

Economic Analysis of Decentralized Options for Providing Water Service to Low-Income Settlements

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ABSTRACT

The U.S.-Mexico border region has large numbers of unincorporated settlements lacking basic services, which are known as colonias. Sanitation and health conditions in colonias can be compared to those in third world countries. El Paso County has approximately 200 known colonias. Despite large-scale investments to extend water supply to the colonias, approximately 3500 colonia residents still lack piped water service. Extending service to these remaining residents would be prohibitively expensive. A previous study estimated that providing piped water supply would cost an average of \$119,000 per lot. In this study, a representative colonia with an estimated population of 558 residents is evaluated to determine the costs of de-centralized approaches to water supply. A survey was administered to document the costs the residents currently pay for delivery by truck. Household water bills were found to average \$808 annually, confirming that the predominantly low-income colonia residents pay more for water than do households served by piped water supplies. A cost comparison of the current water supply delivery cost vs. the proposed cost of well drilling was performed to determine if it is economically feasible to construct wells. The well construction option is estimated to have an initial investment of \$13,980 and a capital recovery period of 6 years. Therefore, the construction of wells appears to be an appropriate option for colonia residents.

Keywords: affordability, decentralized systems, survey, economics

BACKGROUND

Colonias are low-income communities along the United States-Mexico border that are marginalized from local government regulations, inspections, and services. They are characterized by the lack of appropriate water and sewage disposal systems, inadequate access to clean water, and plumbing. Most colonias do not have adequate solid waste disposal facilities available. People in colonias face potential and immediate health threats due to the lack of safe, potable water and sewage disposal. Sanitation and health conditions in these areas can be compared to those in third world countries. Hepatitis, gastrointestinal and other water-borne diseases are very common [1]. Colonias began emerging in the late 1950's, although some sources put their age much older. Residents from colonias are commonly employed at the lowest wage rate in the area or in seasonal work.

Unemployment rates are high in these communities. Low-income people are attracted to colonias because they represent an opportunity to buy a lot where they can build a home at an affordable price. Most of the times utilities are not provided, but there is a promise that they will be available when more lots are sold. These conditions have often made the residents vulnerable to deceptive land-purchase schemes involving no money down and low monthly payments. However, once a number of residents are settled in their lots, the developers are no longer there as well as the promises of getting utility services. Colonia residents are then forced to live without basic utility services.

El Paso County has approximately 200 known colonias built on land that was never zoned for residential uses. Nevertheless, these settlements have expanded with the population. It has been estimated that 80,000 people live in the El Paso colonias [2]. Although most of the colonias in El Paso now have access to potable water after spending \$250 million to extend water lines, there are approximately 3500 colonia residents that are not served by a public water supply, according to a study from CH2M HILL, a consulting engineering firm [3]. The CH2M HILL study reported 2,684 (2.38%) people hauling water; 2,768 (2.45%) people served by a private water system; 1,104 (0.98%) people served by private wells; and 106,273 (94.19%) people served with a public water system in El Paso County [4].

For years, colonia residents have fought to get potable water to their homes through different government agencies but have yet to receive a positive resolution. Many residents are not able to benefit from the arrival of water connection lines to their community because they cannot afford to pay the cost of connecting to these lines. According to the CH2M HILL study, it would cost \$103 million to make the 865 water connections required to serve the 3500 colonia residents that lack water services.

Colonia del Paso also known as Las Colonias is one of the colonias without water services in El Paso County. It is located east of El Paso, TX in the vicinity of Clint, TX as shown in Figure 1.



Figure 1: Location of Colonia del Paso, El Paso, TX
 Source: Mapquest.com

According to residents of this colonia, the first settlements started in the early 1980's. The estimated colonia population in 2000 was 558 residents [5]. This colonia consists of 176 lots of which 111 are occupied lots. One common characteristic that can be seen from lot to lot is the use of on-site water storage containers which range from fifty-five gallon plastic drums, to large metallic vessels with a thousand gallon capacity, to large high density polyethylene (HDPE) water tanks with a 2500 gallons capacity as shown in Figure 2 [2].



Figure 2: Metallic and HDPE water storage tanks used by residents of Las Colonias

Based on information from a study carried out for El Paso County, the estimated cost to provide a water distribution system and connections to Colonia del Paso was \$575,100. One option to overcome this issue is the construction of wells to be used by colonia residents. The objective is to construct a well for a group of families in order for them to share the costs. The construction of several wells can then provide the much needed water supply that colonia residents lack. Currently, residents from Las Colonias pay from \$25 to

\$40 per load of water that a truck delivers every three or two weeks. The amount of water that they receive is approximately 2500 gallons. However many residents do not use this water for drinking purposes. They still have to buy drinking water from stores or from vending machines.

OBJECTIVE

The objective of this project was to assess current conditions on the cost of water and the feasibility of well construction cost for drinking water supply in Las Colonias. Several assumptions were taken into consideration to determine if it would be cost effective to drill wells.

