Latin America and Caribbean Urban and Water Unit
World Bank

IMPACT EVALUATION REPORT

Measuring Human Development Outcomes through Water & Sanitation Connectivity: Treinta y Tres Municipality, Uruguay

February 2012

1. INTRODUCTION

1.1 Sanitation and Development

According to the Millennium Development Goals (MDGs) declared by the United Nations, sustainable and equitable access to adequate sanitation and hygiene are recognized priorities for development, poverty reduction, and health promotion. Inadequate sanitation services affect billions of poor people in the developing world. In the year 2000, five out of every ten people suffered from inadequate access to sanitation, and nine out of ten did not have their wastewater treated at any level[1]. Inadequate sanitation affects several human development outcomes. Children in particular are affected by the use of unsafe sanitation, mainly through gastrointestinal diseases. In rural areas, poor to non-existent sanitation and wastewater disposal systems contribute to the degradation of groundwater, rivers, and coastal resources and impact household incomes. In urban areas, poor sanitation results in increased prevalence of water-related infections and parasitic diseases. Access to safe water supplies and sanitation therefore is a key World Bank priority in its Urban and Rural Development sectors today.

1.2 Uruguay: Country Context

Uruguay is an upper-middle income country with 3.3 million people in South America, and is characterized by relatively high coverage and quality of public services and infrastructure as compared to other middle income countries in the region. The provision of potable water is practically universal in the entire country. However, according to current statistics[2], water coverage falls below 60% when it is measured as the percentage of the population with household water connections. There is even a more drastic drop to 27% when water coverage to the population in the urban interior is studied. Additionally, in Uruguay, while access to adequate sanitation is almost universal, only 42% of households are connected to the sewerage network. The *Administracion de las Obras Sanitarias del Estado* (OSE), the national water and sewage utility, provides water and sanitation services for the entire country except for Montevideo, the capital city. In Montevideo water and sanitation services are provided by the municipality covering 83% of the population living in the capital through household connections to the network. An OSE resolution led to a proposal in the Uruguayan Parliament that declared the connection to a sewerage system as mandatory for all households in the country. According to this proposal, sanitation is a fundamental public service in relation to public health, environmental protection and welfare in general. The government has in turn undertaken efforts to increase urban connectivity throughout the country.

A general trend observed in Uruguay, as in the rest of the Latin American region, is that despite government investments in sewerage infrastructure and various accompanying cost-sharing schemes, the connectivity rate to sewerage infrastructure has remained low. Why households are choosing not to connect even when they have access to a sewerage network continues to puzzle water utility companies and governments in Uruguay and the region. Several hypotheses surmise that this is due to a number of factors: the households' lack of funds to invest in the connection, their credit constraints (particularly for low-income households) and particularly relevant for the purposes of this report, *the lack of knowledge regarding the potential benefits of connecting to the sewerage system.*

1.3 Modernization Measures

[1] Statistics from the World Bank and the World Health Organization (WHO)/United Nations.

[2] '*Evaluating the Impact on Human Development Indicators of Household Connection to the Sewerage System in Uruguay*', Impact Evaluation Concept Note, World Bank. February 24, 2010.

The Government of Uruguay (GoU), through OSE and the support of the World Bank, has made strong efforts to increase household connection to the sewerage system in the last five years. In 2005, OSE started a program that created a line of credit for household's connections to the sewerage system based on a credit limit and household income level. OSE further partnered with the Uruguayan Social Development Ministry (MIDES) in order to provide subsidized connections to low-income households that fell under 25 URs (*Peso Uruguayo)* per month. In addition to these efforts, municipalities nation-wide have used their funding along with external/private funding to increase household connection. These initiatives also follow a previous World Bank project in partnership with OSE that financed the expansion of sewerage networks in several Uruguayan cities.[3] This project put in place civil works that now provide the capacity to connect an additional 16,224 households to the water and sanitation network. A year after the close of that project however, only 41% of the households had opted to connect.

2. PROJECT EVALUATION BACKGROUND

2.1 Rationale and Objectives

The Latin America and Caribbean Region's Urban and Water Unit (LCSUW) at the World Bank recognized the 'connectivity challenge' faced by Uruguayan authorities as an opportunity to study and link water and sanitation to human development outcomes (e.g. health and education indicators). A clear link through the impact evaluation of household connectivity to the sewerage system could establish the benefits that households will receive from connecting. Additionally, this information would be disseminated to the citizens by the government with the intention of raising public awareness of OSE's initiative to connect households to on-going sewerage works, and more importantly, of the health and welfare benefits arising from this provision.

World Bank studies in the Water Supply and Sanitation sector (WSS) have pointed to the fact that few rigorous scientific impact evaluations have been undertaken to show how interventions are contributing to welfare, economic growth and poverty alleviation. Evaluating interventions (such as sewerage connectivity) under WSS programs and policies in order to identify *under which conditions* certain interventions work or do not work can lead to greater success. There is also the strong case for disseminating information on the tools necessary to maximize the impact of WSS interventions and understand these impacts on health outcomes to governments, civil society and the development community. The OSE and the World Bank recognized the need for an accurate evaluation to help maximize household coverage and understand the impact of sewerage connectivity on Human Development outcomes, ultimately leading to more effective implementations in the future.

The World Bank and GoU efforts to address these issues present an opportunity to conduct an impact evaluation with the primary objectives of:

1) Fill in the knowledge gap regarding the budget constraints and other factors inhibiting households from connecting;
2) Feed in the results of the impact evaluation into the OSE and GoU's review of appropriate sanitation standards;

[3] The World Bank (IBRD)/OSE Modernization and Systems Rehabilitation project for the public water system (APL1; 2000-2007).

3) Evaluate the impacts of household connectivity on health, education, and welfare outcomes – in particular, the impact of connectivity on health indicators/outcomes; and,
4) Understand the causal relationship between sewerage connectivity and Human Development outcomes, with significant policy implications, and improving World Bank WSS operations in the LAC region.

2.2 Team and Timelines

The Impact Evaluation team is composed of World Bank staff from the Latin America and Caribbean (LAC) region, led by Luis Andres and Darwin Marcelo Gordillo; OSE-based social specialists and other experts in local utility; and academics, local supervisors and consultants where necessary. The evaluation team also counted with the full collaboration of the World Bank project team consisting of Carlos Velez, who guided the evaluation in its different states.[4] The evaluation team discussed the design with the Department of Social Sciences (*Universidad de la República*) and the staff of the Public Health Ministry, Uruguay.

This impact evaluation exercise of the household connection to the sewerage system in Uruguay was initiated in 2008. The evaluation design was formalized in 2010, along with the sample design, a pilot and questionnaire. Field activities and training for staff were also undertaken and a baseline survey conducted in June 2011. There is to be a follow-up survey in 2013, two years on from the baseline, and a final evaluation of the fieldwork results by December 2013, along with wider dissemination of the results. The primary source of funding for this study was the SIEF (Spanish Impact Evaluation Trust Fund); the project has additionally received funding for the design phase of this evaluation from the World Bank-Netherlands Water Partnership Program in Water Supply and Sanitation.

2.3 Research Questions

This study proposes to provide unambiguous evidence to support or disapprove the following questions:

- **Does connecting households to the sewerage system result in better health development outcomes?**

- **Are there any health externalities in terms of sewerage coverage in health outcomes?**[5]

In particular, this study seeks to identify and measure the causal relationship between the sewerage connection of households in Treinta y Tres city and human welfare measured through health sector indicators. In this case, the intervention impact on welfare will be measured according to the following main indicators of soil and feces parasite presence. 'Welfare' indicators for the purposes of the evaluation are health indicators – given the clear association of health indicators to human development – measured by parasite presence[6] in household members with and without a sewerage connection.

