CE 98: Engineers Without Borders Homework 2

1. **Water Source Options: Pros and Cons**
   Write down 3 key 'pros' and 3 key 'cons' for at least 3 of the following 7 water sources: Rainwater, Springs, Infiltrations Wells/Galleries, Surface Water, Well (Drilled, Deep), Well (Hand dug, shallow), Surface Water. I do not expect complete sentences.

2. **Sheepville: Part 1**
   Welcome to Sheepville! It is a lovely little town located on an island in the middle of the ocean with, you guessed it, lots of sheep. The town of Sheepville is currently woefully undersupplied with water, and currently gets most of their water from a well that has greatly decreased in capacity in recent years. They are interested in setting up a new water system, with only point sources (no distribution network), to satisfy the town. Before choosing sources, they need to determine the demand. They hope to have the system last for at least 25 years (from 2015).
   a. Here is the census data for the town. Estimate the population serviced by the system by the end of its desired lifetime. Justify.

Year	**1995**	**2000**	**2005**	**2010**	**2015**
Population	700	730	768	805	835

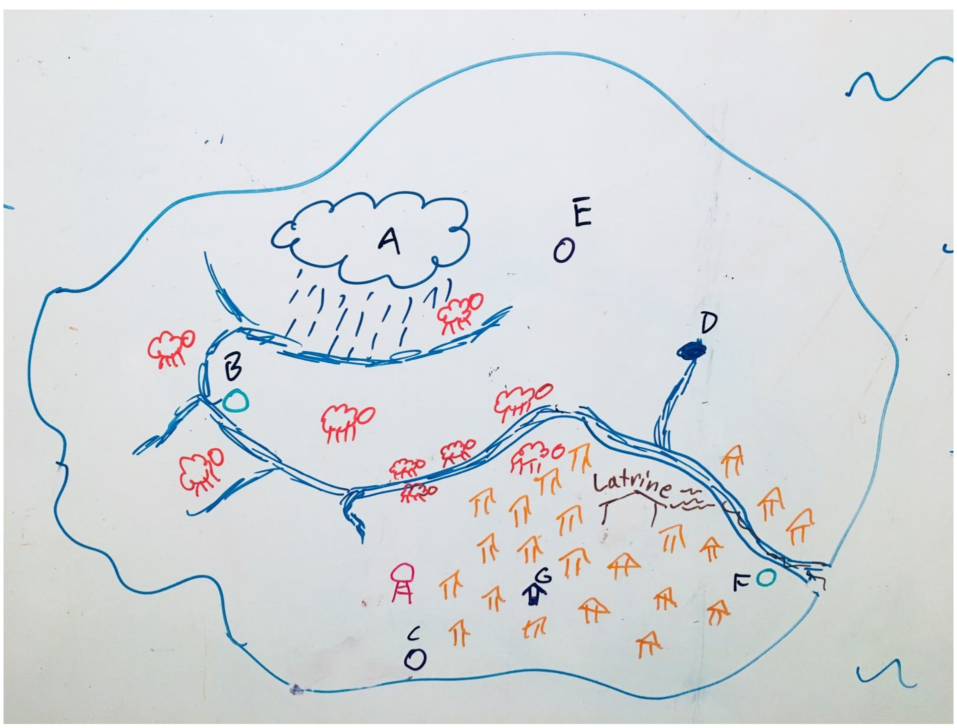
   b. After talking with the community leaders, you find out that the residents allow the sheep to drink from the river, and use their water supply for cleaning, bathing, cooking, drinking, and small community gardens. Estimate daily per capita demand (L/day/person)

   c. Calculate the flow of water (L/d) that you want your system to be capable of supplying for the residents of Sheepville.

3. **Sheepville: Part 2**
After your analysis for demand, a new engineer comes in with some new data for water usage and population growth in the community, and the water you want your system to provide is changed to 50,000 L/d for the community. The current community well provides 20,000 L/d. Community leaders have identified 7 possible sources of new water, none of which can meet the demand on their own. Assume that basic water storage is available in the community, and the community possesses no means of moving heavy equipment onto the island.

Using the information from the table and map below, pick which water sources you will use to meet the community demand. For each water source (those you picked and those you did not) briefly (1-2 sentences) explain why you decided to include/exclude it from the mix.

