Water For Trujillo: Designing a Sustainable Drinking Water System for Trujillo, Honduras

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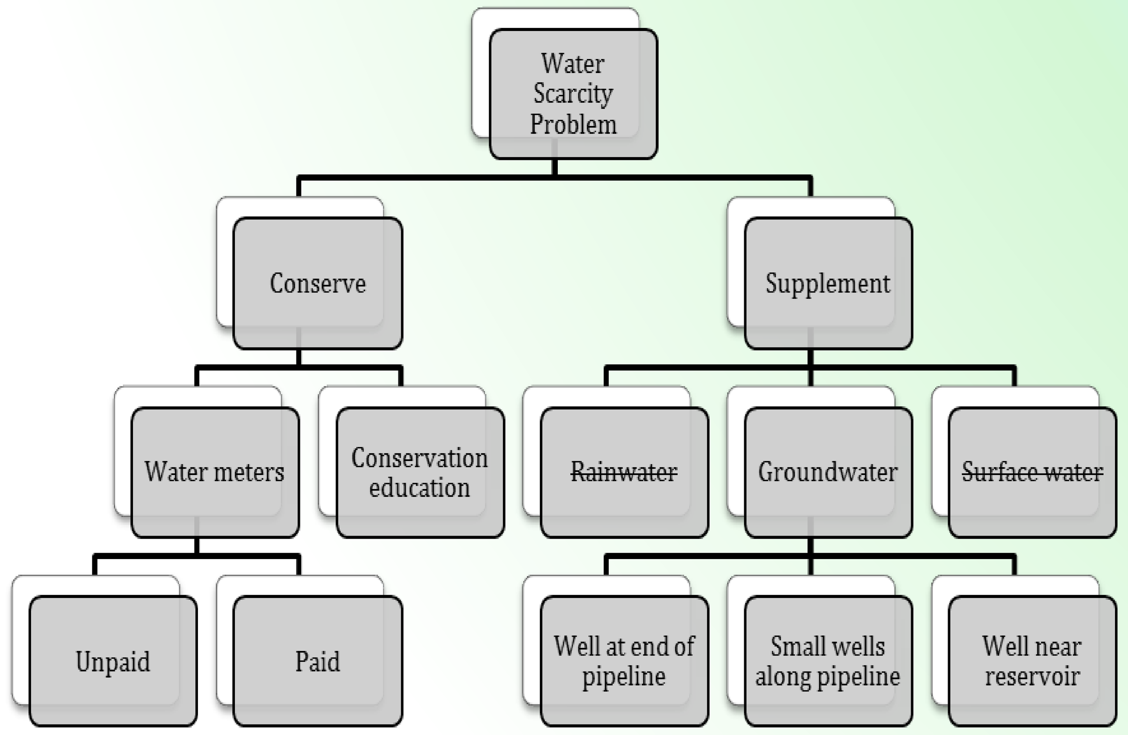
THE PROBLEM

Trujillo, Honduras is a city on the northern coast of Honduras. The main water source for the eastern half of the city is a river, the Rio Negro. This river was dammed to created a reservoir. From this reservoir is a distribution pipeline that travels a total of 12 miles. Unfortunately, Honduras is prone to having dry and wet seasons throughout the year that can cause water shortages. In recent years, these shortages have been causing the amount of water supplied from the distribution pipe to be inadequate. Overall, the system is insufficient for the number of people who depend on it and must be supplemented to become a sustainable one.

