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Circular No. 6 - Measurement and Distribution of Irrigation Water

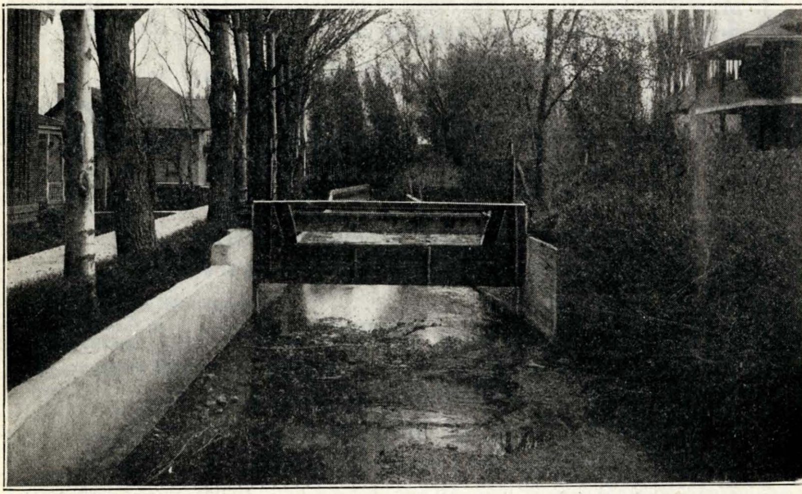
L. M. Winsor

Utah Agricultural College

EXPERIMENT STATION

CIRCULAR No. 6

EXTENSION DIVISION



Measurement and Distribution of Irrigation Water

By L. M. WINSOR

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Measurement and Distribution of Irrigation Water

L. M. WINSOR

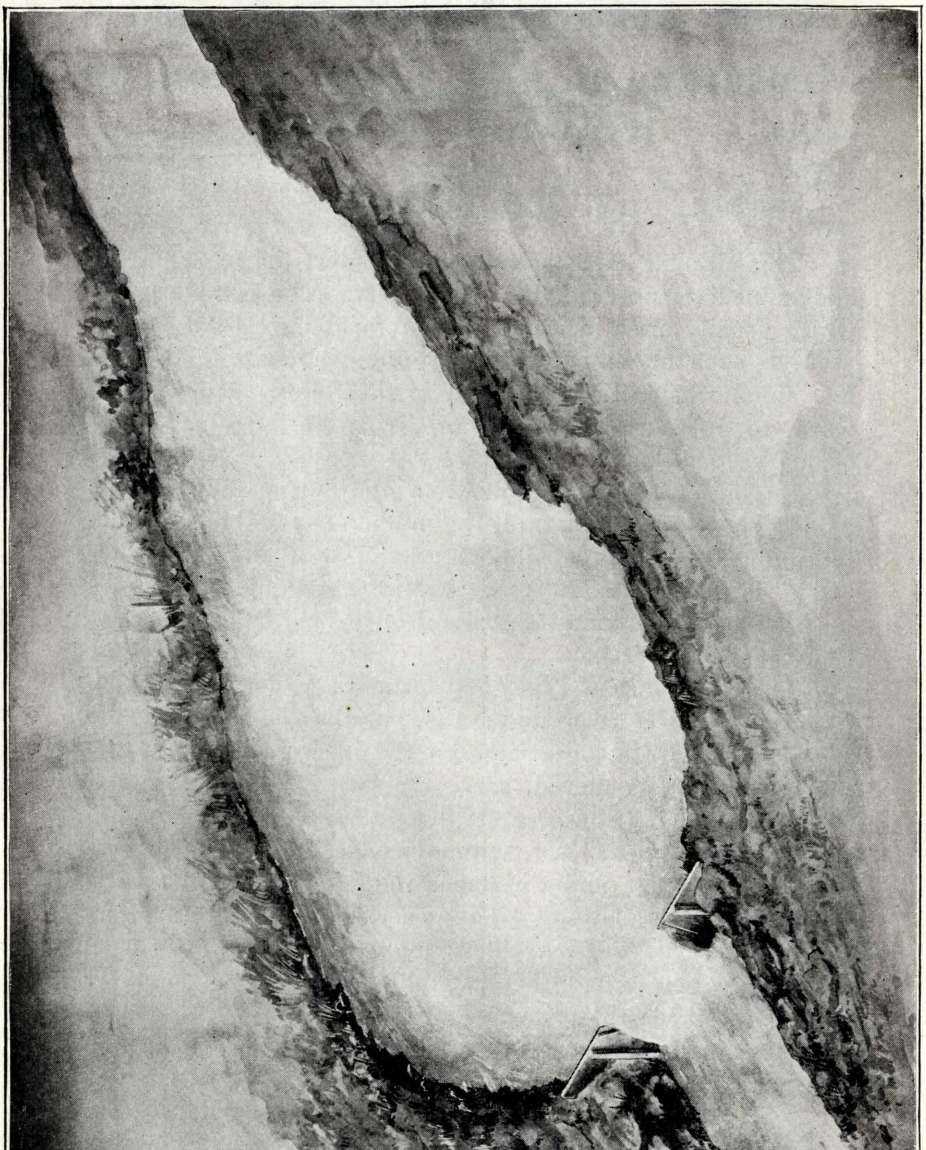
This circular has been prepared to meet the more urgent and immediate needs of the water user. The complications which usually arise in water measurement have been eliminated to such an extent that any one who will follow the few simple instructions outlined in the following pages can learn to measure the flow of irrigation streams under ordinary conditions.

Engineers who have made a thorough study of the subject are agreed that of the numerous methods of determining the flow of streams, the use of the measuring "weir" is the most satisfactory way of obtaining an accurate measure of the volume of water flowing through an irrigation canal or lateral.

There are various types and forms of weirs, all of which give more or less accurate results, but the Cippoletti Trapezoidal weir with a knife edge on the up-stream face of the notch will, it is believed, serve the farmer to the best advantage, and with the greatest degree of safety.

The rectangular weir, without end contractions, may be used to advantage under certain conditions, provided care is taken in the installation. In any case, the weir with a broad or thick crest is to be avoided; for when that form is used the farmer gets into difficulty right away, and an engineer who understands the principles of water measurement would have to be employed to determine the discharge through such a device.

The material of this paper will be confined largely to a discussion of the Trapezoidal weir with complete end and bottom contractions, and with a sharp crest; and if the farmer or watermaster will follow the directions relative to



its installation and use, he can rest assured that he is getting results which are very nearly correct.

The first thing to bear in mind is the fact that there is nothing difficult or complicated for the farmer in the use of this device. The complex problems have been worked out by experimenters who have made an extensive study of the subject and their results are presented to us in a form which is easy to comprehend. Deductions from these results are compiled in the following pages, and they should be very easy to comprehend, and just as easy to follow out. The ability to solve long and complex problems is not at all necessary. There are tables covering weirs of various lengths. When the weir is installed properly, the observer has merely to determine the depth of the water in the pond above the weir and read directly from the table for his particular weir the discharge in cubic feet per second. His chief trouble comes in the proper installation of the weir. If he is going to get good results he must meet the requirements for the particular weir he is adopting. This is not difficult; indeed it is very easy in most cases, especially for the weir discussed herein.

There is one further precaution which must not be slighted. A weir will not remain in good working condition indefinitely without some attention. Sediment must not be allowed to deposit above the crest to such an extent that the channel up stream is reduced in depth beyond the required limits, and moss and grass must not be allowed to collect and grow in such quantities that the free flow of the water is interfered with. These are points which are too often overlooked by the observer.

REQUIREMENTS FOR THE CONSTRUCTION AND INSTALLATION OF THE CIPPOLETTI TRAPEZOIDAL WEIR.

