SECTION 684.15

(a) Use of Optimum Surface Irrigation Design Worksheets.

These tables have been developed to determine an optimum surface irrigation design system when the designer has determined the design slope, the design group, and the crop to be raised. In reality, in most situations it won't be possible to duplicate the times or furrow lengths shown on the worksheets.

Once the optimum situation has been determined, you can use the IRMA tables that follow to adjust the situation and needs of the land user.

If the slope isn't listed for a crop in the worksheets, irrigation by the method isn't considered feasible for the flatter slopes; or it will be too erosive on the steeper slopes. The consideration of excessive erosion pertains to the method of irrigation only. The erosion due to rainfall is a separate consideration which should be addressed by the method outlined in Section I of the Technical Guide.

(b) Explanation and Criteria Used in Developing Optimum Irrigation Designs Worksheets

Column 1 - Adapted Crops

This column shows the major important crops which are irrigated. No attempt has been made to justify the irrigation of crops from an economic cost-return standpoint. The worksheets consider soils, crops, and irrigation methods only.

Column 2 - Normal Irrigation Depth

This is the normal irrigation depth to maintain an adequate moisture supply for the maturing crop grown under proper irrigation on the specific soil. Preplanting irrigations will normally fill the entire plant root zone, and normal irrigations will replenish the moisture subsequently used. The worksheets are for the normal irrigation application only.

Column 3 - Net Moisture to be Replaced Each Irrigation

This column shows the net amount of water to be replaced for each crop during a normal irrigation. This value was obtained by multiplying the available moisture holding capacity of the top one-fourth of the root zone by two. This has been rounded to the nearest 0.5 inch.

Column 4 - Irrigation Methods

(1) Level Borders. Level borders are those having a total fall of not more than one-half the design depth of application.

(2) Graded Borders. Graded borders are those having a grade in excess of that listed for level borders. In this guide, graded borders are listed for alfalfa and small grain crops on slopes to 2.0 percent and for grass pasture on slopes to 3.0 percent.

(3) Corrugations. Corrugations are shown for the irrigation of close growing crops, such as alfalfa, pasture grass and small grain on design slopes from 0.40 percent to 3.0 percent. The design of corrugations was based on the same criteria as for furrow irrigation.

(4) Furrows. Furrows are shown for the irrigation of row crops, including sugarbeets, field beans, corn, potatoes, sorghum, and soybeans. Criteria is given for slopes up to 1.5 percent on all soils that are suitable for furrow irrigation.

C -- Cutback Irrigation. Water is applied at a faster rate at the beginning of the irrigation period and then reduced or cutback to a lesser rate, usually one-half the initial rate.

R -- Re-Use Furrow. This method of irrigation utilizes a tailwater recovery system for storing and re-using the excess water. Water is applied to the rows at the same rate for the entire irrigation interval. Excess water may be reapplied to the same or to another field.

(5) Contour Furrows. These may be used for row crops using a furrow with a relatively large water carrying capacity, such as corn, potatoes, and sorghum on field slopes from 0.75 percent to 5.0 percent. The furrows are run across the slope on a designed grade. The recommended furrow grade is normally about 0.4 to 0.5 percent. The applicable figures from this slope group are used for design.

(6) Contour Ditch. This method is frequently referred to as wild flooding. The method may be used for alfalfa, grass, and small grain on slopes from 0.75 to 3.0 percent.

