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WD 65 File

State of Idaho
DEPARTMENT OF WATER RESOURCES
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Phone: (208) 327-7900 FAX: (208) 327-7866

CECIL D. ANDRUS
GOVERNOR

R. KEITH HIGGINSON
DIRECTOR

July 13, 1994

RECEIVED
JUL 14 1994
WATER RESOURCES
WESTERN REGION

Alva McConnell
Alvin Hadley
Montour Farmers Ditch Co.
Montour Star Rt.
Emmett, ID 83617

Re: Montour Ditch Measuring Device

Gentlemen:

Thank you for meeting with me on July 1 in Montour concerning measurement of water in the Montour Farmers ditch. On that day we discussed some alternatives for measuring water in the ditch. Using a current meter, I had measured 17.7 cfs across the front end of the concrete flume structure located just east of the Canaday place. This structure is about 1.2 miles below the main canal headgate.

You were interested in modifying the existing concrete structure with a weir. Although the placement of a weir in this structure may be convenient and reduce costs, you should be aware that the device may not be considered a standard weir. Since the concrete structure does not have a uniform rectangular shape due to the inclusion of the spill channel, and depending on the operation of that spill channel, there may be some problems with the accuracy of a weir placed in this structure. The fact that the ditch channel is fairly flat at this location may cause additional problems and result in submergence of the weir blade. Despite these concerns, I believe a temporary weir can be installed which may provide a good estimate for most of the flows at this location.

Attached to this letter is a schematic of the weir which I think may work in your structure. This weir is a five foot standard rectangular weir. The weir size and dimensions are based on published guidelines for weir installations, the physical limitations of your concrete structure, and some knowledge of the range of flows in your ditch. This five foot weir can measure flows up to 33 cfs. The corresponding head or depth of water over the weir crest at this maximum flow is 1.66 ft. The maximum discharge which I have measured on the ditch was 35 cfs near the upstream headgate structure.

Note that with this weir, the ends of the weir are 1 foot from the approach channel, or concrete wing walls. The height of the weir crest above the approach channel must be at least 1 foot, which is the minimum height required for all standard weirs. It is recommended however that the weir crest elevation be set at least two times the normal or maximum head. In other words, if the normal flow in the ditch at this location is 20 cfs, then the head, h, through a 5 ft. weir at this flow is 1.17 ft. The elevation of the crest from the approach channel therfore should be 2h or 2.34 ft. In order to guarantee bottom contraction and free fall over the weir blade, I would recommend setting the elevation of the weir crest at about 2 ft above the approach channel. Setting the blade much higher above this may cause problems with freeboard as the height of the concrete structure wing walls is only 4 ft. Setting the blade closer to the one foot minimum however may result in submergence of the weir, particularly at higher flows. Perhaps the weir blade could initially be set at about 2 to 2.5 feet. If there are problems with available free board, then the weir could be reomved and the crest set lower.

The weir blade or crest can be mounted on a wooden bulkhead (at least several inches thick) as long as some care is given to the prevention of leaks along the sides and bottom. The bulkhead could slide in and out of steel brackets mounted on the side walls of the concrete structure, similar to the type of brackets which hold the stoplogs on your spill structure. I estimate that total cost of installing this type of weir should be less than $200.

Please note that I have also enclosed a schematic diagram of a ramped broad crested weir. This weir could be installed as a permanent measuring device at a separate location on the ditch upstream of the concrete structure. This particular device may be less sensitive to freeboard requirements and can measure a broad range of flows in flatter channels, and passes debris and sediment well. The device is basically a rectangular concrete structure with a ramped sill. Concrete costs for the size of structure needed in your ditch are estimated at about $350 to $400. If the ditch owners use contract labor, you may need to add an additional $500 to $900.

I hope that the members of the Montour Ditch will consider installing a measuring device prior to the next irrigation season. I again remind you that the water district does have matching funds to help pay for the installation of any measuring device. The Department and/or the SCS can provide assistance with further designs of a device. Installation of a device will help the water district and Department to determine your diversion from the river, will provide a means of documenting your diversion and help protect your water rights, and will provide for better accuracy of determining natural flow and storage flows in the Payette River.

Please contact me directly at 327-7864 if you have questions concerning this matter.