[4] In order to study the (- expectedly inverse -) causal links between water connectivity and parasitic disease.
[5] This question is covered through a density analysis that aims to capture effects of sewerage connectivity to non-connected households, by the physical proximity to households that are.
[6] Parasites normally inhabit the digestive system and/or liver. In the digestive system or liver, they disrupt digestion and nutrient absorption. Symptoms include chronic diarrhea and abdominal pain. Other symptoms occur from long-standing infections, among them ulcers, hemorrhage, abscesses of the intestinal wall, and liver damage. Sometimes severe toxemia results when the host's body absorbs the worm's metabolites. This type of worm is highly related to poor sanitation particularly in South America. These worms can induce severe toxemia in women that have the worm at

3. IMPACT EVALUATION METHODOLOGY

3.1 Evaluation Design

A team comprising of World Bank staff and local partners selected the *Treinta y Tres* municipality for the pilot study in 2008. According to the Uruguayan Census of 2004, the municipality comprised of 49,000 people with over 25,000 living in the capital, Treinta y Tres city. Today the city accounts for 12,000 water connections for its residents but just over 7,000 sanitation (sewerage) connections: a coverage rate of 59% with respect to the water connections. This again points to the connectivity challenge facing the authorities, sets the context, and further justifies the team's intention to carry out empirical work which will clearly link sewerage connectivity to better developmental outcomes for the people.

Randomization and pairing

Three zones with similar socioeconomic characteristics in Treinta y Tres were identified as the participants for the evaluation study. Within these zones, the first step was to identify clusters of households that belong to the same micro-basin and randomly assign these clusters to the treatment or the control groups[7]. The team could then assess changes in their welfare that could be attributed to the intervention: connectivity to the sewerage system. Hence, the study would determine how the households' well-being would be different (or, in this case, presumably lower) if the intervention had not taken place. Therefore, there was a need for a *counterfactual* and a comparison between what actually happened and what would have happened in the absence of the intervention.[8] These neighborhoods were then divided into 14 respective clusters; each block contained 912 households with mean incomes inside the pre-established limits, two schools, and a local clinic. Essentially, on average, the control group and the treatment group were (statistically) 'identical' in their set-up, and that they could be intervened independently, without risk of cross-contamination since each of them represented a geographic basin[9].

The evaluation was implemented as follows:

1) The 14 clusters were grouped into seven pairs;
2) A lottery was organized to randomly choose which cluster of each pair was to be intervened with first (i.e, given the sewerage connection) and therefore establish a comparison group: comparing the health indicators of households in the cluster that had connection to the clusters that did not;
3) The connection to the sewage system of all the households belonging to the selected clusters in the treatment group will be subsidized in order to assure high level of connectivity to the sewerage system;
4) Select a region with a critical mass of households so that it is possible to implement the intervention in phases for the following year and count with the following characteristics: i) they are not connected to the sewage system; ii) they have similar socioeconomic characteristics; and iii) that households are as representative as possible of households with

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a fertile age and can complicate pregnancy - substantially increasing maternal mortality and having severe consequences for a newborn ranging from premature birth to abnormalities of a newborn.

[7] See Annex 1 for elaboration on the Identification Strategy regarding households, and the manner in which they were grouped.

[8] The main purpose of an impact evaluation is to correctly identify and measure the causal effects of an intervention and its outcomes. In order to isolate and assess these effects, it is necessary to determine what would have happened in the absence of the program or what we could call the program's counterfactual.

[9] OSE's engineers have assessed the independence of the clusters by considering soil characteristics of the referred region, the inclination of each region and the characteristics of the sewerage system itself.

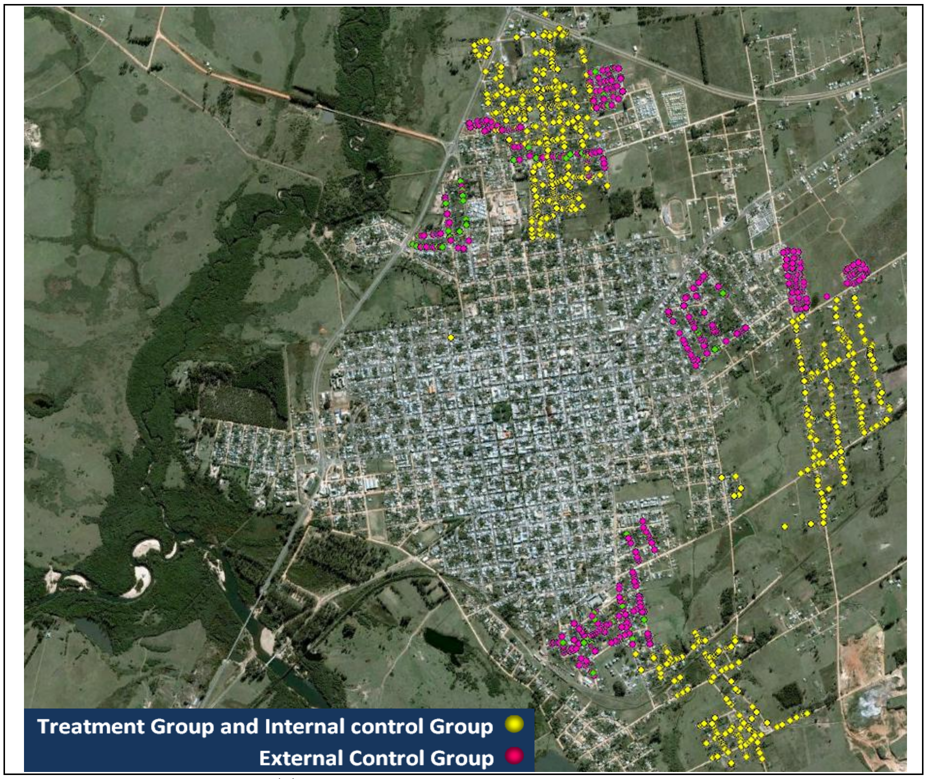
an income between 25 and 60 UR so that results can be extrapolated to households with this level of average income.

5) Identify observation-independent clusters inside the previously selected region. These could be constituted by blocks or group of blocks. In order to use the regressions discontinuity approach, the clusters were associated with one neighboring cluster to form a pair of clusters;
6) A survey was implemented to all the households in the treatment and the control groups;
7) Randomly select which cluster to connect in phase 1 and which clusters to connect in phase 2. The randomization was implemented by a lottery to allocate the clusters in the treatment and in the control groups- in order to guarantee the one cluster in a pair belongs to the control group and the other one in the treatment group. Since there were two clusters (belonging to different pairs) with an elementary school; these clusters were also coordinated in such a way that only one of these clusters with a school was assigned to the treatment group ; Since the baseline data was already collected, the team could verify the balance between the treatment and the control groups right after the lottery;
8) The project will build the sewerage systems in the treatment clusters in 2012. One key element in the design, in order to avoid self selection issues, is that a significant share of the households in the treatment group has to have the intra-household sewerage connection. To this end, OSE will make sure that the large majority of households intervened connects to the sewerage system by an awareness campaign as well as (partial) subsidies for these connections;
9) One year after the majority of the households in the treatment group are connected, the follow survey will be implemented;
10) Those clusters that were not selected in this first phase and acted as the counterfactual (the control group) were to be intervened in under the subsequent phase of the program.

