good and is a clear loss.

The well and reservoir with flume for leading off the water having been secured, also troughs and ditches as required and varying with each outfit, the next step is the erection of a

Pump and Windmill.—The manufacturers of these appliances have issued catalogues fully describing the irrigation outfits now on the market. It is not within the province of this Bulletin to recommend any make of windmill, but it is believed that a galvanized steel wheel on a steel tower is the most economical and will be found best suited to Oklahoma's climatic conditions. There is usually enough wind to run a wheel to its full capacity, the average velocity being ten to twelve miles per hour.

With the exception of the erection of the tower and windmill, practically all of the work connected with the construction of such a plant as suggested may be done by the usual farm help during periods when crops do not require attention. When the work is done in this way, the cost of an outfit consisting of a well, a reservoir, and an eight foot wheel on a forty foot tower with an irrigating pump and fittings need not exceed $100. If a twelve foot wheel is erected on a forty foot tower, the cost will approximate $175 to $200.

An eight foot outfit, as described, is stated by one manufacturer to give, when fitted with the proper pump, the following:

	Gallons per Hour.	Hours required for one acre-inch.
Lifting water five feet	4,176	7
Lifting water ten feet	2,350	12
Lifting water fifteen feet	1.632	17
Lifting water twenty feet	1.044	26
Lifting water twenty-five feet	808	34
Lifting water forty feet	492	54

Under similar conditions, a twelve foot outfit will furnish water as follows:

	Gallons per Hour.	Hours required for one acre-inch.
Lifting water five feet	14,400	2
Lifting water ten feet	7,344	4
Lifting water fifteen feet	4.698	6
Lifting water twenty feet	3,600	8
Lifting water twenty-five feet	2,628	10
Lifting water forty feet	1,836	15

The great advantage of shallow wells when obtainable is thus clearly shown.

There will occur seasons when but little water is needed. At these times a considerable area may be irrigated with a small plant, if properly situated. Again, long dry spells will occur when a great deal of water will be needed and but a small area can be irrigated. But little irrigation has been practiced in climates similar to Oklahoma's and consequently little is definitely known of the quantity of water that will be needed, when and how to apply it under these conditions.

Generally speaking, it would seem advisable to locate the plant with a view to further extension; to dig a good sized well and build a small pond, say seventy-five to 100 feet in diameter, and to equip the outfit with an eight or twelve foot windmill with a good pump; to prepare ditches, flumes, etc., so that the first year's operations may be confined to not more than five acres. The most profitable crops should be grown on the five acres or less and given every attention, the operator observing and studying different methods of application of water and cultivation of the soil. It may require two acre-inches of water and it may require ten or fifteen to secure a good crop, depending upon the rainfall.

The first year's experience will be a great aid in laying plans for more extended irrigation if it is found profitable. It will take work, hard persistent labor, as two crops at least should be grown during the season. It will not be wheat farming or cattle grazing to the man that has the work to do. But there is every reason to hope for and to expect success. This success will not come with a jump as it did to the wheat growers in 1897, but will consist, if achieved, of a permanent foundation for safe farming, where instead of sprinkling energy over a quarter section, it will be confined to less than forty acres, the rest being used for grazing and growing forage crops.

It will be very difficult to change to this method of farming. There is little of the popular true-western, broad-acres spirit in it and those accustomed to western methods of farming will find it hard to begin again and learn a new method. It seems, however, that this kind of farming is being made profitable in localities less favored than is Oklahoma. Irrigation is well worth the trying but haste should be made slowly and surely.

The following articles contain information of value to the prospective irrigator:

Irrigation for the Garden and Greenhouse, L. R. Taft, Year Book of United States Department of Agriculture 1895, pp. 233-246.

Climate, Soil Characteristics, and Irrigation Methods of California, Chas. W. Irish, same Year Book, pp. 475-486.

Irrigation on the Great Plains, F. H. Newell, Year Book of United States Department of Agriculture, 1896, pp. 167-196.

ANALYSIS OF WATERS.

The examination of waters for irrigation and domestic use is considered a part of the work of the chemical department of the Station, and it has been the custom to examine all samples sent in. This work will be continued in the future under certain regulations which have been found necessary. Before sending samples write concerning the work to be done. Instructions for taking samples and forwarding the same will then be sent.

Results of forty-six analyses of waters were published in Bulletin No. 7, copies of which may be had while the supply lasts. In addition to the twenty-six samples reported in this bulletin, ninety-six other samples have been examined more or less completely, but the results are in most cases of only individual interest, and of no general value because of the unreliability of the samples.

It may be said, in general, that good water is obtainable in almost every part of Oklahoma. There are a few localities where more or less difficulty is experienced, but care in digging the well is frequently repaid by a supply, small at times, of good water. The mistake of going deeper for more water is sometimes made, with the result that it is secured but that the whole supply is unfit for use. If the first water struck is good, and there is a fair amount of it, digging should be stopped, especially in those localities where bad water is frequent. A second well may be dug if the supply is insufficient.