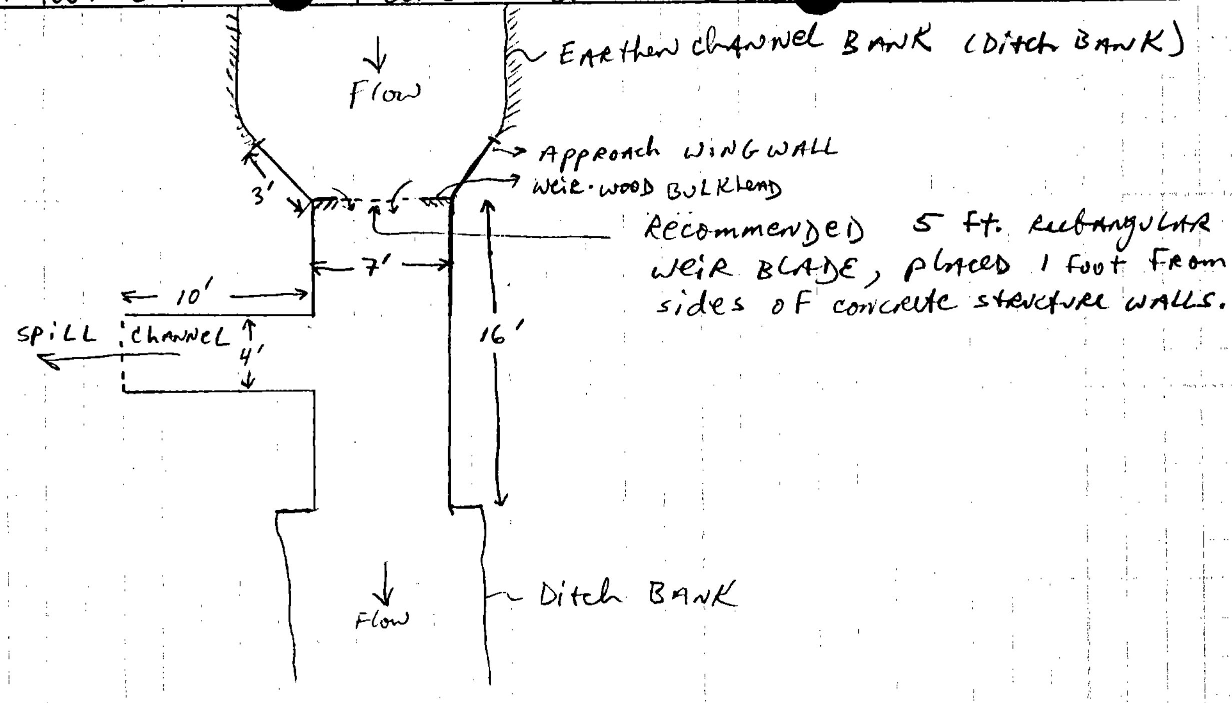
Sincerely,

Tim Luke

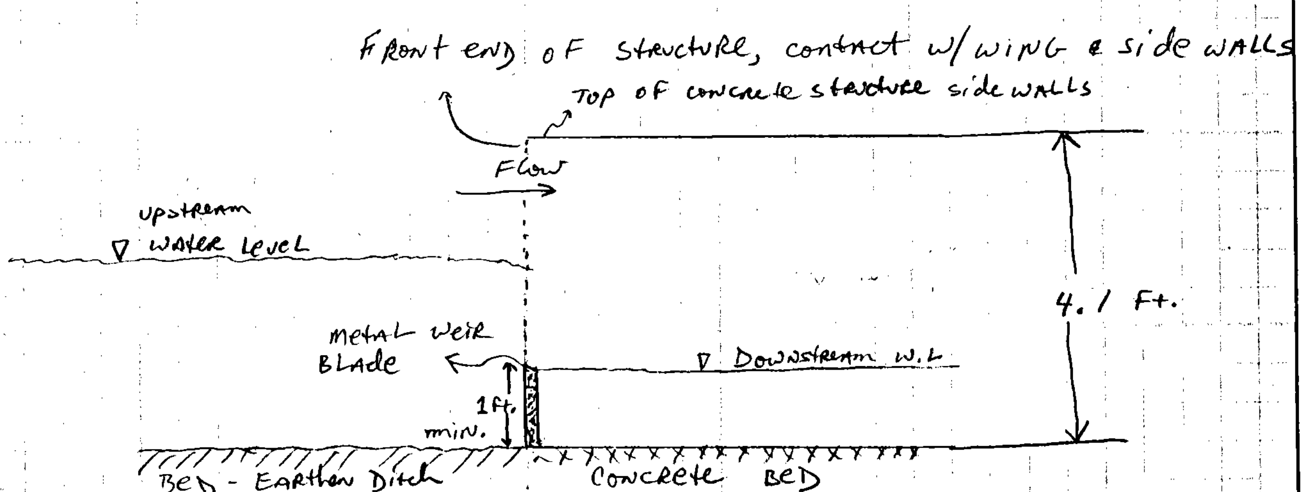
Tim Luke
Water Allocations

cc: Dave Tuthill, Regional Manager
Helen Bivens, Watermaster

Montour Ditch | Existing Concrete Control Structure



↑ Overhead view of concrete structure ↑



Side view of structure w/ weir blade (height set at least 1 foot above approach channel, and preferably twice the normal head.

Weir blade height setting example:

If normal flow is 20 cfs, the head over 4 5 ft. weir is 1.17 ft. For this flow, the weir blade height preferably should be 2 x 1.17 or 2.34 ft. total head in weir pool is 3.5 ft.

rated by the manufacturer, and a rating table is furnished. Current meters should be rated once a year or more often depending on how frequently they are used.

