1 cfs = 448.83 gpm

Name: _____

CVEN 458 – Hydraulic Engineering of WDS
Spring Semester 2011
Dr. Kelly Brumbelow, Texas A&M University

Exam #2

Open-book, Open-notes (8 pages, 3 questions); Time allowed: 75 minutes

1. Due to an unplanned earthquake, a lakeside nuclear reactor has experienced a failure of its cooling system. The reactor operator is desperately working to cool the reactor and is investigating the possibility of pumping lake water up to the containment vessel's coolant reservoir. This would be an improvised system assembled from an assortment of immediately available equipment.

The available components include the following:

- Six W.M. McDonald Model 7624 pumps, size 8x6-8, 7.5 inch impellor (technical data attached)
- Four W.M. McDonald Model 7612 pumps, size 6x4-4, 3.75 inch impellor (technical data attached)
- Ten electric motors (1800 rpm) already mechanically linked to the respective pumps listed above; each motor can be assumed to operate at 75% motor efficiency; each motor can be assumed to provide adequate power for its respective pump
- Four diesel-powered electric generators; motors may be wired to a small electric power distribution grid powered in common by the four generators; the generators may be assumed to operate at 65% efficiency; the energy content of one gallon of diesel fuel is 1.4652×10^8 Joules.
- Flexible pipes are indicated in the diagrams on the next page.

A preliminary design has been put together by an onsite operator and is diagrammed on the next page. You have been asked to evaluate the design and make any needed changes.

Answer the following questions:

(a) What will be the total flowrate of lake water that would be delivered to the coolant reservoir by the current design?

(b) What will be the daily consumption of diesel fuel by this design?

(c) Are there any needed changes in the design for reasons of equipment safety?

(50 points)

