

Improvements to the water supply, wastewater disposal, and solid waste management systems for the El Parque Community, Barranquitas, PR



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

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ABSTRACT

El Parque is a rural community in the mountain area of Puerto Rico with 113 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. 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 Barranquitas Municipality and disposed at the Barranquitas sanitary landfill. The recycling materials are recovered by the IFCO Recycling Inc.

Several alternatives were analyzed in order to improve the water quality, wastewater and solid waste management systems. The selected options were: the use of the existing 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

El Parque is a community composed of 50 homes. A population growth analysis forecasted that the community will increase in the next 25 years and its water average daily demand will be 5,743 GPD. Current water source provide 5,800 GPD.

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).

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 generate approximately 230 kg/day of garbage, which includes 45 kg/day of the organic matter. In order to reduce the amount of garbage that is conveyed to the Barranquitas sanitary landfill, the diversion of such material from the disposal facility is recommended.

OBJECTIVES

1. Improve the existing water supply system in order to comply with the SDWA.
2. Upgrade the wastewater management system.
3. 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

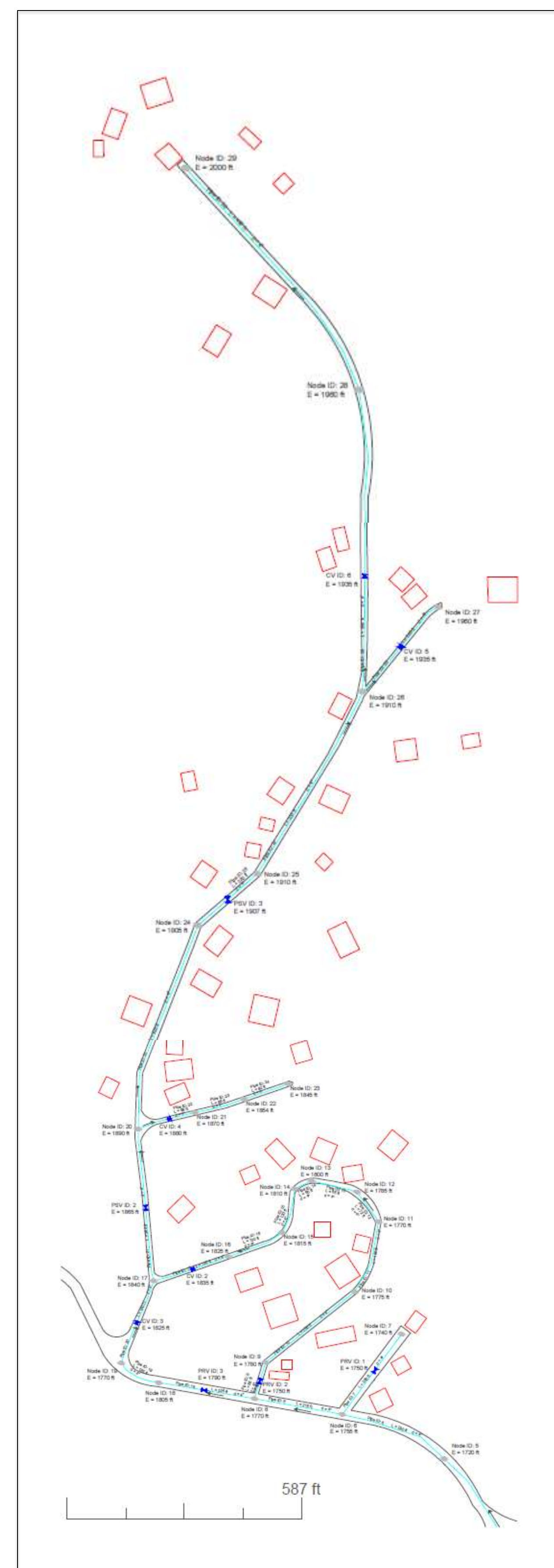


Fig. 1: The redesigned water supply system

Table 1: Estimated cost of selected alternatives

	Cost
New aqueduct	\$151,903
Two-chambers septic tanks	\$126,100
Aerobic composting system	\$10,386
Total	\$288,389

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 use of the existing disuse water supply system. A design of an aqueduct was made in case the actual system is inefficient due to years of low usage. The Barrancas Filtration Plant will supply the residents with drinking water. The aforementioned facility was design with a maximum capacity of drinking water production of 750,000 GPD, currently the daily average production is 530,000 GPD.



