Improvements to the water supply, wastewater disposal, and solid waste management systems for the San José Community, Naranjito, PR

Environmental Engineering and Civil Engineering Senior Design Project, WI-15 and SP-16

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ABSTRACT

San José is a rural community in the mountain area of Puerto Rico with 56 habitants. Currently, a natural spring provide the water that is consumed by the community. The water does not comply with the Surface Water Treatment Rule (SWTR) of the Safe Drinking Water Act (SDWA) since it is not filtered. Also, the natural water corrodes the pipeline of the present water supply system due to its physical-chemical properties. The sewage generated at each housing unit is disposed either in septic tanks/cesspools or directly over the terrain. The solid wastes are handled by the Naranjito Municipality and disposed at the Toa Baja sanitary landfill. The recycling materials are recovered by the Industrial Fibers Corporation.

Several alternatives were analyzed in order to improve the water quality, wastewater and solid waste management systems. The selected options were: the use of a water supply aqueduct, two-chamber septic tanks with an outlet filter, and an aerobic composting system. These are the most feasible options from an environmental, public health, sustainability, and economical perspectives.

BACKGROUND

San José is a community composed of 22 homes. A population growth analysis forecasted that the community will not increase in the next 25 years and its water average daily demand will remain at 2,800 GPD. Current water source provides 1,400 GPD. Currently, the community does not lack of sufficient water.

The existing water supply system does not comply with the SDWA drinking water standards. This was confirmed by the water quality data provided by the Puerto Rico Department of Health and by the sampling and analysis done during the study period. Therefore, a water quality improvement is needed in order to satisfy the regulatory parameters established by the Environmental Protection Agency (EPA).

The sampling show an under-hazard concentrations levels of copper dissolved in the water, and also that the low-alkalinity-natural water is corroding the inside of the copper pipelines. Several incidents have registered that the houses copper pipelines have been broken due to corrosion.

According to a survey conducted at the community, each home disposes its sewage either in septic tanks/cesspools or discharges over the adjacent terrain. These practices represent an environmental and public health risk.

A solid waste production study indicated that in the next 25 years the community will continue to generate approximately 112 kg/day of garbage, which includes 22 kg/day of the organic matter. In order to reduce the amount of garbage that is conveyed to the Toa Baja sanitary landfill, the diversion of such material from the disposal facility is recommended.

OBJECTIVES

Improve the existing water supply system in order to comply with the SDWA, upgrade the wastewater management system, and develop an integrated solid waste management plan.

DESIGN PROCESS

Several alternatives were evaluated and preliminarily designed in order to improve the water supply, wastewater, and solid waste management systems. Comparative tables and Leopold Matrices were used to select the most feasible options from an environmental, public health, sustainability, and economical perspectives.

Final designs of the selected alternatives were done utilizing the: Puerto Rico Aqueduct and Sewer Authority Design Rules, Environmental Protection Agency Manuals, Environmental Quality Board of Puerto Rico Design Rules, Puerto Rico Authority of Solid Wastes Guidelines, American Concrete Institute Codes, Portland Cement Association Design Manual, American Society for Testing and Materials International Standards.

FINAL DESIGN

Table 1: Estimated cost of selected alternatives

	Aqueduct	Two-chambers septic tanks	Aerobic composting system	Total
Cost	$161,298	$55,484	$6,962	$223,744

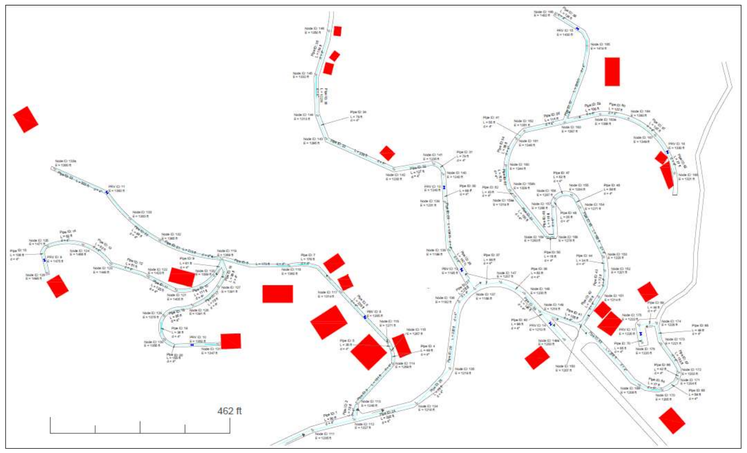

Fig. 1: Water supply system

Due to the lack of near future personal for the maintenance and operation of any kind of water treatment unit at the community, is recommended the installation of a water supply system. The Cedro Arriba Filtration Plant will supply the residents with drinking water. The aforementioned facility was design with a maximum capacity of drinking water production of 1 MGPD, currently the daily average production is 0.75 MGPD.

Fig. 2: Barrancas Filtration Plant

The proposed septic tank was designed following the EPA suggested bedroom-based-guidelines. Using the community population and the amount of houses, around three to four bedrooms were estimated at each residence. Therefore, an on-site septic tank of at least 146.3 ft^3 is necessary to handle all the domestic wastewater generated at each property.

Table 2: Septic tank dimensions

	1st Compartment	2nd Compartment
Height	4 ft - 8 in	4 ft - 8 in
Width	3 ft - 0 in	3 ft - 0 in
Length	7 ft - 0 in	3 ft - 8 in

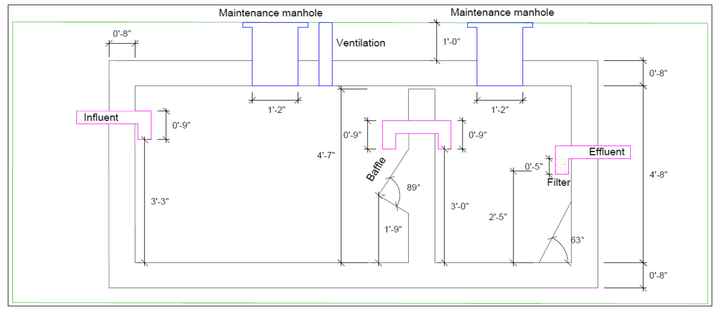

Fig. 3: Side view of the septic tank

The community will produce 17.2 m^3 of organic matter during a 20 week composting production cycle. This amount was calculated considering a 2.2 kg/person of solid waste generation per day and that 20% of the garbage is of organic origin. An area of 1,120 ft^2 is required for the aerobic composting system.

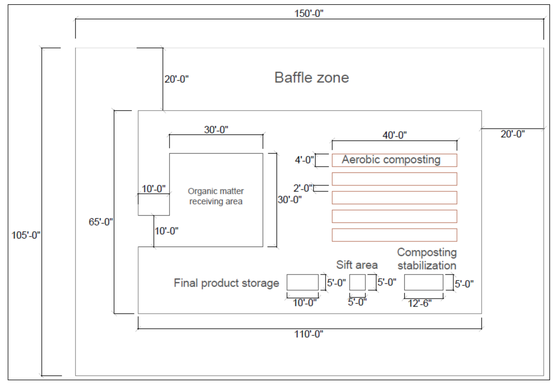

Fig. 4: Top view of the aerobic composting system

Fig. 5: Community boundaries

CONCLUSION

Through the use of an aqueduct, the drinking water quality will be improved and should satisfy the SDWA standards and will guarantee a safe and secure water for consumption. The elimination of sewage discharges into the ground surface and the usage of the designed septic tanks will reduce the public health risk. The diversion and biodegradation of the organic matter in the aerobic composting system represent a collective benefit by increasing the life of the Toa Baja landfill facility.

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