Current-meter measurements are usually taken from a walkway or bridge across the stream or ditch. Very shallow streams can be waded while large rivers may require the use of a boat or cableway.

A zero station or reference point is established on one bank of the stream, and a tape is stretched across the stream for measuring horizontal distances. Soundings and current-meter readings are taken at regular intervals, usually from 2 to 10 feet depending on the width of the stream. Readings should be made where there are abrupt changes in velocity or in the depth of flow.

The problem is to determine the mean velocity at each vertical where readings are taken. This may be done by one of several methods. The most common method requires that readings be taken at only two points in each vertical; namely at 0.2 and 0.8 of the sounded depth measured from the water surface. The average of these two readings is the mean velocity in the vertical. Where the depth of flow becomes too shallow to obtain two readings, a single reading taken at 0.6 depth represents the mean velocity.

The discharge of each segment of the cross section (area between adjacent verticals) is the product of the area of the segment and the mean velocity in the segment. If d_1 and d_2 represent the depths of flow at two adjacent verticals, V_1 and V_2 the respective mean velocities in these verticals, and W the distance between the verticals, then the discharge in that part of the cross section is computed as follows:

$$Q = W \left(\frac{d_1 + d_2}{2}\right) \left(\frac{V_1 + V_2}{2}\right)$$

The total discharge of the stream is the sum of such computations for t entire cross section. Figure 9-16 shows an example of typical current-meter notes. The observations required and computation procedure used are clearly shown in this example.

<u>Weirs</u>
In its simplest form, a weir consists of a bulkhead of timber, metal, c concrete with an opening of fixed dimensions cut in its top edge. This opening is called the weir notch, its bottom edge is the weir crest, a the depth of flow over the crest (measured at a specified distance upstream from the bulkhead) is called the head. The overflowing sheet of water is known as the nappe.

Weirs may be divided into two general classes: (1) Sharp-crested weirs and (2) weirs that are not sharp-crested. Only sharp-crested weirs are discussed, since this type is normally used in the measurement of irrigation water. Weirs that are not sharp-crested, sometimes called broad-crested weirs, are commonly incorporated in hydraulic structures of various types but are not commonly used to measure the flow of water.

If the sides and bottom of the stream or channel are far enough from the perimeter of the weir notch, the water particles approach the notch in converging paths in all directions, continue to travel in curvilinear paths for some distance after leaving the notch, and cause the nappe to contract. When these distances are great enough to cause water to pond above the weir so that it approaches the notch at a velocity not exceeding 0.3 foot per second, the weir is said to have complete contractions. When these distances are not great enough to cause this condition, the weir is said to have partially suppressed contractions.

In order to assure complete end contractions, the distances between the ends of the notch and the sides of the channel or stream should not be less than 2 times the depth of flow over the weir or the head (H) (fig. 9-17). For complete bottom contraction, the weir crest should be placed no closer than 2H from the bottom of the channel.

When the water surface downstream from the bulkhead is far enough below the crest so that air moves freely below the nappe, the weir is said to have free discharge. If the discharge is partially under water, the weir is said to be submerged.

Weirs with complete contractions and free discharge are most commonly used for the measurement of water. Weirs with suppressed contractions and submerged weirs are outside the scope of this handbook. For a complete discussion of these, the reader is referred to King's Handbook of Hydraulics.

