## A - PERMANENT/SOLID-SET SPRINKLER IRRIGATION SYSTEM

### 652.0605 State Supplement

### GENERAL

The example problem in this chapter is intended to illustrate the procedure to follow in the design of permanent and solid-set irrigation systems. It should be understood that one example cannot illustrate all situations or alternatives to consider when designing a permanent or a solid-set irrigation system. This example illustrates a design method for supplying water to the total root zone. A common practice is to establish and manage a moisture control zone which is usually 50% of the rooting depth.

### DESIGN CRITERIA

Design criteria for permanent/solid-set sprinkler irrigation systems are contained in the Alabama NRCS Conservation Practice Standard (CPS), Irrigation System, Sprinkler, Code 442, Field Office Technical Guide. All permanent/solid-set systems must be designed in accordance with applicable requirements contained in CPS 442.

### EXAMPLE PROBLEM

The following example problem is intended to cover the basic steps to follow in the design of permanent/solid-set sprinkler irrigation systems. A standard form (Exhibit AL6-A-1) is a useful tool in designing and recording data.

**Given:**

1. Location: Piney Grove, Alabama (Houston County), Climatic Zone 7.
2. Field Shape: 1,320 ft. E to W by 660 ft. N to S (20 acres).
3. Soil: Orangeburg sandy loam.
4. Crop: Pecans.
5. Row direction and spacing: Rows run N to S, 30 ft. apart.
6. Plant spacing along row: 20 ft.
7. Well information: 10-in. well without pump. Power unit planned is electric, 3 phase. Static water level is at 75 ft. below ground surface.
8. Owner would like to operate the system about 12 hrs. per day using manual shut off valves. Irrigation to be done at night.
9. All pipe to be buried.

**10. Solution:**

The item numbers mentioned in the step-by-step solution refer to the items in Exhibit AL6-A-1, "Irrigation Data Sheet Permanent/Solid-Set Irrigation System."

**Step 1.** Complete Items 1-4. These items provide an inventory of pertinent data at the site.

**Step 2.** Item 5 (sheet 2 of 6) is a drawing (to scale) of the field, locating buildings, trees, the well, and other features.

**Step 3.** Determine the allowable application rate. Orangeburg sandy loam is a deep, well-drained soil with an intake rate of 0.6 in/hr. A common range should be between 0.10 in/hr and 0.6 in/hr.

**Step 4.** Complete Item 6, except for acreage to be grown (which will be discussed later). Refer to chapters 3 and 4 to obtain the moisture extraction root depths (ft) and the peak consumptive use rate (in/day).

**Step 5.** Complete Item 7. Obtain the soil series from a published soil survey report or an on-site investigation to determine the moisture holding capacity.

**Step 6.** Complete the following parts of Item 8.

a. Available water capacity (AWC) within the root zone is the product of the root zone moisture extraction depth (60 in.) times the weighted moisture holding capacity of the soil (0.12 in/in). AWC = (60 in.) x (0.12 in/in) = 7.2 in.

b. The percent depletion allowed prior to irrigation is often considered to be 30% for orchards.

c. The net water applied per irrigation (in.) is the products of the percent depletion allowed prior to irrigation, times the water available within the root zone. The net water applied per irrigation in this example is = (0.30) x (7.2 in.) = 2.16 in.

d. The water application efficiency is 80% for nighttime irrigation. (Note: This is not the same as the coefficient of uniformity.)

e. The gross water applied per irrigation in inches is found by dividing the net water applied per irrigation of 2.16 in. by the water application efficiency of 80%.

Gross water applied = 2.16 in / 0.80 = 2.7 in.

f. The irrigation frequency in days is determined by dividing the net water applied per irrigation (2.16 in) by the crop peak consumptive use rate (0.26 in/day).

Irrigation interval = 2.16 in / 0.26 in/day = 8.3 days.

g. Normally, the irrigation period in days to be used in the formula for determining $Q_R$ is the irrigation frequency 8.3 days, determined above. However, in this example, the field was broken into four irrigation units of five acres each resulting in one unit being irrigated every two days. Therefore, 2 days was entered in each column for the irrigation period and 5 acres per irrigation unit in Item 6. The advantages of dividing the field into four units is that a smaller pump can be used and a smaller well capacity is required.

h. Twelve hours operating per day was requested by the owner; however, do not enter this value yet.

