IRRIGATION STATISTICS

OF THE

TERRITORY OF UTAH,

WITH MATTERS RELATIVE THERETO.

COMPILED AND PREPARED FOR

THE IRRIGATION CONGRESS.

TO BE HELD AT

SALT LAKE CITY, UTAH, SEPTEMBER 15, 16, 17, 1891.

By CHARLES L. STEVENSON,
SECRETARY OF UTAH STATISTICS COMMITTEE.

SALT LAKE CITY, UTAH.
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THE DESERET NEWS CO. PRINTERS.

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PREAMBLE.

To His Excellency Arthur L. Thomas, Governor of Utah; Col. J. W. Donnellan, Chairman of Utah Delegation, Irrigation Congress:

The Committee on Statistics present herewith their report concerning irrigation in Utah and matters relative thereto. In the absence of a Territorial Engineer or other officer where full information can be had, as in other States, your committee have been obliged to adopt the following course:

First. By availing themselves of the very complete machinery of the Mormon Church, as it is the most complete repository of local data, and to which end the Church authorities have given every possible aid, circulars of inquiry embracing the questions deemed most desirable, were forwarded to every President of Stakes and Bishop of Wards throughout the Territory.

Second. Somewhat similar notes of inquiry, but much more in detail, embracing thirty-two questions, have likewise been sent to every county assessor, county surveyor, and Committee Delegate from Utah.

Third. Special letters to Utah Delegates from Scientific Societies and to Departments at Washington.

Fourth. To private individuals and companies who are owners or have been engaged in the construction of important canal and storage works in the Territory, and

Fifth. The obtaining of all literature, maps, and public documents pertaining to irrigation in Utah.

The number of letters thus sent was four hundred and seventy-three.

By this method it was believed that so many checks would be had upon the returns as to eliminate many of the sources of error and wide differences of statement had in previous investigations. In this respect the result has been quite satisfactory, and the amount of valuable data collected very large.

The Committee began their investigations the first week in August, but owing to circumstances beyond their control, and several vexatious delays, the returns only began to come in by September, so that it was not until September 6th that the work of collating could be commenced.

Owing to the then short time at our disposal it was found impracticable to carry out the original intentions and very reluctantly we were forced to leave out some two-thirds of the data collected. Much of this was quite valuable reading and of great interest to Utah. It will be seen that the whole book has been prepared and printed inside of eight days. These facts are mentioned so that our sins of omission and commission may be condoned, and the few errors that have crept in be accounted for

Necessarily any book of statistics is a work mainly of compilation, hence we desire to here extend the thanks of the Committee to all who have so willingly imparted information. Especially are we indebted to Hon. John T. Caine, U. S. Congressional Delegate; Professor Marcus E. Jones, U. S. Treasury Expert; R. J. Hinton, Expert of U. S. Agricultural Department; F. E. Newell, Expert U. S. Interior Department; General A. W. Greely, Chief Signal Officer, War Department; Major J. W. Powell and G. K. Gilbert, of Geological Survey; Joseph Lipman, Territorial Statistician; O. J. Hollister, Statistican; the Territorial and Church officers, and U. S. Senator Hon. Wm. M. Stewart.

As a fact that may be overlooked, we would remind the Utah delegation that at the last session of our Legislature a memorial was addressed to the U. S. Congress petitioning it to enact into law, Senate Title 326, "A bill ceding, upon condition, public lands to the State of California and other existing States, and to the eventual States to be formed out of the existing Territories, in aid of the irrigation of dry and arid lands." In this memorial the Legislature says:

"We believe that such a law will greatly aid the important work of reclamatoin of vast tracts of land now useless, and would add to the population, wealth, and grandeur of this country's western domain." We have endeavored to obtain a copy of this bill, but unsuccessfully up to date.

Regretting that the time will not permit rendering more complete work, we remain.

Respectrully Yours,

JESSE W. FOX, JR., *Chairman,*

CHARLES L. STEVENSON, *Secretary,*

Statistics Committee, Utah Delegation to Irrigation Congress.

Salt Lake City, Utah, Sept. 14, 1891.

IRRIGATION STATISTICS OF UTAH. (Prepared for Irrigation Congress, September 15th, 1891.

County.	Acres under Irrigation Ditches.	Acres actually Irrigated 1890.	Acres Cultivated 1890.	Total Acres Irrigable Lands in Territory.	Irrigation Season begins.	Irrigation Season ends.	No. of Times Lands Irrigated during Season.	No. of Hours Land is Irrigated each Time.	Elevation above Sea in feet.	Depth of Snow in Adjacent Mountains in Feet.	Duty of Water per cubic foot per second.
Beaver	9,000	6,350	6,350	Total acreage of Irrigable Lands in Territory, 2,304,000 acres. (Time insufficient to make county divisions.)	May 15	Aug. 15	8	24	5,000 to 6,000	4 feet	. . .
Box Elder ..	120,695	9,708	26,177		May	August	8	1½	4,000 to 5,000	3 "	. . .
Cache	66,654	30,951	54,301		May	Sept.	8	4	4,500	3 "	150
Davis.....	19,530	10,591	23,161		April	Oct.	10	2½	4,200 to 5,000	3 "	. . .
Emery	23415	13,062	14,363		March	Nov.	. . .	. . .	3,900 to 4,500	4 "	. . .
Grand		1,375	1,416		April 15	Oct. 1	. . .	. . .	5,800 to 6,300	. . .	. . .
Garfield	12,029	7,635	8,635		April	August	8	5	6,500	3 "	. . .
Iron.....	8,197	3,956	4,523		April	Nov.	6	6	5,000 to 6,000	4 "	80
Juab	8,100	4,914	9,489		May	Sept.	10		5,500	8 "	. . .
Kane.....	1,463	722	1,087		April 1	Oct.	8	12	5,500	. . . .	75
Millard	88,586	8,152	8,152		April 15	Aug. 15	. . .	. . .	5,500	3 "	. . .
Morgan	7,924	5,633	5,633		May 20	Sept. 1	7	. . .	4,000 to 5,000	6 "	100
Piute.....	17,172	9,918	9,918		April	Sept.	5	8	5,000 to 7,000	4 "	. . .
Rich	31,484	26,099	26,099		April	August	3	3	6,000	5 "	. . .
Salt Lake...	53,086	29,107	30,555		May 15	Sept. 15	8	. . .	4,300	6 "	100
San Juan ...	1,107	927	927		. . . . .	. . . . .	. . .	. . .	5,000	. . . .	. . .
Sanpete	45,102	33,859	47,113		May 15	Sept.	5	24	5,550	6 "	95
Sevier	29,106	15,340	15,340		April	Oct.	5	12	4,000 to 7,000	. . . .	. . .
Summit	18,743	14,550	14,550		May	Sept.	3	. . .	5,845	5 "	. . .
Tooele	14,400	5,343	7,524		March	Sept.	. . .	. . .	4,600	2 "	80
Uintah.....	17,826	10,054	10,054		April	Oct.	. . .	. . .	4,600	6 "	. . .
Utah	79,380	53,586	60,520		March	Sept.	8	. . .	4,600	4 "	. . .
Washington	9,533	4,203	4,203		April	Oct.	12	3	2,700 to 5,000	4 "	40
Weber	33,344	17,004	22,450		May	Oct.	12	2	4,500	2 "	. . .
Wasatch ...	19,350	10,365	10,824		. . . . .	. . . . .	. . .	. . .	6,000 to 7,500	6 "	. . .
Total,	735,226	333,404	423,364								

NOTE.—The total acreage of Irrigable Lands in Utah Territory is 2,304,000.
The total acreage covered by present ditches is - - 735,226.

