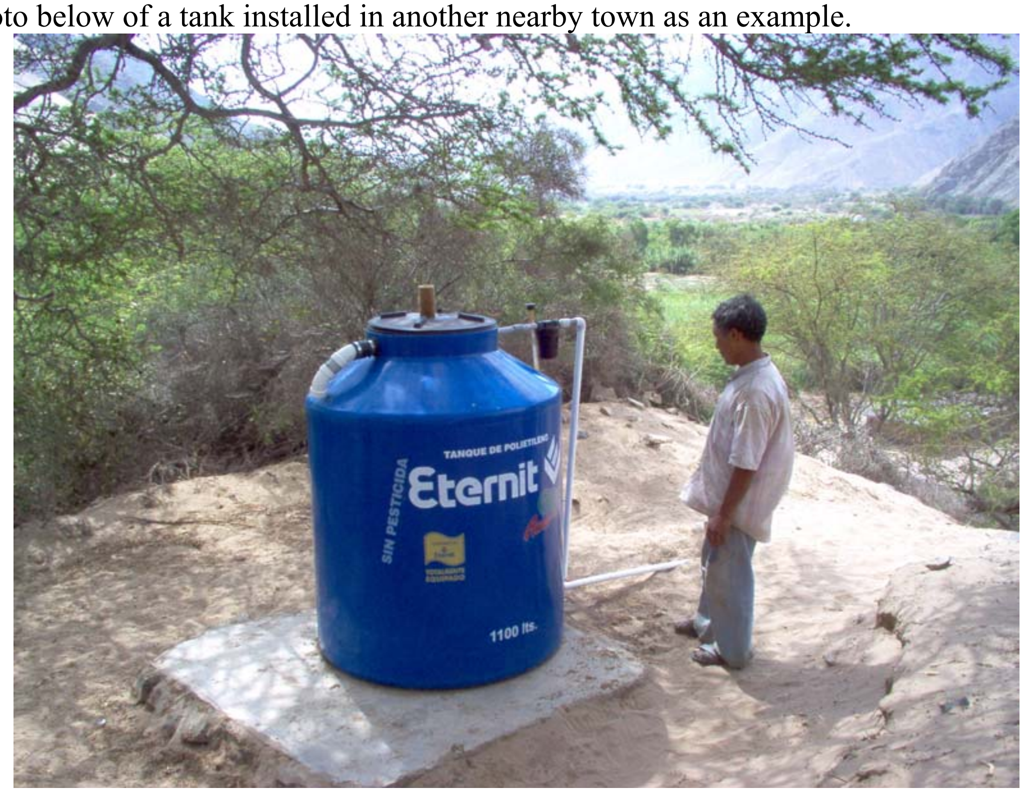
Miniproject: Water System Design for Muchipampa
For Convective Processes, Fall 2005, U Mass Lowell

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 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, and loss in the different joint or connections such as elbows and valves.

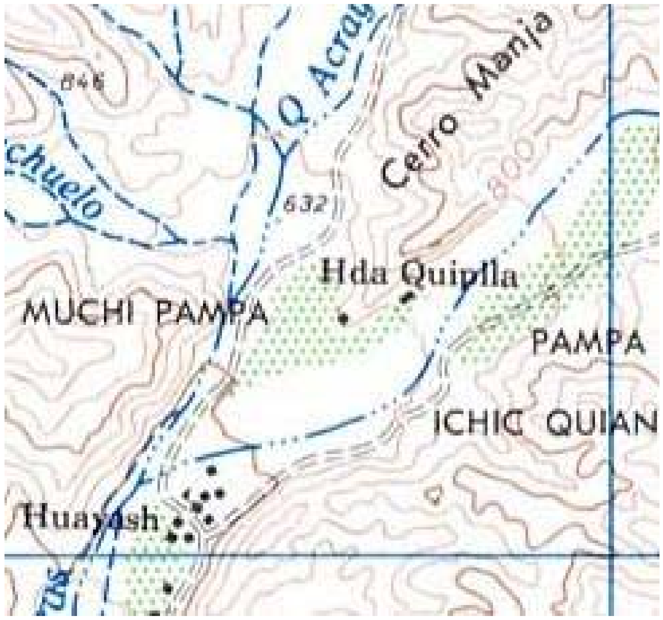
Each year for the last five years one more remote village in Peru is helped with a new solar water system that it is provided by U Mass Lowell Village Empowerment Project. The project background is described at http://energy.caeds.eng.uml.edu/Peru/index.shtm . Students have designed and helped install over 60 systems for water, communication, laptops, medical devices, lighting in 27 villages and towns (ranging in size from 5000 inhabitants down to 25). Muchipampa was selected this year to be the next town to have the solar water system installation. Muchipampa is a community that has about 6 families living in drought conditions for the past year. 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. There is a hill about 300 meters from the spring upon which a water storage tank of 1100 liters can be placed. See the photo below of a tank installed in another nearby town as an example.



The distance from the tank to the farthest house will be roughly 500 meters, and the houses are all at roughly the same elevation as the spring. 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 (as in the above photo) between the pump and the tank. Assume PVC pipe is available in a nearby town, in half inch increments. Representative costs of pipe are shown in the table below, and a ShurFlo pump (12 V, model 2088-414-734) will be purchased in the U.S. and taken down to Peru. Assume the outflow from the tank will be 1 gpm to each house 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, the height of the tank, and the pump—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.

Spring in Muchipampa.

View from the "hill" where the tank will be installed to the spring (near the greenest tree just left of center) and a house to the right center.



This is a section of a topo map of the Muchipampa village area. There is a 500 m distance between the first houses near the spring (represented by the black dots just below the Q in Quiplla) and last house (below the H in Hda). Each of the other houses is about equally spaced between the first and last in an approximate straight line. Each contour line on the hill just above the houses represents 50 m in height, so there is easily a 50 m height that could be utilized on the hill to place the tank, if needed. But keep in mind the maximum pressure the pump can put out.

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. But Lima prices for the pipe would be fine for this project. In the table below are representative prices for PVC pipe in Lima.

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