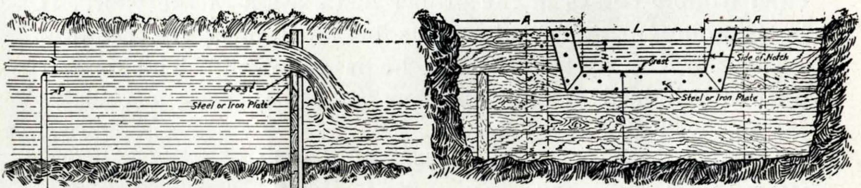
A. Construction.

1. Give the sides of the notch a slope of one unit horizontal to four units vertical, as indicated in fig. III.

2. Cut the notch with a bevel edge on the down-stream face so that there will be a sharp edge up stream. Make the bevel at least 45 degrees, and more if the wall of the weir is thicker than two inches.

3. Face the up-stream side of the notch with sheet iron strips as shown in figure II, and file the notch to a knife edge. When the weir is finished the up-stream face should be smooth.

4. Make the weir board long enough so that when it is installed the distance from the end of the crest to the side of the canal bank up-stream (A, figure II), shall be at least three times the depth of the water (H, figure II), above the crest. Make the weir board deep enough so that the distance from the crest to the bottom of the channel shall be at least three times the depth of the water above the crest, i. e., B equals at least three times H in figure II.



Cross Sec of a Weir Showing the Peg "P" From Which the Depth "H" is Measured

Up Stream Face of Trapezoidal WEIR Showing Relative Position to the Bottom and Sides of the Canal and the Depth of Water "H".

Fig. II.

B. Installation.

1. Choose a position in the channel where the approach is straight and level. When the weir is set there should be a pond of comparatively still water above for at least 50 feet for weirs of 6-foot crest or smaller, and 50 to 150 feet for weirs of 6 to 20-foot crest. The water should be quiet as it approaches the weir, and the filaments should be moving parallel to each other, and not be whirling in eddies or moving in cross-currents. To insure this condition is the reason for enlarging the channel above the weir. As the water approaches the weir it should always move slower than 6 inches per second.

2. The up-stream channel can be a large pond, as shown

in figure I, if it is convenient; but if it is small in cross-section, it should be uniform for 50 to 150 feet above.

3. The weir should be placed directly across the channel, at right angles to the approach, in a vertical position, and with the crest on a level.

4. Provision should be made for washing out the sediment which will be deposited above. The weir can be made movable so that it can be lifted out of the channel, or it can be provided with small flush gates beneath the crest.

5. The down-stream channel should have sufficient fall so that the water will be carried away without interfering with the flow through the weir. Always have free circulation of air under the jet of water (C, figure II), as it pours through the notch; it does not matter how little or how great the drop so long as this condition is maintained.

6. For accurate measurement, the depth of the water on the crest should not be less than 3 inches and not greater than one-third the length of the crest. For large weirs, the depth should not exceed two to three feet.

DEPTH OF NOTCH AND LENGTH OF CREST.

By the help of the weir tables in the back of this pamphlet, the dimensions of the notch for a weir to meet a particular condition, can be determined very easily. Let it be required to construct a weir for a stream which varies between 4 and 25 second feet in volume. By referring to the table of discharge, we see that a weir 3½ feet long with the depth of 5⅞ inches will discharge 4 second feet, and at a depth of 19¾ inches will discharge 25 second feet; also that a weir 10 feet long at a depth of 3 inches will discharge 4.2 second feet, and at a depth of 9⅞ inches will discharge 25 second feet. It is also seen that if the weir were 12½ feet long the depth for a 4 second foot discharge would be only 2¼ inches. This is too shallow for accurate measurement, therefore the limits for this particular weir lie between 3½-foot crest, with a notch 19¾ inches deep, and a 10-foot crest with a notch 9⅞ inches deep. If there is slight fall, the latter should be chosen, and if there is plenty of fall, the former would be preferable. Any of the intermediate sizes can be used if desired. To insure safety, the depth of the notch is made a little greater than the greatest depth necessary to discharge the maximum flow of water. The weir should be designed with the idea of giving accurate measurement at low water time rather than at high water, because then is when most careful distribution is needed. For this reason a weir should always be put in which will carry a depth or head of more than three inches when the stream is at its lowest level.

MEASURING THE DEPTH.

It will be seen by a glance at figure II that the surface of the jet of water curves downward, commencing at E considerable distance back of the face of the weir at "F." Therefore, it is necessary to measure the head "H" up stream to still water. For this reason a peg is set somewhere between 5 and 15 feet up stream with its head on a level with the crest. The depth of water "H" is measured from the peg (P., fig. II).

A special device called the "hook-gauge" is used for close determinations, but the rule or carpenter's square will give results close enough for ordinary purposes.

TO DETERMINE THE DISCHARGE THROUGH THE CIPPOLETTI WEIR.

Having determined the depth of the water and knowing the length of the weir crest, the discharge is read directly from the weir table. For example, let us suppose that we have a 5-foot weir installed. If our measured depth is 3½ inches, we turn to the table and run down the column for depth in inches to 3½, then run along horizontally to the right to the column of discharge under the 5-foot weir, and there we find 2.63 second feet as the discharge. Again, suppose the depth on the same weir is 18 inches. We follow down the depth column as before to 18 inches, then across under the 5-foot weir we read 30.92 second feet as the discharge. If the depth is measured in hundredths of feet instead of inches, the operation is just the same, and the discharge for any length of weir is determined in a like manner. However, the table provides for weirs of 1, 1½, 2, 2½, 3, 3½, 5, 7½, 10, 12½, 18, and 20-foot lengths only; and if a weir is installed which is not included in this table the discharge can be readily determined from the table, because the discharge is directly proportional to the length of the crest. As an example: suppose a 6-foot weir is installed; the discharge will be just twice what it is for the 3-foot weir, six times what it is for the 1-foot weir, or ⅓ what it is for the 18-foot weir at the same depth or head.

DIVISION OF WATER.

The ordinary method of dividing water is very crude and at the same time very inaccurate, being nothing more than a mere guess in most cases. This can but result in trouble during the entire irrigation season. When the farmer does make an attempt at installing some sort of divider, he usually adopts some device which only approaches accuracy, and one which is just as expensive to install as an accurate divider would be.

The Cippoletti weir can be used as a divider by placing a sharp-edged partition below the weir to split the jet of water as it falls over the crest. Thus the weir serves not only to measure the flow, but also to distribute the water equally along its crest, so that it can be divided accurately. The discharge through a Cippoletti weir is directly proportional to its length. Therefore, if, for example, a stream is to be divided so that one-fifth is diverted and four-fifths goes on, and the weir is five feet long, the divider will be placed just one foot from one end of the weir crest—or in figure III let "A" equal 5, then "B" equals 1.

The partition or sharp edge of the divider should be placed just far enough below the crest so that there is always free circulation of air over the sharp edge of the split and under the jet of water.