The total additional acreage susceptible of irrigation is 1,568,774.

IRRIGATION STATISTICS

OF THE

Territory of Utah,

WITH MATTERS RELATIVE THERETO.

MAIN PHYSICAL FEATURES.

UTAH is situated between the parallels of 37 and 42 degrees north latitude, and the meridians of 109 and 114 degrees west of Greenwich. It is on the same parallels as Colorado, Kansas, Missouri, Southern Illinois, Kentucky, Virginia, Spain, Italy, Greece, Turkey, and Corea. Utah belongs to the great plateau of the Rocky Mountains, its valleys being elevated from 2,700 to 7,000 feet above the sea, while its mountain peaks reach a height of 12,000 to 13,500 feet above the sea. One-half of the Territory is on the western side of the Wasatch Mountains, and within what is called the great basin. This basin occupies western Utah, nearly all of Nevada, and parts of California, Oregon, and Idaho. It has no outlet, the drainage being toward two great depressions where there are salt lakes, one on the western side under the Sierra Nevada Mountains, and the other, under the base of the Wasatch Mountains, called Great Salt Lake. There are many other minor lakes that receive the drainage of small areas which do not now flow into either of these depressions, but once they all flowed into one or other of them. These lakes have no outlet, and the water that flows into them evaporates by the heat of the sun. The average elevation

of the great basin is from 4,200 to 5,500 feet above the sea. Most of the inhabited portion of Utah lies at the western base of the Wasatch Mountains and on the eastern side of the Great Basin. The eastern half of Utah and a small portion of the southern part lies on the eastern side of the Wasatch Mountains, and belongs to the drainage of the Colorado River and its tributaries. Its valleys range from 2,700 on the south to 7,000 feet on the north. In the former, figs, almonds, cotton, and delicate fruits are raised, while in the latter only small grain and potatoes are grown.

The Wasatch Mountains enter the Territory on the north at about the middle, extend nearly due south until near the southern boundary, where they turn to the westward and pass out into Nevada, forming in Utah the letter "J." The Wasatch are not, however, the rim of the Great Basin. They are cut through by all the larger streams which flow to the westward, but they are the chief sources of the water supply. About twenty miles east of the Wasatch and parallel with them runs the rim of the Great Basin, a low, broad, and well-rounded range called the Coal Range, which has an average elevation of 7,000 to 8,000 feet above the sea, and encloses between it and the Wasatch some very fertile valleys, such as Ogden, Weber, Sanpete, Provo, and Sevier. At the upper (southern) end of Sevier Valley the Coal Range joins the Wasatch, or rather the Wasatch fades into the Coal Range, and turns westward into Nevada. West of the Wasatch and about 15 miles from them runs the Oquirrh range parallel with them. About the same distance west from the Oquirrh and parallel with it is the Aqui range, and so on, with more or less regularity to the western boundary, extend parallel ranges. These mountains reach a height of 8,000 to 11,000 feet above the sea, rising out of what was once the bed of the Great Salt Lake. These ranges run from the northern boundary of the Territory nearly to the southern, as far as the rim of the basin. They have the peculiarity of running along for 30 miles or thereabouts, and then sinking beneath the plain, only to reappear as another range a few miles further on. These

interrupted ranges do not, therefore, prevent easy communication with any parts of western Utah, and they also enclose between them many beautiful valleys, which would be garden spots if there were sufficient water flowing from the mountains to irrigate them. The Oquirrh, Aqui, and Lakeside mountains run through Great Salt Lake, forming those ranges of islands which add much to the picturesqueness of the lake.

DRAINAGE SYSTEMS.

As stated, the Wasatch rise over a mile above the valleys, run from north to south through the Territory, a little west of the middle, until they reach Iron County, where they turn to the southwest and into Nevada. Their average height will not fall far below 10,000 feet above the sea. Nearly east of Salt Lake City, the Uintahs, still loftier than the Wasatch, abut on them and run eastward until they pass out of the Territory. These are so close to the northern edges of Utah that we get little benefit from them, while to the south of them is an Indian reservation embracing the greater part of the arable lands. Nearly due east of Utah Lake and about forty miles from the Wasatch, the coal range starts from the Uintahs and runs southward parallel with the Wasatch for 160 miles when it joins them at Panguitch Lake. These three ranges form the watershed of Utah, the coal range and Uintahs forming the rim of the Great Basin, while the Wasatch perform a similar part below Panguitch. The Wasatch and Uintahs are narrow, lofty and rugged, while the coal range is younger, lower and broad. The Wasatch reach their culmination near Salt Lake City, and, aided by Great Salt Lake, give the greatest water supply in the Territory. The streams from this source irrigate the bulk of the cultivated area of Utah.

The eastern part of the Territory is drained by the Rio Colorado and its tributaries; the western part, by streams that head in the Wasatch and the high plateaus of the central part, and find their way into the salinas and desert sands of the Great Basin. Thus we have the Rio Colorado drainage area, and

the Desert drainage area; the former about two-fifths, the latter about three-fifths of the total area.

Great Salt Lake Drainage System.—Three rivers enter Great Salt Lake, namely, the Bear, the Weber and the Jordan, and upon their water will ultimately depend the major part of the agriculture of Utah. They rise close together in the western end of the Uintah Mountains, and cut through the Wasatch. Bear River flows northward, now in Utah, now in Wyoming, and into Idaho as far as Soda Springs. Here it bends round like a fish hook and returns on a more westerly line. Reentering Utah in Cache Valley, it passes thence by a short canyon to its delta plain on the northeastern border of Great Salt Lake. Its principal tributaries are received in Idaho and Cache Valley. Utah occupies the central position in the arid region, and therefore the details of irrigation in this Territory possess more than ordinary interest, from the fact that they represent conditions intermediate between those of the north and south, the east and the west. Besides this the irrigation methods and systems have been developed by men of English-speaking origin, who, unaided by capital or previous experience, have introduced methods of their own, and, taught by repeated failures, finally achieved success.

IRRIGABLE LANDS.

In Utah Territory agriculture is dependent upon irrigation. To this statement there are some small exceptions. In the more elevated regions there are tracts of meadow land from which small crops of hay can be taken; such lands being at higher altitudes need less moisture, and at the same time receive a greater amount of rainfall because of the altitude. But these meadows have been, often are, and in future will be, still more improved by irrigation. Again, on the belt of country lying between Great Salt Lake and the Wasatch Mountains, the local rainfall is much greater than the general rainfall of the region. The water evaporated from the lake is carried by the westerly winds to the adjacent mountains on the east and again condensed, and the rainfall thus produced extends somewhat beyond the area oc-

cupied by the mountains, so that the foothills and contiguous bench lands receive a modicum of this special supply. In some seasons this additional supply is enough to water the lands for remunerative agriculture, but the crops grown will usually be very small, and they will be subject to seasons of extreme drought, when all agriculture will result in failure. Most of these lands can be irrigated, and doubtless will be, from a consideration of the facts already stated, namely, that crops will thereby be greatly increased and immunity from drought secured.