**Step 7.** Tentatively determine the quantity of water required.

$Q_R$ for each irrigation unit. Use the formula:

$$Q_R = \frac{453 \times A \times d}{H \times F}$$

Where $Q_R$ = minimum required discharge capacity in gallons per minute (gpm)

A = acreage of the design area.

d = gross depth of application in inches.

H = number of actual operating hours per day.

F = number of days allowed for completion of one irrigation.

$$Q_R = \frac{453 \times 5 \text{ ac.} \times 2.7 \text{ in. gross application}}{12 \text{ hr. operation/day} \times 2 \text{ days per irrigation}}$$

$Q_R$ = 255 gpm

Note that the $Q_R$ should not exceed the well capacity. In situations where the well capacity is exceeded then the irrigation unit acreage would need to be decreased, the operating hours per day increased, or a well of higher capacity would need to be installed.

**Step 8.** Select a sprinkler spacing that is compatible with the tree spacing. Some alternatives would be 40 ft x 60 ft or 60 ft x 60 ft. The 60 ft x 60 ft in a square pattern, was tentatively selected.

**Step 9.** Check the sprinkler spacing requirement in the CPS, Code 442. Since irrigation will be done at night, no wind is considered, resulting in a requirement that the sprinkler spacing be no greater than 65% of the wetted diameter.

**Step 10.** Select a sprinkler. The selection is based on the wetted diameter and the minimum gpm required per sprinkler. The wetted diameter is computed by dividing the sprinkler spacing of 60 ft. by the required maximum spacing of 65% of the wetted diameter. Thus, 60 ft x 0.65 = 92.3 ft. The minimum required GPM of the sprinkler (spk) is determined by the following equation:

$$\text{Application rate (in/hr)} = \frac{\text{gpm/spk} \times 96.3}{S \times L}$$

Where S = Spacing of sprinklers along lateral.

L = Spacing between laterals in feet.

(Note: 96.3 converts gpm/ft$^2$ to in/hr)

For tentative application rate, divide the gross application of 2.7 in. by the hours operating per day (12 hr) and by the number of days. The result is 0.113 in/hr. Now solve the formula for gpm/spk:

$$\text{gpm/spk} = \frac{0.113 \text{ in/hr} \times 60 \text{ ft} \times 60 \text{ ft}}{96.3}$$

gpm/spk = 4.22 gpm

With the two requirements of 4.22 gpm/spk and 92.3 feet wetted diameter refer to the sprinkler manufacturer's charts. Table AL6-A-1 shows a typical manufacturer's sprinkler data and was used to select the sprinkler. The sprinkler selected has a capability of 4.22 gpm at 55 psi with a wetted diameter of 94 feet, which meets the criteria. The nozzle size is 9/64 in. These data are entered in Item 10.

**Step 11.** Complete Item 9.

a. Application rate is recomputed using the formula:

Application rate (in/hr) =

$$\frac{\text{gpm/spk} \times 96.3}{S \times L} = \frac{4.22 \times 96.3}{60 \times 60} = 0.11$$

b. Time per lateral or unit set in hours is computed by dividing the gross application of 2.7 in. by the application rate of 0.11 in/hr and the irrigation period.

Time/lateral set = 2.7 in / (0.11 in/hr x 2) = 12.3 hr.

c. Determine the actual gpm/unit ($Q_A$). Multiply the number of sprinklers per unit times the gpm/spk to determine gpm/unit.

Units 1 & 4: $Q_A$ = 60 spk x 4.22 gpm/spk = 253 gpm

Units 2 & 3: $Q_A$ = 61 spk x 4.22 gpm/spk = 257 gpm

**Step 12.** Complete Item 8. Enter the actual hours of operation per unit of 12.3 hours as calculated in Step 11 b. The $Q_R$ is obtained by the following formula:

$$Q_R = \frac{453 \times 5 \text{ acres} \times 2.7 \text{ in gross application}}{12.3 \text{ hr oper/day} \times 2 \text{ days/irrigation}}$$

$Q_R$ = 249 gpm

Note that as a check, the $Q_A$ should be approximately equal to $Q_R$.

