Appendix D

Uniplot for Lateral Line and Submain Design

(From "Micro Irrigation Design Manual" Hardie Irrigation)

Uniplot curves are used to design submains and laterals with many discharge outlets where the flow decreases uniformly (i.e., rectangular-shaped fields). Uniplot is a simple and versatile design tool; it may be used to design submains and laterals of one or many pipe sizes, and it may be used in the design of submains and laterals on non-uniform (undulating) terrain. The steps which follow serve to illustrate the proper use of the Uniplot System.

Procedure

1. Calculate the Specific Discharge Rate (SDR).

   SDR = Total Discharge/Total Length

2. Use this SDR to determine the working curve to be used for each pipe size from the working curve nomograph. See Figures D.2 and D.3. Lay a ruler along the diagonal line for the appropriate SDR as determined above. At the point where this line intersects the horizontal line for the actual internal diameter of the pipe being used, read off the working curve to be used on the working curve axis. Internal diameters for PVC pipes are given in Table D.1.

3. Place a sheet of tracing paper over the Uniplot curves (Figure D.6). Draw the vertical and horizontal axes. Draw a vertical line at the distance along the horizontal axis equal to the length of the pipeline.

   For level ground: Draw a line above the horizontal axis at a height equal to the design tolerance for the emitter used.

   For sloping ground: Assuming the pipeline is running downhill, draw a line from the bottom left hand corner (origin) to the elevation change at the other end of the pipeline. Draw a second line parallel to this line and separated from it by a VERTICAL distance equal to the design tolerance for the emitter being used. This creates the pressure envelope.

   See Figure D.1.

Table D.1		Internal Diameters for PVC Pipe		
Nominal Pipe Size (in)	**Schedule**	**Class**	**Working Pressure (psi)**	**Inside Diameter (in)**
1/2"	40		600	0.622
	80		850	0.546
		200	200	0.680
3/4"	40		480	0.824
	80		690	0.742
		200	200	0.890
1"	40		450	1.049
	80		630	0.957
		200	200	1.155
1 1/4"	40		370	1.380
	80		520	1.278
		200	200	1.500
1 1/2"		160	160	1.740
		200	200	1.720
2"		160	160	2.193
		200	200	2.149
2 1/2"		160	160	2.655
		200	200	2.601
3"		160	160	3.230
		200	200	3.116

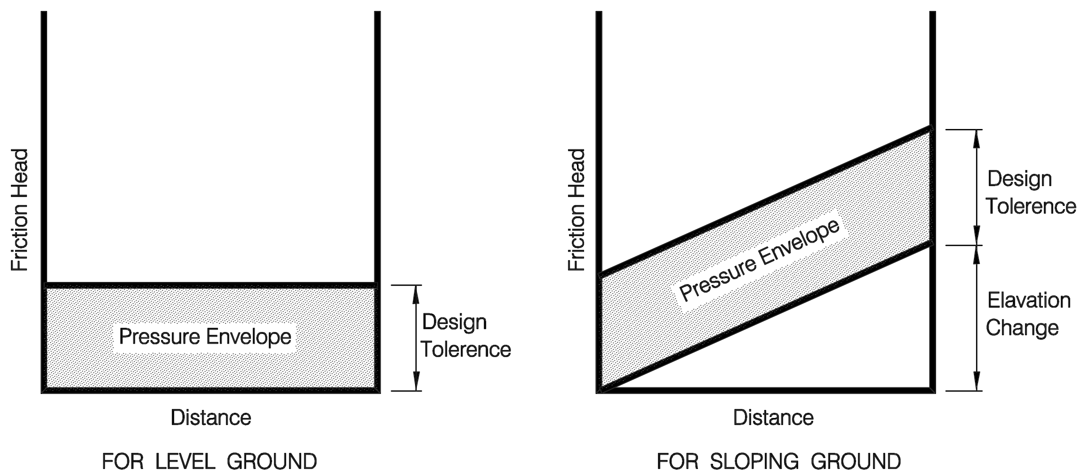

Figure D.1 *Determination of Pressure Envelopes for Uniplot*

4. Start at the closed end of the pipeline and match the working curves determined in Step 2 to the pressure envelope determined in Step 3. The tracing paper can be moved vertically but the vertical axis of the curves and tracing paper must remain aligned.
5. Segments of different working curves may be used for various pipe sizes to arrive at a submain or lateral design.
6. The design requirement will be met provided the working curves are within the pressure envelope.