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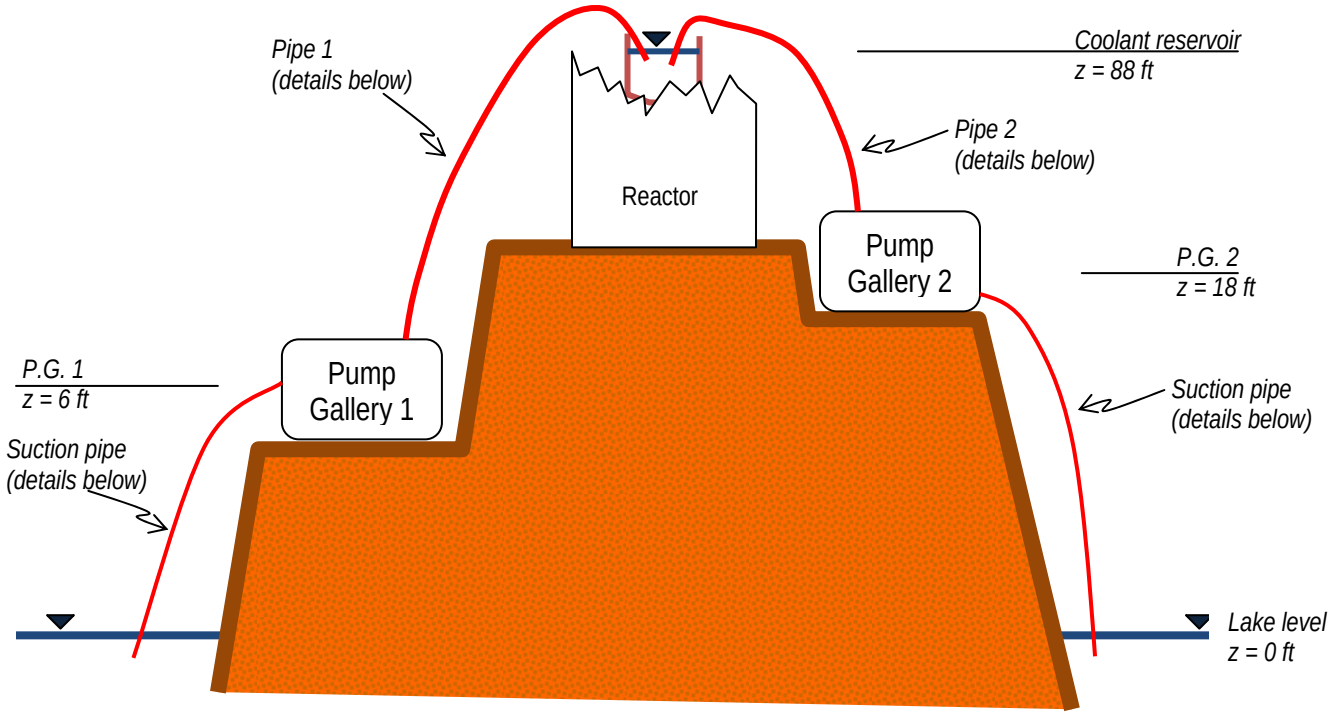
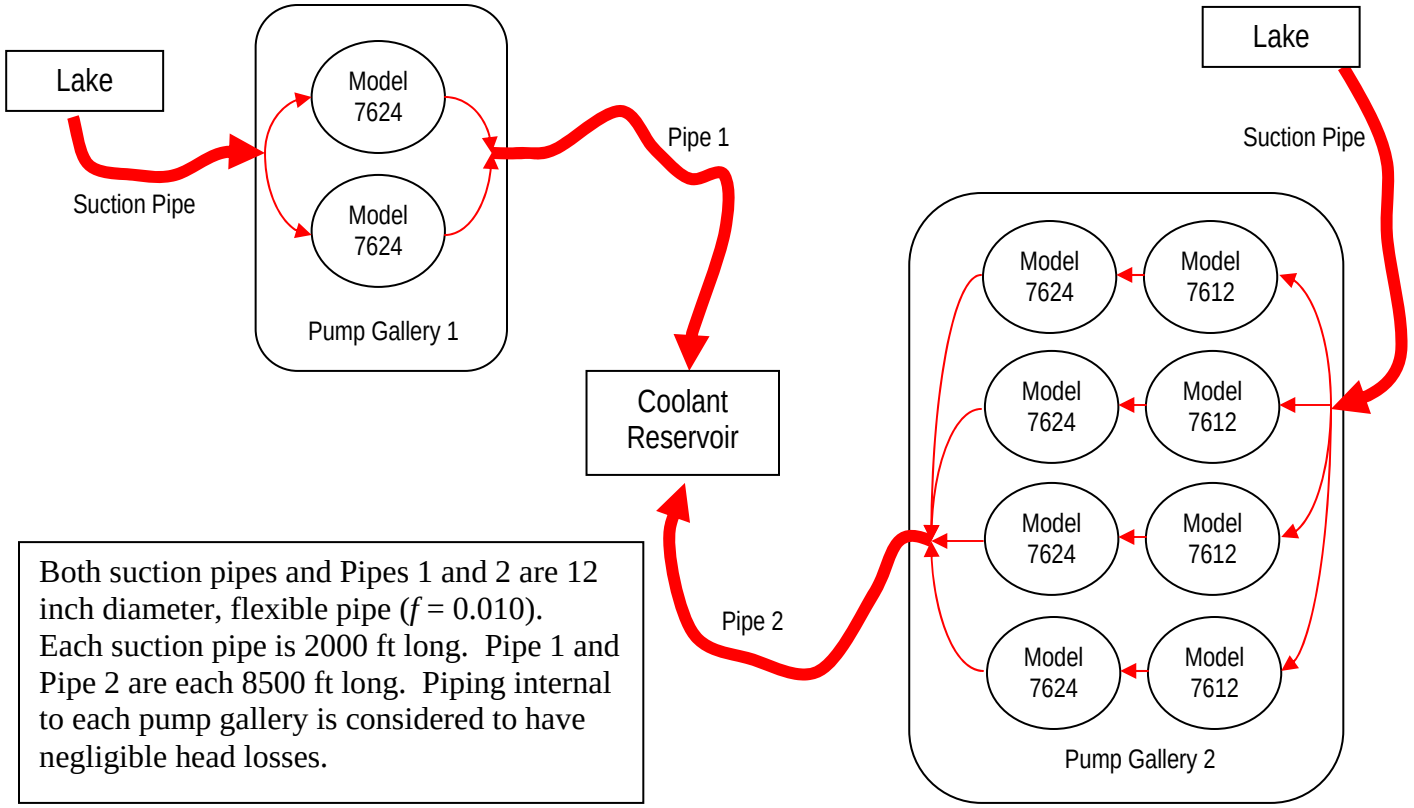
Schematic elevation diagram (not to scale)