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 ft³ 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

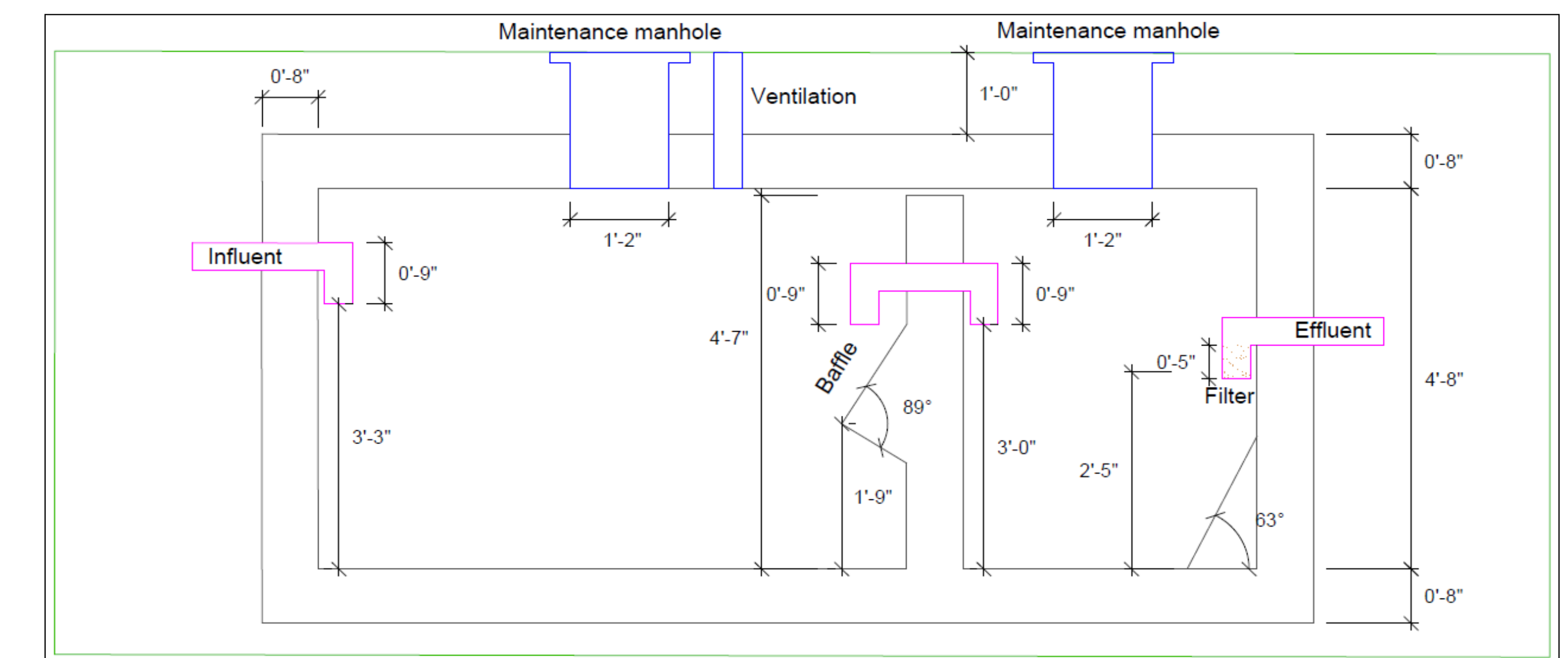


Fig. 3: Side view of the septic tank

The community will produce 35.4 m³ 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 2,000 ft² is required for the aerobic composting system.