   The following possibilities can occur:

   (i) If one curve is completely contained in the pressure envelope for the entire pipe length, then a single pipe diameter can be selected for the pipeline design.

   (ii) If more than one curve is completely contained within the pressure envelope, a choice of pipe diameters is possible. The smallest diameter will be the most economical. However, selecting the curve which is most nearly parallel the contour envelope will give the least pressure variation along the pipe. (A contour envelope is not necessarily a straight line but follows the land surface shape.)

   (iii) If there is no single curve contained in the pressure envelope then a single pipe diameter is not adequate and a pipe size change somewhere along the line must be made.

Example D.1 (For level ground)

A 400 ft lateral is to be laid on level ground with 1 gph emitters installed every 4 ft. The pressure variation along the lateral must not exceed 5 ft. Use polyethylene to size the lateral.

$$\text{SDR} \quad \frac{1 \text{ gph}}{4 \text{ ft}} = 0.25 \text{ gph/ft}$$

From Figure D.5 – The working curves for an SDR of 0.25 for 13 mm is 17
15 mm is 19.5
16 mm is 21
20 mm is 27

Use Figure D. 6

Lay a piece of tracing paper over the Uniplot curves and trace the axes. At the 400 ft distance on the distance axis, place a point 5 ft above the axis and draw a horizontal line to the friction loss axis. The area beneath this line represents the pressure envelope.

Keeping the axes aligned trace the working curves #17, 19.5, 21 and 27 onto the tracing paper as shown in Figure D.2

For this example note that working curve number 21 most closely approaches the allowable design tolerance of 5 ft without exceeding this pressure loss. The least expensive design would be to select 16 mm I.D. polyethylene hose for the 400 ft lateral line subjected to the condition stated in this example.

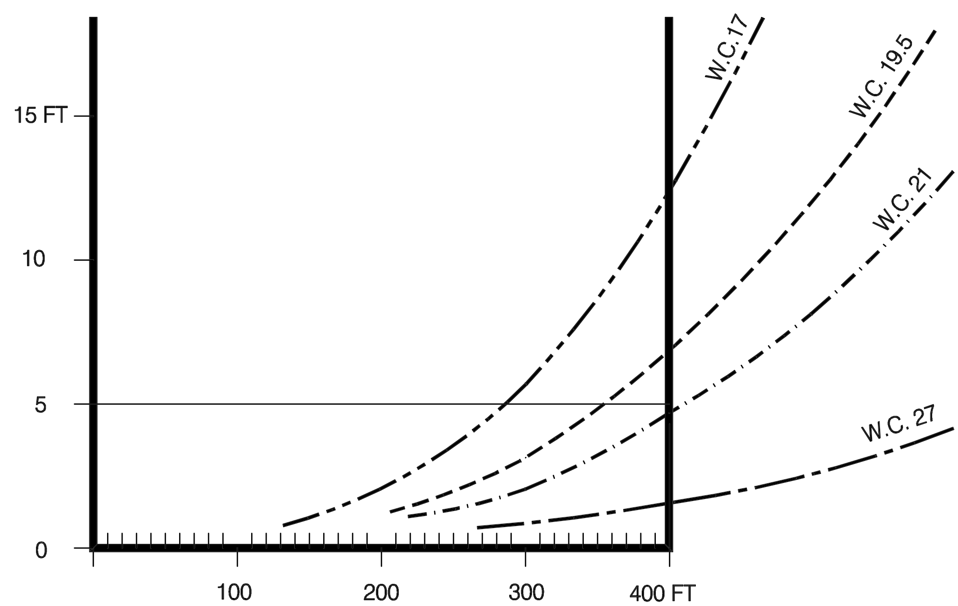

Figure D.2 *Using Uniplot for a Lateral on Level Ground*

Example D.2 (For sloping ground)