In order to determine the amount of irrigable land in Utah, it was necessary to determine the areas to which the larger streams can be taken by proper engineering skill, and the amount which the smaller streams can serve. In the latter it was necessary to determine first the amount of land which a given amount or unit of water would supply, and then the volume of water running in the streams; the product of these factors giving the extent of the irrigable lands. A continuous flow of one cubic foot of water per second was taken as the unit, and after careful consideration it was assumed that this unit of water will serve from 80 to 100 acres of land. Usually the computations have been made on the basis of 100 acres. The unit was determined in the most practical way—from the experience of the farmers of Utah, who have been practicing agriculture for the past thirty years. Many of the farmers will not admit that so great a tract can be cultivated by this unit. In the early history of irrigation in this country the lands were over-supplied with water, but experience has shown that irrigation is most successful when the least amount of water is used necessary to a vigorous growth of the crops; that is, a greater yield is obtained by avoiding both scanty and excessive watering; but the tendency to over-water the lands is corrected only by extended experience. A great many of the waterways are so rudely constructed that much waste ensues. As irrigating methods are improved this wastage will be avoided; so in assuming that a cubic foot of water will irrigate an average of 100 acres of land, it is at the

same time assumed that only the necessary amount of water will be used, and that the waterways will eventually be so constructed that the waste now almost universal will be prevented.

The recent returns to the committee show an average waste of 70 per cent.

In determining the volume of water flowing in the streams, great accuracy has not been attained. For this purpose it would be necessary to make continuous daily, or even hourly, observations for a series of years on each stream.

Having determined from the operations of irrigation in Utah that one cubic foot per second of water will irrigate from 80 to 100 acres of land, and having determined the volume of water or number of cubic feet per second flowing in the several streams of Utah by the most thorough methods available under the circumstances, it appears that within the Territory the amount of land which it is possible to redeem by this method including that already under irrigation, is about 3600 square miles, or 2,304,000 acres. Of course this amount does not lie in a continuous body, but is scattered in small tracts along the water courses. Utah has an area of 84,970 square miles, or 52,601,600 acres. That is, 4.23 per cent. of the lands under consideration can be cultivated by utilizing all the available streams during the irrigating season. Previous estimates of the total arable-irrigable lands of the Territory have been as follows:

Church authorities, ...	2,525,403 acres.
Powell (not entire)	1,447,920 "
Hollister, ...	3,000,000 "
Jones, ...	2,000,000 "

In addition to the streams considered in this statement there are numerous small streams on the mountain sides, scattered throughout the Territory—springs which do not feed permanent streams; and if their waters are used for irrigation, the extent of irrigable land will be slightly increased; to what exact amount cannot be stated, but the difference will be so small as not to materially affect the general statement, and doubtless these

springs can be used in another way and to a better purpose, as will hereafter appear.

This statement of the facts relating to the irrigable lands of Utah will serve to give a clear conception of the extent and condition of the irrigable lands throughout the arid region. Such as can be redeemed are scattered along the water courses, and are in general the lowest lands of the several districts to which they belong.

Whatever conditions future developments may bring about, the present water supply in Utah Territory is surface. It depends entirely upon the fall of snow in the winter, and to a slight degree upon the rainfall during the spring and fall months. As a consequence the character of the water supply is found in the mountain streams. The fall of snow in the mountains is incomparably greater than in the valleys, and it lasts much longer, for the reason that the cold is much severer.

The snow packs in the ravines until almost as hard and solid as stones. The solidifying is materially assisted by what are termed "January thaws," the result of a marked relaxation in the severity of the weather, which generally occurs during the month of January. This temporary relaxation is invariably followed by a renewal of the rigor of winter, when the snow which has settled and become packed by the thaw, freezes until it is almost a solid mass of ice. The snow is the source of all streams in Utah save the little running water that comes through rains.

The volume of these streams depends entirely upon the season of the year. During the winter months the supply is very small, for the reason that the quantity of melting snow is at its minimum and the cold has a tendency to stay the flow .With the disappearance of winter and the increased warmth of the sun the snow begins to melt, the volume of water increases and continues to grow until puny and tiny streams are swollen into rushing torrents, sometimes causing great damage from the overflowing of their banks. The water supply attains its maximum height between the 10th and 20th of the month of June. This statement may be given the force that attaches to a rule almost,

if not entirely, without exception. The solidifying and freezing of the snow in winter, as above stated, makes certain the tenure of the water supply that would otherwise be both uncertain and disastrous; it prevents the too rapid melting, that would otherwise result in absolutely uncontrollable torrents for a period, and thus makes the streams available for agricultural purposes.

The experience of Utah farmers as to the best methods for increasing and controlling the water supply would be valuable only to people surrounded by similar country with like elementary conditions existing. The introduction of genuine artesian wells and utilization of the sub-flow may considerably increase the irrigable acreage. Experiments, sufficiently thorough to demonstrate the success that would attend the digging or boring of such wells in Utah, have not been made. The best opinions, however, are that the geological conditions existing in Utah are peculiarly favorable to their introduction and successful development.

The Territory, or rather its habitable portion, is composed of valleys, mountains and canyons, with some lakes. The melting snow on mountain and in valley which fails to find its way into some of the streams must sink and collect somewhere, and there is a well-founded belief, which can easily be verified, that beneath these valleys are subterranean lakes that would feed with a never-failing supply of water innumerable artesian wells. To increase the supply by other means would be to increase the fall of snow, a thing humanity is not yet prepared to base a calculation upon. Preserving methods are, however, more practicable, and nature has done her best to make that task as light as possible. The outlet for all the streams is into the valleys. The streams come from the canyons high above the valleys, and the supply can be preserved or saved by the construction of reservoirs or by dams. In case the latter method was adopted, it would simply be necessary to select the most suitable place in season and place a dam across the ravine.

The work would be more or less expensive as the stream was large or small and the canyon wide or narrow, but in every can-

yon suitable points abound, and as the future development of Utah largely depends on her permanent and increased water supply, her people will be forced to resort to damming the streams within their natural confines in the ravines. To what extent this idea carried out, would save the water that yearly runs to waste, the word "waste" being used here with the knowledge that every drop of water is invaluable in a country, where agriculture depends upon irrigation, it is absolutely impossible to form even an estimate, and for several reasons: First, the volume of the stream differs every day in the year, and one year from another. Second, it would require a measurement of the streams and a knowledge of the amount consumed in irrigation and in local evaporation, which would increase with increased distributing canals and ditches.

It may be safe to state, however, that if complete and thorough methods of saving were introduced, all the land in the Territory, if it could be reached, could be well and thoroughly irrigated; this, too, without resorting to artesian wells, so vast is the amount of water that runs to waste during the winter, spring and early summer months.

As now ascertained the average first cost of water right in Utah, $10.55 per acre, is noticeably great, being largely due to the manner in which the ditches and canals are made. Nearly all are laid out and constructed by farmers of ordinary education, without the use of surveying instruments. As a consequence, few of the more important works laid out in this manner have proved serviceable without great changes, involving in many instances the reconstruction of almost the entire system. The perseverance shown in many of these cases is remarkable.

On the other hand, the annual cost of 91 cents per acre is remarkably low, from the fact that farmers have done all the work of cleaning and making the small annual repairs necessary after the canals and ditches were in successful operation. It should be noted, however, that the maintenance is, as a general thing, comparatively poor, and that the main canals and ditches receive only enough labor to keep the water flowing. It undoubtedly would be far

more economical to spend a larger sum annually, and thus save much water which is lost through evaporation and seepage, due to the poor condition of the channel. The changes now being made in the construction of permanent works, scientifically built, while they may not materially reduce the cost, will insure a stability of construction and maintenance which heretofore has been as variable as the rainfall.

