Financing Municipal Water and Sanitation Services in Nairobi's Informal Settlements: IRB proposal and approvals

The below submission was first reviewed and approved in 2013 for the original Sanitation subsidy study. In July 2018 the proposal was amended to include the repayment component of the study. The same proposal was used for IPA and Maseno IRBs. In July 2018, the IPA IRB requested further clarification on the process of disconnections prior to approval and the response is provided below (under title "Email Clarification"). IPA and Maseno approval certificates, together with the NACOSTI research permit are available publicly and accessible in the embedded hyperlinks. The IPA IRB has also released a statement in September 2020 about the process followed which can be found here.

1. **Title of the application/proposal**

Demand for Sanitation in Kenyan Urban Slums

2. **Names of the investigators/applicants, co-investigators/co-applicants and supervisors (where applicable). In addition, the addresses, signatures and curriculum vitae should be included**

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4. Names and addresses of sponsors and/or funding agencies

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Email clarification to IPA IRB Board (July 31 2018):

*Currently NCWSC has a standard disconnection policy where households that fail to pay their bill and are in arrears of more than 30 days are served a notice of disconnection. They are given 15 days to meet their payment or will be subjected to a disconnection. In practice, in informal settlements, the number of households in arrears is large, and implementing their official policy would result in more than 70% of compounds being disconnected in the study area (based on billing data). This level of disconnections is both undesirable and unfeasible from NCWSC's perspective, and so the study is designed to implement a narrower version of the disconnection policy, with the same conditions, but only targeting a randomly selected subset of **disconnection-eligible** households for actual disconnection notices. While exact numbers will differ by block, the local proportion of compounds in any block receiving disconnection notices will not exceed 10% which is well below the actual proportion of disconnection-eligible households. Further, control blocks will be subject to 0% possibility of disconnection, meaning that the overall likelihood of being subject to disconnection in the study area will be even lower. While NCWSC's enforcement of the disconnection policy in informal settlements has been ad hoc to date, they are expanding these activities, and the study will help direct these activities in a small-scale, targeted approach, with the aim of keeping actual disconnection rates well below what the official policy dictates.*

The broader study objective is to help NCWSC identify sustainable solutions to repayment. Without this there is a non-trivial chance that NCWSC would need to withdraw water resources provided to some informal settlements and will avoid further expansion of services into new informal settlements. As such, evidence from this work has the overall objective of increasing water and sanitation coverage rates even if a subset of households will be disconnected as part of the process.

5. An abstract (summary) of the proposed study/project not exceeding 400 words

This study will investigate the demand for household connection to municipal sewage systems in informal slums in Nairobi Kenya. Governments are investing in expensive sewerage systems to bring sanitation services to the household door. The cost-effectiveness of these investments depends on the number of households that connect the sanitation systems. However, there are large fixed costs to connect to sewage systems including both the costs charged by the utility investment in household sanitation facilities and pipes to connect from the house to the network. Given these high costs, the extent to which low-income households in slum areas are likely to benefit from this investment is unclear.

The study will employ a randomized control trial (RCT) to estimate price elasticity of the demand for connections and the extent to which price elasticities depend on information about the relationship between sanitation and health. Partnering with Nairobi Water and the Water and Sanitation Program (WSP) of the World Bank, two cross-cutting interventions in Soweto, Kayole will be implemented: a targeted hygiene campaign and varying subsidy levels designed to promote take-up of household connections to the sewage system.

This evaluation will assess the individual impacts of the treatments described above on sanitation demand, as well as the interaction between the two. It will also consider complications related to collective action in multi-household compound connections and resident versus non-resident landlords. Results from this study are critical to developing pricing/subsidy and information campaign policies to cost-effectively improve connectivity.

The study will continue to track compounds connected to the sewer system with the objective of testing approaches to learn how to increase customer repayment of water and sewer services and loans. In partnership with the Nairobi City Water and Sewerage Company (NCWSC) who were responsible for connecting these compounds, we will test the role of enforcement (disconnections) and positive reinforcement (financial planning and debt relief) approaches to improving repayment behavior, as measured by administrative customer billing data.

6. The introduction or background of the study/project

Access to safe water and sanitation is essential for health and welfare, and is especially critical to women and children. Approximately 88 percent of all diarrhea infections are attributed to unsafe water supply, unsafe hygiene practices, and lack of basic sanitation infrastructure (Evans, 2005). Improved water supply and sanitation interventions could thus provide a wide range of benefits: longer lifespan, reduced morbidity and mortality from various diseases, higher school attendance, lower health costs, and lower time and effort devoted to managing water and waste.

