# Tierras Nuevas Onsite Wastewater Treatment Design
# International Senior Design – Santa Cruz, Bolivia

## Introduction

Tierras Nuevas is a public school located in UV 135, District 10 of Santa Cruz, Bolivia. The school contains two sites; the main primaria/secundaria location and the newer, smaller kinder location attended by 2300 and 110 students respectively.

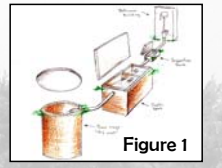

Figure 1

Two traditional Bolivian septic systems (Figure 1) serve the main site. Neither system is large enough to meet current demands. Wetness resulting from overflow can be observed in surrounding soil. A traditional Bolivian system is currently malfunctioning at the kinder site as well. Students, who suffer from stomachaches, diarrhea, and infection, congregate in contaminated areas (Figure 2). All three of these systems pose serious health risks to the students.

Figure 2

Ernesto Engineering spent 2 weeks in Santa Cruz working with the faculty and community members involved with Tierras Nuevas. Need for and support of the project were strong so engineers collected the necessary data and designed an alternative wastewater treatment system.

## Methods and Procedures

### Surveying

Surveying data was collected at both sites in order to acquire information on system dimensions, space available for design, and general layout of the schools.

Figure 3 at right shows the layout of the main site created using survey data.

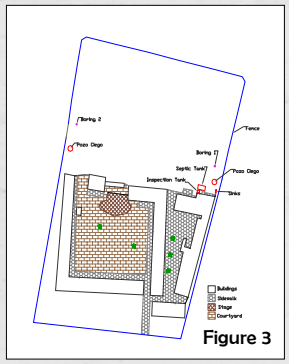


Figure 3

Figure 4

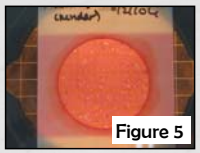

Figure 5

### Water Quality Testing

Hach Coliform Presence/Absence tests (Figure 4) and 3M Petrifilm tests (Figure 5) were performed to determine the presence and amount of coliforms. Samples were collected at both sites from standing water puddles, wet soils, and tap water. All samples, except for tap water and a control sample, tested positive for coliforms including *E. coli*.

### Usage Surveys

Surveys were distributed to a sample population of 288 students in order to determine the following statistics:

- 75% of students prefer the west toilet room
- Students use toilet rooms an average of 1.5 times per day
- 97% of student wash hands
- 37% of students use soap
- Stomachache frequency (Figure 6)

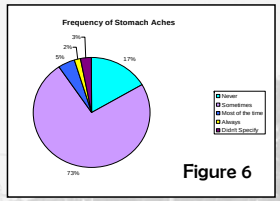


Figure 6

### Soil Analysis

Engineers performed three soil borings (Figure 7) near each of the distribution systems. Borings were taken to depths of 7 ft. at the main site and 9 ft. at the kinder site with samples being collected each time soil texture or color changed (Figure 8). Engineers determined the seasonal high water table to be located at 1.5 m due to visible mottling in the soil.

Soils consisted mainly of loamy sand with small amounts of clay present in some layers. Visual analysis and hydrometer jar tests (Figure 9) were used to draw these conclusions.

Figure 7

Figure 8

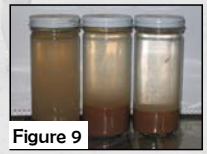

Figure 9

## Design Alternatives

The main factors influencing design for Tierras Nuevas' septic systems were flow, soil type and conditions, appropriate technology, and sustainability. With this in mind, nine design alternatives were considered. Seven were eliminated for reasons stated below. Two were utilized in final design.

| Design Alternative | Reason for Elimination |
|---|---|
| Mound System | Unnecessary, expensive, extra maintenance |
| Sand Filter | Unnecessary, expensive, extra maintenance |
| Vegetative Submerged Bed | Unnecessary, unfamiliar technology |
| Holding Tank | Would not handle flow |
| Composting Toilets | Would not handle flow, high maintenance |
| Piranha™ System | Expensive, requires regular technical assistance |
| Traditional Bolivian System | Violates Bolivian Law 1333, unable to handle current flow |
| Modified Bolivian System | None - Utilized at kinder site |
| Gravity Fed Drainfield | None – Utilized at primaria/secundaria site |

## Final Design

### Primaria/Secundaria Site

This site had good soil conditions and abundant space available. The septic tanks in both systems are too small to support the student populations. Final design recommendations include larger septic tanks and a gravity fed drainfield (Figure 10) for each system. Sample design drawing (Figure 11) and proposed layout (Figure 12) are shown below.

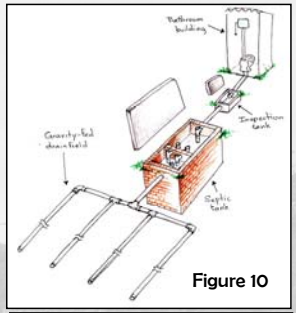


Figure 10

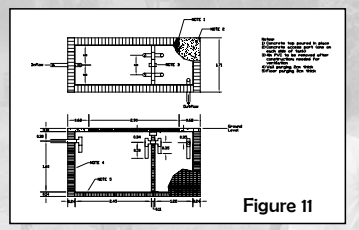

Figure 11

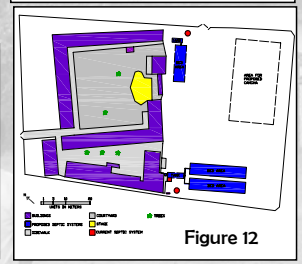

Figure 12

### Kinder Site

Final design recommendations are to first investigate the connection between the septic tank and pozo ciego (dry well) then install a small gravity fed drainfield off the pozo ciego. Proposed layout is shown at right (Figure 13)

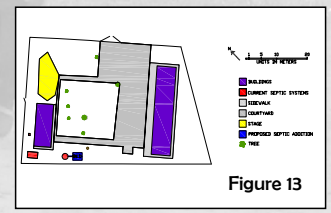

Figure 13

| System | Estimated Cost ($US) |
|---|---|
| Main Site East | $1800 |
| Main Site West | $3150 |
| Kinder | $350 |

## Conclusion

Implementation of the final design recommendation will provide the treatment capacity needed at the two Tierras Nuevas locations and create a safer environment for children to play in. The design utilizes appropriate technology and is cost effective, however it provides temporary solution. The best solution for Tierras Nuevas is to connect to a sanitary sewer when the option becomes available.


ERNESTO ENGINEERING

Bailey Gamble – Project Manager
Amanda Kohler- CAD specialist
Jeff Dambrun – Translator and Field Engineer