The impact evaluation design chosen was prospective (*ex ante*) and was made at the beginning of the intervention. Baseline data – in this case primarily health indicators – from the clusters comprising of households was collected at the onset and will be collected one year after the treatment group is intervined. While all of the households and clusters would eventually be covered by the sewerage system, there emerge the intervention beneficiaries (the 'treatment group') and the non-beneficiaries (the 'control group', the comparison) for the duration of the intervention.

In the baseline survey, in total, 1,386 households were interviewed in the city, 473 (34%) as part of the Internal Treatment and Internal Control Groups, and 524 households as part of the External Group. These households are equivalent to a total population of 4417 individuals. The households which are spatially distributed into 3 geographic zones comprising 14 micro-basins can be seen in Figure 1 below: All the micro-basins where the external group is placed already have access to the sewerage systems; however, 15% of the households of this group have no domiciliary sewage connection (see green dots, Fig. 1). In contrast, the treatment and internal control group belong to zones characterized by the complete absence of sewerage systems at present.

Figure 1: Spatial distribution of households by group, Treinta y Tres, Uruguay



Source: Impact Evaluation Team, 2011.

Once the intervention is implemented in the selected clusters, it is expected that at least 95% of the eligible households will be connected to the sewage system. To reach this goal, the government will subsidize all the household connections to the sewerage system: a formal agreement was signed by the city authorities committing themselves to ensure household connections[10].

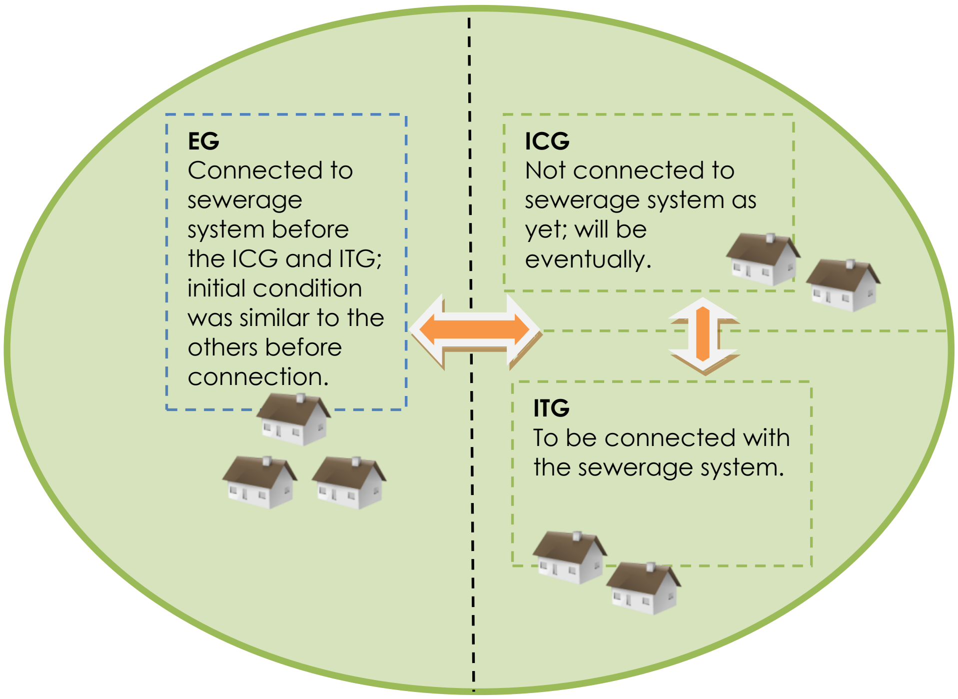
The 'External Group'

This impact evaluation analysis however is relatively recent in its initiation (2008) and since the baseline data was collected in 2011 and the final evaluation would be produced only at the end of 2013, it will be improbable to produce a rigorous impact evaluation that compared households with and without the sewage connection before 2013. The approach above was complemented with a second approach in order to use the baseline for generating preliminary evidences of the impact of this type of interventions. The team identified an External Group (EG) that was calculated to have the same initial socio-economic characteristics and conditions to that of the (Internal) Control Group and (Internal) Treatment Group (henceforth, ICG and ITG). The EG has already received the intervention and was connected to the sewerage system a few years before. While the ICG and ITG cannot be compared as, by definition, both groups should have similar initial conditions due to their randomized assignment (i.e. they are 'balanced groups' as verified in Section 4.2). A preliminary comparison between the EG and the ICG and/or ITG (since they are still very similar at present) would therefore provide stakeholders (the government, the households, others) with a preliminary assessment that would be validated at the end of the final evaluation.

[10] See formal agreement signed by the local authorities committing themselves to ensure households connections in Annex 2.

Subsequently, as results emerge from the effects of ITG's sewerage connectivity over 2012, the team can resort to its original objective of comparing the households with connections (ITG) to those without (ICG) and the presumably positive welfare levels in the ITG would make a case for connectivity. A conceptual graphic below illustrates how the team has structured their approach:

Figure 2: External Group (EG), Internal Control (ICG) and Treatment Groups (ITG) – Two comparisons.



In attempting to prepare a preliminary evaluation result, the impact evaluation is pursuing two strategies that result in essentially two comparisons:

- **For the short-term and for immediate comparison to evaluate the intervention**, comparing the average EG household welfare indicators post-intervention to the average household welfare indicators of ICG and ITG; and eventually; and
- **Over the medium to long-term**, comparing the household welfare indicators between the ICG and ITG that will be indicative of the benefits from the sewerage connectivity (the 'intervention').

The premise in the approaches above is that a) The internal treatment group and internal control groups have the same socio-economic conditions at present, and b) the external group, which already has connection to the sewerage system, had the same *initial* conditions as what the ICG and ITG have at present – before the treatment begins. In the data analysis to follow therefore, it would be crucial to establish that *ITG = ICG.*

This is at present an *ex-post* analysis comparing household groups already connected to household group comprising of those that now are and those that are not. Measuring impacts between the ICG and ITG through the Difference-in-Differences (DiD) methodology (Section 3.3) will be done in the final phase of this impact evaluation study.

3.2 Indicators

Soil and feces samples from children under 12 years old were taken from all the treatment and the control groups. Questionnaires were prepared to measure characteristics for a list of biomarkers that the team identified – and perception indicators were collected from connected and unconnected households before the intervention. These same indicators will be measured 12 months after the intervention. Other outcomes will be also considered such as children's morbidity and mortality, nutrition, and anemia. The design will also measure indicators such as welfare perception, quality of surface water, school attendance, and work attendance.

The impact evaluation team identified the prevalence of parasites in children younger than 12 years old as the relevant biomarker (the team assumes an incidence of 4 to 8 percent before the intervention, and an expectation to find a reduction of 30 percent in the connected clusters). The incidence could be higher if the soil was significantly polluted. Uruguayan epidemiologist belonging to the team's group of local experts has assessed this issue and found that three soil samples should be taken every six months as well as children sample feces.

3.3 Measuring Impacts: The Methodology of Analysis

In addition to the identification of the research questions, the sample structure, treatment and control groups, a systematic impact evaluation requires the definition of a framework of analysis. The study will implement a Difference-in-difference (DiD) approach. DiD methodology consists of measuring the average changes in a given indicator between the periods before and after the intervention for both treatment and control groups, and then comparing the changes for the two groups. The differences between two groups reflect the isolated effect of the program.
This approach requires the existence of base-line and post-intervention information for both groups. For this reason, this project will start with the implementation of a base-line survey collecting information about individual, household and community characteristics of the beneficiaries as well as some indicators. The data collection will include the entire population in the zone selected for this study. The survey will be re-applied to the same sample just before the beginning of the last round of the program.