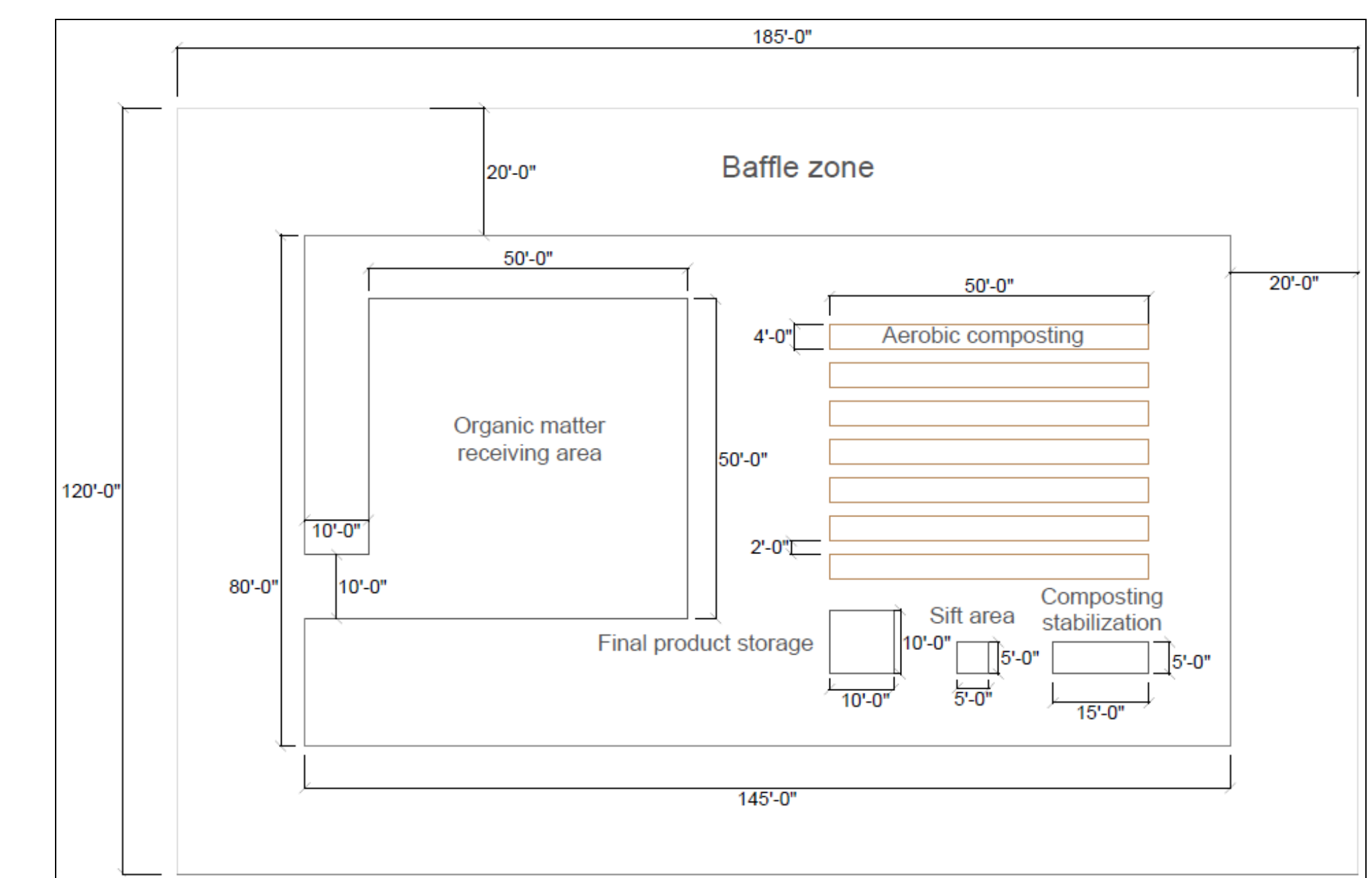


Fig. 4: Top view of the aerobic composting system

CONCLUSION

Through the use of the existing 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 Barranquitas landfill facility.