A 500 ft lateral line is to be laid on a 2% slope (downhill) with 1 gph emitters installed every 3 ft. The pressure variation along the lateral must not exceed 5 ft. Using polyethylene line, size the lateral.

$$SDR = \frac{1 \text{ gph / ft}}{3 \text{ ft}}$$
$$= 0.33 \text{ gph /ft}$$

From Figure D. 5 – the working curve for an SDR of 0.33 for

13 mm polyethylene is 15
16 mm polyethylene is 19
20 mm polyethylene is 24

A 2% slope for 500 ft is an elevation drop of 10 ft.

Lay a sheet of tracing paper over the Uniplot curves and trace over the axes. At the 500 ft mark on the distance axis, place a point 10 ft above the axis and draw a line from the point to the origin. This line represents the 2% land slope.

Draw a second line parallel to the first but 5 feet above it. These two lines represent the pressure envelope for a 5 ft pressure variation.

Keeping the vertical axis aligned, slide the tracing paper downwards and trace working curve 15 within the pressure envelope. Note that the curve is fully within the pressure envelope from 0 to 290 ft. (See Figure D.3) Trace working curves 19 and 24 ensuring that the maximum portion of the curves remain within the pressure envelope. When tracing curve 24, position the tracing paper so that the curve passes through the maximum boundary point of 15 ft at the 500 ft length as this will minimize the lateral cost.

Mark the lengths where the traced working curves intersect. The intersected points mark the length of 13 mm, 16 mm and 20 mm hose required to make up the lateral.

(Continued)

Example D.2 (For sloping ground) *(Continued)*

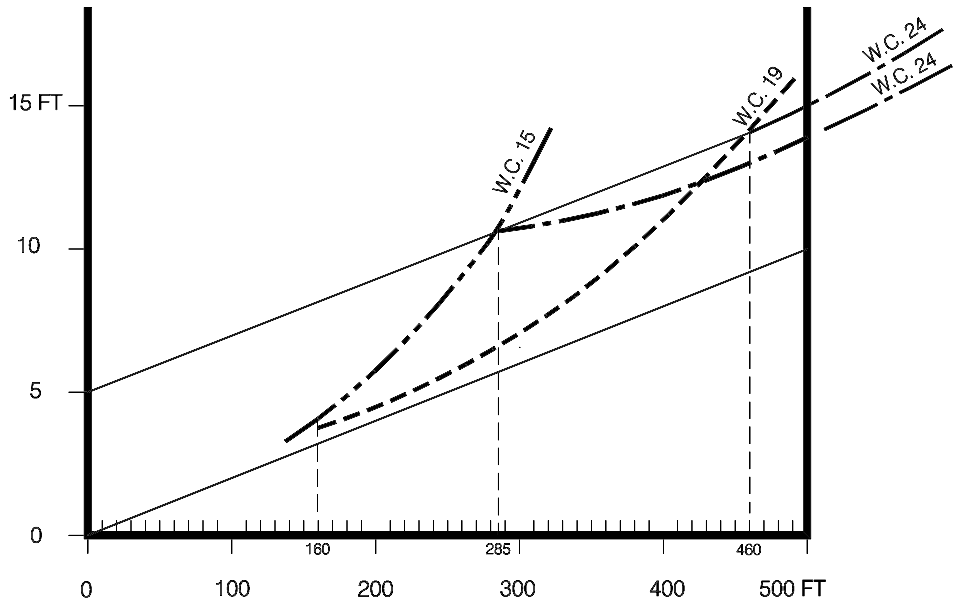

Figure D.3 *Using Uniplot for a Lateral on Sloping Ground*

Two possibilities for the lateral design would be:

(i) 160 ft 13 mm, 300 ft 16 mm and 40 ft 20 mm
or (ii) 285 ft 13 mm, 215 ft of 24 mm

The most economical design will be selection number (i).