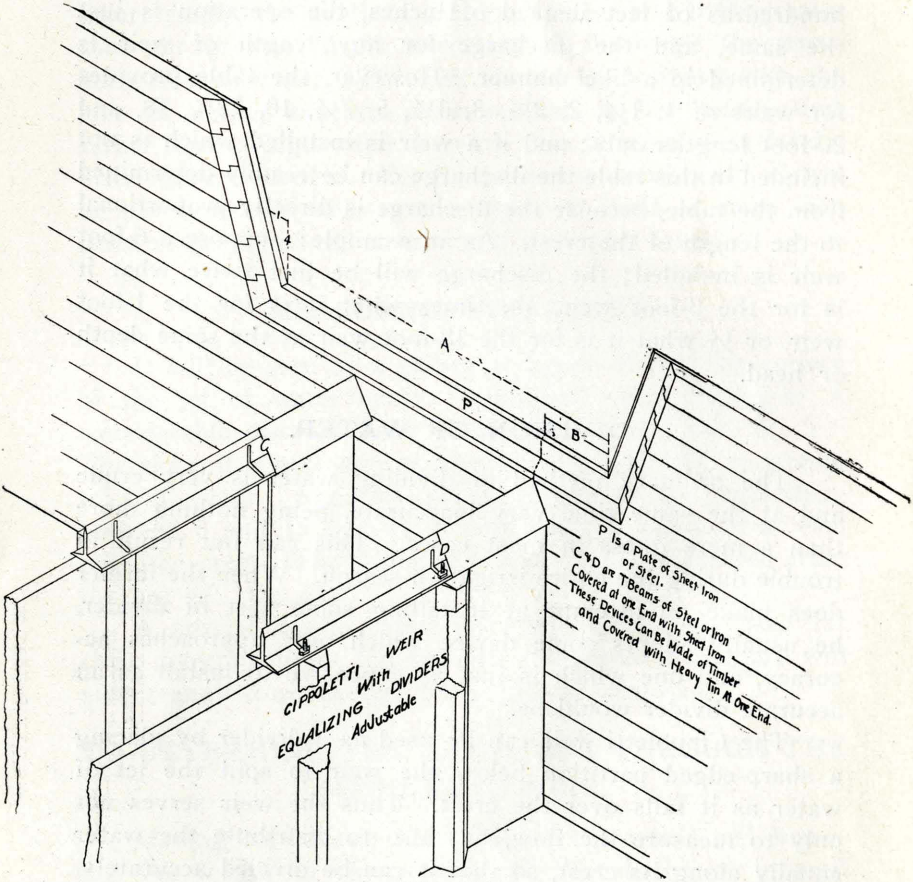


Fig. III.

ADJUSTABLE DIVIDER.

Sometimes it is desired to change the proportion of water which is to be diverted from the main stream. In this case the divider should be made adjustable. The device set on top of the division wall at C and D, in figure III, illustrates one way by which this can be accomplished.

A contrivance arranged so that the entire partition moves is to be avoided. If the division is to be constant, the split or divider need not be made movable. In this case the construction is very simple.

DIVERTING A CONSTANT QUANTITY OF WATER.

In some cases it is desired to divert a constant volume of water from the main stream, regardless of the rise and fall in that stream. A considerable amount of designing has been done in this connection, but nothing has come to the writer's notice which is at all satisfactory. However, the Foote Module, designed by Mr. A. D. Foote for the

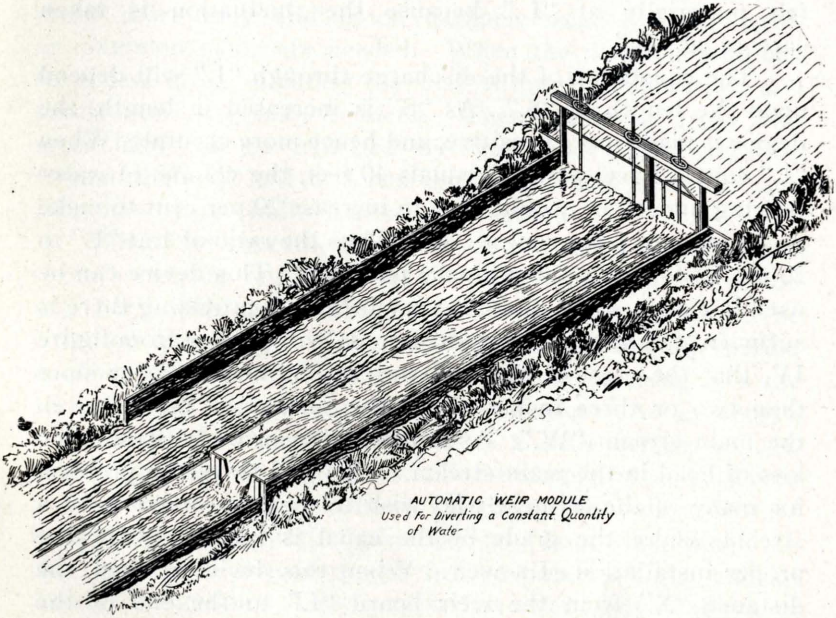


Fig IV.

measure of miner's inches, suggests a principle which may be used to advantage in connection with the weir. It is a very simple appliance, and yet will give far better results than some of the more complicated mechanisms which various engineers have attempted to use to accomplish the same purpose. Figure IV illustrates the general principle for constructing what we shall call the "Automatic Weir Module."

The gates "A" and "B" regulate, to a certain extent, the amount of water admitted into the diverting channel from the main stream.

The crest of the weir at "L" is placed far enough below the crest of the spill-way "S" to provide for a certain discharge. The gates are regulated so as to admit a little more water at "B" than is required for a certain discharge at "L." The surplus passes over the long spill-way at "S." Any rise and fall in the flow of the main stream is not felt materially at "L," because the fluctuation is taken care of at "S."

The constancy of the discharge through "L" will depend upon the length of "S." As "S" is increased in length, the device is made more sensitive, and hence more accurate. When "L" equals 2 feet and "S" equals 40 feet, the volume of water flowing under "B" would have to increase 20 per cent to make an increase of 1 per cent at "L." Thus the ratio of 1 at "L" to 20 at "S" is ample for ordinary purposes. This device can be used in canals where there is very little fall, providing there is sufficient fall in the lateral stream. It will be seen from figure IV, that the crest of the spill-way at "S" need not set more than two or three inches above the surface of the water in the main stream "W." As a result, it can be used with no loss of head in the main stream. This will solve the problem for many of the farmers who wish to measure water from a stream where the grade of the canal is too slight for the proper installation of a weir. When this device is used, the distance "X" from the weir board "L" to the end of the overflow "S," should never be less than 10 feet, and 16 feet would be still better to insure steady flow of water as it approaches the weir.

DIVISION BY TIME.

The most accurate way to divide water is by the "Time

Method." Where a canal is divided into many small streams in proportion to the shares held by each farm owner, there is always the chance for inaccuracy of division, especially where the ordinary methods are employed. On the other hand, if the small streams are combined into a few large streams, and each large stream covers a certain district, going in rotation from farm to farm, then the division among the various share-holders can be made accurately. The water is divided by time, and time division can be made absolute. When the time or rotation system is employed, the laterals are usually kept in much better shape. With this system the division from the main canal is made much more easy and much cheaper because fewer weirs or diversion gates are needed. When the water is confined to a few large streams, the loss through evaporation and percolation is greatly reduced. Then, again, a great deal more land can be irrigated by one good sized irrigation stream than by half a dozen garden streams such as each farm has by the individual stream method.

When the time method is used, the turns come around to each farm at regular intervals. The length of the period will vary with the conditions of the soil, the crops to be irrigated and so on. Under ordinary conditions, the period is about 7½ days, though it may be twice that long in some sections, and it may vary during the season. At all events, it is advisable to make the period a little longer than a certain number of even days. For example, it is better to make the period between turns 7½ days than 7 days, so that it does not come at the same day and hour each time. In this way each irrigator gets his portion of night and of Sunday irrigation. This system has every advantage over the individual distribution system.

DEFINITIONS AND HINTS WHICH WILL BE OF ADVANTAGE TO THE IRRIGATOR.

Second Foot.—The "miner's inch" is a term which is being discarded because of the many inconsistencies which are associated with it. There is no excuse for using such a unit when we have one which conveys so much more information, and is so much easier to comprehend. The "Second Foot" does away with all the vagueness associated with the miner's inch, and gives us something concrete. By combining the second of time with the cubic foot of measure we get the term "second foot," which is used as the unit of measure for the flow of streams. **When a stream is discharging one cubic foot of water every second of time, there is a second foot flow.**

Acre Foot.—An acre foot of water means enough water to cover an acre to a depth of one foot, or a sheet of water over an acre one foot deep. "Acre Foot" is the unit used in speaking of the amount of water applied in the production of the crop, or of the duty of water. An acre inch is one-twelfth of an acre foot.