A DiD econometric analysis will allow verification of the effectiveness of the randomization strategy creating comparable groups and to correct some potential 'contamination' of the data. The before-and-after difference for each group corrects for any remaining fixed difference between treatment and control, while the between groups deal with external factors that affect the target population during the interval of analysis. Assuming that those factors reach treatment and control equally, the second difference successfully isolates the true causal effect of the intervention.

4. DATA ANALYSIS, EVALUATION AND FINDINGS

4.1 Household Data Summary

A statistical summary from the baseline data gives us a profile of the households under this study:

In total, 1386 households were interviewed that included 4,417 individuals. The results show that 47.50% (2,098) of surveyed individuals are male, while 52.50% (2,319) are female. The average age for the individuals is close to 32 years old, and 22.21% (981) of them are 12 or younger. The oldest person in the sample is 96 years old.

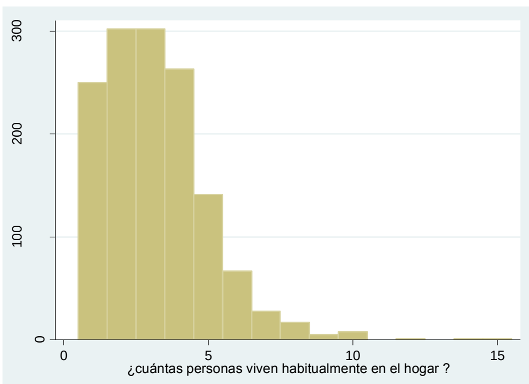
Descriptive Statistics – Structure of the Survey

Variable	Obs.	Mean	Std. Dev.	Min	Max
Male (binary)	4417	0.475		0	1
Age	4417	32.32	21.98	0	96
Younger than 13 (binary)	4417	.2221		0	1
Age of the household head	1386	51.44	12.44	18	96

Source: Survey Data, Impact Evaluation Team, 2011.

Given that we will observe that program's impacts in children, which means we need to focus on the households that have at least two members.

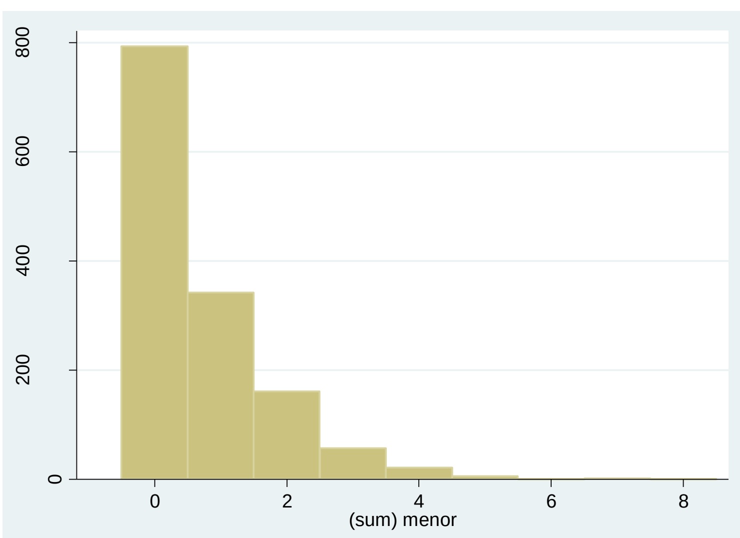
Number of individuals living in the household



Source: Survey Data, Impact Evaluation Team, 2011.

The figue above shows that most households have two, three and four members, with the mean of the household being 3.18 family members. This study looks particularly at the number of children within the households (any household member younger than 12 years is treated as a child). The figure below presents the distribution of children within the households.

Number of children younger than 12 (by household)



Source: Survey Data, Impact Evaluation Team, 2011.

The figure above derived from the data shows that 57.29% of households do not have any children, while 24.68% report having one child, and 11.62% have two children. The number of households with more than two kids is just 6.41%, which amounts to just 89 households. In total, there are 981 children in the survey who are distributed across 600 households.

We are also interested in the variables which show the economic characteristics of the surveyed individuals. The table below presents the descriptive statistics that show the number of hours worked and the monthly income for the participants. The survey indicates that 1633 individuals work at least one hour per week, and that the average is about 8 hours per week. The average monthly income is 9,600 Uruguayan Pesos, with a standard deviation, which equals $6,661.

Descriptive Statistics: Socioeconomic Characteristics

Variable	**Obs.**	**Mean**	**Std. Dev.**	**Min**	**Max**
Hours Worked	1633	7.96	2.64	1	16
Monthly income	1314	9605	6661	200	60000

Source: Survey Data, Impact Evaluation Team, 2011.

The table below contains information about the relevant health indicators in the survey. Only 10.12% of those surveyed had been sick in the past 30 days before the survey. Moreover, just 6.83% of children younger than 12 years old have had diarrhea in that period. Finally, only 22.82% of those surveys had ever been de-wormed in their lives.

Descriptive Statistics – Health Statistics

Variable	Obs.	Mean	Min	Max
Sick in the past 30 days	4405	0.1012	0	1
Dewormed (binary)	4373	0.2282	0	1
Diarrhea in past 30 days	977	0.0683	0	1
Coproparasitic Test I	800	0.1258	0	1
Coproparasitic Test II	800	0.1425	0	1

Source: Survey Data, Impact Evaluation Team, 2011.

The table above also includes the results of the Coproparasitic test, which was given to children younger than 12 who were willing to participate. The first test was administered directly, and it showed that just 12.58% of kids had some type of worm. Most of those had been affected by giardia lambia cysts, as well as by endolimax nana and Ecoli. The second test was done through an enrichment procedure and it showed similar results. Just 14.25% of children had some kind of worm, and the most prevalent ones were the same ones found through the direct test.

The data also reveals general information on the households' situation in terms of water access, hygiene and sewage. Most households are connected to the network provided by the Obras Sanitarias del Estado (OSE). The majority of households (68.76% of them) use water without treating it, while 19.70% of them need to boil the water before using it.

Descriptive Statistics – Variables related to water, hygiene, and sewage

Variable	Obs.	Media	Min	Max
Connected to OSE network	1386	0.9755	0	1
Use water as obtained	1382	0.6876	0	1
Boil water	1376	0.1970	0	1
Disposal of blackwater through the sewage network	1386	0.3287	0	1
Sewage Problems				
Water in ditches	937	0.4408	0	1
Soil contamination	937	0.2305	0	1
Water contamination	937	0.1345	0	1
Proliferation of illnesses	937	0.2017	0	1
Mosquitos	937	0.4995	0	1

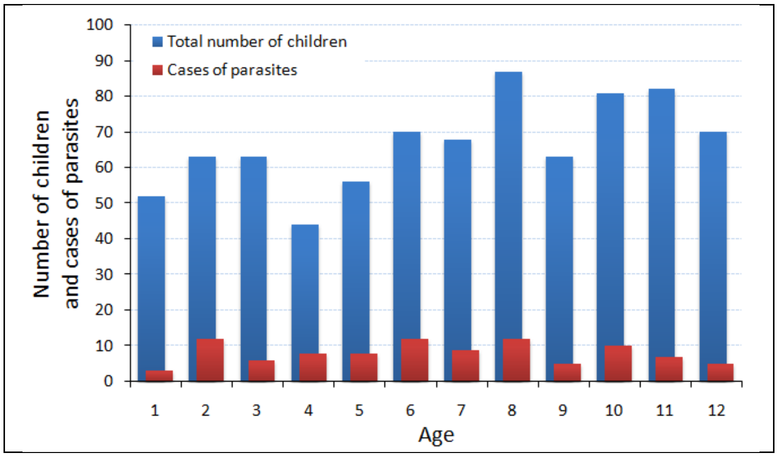
Source: Survey Data, Impact Evaluation Team, 2011.

