Name: ____

CVEN 339 – Water Resources Engineering
Summer Semester 2010
Dr. Kelly Brumbelow, Texas A&M University

Exam #1

<u>Open-book, Open-notes (8 pages, 3 questions); Time allowed: 120 minutes</u>

1. Kolachebahn, the new family water park in Caldwell, Texas, will build the SolarBlast (the world's first solar powered waterslide) next year. The conceptual design is sketched on the next page. The recirculation pump will be powered by a solar panel, capable of supplying 25 kW of power during sunlight hours. So that the ride can continue to operate during non-sunlight hours, the recirculation system will also fill a storage tank at the top of the ride; when the pump receives no solar power, stored water will flow out of the tank to flow down the slide.

On the next page is the manufacturer supplied characteristic curve for the recirculation pump. Also given are technical specifications on other components of the design, and notes on assumptions you should make.

The storage tank at the top of the slide has been equipped with a float switch that will cut power to the recirculation pump when the water level reaches elevation 50 feet, and it will restore power when the water level reaches elevation 43 feet. The intent is for the pump to "cycle" on and off filling the tank and then letting it drain to conserve energy. Of course, this scheme might not work if the tank fills too fast or too slow before the pump is shut off or if it drains too fast when the pump is re-started.

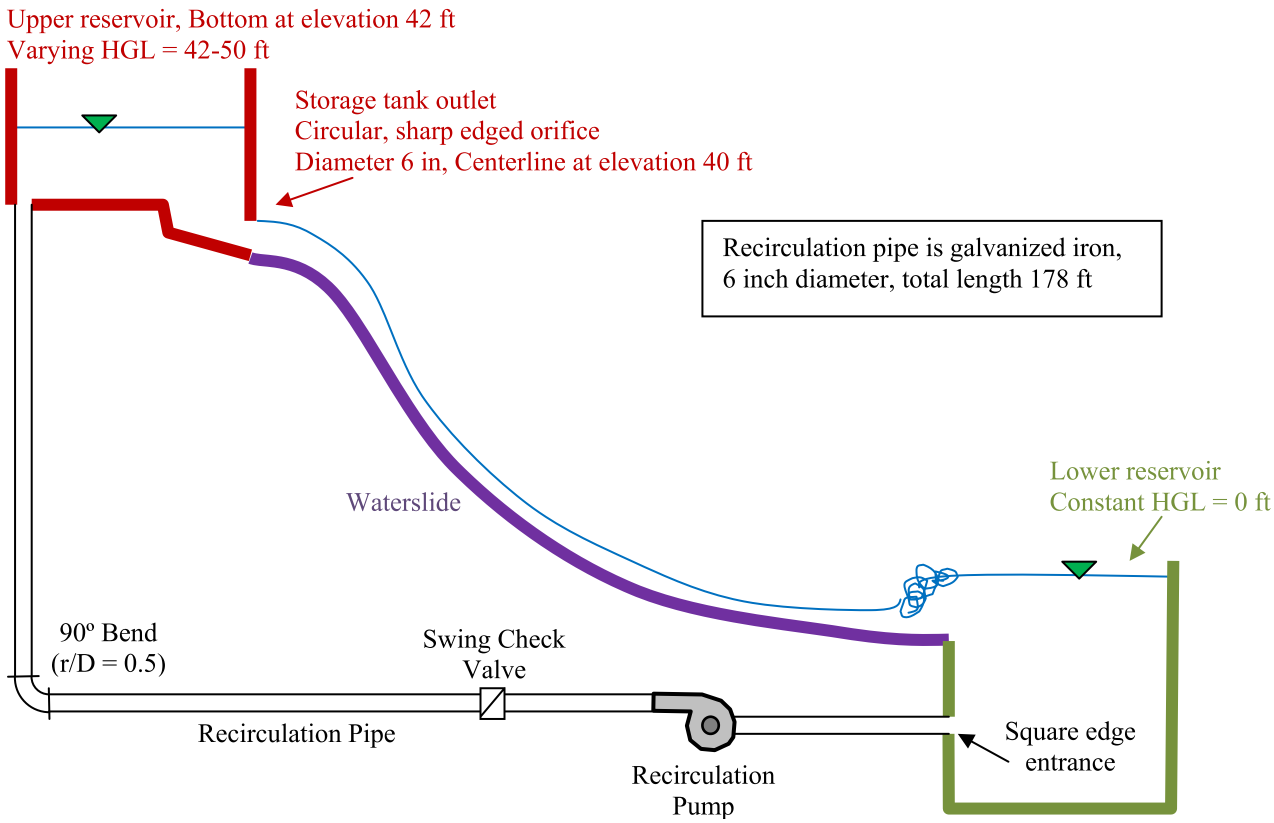
(a) At the beginning of the day when the storage tank is empty, verify that the tank will begin to fill when the pump is first started and that there will be at least 1.1 cfs of flow down the waterslide.