Second Foot and Acre Foot.—There is a direct relationship between the second foot and the acre foot, hence if the farmer knows how to measure his stream he can easily determine how much water he is using per acre, and he can begin to use water with some degree of intelligence. A second foot stream discharges one acre inch per hour, one acre foot in 12 hours and two acre feet per day.

The average irrigation season in Utah runs from May 1st to August 31st, or four months.

A second foot stream discharges 240 acre feet in four months.

DUTY OF WATER.

In irrigation, the duty of water means the amount of water applied per acre in the production of a crop. A high duty means a small amount of water for a large amount of land, and a low duty means a large amount of water for a small amount of land. In Utah there is a very low duty in most sections as compared with the duty in some of our sister states—California for example. In the citrus belt of California, the duty ranges between one second foot to 200 acres and one second foot to 120 acres. In Utah the duty as allowed by the State engineer at the present time, is one second foot for each 70 acres, and many of the old water users have acquired rights to as high as one second foot to 20 acres, which means enough water to cover each acre to a depth of 12 feet in four months, or 36 feet during the year. When we consider that 2½ acre feet is the maximum needed in this state, in addition to the precipitation, to produce a crop, if applied during the irrigation season, it is seen how extravagant we are in the use of water.

A second foot stream will deliver 3.4 acre feet per acre to 70 acres between May 1st and August 31st. A second foot stream will deliver 2.4 acre feet per acre to 100 acres between May 1st and August 31st, and 2 acre feet per acre to 120 acres or 1.5 acre feet per acre to 160 acres in the same length of time.

Irrigation Stream.—A second foot flow is too small for an ordinary irrigation stream. Under average conditions, one man can handle from 2 to 5 second feet. Three to five acre inches is enough for a good irrigation.

If the irrigation stream is 3 second feet and if 4 acre inches is taken as a good irrigation, then—

3 second feet covers	¾	acres 4 inches deep in	1	hour
3 second feet covers	17.8	acres 4 inches deep in	24	hours
3 second feet covers	125	acres 4 inches deep in	7	days
3 second feet covers	135	acres 4 inches deep in	7½	days

Note.—The reason for the 7½ day division is explained in a previous paragraph under "Division by Time."

If, then, the water from the main canal be divided into lateral streams of 3 second feet each, and if the water be taken in turns by the farmers under each lateral system, and it comes around to each farm every 7½ days, this means that 135 acres can be irrigated under each system each period. If it is necessary to cover only ¼ the land on each farm at any one time, then each lateral stream of 3 second feet can cover 540 acres and give each acre 4 good irrigations between May 1st and August 31st. This means a duty of one second foot to 180 acres during the 4 months, and allowing the water to waste during the other 8 months.

Again, if we assume that 1/3 the land in each farm is irrigated each period of 7½ days, then 400 acres of irrigable land can be included under each lateral system and each acre will receive 5½ irrigations during the irrigation season of 4 months. In this case the duty of water is one second foot to 135 acres.

If we take the present duty of water as allowed by the State Engineer, or one second foot for 70 acres, this means that with lateral streams of 3 second feet, only 210 acres are included under each lateral system. Furthermore, this means that two-thirds of the land in each farm can be irrigated every 7½ days, or that all the land on every farm can be irrigated every 11⅔ days, and that each acre can receive over 10 good irrigations during the 4 months time, or a total of 3.4 acre feet during the irrigation season.

When we consider that the irrigation season usually extends from April 16th to September 15th (5 months), we see again that our present duty of water is very extravagant.

Of the factors which have played such an important part in the development of the great West and Southwest, irrigation has been in the front rank. In a like manner, the future development of this state will depend very largely upon the proper conservation of its available water.

If the state is to grow the communities must grow. If the communities are to grow, the farmers must become better farmers. One way to become a better farmer is to become a better irrigator. To become a better irrigator, the careless methods of the past 65 years must gradually be abandoned for the more careful methods of the present. The water must first be prevented from wasting, by evaporation and by leaching, or percolating from the channels; Second, it must be measured and distributed accurately to the different irrigators; and Third, it must be used economically when it reaches the farm.

The accomplishment of these things will result not only in gain for the individuals, but also in the development of a bigger and better state.

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR.

For Various Lengths and Depths. Formula: $Q = 3.3\frac{2}{3}\,LH^{\frac{3}{2}}$

Head "H" on Crest Measured to Still Water		Discharge in Cubic Feet per Second											
		Length of Weir Crest in Feet											
In feet	In inches	1	1½	2	2½	3	3½	4	5	7½	10	12½	15
.01	⅛	.003	.01	.01	.01	.01	.01	.01	.02	.02	.03	.04	.05
.02	¼	.010	.01	.02	.02	.03	.03	.04	.05	.07	.10	.12	.14
.03	⅜	.018	.03	.04	.04	.05	.06	.07	.09	.13	.18	.22	.26
.04	½	.027	.04	.06	.07	.08	.09	.11	.13	.20	.27	.34	.40
.05	⅝	.038	.06	.08	.09	.11	.13	.15	.19	.28	.38	.47	.56
.06	¾	.050	.07	.10	.12	.15	.17	.20	.25	.37	.49	.62	.74
.07	⅞	.062	.09	.12	.16	.19	.22	.25	.31	.47	.62	.78	.94
.08	1	.076	.11	.15	.19	.23	.27	.30	.38	.57	.76	.95	1.14
.09	⅛	.091	.14	.18	.23	.27	.32	.36	.45	.68	.91	1.14	1.36
.10	¼	.107	.16	.21	.27	.32	.37	.43	.53	.80	1.06	1.33	1.60
.11	1⅜	.123	.18	.25	.31	.37	.43	.49	.61	.92	1.23	1.54	1.84
.12	½	.140	.21	.28	.35	.42	.49	.56	.70	1.05	1.40	1.75	2.10
.13	9/16	.158	.24	.32	.39	.47	.55	.63	.79	1.18	1.58	1.97	2.37
.14	⅝	.176	.26	.35	.44	.53	.62	.71	.88	1.32	1.76	2.20	2.65
.15	¾	.196	.29	.39	.49	.59	.68	.78	.98	1.47	1.96	2.44	2.93
.16	1⅞	.216	.32	.43	.54	.65	.75	.86	1.08	1.62	2.15	2.69	3.23
.17	2	.236	.35	.47	.59	.71	.83	.94	1.18	1.77	2.36	2.95	3.54
.18	⅛	.257	.39	.51	.64	.77	.90	1.03	1.29	1.93	2.57	3.21	3.86
.19	¼	.279	.42	.56	.70	.84	.98	1.12	1.39	2.09	2.79	3.49	4.18
.20	⅜	.301	.45	.60	.75	.90	1.05	1.20	1.51	2.26	3.01	3.76	4.52
.21	2½	.324	.49	.65	.81	.97	1.13	1.30	1.62	2.43	3.24	4.05	4.86
.22	⅝	.347	.52	.69	.87	1.04	1.22	1.39	1.74	2.61	3.47	4.34	5.21
.23	¾	.371	.56	.74	.93	1.11	1.30	1.49	1.86	2.79	3.71	4.64	5.57
.24	⅞	.396	.59	.79	.99	1.19	1.39	1.58	1.98	2.97	3.96	4.95	5.94
.25	3	.421	.63	.84	1.05	1.26	1.47	1.68	2.10	3.16	4.21	5.26	6.31
.26	3⅛	.446	.67	.89	1.12	1.34	1.56	1.79	2.23	3.35	4.46	5.58	6.70
.27	¼	.472	.71	.94	1.18	1.42	1.65	1.89	2.36	3.54	4.72	5.90	7.09
.28	⅜	.499	.75	1.00	1.25	1.50	1.75	2.00	2.49	3.74	4.99	6.24	7.48
.29	½	.526	.79	1.05	1.31	1.58	1.84	2.10	2.63	3.94	5.26	6.57	7.89
.30	⅝	.553	.83	1.11	1.38	1.66	1.94	2.21	2.77	4.15	5.53	6.92	8.30
.31	3¾	......	.87	1.16	1.45	1.74	2.03	2.32	2.91	4.36	5.81	7.26	8.72
.32	⅞	......	.91	1.22	1.52	1.83	2.13	2.44	3.05	4.57	6.09	7.62	9.14
.33	4	......	.96	1.28	1.60	1.91	2.23	2.55	3.19	4.79	6.38	7.98	9.57
.34	⅛	......	1.00	1.33	1.67	2.00	2.34	2.67	3.34	5.01	6.67	8.34	10.01
.35	¼	......	1.05	1.39	1.74	2.09	2.44	2.79	3.49	5.23	6.97	8.71	10.46
.36	4⅜	......	1.09	1.45	1.82	2.18	2.56	2.91	3.64	5.45	7.27	9.09	10.91
.37	½	......	1.14	1.52	1.89	2.27	2.65	3.03	3.79	5.68	7.58	9.47	11.37
.38	9/16	......	1.18	1.58	1.97	2.37	2.76	3.15	3.94	5.91	7.89	9.86	11.83
.39	⅝	......	1.23	1.64	2.05	2.46	2.87	3.28	4.10	6.15	8.20	10.25	12.30
.40	¾	......	1.28	1.70	2.13	2.56	2.98	3.41	4.26	6.39	8.52	10.65	12.78
.41	4⅞	......	1.33	1.77	2.21	2.65	3.09	3.54	4.42	6.63	8.84	11.05	13.26
.42	5	......	1.37	1.83	2.29	2.75	3.21	3.67	4.58	6.87	9.16	11.46	13.75
.43	⅛	......	1.42	1.90	2.37	2.85	3.32	3.80	4.75	7.12	9.49	11.87	14.24
.44	¼	......	1.47	1.97	2.46	2.95	3.44	3.93	4.91	7.37	9.83	12.28	14.74
.45	⅜	......	1.52	2.03	2.55	3.05	3.56	4.07	5.08	7.62	10.16	12.70	15.24
.46	5½	......	1.58	2.10	2.63	3.15	3.68	4.20	5.25	7.88	10.50	13.13	15.76
.47	⅝	......	1.63	2.17	2.71	3.25	3.80	4.34	5.42	8.14	10.85	13.56	16.27
.48	¾	......	1.68	2.24	2.80	3.36	3.92	4.48	5.60	8.40	11.20	14.00	16.79
.49	⅞	......	1.73	2.31	2.89	3.46	4.04	4.62	5.77	8.66	11.55	14.43	17.32
.50	6	......	1.79	2.38	2.98	3.57	4.17	4.76	5.95	8.93	11.90	14.88	17.85