**Step 13.** Determine Total Dynamic Head (TDH). Refer to item 11, as each of the following points are discussed:

**a.** Size the lateral and submain to determine its head loss. Usually the longest lateral and submain is used to determine the head loss within the irrigation unit. However, ground elevation changes may sometimes cause the maximum head loss to occur elsewhere. This will be discussed later in this step. Sheets 5 and 6 of Exhibit AL6-A-1, Pipe Sizing Data Sheet, were used for this purpose. First, the gpm for the lateral and submain was listed in a cumulative manner beginning with the last sprinkler. The length of pipe carrying the corresponding gpm was then listed. Using Appendixv, the pipe was sized and the corresponding friction head loss ($HL_f$) in ft/100 ft was listed on the data sheet. The pipe is sized so that the velocity of water flow through the pipe is less than or equal to 5 fps. The total friction head loss is determined by multiplying the $HL_f$ (ft/100 ft) x the pipe length (ft) and summing the results. The elevation difference (zero in this example due to a level field) is then totaled and added to the total friction head loss to obtain the total head loss in the lateral. The summation for Irrigation Unit 4 of 8.81 ft. was used in the design.

The elevation difference of natural ground between the risers and within an irrigation unit was not significant in the example discussed. However, it must be evaluated for each design as it can, to a great extent, affect the layout of the irrigation unit and the pipe sizing. It affects the layout because the nozzle pressure must be maintained within certain limits in each irrigation unit. These limits are discussed in Step 13.b.

The effect that elevation difference has on pipe sizing can best be explained using an example. For instance, if a lateral is to be installed downhill from the mainline, a smaller pipe with higher friction head loss may be used. The elevation difference is downhill (increase in pressure) which offsets the decrease in pressure due to friction head loss. An increasing elevation plays a reverse role, often resulting in a larger diameter pipe.

The multiple outlet factor (See Appendix), which could not be used to an advantage in this problem, can be used to determine the friction head loss in a length of pipe of one diameter. For example, if the entire lateral was designed to be 1½ in. diameter, then with a flow of 25.3 gpm it would have $HL_f$ of 2.76 ft/100 ft with six outlets in the lateral, the multiple outlet factor from Appendix is 0.438. The total head loss in the lateral would be 2.76 ft/100 ft x (360/100) x 0.438 = 4.35 ft.

**b.** The head loss for the irrigation unit should then be modified so that the theoretical mid-system sprinkler operates at the design nozzle pressure. This provides for a more balanced system in that the sprinkler closer to the pump operates at a pressure higher than the design nozzle pressure and the farthest sprinkler lower in pressure. The head loss is modified by multiplying the summation of 8.81 ft x 0.5 = 4.4 ft. The sprinklers within an irrigation unit for pecans must operate at a pressure within ± 20%t of the design operating pressure. In this case, with the design operating pressure at 55 psi, the allowable variation in sprinkler operating pressure is ± .20 x 55 psi. Therefore, 55 psi ± 11 psi = 44 psi and 66 psi for the minimum and maximum sprinkler operating pressure.

**c.** Size the mainline and determine the head loss. Item 11 was used for sizing and determining the mainline head loss. The 6 in. main with 253 gpm has a friction head loss of 0.45 ft/100 ft. Total head loss is equal to 0.45 ft/100 ft x 210 ft = 0.94 ft. The 0.94 ft. is equal to 0.40 psi. If elevation differences has been encountered, the pipe sizing data sheet would have been used.

**d.** Design sprinkler nozzle pressure. The 55 psi sprinkler operating pressure was determined in Item 10. Remember that this is the operating pressure of the theoretical mid-sprinkler of the irrigation unit.

**e.** Miscellaneous and fitting friction losses. This can be computed using the formula h = ($Kv_2$/2g) where values of K are in Appendix. However, this is usually estimated to be within a range of 1.3 psi to 3.5 psi, depending on the complexity of the system. This example was estimated to have about 1.3 psi head loss for miscellaneous and fitting losses.

**f.** Riser height. In this case, 3 feet is used.

**g.** Pump discharge pressure. This is the pressure the pump must produce at its discharge side so that the theoretical mid-sprinkler of the irrigation unit is operating at its design operating pressure of 55 psi. To obtain the pump discharge pressure the preceding items were totaled as follows:

| | | |
|---|---|---|
| Lateral & sub-main friction losses | - | 1.9 psi |
| Mainline friction losses | - | 0.4 psi |
| Nozzle pressure | - | 55.0 psi |
| Miscellaneous & fitting friction losses | - | 1.3 psi |
| Riser height | - | 1.3 psi |
| Pump discharge pressure | - | 59.9 psi |

**h.** Pumping lift is the vertical distance the pump must lift the water in the well to reach ground level or, in the case of the centrifugal pump, the vertical distance from the water source to the pump discharge. The well drawdown is considered in determining the pumping lift. This example has the static water level at 75 ft. with 15 ft. of drawdown when pumping. Therefore, the pumping lift is 75 ft + 15 ft = 90 ft, which is equal to 39.0 psi.