With respect to the sewage variables, only 32.87% of households dispose of their blackwater through the sewage network. The households that do not have access to the network showed their concern about the presence of mosquitoes, the water that is present in ditches, soil contamination, the proliferation of various illnesses, and soil contamination, in that order of magnitude.

The households, as already mentioned, were spatially distributed in 3 geographic zones comprising of 14 micro-basins (see *Figure 1* for the spatial distribution). All the micro-basins where the external group is placed already have sewerage systems; however, 15% of the households that belong to this group have no domiciliary sewage connection. In contrast, zones belonging to the treatment and internal control group were characterized by absence of sewerage systems. 12.1% of children under-12 has some type of intestinal parasite. Under the scope of this study, 97 out of the 799 fecal samples collected were contaminated with parasites mainly belonging to the groups of Giardia and Endolimax (amoeba). In turn, 58% of the contaminated samples were concentrated in children from 5 to 10 years old.

The connection to the sewerage system is associated with lower parasitic presence. In fact, the percentage of children with parasites is higher in homes with no connection to the sewerage system; 13% of children in the treatment and internal control groups (see yellow dots in Figure 1) tested positive in laboratory fecal tests. This percentage is 25% higher than the one detected in households with sewerage connections belonging to the external group.

Distribution function of parasites by age



Source: Survey Data, Impact Evaluation Team, 2011.

Apparently, areas with sewerage systems generate positive externalities in residents without domiciliary sewerage connection. 15% of the households located in areas with sewerage systems have no intra-household connections, however, in these households the percentage of children with parasites is 10% lower than in households located in areas with absence of sewage systems (with 13% of children contaminated).

Boys are more likely to contract parasites than girls. In fact, the percentage of boys with parasites is 14% while this percentage reached 10% in girls. Likewise, within the group of children with parasites, 57% of cases were detected in boys. Moreover, positive cases detected in homes with sewerage connection (see pink dots, Figure 1) are mainly concentrated in boys (73%). Interestingly, children who tested positive for parasites have used more frequently some type of de-wormer. During the last year, the percentage of children that consumed de-wormers and tested positive for presence of parasites reached 15% while the percentage of children who did not use but tested positive amounted to 11%.

Furthermore, in areas without sewage systems the use of de-wormers is also greater. Over the last year, 20% of children belonging to the treatment and the internal control group have consumed de-wormers while 16% of children in the external group have taken this type of medication. Finally, contrary to what people might think, there are no significant differences in the number of children with parasites between households that boil the water and those who do not. About 9% of children living in homes where the water is boiled tested positive in the presence of parasites.

Finally, the database includes information for the three different groups of households: the Internal Control and Treatment Groups, and the External Group. The first group had access to the sewage system at the time of the survey. The second group consists of households that do not have access, but will get access in the first part of the project. Finally, the third group is made up of households that currently do not have access to the system, but who will gain it during the second phase of the project.

The table below presents the number of individuals, households, and children in each of the three groups.

Number of observations by Group

Variable	EG Group	ITG Group	ICG Group

Number of households	524	473	389
Number of individuals	1610	1548	1259
Number of children in household	330	419	338

Source: Survey Data, Impact Evaluation Team, 2011.

We find small differences in the number of observations for each of the three groups. In general however, these differences are not be a concern as long as they have enough statistical power to be able to evaluate the impact of the project in providing access to the sewage system.

4.2 Balance Statistics: Internal Control and Treatment Groups

Examining the differences between the Internal Treatment and Control groups is crucial: the validity of the information derived from the survey depends critically on the similarity of the households that will eventually receive the treatment compared to those that will not. In order to undertake such an analysis, the table below presents the means for a number of relevant variables and the p-value for the related t-test. The p-value can be interpreted as not rejecting the null hypothesis.

T-tests: Comparison of the treatment and control groups

Variable	ITG (1)	ICG (2)	P-value (3)
Age	30.52	31.12	0.467
People in household	3.273	3.237	0.769
Kids younger than 12	0.886	0.869	0.828
Average income	9073	9035	0.929
% of dewormed	0.211	0.267	0.000
Sick in the past 30 days	0.116	0.117	0.911
Frequency of diarrhea	0.086	0.068	0.389
Percentage of men	0.490	0.477	0.495
Age of the household head	49.14	50.19	0.346
Hours worked per day	7.806	8.100	0.079
Connected to the water network (OSE)	0.967	0.968	0.937
Use water as obtained	0.781	0.754	0.099
Boil water	0.194	0.202	0.598

Source: Survey Data, Impact Evaluation Team, 2011.

The results suggest that the treatment and control groups do not show any significant differences, except for the percentage of de-wormed individuals in each group. The existence of this difference is unexpected. Although the results don't imply that the data is invalid, this small problem should be considered at the time of the impact assessment.

4.3 Summary Statistics: Internal vs External Groups

The differences between the groups with and without access to the sewage network at present makes for a crucial comparison; the table below presents the differences between the households that do not have access to the network yet (Internal Treatment and Internal Control Groups – IG) and those already do (the External Group – EG) for a number of relevant variables. The first two columns show the averages for each of the variables in the respective group, while the third column includes the p-value for the t-test. This value can be interpreted as the probability of not rejecting the null hypothesis of the equal mean tests. As expected, the results show significant differences between groups. This is due to the fact that the groups were not randomly assigned.

T-tests: Comparison of the groups with and without access to the sewage network

Variable	IG (1)	EG (2)	P-value (3)
Age	30.79	34.99	0.000
People in the household	3.256	3.07	0.065
Kids younger than 12	0.787	0.576	0.000
Average Income	9676	11116	0.000
Percentage of dewormed	0.236	0.221	0.246
Sick in the past 30 days	0.116	0.081	0.000
Frequency of diarrhea	0.078	0.047	0.074
Percentage of men	0.485	0.458	0.094
Age of the household head	49.68	54.45	0.000
Hours worked per day	7.930	8.021	0.501
Connected to the water network (OSE)	0.968	0.999	0.000
Use water as obtained	0.769	0.649	0.000
Boil water	0.198	0.125	0.000

Source: Survey Data, Impact Evaluation Team, 2011.

The average age for the group with access to the network is lower (and statistically significant) when compared to the group without access. Moreover, the first group has more individuals and kids younger than 12 in the household (both variables are significant at the 1%), which should be taken into account when analyzing the regression results. Finally, the economic analysis shows us that the households with access to the network have a lower monthly income than those in the other group.

In terms of the health variables, the members of the IG have a higher percentage of de-wormed individuals, but the variable is not significant. The IG also shows a higher incidence of sick persons in the last 30 days and in the frequency of diarrhea in kids. These results are consistent with the idea that having access to the sewage system should improve the health indicators in those households, which explains the better indicators for the EG. However, as long as we do not take into account the households in each group, it is not possible to determine a causal relationship between having access to the sewage system and the health indicators.