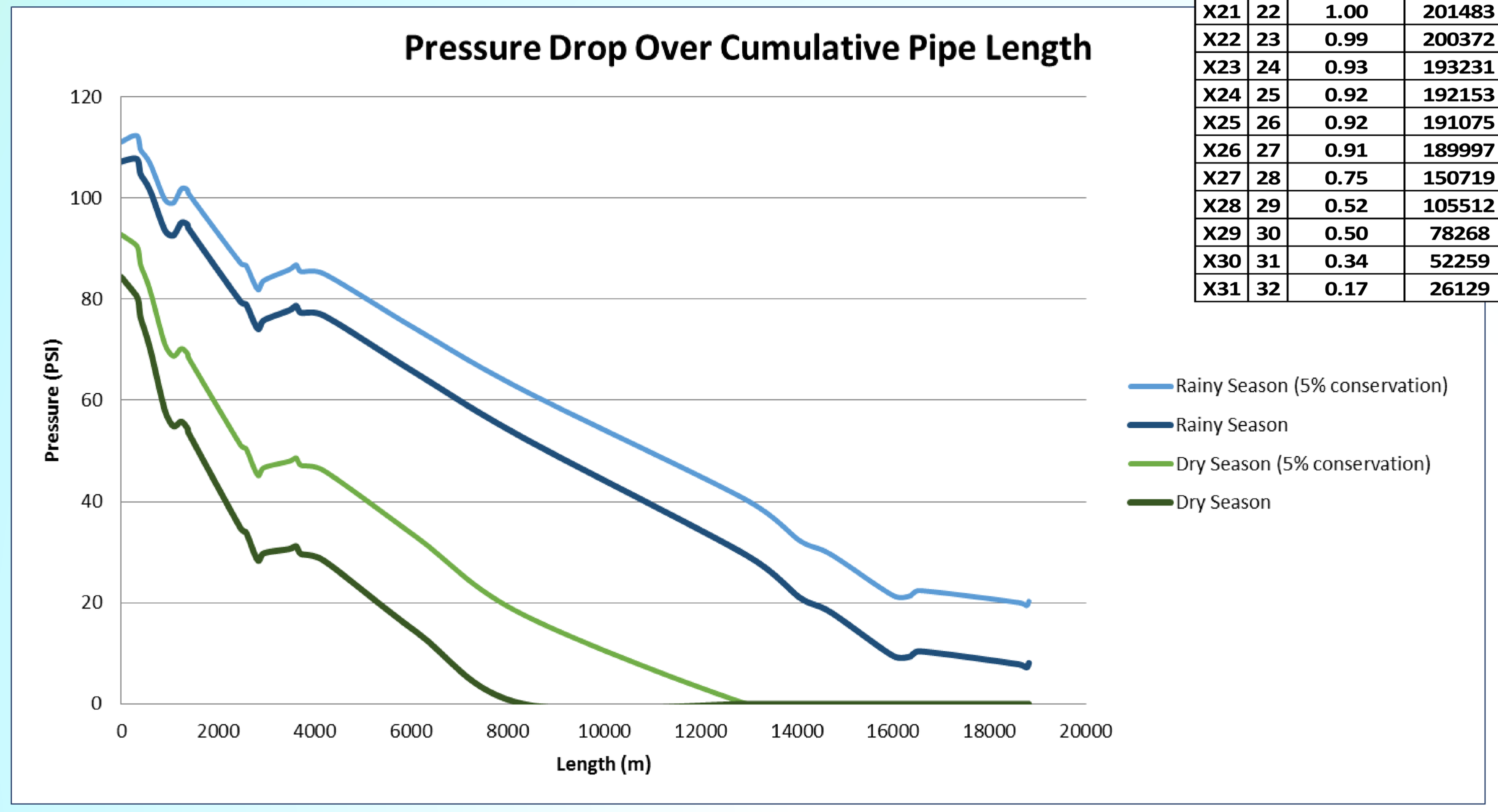
THE PROJECT

This problem was brought to our attention by a American connection with a residence in Trujillo, Richard Machen. Our team, a group of seniors in the College of Engineering, began to look at different alternatives to provide water to either the pipeline or the people directly. An excel model was created of the distribution pipe to measure the pressure along the pipeline and evaluate possible solutions. The flow chart below shows some of the team's thoughts as we went through the design process.



The table to the right shows the model of the distribution pipeline as it travels along the coast. The flow rate was determined by the estimated usage per person per day. This flow rate along with elevation measurements, length measurements, and pipe details allow us to calculate pressure along the pipeline. There is great uncertainty in the usage/population data. Further field data is needed to sufficiently fix the water problem.