**i.** Total dynamic head (TDH) is the total head loss that the pump must operate against in order to perform the required work. The pump discharge pressure 59.9 psi + pumping lift 39 psi = 98.9 psi TDH. This is usually expressed in ft which would be 228.5 ft TDH.

**Step 14.** Complete Item 12, Pump Requirement. This is the maximum gpm the pump must produce at a given TDH. From Item 9, the maximum $Q_A$ for an irrigation unit is 257 gpm. The TDH from the preceding section is 228.5 ft. Therefore, the pump requirement would be expressed as 257 gpm at 228.5 ft. TDH.

**Step 15.** Complete Item 13. Check the sprinkler pressure variation within the system (Irrigation Units) against the allowable pressure. This was discussed earlier under Item 13.b. The actual pressure is found by using Sheet 4 of 6 of Exhibit AL6-A-1. The actual nozzle pressure of the closer sprinkler is the pump discharge pressure (59.9 psi) - the mainline loss (0.4 psi) - miscellaneous and fitting friction losses (1.3 psi) - the riser height loss (1.3 psi) = 56.9 psi. The actual nozzle pressure of the farthest nozzle is the pump discharge pressure (59.9 psi) - the mainline loss (0.4 psi) - miscellaneous and fitting friction losses (1.3 psi) - the riser height loss (1.3 psi) - actual total lateral and sub-main losses (3.8 psi) = 53.1 psi.

The allowable nozzle pressure as taken from Section 13 b is 44 psi (minimum) and 66 psi (maximum). The actual nozzle pressure of 53.1 psi and 56.9 psi is within this range.

## LAYOUT CONSIDERATIONS

Items that must be considered in the layout of a permanent and solid-set irrigation system are as follows:

**a.** Soil limitations which may affect the ease of installation such as cut banks caving in, depth to rocks, and wetness.

**b.** Plant spacing and row direction so that riser can be properly located.

**c.** Maximum height of plants for determining riser height if sprinklers are positioned over crop.

**d.** Location of obstacles such as ponds, fences, overhead power lines, and buried electrical and gas lines which are safety hazards.

**e.** Topography which may affect the layout of the system and valving arrangement so that each irrigation unit can be operated within the allowable pressure variation.

## CONSTRUCTION REQUIREMENTS

Construction items that must be checked to assure quality installation are as follows:

**a.** Depth of cover over the buried main line for adequate protection from vehicular traffic and the farming operation.

**b.** Thrust block dimensions, location, and alignment to prevent pipe joint separation.

**c.** Location and size of air vents and pressure relief valve. Risers function as air vents but others may be required if a pipeline has a summit with no riser.

**d.** Riser material, diameter, height, and spacing.

**e.** Sprinkler model and size nozzle. Location of part circle sprinklers, if planned.

**f.** Location and size of valves which serve each irrigation unit.

**g.** Depth of cover over the buried pipe.

**h.** Pipe requirements to verify things such as SDR number, pressure rating, ASTM designation, PVC material, pipe diameter, and if PIP or IPS pipe.

**i.** Check valve installed at pump discharge.

**j.** Pump, motor, and well size must be verified. Then check the nozzle pressure and variation within each irrigation unit using a pressure gauge with a pitot tube.