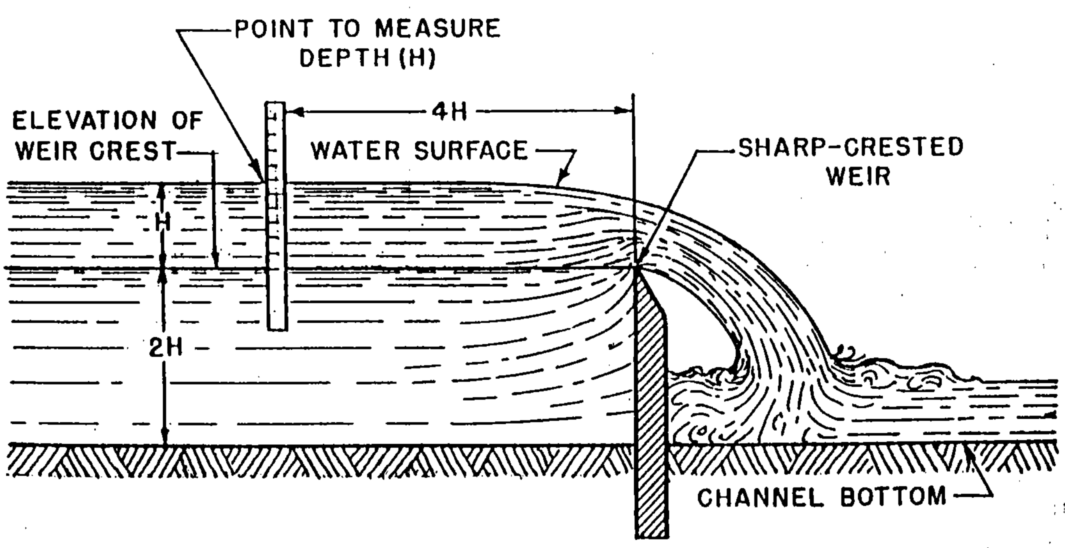


Figure 9-17--Profile of a sharp-crested weir

Standard sharp-crested weirs are of one of three general types depending on the shape of the weir notch: (1) Rectangular-notch weir, the notch of which has a level crest and vertical sides; (2) trapezoidal or Cipolletti weir, which has a level crest and sides of the notch sloping outward from the vertical at one horizontal to four vertical; (3) 90° triangular-notch weir formed by the sides of the notch sloping outward from the vertical at a 45° angle and meeting at a point in the center of the bulkhead. This latter type has no crest length.

The weir selected should be that most adapted to the circumstances and conditions at the site of measurement. Usually, the rate of flow expected, or the limiting rates in the case of fluctuating streams, can be roughly estimated in advance and used to select both the type of weir to be used and the dimensions of the weir. In selecting the type of weir, consideration should be given the following:

1. The head should be no less than 0.2 foot for the rate of flow expected and should not exceed 2 feet.
2. For rectangular and trapezoidal weirs, the head should not exceed one-third of the weir length.
3. Weir length should be selected so that the head for design discharge will be near the maximum subject to the limitations in 1 and 2.

The 90° triangular-notch weir gives the most accurate results when measuring small discharges of less than 1 second-foot and is particularly adapted to measuring fluctuating rates of flow provided the maximum discharge does not exceed 10 second-feet. Rectangular- and trapezoidal-notch weirs are used to measure discharges up to 75 second-feet or more.

The rectangular-notch weir.--This is probably the oldest type now in common use, and its simplicity of construction makes it the most popular (fig. 9-18).

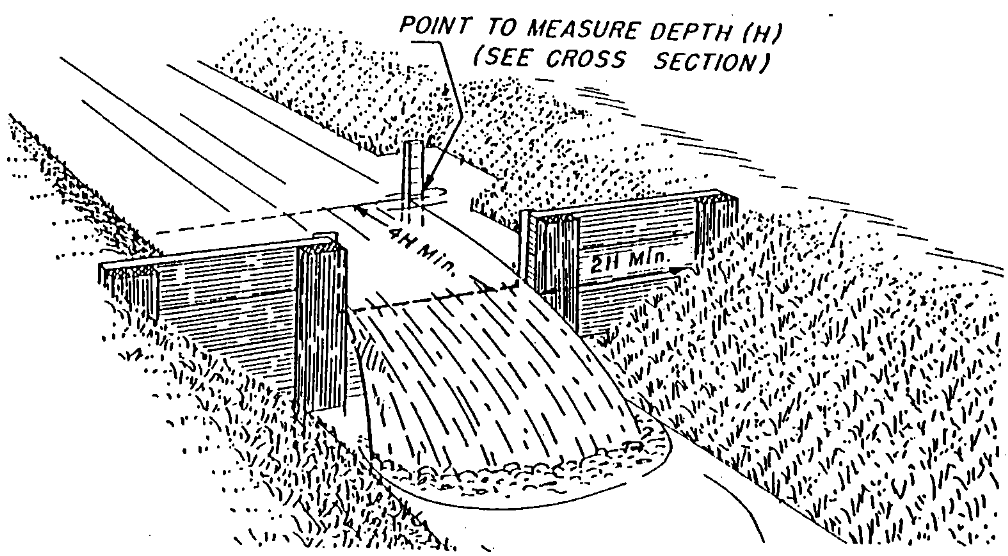


Figure 9-18--Rectangular-notch weir with end contractions

Numerous formulas have been developed for computing the discharge of rectangular-notch, sharp-crested weirs with complete contractions. The most popular and generally accepted is the Francis formula.

$$Q = 3.33\ (L - 0.2H)H^{3/2}$$

where Q = discharge in cubic feet per second
L = Length of the notch in feet
H = head in feet or the vertical difference between the elevation of the weir crest and the elevation of the weir pond

The elevation of the weir pond should be measured at a point no less than 4H upstream from the bulkhead.

Table 9-10 gives discharge values for weir-notch lengths up to 10 feet and depths of flow or head up to 1.5 feet.

The trapezoidal-notch or Cipolletti weir.--This is shown in figure 9-19. The slope of the sides, one horizontal to four vertical, is that required to secure a discharge in the triangular part of the notch about equal to the decrease in discharge caused by end contractions. Thus no correction for end contractions is required.