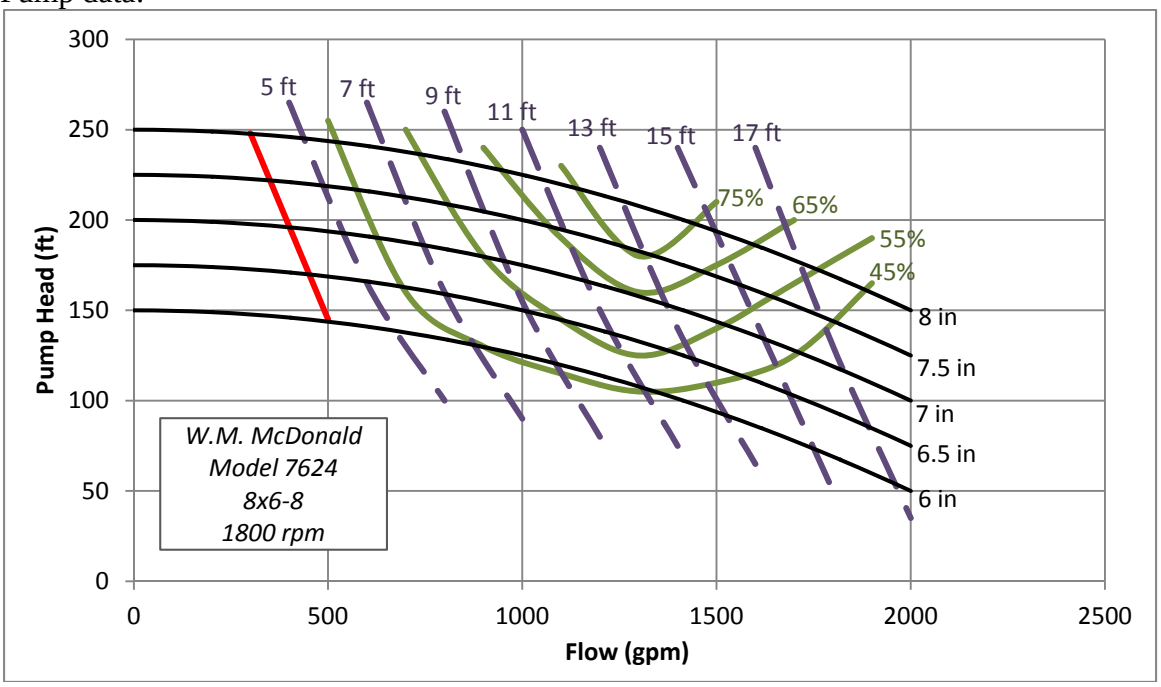


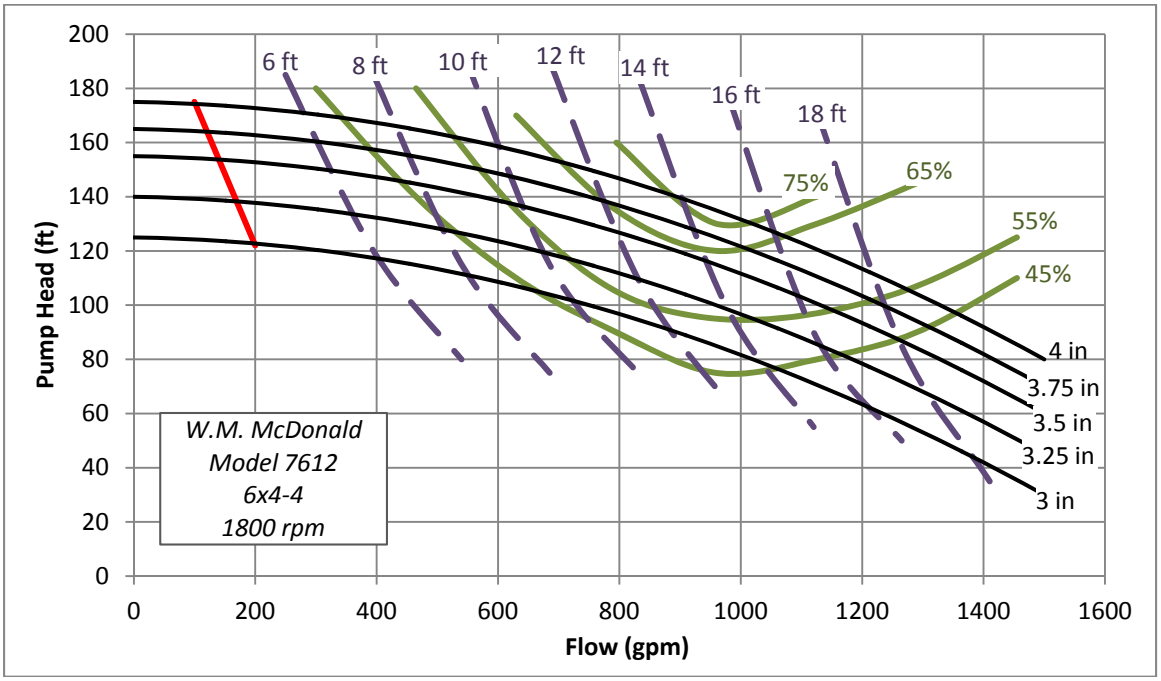
Schematic plan diagram (not to scale)