As many as 2.5 billion people in the developing world have no access to improved sanitation, and over a billion of them still practice open defecation. While the situation in urban areas is better than in rural areas, rapid urbanization has resulted in an increase of 183 million people without access to improved sanitation in urban areas. The inability of the utilities to deliver adequate sanitation services has disproportionately hurt poor urban residents, especially those living in informal settlements in urban areas.

Despite the potential health benefits of improved sanitation, there are many barriers to achieve greater coverage in urban areas (JPAL 2012). While one of the major barriers is insufficient supply, even in places where sewerage systems are in place, there are likely demand constraints that limit people's access. Such demand constraints exit when there are large fixed costs to connect to sewage systems. Connection costs not only include costs charged by the utility, but also the investment in sanitation facilities and pipes to connect from the house to the network of municipal sewage pipes. Demand may be limited by liquidity constraints and low willingness to pay. Liquidity constraints are likely to be especially constraining to poor households. Low willingness-to-pay could be due to a lack understanding of the relationship between sanitation and health, and especially a barrier in poorer households with less education.

The World Bank's engagement with the NCWSC is seen as a test case for assessing the financial viability of expanding services to informal settlements through utility credit on-lended to consumers. With high existing rates of default, the program's success critically depends not only on connecting compounds to the sewer system, but also ensuring they pay. This requires identifying the right balance between stronger accountability and incentives when strong enforcement measures are met with political resistance. The results of this study will bring new evidence on how to effectively deliver and manage water and sanitation services in large informal settlements, to improve the health, prosperity and dignity of slum dwellers. Ultimately, the economic benefits of adequate sanitation and slum upgrading will help policymakers to create cities that drive economic growth, rather than sustaining poverty traps.

7. Literature review of the study/project

There are a few studies assessing willingness to pay for improved water. Randomized experiments in Zambia (Ashraf et al., 2010) and Kenya (Kremer et al., 2009; Kremer et al., 2011) suggest that the willingness to pay for improved water quality is low in terms of money spent on chlorine or time allocated to water collection. In addition to low willingness to pay, poor households may not fully understand the benefits of the new technologies, have a wrong assessment of its costs, or there may face behavioral constraints. For instance, in Morocco, Devoto et al. (2011) found increases in household water connections by 59 percentage points when a credit option was provided, and in Bangladesh, households switched taps in response to warnings about arsenic at the cost of collecting much dirtier water (Soumya et al., 2011).

However, there are few if any studies on the willingness to pay for sanitation services, especially to connect to sewage in urban areas. In the long run, laying sewage pipes is likely to be the most cost-effective solution to remove human excrement from crowded urban area. However, sewage systems would be ineffective if few households connect to the system. Connection pricing, targeted subsidy policies, and information campaigns will be critical to maximizing the number of households that connect to urban sewage systems and therefore to the cost-effectives of investment in sewage systems on health

outcomes. Understanding the demand for connection to the sewage is key to developing these policies. The limited existing evidence on subsidies and/or lines of credit in WASH have been successful in increasing household-level access (e.g. Devoto et al. 2012, Guiteras et al, 2015), but this can increase the debt burden of utilities and households if customers fail to pay. There is a small, but growing evidence base on approaches to increase household take up of electricity (Lee et al, 2016), water (Devoto et al, 2012) and sanitation (Guiteras et al, 2015) but this research does not extend to questions regarding financial sustainability after connections are made. The evidence on changing customer usage and payment behavior has mostly focused on using information campaigns appealing to social norms to reduce waste (e.g. Ferraro et al, 2011; Alcott, 2011) or promoting repayment behavior (Szabo & Ujhelyi, 2015), or providing metering systems (e.g. Jack & Smith, 2015; McRae, 2015).

8. The rationale of the study/project

The objective of this research is to begin to fill this gap in knowledge by studying the demand for sanitation in informal urban slums in Nairobi. The Kenyan Government, through a loan form the World Bank, is installing a municipal sewage system in slums around Nairobi. However, the costs of household connection to the system are substantial. We propose to estimate the price elasticity of demand for connection and how the price elasticity varies with knowledge of the role of proper sanitation in health outcomes. Moreover, we will investigate how collective action problems affect demand.

The demand for sanitation services is likely confounded with collective action problems. Moral hazard and free riding problems typically arise when the sanitation infrastructure is shared. In urban slums, multiple households typically live in compounds that share a single connection to the sewage network. There also may be differences in willingness to pay when the landlord is resident versus absentee. Absentee landlords might benefit from increased rent that they could charge by connecting their property to the sewage network, and resident landlords should additionally benefit from the health value of having sanitation in their homes. If the demand for sanitation is substantially different, pricing policies might have to be different depending on the structure of housing compounds and whether the landlord is resident.

A related issue is that subsidized sewage connection might allow landlords to raise housing rent to tenants. If tenants are not willing to pay the increased rent, then they may be forced to move further disadvantaging the poor. Hence, rather than subsidizing the cost of connection to the landlord, it might be better to subsidize tenants' rent in newly connected compounds thereby mitigating the impact on poor tenants.