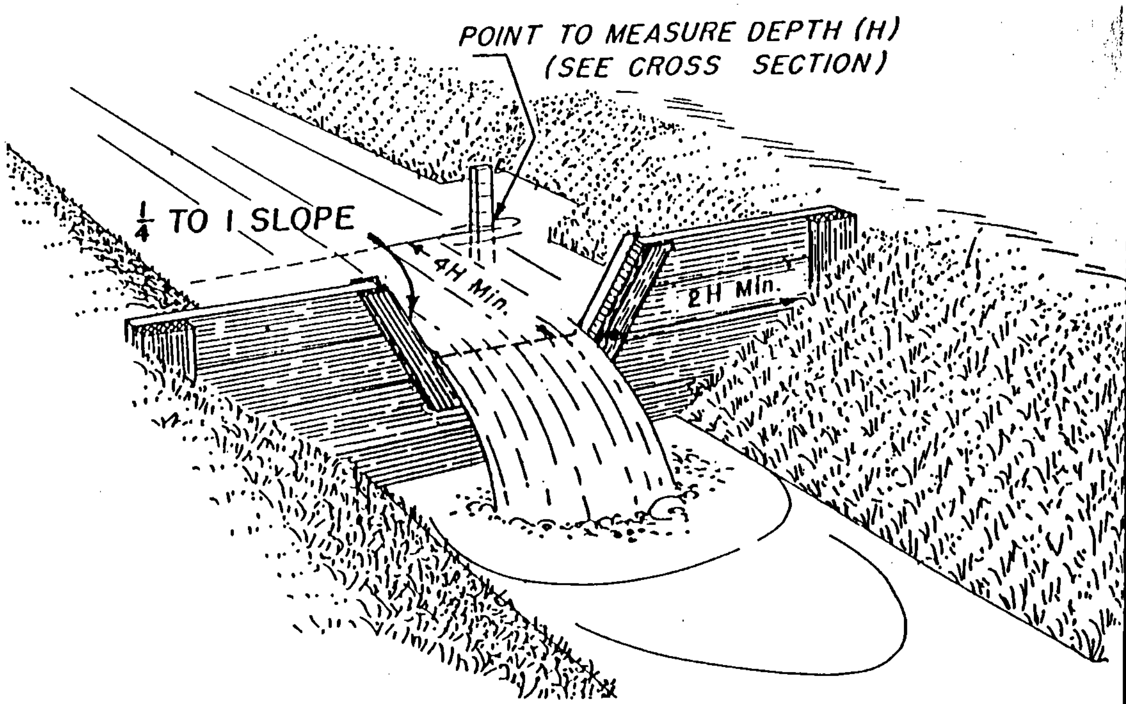


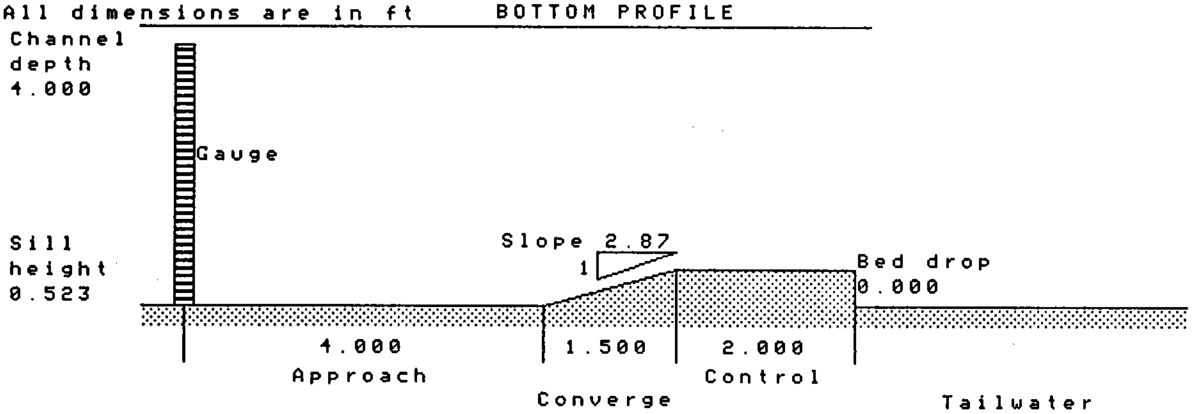
Figure 9-19--Trapezoidal-notch or Cipolletti weir

Table 8.—Discharge of standard contracted rectangular weirs in second-feet. Values below and to left of heavy line determined experimentally, others computed from the formula $Q=3.33(L-0.2H)H^{3/2}$. (See sec. 15.)—Continued