		CALC	CALC	INPUT					CALC	INPUT	OUTPUT	CALC
		Velocity (v) in m/s	Reynolds # (R)	Pipe Details	Pipe Size	roughness (ε) in mm	ID (D) in	Pipe Length (L)	Friction (F)	Elevation (z) in ft	Pressure (P) in psig	Q(pipe) m^3/s
X00	0	0.00	0	Cast Iron	12	0.26	0	0	0.00	496	0.0	0.000
X0	1	1.28	398657	Cast Iron	12	0.26	12.24	12	0.05	475	8.5	0.098
X1	2	2.84	592900	Cast Iron	8	0.26	8.23	1117	54.77	100	92.8	0.098
X2	3	3.02	611398	PVC	8	0.046	7.981	243	8.40	76	91.2	0.098
X3	4	3.02	611398	PVC	8	0.046	7.981	98	2.91	69	90.2	0.098
X4	5	2.78	579155	Cast Iron	8	0.26	8.23	39	1.56	69	88.0	0.095
X5	6	2.71	565411	Cast Iron	8	0.26	8.23	28	1.05	69	86.5	0.093
X6	7	2.64	551666	Cast Iron	8	0.26	8.23	187	6.72	58	81.8	0.091
X7	8	2.58	537922	Cast Iron	8	0.26	8.23	311	10.63	48	71.0	0.088
X8	9	2.38	496060	Cast Iron	8	0.26	8.23	172	5.01	37	68.8	0.082
X9	10	2.18	454197	Cast Iron	8	0.26	8.23	159	3.90	21	70.2	0.075
X10	11	1.98	412335	Cast Iron	8	0.26	8.23	94	1.90	16	69.7	0.068
X11	12	1.78	370473	Cast Iron	8	0.26	8.23	47	0.77	15	69.1	0.061
X12	13	1.58	328610	Cast Iron	8	0.26	8.23	19	0.25	16	68.4	0.054
X13	14	1.37	286748	Cast Iron	8	0.26	8.23	1078	10.66	21	51.2	0.047
X14	15	1.17	244796	Cast Iron	8	0.26	8.23	112	0.81	20	50.5	0.040
X15	16	1.11	232489	Cast Iron	8	0.26	8.23	241	1.58	27	45.2	0.038
X16	17	1.06	220181	Cast Iron	8	0.26	8.23	131	0.77	21	46.7	0.036
X17	18	1.00	207784	Cast Iron	8	0.26	8.23	529	2.78	9	48.0	0.034
X18	19	0.94	195387	Cast Iron	8	0.26	8.23	138	0.75	5	48.6	0.032
X19	20	0.94	195387	Cast Iron	8	0.26	8.23	106	0.44	7	47.1	0.032
X20	21	1.00	201483	PVC	8	0.046	7.981	465	1.93	3	46.1	0.032
X21	22	1.00	201483	PVC	8	0.046	7.981	1924	6.84	11	33.0	0.032
X22	23	0.99	200372	PVC	8	0.046	7.981	2214	10.20	13	17.6	0.032
X23	24	0.93	193231	Cast Iron	8	0.26	8.23	4638	21.14	10	0.0	0.032
X24	25	0.92	192153	Cast Iron	8	0.26	8.23	1086	4.89	16	0.0	0.032
X25	26	0.92	191075	Cast Iron	8	0.26	8.23	646	2.88	15	0.0	0.031
X26	27	0.91	189997	Cast Iron	8	0.26	8.23	1297	6.70	17	0.0	0.031
X27	28	0.75	150719	PVC	8	0.046	7.981	359	0.86	15	0.0	0.024
X28	29	0.52	105512	PVC	8	0.046	7.981	191	0.24	12	0.0	0.017
X29	30	0.50	78268	PVC	6	0.046	6.14	2054	3.31	9	0.0	0.010
X30	31	0.34	52259	Cast Iron	6	0.26	6.14	163	0.15	10	0.0	0.006
X31	32	0.17	26129	Cast Iron	6	0.26	6.14	49	0.01	8	0.0	0.003



The graph to the left illustrates the possible water conservation benefits during both rainy and dry seasons. The data in this graph is from the pressure calculated by the model above.

SUSTAINABILITY

In relation to sustainability, the project has always had both natural and social systems at the fore front of the work that has been done throughout the year. A strong concern through the design process was the water rights to the pipeline and the social tension the ineffective pipeline had caused. Water trucks in the city were being used to pipe water from the river and then selling it to the people. This was difficult for the people making low incomes to purchase the water as well as take extra time to wait in line and travel to distribution centers. Overall, our system will hopefully bring some balance to the economy and social lives of all the people in Trujillo.

In addition, the natural systems were always being considered as the team went through the design process. The proposed system needed to be great at providing the water necessary, yet also not harm any of the surrounding ecosystems or habitats. Water conservation proved to be a viable option. It is both economically and environmentally feasible. A groundwater well is also being considered. Considering the water abundance in the city of Trujillo and country of Honduras, aquifer depletion is negligible.

Discussion

As we look to solve the water problem for the area, different solutions are being considered in coordination with Mr. Machen. One such option is adding water meters to the existing water taps to monitor usage and more accurately depict the flow along the pipeline and reduce usage. Another option would be to design a groundwater system, as already discussed above. Our team hopes to have something implemented from our work so that the water problem can be solved for years to come.

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