Pond waters are usually unfit for domestic use. They contain too much organic matter, which serves as a medium for the culture of disease germs. The condition of the waters of ponds is not bettered by permitting cattle to stand and hogs to wallow in them. Ponds should be fenced and arranged so that the water may be conveyed to troughs as required. Drinking stale, muddy pond water does not improve the health of farm animals. Milk from cows that drink these filthy waters is almost certain to be tainted; so is the butter.

ANALYTICAL DATA—IRRIGATION WATERS.

1—Record of Samples.

No. 739.—Black Bear at crossing 2 miles west of north of Stillwater, June 12, 1897.

No. 740.—Red Rock, Otoe School, U. S. Government bridge, June 12, 1897.

No. 741.—Salt Fork of Arkansas at ford and ferry south of Ponca School, June 12, 1897.
No. 742.—Arkansas River 2 miles east of Ponca City, June 13, 1897.
No. 743.—Shakaska at bridge west of Ponca City, June 13, 1897.
No. 744.—Deer Creek at bridge west of Tonkawa, June 14, 1897.
No. 745.—Pond 1 mile east ½ mile north of Lamont, June 14, 1897.
No. 746.—Well 30 feet deep 1 mile east of Pond Creek, fitted with windmill and pond 75x75 feet, for irrigating about one acre, June 14, 1897.
No. 747.—Shallow well at southeast corner of Rock Island station at Pond Creek postoffice, June 15, 1897.
No. 748.—Pond 5 miles west of Pond Creek, June 15, 1897.
No. 749.—Well 9 miles east 6½ miles north of Cleo, June 16, 1897.
No. 750.—Town well of Cleo, 16 feet deep, June 17, 1897.
No. 751.—Cimarron at ford south of Cleo, June 17, 1897.
No. 752.—Well 22 feet deep at Leslie postoffice, June 17, 1897.
No. 753.—North Fork of Canadian near Cantonment, June 17, 1897.
No. 754.—Well 90 feet deep 13 miles east 1 mile south of Taloga, June 18, 1897.
No. 755.—Canadian 3½ miles east ¼ mile south of Taloga, June 19, 1897.
No. 756.—North Fork of Canadian 4 miles northwest of Watonga, June 19, 1897.
No. 757.—Well at hotel at Omega, June 20, 1897.
No. 758.—Well 30 feet deep, Ball's feed barn, Kingfisher, June 21, 1897.
No. 759.—Well 30 feet deep 6 miles east 2½ south of Kingfisher, June 21, 1897.
No. 760.—Well 25 feet deep at Downs, June 21, 1897.
No. 761-—Pond 5 miles west 1 mile south of Langston, June 22, 1897.
No. 762.—Well 50 feet deep at livery barn, Langston, June 22, 1897.
No. 763.—Cimarron 3 miles east ot Langston, June 22, 1896.
No. 764.—Well 24 feet deep 1 mile north of Stillwater, July 1, 1897.

2—Composition of Solids.

Sample Number.	PARTS PER HUNDRED THOUSAND.							
	Chlorin	Solids	CaO	MgO	SO_3	Tot'l CO_2	Water—sol. CO_2	Insoluble CO_2
739	5.5	59.7	11.1	5.2	3.6	16.9	5.9	11.0
740	2.5	25.0	6.0	1.5	2.0	5.1	0.9	4.2
741	491.5	884.9	29.8	6.5	38.3	1.5	0 4	1.1
742	13.0	51 0	11.2	0.6	5.4	6.8	0.2	6.6
743	3.0	35.2	8.3	3.0	6.9	6.6	0.3	6.3
744	16.5	57.7	11.4	4.6	9.0	2.4	0.9	1.5
745	0.5	23.2	2.1	0.3	0.0	1.1	0.4	0.7
746	59.5	151.0	11.2	9.6	6.9	18.5	4.2	14.3
747	44.0	153.4	10.3	6.8	21.2	16.5	4.8	11.7
748	2.0	34 1	1.2	0 5	0.0	6.6	4.6	2 0
749	14.0	59.1	10.8	2.1	4.9	10.8	1.1	9.7
750	6.5	37.1	13.1	1.4	0.9	9.2	0.6	8.6
751	405.0	747.3	28.1	4.7	41.9	4.4	0.5	3.9
752	12.5	91.1	12 5	8.7	19.0	11.7	0.9	10.8
753	33 5	111.8	12.9	4.0	16.4	8.1	1.1	7.0
754	2.0	30.8	10.8	0.6	0.2	9 5	1.1	8.4
755	7.5	53.2	8.3	3.4	13.1	5.3	0.4	4.9
756	33.5	116.0	9.5	6.7	17.6	5.5	0.7	4.8
757	67.5	195.8	17.1	5.8	27.7	15.8	1.5	14.3
758	17.0	117.6	15.5	8.8	19.9	16.1	0.7	15.4
759	8.0	86.0	2.8	6.5	21 7	13 9	0.9	13.0
760	4.0	45.0	6.6	2.3	1.4	13.0	5.5	7.5
761	0.5	12.0	2.5	0.3	0.0	3.5	0.4	3.1
762	18.0	75.9	10.4	8.8	3.4	13.0	2.2	10.8
763	352.0	661.1	24.5	9.6	36.3	6.4	0.4	6.0
764	2.5	45.1	4.6	1.9	0 8	13.6	8.6	5.0

CaO, lime: SO_3, sulfur trioxid: MgO, magnesia: CO_2, carbonic acid gas.