Source	Source Type	Capacity (L/d)
A	Rainwater	5,000 (dry szn) 10,000 (wet szn)
B	River Water	100,000
C	Shallow, Hand Dug Well	12,000
D	Spring	5,000
E	Shallow, Hand Dug Well	10,000
F	Infiltration Gallery	20,000
G	Rehab old well (chemical)	10,000



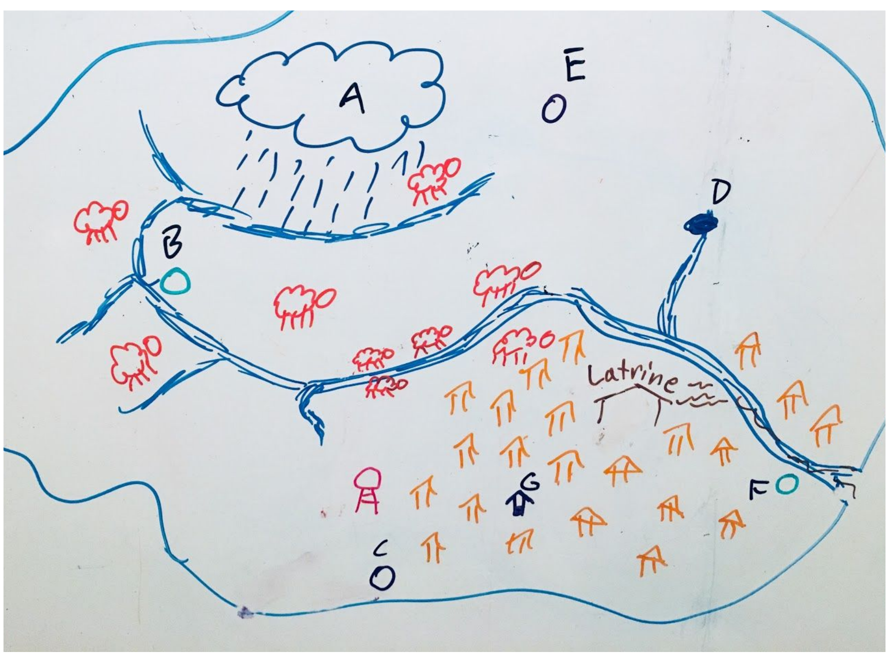
CE 98: Engineers Without Borders Homework 3

1. **Sheepville Water Testing:**

Let us return to our wonderful sheepville case study. Due to the previous evaluation of our sources, our team has decided to ignore the possibility of utilizing source B (plain river water). We decided that we should undertake further testing of the water quality of each source before making any further decisions. For each water source, except source B, make a list of what parameters should be tested. Briefly Justify as necessary. A range of answers will be accepted with proper justification. List any assumptions made. A list of key parameters is included for your convenience.

Table 5.1: Water Quality Parameters to be Tested		
High Priority (critical) Parameters:		
1. Microbiological : (Total Coliform, Fecal Coliform) 2. Arsenic 3. Cadmium 4. Lead 5. Nitrate	6. Benzene 7. Color 8. Turbidity 9. Iron 10. pH	11. Manganese 12. Chloride 13. Sulfate 14.Total Dissolved Solids (TDS)
Other Parameters:		
1.Temperature 2. Biological Oxygen Demand 3. Ammonia as NH_3-N	4.Total Hardness 5. Chromium 6. Sulfide	7. Dissolved Silica 8. Total Mercury 9. Pesticides

To remind you of the specifics of each source: Source A is rainwater. Assume that it is collected from the metal roofs of community centers, houses, schools, etc. in the community. Source C is a shallow well near the ocean. Source D is a spring from an uphill spring source. It runs through sands before being extracted. Source E is a shallow well. Source G is simply rehabilitation of an existing functional well whose water quality can be assumed to be good. Source F is an infiltration gallery near the river. NOTE: Water is flowing in the direction from source B to source F.