The use of flowing wells for the irrigation of gardens, orchards and vineyards is such a matter of interest and importance, that at the time of making the agricultural census the enumerators obtained the number of artesian wells owned by each farmer. The total number of these is 2,524. Of this number, facts concerning the depth, cost, flow and other matters of interest have been obtained from the owners regarding 897 wells. The average depth of these is 145.54 feet, and the average cost is $77.60 per well, the average cost per foot in depth being 53 cents. The diameter of these wells ranged from one and a quarter to four inches, or, in a few cases, to six inches or more, the average being from one and three-quarters to two and one-half inches. The average amount of water discharged by these wells was 26.37 gallons per minute, equivalent to 0.059 cubic feet per second, or second feet, as is the common term.

Most of these wells were used for domestic supply and watering stock, 48.49 per cent. being employed in irrigation, watering on an average 4.74 acres per well, thus making the average cost of irrigation from the successful flowing wells $16.37 per acre. It has already been shown that the average cost of water right from canals or ditches was $10.55 per acre.

From the preceding figures the average duty of water from these flowing wells has been ascertained to be one second foot to 80.3 acres, an amount which could doubtless be increased if the farmers considered it feasible to store part of the water which flows daily during the non-irrigating season.

These flowing wells are confined mostly to the lower parts of the valleys along the foot of the Wasatch mountains and to the lacustrine deposits from the great body of fresh water which

formerly filled these valleys, and which has been named Lake Bonneville. The wells are made by drilling and by driving pipe through the sands and clays until some pervious water-bearing layer is reached. Along the eastern shores of Great Salt Lake and Utah Lake these wells are particularly numerous, but they gradually decrease in number and discharge as the higher ground is reached. The depth as a rule ranges from 30 feet on the lowest ground up to 400 feet or more nearer the edge of the valley.

The Utah Bureau of Statistics has only recently been organized, and it is impossible to give any idea of the extent, character and cost of the artificial means introduced in the Territory for the utilization and distribution of the water supply. As to the flumes for mining and railroad purposes it is impossible to give even an estimate. Very little is necessary for railroad purposes, and where water is not otherwise naturally available, wells are utilized and form the almost exclusive supply. It is sufficient with regard to mining, as flumes are used in this case to carry off water from the lower workings of the mines. There is no hydraulic mining carried on in any part of Utah, for which reason supply flumes, save for reduction works, concentrators, leaching purposes and milling, are unnecessary. It is not infrequently the case that the water out of the mines is more than enough to run the mills.

As heretofore stated, the increase and decrease in the water supply depends entirely upon the fall of snow in the winter and, in an unimportant degree, upon the fall of rain in the fall, spring and early summer months. A very noteworthy fact, attested on the best authority, is that for a period of years there has been a steady increase in the water supply. It has been thought by many that the claim of increased water has been more imaginary than real. The claim, however, has been verified by measurements made in Great Salt Lake, which is the reservoir for many of the largest mountain streams, including the Jordan, which is the outlet of Utah Lake, the Bear River, the Ogden, Weber, Logan, and Blacksmith Fork, and innumerable smaller streams.

The lake has a shore line of 350 miles, and since 1856 the water has increased 14 feet in depth; though not at present quite that much; and Great Salt Lake, depending as it does entirely upon the inflowing of mountain streams and that amount of water which is not consumed by agricultural utilization, shows beyond question that there has been a marked increase in the water supply.

This rise in the body of the water of the lake has taken place, it must be remembered, during a period when there was a rapid increase in the demand for water for agricultural purposes.

Where irrigation has been applied for a few years there has been a perceptible decrease in the amount of water necessary to irrigate the land properly. The decrease is placed at about 25 per cent.

The value of irrigated land depends entirely on its location, not only in the Territory, but in a precinct or county, and upon the character of the soil, which often differs materially from land adjoining it and enjoying the same water advantages. In earlier days all persons interested in digging a canal would turn out and keep on working under the direction of a person chosen by themselves. Later, laws were passed on the subject, and will be found by reference to the statutes of the Territory, which will give the fullest attainable information as to water rights and conditions in the Territory.

Grants, of course, were given to municipal and canal corporations, counties, and districts, but these also are set forth in the statutes.

One of the most important of the class under consideration in the Territory was the construction of a canal to supply Salt Lake City with water. The city was bonded for the purpose, and the canal was commenced in December of 1879, and finished in the fall of 1881.

Its length is something over 27 miles, and its source is the Jordan River, a short distance below the point where Utah Lake has its outlet into the Jordan. The canal is 20 feet wide at the

bottom, the depth being 5 feet, sufficient to carry 3½ feet of water.

Four other canals have been constructed in the valley of the Jordan, all about of the same capacity, and built about the same time. These canals, owing to inferior construction in vogue at that period, do not furnish more than 60 per cent. of the water entering their heads. The total length being 132 miles, covering about 44,000 acres.

As a contrast, the great Bear River Canal, which enters the north end of Salt Lake Valley, is a good illustration of the more modern system of scientific construction, and also shows what may be done by successfully damming a large river.

BEAR RIVER CANAL COMPANY.

The big irrigating enterprise of the Bear River Canal Company has been mentioned before, and also the appropriation of Bear Lake as a reservoir by the company. The latter step forever assures the supply. The headworks for the canals are in Bear River Canyon. A canal of 1,000 second cubic feet capacity is taken out on each side of the river. That on the left bank is carried down along the base of the mountains, about forty miles to Utah Hot Springs. In this vicinity a branch is led off toward the lake, where, around Plain City, there is a large body of warm, sandy, rich land. The main canal goes on to Ogden. There, exchanged with the users of Weber River water, the latter is said to be taken out high up in Weber Canyon and carried out upon the sand ridge south of Ogden.

The canal on the right bank, where it reaches the valley plain, strikes up the valley diagonally three miles to near the Toponce Ranch, where it is carried over the Malad, here 100 feet below its banks, on an iron viaduct costing $30,000. Thence it is led around the northeastern edge of the valley past Point Lookout and the Walker Ranch, toward Blue Creek, about forty miles. Soon after reaching the plateau it throws off one branch which goes down near Bear River, past Corinne, to the lake, about 30 miles. It throws off a second branch west of the Malad,

which runs southward to near Little Mountain, and then westward to the main canal.

The area of lands which will be tributary to these canals is some 200,000 acres. The soil is extremely fertile, and the lands most favorably located.

The Canal Company offer these lands for sale at $25 to $35 an acre, which includes $10 for perpetual right to one cubic foot of water per second for each 80 acres. The yearly rental or maintainance tax it is proposed to put at $1.50 or $2.00 an acre of land watered. The irrigating works were planned by eminent engineers; the canal owners have water power and city (Ogden) water works to look after, which will compel them to maintain the works in good repair. The water may be depended upon absolutely.

This work of the Bear River Canal Company, though less than one-third completed, is by far the most important irrigation work yet undertaken in this Territory.

DUCHESNE AND STBAWBERRY RIVER CANAL CO.

There is now a very elaborate and extensive project, well under way, to take out a portion of the waters of the Strawberry and Duchesne Rivers and irrigate 200,000 acres of the most fertile lands. Much of this now lies within the Indian Reserve, but which it is believed will be set off. As this enterprise will form the subject of a separate paper by one of the delegates (Mr. A. D. Ferron, C. E.) reference is made thereto.

NORTH POINT CONSOLIDATED CANAL.