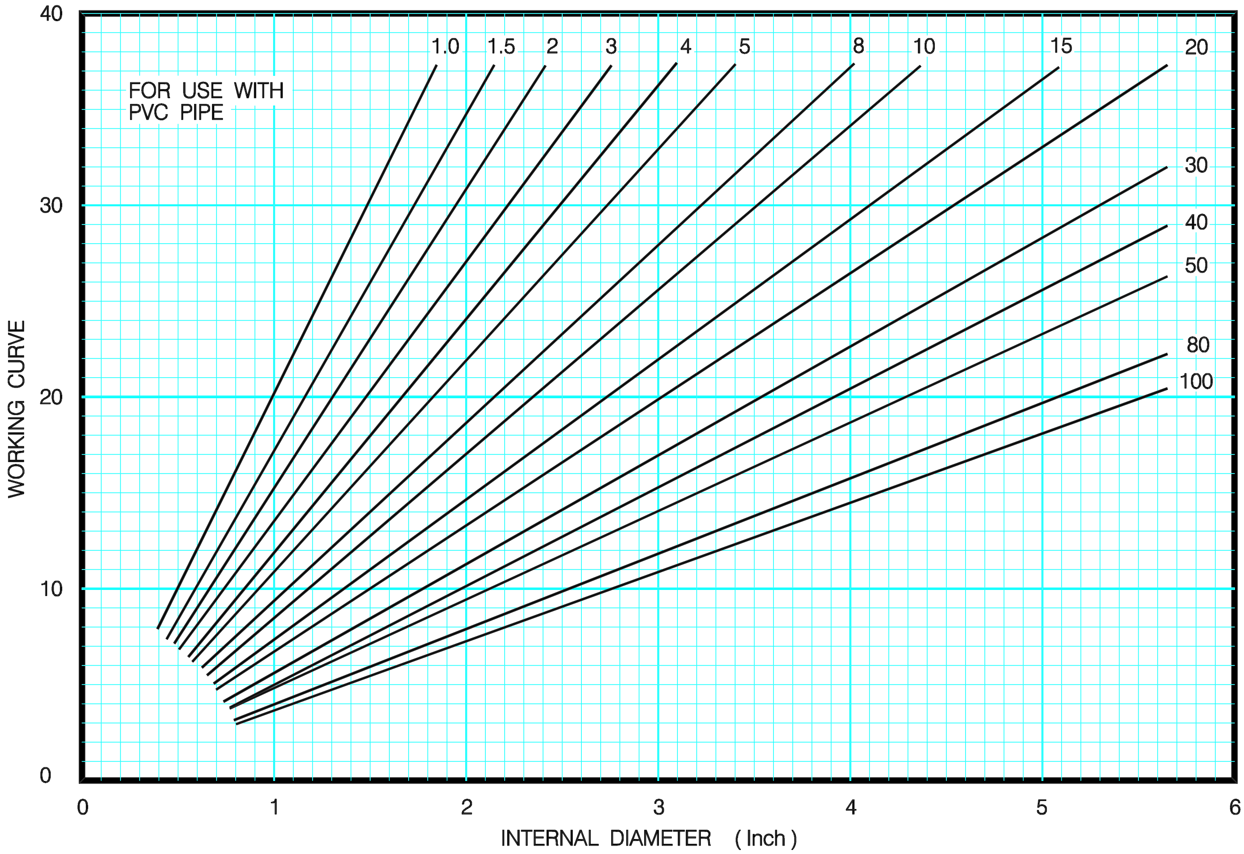

Figure D.4 *Specific Discharge Rate for PVC Pipe (gph/ft)*