2. **Sheepville Water Treatment:**
    a. After testing, including your recommendations and ones that the community leaders wished to undertake, four of the water sources are reported to have contaminants at the levels listed below. EWB has decided to follow the EPAs recommendations for water quality standards. For each contaminant, report the Maximum Contaminant Level (MCL) according the the EPA and identify if any of the sources have exceeded the MCL provided. Note: Some of the contaminants are listed as Secondary Drinking Water Standards, so you may not find them in lists only containing Primary Drinking water Standards.

	Total Coliforms (% of samples positive)	Arsenic (mg/L)	Manganese (mg/L)	Total Dissolved Solids (mg/L)	Nitrates (mg/L)
Source 1	0%	.1	.2	230	5
Source 2	0%	.002	.4	50	1
Source 3	50%	0	.02	720	7
Source 4	2%	N/A	N/A	300	.1

    b. Recommend the treatment method(s), from those listed in the slides, for each source in 2a. If treatment requires advanced chemical/filtering treatment, specifics are unnecessary. Justify choice.

CE 98: Engineers Without Borders Homework 4

1. Sheepville Spring Water
   The community of Sheepville needs our assistance once again. After identifying, among others, the Spring water as a viable source for some of the community's water supply, they are ready to build a storage and basic distribution system that will connect the spring water to a community tap located near a community center and the school.
   a. First they need to size the tank. The estimated maximum flow rate from the spring is .07 Lps, and the average daily demand from the tap stand is 2000 L/d

   b. We now want to determine tapstand location. How should we decide where to place the tapstand and what factors should we consider?

   c. Now we need to determine a pipe diameter for distribution pipe to the tapstand. Assume the storage tank is located on a hill, and that when the tank is nearly empty the water surface is 15 m above the tapstand. The distance from the tank to the desired tapstand location is 325m . Along the route to the tapstand, 3 90^o elbows will be needed. The tapstand faucet has a diameter of 13mm and we would like the flow at the faucet to be .1 Lps. Given that you are using PVC pipe, is it possible to have a minimum residual pressure of 3m at the faucet without installing a pump? What diameter of pipe achieves this or gives us the largest residual pressure? *Hint: utilize tables on the last page of the homework and see the book (RWS vol1 Chapter 11) for examples.*

   d. If we used GI pipe instead of PVC for part c, would we have better residual pressures?

2. Sheepville Distribution System
   Sheepville is considering implementing a full scale house to house distribution system. They are obviously primarily concerned with the cost and feasibility, and as such would like you to do a feasibility study by designing a system and running it through EPANET or similar modeling software
   a. The community would like to understand the major differences between a looped and branched distribution system. Lay out the pros and cons of each type of system

   b. You plan on simulating the system assuming the demand is the average daily demand. What additional demand profiles should you simulate the system under?

   c. Upon simulating the system, you find pressures in parts of the pipe reach a low of only 1m. Why is this unacceptable?

(Tables from RWS Chapter 11)

Table 11.1: Friction Head Loss in meters per 100 meters in Plastic Pipe

Q Lps	Pipe Sizes (mm)									
	13	19	25	31	38	50	63	75	100	150
.01	0.1									
.02	0.4									
.03	0.8	0.11								
.o4	1.4	0.19								
.05	2.1	0.20								
.06	3.0	0.41	0.10							
.07	4.0	0.50	0.13							
.08	5.0	0.65	0.17							
.09	6.3	0.82	0.22							
.10	7.0	1.06	0.26							
.11	9.1	1.18	0.31	0.11						
.12	10.7	1.50	0.36	0.13						
.14		2.00	0.48	0.17						
.15		2.10	0.55	0.18						
.16		2.50	0.62	0.22						
.18		3.10	0.77	0.27	0.101					
.20		3.80	0.94	0.32	0.131					
.25		5.80	1.42	0.48	0.20					
.30			2.00	0.67	0.23					
.40			3.40	1.15	0.47	0.12				
.50			5.10	1.74	0.71	0.18				
.60			7.20	2.40	1.00	0.25				
.70				3.20	1.33	0.33	0.11			
.80				4.10	1.70	0.42	0.14			
1.00				6.30	2.60	0.64	0.21	0.069		
1.20				8.80	3.60	0.89	0.30	0.124		
1.40					4.40	1.20	0.40	0.165		
1.50					4.90	1.35	0.44	0.187		
1.60					5.50	1.52	0.51	0.211		
1.80					7.35	1.80	0.64	0.262		
2.00					8.40	2.30	0.77	0.32	0.079	
2.50						3.50	1.20	0.48	0.119	
3.00						4.95	1.65	0.68	0.166	
3.50						6.95	2.19	0.90	0.221	
4.00						9.20	3.00	1.15	0.184	
4.50						11.85	3.60	1.43	0.353	
5.00							4.50	1.74	0.429	0.06
6.00							6.20	2.44	0.60	0.09
7.00							8.60	3.20	0.80	0.11
8.00								4.15	1.20	0.14
10.00								6.50	1.55	0.21