**Table AL6-A-1. Typical Sprinkler Manufacturer's Data**

**Highest point of stream is 7 ft above nozzle.***

| psi@ Nozzle | Nozzle 7/64 in. diam | gpm | Nozzle 1/8 in. diam | gpm | +Nozzle 9/64 in. diam | gpm | Nozzle 5/32 in. diam | gpm | Nozzle 11/64 in. diam | gpm |
|---|---|---|---|---|---|---|---|---|---|---|
| 25 | 78 | 1.73 | 82 | 2.25 | 85 | 2.90 | 88 | 3.52 | 90 | 4.24 |
| 30 | 79 | 1.89 | 84 | 2.47 | 87 | 3.16 | 90 | 3.85 | 92 | 4.64 |
| 35 | 80 | 2.05 | 85 | 2.68 | 89 | 3.40 | 92 | 4.16 | 94 | 5.02 |
| 40 | 81 | 2.20 | 86 | 2.87 | 91 | 3.63 | 94 | 4.45 | 96 | 5.37 |
| 45 | 82 | 2.32 | 87 | 3.05 | 92 | 3.84 | 96 | 4.72 | 98 | 5.70 |
| 50 | 83 | 2.44 | 88 | 3.22 | 93 | 4.04 | 98 | 4.98 | 100 | 6.01 |
| 55 | 84 | 2.56 | 89 | 3.39 | 94 | 4.22 | 100 | 5.22 | 102 | 6.30 |
| 60 | 85 | 2.69 | 90 | 3.55 | 95 | 4.38 | 101 | 5.44 | 103 | 6.56 |

+ Standard Nozzle.
*Shown for standard nozzle at normal operating pressure.
Area below dotted line in chart is the recommended working pressure for best distribution.

U.S. Department of Agriculture
Natural Resources Conservation Service

IRRIGATION DATA SHEET
PERMANENT/SOLID-SET SPRINKLER IRRIGATION SYSTEM

Sheet 1 of 6

CONSERVATION DISTRICT Houston Co. FIELD OFFICE Dothan
COOPERATOR Tom Biggs LOCATION 1 mi. E. of Piney Grove
IDENTIFICATION NO. ___ FIELD NO. 1

1. Design area 20 acres
Description of soils 0-60 inches Fine Sandy Loam, Sandy Clay Loam (SM)

Design Soil Series: Orangeburg

| Soil Depth (in.) | Average AWC (in./in.) |
|---|---|
| 0-12 | 0.10 |
| 12-24 | 0.13 |
| 24-36 | 0.13 |
| 36-48 | 0.13 |
| 48-60 | 0.13 |

2. Crops:

| Crop | Acres | Planting Date | Maturity Date |
|---|---|---|---|
| Pecans | 20 | | |
| | | | |
| | | | |
| | | | |
| | | | |
| Total | 20 | | |

3. Water Supply:
Source of supply: (stream, well, reservoir, etc.) 10" dia.
Reservoir: Storage ___ ac-ft Available for Irrigation ___ ac-ft
Well: Static Water Level 75 ~~gpm~~ ft.
Measured Capacity 500 gpm @ 15 ft drawdown
Design Pumping Lift 90 ft
Stream: Measured flow (season of peak use) ___ gpm
Quality of water (evidence of suitability): Good

Distance supply source to field 0 ft

4. Other Data:
Type of power unit and pump to be used: The power unit will be a 60 cycle, 460 V., 3 ph., part-wind starting squirrel cage induction vertical-hollow shaft electric motor. The pump is a deep well turbine pump, direct drive.