This is also a canal of quite recent construction (1891). It adds 14½ miles to the system now west of the Jordan River. Of the whole length, nearly one quarter, has a bottom width of 50 feet, the remainder varying from 20 to 15 feet. The fall is very slight, 0.7 feet to the mile. The estimated capacity is 93 cubic feet to the second. The soils are such that two-thirds of a second foot, it is stated, will irrigate 100 acres, or a total of about 14,000 acres.

SWAN LAKE RESERVOIR AND CANAL COMPANY.

This is another comparatively recent enterprise and has for its object the utilization of the waters of the Sevier River. It consists of a reservoir covering an area of 70 square miles fed by the river and located in the central portion of Millard County, five miles west of the Union Pacific railroad, fifteen miles northeast of Sevier Lake or Sink, and 170 miles south of Salt Lake City.

This large reservoir of over 40,000 acres, as may be supposed, is very largely natural, and consists of a number of lake basins which are appropriated by the work of construction, such changes being made as were necessary to adapt them to the requirements of the reservoir.

The continued action of the river current has built up walls or natural levees which rise to a height above the surrounding country like the levees of the Mississippi and other streams. The company in constructing their reservoir have repaired the natural walls, built strong dykes across channels, cut ditches and canals, built dams and flumes. The entire plant is of such a character it can be enlarged and improved indefinitely.

There are at present over 200,000 acres of level fertile and irrigable land lying under the reservoir supply. There has already been completed about 15 miles of canal. A townsite and buildings for employers and laborers has been laid out, some 20,000 shade trees planted a rod apart and along also several of the streets.

The reservoir, or more appropriately lake, when full will hold about three and one half billion cubic feet, or 200,000 acre feet. In May, 1891, when the river had its rise, the flow over the waste dam was 30,000 miners' inches. The irrigable land has an underlie of clay a few feet below surface, which will materially lessen the amount of water required for irigation. The company expect to irrigate 75,000 acres.

OQUIRRH WATER AND LAND COMPANY.

This company has for its object the lowering of the Jordan River at the outlet and below Utah lake. The present river

bed is much higher than the bottom of the lake and acts as a bar to the lowering thereof and to the obtaining of a large supply of water that now cannot be utilized and which when so utilized will be restored in the winter. Such a lowering will also admit of a better regulation of the rise and fall of the lake. This lowering of the outlet will permit the irrigation of possibly some 25,000 acres, and by storing in the Provo River this can be still further augmented.

In cities the municipal corporations control the waters, water-masters being appointed to regulate the division of the water.

For regulation of water rights see Utah statutes of 1880, page 36; for acts relating to Salt Lake City Canal, see same, pages 55 and 85; for law relating to irrigating companies, see Utah statutes of 1884, page 127, laws of 1890, pp. 12, 21, and 142.

PRINCIPAL IRRIGATION STREAMS.

As concerns the Great Salt Lake drainage system it has been shown that the three principal rivers are the Bear, the Weber and the Jordan.

The mean annual flow of Bear River, where it enters Salt Lake Valley, is about 5,000 cubic feet per second. Its delta-plain contains about 214 square miles of unsurpassable soil, upon which the Bear River Canal Company has diverted 2,000 second-cubic feet of water through upward of 100 miles of canals at a cost of nearly $2,000,000. The soil is rich and ideally adapted to irrigation, having a gentle fall, being smooth as a floor, and well and deeply drained by the Bear and Malad rivers.

As if to forever bar a water famine in North Salt Lake Valley, nature has provided a natural reservoir in Bear Lake, situated near Bear River and connected with the river by a narrow outlet, high up in the mountains. The lake has an area of 150 square miles, and can be raised ten feet by a dam thrown across the outlet at small expense. Thus enough water can be stored during two-thirds of the year to flow, in connection with the current, 5,000 feet per second during the other third

of the year. Bear River itself can be turned into the lake by a short canal from above, and upon its upper tributaries, on the northern slope of the Uintah Range, there are many glacial lakes which can be made use of for impounding water.

The Weber River runs in a general northwesterly course from the Uintah Mountains to Great Salt Lake, entering the latter at the middle of its eastern shore. The Ogden is its only important tributary. Its delta-plain comprises about 200 square miles of farming land.

The Jordan River is the outlet of Utah Lake, and runs northward, entering Great Salt Lake at its southeastern angle. On the right it receives a number of large tributaries from the Wasatch. The largest tributary of Utah Lake is Provo or Tunpanogas River, which rises near the source of the Weber and Bear, in the Uintah Mountains. Minor tributaries of Utah Lake are American Fork, Spanish Fork, Hobble Creek, Payson Creek, Salt Creek, etc. On all the tributaries of Utah Lake there are about 320 square miles of irrigable land; and in the Jordan Valley, below Utah Lake, inclusive of Bountiful and Centerville, there are about 250 square miles. In addition the water can be carried around the point of the Oquirrh Range on the southern shore of Great Salt Lake, and be used to water 50 square miles of Tooele Valley.

Utah Lake is a natural reservoir, 145 square miles in surface area. With suitable headworks its volume can be controlled, and the entire charge be concentrated in the season of irrigation. The mean volume of the outlet is about 1,000 second-cubic feet, but one-fourth of this must be assigned to watering lands on the tributaries of the lake and to evaporation, leaving a perennial flow of 750 second-cubic feet, which if concentrated into four months would irrigate for that period, 350 square miles.

There is thus water enough forever assured to irrigate every acre of the eastern border of Great Salt Lake Basin, from Nephi on the south to Bear River canyon on the north, a distance, as traveled, of about 180 miles. This fringe of the desert, between the Wasatch and Great Salt Lake, and between the Wasatch and Utah

Lake, is, in location, resources, climate, fertility, potentially, the glory of the earth. It is easily the garden spot of Utah. Every acre of land is intrinsically worth $100, although it ranges in prices all the way from $5 to $225 per acre. The average, away from the suburbs of larger towns, is perhaps, $50 per acre. Altogether, about 7,500 second-cubic feet of water perennially flows into Great Salt Lake.

Sevier Lake Drainage Basin.—According to the accomplished geologists of the United States Geological Survey, which this sketch follows, the Wasatch ends with Mount Nebo, which overhangs Nephi. The elevated lands southward these gentlemen term the high plateaus, divided by great longitudinal faults into three ranges, each made up of different members, as the Sanpete, the Pahvant, the Tushar, and the Markagunt, facing the Great Basin; and the Wasatch, the Fish Lake, the Awapa, and the Aquarius, east of Grass Valley. The Pahvant and the Tushar, says Captain Dutton, present a curious admixture of plateau and sierra, but the others are true tables, made and kept so by the lavas which cap them and successfully resist erosion.

The Wasatch plateau is east of Sanpete Valley, above which it rises a whole mile. The San Pitch River is the largest tributary of the Sevier. In 1890 the farmers of Gunnision dammed the San Pitch River a few miles southwesterly of the town of Manti; by this they have funished a reservoir with capacity of 260,000,000 cubic feet, or 6,000 acre feet. Powell gives the capacity of this stream at 60 second-feet. This reservoir is intended only as a storage basin, but is good evidence in showing the tendency of the people to increase their cultivable acreage in the most practical way. The whole cost had not equalled $4,000.

Probably upward of a hundred square miles are served by the small streams of southwestern Utah, as at Levan, Scipio, Holden, Fillmore, Oak City, Kanosh, Beaver, Paragoonah, Cedar City, Pinto, Hebron, etc. In this region the water is insufficient to supply the arable land, but it can be largely increased by storage, without doubt.