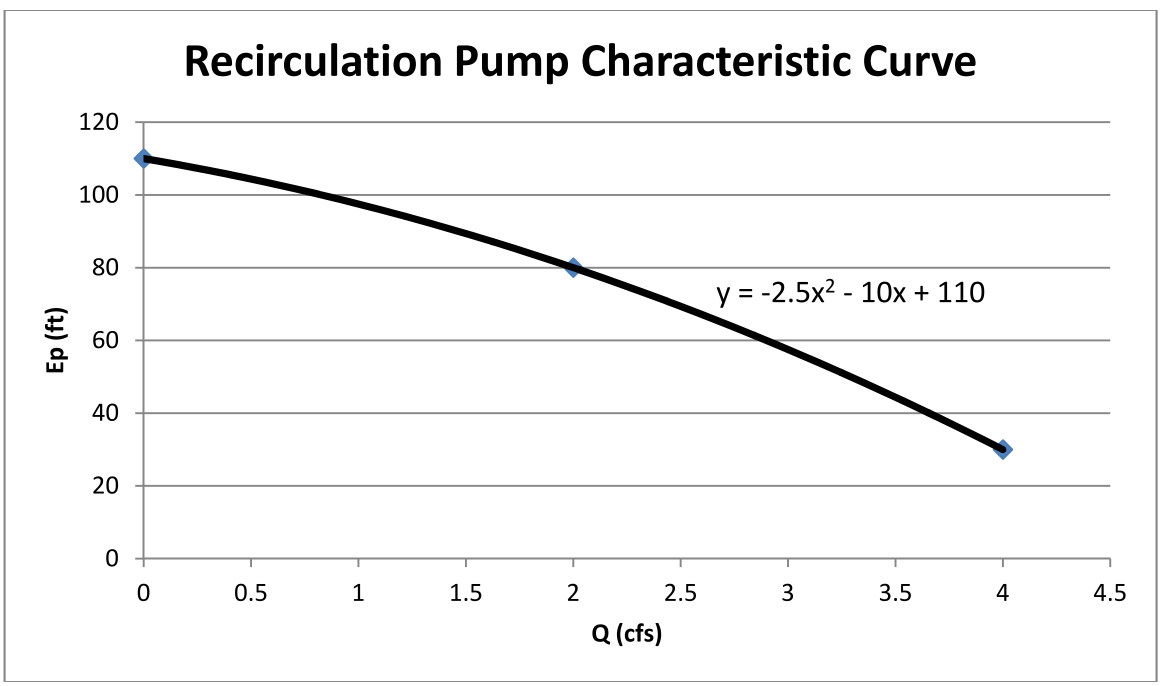
(b) Determine whether the storage tank level will actually reach the 50 ft elevation where the float switch will turn off the pump. If not, what will be the approximate elevation that the water surface will reach (nearest 0.5 to 1.0 ft)?

(c) Once the float switch has turned off the pump, verify that the tank will begin to re-fill if the float switch re-starts the pump at tank level 43 ft.

A sheet of graph paper is attached that may be very useful for your work on this problem.