ACKNOWLEDGEMENTS

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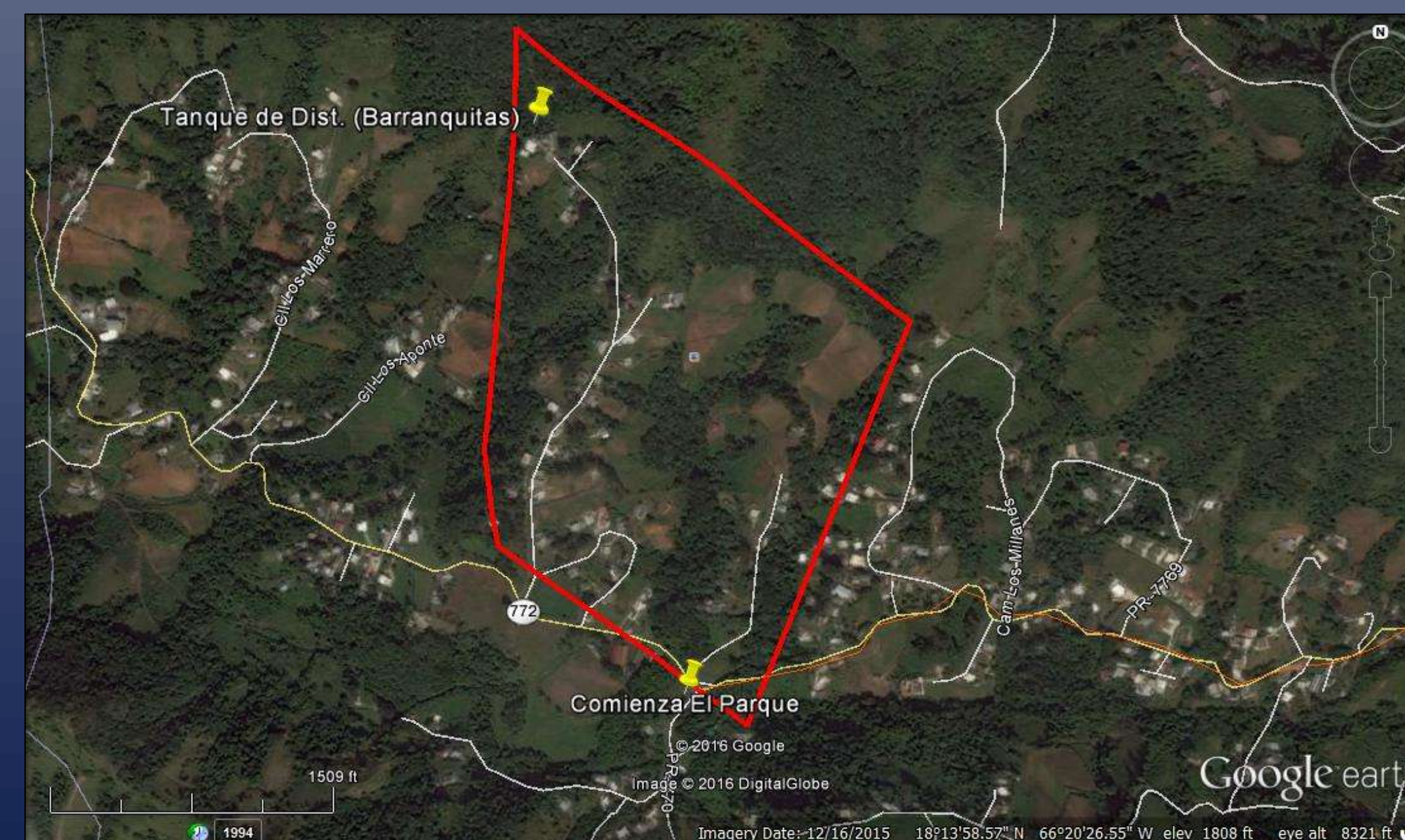


Fig. 5: Community boundaries