Colorado River Drainage.—Of the Rio Colorado drainage

system, the main channel is the river Colorado and its proper continuation, the Green River. The principal tributaries of these streams from the east are the White, the Grand and the San Juan, the White entering the Green, the Grand uniting with the Green to form the Colorado, and the San Juan entering the latter about 125 miles from the confluence of the Grand and the Green. The tributaries from the west are the Virgin, the Kanab, the Paria, the Escalante, the Fremont, the San Rafael, the Price, the Minnie Maud, the Uintah, or Du Chesne and the Ashley Fork.

The climate is extremely arid, the elevation between 2,500 and 11,500 feet, giving great range in the temperature. The limit of successful (hay) farming is about 7,000 feet. Aside from the Uintah-White basin, which contains more than half of the irrigable land of the entire district, and which is an Indian Reserve, the lands are generally of terraces or benches, or in restricted valleys between the higher courses of the streams and their canyons, and are from 4,500 to 6,000 feet in altitude. The Price, the Uintah or Du Chesne, the Green and the Grand have plenty of water, but, excepting the Uintah, the land upon which their waters can be diverted is very limited. On the Virgin, which is far south and low in altitude, there are thirty to fifty square miles. In the entire district there may be a thousand square miles of irrigable arable land.

METHODS OF IRRIGATION.

As will be seen there are only a few square miles in Utah that do not require irrigation. The system of cultivating the soil in Utah is to start canals at the mouth of the canyons, where dams are built. These canals are run from the canyons out upon the more level land of the valleys and there subdivided into branch canals, and these again divided into laterals leading to every farm so long as there is water to be distributed. Each farmer has canals leading from the main one to every field, and generally along the whole length of the upper side of each field. Each field has little furrows, a foot or more apart, and parallel with each

other, running either lengthwise or crosswise or diagonally across as the slope of the land requires. Into these furrows the water is turned, one or more at a time, as the quantity of water permits, until it has flowed nearly to the other end, when it is turned into the next furrows, and so on until all are watered.

This is the usual custom, but where the soil is made of clay this method is not so good and another is used. This method is to throw up little embankments six inches high around separate plats of land that are of uniform level, and turn the water in until the plat is full to the top, when the water is drawn off to the next lower plat and so on to the end. This enables the water to soak in more and so does the crop more good, but where the soil is porous, as is generally the case, it is not so good a method, as it wastes water. Each farm generally has the right to use the water so many hours once a week or once in 10, 12 or 14 days, as the particular valley and the time of the year require. The crops are supposed to get a good soaking at every watering. The amount of land that each person can cultivate depends upon the quantity of water right that he owns. The method of dividing the water depends upon the intelligence of the farmers; in some places it is very crude, in others it is thorough. In few places is any one entitled to a certain number of cubic feet per second. Generally each man has a right to such a portion of the water in a certain stream or river; if the season is a dry one he gets less water, and if it is a wet one he gets plenty. He must govern the quantity of crops put in by what he thinks will be the water supply for the season.

The method of dividing the water is to put in a dam at the head of the canal on the stream, with a partition in it separating the proper share for the canal, the rest being allowed to flow down the channel of the stream. The same method is used in the canal where people have certain shares in the stream at every new canal. Where the rights of people are based on a certain number of cubic feet per second, or miners' inches, there is a gate put in at every dam and lowered into the water till the water reaches a mark six inches above the bottom of the gate. This

gate is raised or lowered as the quantity of water requires to keep the water on that point on the gate. The length and width of the space below the gate are multiplied together, and the product is called so many miners' inches; generally 48 of these are considered to be equal to one cubic foot per second. This method is correct where there is no back water below the dam to interfere with the fall of the water. The partition is then put in at the proper place to give the owners their due share of water. This division is kept up until there is no water to distribute. Those people who have a secondary right get what is left after the primary rights are filled. The irrigation season generally begins in May or the first of June, and ends in August, and is about 120 days long. The amount of land that one cubic foot of water can irrigate, ranges from 35 acres in the very hot and sandy country in the south, to 150 acres in the higher valleys. The average is about one cubic foot to 100 acres. The future growth in agriculture depends upon the storage of water in reservoirs, and above all in the economical use of the water we have. Subsoil irrigation is another great hope of Utah. By this many times the present cultivated area can be reclaimed, and as before stated, by a proper use of the underground sources.

SOIL AND CLIMATE.

As before stated, Salt Lake is in latitude 40 degrees 46 minutes north, and longitude 111 degrees 54 minutes west, and is near the isotherm of 52 degrees. In latitude we are in line with northern Missouri, Peoria, Illinois; Columbus, Pittsburg, Reading, and Staten Island; and can raise all kinds of fruits except oranges, etc., and even these we can raise in Southern Utah. Every kind of tree growing north of Virginia will thrive here in the open air. There are now growing in Salt Lake City the following: sycamore, basswood, locust, honey locust, ailantus, cottonwood, balm of gilead, lombardy, soft and hard maple, box elder, walnut, chestnut, white ash, white and roch elm, mulberry, butternut, larch, pines, spruces, firs, oaks, peach, plum, apricot, apple, etc.

Since our winter is only about six weeks long, the spring is

quite early; the farmers frequently plow in February, and sow their small grain. Our latest frost averages April 8th, so that the most delicate plants are safe after that. Our earliest frost comes about September 26, so that all our crops have ample time to mature.

During the season of 1890, crops were raised by irrigation on 396,000 acres, say about three-fourths of one per cent. About 85 per cent. of the cultivated areas required irrigation, the remaining 15 per cent. being "dry farmed."

The average size of the portions of farms under cultivation was 40 acres. The average first cost of the water right is $10.55 per acre, and the average first cost of preparing the soil for cultivation, including the purchase price of land is $16.10 per acre. The average present value of the irrigated land of the Territory, including improvements etc., is reported at $84.25 per acre, showing an apparent profit, less cost of improvements of $57.60 per acre.

The average of the estimated value placed by the farmer upon this water right is $26.84 this is the price which the water rights, wherever transferable without the land, have usually brought or would probably bring in the various localities, the value of these rights being dependant largely upon the probabilities of the owner receiving the amount of water claimed.

A TYPICAL CASE.

The following statement, based on actual experience, and made by one of the most intelligent farmers in Utah, shows the prime cost of settlement; what he has done and what may be done with a typical farm of forty acres, well irrigated land and properly handled:

EXPENDITURE.

First cost 40 acres of land and water right, $40 per acre,	$1,600.00
One mile of fence (4 wire) - - - - - -	140.00
Dwelling house, complete, - - - - -	600.00
Stable, barn and sheds, - - - - - -	260.00
Clearing, plowing and harrowing 40 acres, - -	150.00
100 shade trees, - - - - - - -	15.00

200 fruit trees,	$30.00
10 acres planted to alfalfa and seed,	20.00
20 acres wheat and seed,	30.00
4 acres of potatoes, seed and planting,	20.00
5 acres of oats,	10.00
Water rental,	80.00
Total,	$2,955.00

FIRST YEAR'S RETURNS, HARVESTED.

800 bushels of wheat, 60 cents per bushel,	$ 480.00
1,200 bushels of potatoes, 50 cents per bushel,	600.00
250 bushels of oats, $1.00 per bushel,	250.00
10 acres of alfalfa and seed (⅓ return),	150.00
Total,	$1,480.00

The above shows a net earning of 50 per cent., or one-half the total amount invested, for the first year's work.

RAINFALL AND HUMIDITY.