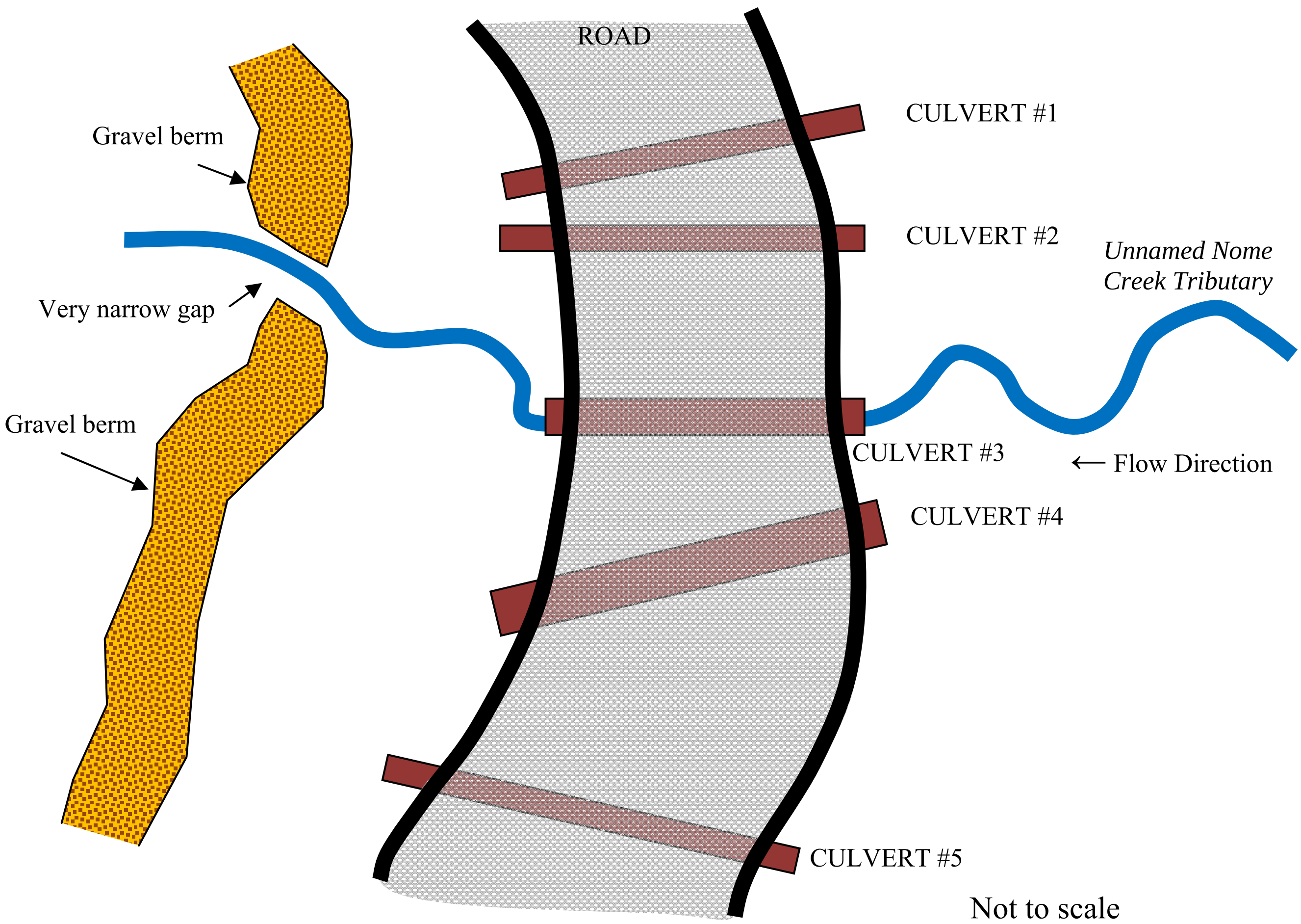
(35 points)


Upper reservoir, Bottom at elevation 42 ft
Varying HGL = 42-50 ft
Storage tank outlet
Circular, sharp edged orifice
Diameter 6 in, Centerline at elevation 40 ft
Recirculation pipe is galvanized iron,
6 inch diameter, total length 178 ft
Waterslide
Lower reservoir
Constant HGL = 0 ft
90º Bend
(r/D = 0.5)
Swing Check
Valve
Recirculation Pipe
Recirculation
Pump
Square edge
entrance