Head H, feet	Length of weir, L, feet								
	1.5	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
0.51	1.70	2.30	3.52	4.73	5.94	7.15	8.37	9.58	10.8
.52	1.74	2.37	3.62	4.86	6.11	7.36	8.61	9.86	11.1
.53	1.79	2.43	3.72	5.00	6.29	7.57	8.86	10.1	11.4
.54	1.84	2.50	3.82	5.14	6.46	7.79	9.11	10.4	11.8
.55	1.89	2.57	3.92	5.28	6.64	8.00	9.36	10.7	12.1
.56	1.94	2.64	4.03	5.43	6.82	8.22	9.61	11.0	12.4
.57	1.99	2.70	4.14	5.57	7.00	8.44	9.87	11.3	12.7
.58	2.04	2.77	4.24	5.71	7.18	8.66	10.1	11.6	13.1
.59	2.08	2.84	4.35	5.86	7.37	8.88	10.4	11.9	13.4
.60	2.14	2.91	4.46	6.00	7.55	9.10	10.6	12.2	13.7
.61	2.19	2.98	4.57	6.15	7.74	9.32	10.9	12.5	14.1
.62	2.24	3.05	4.68	6.30	7.93	9.55	11.2	12.8	14.4
.63	2.29	3.12	4.79	6.45	8.12	9.78	11.4	13.1	14.8
.64	2.34	3.19	4.90	6.60	8.31	10.0	11.7	13.4	15.1
.65	2.39	3.26	5.01	6.75	8.50	10.2	12.0	13.7	15.5
.66	2.44	3.34	5.12	6.91	8.69	10.5	12.3	14.0	15.8
.67	2.50	3.41	5.23	7.06	8.89	10.7	12.5	14.4	16.2
.68	2.55	3.58	5.35	7.22	9.08	11.0	12.8	14.7	16.6
.69	2.60	3.66	5.46	7.37	9.28	11.2	13.1	15.0	16.9
.70	2.65	3.74	5.58	7.53	9.48	11.4	13.4	15.3	17.3
.71	2.70	3.82	5.69	7.69	9.68	11.7	13.7	15.7	17.6
.72	2.76	3.90	5.81	7.84	9.88	11.9	13.9	16.0	18.0
.73	2.81	3.98	5.93	8.00	10.1	12.2	14.2	16.3	18.4
.74	2.87	4.06	6.05	8.16	10.3	12.4	14.5	16.6	18.8
.75	2.92	4.14	6.16	8.33	10.5	12.7	14.8	17.0	19.1
.76	-----	4.22	6.28	8.49	10.7	12.9	15.1	17.3	19.5
.77	-----	4.30	6.40	8.65	10.9	13.2	15.4	17.7	19.9
.78	-----	4.38	6.52	8.82	11.1	13.4	15.7	18.0	20.3
.79	-----	4.46	6.64	8.98	11.3	13.7	16.0	18.3	20.7
.80	-----	4.54	6.77	9.15	11.5	13.9	16.3	18.7	21.1
.81	-----	4.62	6.89	9.32	11.7	14.2	16.6	19.0	21.5
.82	-----	4.70	7.01	9.48	12.0	14.4	16.9	19.4	21.8
.83	-----	4.78	7.14	9.65	12.2	14.7	17.2	19.7	22.2
.84	-----	4.87	7.26	9.82	12.4	15.0	17.5	20.1	22.6
.85	-----	4.96	7.38	10.0	12.6	15.2	17.8	20.4	23.0
.86	-----	5.05	7.51	10.2	12.8	15.5	18.1	20.8	23.4
.87	-----	5.14	7.64	10.3	13.0	15.7	18.4	21.1	23.8
.88	-----	5.23	7.76	10.5	13.3	16.0	18.8	21.5	24.3
.89	-----	5.32	7.89	10.7	13.5	16.3	19.1	21.9	24.7
.90	-----	5.41	8.02	10.9	13.7	16.5	19.4	22.2	25.1
.91	-----	5.50	8.15	11.0	13.9	16.8	19.7	22.6	25.5
.92	-----	5.59	8.28	11.2	14.2	17.1	20.0	23.0	25.9
.93	-----	5.68	8.40	11.4	14.4	17.4	20.4	23.3	26.3
.94	-----	5.77	8.53	11.6	14.6	17.6	20.7	23.7	26.7
.95	-----	5.86	8.66	11.7	14.8	17.9	21.0	24.1	27.2
.96	-----	5.95	8.80	11.9	15.1	18.2	21.3	24.5	27.6
.97	-----	6.04	8.93	12.1	15.3	18.5	21.7	24.8	28.0
.98	-----	6.13	9.06	12.3	15.5	18.8	22.0	25.2	28.4
.99	-----	6.22	9.19	12.5	15.8	19.0	22.3	25.6	28.9
1.00	-----	6.31	9.32	12.7	16.0	19.3	22.6	26.0	29.3

Table 8.—Discharge of standard contracted rectangular weirs in second-feet. Computed from the formula $Q=3.33(L-0.2H)H^{3/2}$. (See sec. 15.)—Continued