4.4 Econometric Results (- ***preliminary***)

Two econometric approaches were performed to obtain an estimation of the potential effects and externalities generated by the access to the sewerage system, particularly, on child health indicators: First, a standard probabilistic model – probit – was applied to estimate the effect of the sewerage connection on the probability of contracting parasites on children less than 12 years of age. Second, a spatial model approach was performed to calculate the externalities produced by sewerage access, by estimating the effect produced by the density (sewerage coverage at 100 and at 200 meters around each of the households under study) on the probability of contracting parasites (see Table below).

Probit regression
Marginal effects on the probability of contracting parasites

Variable	V0	V1	V3	V4	V5
Household with sewer connection*	-0.046 **				
Distance (Hundred of meters)		0.007 ***	0.006 *	0.008 ***	0.006 **
Interaccion (Connection*Distance)			0.004		
Age	0.043 ***	0.043 ***	0.043 ***	0.046 ***	0.052 ***
Age square	-0.003 ***	-0.003 ***	-0.003 ***	-0.003 ***	-0.004 ***
Sex (1=male)*	0.041 **	0.044 **	0.044 **	0.045 **	0.038 **
School attendance*	-0.051	-0.054	-0.053	-0.056	-0.092 *
Dewormed less than a year ago*	0.044 *	0.043 *	0.043 *		
Diarrhea in the last 30 days*	-0.001	-0.005	-0.004	-0.001	-0.016
Homeowner*	0.048	0.041	0.042	0.043	0.025
Household income	0.001	0.001	0.001	0.001	0.001
Boil water*	-0.027	-0.025	-0.025	-0.021	-0.044 *
Sector 1	-0.064 ***	-0.052 **	-0.054 **	-0.054 **	-0.025
Sector 2	-0.043 **	-0.038 *	-0.039 *	-0.038 *	-0.036
Pseudo r2	0.07	0.08	0.08	0.07	0.09
N	798	798	798	798	615

(*) dF/dx is for discrete change of dummy variable from 0 to 1
V1: Includes distance of each house to the closest border separating microbasins with and without sewage
V5: Includes distance of each house to the closest border separating microbasins with and without sewage systems and excludes dewormed children during the last year.
Legend: * p<.1; ** p<.05; *** p<.01

Children belonging to households with sewerage connection are less likely to contract parasites. Households with connection to the sewage system reduce the probability of contracting parasites by 4 percentage points (under the 'V0' column). At first glance, this result seems small in magnitude; however, it represents a decrease of 50% in the probability of contracting parasites when households have no sewerage connection.

However, the effect of the sewerage connection varies depending on the age, this being more pronounced in children at the 6 to 9 years age range. Within this age range, the reduction in the probability of contracting parasites as a result of the sewerage connection is up to 10 percentage points (below).

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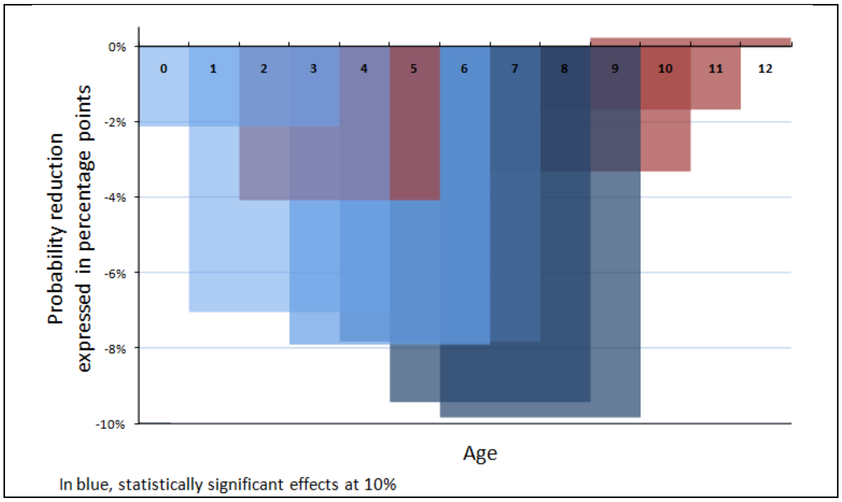
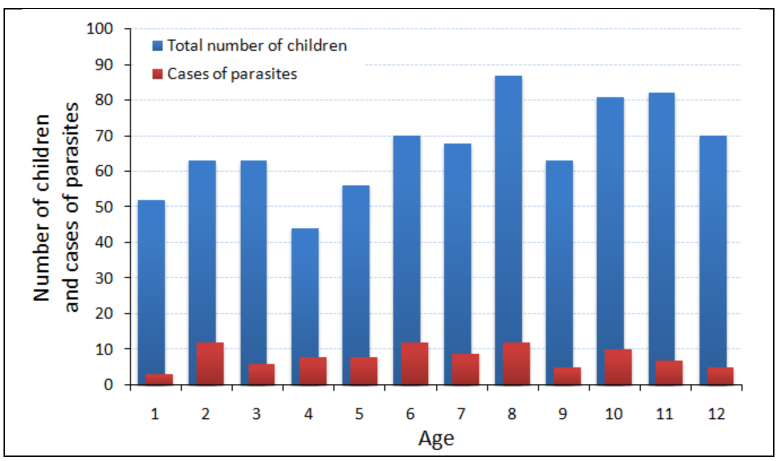
Reduction in the probability of contracting parasites by age group



As the distribution function below displays, there is no particular concentration of children in this age range: 36% of children under 12 who tested positive for parasites presence belonged to this range

Distribution function of parasites by age

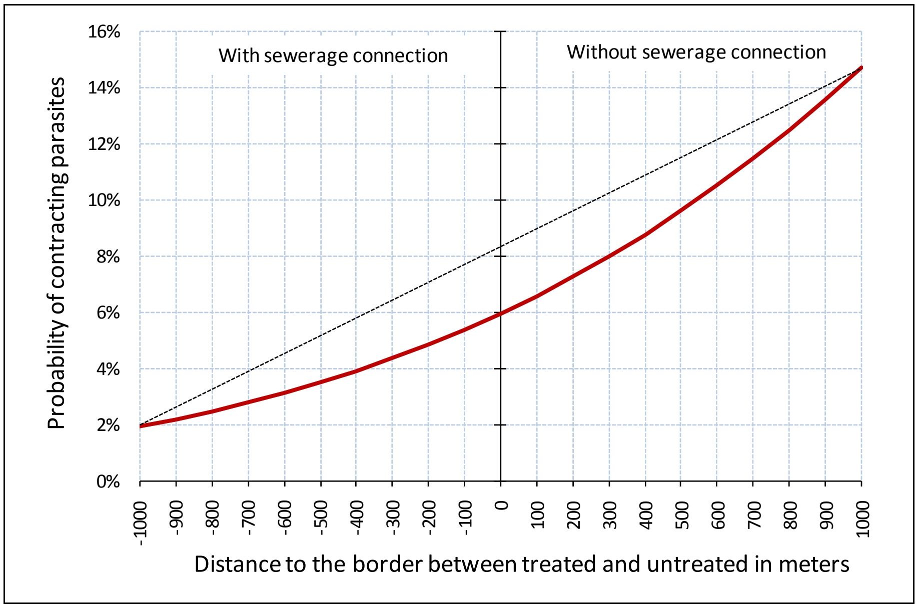


Source: Survey Data, Impact Evaluation Team, 2011.