METHODOLOGY

Fourteen Las Colonias residents were surveyed about the amount of water use per month to determine how much money they are spending in water supply for their home. They were also questioned on the amount of money they pay to have water delivered to their homes. In addition, the number of family members in each residence was obtained. This information was used to determine the per capita water use. Water consumption and cost were estimated using the information provided by residents of Las Colonias.

Several assumptions had to be established for this study to be conducted. First, the depth of the water table was assumed to be 110 ft. Second, the water at this depth was considered to be fresh water. These assumptions are based on information provided by B & G Drilling Co. which has experience in residential well drilling. This company has drilled wells near the area of Clint, TX, and they have found that the depth of wells has increased from 40 ft to about 60 to 80 ft due to the drilling of new irrigation wells. Therefore, the water table has gone down, and they have to drill deeper into the ground to reach fresh water supply. In addition, some constrictions will also be considered. For instance, the amount of ground water pumped will be equal to the amount of water residents are currently using. Furthermore, each well will be used by a maximum of four families.

A cost analysis comparison of the current water supply delivery cost vs. the proposed cost of well drilling will be performed to determine if it is economically feasible to construct wells. Based on the results of the analysis, a conclusion will be made on whether the construction of wells will benefit residents from Colonias del Paso or if they are better off with their current condition, which is to have water delivered to their homes.

RESULTS

1. Survey

The information provided by Colonia del Paso residents is presented in Table 1. This table summarizes the results from a survey conducted among Las Colonias residents. A total of 14 households were interviewed.

Table 1: Current water supply delivery cost and use

| House No. | Fam. Members | Winter Loads per mo. | Summer Loads per mo. | Loads per year | Gallons per load | Gallons per yr | Cost per Load | Annual Cost | Gallons per capita/day |
|--|--------------|----------------------|----------------------|----------------|------------------|----------------|---------------|-----------------|------------------------|
| 1 | 5 | 2 | 4 | 34 | 2,500 | 85,000 | \$30 | \$1,020 | 47 |
| 2 | 4 | 2 | 4 | 34 | 2,500 | 85,000 | \$30 | \$1,020 | 58 |
| 3 | 4 | 1 | 2 | 17 | 2,500 | 42,500 | \$30 | \$510 | 29 |
| 4 | 6 | 2 | 4 | 34 | 2,500 | 85,000 | \$30 | \$1,020 | 39 |
| 5 | 5 | 2 | 3 | 29 | 2,500 | 72,500 | \$30 | \$870 | 40 |
| 6 | 3 | 1.3 | 1.3 | 16 | 2,500 | 39,000 | \$32 | \$499 | 36 |
| 7 | 5 | 2 | 3 | 29 | 2,500 | 72,500 | \$35 | \$1,015 | 40 |
| 8 | 2 | 1.3 | 2 | 19 | 2,500 | 47,750 | \$30 | \$573 | 65 |
| 9 | 2 | 1 | 2 | 17 | 2,500 | 42,500 | \$35 | \$595 | 58 |
| 10 | 5 | 2 | 3 | 29 | 2,500 | 72,500 | \$35 | \$1,015 | 40 |
| 11 | 5 | 2 | 3 | 29 | 2,500 | 72,500 | \$30 | \$870 | 40 |
| 12 | 6 | 2 | 2 | 24 | 2,500 | 60,000 | \$26 | \$624 | 27 |
| 13 | 4 | 2 | 2 | 24 | 2,500 | 60,000 | \$26 | \$624 | 41 |
| 14 | 5 | 2.5 | 2.5 | 30 | 2,500 | 75,000 | \$35 | \$1,050 | 41 |
| Avg. | 4.4 | 1.8 | 2.7 | 26 | 2,500 | 65,125 | \$31 | \$808 | 43 |
| Total Cost and Consumption per Year | | | | | | | | \$11,305 | 911,750 |

The loads per year values were calculated by multiplying the winter loads/month by 7 and the summer loads/month by 5. From Table 1 it can be seen that on average a family will spend \$808 per year for water delivered to their homes. This accounts for an average annual water consumption of 65,000 gallons per family. Moreover, a group of four families will spend approximately \$3200 per year on water alone. This estimated cost was used to make a comparison between current water supply cost conditions of Las Colonias and the proposed well construction cost.

2. Well Construction Estimates

Water wells can be expensive. The actual cost of a water well will depend upon the depth to groundwater, the desired well capacity, and the selection of well drilling, well design, well construction, and well development considerations. In addition, the cost of electricity to run the pump as well as the maintenance cost of the pump has to be considered in the cost analysis.

According to B & G Drilling Co. the cost of constructing a 4 in. diameter residential well at a depth of 120 ft will be just about \$2,800 or \$23.33/foot . This includes the cost of the slotted pipe screen, concrete sled pipe and labor installation. RS Means Construction Cost Data shows that the cost per linear foot of a 4 in diameter well is \$41.50 which includes material cost, labor cost (plus total overhead and profit), and equipment cost. The cost of a pump will vary from \$875 to \$1,500 depending on the amount of water to be pumped, usually 20 gpm. However, there are other costs that need to be considered such as engineering cost, plumbing as well as electrical connections and installations that need to be done by a licensed plumber and electrician. These costs will vary depending on the

location of the well and the distance between the well and the home of each of the residents. In addition, the annual cost of operating the pump will also need to be considered to obtain a better cost analysis of the two options.