**Exhibit AL6-A-1. Irrigation Data Sheet - Permanent/Solid-Set Sprinkler Irrigation System.**

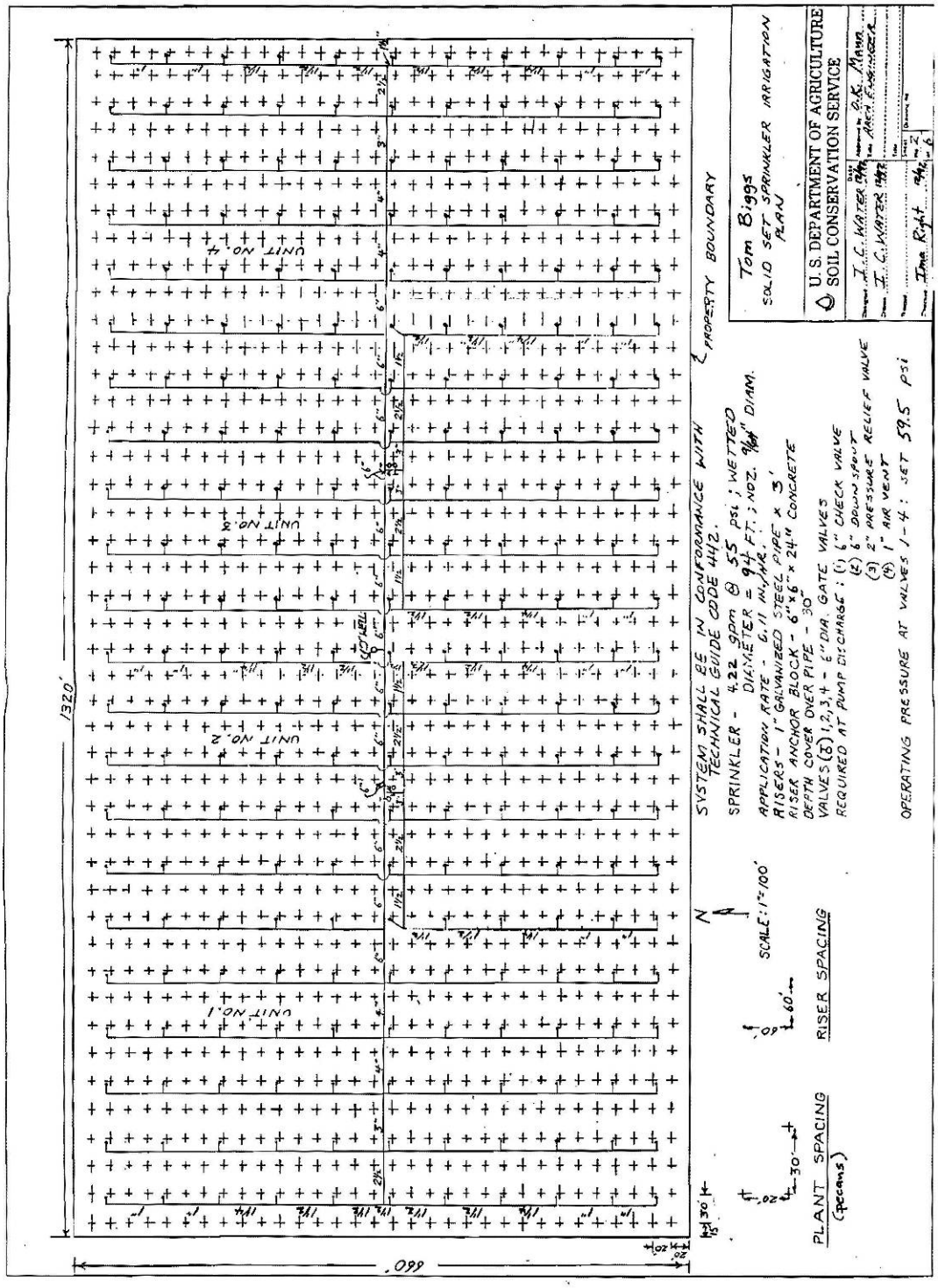


**Exhibit AL6-A1. (con't)**

PERM./SOLID-SET SPRINKLER IRRIG. SYSTEM Sheet 3 of 6

Cooperator: Tom Biggs Designed by: I.C. Water Checked by: Ima Right

| | IRRIGATION UNIT NUMBER | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 |
| **6. Crop Information** | | | | | |
| Kind of crop | pecans | pecans | pecans | pecans | |
| Acreage to be grown (acres) 1/ | 5 | 5 | 5 | 5 | |
| Rooting depth (in.) | 60 | 60 | 60 | 60 | |
| Peak use rate (in./day) | 0.26 | 0.26 | 0.26 | 0.26 | |
| **7. Soil Information** | | | | | |
| Weighted AWC for rooting depth (in./in.) | 0.12 | 0.12 | 0.12 | 0.12 | |
| Basic intake rate (in./hr) | 0.6 | 0.6 | 0.6 | 0.6 | |
| **8. Design Procedure** | | | | | |
| AWC within root zone (in.) | 7.2 | 7.2 | 7.2 | 7.2 | |
| % Depletion allowed prior to irrigation | 30 | 30 | 30 | 30 | |
| Net water applied per irrig. (in.) | 2.16 | 2.16 | 2.16 | 2.16 | |
| Water application efficiency (%) | 80 | 80 | 80 | 80 | |
| Gross water applied per irrig. (in.) 1/ | 2.7 | 2.7 | 2.7 | 2.7 | |
| Irrigation interval (days) | 8.3 | 8.3 | 8.3 | 8.3 | |
| Irrigation period (days per irrigation) 1/ | 2 | 2 | 2 | 2 | |
| Hours operating per day 1/ | 12.3 | 12.3 | 12.3 | 12.3 | |
| $Q_R$ = Quantity of water required (gpm) 1/ | 249 | 249 | 249 | 249 | |
| **9. Irrigation Unit Design** | | | | | |
| Application Rate (in./hr) 2/ | 0.11 | 0.11 | 0.11 | 0.11 | |
| Time per lateral or unit set (hrs = gross application / application rate) | 12.3 | 12.3 | 12.3 | 12.3 | |
| Number of sprinklers per unit | 60 | 61 | 61 | 60 | |
| $Q_A$ 3/ = Quantity of water actual (gpm/unit) = No. of sprinklers/unit x gpm/spk.) | 253 | 257 | 257 | 253 | |