Boys are more susceptible to parasites than girls, while the use of de-worming is positively related to the presence of parasites. These results are consistent with the preliminary description and raise questions beyond the scope of this study. In both cases, these factors increase the probability of contracting parasites in about 5% (based on the earlier Probit Regression table).

On the other hand, it was calculated the distance of each house to the nearest edge separating households with and without sewerage. This variable was used as a regressor to measure the effect of the nearness or remoteness to homes with and without sewerage. The results show an exponential effect associated with the distance from homes not connected to the sewerage network. Children belonging to households with sewerage connection and located one kilometer away from homes without connection have a probability of contracting parasites 8 times higher than children from homes without sewerage connection living one kilometer away from homes with connection (as displayed in the table below).

Increasing in the probability of contracting parasites by distance

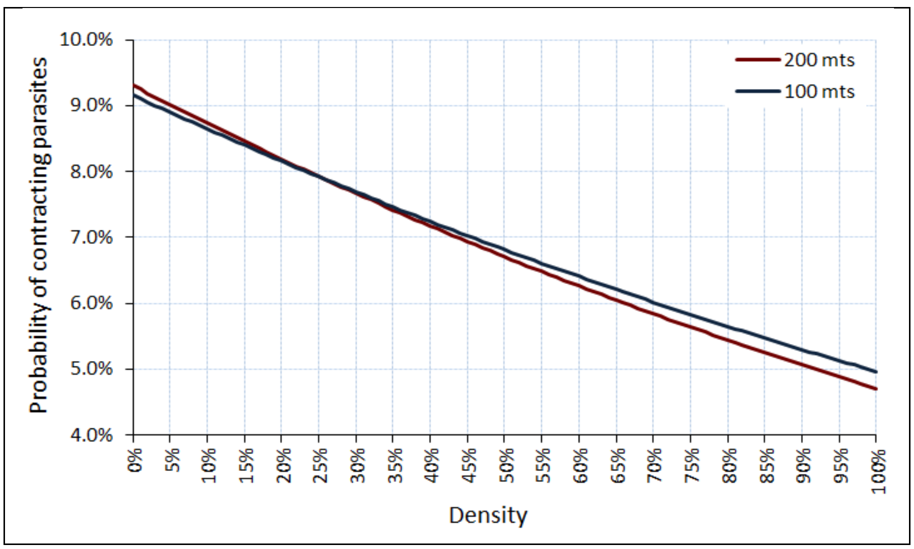


Alternatively, densities (percentage of households with connection to the sewerage system) were calculated at 100 and 200 meter radius of each of the households under study. These densities were used as regressors to estimate the externality generated at different levels of connection on the probability of having parasites. The results show that as sewerage coverage increases, the probability of contracting parasites decreases rapidly (the Density Analysis below). The effect is similar to 100 and 200 meter radius.

Densities analysis		
Marginal effects on the probability of contracting parasites		
Variable	100 mts	200 mts
Density: % Households connected to the sewerage network	-0.049 *	-0.052 *
Age	0.048 ***	0.048 ***
Age square	-0.004 ***	-0.004 ***
Sex (1=man)*	0.048 **	0.049 **
School attendance*	-0.057	-0.056
Dewormed less than a year ago*	0.054 **	0.054 **
Diarrhea in the last 30 days*	-0.007	-0.007
Homeowner*	0.044	0.043
Household income	0.000	0.000
Household that boil water to drink*	-0.033	-0.034
Pseudo r2	0.06	0.06
N	755	755

For instance, the probability of contracting parasites is 9% when connection to sewerage under a 100m radius is close to 0%; however, this probability decreases 47% up to 5% at a coverage close to 100%. This result is consistent with the base-line information (below).

Effect of density on the probability of contracting parasites in children less than 12 years of age



ANNEX 1: Identification Strategy

Establishing a true counterfactual is practically impossible since in theory, we are to compare the *same* subject (in this case, households/blocks) with the intervention and without the intervention over the *same* period of time. Since this is naturally unobservable, a common procedure is to construct a proxy for it by a) identifying two or more groups with similar characteristics and hence the argument for them to be as practically "identical" as possible, and b) dividing the sample in two comparable groups:

Treatment Group:	A representative sub-sample of the target population that will receive the intervention.
Control Group:	A representative sub-sample of the population that will not be intervened (at least initially).

Ideally, groups should be identical (*ex-ante*). They should be equally affected by observable and, especially, unobservable factors – such that on average, ***the single difference between the two groups is the result of the implementation of the program***. This, in the case of Uruguay, makes the case for the WSS program implementation for communities not covered by a sewerage system.

Grouping Households

Assigning households to each group randomly would ideally ensure comparability between the control group and the treatment group. Randomization at the household level presents some problems for the implementation of the connection subsidies. Therefore, the Uruguay evaluation team proposed a robust identification strategy randomizing at the block level. Step-wise:

a) Select a region with a critical mass of households so that it is possible to implement the intervention in phases for the following year and count with the following characteristics:
   - they are not connected to the sewage system;
   - they have similar socioeconomic characteristics' and
   - that households are as representative as possible of households with an income between 25 and 60 UR so that extrapolation of the results are possible at least to households with this level of average income.

b) Identify observation-independent blocks inside the previously selected region. Each one of those blocks is contiguous, at least, to another block in the evaluation areas.

c) Group the blocks in contiguous pairs.

d) Randomly select from each pair a blocks to connect in phase 1 (the other one will be connected in phase 2). The randomization will be implemented together between the evaluation team and staff from OSE.

e) Once this randomization is completed, a representative sample of the beneficiaries in the first intervention phase will be defined as the treatment group while a representative sample of the households belonging to the last intervention phase will be defined as the control group. To this end, OSE will ensure that almost all the households intervened are connected to the sewerage system according to a formal agreement signed by the corresponding authorities.

f) Finally, data collection will be done at the beginning of the first phase (baseline) and before the beginning of the last phase.

To evaluate the intervention externalities and be able to answer the second research question ("Are there any health externalities in terms of sewerage coverage in health outcome?"), we need alternative adoption densities. To this end, we will artificially create different densities, and compare the observation results across them. The procedure is the following: after the intervention, in each frontier between two blocks belonging to the same pair, there will be households connected (the ones belonging to the treated group) and households that are not connected (those belonging to the control group). The density in such a frontier is 50 percent of households connected. The results for the chosen biomarkers in that point will be compared with the results of the closer point in which density is 100 percent, namely in the middle of a cluster belonging to the treated group, and with the closer point in which density is 0 percent, namely in the middle of a cluster in the control group. Intermediary densities can also be compared to understand for which density the benefits in human development indicators start to be as high as in the case of a maximum density of 100 percent.

Annex 2: Formal Agreement Signed by OSE Regarding Connection Subsidies

<u>**ESTUDIO DEL IMPACTO DEL SANEAMIENTO EN LA SALUD PÚBLICA**</u>

Noviembre de 2009

La finalidad del presente estudio es determinar el impacto que tiene la conexión al saneamiento público a través de la red de colectores, en la salud pública.

Para ello se eligió trabajar en la ciudad de Treinta y Tres, capital del Departamento del mismo nombre. Se trata de una localidad con aproximadamente 26.000 habitantes, que consideramos representativa de las ciudades del interior del país que constituyen los potenciales clientes de OSE.

En la actualidad cuenta con 12.450 conexiones de agua y 7.375 de saneamiento, lo que implica una cobertura del 59% de saneamiento respecto a las de agua potable.