Head H, feet	Length of weir, L, feet						
	3.0	4.0	5.0	6.0	7.0	8.0	9.0
1.01	9.46	12.8	16.2	19.6	23.0	26.4	29.8
1.02	9.59	13.0	16.5	19.9	23.3	26.7	30.2
1.03	9.72	13.2	16.7	20.2	23.6	27.1	30.6
1.04	9.86	13.4	16.9	20.5	24.0	27.5	31.1
1.05	10.00	13.6	17.2	20.7	24.3	27.9	31.5
1.06	10.14	13.8	17.4	21.0	24.7	28.3	31.9
1.07	10.27	14.0	17.6	21.3	25.0	28.7	32.4
1.08	10.40	14.1	17.9	21.6	25.4	29.1	32.8
1.09	10.54	14.3	18.1	21.9	25.7	29.5	33.3
1.10	10.68	14.5	18.4	22.2	26.0	29.9	33.7
1.11	10.82	14.7	18.6	22.5	26.4	30.3	34.2
1.12	10.95	14.9	18.9	22.8	26.7	30.7	34.6
1.13	11.09	15.1	19.1	23.1	27.1	31.1	35.1
1.14	11.24	15.3	19.3	23.4	27.4	31.5	35.6
1.15	11.37	15.5	19.6	23.7	27.8	31.9	36.0
1.16	11.51	15.7	19.8	24.0	28.2	32.3	36.5
1.17	11.66	15.9	20.1	24.3	28.5	32.7	36.9
1.18	11.80	16.1	20.3	24.6	28.9	33.1	37.4
1.19	11.94	16.3	20.6	24.9	29.2	33.6	37.9
1.20	12.08	16.5	20.8	25.2	29.6	34.0	38.3
1.21	12.22	16.7	21.1	25.5	30.0	34.4	38.8
1.22	12.36	16.9	21.3	25.8	30.3	34.8	39.3
1.23	12.51	17.1	21.6	26.1	30.7	35.2	39.8
1.24	12.65	17.3	21.8	26.4	31.0	35.6	40.2
1.25	12.79	17.5	22.1	26.8	31.4	36.1	40.7
1.26	12.94	17.7	22.4	27.1	31.8	36.5	41.2
1.27	13.09	17.9	22.6	27.4	32.2	36.9	41.7
1.28	13.23	18.1	22.9	27.7	32.5	37.3	42.2
1.29	13.38	18.3	23.1	28.0	32.9	37.8	42.7
1.30	13.52	18.5	23.4	28.3	33.3	38.2	43.1
1.31	13.68	18.7	23.7	28.6	33.6	38.6	43.6
1.32	13.82	18.9	23.9	29.0	34.0	39.1	44.1
1.33	13.97	19.1	24.2	29.3	34.4	39.5	44.6
1.34	14.11	19.3	24.4	29.6	34.8	39.9	45.1
1.35	14.26	19.5	24.7	29.9	35.2	40.4	45.6
1.36	14.41	19.7	25.0	30.3	35.5	40.8	46.1
1.37	14.55	19.9	25.2	30.6	35.9	41.3	46.6
1.38	14.70	20.1	25.5	30.9	36.3	41.7	47.1
1.39	14.86	20.3	25.8	31.2	36.7	42.1	47.6
1.40	15.00	20.5	26.0	31.6	37.1	42.6	48.1
1.41	15.15	20.7	26.3	31.9	37.5	43.0	48.6
1.42	15.30	20.9	26.6	32.2	37.8	43.5	49.1
1.43	15.45	21.1	26.8	32.5	38.2	43.9	49.6
1.44	15.61	21.4	27.1	32.9	38.6	44.4	50.1
1.45	15.77	21.6	27.4	33.2	39.0	44.8	50.6
1.46	15.92	21.8	27.7	33.5	39.4	45.3	51.2
1.47	16.06	22.0	27.9	33.9	39.8	45.7	51.7
1.48	16.21	22.2	28.2	34.2	40.2	46.2	52.2
1.49	16.37	22.4	28.5	34.5	40.6	46.6	52.7
1.50	16.52	22.6	28.8	34.9	41.0	47.1	53.2


