## Miniproject: Water System Design for Yanacaca
## For Convective Processes Course, Fall 2006, U Mass Lowell

The goal of this miniproject is to provide you with a chance to apply the theory and tools of convective processes to an actual system design and an opportunity to help a remote village. With our knowledge of convective processes, we will estimate the losses (friction loss factor), optimal diameter of pipes, pump selection, water tank height, and loss in the different joint or connections such as elbows and valves.

Each year for the last five years one more remote village in Peru is helped with a new solar water system that it is provided by U Mass Lowell Village Empowerment Project. The project background is described at http://energy.caeds.eng.uml.edu/Peru/index.shtm . Students have designed and helped install over 70 systems for water, communication, laptops, medical devices, lighting in 32 villages and towns (ranging in size from 5000 inhabitants down to 25). Last fall ('05) the convective processes class designed a system for the town of Muchipampa, which was actually installed last January (see photos below). Yanacaca was selected this year to be the next town to have the solar water system installation. The folks there pleaded with us to put in a water supply system. There is a spring that has a flow rate of roughly 1 gallon per minute.


**Figure 1 Solar powered water supply system in Muchipampa, installed Jan. 2006**


**Figure 2  Tower and tank in Raypa, Jan. 2006**

A tower will be designed by another class to support an 1100 l tank as pictured above. But you need to estimate the height needed so they can design the tower. Assume that there will be 15 houses serviced by your system. Assume that the houses are an average distance of 100 m from the tank, but the distances can vary from 15 m to 150 m. The houses are all at roughly the same elevation, and the "spring" or well will be about 1.5 m deep. A solar-powered pump can be installed to transfer water from the spring to the tank; the water will flow by gravity from the tank to the houses. Assume there will be three 45 degree elbows, three 90 degree elbows, one shut off globe valve, and a filter (near the inlet to the tank, as in the above photo) between the pump and the tank. Assume PVC pipe is available for purchase in a nearby town, in half inch increments. Representative costs of pipe are shown in the table below, and a pump (for example, ShurFLo 12 V, model 2088-414-734 has been used in other of our systems) will be purchased in the U.S. and taken down to Peru. Assume the outflow from the tank will be 2 gpm when the water is in use there. For the design, please specify the following: the diameter of the inlet pipe to the tank, the diameter of the outlet pipe from the tank to the houses, the height of the tank, and the pump specification—all to minimize the cost. Also please estimate the maximum pressure in the pipe so we can obtain the class of pipe to withstand the pressure. You can assume that the tower will cost about $200/m of height.

**Figure 3 "Well" in Yanacaca (with the highest bacteria count we have tested)**

**Figure 4 Talking to the folks in Yanacaca about their water and related health problems in June 2006.**

Lima is the biggest city near the village (300 km away); whereas the town of Huarmey which has about 5000 people, is closer (about 40 km) and is where we usually buy pipe and water tanks for the villages. In the table below are representative prices for PVC pipe that we can purchase. For other items you can use Lima prices that may be available on the web. The pipe, tower, and pump represent the major costs that can be influenced by your design.

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| Pipe PVC Class 15, 2 in. dia., 5 meter length | $ 9.37 |
| Pipe PVC Class 15, 1.5 in., 5 m length | $ 5.90 |
| Pipe PVC Class 15, 1in., 5 m length | $ 4.00 |