La ciudad posee Planta de Tratamiento de Efluentes, consistente en un tratamiento secundario mediante Aireación Extendida, con vertido final al Río Olimar. La capacidad de la misma se estima suficiente a un horizonte de proyecto previsto al 2030.

Actualmente las viviendas cuentan con soluciones individuales (en general “pozos negros”). Si bien en su mayoría se encuentran en los frentes de las casas, en algunos casos se sitúan en el retiro lateral o en los fondos. Tal como sucede en la mayor parte de las localidades, el vaciado de los mismos con camiones barométrica, no se da con la frecuencia que sería deseable, estimándose que en reiterados casos los mismos infiltran al terreno y muchas veces sufren desbordes.

Para el estudio fueron elegidas 14 “cuencas” agrupadas en 3 zonas de la ciudad. Las mismas son de similares características en lo social, cultural y económico, y cumplen la condición de no tener escurrimientos pluviales cruzados que pudieran permitir contaminación entre las mismas por esta vía.

Totalizan unas 1.000 viviendas, además de dos Escuelas Públicas y una Policlínica barrial.

Indicamos en el siguiente cuadro las características y obras necesarias para la red de saneamiento:

<table>
<tr><th>Cuenca</th><th>Nº viv. Proyecto Red</th><th>Long.red (mts)</th><th>Densidad (viv./100m)</th><th>Nº viv. Estudio</th><th>Long.emisario (mts)</th><th>Pozo Bombeo</th><th>Long. Impulsión (mts)</th></tr>
<tr><td>1</td><td>37</td><td>540</td><td>6.8</td><td>37</td><td>120</td><td>No</td><td></td></tr>
<tr><td>2</td><td>85</td><td>1470</td><td>5.8</td><td>78</td><td></td><td>No</td><td></td></tr>
<tr><td>3</td><td>84</td><td>1400</td><td>6.0</td><td>65</td><td></td><td>No</td><td></td></tr>
<tr><td>4</td><td>97</td><td>1300</td><td>7.5</td><td>97</td><td></td><td>No</td><td></td></tr>
<tr><td>5</td><td>97</td><td>950</td><td>10.2</td><td>97</td><td></td><td>No</td><td></td></tr>
<tr><td>6</td><td>31</td><td>320</td><td>9.7</td><td>30</td><td rowspan="3">280</td><td>No</td><td></td></tr>
<tr><td>7</td><td>62</td><td>700</td><td>8.8</td><td>51</td><td>No</td><td></td></tr>
<tr><td>8</td><td>29</td><td>700</td><td>3.6</td><td>21</td><td>No</td><td></td></tr>
<tr><td>9</td><td>88</td><td>1780</td><td>4.9</td><td>68</td><td></td><td rowspan="2">Si</td><td rowspan="2">600</td></tr>
<tr><td>10</td><td>156</td><td>2500</td><td>6.4</td><td>156</td><td></td></tr>
<tr><td>11</td><td>75</td><td>1135</td><td>6.6</td><td>75</td><td rowspan="2">300</td><td rowspan="4">Si</td><td rowspan="4">600</td></tr>
<tr><td>12</td><td>23</td><td>353</td><td>6.5</td><td>23</td></tr>
<tr><td>13</td><td>34</td><td>744</td><td>4.6</td><td>34</td><td></td></tr>
<tr><td>14</td><td>80</td><td>1831</td><td>4.4</td><td>80</td><td>280</td></tr>
</table>

987 viv.	15.732m	6.3	912 viv.	980m	1.200

De acuerdo al mecanismo de trabajo previsto, el agrupamiento en pares de cuencas será el siguiente: 1 y 2; 4 y 5; 6 y 7; 8 y 3; 9 y 10; 11 y 12; 13 y 14.
Debe tenerse en cuenta que las cuencas 10 (12) y 13 cuentan con una Escuela Pública cada una.

A efectos de asegurar el éxito del trabajo, se estimulará y financiará la conexión al saneamiento a construir, por diversos mecanismos en coordinación con la Intendencia Municipal:

- Exoneración por parte de OSE de la tasa de conexión entre la red intradomiciliaria y la red externa de OSE.

- Programas de financiamiento por parte de OSE para la adecuación de la sanitaria interna. Se trata de un préstamo pagadero en hasta 36 cuotas. Hasta la cancelación del mismo, no se le cobrará al cliente la tarifa correspondiente al cargo variable. Esta financiación se puede otorgar por OSE directamente al vecino o a través del Convenio con la IM de Treinta y Tres.

- Aplicar los criterios del nuevo convenio con IM de Treinta y Tres para financiar junto con OSE, a través del denominado “Plan Conexiones” de la Intendencia, un número limitado de obras intradomiciliarias dirigido a los vecinos de más bajo nivel socio-económico.

- Utilizar el acuerdo entre el MIDES (Ministerio de Desarrollo Social) y OSE para construir conexiones al saneamiento (incluyendo la obra intradomiciliaria) dirigido específicamente a los vecinos que estén inscriptos en el Plan de Equidad del MIDES. Estos vecinos pagan solamente una cuota fija y muy bonificada por los servicios de agua y saneamiento (actualmente $ 61 por tarifa de agua mas $ 37 por tarifa de saneamiento).

- La Intendencia Municipal restringe el envió de servicios de barométrica subsidiados a vecinos de barrios en que cuentan con redes de alcantarillado.

- Trabajo educativo de concientización respecto a la importancia de contar con la conexión al saneamiento. Se prevé realizar el mismo por parte de asistentes sociales de la Intendencia Municipal y de la Oficina de Relaciones Públicas de OSE, en parte a través de los centros de enseñanza del barrio.

Las líneas de acciones estratégicas se apoyan en los siguientes acuerdos institucionales ya firmados:

- Convenio Marco entre la IM de Treinta y Tres y OSE, de Octubre de 2003, para la Ejecución de Obras del Programa de Ampliación de Redes de Alcantarillado. OSE y la IM asumen responsabilidad en la ejecución de Programas de Educación Ambiental.

- Acuerdo Marco de Cooperación Interinstitucional para Obras de Saneamiento entre la IM de Treinta y Tres y OSE, del 3 de Agosto de 2007, para facilitar el acceso al saneamiento mediante una acción coordinada para facilitar la financiación y realización de las obras de conversión de la sanitaria interna para la población de menores recursos. Se exonera de pago del cargo variable de la tarifa de saneamiento a todos los usuarios amparados en el Convenio. En ningún caso se brindará o financiará servicios de barométricas a las partes beneficiadas por el presente Convenio.

- Convenio entre OSE, el Ministerio de Vivienda, Ordenamiento Territorial y Medio Ambiente (MVOTMA) y el Ministerio de de Desarrollo Social (MIDES), destinado a otorgar a los núcleos o grupos amparados por dichos Ministerios, una tarifa subsidiada, disponiendo de un régimen especial, de acuerdo a sus posibilidades socio económicas (tarifa de agua subsidiada $61 y tarifa de alcantarillado subsidiada $36). El convenio comprende además la posibilidad de realizar obras de saneamiento destinadas a hogares en situación de vulnerabilidad socio económicas. En estos casos el MIDES suministrará mano de obra, capacitación y los materiales para la sanitaria interna; OSE suministrará la cámara, el seguimiento y la dirección de obra.

- Resolución de Directorio que exonera del pago de la tasa de 2 UR por conexión a la red de alcantarillado.

Ing. Rosanna Pagano
SubGerente Saneamiento

Ing. Natan Wajner
Gerente Prog. con Financ. Externo