All dimensions are in ft
BOTTOM PROFILE
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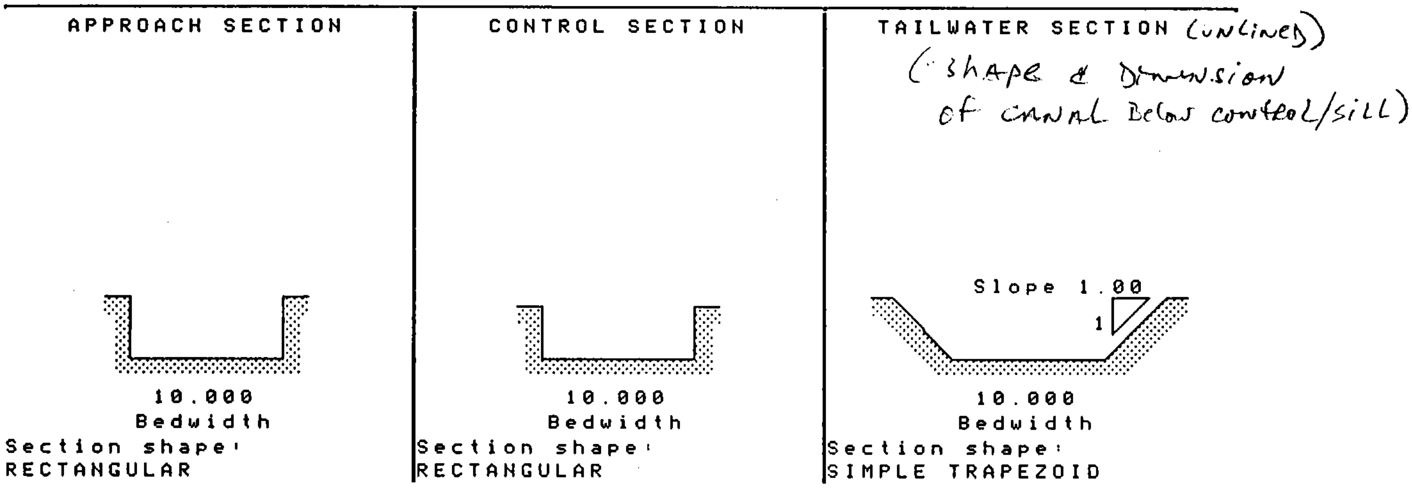
Gauge
Sill height 0.523
Slope 2.87
1
Bed drop 0.000
4.000
Approach
1.500
Converge
2.000
Control
Tailwater


APPROACH SECTION
10.000
Bedwidth
Section shape:
RECTANGULAR
CONTROL SECTION
10.000
Bedwidth
Section shape:
RECTANGULAR
TAILWATER SECTION (unlined)
(shape & Dimension of canal below control/sill)
Slope 1.00
1
10.000
Bedwidth
Section shape:
SIMPLE TRAPEZOID

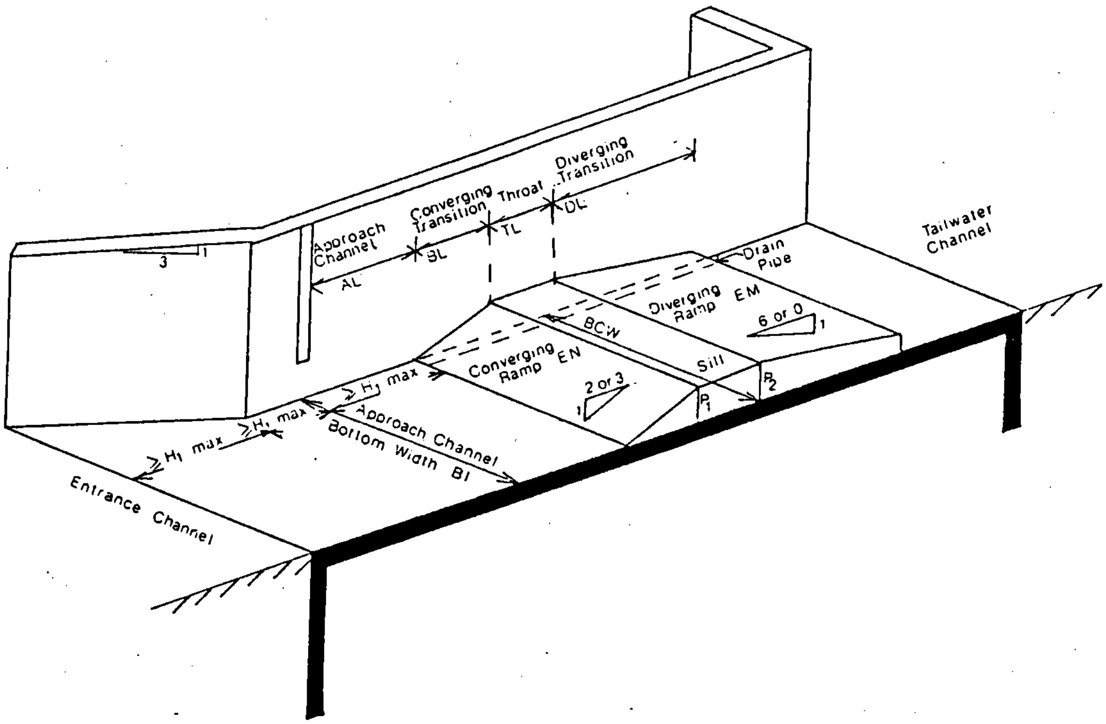


Figure 5. Ramped Broad Crested Weir.

throat length (H1/TL) should be less than 0.7. At ratios larger than this, streamline curvature is too great for the mathematical model to apply. At the minimum discharge, H1/TL should be greater than 0.07. The model is unable to reliably account for the frictional effects at H1/TL ratios smaller than this.

The sill height must be large enough to insure that the tailwater does not affect the flow in the throat. The sill height referenced to the upstream channel (P1) must be greater than the sill height referenced to the downstream channel (P2) in order for the mathematical model to apply. If P1 is less than P2, then the head loss and modular limit calculations