BIE 5110/6110
Sprinkle & Trickle Irrigation
Fall Semester, 2004

Assignment #2 (100 pts)
Due: 29 Sep 04

Given:

A solution for the economic selection of pipe sizes is needed. The solution is to be based on the following data:

- interest rate, i = 2.4%
- inflation rate, e = 0.1%
- useful system life, n = 22 years
- area irrigated, A = 58 ha
- gross annual depth, d = 890 mm/year
- maximum system capacity, Q = 210 lps
- motor efficiency, E_m = 94%
- pump efficiency, E_p = 88%
- avg cost of electricity for pumping = 0.06104 $/kWh
- purchase cost of PVC pipe:

Size (inches)	O.D. (inches)	I.D. (inches)	Wall (inch)	Price ($/20 ft)
6	6.625	6.031	0.297	35.10
8	8.625	7.943	0.341	53.22
10	10.750	9.976	0.387	75.81
12	12.750	11.890	0.430	98.08
14	14.000	13.072	0.464	116.95
16	16.000	14.940	0.530	154.33
18	18.000	16.809	0.595	198.39

- In the above table: “O.D.” is outside diameter; “I.D.” is inside diameter; and “Wall” is the pipe wall thickness

Required:

- Determine the cutoff flow rate values for each adjacent pair of pipe sizes (you are not required to graph the pipe selection chart)
- The solution is to include the PVC pipe with nominal sizes 6, 8, 10, 12, 14, 16, and 18 inches, as shown above.
- You can use either the Hazen-Williams or Darcy-Weisbach equations.
- For PVC pipe, use a Hazen-Williams “roughness” factor of C = 150.
- Or, for Darcy-Weisbach, use the Blasius equation for smooth pipe.
- Assume that MAC is negligible.

Solution:

BIE 5110/6110
Economic Pipe Selection Method
Assignment #2, Fall 2004

Given data:

useful life:	22	years	inflation:	0.001	per year	motor efficiency:	0.94	
interest rate:	0.024	per year	area:	58	ha	pump efficiency:	0.88	
			depth:	0.89	m/year	electricity:	0.06104	$/kWh
			capacity:	210	lps	Hazen-Williams:	150	C factor

Pipe purchase prices:

Size	O.D.	I.D.	Wall	Price
(inches)	(inches)	(inches)	(inch)	($/20 ft)
6	6.625	6.031	0.297	35.10
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Capital Recovery Factor: CRF= 0.0590

Uniform annual pipe cost:

Size	UAC	
(inches)	($/20 ft/yr)	($/100 ft/yr)
6	2.07	10.36
8	3.14	15.71
10	4.48	22.38
12	5.79	28.95
14	6.90	34.52
16	9.11	45.56
18	11.71	58.56

Operating hours per year:

Ot= 683 hrs/year

Present annual energy cost:

E= 50.38 $/kW/yr *(MAC said to be negligible)*

Equivalent annual energy cost:

EAE= 1.0096
E'= 50.87 $/kW/yr

Difference in WHP between adjacent pipe sizes:

Sizes	delta WHP
(inches)	kW/100 ft
6 and 8	0.10515
8 and 10	0.13109
10 and 12	0.12923
12 and 14	0.10950
14 and 16	0.21691
16 and 18	0.25567

Difference in J between adjacent pipe sizes:

Sizes	delta J
(inches)	m/100 m
6 and 8	0.16756
8 and 10	0.20889
10 and 12	0.20593
12 and 14	0.17449
14 and 16	0.34566
16 and 18	0.40743

(note: m/100 m is equivalent to ft/100 ft)
(however, must use 102 for lps or 3,960 for gpm)

Threshold flow rate between adjacent pipe sizes:

Sizes	Section flow rate	
(inches)	lps	gpm
6 and 8	11.2	177.4
8 and 10	27.4	434.3
10 and 12	53.8	852.8
12 and 14	99.1	1,570.0
14 and 16	160.0	2,535.6
16 and 18	260.9	4,134.8

(note: Hazen-Williams equation)