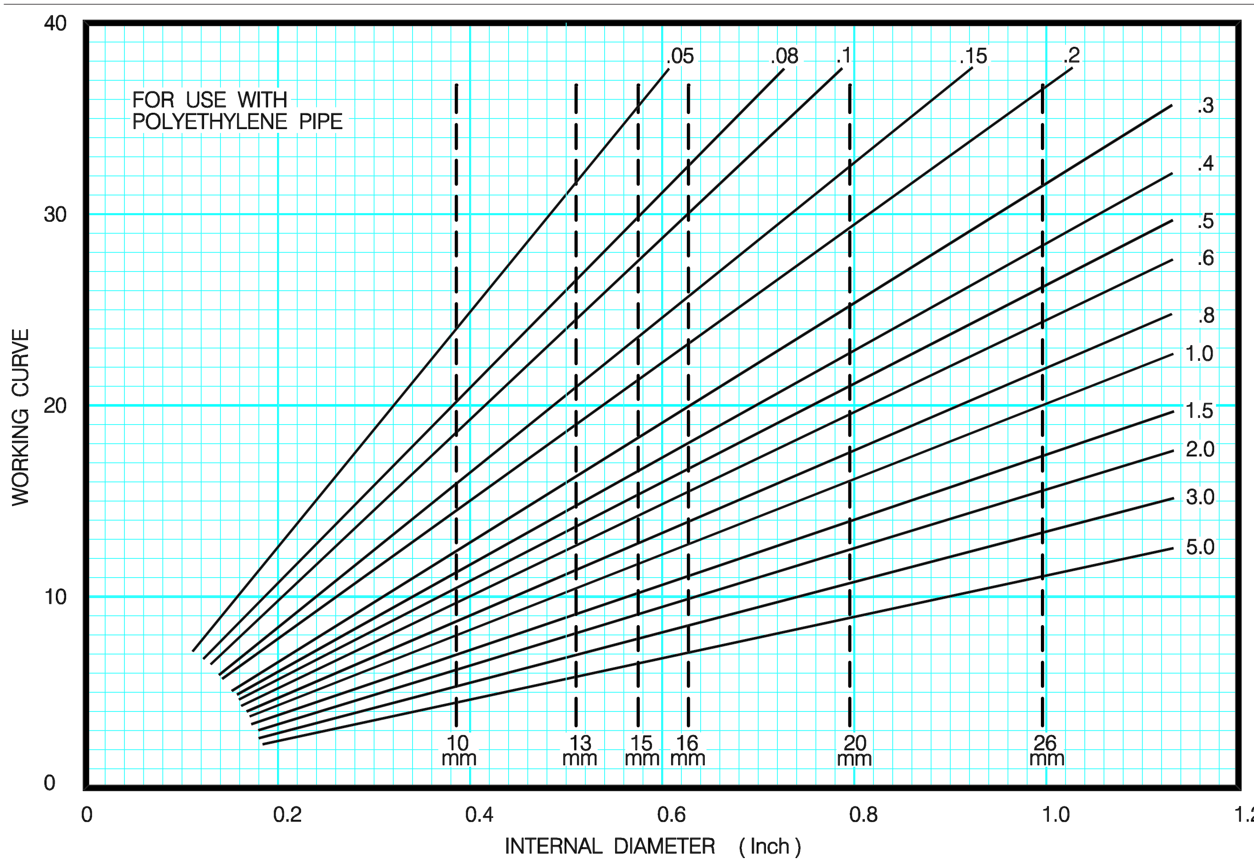

Figure D.5 *Specific Discharge Polyethylene