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR—Cont'd.

For Various Lengths and Depths. Formula: $Q=3.3\frac{2}{3} LH^{\frac{3}{2}}$

Head "H" on Crest Measured to Still Water		Discharge in Cubic Feet per Second — Length of Weir Crest in Feet											
In feet	In inches	1½	2	2½	3	3½	4	5	7½	10	12½	15	18
.51	6⅛	1.84	2.45	3.07	3.68	4.29	4.90	6.13	9.20	12.26	15.33	18.39	22.07
.52	¼	1.89	2.52	3.16	3.79	4.42	5.05	6.31	9.47	12.62	15.78	18.94	22.72
.53	⅜	1.95	2.60	3.25	3.90	4.55	5.20	6.50	9.74	12.99	16.24	19.49	23.38
.54	½	2.00	2.67	3.34	4.01	4.68	5.34	6.68	10.02	13.36	16.70	20.04	24.05
.55	⅝	2.06	2.75	3.43	4.12	5.81	5.49	6.87	10.30	13.73	17.17	20.60	24.72
.56	6¾	2.12	2.82	3.53	4.23	4.94	5.64	7.05	10.58	14.11	17.64	21.16	25.40
.57	⅞	2.17	2.90	3.62	4.35	5.07	5.80	7.24	10.87	14.49	18.11	21.73	26.08
.58	7	2.23	2.97	3.72	4.46	5.20	5.95	7.44	11.15	14.87	18.59	22.31	26.77
.59	⅛	2.29	3.05	3.81	4.58	5.34	6.10	7.63	11.44	15.26	19.07	22.89	27.46
.60	¼	2.35	3.13	3.91	4.69	5.48	6.26	7.82	11.74	15.65	19.56	23.47	28.16
.61	7⅜	......	3.21	4.01	4.81	5.61	6.42	8.02	12.03	16.04	20.05	24.06	28.87
.62	½	......	3.29	4.11	4.93	5.75	6.57	8.22	12.33	16.44	20.54	24.65	29.58
.63	9/16	......	3.37	4.21	5.05	5.89	6.73	8.42	12.63	16.83	21.04	25.25	30.30
.64	⅝	......	3.45	4.31	5.17	6.03	6.89	8.62	12.93	17.24	21.55	25.86	31.03
.65	¾	......	3.53	4.41	5.29	6.18	7.06	8.82	13.23	17.64	22.05	26.46	31.76
.66	7⅞	......	3.61	4.51	5.42	6.32	7.22	9.03	13.54	18.05	22.56	27.08	32.49
.67	8	......	3.69	4.62	5.54	6.46	7.39	9.23	13.85	18.46	23.08	27.70	33.23
.68	⅛	......	3.78	4.72	5.66	6.61	7.55	9.44	14.16	18.88	23.60	28.32	33.98
.69	¼	......	3.86	4.82	5.79	6.75	7.72	9.65	14.47	19.30	24.12	28.94	34.73
.70	⅜	......	3.94	4.93	5.92	6.90	7.89	9.86	14.79	19.72	24.65	29.58	35.49
.71	8½	......	4.03	5.04	6.04	7.05	8.06	10.07	15.11	20.14	25.18	30.21	36.25
.72	⅝	......	4.11	5.14	6.17	7.20	8.23	10.28	15.43	20.57	25.71	30.85	37.03
.73	¾	......	4.20	5.25	6.30	7.35	8.40	10.50	15.75	21.00	26.25	31.50	37.80
.74	⅞	......	4.29	5.36	6.43	7.50	8.57	10.72	16.07	21.43	26.79	32.15	38.58
.75	9	......	4.37	5.47	6.56	7.65	8.75	10.93	16.40	21.87	27.33	32.80	39.36
.76	9⅛	......	4.46	5.58	6.69	7.81	8.92	11.15	16.73	22.31	27.88	33.46	40.15
.77	¼	......	4.55	5.69	6.82	7.96	9.10	11.37	17.06	22.75	28.43	34.12	40.95
.78	⅜	......	4.64	5.80	6.96	8.12	9.28	11.60	17.39	23.19	28.99	34.79	41.75
.79	½	......	4.73	5.91	7.09	8.27	9.46	11.82	17.73	23.64	29.55	35.46	42.55
.80	⅝	......	4.82	6.02	7.23	8.43	9.64	12.05	18.07	24.09	30.11	36.13	43.36
.81	9¾	......	4.91	6.14	7.36	8.59	9.82	12.27	18.41	24.54	30.68	36.81	44.18
.82	⅞	......	5.00	6.25	7.50	8.75	10.00	12.50	18.75	25.00	31.25	37.50	45.00
.83	10	......	5.09	6.36	7.64	8.91	10.18	12.73	19.09	25.46	31.82	38.19	45.82
.84	⅛	......	5.18	6.48	7.78	9.07	10.37	12.96	19.44	25.92	32.40	38.88	46.65
.85	¼	......	5.28	6.60	7.92	9.23	10.55	13.19	19.79	26.38	32.98	39.57	47.49
.86	10⅜	......	5.37	6.71	8.06	9.40	10.74	13.43	20.14	26.85	33.56	40.28	48.33
.87	½	......	5.46	6.83	8.20	9.56	10.93	13.66	20.49	27.32	34.15	40.97	49.18
.88	9/16	......	5.56	6.95	8.34	9.73	11.12	13.90	20.84	27.79	34.74	41.69	50.03
.89	⅝	......	5.65	7.07	8.48	9.89	11.31	14.13	21.20	28.27	35.33	42.40	50.88
.90	¾	......	5.75	7.19	8.62	10.06	11.50	14.37	21.56	28.75	35.93	43.12	51.74
.91	10⅞	......	......	7.31	8.77	10.23	11.69	14.61	21.92	29.23	36.53	43.84	52.61
.92	11	......	......	7.43	8.91	10.40	11.88	14.85	22.28	29.71	37.14	44.56	53.48
.93	⅛	......	......	7.55	9.06	10.57	12.08	15.10	22.65	30.19	37.74	45.29	54.35
.94	¼	......	......	7.67	9.20	10.74	12.27	15.34	23.01	30.68	38.35	46.02	55.23
.95	⅜	......	......	7.79	9.35	10.91	12.47	15.59	23.38	31.17	38.97	46.76	56.11
.96	11½	......	......	7.92	9.50	11.08	12.67	15.83	23.75	31.67	39.58	47.50	57.00
.97	⅝	......	......	8.04	9.65	11.26	12.87	16.08	24.12	32.16	40.20	48.24	57.89
.98	¾	......	......	8.17	9.80	11.43	13.06	16.33	24.49	32.66	40.83	48.99	58.79
.99	⅞	......	......	8.29	9.95	11.61	13.27	16.58	24.87	33.16	41.45	49.74	59.69
1.00	12	......	......	8.42	10.10	11.78	13.47	16.83	25.25	33.67	42.08	50.50	60.60