For ease of comprehension Utah may best be divided into three divisions: The moist counties, whose rainfall exceeds 12 inches per annum; the dry counties, with a rainfall of 6 to 12 inches; and the hot counties, with a slight rainfall and great heat.

The moist counties are Cache, Box Elder, Rich, Morgan, Weber, Davis, Summit, Salt Lake, Utah, Wasatch, Uintah, Sanpete, Sevier and parts of Emery, Garfield, Piute and San Juan.

The dry counties are Tooele, Juab, Millard, Beaver, Iron and parts of others.

The hot counties are Washington, Kane, and parts of San Juan, Piute and Garfield.

General Greely, Chief Signal Officer of the United States has most thoughtfully sent through Governor Thomas advance sheets (galley proofs) giving complete tables and graphical charts of the rainfall and temperature. The former dating from 1856, the latter from 1850. Whether the observations as to rainfall made prior to the establishment of the signal office here, 1874, are reliable, is very doubtful—they increase the annual average very materially.

No other data more forcibly shows the arid nature of Utah, and it is only to be regretted that we have not yet established points of observations in the Wasatch and Uintah ranges that we might have a better knowledge of the annual precipitation in the locality from which our irrigation supply is obtained.

Temperature also cuts quite a figure, for a "late spring" and cool summer, even with a lesser and late snowfall, gives better and more equable results from the irrigation standpoint, as witness this "season" of 1891.

In Salt Lake Valley, 40 per cent. of the rainfall occurs in the spring, 9 in the summer, 25 in the fall, and 26 in the winter. Winter begins about January 1st and lasts six weeks. In latitude 40 degrees there should be on general principles 30 inches in a year.

Over the United States, east of the one hundredth meridian west of Greenwich, the average rainfall is 40 inches, 60 per cent. of which is at once thrown off in the river discharge.

The meterological records do not indicate that the climate is growing moister; but Rush Lake rolls its blue waves over what was a meadow 20 years ago, and Great Salt Lake has at least ten feet of brine where wagons were driven to and fro in 1863.

Increased humidity has followed the settlement and cultivation of the Mississippi valley prairies, and it is not unlikely that it is doing so in Utah, although there is not sufficient data as yet to determine in what degree.

The mean-air pressure at Salt Lake City is 25.63 inches; water boils at 204.3 degrees. The prevailing winds are from the north-northwest, and the most windy months are March, July, August and September. The mean velocity of the winds during the entire year is $5\frac{1}{3}$ miles an hour. On the ocean it is 18; at Liverpool it is 13; at Toronto, 9; at Philadelphia, 11. The climate of Utah on the whole is not unlike that of northwestern Texas and New Mexico, and is agreeable except for a month or so in winter, and then the temperature seldom falls to zero or snow to a greater depth than a foot; and it soon melts away, although it sometimes affords a few days' sleighing. The spring opens early in March.

MONTHLY AND ANNUAL PRECIPITATION AT SALT LAKE CITY, UTAH, FROM RETURNS U. S. SIGNAL OFFICE, WAR DEPARTMENT.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August	Sept.	Oct.	Nov.	Dec.	Annual
1857	. . . .	0.85	0.97	0.19	0.83	1.00	0.64	0.85	0.58	1.00	. . . .	. . . .	. . . .
1858	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	0.15	3.28	. . . .	. . . .	. . . .
1859	0.65	3.88	3.33	1.43	1.85	0.11	. . . .	0.13	1.58	0.22	3.85	0.70	. . . .
1861	1.40	2.13	2.49	1.47	1.10	. . . .	1.57	1.47	3.01	. . . .	1.76	2.13	. . . .
1863	. . . .	2.74	. . . .	. . . .	. . . .	0.30	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
1864	3.28	0.86	2.94	1.37	1.96	1.50	0.00	1.25	0.73	3.75	1.19	5.04	23.87
1865	1.22	3.72	2.38	0.54	0.26	0.70	1.75	0.62	1.52	3.15	0.42	6.39	22.67
1866	1.83	1.60	2.72	3.34	2.05	5.34	8.73	1.98	2.05	1.80	2.20	4.56	38.20
1867	. . . .	1.75	. . . .	. . . .	. . . .	1.47	2.61	9.43	1.07	1.41	. . . .	3.65	. . .
1868	2.64	. . . .	. . . .	. . . .	2.43	4.00	. . .	3.69	. . . .	. . . .	. . . .	. . . .	. . . .
1872	. . . .	. . . .	. . . .	. . . .	2.50	3.90	0.00	1.56	0.54	1.01	0.90	1.90	. . . .
1873	3.65	5.60	1.60	1.25	10.05	0.85	0.60	4.75	1.00	1.60	1.00	1.00	32.95
1874	. . . .	. . . .	1.31	0.90	2.84	0.74	2.42	1.63	0.20	1.74	2.16	0.73	. . . .
1875	3.05	0.79	2.81	1.50	2.91	0.90	1.01	0.25	1.22	1.36	5.81	2.03	23.64
1876	1.23	1.52	4.00	2.09	4.30	0.09	0.83	0.92	0.42	3.27	0.81	1.80	21.28
1877	0.87	0.38	2.98	2.14	3.49	0.80	0.02	0.28	0.90	2.41	1.02	1.11	16.35
1878	1.07	3.49	2.54	2.63	2.50	0.35	1.08	0.81	3.15	1.39	0.63	0.11	19.75
1879	1.87	0.71	0.67	3.26	0.10	1.34	0.07	0.06	0.01	1.62	0.32	3.08	13.11
1880	0.29	1.02	0.43	2.37	1.85	0.01	0.20	0.74	0.56	0.40	1.17	1.90	10.94
1881	1.24	2.44	0.88	2.37	2.55	0.28	0.21	1.61	0.43	2.19	1.44	1.24	16.88
1882	1.50	0.42	1.12	3.81	0.26	2.24	0.30	1.61	0.37	2.89	0.54	0.92	15.98
1883	1.47	0.72	1.75	2.92	0.98	0.33	0.10	0.62	0.13	2.24	1.78	1.20	14.24
1884	0.71	2.23	3.69	2.89	1.78	0.33	0.27	0.73	1.91	0.36	0.50	2.12	17.52
1885	1.48	1.56	2.64	3.47	2.49	2.67	0.58	0.90	1.29	0.59	3.10	0.92	21.60
1886	1.91	1.36	2.60	4.43	0.06	1.02	T	0.59	1.88	1.98	1.79	1.27	18.89
1887	2.36	1.41	0.35	1.87	0.73	0.37	1.23	0.69	0.55	0.30	0.25	1.55	11.66
1888	1.52	1.22	2.18	0.99	0.34	0.98	0.24	0.63	0.51	0.80	2.00	2.21	13.62
1889	0.73	0.81	1.64	1.52	2.97	0.01	0.08	0.92	0.52	3.85	1.04	4.37	18.46
1890	3.07	2.05	1.12	0.74	0.58	0.32	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .	. . . .
Means....	1.52	1.38	1.92	2.35	1.81	0.75	0.54	0.81	0.88	1.71	1.52	1.66	16.85

The following gives the average annual precipitation at prominent points north, east, south and west of Salt Lake City:

STATION.	DURATION OF OBSERVATIONS.	AVERAGE ANNUAL PRECIPITATION.
Kelton, - - - - - - -	12 years.	6.10 inches.
Ogden, - - - - - - -	21 "	13.46 "
Coalville, - - - - - -	10 "	13.74 "
Fort Duchesne, - - -	3 "	6.53 "
Fort Douglass, - - - -	9 "	17.41 "
Deep Creek, - - - - -	3 "	5.18 "

UNITED STATES LAND OFFICE RETURNS,

No. of acres entered under the Desert Land Laws,	694,176.76
No. of acres on which final papers have issued under Desert Land Laws, - - -	135,340.32
No. of acres entered under the Timber Culture Laws,	179,118.35
No. of acres entered under the Homestead Laws,	1,293,750.00
No. of acres on which Cash Certificates have issued,	375,791.25
No of acres entered under all the land laws, -	2,542,836.36
Estimated No. of acres of surveyed land still subject to entry, under the public land laws,	6,919,840.00
Estimated No. of acres of unsurveyed land subject to entry, - - - - - - -	26,882,853.00

ESTIMATED NUMBER OF ACRES OF LAND IN EACH COUNTY SUBJECT TO ENTRY.