Column 5 - Maximum Size Stream for Furrows or Corrugations

Information in this column applies to furrows and corrugations only. The maximum stream is calculated based on three limitations: (1) soil intake, (2) the maximum nonerosive stream, and (3) the furrow or corrugation capacity. The stream shown is the least of the above three maximum streams. The values used for each of these items are as follows:

(1)

Irrigation Design Group	Maximum Stream (gpm)
1	30
2 & 3	40
4	50
5 to 10	60

(2)

Design Slope Group (%)	Maximum Nonerosive Stream (gpm)
0.10	60
0.20	50
0.40	30
0.75	17
1.25	10
2.00	7
3.00	4

(3)

Furrow or Corrugation Spacing (in)	Maximum Stream (gpm)
15	10
18	12
20	15
22	30
30	40
36	50
40	60

Column 6 - Unit Streams

(1) Borders or Flooding. Unit (CFS) -- stream sizes for borders and contour ditch irrigation are shown as "Unit Stream." A unit stream is the stream required for a strip one foot wide and 100 feet long. The stream given is in cubic feet per second. For contour ditch irrigation, a strip of field 100 feet wide perpendicular to the ditch would require a stream size of one cfs.

(2) Furrows or Corrugations. The stream size is the stream needed in gpm per 100 feet to apply the planned gross application efficiently.

Column 7 - Maximum Border Widths and Normal Furrow Spacing

(1) Borders. Border strip widths are dependent upon the size of irrigation stream available, the amount of cross slope to be overcome, the kind of equipment to be used in farming, and the accuracy of the land leveling in relation to the normal depths of flow anticipated.

(2) Furrows or Corrugations. Furrow spacing (Inches) - The furrow spacing shown is what is customarily used. For corrugations, it is the maximum recommended spacing. Corrugation spacings usually found satisfactory are as follows:

Net Depth Of Irrigation	Irrigation Design Group		
	1, 2, & 3	4	5, 6, 7, 8, & 9
2	18	15	15
3	20	18	15
4	22	20	18
5	24	22	20

Column 8 - Maximum Length of Run

(1) Furrows or Corrugations. Length of run is computed from the relationships of water intake characteristics of the soil, stream size, and net irrigation application. This column is found by dividing Column 5 by Column 6 and multiplying by 100. When this procedure produced a length in excess of 2600 feet, the maximum furrow stream in Column 5 was reduced to provide a furrow stream needed for the 2600 feet length.

a. Contour Ditch. The maximum length of run is dependent upon the topography of the area. The length of run shown is for very smooth topography where the controus are nearly parallel, cross slope does not exceed 0.1 percent, and all minor irregularities have been removed.

Column 9 - Estimated Field Efficiencies

The field efficiencies shown are those considered realistic for the method of irrigation when good management practices are followed. Efficiency may be defined as the ratio of the quantity of water effectively put into the crop root zone and utilized by growing crops to the quantity delivered to the field. It is expressed as a percentage. It takes into consideration evapotranspiration, losses due to deep percolation, and direct runoff. These efficiencies have been rounded to the nearest "5," i.e., 60, 65, 70, etc.

a. Level Borders. Estimated to be 80 percent regardless of crop.

b. Graded Borders. Estimated efficiency varies from 50 to 80 percent.

c. Furrows--Re-use Method. When runoff water is recovered and pumped back into the system, an overall efficiency of approximately 85 percent is obtainable. Approximately 35 percent of the applied water will leave the area where applied and be reused on the same field or adjacent land.

d. Corrugations. Efficiency shown is that expected if proper size stream is applied according to soil intake rate. Sixty percent is shown for slopes of 1.5 percent or less and 55 percent for slopes over 1.5 percent.

e. Contour Ditch. The efficiency shown is that obtainable for very smooth topography. Re-use of runoff water is essential to obtain good irrigation efficiency with this method.

Column 10 - Gross Water Used

The total amount of water to be used per irrigation is found by dividing Column 3 by Column 9.

Column 11 - Estimated Time Required

(1) Level Border. The time required to apply water is determined mathematically based on area and application rate.

(2) Graded Border. This is the time required to deliver the gross amount of water to be applied to the field.

(3) Furrows

a. Re-use Method. The time shown is the approximate application time (T_A).

(4) Corrugations. Estimated time required computed by changing gpm per 100 feet in Column 6 to inches per hour. Then divide the gross application by this value.