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR—Cont'd.

For Various Lengths and Depths. Formula: $Q=3.3^2/_3 \, LH^{\frac{3}{2}}$

Head "H" on Crest Measured to Still Water		Discharge in Cubic Feet per Second										
		Length of Weir Crest in Feet										
In feet	In inches	2½	3	3½	4	5	7½	10	12½	15	18	20
1.01	12⅛	8.54	10.25	11.96	13.67	17.09	25.63	34.17	42.72	51.26	61.51	68.35
1.02	¼	8.67	10.40	12.14	13.87	17.34	26.01	34.68	43.35	52.02	62.43	69.36
1.03	⅜	8.80	10.56	12.32	14.08	17.60	26.39	35.19	43.99	52.79	63.35	70.39
1.04	½	8.93	10.71	12.50	14.28	17.85	26.78	35.71	44.63	53.56	64.27	71.41
1.05	⅝	9.06	10.87	12.68	14.49	18.11	27.17	36.22	45.28	54.33	65.20	72.45
1.06	12¾	9.19	11.02	12.86	14.70	18.37	27.56	36.74	45.93	55.11	66.14	73.48
1.07	⅞	9.32	11.18	13.04	14.91	18.63	27.95	37.26	46.58	55.89	67.07	74.53
1.08	13	9.45	11.34	13.23	15.11	18.89	28.34	37.79	47.23	56.68	68.02	75.57
1.09	⅛	9.58	11.49	13.41	15.33	19.16	28.73	38.31	47.89	57.47	68.96	76.62
1.10	¼	9.71	11.65	13.59	15.54	19.42	29.13	38.84	48.55	58.26	69.91	77.68
1.11	13⅜	9.84	11.81	13.78	15.75	19.69	29.53	39.37	49.21	59.06	70.87	78.74
1.12	½	9.98	11.97	13.97	15.96	19.95	29.93	39.90	49.88	59.86	71.83	79.81
1.13	9/16	10.11	12.13	14.15	16.18	20.22	30.33	40.44	50.55	60.66	72.79	80.88
1.14	⅝	10.24	12.29	14.34	16.39	20.49	30.73	40.98	51.22	61.47	73.76	81.96
1.15	¾	10.38	12.46	14.53	16.61	20.76	31.14	41.52	51.90	62.28	74.73	83.04
1.16	13⅞	10.52	12.62	14.72	16.82	21.03	31.55	42.06	52.58	63.09	75.71	84.12
1.17	14	10.65	12.78	14.91	17.04	21.30	31.96	42.61	53.26	63.91	76.69	85.21
1.18	⅛	10.79	12.95	15.10	17.26	21.58	32.37	42.15	53.94	64.73	77.68	86.31
1.19	¼	10.93	13.11	15.30	17.48	21.85	32.78	43.70	54.63	65.56	78.67	87.41
1.20	⅜	11.06	13.28	15.49	17.70	22.13	33.19	44.26	55.32	66.38	79.66	88.51
1.21	14½	......	13.44	15.68	17.92	22.41	33.61	44.81	56.01	67.22	80.66	89.62
1.22	⅝	......	13.61	15.88	18.15	22.68	34.03	45.37	56.71	68.05	81.66	90.73
1.23	¾	......	13.78	16.07	18.37	22.96	34.44	45.93	57.41	68.89	82.67	91.85
1.24	⅞	......	13.95	16.27	18.59	23.24	34.87	46.49	58.11	69.73	83.68	92.97
1.25	15	......	14.12	16.47	18.82	23.53	35.29	47.05	58.81	70.58	84.69	94.10
1.26	15⅛	......	14.28	16.67	19.05	23.81	35.71	47.62	59.52	71.42	85.71	95.23
1.27	¼	......	14.46	16.86	19.27	24.09	36.14	48.18	60.23	72.28	86.74	96.37
1.28	⅜	......	14.63	17.06	19.50	24.38	36.57	48.75	60.94	73.13	87.76	97.51
1.29	½	......	14.80	17.26	19.73	24.66	37.00	49.33	61.66	73.99	88.79	98.65
1.30	⅝	......	14.97	17.47	19.96	24.95	37.43	49.90	62.38	74.85	89.82	99.80
1.31	15¾	......	15.14	17.67	20.19	25.24	37.86	50.48	63.10	75.72	90.86	100.96
1.32	⅞	......	15.32	17.87	20.42	25.53	38.29	51.06	63.82	76.59	91.90	102.12
1.33	16	......	15.49	18.07	20.66	25.82	38.73	51.64	64.55	77.46	92.95	103.28
1.34	⅛	......	15.67	18.28	20.89	26.11	39.17	52.22	65.28	78.33	94.00	104.45
1.35	¼	......	15.84	18.48	21.12	26.40	39.61	52.81	66.01	79.21	95.05	105.62
1.36	16⅜	......	16.02	18.69	21.36	26.70	40.05	53.40	66.74	80.09	96.11	106.79
1.37	½	......	16.20	18.90	21.59	26.99	40.49	53.99	67.48	80.98	97.18	107.97
1.38	9/16	......	16.37	19.10	21.83	27.29	40.93	54.58	68.22	81.87	98.25	109.16
1.39	⅝	......	16.55	19.31	22.07	27.59	41.38	55.17	68.97	82.76	99.31	110.35
1.40	¾	......	16.73	19.52	22.31	27.88	41.83	55.77	69.71	83.65	100.38	111.54
1.41	16⅞	......	16.91	19.73	22.55	28.18	42.28	56.37	70.46	84.55	101.46	112.74
1.42	17	......	17.09	19.94	22.79	28.48	42.73	56.97	71.21	85.45	102.54	113.94
1.43	⅛	......	17.27	20.15	23.03	28.79	43.18	57.57	71.96	86.36	103.63	115.14
1.44	¼	......	17.45	20.36	23.27	29.09	43.63	58.18	72.72	87.26	104.72	116.35
1.45	⅜	......	17.63	20.57	23.51	29.39	44.09	58.78	73.48	88.17	105.81	117.57
1.46	17½	......	17.82	20.79	23.76	29.70	44.54	59.39	74.24	89.09	106.91	118.78
1.47	⅝	......	18.00	21.00	24.00	30.00	45.00	60.00	75.00	90.01	108.01	120.01
1.48	¾	......	18.19	21.22	24.25	30.31	45.46	60.62	75.77	90.93	109.11	121.23
1.49	⅞	......	18.37	21.43	24.49	30.62	45.92	61.23	76.54	91.85	110.22	122.46
1.50	18	......	18.55	21.65	24.74	30.92	46.39	61.85	77.31	92.77	111.33	123.70

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR—Cont'd.