Forbes Environmental Engineering provided an estimate of \$6,500 for the engineering cost for this type of project plus an additional \$3,000 for a required well test. The well test is required by law and it lasts 36 hours. This test is performed in order to determine the drawdown conditions of the aquifer as well as the quality of water.

Plumbing and electrical cost was estimated using RS Means Building Construction Code, although plumbing cost will vary depending on how water is going to be distributed among residents.

In order to determine the cost of running the pump, it was assumed that the water consumption would increase from 43 gallons of water per person per day (gpd) to about 90 gpd. This assumption was established because once residents recognize the benefit of having a well they will tend to consume more water than before. The well pump is a one-horsepower pump that delivers water at a rate of 20 gallons per minute (gpm) and uses about 1 kilowatt of electricity when in service. The operating cost of the pump can be estimated using the previous information and the cost per kilowatt-hour (kwh) use in the city of El Paso.

Since the well will be used by a total of four families, and assuming that each family consists of five members, then the total number of residents making use of a well will be 20. This number multiplied by the 90 gpd and divided by the pump delivering rate of 20 gpm gives the operating time of the pump which is 90 minutes or 1.5 hours. To estimate the cost of operating the pump, the wattage of the pump was multiplied by the operating time of 1.5 hours and then multiplied by the residential cost of one KWh for El Paso, TX customers' which is 11 cents. Therefore, the annual cost of operating the well pump was estimated to be \$63.

Table 2 shows the estimated cost of the overall well construction. The total capital cost is estimated to be equal to \$13,980 or \$3,495 per house, while the annual maintenance and operation (M&O) cost is estimated to be about \$113. The estimated cost for municipal water supply for this colonia is \$70,000 per connection with current population if served by the Lower Valley Water Authority or \$45,000 per connection if served by the El Paso County Water Authority [4].

Table 2: Estimated Water Well Construction Cost

| Item | Cost Estimate Assuming 120 ft | Source |
|--|-------------------------------|----------------------------|
| Slotted pipe screen, concrete sled pipe and labor | \$2,800 | B & G Drilling, 2004 |
| Well Pump | \$1,000 | B & G Drilling, 2004 |
| Engineering Cost (including well test) | \$9,500 | Forbes Environmental, 2004 |
| Plumbing and Electrical Cost (labor and materials) | \$680 | RS Means, 2004 |

Table 2: Estimated Water Well Construction Cost continuation...

| Item | Cost Estimate Assuming 120 ft | Source |
|---|-------------------------------|-----------|
| Total Capital Cost (initial investment)= | \$13,980 | |
| Cost of pumping water | \$63 | Estimated |
| Maintenance Cost | \$50 | Estimated |
| Total annual M&O= | \$113 | |

DISCUSSION

Currently, the average water cost per household is \$808/year. It is intended that one well will be shared by four families. Consequently, the annual saving realized by construction of the well is equal to \$3,119. This figure is the sum of the current water costs for the 4 households (\$3,232), less the M&O cost for this well (\$113). The capital investment for the well was estimated to be \$13,980. The capital-recovery period can be estimated using the following equation:

$$A = P \left[\frac{i(1+i)^n}{(1+i)^n + 1} \right] \quad (\text{Eq. 1})$$

where,

A = equivalent uniform annual worth value

P = present worth (initial investment)

i = interest rate, %

n = capital recovery period, yrs

Equation 1 can also be expressed in the following manner:

$$A = P(A/P, i\%, n) \quad (\text{Eq. 2})$$

where,

(A/P, i%, n) is referred to as the capital-recovery factor (CRF). CRF values have been calculated by different authors [6,7].

The capital recovery period (n) was calculated using Equation 2 and assuming a 10% interest rate, A equal to \$3,119 (annual water cost for 4 families), and P equal to an initial investment of \$13,980. A CFR value of 0.2231 was calculated and this value corresponds to a capital-recovery period of 6.3 years.

It is estimated that Las Colonias residents will be able to pay for the total cost of well construction in 6.3 years assuming that each household will continue paying the current water cost towards the initial investment. After this time, the capital cost will be paid in full and they just need to pay for annual M&O cost.

CONCLUSIONS

Based on findings, the following conclusions can be drawn:

1. Current water cost for the Las Colonias residents is \$808/year/household.
2. The total capital cost for the construction of a well is estimated at \$13,980, with an annual M&O cost of \$113.
3. The construction of wells is feasible with a capital-recovery period of 6.3 years at an interest rate of 10%.

RECOMMENDATION

This is a preliminary study to assess well construction feasibility. Factors such as water quality and quantity, actual water depth studies, funds availability, and residents' preferences need to be taken into consideration.

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