Both suction pipes and Pipes 1 and 2 are 12 inch diameter, flexible pipe (f = 0.010). Each suction pipe is 2000 ft long. Pipe 1 and Pipe 2 are each 8500 ft long. Piping internal to each pump gallery is considered to have negligible head losses.

Pump data:


Pump Head (ft)
Flow (gpm)
5 ft
7 ft
9 ft
11 ft
13 ft
15 ft
17 ft
75%
65%
55%
45%
8 in
7.5 in
7 in
6.5 in
6 in
W.M. McDonald
Model 7624
8x6-8
1800 rpm


Pump Head (ft)
Flow (gpm)
6 ft
8 ft
10 ft
12 ft
14 ft
16 ft
18 ft
75%
65%
55%
45%
4 in
3.75 in
3.5 in
3.25 in
3 in
W.M. McDonald
Model 7612
6x4-4
1800 rpm

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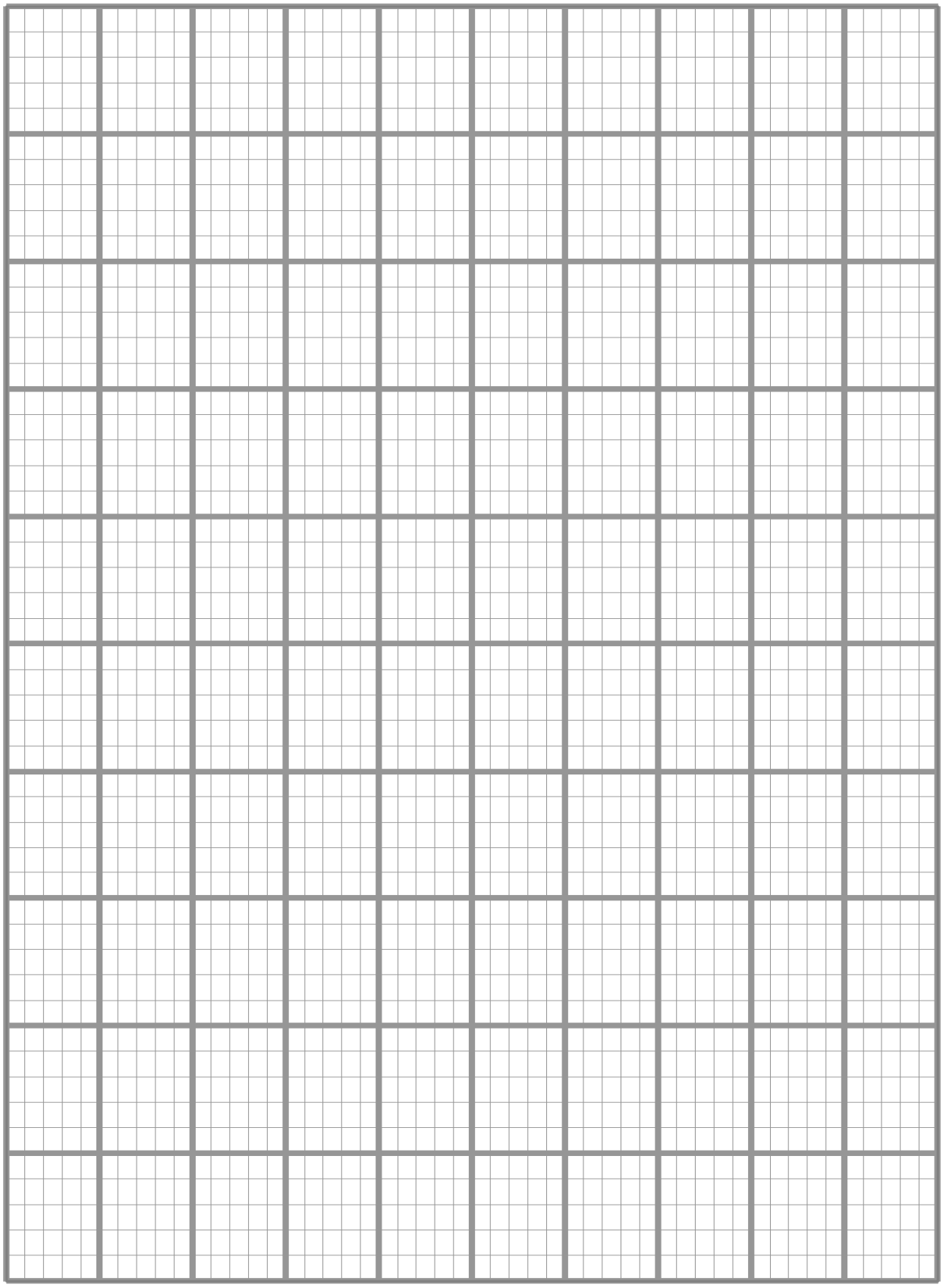

