Design of Tailwater Recovery System

Example:

Given:

Field Data

| | |
|---|---|
| Soil Sharpsburg Silty Clay Loam | (Group 3) |
| Slope in direction of irrigation | = 0.2% |
| Cross slope | = 0.1% |
| Length of field in direction of irrigation | = 2,640’ |
| Yield of well | = 1,000 gpm |

From Irrigation Guide

| | |
|---|---|
| Intake rate | -- 1.3 gpm/100 ft. |
| Furrow spacing | -- 30" |
| Maximum furrow stream | -- 34 gpm |
| Maximum length of run | -- 2,600 ft. |

Design

Length of run – 2,640 ft.

Furrow spacing - 30 in.

Furrow stream - $\frac{2{,}640}{2{,}600} = 1.02$ ; 1.02 x 34 = 34.7 (use 35)

Moisture to replace = 4.1 in. gross

Time required for gross application - calculate for re-uses

Col. 6 - 1.3 gpm/100 Change to in./hr. (Table 6.13, Page 6.14*) = .50

Net application (Col. 3) = 3.5 in.

$\frac{3.5 \; x \; 1.8}{.50} = \frac{6.3}{.50}$ = 12.6 hr. (use 12 hr.)

*Tables and charts are in Nebraska Irrigation Guide.

First Set; number of furrows = $\frac{1{,}000}{34}$ gpm = 29.4 (use 29 or 30)

All other sets; number of furrows = $\frac{1{,}000 + 330}{34} = 39.1$ (use 39 or 40)

Sump or Pit

Size - $\frac{1{,}000}{2} = 500$ = 1.11 cfs - 1.11 ac. in./hr.

$$\frac{1.11\ x\ 12\ hr.\ set}{12\ in./\ ft.} = 1.11 \text{ ac. ft.}$$

1.11 ac. ft. x 1,613 cu. yd./ac. ft. = 1,790 cu. yds.

Pick appropriate pit size from charts*

Pipeline

The pipeline back to the top of the field will be 2,350 feet long and will require a minimum capacity of 330 gpm. For design purposes, use 360 gpm.

Static or Elevation Head

| | | |
|---|---|---|
| Elevation Difference | = | 5.7 ft. |
| Suction Lift | = | 8.0 ft. |

Friction Loss - Low Head Plastic pvc P.I.P. (Page 6-27*)

6" pipe 5.556 id

| | |
|---|---|
| Friction Loss per 100 ft. = 1.25 ft. thus 2,350 ft. =23.5 x 1.25 = | 29.4 ft. |
| Add for minor losses | 2.0 ft. |
| Total Head = | 45.1 ft. |

Consider 8" 7.382 id

Loss per 100 ft. = .31 ft. for 2,350 ft. = 23.5 x .31 = 7.3 ft.

Total Head = 13.7 + 7.3 + 2.0 = 23 ft.

Compute extra hp required to operate at 45.1 ft. head as compared to 23 ft.

*Tables and charts are in Nebraska Irrigation Guide.

bhp = $\frac{lift\ x\ gpm}{3{,}960\ x\ pump\ eff.}$ assume average pump efficiency of 75% 3,960 x pump eff.

$\frac{45.1\ x\ 360}{3{,}960\ x\ .75} = 5.5hp$ ; $\frac{23\ x\ 360}{3{,}960\ x\ .75} = 2.5\ hp$

5.5 - 2.5 = 3.0 hp difference

Propane engine uses 1/7 gallons per hp hour

$\frac{3.0}{7}$ = .43 gals. fuel/hr. .43 gals. x .30/gal. = .13/hr.

Average pumping year = 800 hrs. ; .13 x 800 = $104/yr. in extra fuel costs

Cost of 8" pvc = $1.67

6" pvc = $1.42

Difference = $ .25/ft.

.25 x 2,350 = $587.50 as this is more than 3 years extra fuel costs a 6-inch line would be approved.