NO.	COUNTY.	ACRES SURVEYED.	ACRES UNSURVEYED.
1	Beaver, - - -	335,160	1,700,000
2	Box Elder, - -	483,316	1,906,960
3	Cache - - -	90,740	95,668
4	Davis, - - - -	9,367	700,000
5	Emery, - - -	448,165	2,300,000
6	Garfield, - - -	214,500	2,300,000
7	Iron, - - - -	582,250	1,920,000
8	Juab, - - - -	707,920	1,500,000
9	Kane, - - -	377,580	1,610,000
10	Millard, - - -	1,191,590	2,500,000
11	Morgan, - - -	51,080	500,000
12	Piute, - - - -	220,880	1,380,000
13	Rich, - - - -	289,880	7,000
14	Salt Lake, - -	2,700	130,000
15	Sanpete, - - -	122,680	860,000
16	Sevier, - - -	211,100	1,460,000
17	Summit, - - -	217,500	1,000,000
18	Tooele, - - -	769,220	2,500,000
19	Uintah, - - -	150,540	1,644,000
20	Utah, - - - -	182,677	1,000,000
21	Wasatch, - -	62,155	207,000
22	Washington, - -	188,340	1,000,000
23	Weber, - - -	8,500	290,519
	Total, - - -	6,919,840	26,882,853

DUTY OF WATER.

As there does not appear to be a clear understanding by most people of many of the terms used in connection with irrigation, the following, defining the meaning of such expressions and giving the comparative values used, it was deemed would be useful. Irrigation water is measured generally by the cubic foot, by the gallon or by miners inches.

The "duty of water" means the area of land upon which a definite volume of water, applied during a given period, will successfully raise crops. Thus the average duty in Utah of one cubic foot per second, during a period of 120 days, is 100 acres.

One cubic foot per second is called a "second-foot." The "acre-foot" is the equivalent of one acre covered one foot deep or 43,560 cubic feet. The miners inch is a variable quantity depending upon the head above the one inch orifice of discharge. It varies from a four inch head to a six inch head, and is not a commendable unit of measure. Thus there are 50 miners inches to a cubic foot per second, California measurement, and about 40 miners inches Colorado measurement. One cubic foot contains $7\frac{1}{2}$ U. S. gallons of 231 cubic inches.

CUBIC FEET.

1 cubic foot per second equals 2 acre feet in 24 hours.
" " " " 60 " " 30 days.
" " " " 130 " " 3 months.
" " " " 170 " " 1 year.
" " " " 7.5 gallons per second.
" " " " 449 " " minute.
" " " " 50 California inches.
" " " " 38.4 Colorado "

CALIFORNIA INCHES.

100 California inches equals 4 acre feet in 24 hours.
" " " 1 " foot 6 "
" " " 120 " feet 30 days.
" " " 360 " " 3 months.
" " " 1440 " " 1 year.
" " " 15 gallons per second.
" " " 900 " minute.
" " " 77 Colorado inches.
" " " 2 Cubic feet per second.

COLORADO INCHES.

100 Colorado inches equals $5\frac{1}{6}$ acre feet in 24 hours.
" " " 1 " foot in 4.2 "
" " " 155 " feet in 1 month.
" " " 465 " " 3 months.
" " " 1,860 " " 1 year.
" " 19.50 gallons per second.
" " 1,170 " minute.
" " 2.6 cubic feet per second.
" 130 California inches.

The terms as applied to wells such as "artesian positive" means one from which the water rises above the surface.

"Artesian negative" is one in which the water does not rise above the surface.

"Phreatic water" (signifying ground water), is that nearer the surface and derived from absorption, and is a name given in a general way to all species of wells that are supplied from the "ground water."

SYNOPSIS OF UTAH LAWS RELATIVE TO IRRIGATION.

Whenever the public necessity requires it, the county court may organize the county, or a part of it, into an irrigation district, and the land holders therein may use the water brought into the district according to their respective needs, provided they pay and perform their proportion of the necessary expense and labor. They may, on due notice, elect trustees, a secretary, and a treasurer.

The trustees shall locate the ditches and estimate all costs and report to the county court. If the report be approved by a two-thirds vote, a tax shall be assessed and the ditch constructed.

The trustees have general supervision of the construction, maintenance, and regulation of the ditches; they may hold such personal property as is necessary to the performance of their duties; may sue and be sued, and may have appraised and sell any unclaimed lands that are to be benefited, and apply the proceeds to the construction of the ditches.

Lakes and ponds may be used as reservoirs, provided they are not raised so as to injure settlers upon their banks.

In case of inundation or other sudden emergency, the trustees may take measures for protection.

Property and money in the hands of trustees to be used on the ditches is exempt from taxation.

Ditches have the right of way, a proper compensation having been paid.

Any person injuring a ditch or any of its appurtenances, is liable in damages and to a fine and imprisonment.

The district is liable for damage caused by the breakage of a ditch.

The rate of tax at any election subsequent to the first may be determined by a majority vote, and the tax thus assessed shall

be a lien upon the taxpayer's interest in the ditch and a right to use the water.

By act of February 20, 1880, the selectmen of the several counties are made water commissioners, who have a kind of superior jurisdiction of the water rights in their respective counties.

They determine claims relative to the use of water, oversee, either personally or by agents, its distribution, and determine questions of right of way, etc.

They also issue certificates showing the extent of water rights.

A person first taking water from any source of supply, or having the open, peaceable, and continuous use of the water for seven years, has a primary right therein to the extent of the reasonable use thereof.

Whenever persons having the primary right use the water for a part of the year only, the person appropriating it for the balance of the year acquires a secondary right.

The person appropriating the surplus above the average of seven years also acquires a secondary right.

Water rights may be measured in inches or by fractional parts of the whole supply. Water rights may pertain to the land or may be personal property, as the owner may elect, and a change of place shall not affect the right to use the water; but no change of place shall be made to the injury of another owner without just compensation Neglect for seven years to use water, or keep in repair the means of conveying it, is regarded as an abandonment of the right.

Water rights are exempt from taxation, except for the purpose of regulating the use of the rights, but the increased value of the land may be regarded in making the assessments.

Surplus water must be returned to the natural channel, and any person wasting it is liable to have his supply shut off, and to pay damages to any person injured.

Any person using water lawfully appropriated to another, or diverting the flow of water lawfully distributed, or injuring any dam, ditch, etc., is guilty of a misdemeanor.

Whenever the supply is not sufficient for all purposes, the use for domestic purposes and for irrigating purposes takes precedence in that order.

Corporations may be formed under general laws for distributing water to their stockholders.