ENGR30002 FLUID MECHANICS – WRITTEN ASSIGNMENT #1

Tenganan Water Supply Project

Bukit Kauh requires a daily volume of 40kL of water per day to sustain its residents. Three potential water sources were identified and are illustrated below (Figure 1).

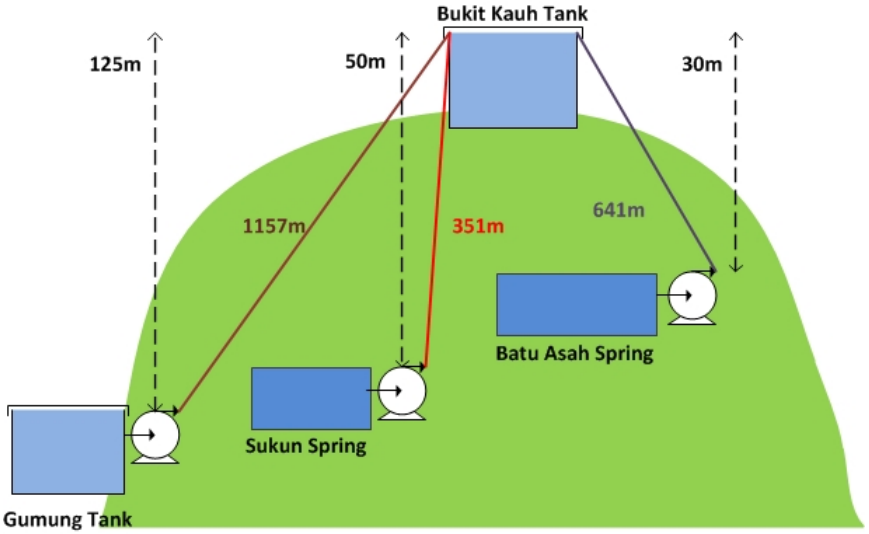

Figure 1. Diagram of all water source options for Bukit Kauh (not to scale)

It was decided that a pump will be installed at one of the three water sources, with pipes to connect the pump to a water holding tank located at Bukit Kauh. It was determined that steel piping with an inner diameter of 50mm and a roughness of 0.046 mm was the most economical choice of piping, with the required strength to withstand the rugged terrain of the area.

QUESTION 1 [3.5 marks]

Calculate the pump power required for each of the three options. Based on your calculations, which option should be selected for the residents of Bukit Kauh? Additional information is given below. State all assumptions.

Table 1. Summary of water system specifications

		Source		
		Batu Asah	**Sukun Spring**	**Gumung Tank**
Pipe Specifications	**Type**	Steel	Steel	Steel
	Diameter (mm)	50mm	50mm	50mm
	Length (m)	641	351	1157
	Elevation (m)	30	50	125

QUESTION 2 [3.5 marks]

Sourcing water from Gumung Tank was a popular option among the residents of Bukit Kauh, as it offered the option of supplying the village with treated water from the water treatment plant located in Gumung.

(a) As Gumung Tank is a preferred water source, someone suggested that the pump should be moved and placed higher up the hill so that it would be closer to Bukit Kauh (Figure 2). Would this work?

(b) If Gumung was selected to be the source of water for Bukit Kauh residents, what is the maximum height to which the pump should be moved relative to Gumung Tank? (Hint: You will need to know that the vapour pressure of water at 20^{o}C is 2.34 kPa)

Explain your answers, stating all assumptions.

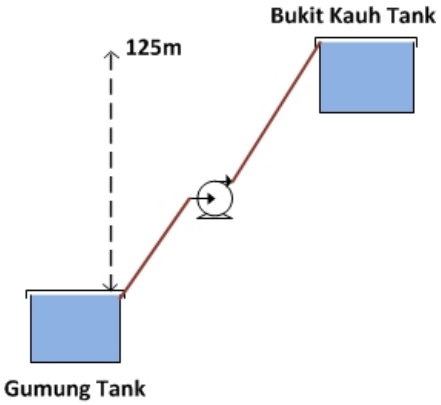

Figure 2. Suggested arrangement of pipes and pump from Gumung

QUESTION 3 [3 marks]

Several years after the installation of the pipe system from Batu Asah spring, a destructive storm passed by the area and a large tree toppled over, destroying a section of the pipe length. As the tree was too large to cut by hand and as it was difficult to transport tree-cutting equipment to the area where the tree fell, it was decided that the pipes would be reconnected around the tree.

The village had 120 m of steel pipe available, supplied by the Indonesian government several days after the storm. However, the new steel pipe supplied had an inner diameter of 100 mm.

It was decided that 600m of the original piping from Batu Asah spring and Bukit Kauh tank would be kept. At the end of the 300m of pipe from Batu Asah spring, the pipe would be expanded to the 100mm pipe for 0.5m. Four 90° elbows (K = 0.8) would be installed along the new length of pipe to bypass the fallen tree. The new pipe would extend for another 0.5m before contracting to the original pipe for the last 300m to the Bukit Kauh tank.

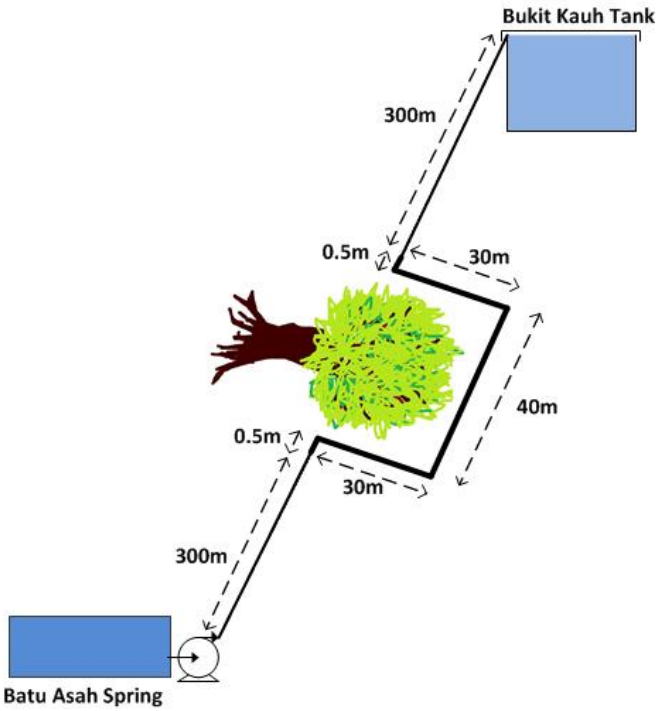

Figure 3. New arrangement of the pipes from Batu Asah spring (new pipe shown in bold)

Calculate the pump power required by this new arrangement, and compare it to the power required for Batu Asah in Question 1. State all assumptions.