For Various Lengths and Depths. Formula: $Q=3.3\frac{2}{3}LH^{\frac{3}{2}}$

Head "H" on Crest Measured to Still Water		Discharge in Cubic Feet per Second								
		Length of Weir Crest in Feet								
In feet	In inches	3½	4	5	7½	10	12½	15	18	20
1.51	18⅛	21.86	24.99	31.23	46.85	62.47	78.09	93.70	112.44	124.94
1.52	¼	22.08	25.24	31.55	47.32	63.09	78.86	94.64	113.56	126.18
1.53	⅜	22.30	25.49	31.86	47.79	63.71	79.64	95.57	114.69	127.43
1.54	½	22.52	25.74	32.17	48.26	64.34	80.43	96.51	115.81	128.68
1.55	⅝	22.74	25.99	32.48	48.73	64.97	81.21	97.45	116.94	129.94
1.56	18¾	22.96	26.24	32.80	49.20	65.60	82.00	98.40	118.08	131.19
1.57	⅞	23.18	26.49	33.11	49.67	66.23	82.79	99.34	119.21	132.46
1.58	19	23.40	26.75	33.43	50.15	66.86	83.58	100.29	120.35	133.73
1.59	⅛	23.62	27.00	33.75	50.62	67.50	84.37	101.25	121.50	135.00
1.60	¼	23.85	27.25	34.07	51.10	68.14	85.17	102.20	122.65	136.27
1.61	19⅜	24.07	27.51	34.39	51.58	68.78	85.97	103.16	123.80	137.55
1.62	½	24.30	27.77	34.71	52.06	69.42	86.77	104.13	124.95	138.84
1.63	9/16	24.52	28.02	35.03	52.55	70.06	87.58	105.09	126.11	140.12
1.64	⅝	24.75	28.28	35.35	53.03	70.71	88.38	106.06	127.27	141.42
1.65	¾	24.97	28.54	35.68	53.52	71.36	89.19	107.03	128.44	142.71
1.66	19⅞	25.20	28.80	36.00	54.00	72.00	90.01	108.01	129.61	144.01
1.67	20	25.43	29.06	36.33	54.49	72.66	90.82	108.98	130.78	145.31
1.68	⅛	25.66	29.32	36.66	54.98	73.31	91.64	109.97	131.96	146.62
1.69	¼	25.89	29.59	36.98	55.47	73.97	92.46	110.95	133.14	147.93
1.70	¾	26.12	29.85	37.31	55.97	74.62	93.28	111.93	134.32	149.25
1.71	20½	26.35	30.11	37.64	56.46	75.28	94.10	112.92	135.51	150.57
1.72	⅝	26.58	30.38	37.97	56.96	75.94	94.93	113.92	136.70	151.89
1.73	¾	26.81	30.64	38.30	57.46	76.61	95.76	114.91	137.89	153.21
1.74	⅞	27.05	30.91	38.64	57.95	77.27	96.59	115.91	139.09	154.54
1.75	21	27.28	31.18	38.97	58.45	77.94	97.42	116.91	140.29	155.88
1.76	21⅛	27.51	31.44	39.30	58.96	78.61	98.26	117.91	141.50	157.22
1.77	¼	27.75	31.71	39.64	59.46	79.28	99.10	118.92	142.70	158.56
1.78	⅜	27.98	31.98	39.98	59.96	79.95	99.94	119.93	143.91	159.90
1.79	½	28.22	32.25	40.31	60.47	80.63	100.78	120.94	145.13	161.25
1.80	⅝	28.46	32.52	40.65	60.98	81.30	101.63	121.96	146.35	162.61
1.81	21¾	......	32.79	40.99	61.49	81.98	102.48	122.97	147.57	163.96
1.82	⅞	......	33.06	41.33	62.00	82.66	103.33	123.99	148.79	165.32
1.83	22	......	33.34	41.67	62.51	83.34	104.18	125.02	150.02	166.69
1.84	⅛	......	33.61	42.01	63.02	84.03	105.04	126.04	151.25	168.06
1.85	¼	......	33.89	42.36	63.54	84.71	105.89	127.07	152.49	169.43
1.86	22⅜	......	34.16	42.70	64.05	85.40	106.75	128.10	153.72	170.80
1.87	½	......	34.44	43.05	64.57	86.09	107.61	129.14	154.97	172.18
1.88	9/16	......	34.71	43.39	65.09	86.78	108.48	130.18	156.21	173.57
1.89	⅝	......	34.99	43.74	65.61	87.48	109.35	131.22	157.46	174.95
1.90	¾	......	35.27	44.09	66.13	88.17	110.22	132.26	158.71	176.34
1.91	22⅞	......	35.55	44.43	66.65	88.87	111.09	133.30	159.96	177.74
1.92	23	......	35.83	44.78	67.18	89.57	111.96	134.35	161.22	179.14
1.93	⅛	......	36.11	45.13	67.70	90.27	112.84	135.40	162.48	180.54
1.94	¼	......	36.39	45.49	68.23	90.97	113.71	136.46	163.75	181.94
1.95	⅜	......	36.67	45.84	68.76	91.68	114.59	137.51	165.02	183.35
1.96	23½	......	36.95	46.19	69.29	92.38	115.48	138.57	166.29	184.76
1.97	⅝	......	37.24	46.54	69.82	93.09	116.36	139.63	167.56	186.18
1.98	¾	......	37.52	46.90	70.35	93.80	117.25	140.70	168.84	187.60
1.99	⅞	......	37.80	47.26	70.88	94.51	118.14	141.77	170.12	189.02
2.00	24	......	38.09	47.61	71.42	95.22	119.03	142.84	171.40	190.45

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR—Cont'd.