10. Sprinkler Specifications:
a. sprinkler spacing 60 ft, lateral spacing 60 ft
b. nozzle size 9/64 x — wetted diameter 94 ft
c. capacity 4.22 gpm @ 55 psi or 127 ft

1/ $Q_R = \frac{453 \times 5 \text{ acres} \times 2.7 \text{ in. gross application}}{12.3 \text{ hrs opr. per day} \times 2 \text{ days per irrigation}} = 249$ gpm

2/ Application rate (in./hr) = $\frac{\text{gpm/spk} \times 96.3}{S \times L}$ MUST BE $\leq$ BASIC INTAKE RATE
Where S = Spacing of sprinklers along lateral in feet.
L = Spacing between laterals in feet.

3/ $Q_A$ = maximum unit gpm: Must be $\geq Q_R$

**Exhibit AL6-A-1. (con't)**

PERM./SOLID-SET SPRINKLER IRRIG. SYSTEM Sheet 4 of 6

Cooperator: Tom Biggs Designed by: I.C. Water Checked by: Ima Right

11. Determining Total Dynamic Head 4/

| Kind of Pipe | | | Design Capacity (gpm) | IPS ☐ PIP ☐ Other___ Diameter (in.) | Length (ft) | Friction Head Loss (ft/100ft) | Total Head Loss HL (ft) | Total Head Loss, HL | |
|---|---|---|---|---|---|---|---|---|---|
| Main | Sub-Main | Lateral | | | | | | (ft) | (psi) |
| XXXX | ✓ | ✓ | (see attached pipe sizing | | | | 8.81 | XXXX | XXXX |
| XXXX | | | | data sheet) | | | | XXXX | XXXX |
| XXXX | | | | | | | | XXXX | XXXX |
| XXXX | | | | | | | | XXXX | XXXX |
| XXXX | | | | | | | | XXXX | XXXX |
| XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | XXXX | ΣHL 8.81 x 0.5/5/ = | 4.4 | 1.9 |
| | XXXX | XXXX | 253.2 | 6 | 210 | 0.45 | XXXX | 0.9 | 0.4 |
| | XXXX | XXXX | | | | | XXXX | | |
| | XXXX | XXXX | | | | | XXXX | | |
| | XXXX | XXXX | | | | | XXXX | | |
| | XXXX | XXXX | | | | | XXXX | | |
| Design Sprinkler Nozzle Pressure | | | | | | | | 127 | 55 |
| Miscellaneous Losses | | | | | | | | 3.0 | 1.3 |
| Riser Height | | | | | | | | 3.0 | 1.3 |
| Pump Discharge Pressure | | | | | | | | 138.4 | 59.9 |
| Pumping Lift | | | | | | | | 90.0 | 39.0 |
| Total Dynamic Head, TDH | | | | | | | | 228.5 | 98.9 |

12. Pump Requirements: 257 gpm @ 98.9 psi or 228.5 ft of head

13. Check allowable pressure variation within system (irrigation unit)

Allowable = ± 15 % of nozzle operating pressure = 8 psi

= 44 psi to 66 psi

Actual 6/ = 53.1 psi to 56.9 psi

14. Remarks Set pressure pump at 59.9 psi or 59.5 psi at each gate valve.

4/ Use pipe sizing data sheets where elevation differences are present and/or additional data lines needed.

5/ Sets optimum nozzle pressure at a theoretical mid-system sprinkler.

6/ Consider elevations and location. Adjust 5/ if possible to stay within allowed variation. If not, the system must be redesigned.