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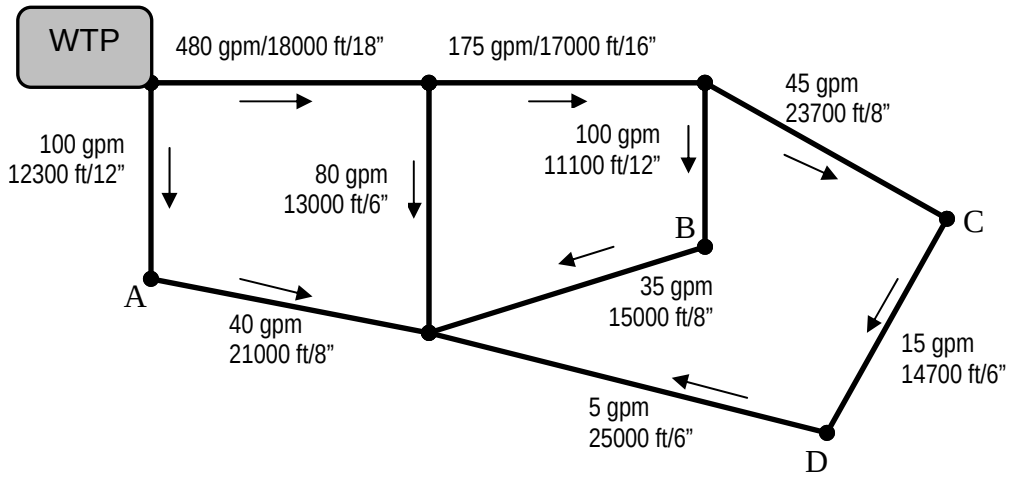
{Work space for #1}

2. Grab samples have been taken from a water distribution system as shown in the sketch below and tested for chlorine residual concentration. Treated water leaves the water treatment plant with dissolved chlorine concentration of 1.2 mg/L, and it is assumed that chlorine residual decay follows first-order kinetics. Answer the following questions:

(a) What is a best estimate of the combined decay coefficient according to the data obtained?
(b) What factors might explain deviation of sample chlorine concentrations from the theoretical first-order kinetics model?
(c) Are there any significant issues with the measured chlorine concentrations?

Graph paper is attached. Logarithms are useful. (30 points)