For Various Lengths and Depths. Formula: $Q=3.3^2/_3 LH^2$

Head "H" on Crest Measured in Still Water		Discharge in Cubic Feet per Second — Length of Weir Crest in Feet							
In feet	In inches	4	5	7½	10	12½	15	18	20
2.01	24⅛	38.38	47.97	71.95	95.94	119.92	143.91	172.69	191.88
2.02	¼	38.66	48.33	72.49	96.66	120.82	144.98	173.98	193.31
2.03	⅜	38.95	48.69	73.03	97.37	121.72	146.06	175.27	195.75
2.04	½	39.24	49.05	73.57	98.09	122.62	147.14	176.57	196.19
2.05	⅝	39.53	49.41	74.11	98.82	123.52	148.23	177.87	197.63
2.06	24¾	39.82	49.77	74.66	99.54	124.43	149.31	179.17	199.08
2.07	⅞	40.11	50.13	75.20	100.27	125.33	150.40	180.48	200.53
2.08	25	40.40	50.50	75.75	100.99	126.24	151.49	181.79	201.99
2.09	⅛	40.69	50.86	76.29	101.72	127.15	152.58	183.10	203.45
2.10	¼	40.98	51.23	76.84	102.45	128.07	153.68	184.42	204.91
2.11	25⅜	......	51.59	77.39	103.19	128.98	154.78	185.74	206.37
2.12	½	......	51.96	77.94	103.92	129.90	155.88	187.06	207.84
2.13	9/16	......	52.33	78.49	104.66	130.82	156.99	188.38	209.31
2.14	⅝	......	52.70	79.05	105.40	131.74	158.09	189.71	210.79
2.15	¾	......	53.07	79.60	106.13	132.67	159.20	191.04	212.27
2.16	25⅞	......	53.44	80.16	106.88	133.60	160.31	192.38	213.75
2.17	26	......	53.81	80.71	107.62	134.52	161.43	193.71	215.24
2.18	⅛	......	54.18	81.27	108.36	135.45	162.55	195.06	216.73
2.19	¼	......	54.56	81.83	109.11	136.39	163.67	196.40	218.22
2.20	⅜	......	54.93	82.39	109.86	137.32	164.79	197.75	219.72
2.21	26½	......	55.30	82.96	110.61	138.26	165.91	199.10	221.22
2.22	⅝	......	55.68	83.52	111.36	139.20	167.04	200.45	222.72
2.23	¾	......	56.06	84.09	112.11	140.14	168.17	201.80	224.23
2.24	⅞	......	56.43	84.65	112.87	141.09	169.30	203.16	225.74
2.25	27	......	56.81	85.22	113.63	142.03	170.44	204.53	227.25
2.26	27⅛	......	57.19	85.79	114.38	142.98	171.58	205.89	228.77
2.27	¼	......	57.57	86.36	115.14	143.93	172.72	207.26	230.29
2.28	⅜	......	57.96	86.93	115.91	144.88	173.86	208.63	231.81
2.29	½	......	58.33	87.50	116.67	145.84	175.00	210.00	233.34
2.30	⅝	......	58.72	88.08	117.43	146.79	176.15	211.38	234.87
2.31	27¾	......	59.10	88.65	118.20	147.75	177.30	212.76	236.40
2.32	⅞	......	59.48	89.23	118.97	148.71	178.45	214.14	237.94
2.33	28	......	59.87	89.80	119.74	149.67	179.61	215.53	239.48
2.34	⅛	......	60.26	90.38	120.51	150.64	180.77	216.92	241.02
2.35	¼	......	60.64	90.96	121.28	151.60	181.93	218.31	242.57
2.36	28⅜	......	61.03	91.54	122.06	152.57	183.09	219.71	244.12
2.37	½	......	61.42	92.13	122.84	153.54	184.25	221.10	245.67
2.38	9/16	......	61.81	92.71	123.61	154.52	185.42	222.50	247.23
2.39	⅝	......	62.20	93.30	124.39	155.49	186.59	223.91	248.79
2.40	¾	......	62.59	93.88	125.17	156.47	187.76	225.31	250.35
2.41	28⅞	......	......	94.47	125.96	157.45	188.94	226.72	251.92
2.42	29	......	......	95.06	126.74	158.43	190.11	228.14	253.49
2.43	⅛	......	......	95.65	127.53	159.41	191.29	229.55	255.06
2.44	¼	......	......	96.24	128.32	160.40	192.48	230.97	256.63
2.45	⅜	......	......	96.83	129.11	161.38	193.66	232.39	258.21
2.46	29½	......	......	97.42	129.90	162.37	194.85	233.82	259.80
2.47	⅝	......	......	98.02	130.69	163.36	196.04	235.24	261.38
2.48	¾	......	......	98.61	131.49	164.36	197.23	236.67	262.97
2.49	⅞	......	......	99.21	132.28	165.35	198.42	238.11	264.56
2.50	30	......	......	99.81	133.08	166.35	199.62	239.54	266.16

DISCHARGE OVER CIPPOLETTI'S TRAPEZOIDAL WEIR—Cont'd.

For Various Lengths and Depths. Formula: $Q = 3.3^2/_3 LH^{\frac{3}{2}}$

Head "H" on Crest Measured to Still Water		Discharge in Cubic Feet per Second — Length of Weir Crest in Feet					
In feet	In inches	7½	10	12½	15	18	20
2.51	30⅛	100.41	133.88	167.35	200.82	240.98	267.76
2.52	¼	101.01	134.68	168.35	202.02	242.42	269.36
2.53	⅜	101.61	135.48	169.35	203.22	243.87	270.96
2.54	½	102.21	136.29	170.36	204.43	245.31	272.57
2.55	⅝	102.82	137.09	171.36	205.64	246.76	274.18
2.56	30¾	103.42	137.90	172.37	206.85	248.22	275.80
2.57	⅞	104.03	138.71	173.38	208.06	249.67	277.41
2.58	31	104.64	139.52	174.40	209.28	251.13	279.04
2.59	⅛	105.25	140.33	175.41	210.49	252.59	280.66
2.60	¼	105.86	141.14	176.43	211.71	254.06	282.29
2.61	31⅜	106.47	141.96	177.45	212.94	255.53	283.92
2.62	½	107.08	142.77	178.47	214.16	256.99	285.55
2.63	9/16	107.69	143.59	179.49	215.39	258.47	287.19
2.64	⅝	108.31	144.41	180.52	216.62	259.94	288.83
2.65	¾	108.93	145.23	181.54	217.85	261.42	290.47
2.66	31⅞	109.54	146.06	182.57	219.09	262.90	292.11
2.67	32	110.16	146.88	183.60	220.32	264.39	293.76
2.68	⅛	110.78	147.71	184.63	221.56	265.97	295.41
2.69	¼	111.40	148.53	185.67	222.80	267.36	297.07
2.70	⅜	112.02	149.36	186.70	224.05	268.86	298.73
2.71	32½	112.65	150.19	187.74	225.29	270.35	300.39
2.72	⅝	113.27	151.03	188.78	226.54	271.85	303.05
2.73	¾	113.90	151.86	189.83	227.79	273.35	303.72
2.74	⅞	114.52	152.70	190.87	229.04	274.85	305.39
2.75	33	115.15	153.53	191.92	230.30	276.36	307.06
2.76	33⅛	115.78	154.37	192.96	231.56	277.87	308.74
2.77	¼	116.41	155.21	194.01	232.82	279.38	310.42
2.78	⅜	117.04	156.05	195.06	234.08	280.89	312.10
2.79	½	117.67	156.89	196.12	235.34	282.41	313.79
2.80	⅝	118.30	157.74	197.17	236.61	283.93	315.48
2.81	33¾	118.94	158.58	198.23	237.88	285.45	317.17
2.82	⅞	119.57	159.43	199.29	239.15	286.98	318.86
2.83	34	120.21	160.28	200.35	240.42	288.50	320.56
2.84	⅛	120.85	161.13	201.41	241.70	290.03	322.26
2.85	¼	121.49	161.98	202.48	242.97	291.57	323.96
2.86	34⅜	122.13	162.84	203.54	244.25	293.10	325.67
2.87	½	122.77	163.69	204.61	245.54	294.64	327.38
2.88	9/16	123.41	164.55	205.68	246.82	296.18	329.09
2.89	⅝	124.05	165.40	206.76	248.11	297.73	330.81
2.90	¾	124.70	166.26	207.83	249.40	299.27	332.53
2.91	34⅞	125.34	167.12	208.91	250.69	300.82	334.25
2.92	35	125.99	167.99	209.98	251.98	302.38	335.97
2.93	⅛	126.64	168.85	211.06	253.28	303.93	337.70
2.94	¼	127.29	169.72	212.14	254.57	305.49	339.43
2.95	⅜	127.94	170.58	213.23	255.87	307.05	341.16
2.96	35½	128.59	171.45	214.31	257.18	308.61	342.90
2.97	⅝	129.24	172.32	215.40	258.48	310.18	344.64
2.98	¾	129.89	173.19	216.49	259.79	311.74	346.38
2.99	⅞	130.55	174.06	217.58	261.09	313.31	348.13
3.00	36	131.20	174.94	218.67	262.41	314.89	349.87