Design approved by: O.K. Mann Date: 12-7-92

**Exhibit AL6-A-1. (con't)**

U.S. Department of Agriculture
Natural Resources Conservation Service

PIPE SIZING DATA SHEET

Sheet 5 of 6

Cooperator Tom Biggs

Designed by I.C. Water

Field Office Dothan

Checked by Ima Right

Irrigation Unit No. 3

Pipe Sizing Calculations

Pipe Material PVC, SDR 21
IPS ☑ PIP ☐ Other

| Main | Sub-Main | Lateral | Q Design Capacity (gpm) | D Pipe Diam. (in.) | L Length (ft) | Friction Head Loss J (ft/100') | Multiple Outlet Factor F | Total Head Loss $H_f$ (ft) | Elevation Difference ΔEl (ft) | Total $\Delta H_m = H_f + \Delta El$ (ft) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ✓ | 4.22 | 1 | 60 | 0.61 | – | 0.37 | 0 | 0.37 | |
| | | | 8.44 | 1 | 60 | 2.19 | – | 1.31 | 0 | 1.31 | |
| | | | 12.66 | 1¼ | 60 | 1.52 | – | 0.91 | 0 | 0.91 | |
| | | | 16.88 | 1½ | 60 | 1.32 | – | 0.79 | 0 | 0.79 | |
| | | | 21.1 | 1½ | 60 | 1.98 | – | 1.19 | 0 | 1.19 | |
| | | | 25.32 | 1½ | 60 | 2.77 | – | 1.66 | 0 | 1.66 | |
| | | | | | | | | | | | |
| | ✓ | | 71.7 | 2½ | 60 | 2.53 | – | 1.52 | 0 | 1.52 | |
| | | | 118.2 | 3 | 30 | 2.45 | – | 0.73 | 0 | 0.73 | |
| | | | | | | | | | Σ = | 8.48 | |
| | | | | | | | | | | | |
| ✓ | | | 257 | 6 | 215 | 0.45 | – | 0.97 | 0 | 0.97 | |

**Exhibit AL6-A-1. (con't)**

**Exhibit AL6-A-1. (con't**

U.S. Department of Agriculture
Natural Resources Conservation Service

PIPE SIZING DATA SHEET

Sheet 6 of 6

Cooperator Tom Biggs

Designed by I.C. Water

Field Office Dothan

Checked by Ima Right

Irrigation Unit No. 4

Pipe Material PVC, SDR 21
IPS ☑ PIP ☐ Other

| Main | Sub-Main | Lateral | Q Design Capacity (gpm) | D Pipe Diam. (in.) | L Length (ft) | Friction Head Loss J (ft/100') | Multiple Outlet Factor F | Total Head Loss $H_f$ (ft) | Elevation Difference ΔEl (ft) | Total $\Delta H_m = H_f + \Delta El$ (ft) | Remarks |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | ✓ | 4.22 | 1 | 40 | 0.61 | — | 0.24 | 0 | 0.24 | Unit No. 1 is same |
| | | | 8.44 | 1 | 60 | 2.19 | — | 1.31 | 0 | 1.31 | as Unit No. 4 except |
| | | | 12.66 | 1¼ | 60 | 1.52 | — | 0.91 | 0 | 0.91 | the length of the |
| | | | 16.88 | 1½ | 60 | 1.32 | — | 0.79 | 0 | 0.79 | mainline in Unit |
| | | | 21.1 | 1½ | 60 | 1.98 | — | 1.19 | 0 | 1.19 | No. 4 is about |
| | | | 25.32 | 1½ | 10 | 2.77 | — | 0.28 | 0 | 0.28 | 30 ft. longer. |
| | | | | | | | | | | | |
| | ✓ | | 46.4 | 2½ | 60 | 1.13 | — | 0.68 | 0 | 0.68 | |
| | | | 92.8 | 3 | 60 | 1.57 | — | 0.94 | 0 | 0.94 | |
| | | | 139.3 | 4 | 60 | 0.97 | — | 0.58 | 0 | 0.58 | |
| | | | 185.7 | 4 | 60 | 1.66 | — | 1.00 | 0 | 1.00 | |
| | | | 232.1 | 6 | 60 | 0.38 | — | 0.23 | 0 | 0.23 | |
| | | | 253.2 | 6 | 150 | 0.44 | — | 0.66 | 0 | 0.66 | |
| | | | | | | | | | Σ = | 8.81 | Place on Sheet 4 of 6 |
| | | | | | | | | | | | |
| ✓ | | | 253.2 | 6 | 210 | 0.44 | — | 0.92 | 0 | 0.92 | |