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Table 11.2: Friction Head Loss in meters per 100 meters Galvanized Iron (GI) Pipes

Q	Pipe Sizes (mm)									
Lps	13	19	25	31	38	50	63	75	100	150
.06	6.00	0.82	0.20							
.07	8.00	1.00	0.26							
.08	10.00	1.30	0.34							
.09	12.60	1.64	0.44	0.15						
.10	15.20	2.12	0.52	0.18						
.11	18.20	2.36	0.62	0.22						
.12	21.40	3.00	0.72	0.26						
.14		4.00	0.96	0.34	0.13					
.15		4.20	1.10	0.36	0.15					
.16		5.00	1.24	0.44	0.16					
.18		6.20	1.54	0.54	0.202					
.20		7.60	1.88	0.64	0.262	0.70				
.25		11.60	2.84	0.96	0.400	0.10				
.30			4.00	1.34	0.46	0.14				
.40			6.80	2.30	0.94	0.24				
.50			10.20	3.48	1.42	0.36	0.12			
.60			14.40	4.80	2.00	0.50	0.17	0.70		
.70				6.40	2.66	0.66	0.22	0.91		
.80				8.20	3.40	0.84	0.28	0.117		
1.00				12.60	5.20	1.28	0.42	0.177		
1.20				17.60	7.20	1.78	0.60	0.248		
1.40					8.80	2.40	0.80	0.330		
1.50					9.80	2.70	0.88	0.374		
1.60					11.00	3.04	1.02	0.422	0.104	
1.80					14.70	3.76	1.28	0.524	0.129	
2.00					16.80	4.60	1.54	0.640	0.157	
2.50						7.00	2.40	0.96	0.238	
3.00						9.90	3.30	1.36	0.332	
3.50						13.90	4.38	1.80	0.442	
4.00						18.40	6.00	2.30	0.368	
4.50						23.70	7.20	2.86	0.706	
5.00							9.00	3.48	0.858	0.12
6.00							12.40	4.88	1.200	0.17
7.00							17.20	6.40	1.60	0.22
8.00								8.30	2.40	0.20
10.00								13.00	3.10	0.42

Table 11.3: Head Loss Due to Valves and Fittings

Resistance of Valves and Fittings

Nominal Ø in mm	90° Elbow	45° Elbow	Tee	Gate Valve Fully Open	Globe Valve Fully Open	Angle Valve Fully Open	Faucet Fully Open	Foot Valve Fully Open	Strainer	Check Valve Fully Open
Equivalent Length Straight Pipe (meters)										
13	0.55	0.24	1.04	0.11	4.88	2.56	4.88	1.22	3.05	1.16
19	0.69	0.30	1.37	0.14	6.40	3.66	6.40	1.52	3.66	1.58
25	0.84	0.41	1.77	0.18	8.23	4.57		1.83	4.27	1.98
32	1.14	0.52	2.29	0.24	11.28	5.49		2.13	4.88	2.74
38	1.36	0.61	2.74	0.29	13.71	6.71		2.44	5.49	3.35
50	1.62	0.76	3.66	0.38	16.76	8.54		2.74	6.10	4.27
63	1.98	0.91	4.27	0.43	19.81	10.06		3.05	6.71	5.18
75	2.50	1.16	4.88	0.53	25.90	12.80		3.66	7.62	5.79
100	3.35	1.52	6.71	0.70	33.54	12.80		4.57	9.15	7.62
150	5.03	2.04	9.76	1.01	48.78	24.39		6.42	12.21	11.59

*** When the length of pipe is greater than 1,000 times its diameter, the loss of head due to valves and fittings maybe disregarded.**

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