Sample	Chlorine concentration (mg/L)
A	0.76
B	0.28
C	0.18
D	0.06



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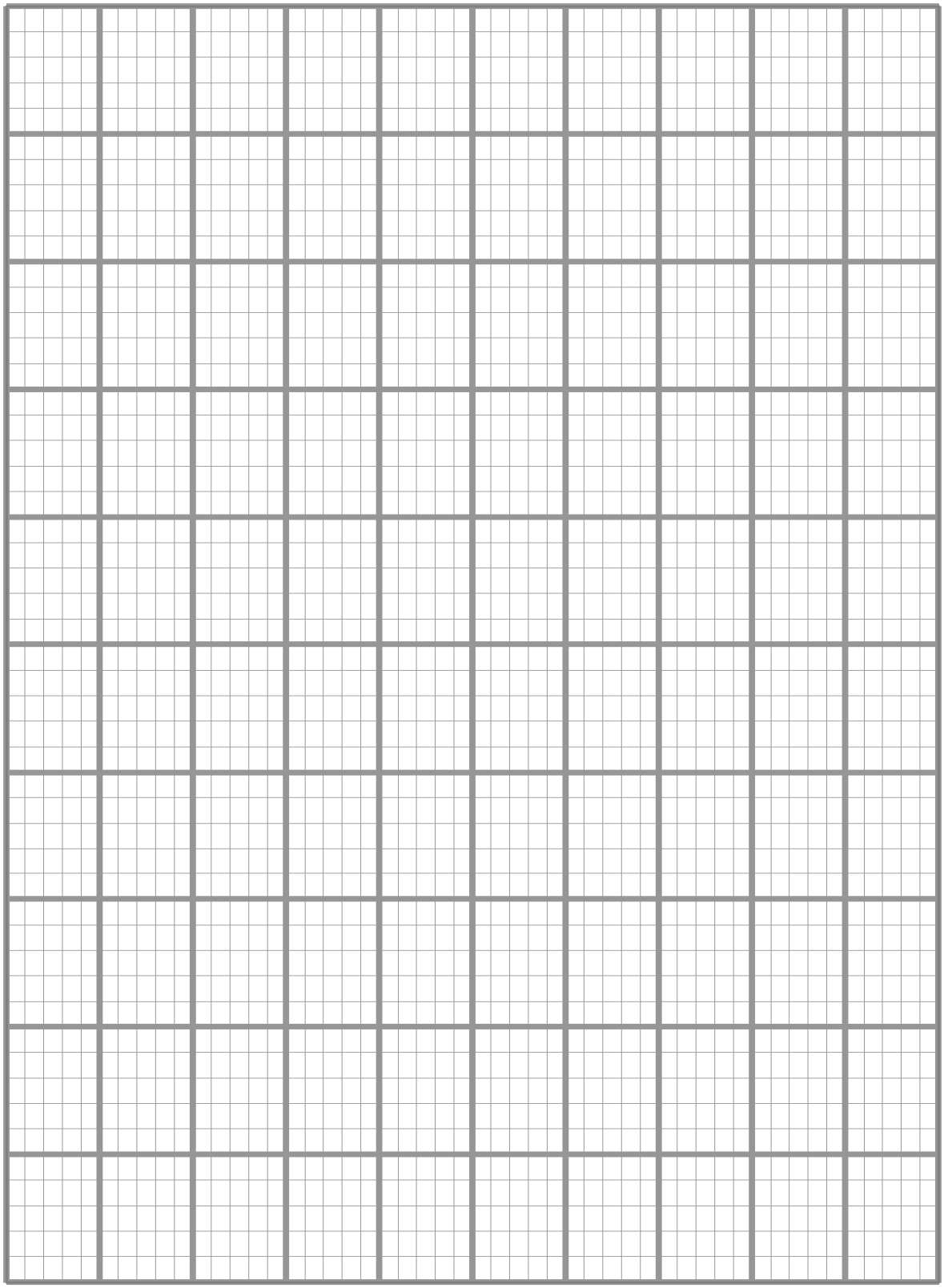

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3. You are working on the design of a small water transmission pipeline. The pipeline will be 8 inch diameter schedule 40 PVC, 5000 ft long, and will be used to transfer water from one reservoir to another that is 75 feet above it. A single W.E. McDonald Model 7624 pump (8x6-8, 8 inch impeller) will be located at the lower reservoir and will discharge to the pipeline (see page 3 for technical data). Your boss has asked you to determine if water hammer issues need to be addressed in the design, specifically whether a "soft-start" will be needed when the pump is powered on. The critical location appears to be immediately after the pump discharge where the pipe elevation is equal to that of the starting reservoir. Given the technical data below and assuming that the pump could reach 100% speed within one characteristic time of the pipeline, *does it appear that water hammer could be a problem for this pipeline?* (20 points)

8 inch nominal diameter schedule 40 dimensions: Inner diameter = 7.98 in; Wall thickness = 0.32 in

Assume $f = 0.014$

Max pressure rating of the pipe = 150 psi