Recirculation Pump Characteristic Curve
120
100
80
60
40
20
0
Ep (ft)
y = -2.5x² - 10x + 110
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
Q (cfs)

(Work space for #1)

2. A road crosses a creek that has had 5 different culverts installed at various times as sketched in plan view below. Based upon the information given, *what is the highest flowrate (cfs) for "Unnamed Nome Creek Tributary" that can be accommodated by the culverts without overtopping of the roadway?* (35 points)



P L A N

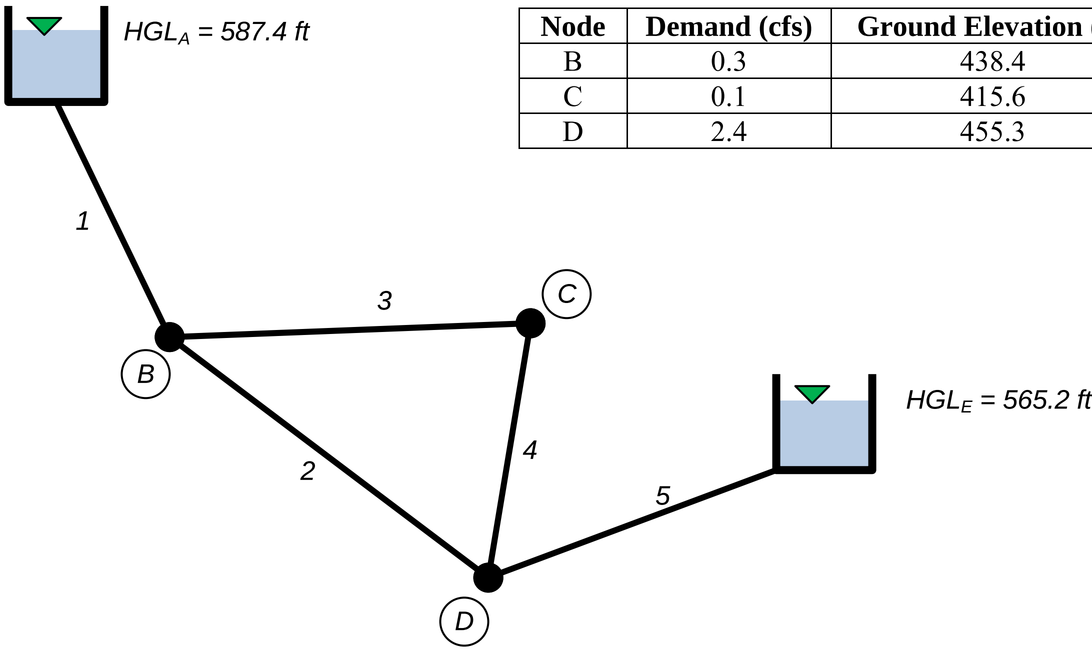
All culverts are circular corrugated metal pipe (Manning's $n = 0.025$)

Culvert	Diameter (in)	Length (ft)	Inlet Invert Elevation (ft)	Outlet Invert Elevation (ft)	Roadway Crest Elevation above Culvert (ft)
#1	24	98.6	759.3	758.3	769.0
#2	24	102.5	757.2	752.1	767.1
#3	48	65.2	750.6	748.3	762.1
#4	60	112.6	751.2	752.2	766.6
#5	24	125.6	763.0	756.8	768.7

The gravel berm on the downstream side of the road is capable of impeding flow and creating a backwater between it and the road during high flow periods. With the exception of the narrow gap in its center, the minimum crest elevation of the berm (at which water would spill over the berm) is 758.0 ft.

(Work space for #2)

3. A simple pipe network is diagrammed below. *Solve for flow (cfs) in all pipes and pressure (psi) at all nodes.* (30 points)



Node	Demand (cfs)	Ground Elevation (ft)
B	0.3	438.4
C	0.1	415.6
D	2.4	455.3

Pipe	Length (ft)	Diameter (in)	Friction Factor, *f*
1	1500	12	0.016
2	2000	6	0.019
3	500	10	0.017
4	2000	6	0.019
5	1500	12	0.016

GIVEN: The correct flow magnitude and direction for pipe 1 is 2.01 cfs from A to B.

(Work space for #3)