3. Probable Constituents of Solids.

Sample No.	PARTS PER HUNDRED THOUSAND.										
	Ca CO_3	Mg CO_3	Ca SO_4	Mg SO_4	Ca Cl_2	Mg Cl_2	Na_5SO_4	Na Cl	Na_2CO_3	Und'd	Total[1]
739	19.8	4.4		5.4		4.3		3.8	14 1	7.9	59.7
740	9.3		2.2	1.0		2.8		0.7	2.2	6.8	25.0
741	2.5		65.4	1.9		14.0		794.3	0.9	5.9	884.9
742	15 0		1.4	1.8			6.0	21.4	0.5	4.9	51.0
743	14.3		0.7	9 0			0.9	4.9	0.7	4.7	35.2
744	3.4		15.3		6.3	10.9		7 4	2.2	12.2	57.7
*745	1.6				0.8				0.9	19.9	23.2
746	20.0	8 4		10.4		9.5		86.4	10.1	6.2	151.0
747	18.4	6.8		10.8			24.8	72.6	11.5	8.5	153.4
748	2.2	1.1						3.3	11.8	15.7	34.1
749	19.3	2.3		3.0			4.5	23.1	2.6	4.3	59.1
750	19.5		1 5		3.2	3.3		3.1	1.4	5.1	37.1
751	8.8		56.3	13.1		0.7		667.3	1.1		747.3
752	22.3	1.9		23.4			6.0	20.6	2·2	14.7	91.1
753	15.9		9.7	12.0			4.8	55.3	2.6	11.5	111.8
754	19.2			0.3		1.2		1.8	2.6	5.7	30.8
755	11.1		7.5	10.2			3.4	12.3	0.9	7.8	53.2
756	10.9		8.2	19.2		0.7		54.4	1.7	20.9	116.0
757	30.5	1.7		15.0			31.4	111.3	3.6	2.3	195.8
758	27.7	6.1		17.7			14.4	28.0	1.7	22.0	117 6
759	22.9	6.2		9.6			27.2	13.2	2.2	4.7	86.0
760	11.8	4.4		0.6			1.8	6.0	13.2	7.2	45.0
761	4.5	0.6						0.9	0.9	5.1	12.0
762	18.6	4.6		5.1		11.6		15.5	5.3	15.2	75.9
763	13.6		41.0	18.3		8.3		570.5	0.9	8.5	661.1
764	8.2	2.6		1.2				4.1	20.7	8.3	45.1

* Trace of Calcium and Magnesium Silicates.

Ca CO_3, Calcium Carbonate: Mg CO_3, Magnesium Carbonate: Ca SO_4, Calcium Sulfate: $MgSO_4$, Magnesium Sulfate: $CaCl_2$, Calcium Chlorid: $MgCl_2$, Magnesium Chlorid: Na_5SO_4, Sodium Sulfate: Na Cl, Sodium Chlorid: Na_2 CO_3, Sodium Carbonate.

WATER ANALYSIS—By Students in the Junior Class of College.

DATE 1897	SOURCE OF SAMPLE	*GRAINS PER GAL.			PARTS PER MILLION			NAME OF STUDENT MAKING ANALYSIS
		Total Solids	Loss on Ign.	Chlorin	Free NH_3	Alb'd NH_3	O Consumed	
March 30	College Pond outside of filter	12.2	7.6	0.3	0.24	1.00	21.14	Clark
March 30	College Pond inside of filter	12.7	6.4	0.27	0.07	0.54	21.81	Clark
April 5	Cistern North of College	12.4	3.7	1.25	0.025	0.18	2.84	Clark and Ford
April 8	Well, Duncan's Addition to Stillwater	21.95	6.0	1.30	0.015	0.133	1.3	Clark and Ford
April 12	Well, College Addition to Stillwater	22.5	4.7	1.00	0.011	0.109	0.3	Ford and Gilbert
April 14	Well, College Addition to Stillwater	19.1	4.8	0.4	0.009	0.118	0.67	Ford and Gilbert
April 16	Cistern, Stillwater	5.6	3.9	0.3	0.037	0.556	10.0	Ford and Gilbert
April 19	Well, College Addition to Stillwater	22.45	5.6	0.47	0.044	0.185	0.6	Gilbert and Hartman
April 19	Well, 50 feet south of previous one	22.75	6.15	0.4	0.025	0.145	1.0	Gilbert and Hartman
April 26	Cistern on Station grounds	22.25	3.9	4.2	0.032	0.508	20.0	Hartman and Morris
April 26	Well, Stillwater	37.4	7.9	1.6	0.187	0.358	2.35	Hartman and Morris
May 3	Well near Cimarron	33.0	10.65	2.4	0.032	0.768	44.1	Hartman and Morris

*For explanation of above terms, refer to Bulletin No. 7 of this Station.