Pipe (gph/ft)*

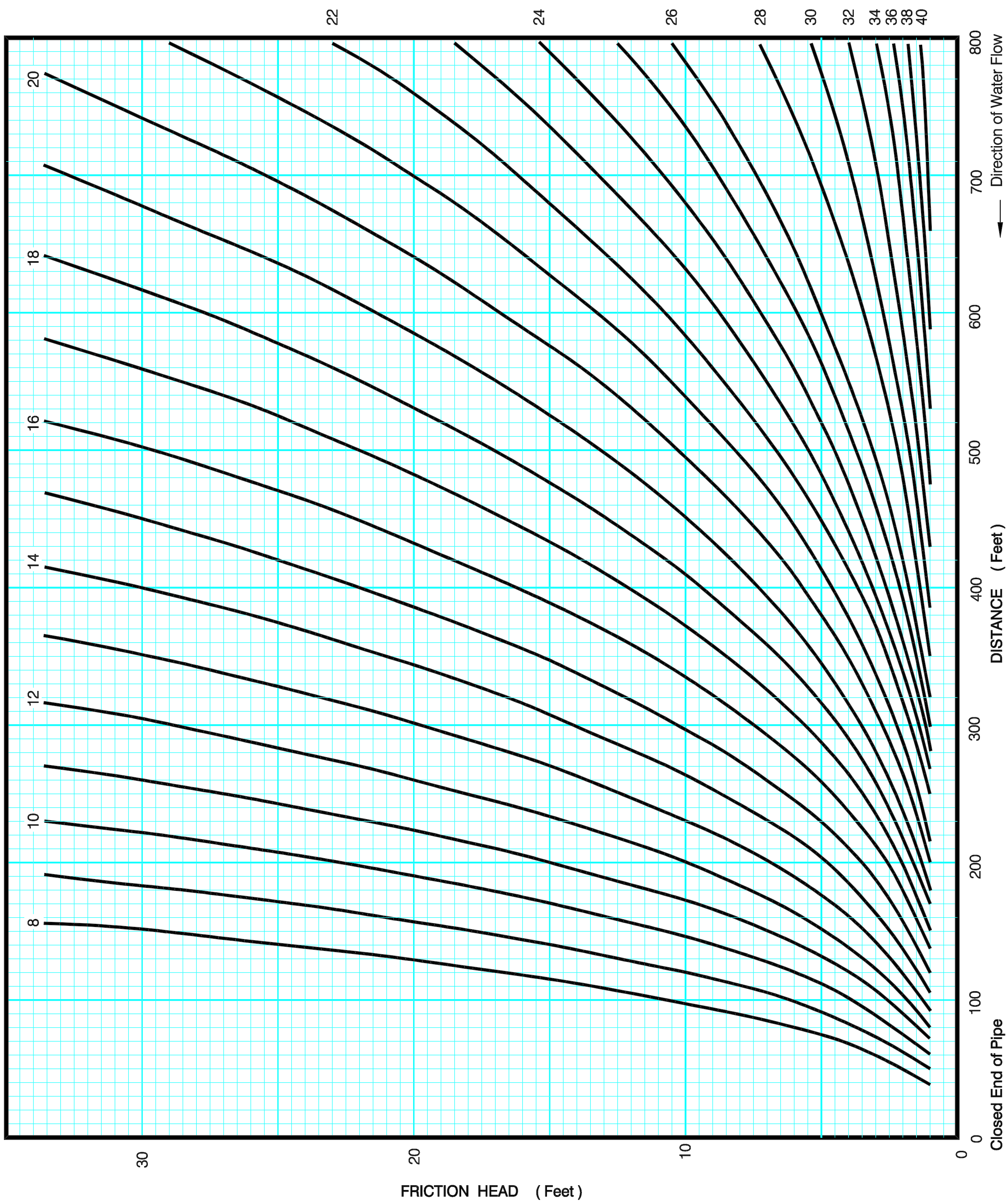

Figure D.6 *Uniplot Design Curves*