Understanding the underlying reasons that can potentially encourage adequate demand for urban services is the first step to design the most suitable incentive mechanisms to ensure adequate provision of these services and maximize their health externalities. There are very few rigorous studies that unpack the demand for sanitation services and take up rates for sewerage connections. Thus, the focus of this evaluation will be to understand the demand curve of sanitation services. Achieving impacts in health and welfare are critically dependent on the earlier stages of the causal chain, and therefore understanding how to increase demand for sanitation services will fill an important knowledge gap needed to maximize the potential impacts of these services on longer-term outcomes. In so doing, this evaluation will inform the Government of Kenya and other developing countries on how to effectively deliver services to informal settlements**.** However, even after increasing connection rates, low repayment rates threaten the sustainability and incentives of utilities to expand access to the urban poor. Combining limited

ability/willingness to pay with weak and ad hoc enforcement mechanisms in informal settlements, where the majority of Kenya's urban poor live, means that defaulting on monthly fees for water and sewer charges is the norm rather than the exception. The NCWSC currently has just over 8300 customers connected with water meters and sewerage in informal settlements. More than half are yet to make a payment for their services and nearly 60% have loans for sanitation upgrades and sewer connections (taken through the NCWSC) that are now larger than their original loan amount. This increasing debt creates a substantial challenge for households, and the utility. For customers, the use and payment of water and sanitation services faces collective action problems since, in Kenyan urban slums, multiple households typically live in compounds that share a single water meter and connection to the sewage network.

9. The hypotheses and/or research questions of the study/project

Research Questions:

- What is the overall price elasticity of the demand for sewerage connections?
- How does the price elasticity of demand change with better knowledge of the role of sanitation and preventing illness?
- How does the price elasticity differ as the number of residents in the compound grows?
- Is the price elasticity different when the landlord is resident versus non-resident?
- How much of the cost of connection is passed onto tenants and how does connection to the sewage systems affect housing rental prices?
- How does increased threat of enforcement affect water and sewer repayment rates among informal settlement residents?
- Can approaches focusing on positive reinforcement (namely face-to-face contact from the utility to help with financial planning) improve repayment behaviors on their own, or do they require credible enforcement?
- How do compound water/sewer disconnections affect neighboring compounds water use and repayment behavior?

10. Objectives of the study/project subcategorized into:

i. Broad objective(s)

The overall objective of this research is to study the demand for sanitation in informal urban slums and subsequent sewer loan/service repayment behavior. The lessons from this evaluation will inform the Government of Kenya on how to successfully scale up the delivery of sanitation services. Other developing countries will also benefit from understanding the main factors that constrain sanitation demand and repayment behavior, and thus may replicate the approach to effectively increase sanitation coverage among the urban poor and how to effectively and sustainably upgrade slum areas. We expect that the results from this study will inform pricing, subsidy, enforcement and information campaign policies aimed at cost-effectively maximizing connections to sewage systems and improving the living of poor residents.

ii. Specific objective(s)

a. Estimate the price elasticity of demand for connection. We will use data generated from a random offering of different subsidy amounts to estimate the demand function. By observing take-up at different levels of subsidies, we will trace out the demand function of poor households for sanitation connections.

b. Estimate the effect of an awareness campaign that promotes the benefits of sanitation and hygiene, combined with access to sewerage connections – how this affects take-up and the price elasticity of demand. We will randomly assign each household an information and promotion campaign to treatment and control groups within each subsidy level stratum.

c. Estimate how take-up rates and the price elasticity vary with the number of households in a compound and if the landlord is also a resident. We will stratify the random assignment with strata defined by the compound size and residence of landlord.

d. Measure the extent to which the landlord passes on the costs of connection in terms of either lump sum payments or increased rent to already impoverished tenants, and how the amount passed on depends on the number of tenants, residence of the landlord, and altruism of the landlord.

e. Estimate the effect of increased threat of enforcement on water and sewer repayment rates and water use among informal settlement residents

f. Estimate the effect of positive reinforcement (namely face-to-face contact from the utility to help with financial planning) of repayment behaviors on their own, in comparison to when combined with credible enforcement?

g. Measure the extent to which compound water/sewer disconnections affect neighboring compounds water use and repayment behavior

11. Description of the Study/project area/region, design, materials and methods

The Government of Kenya spent approximately $427 million on water and sanitation bulk infrastructure upgrading between 2012 and 2016. However, the extent to which low-income households in slum areas are likely to benefit from this investment is unclear since the costs that households will need to incur to connect to the system will remain substantial. To address this, the Global Program on Output Based Aid (GPOBA) is offering landlords subsidies to offset the upfront costs of connecting to the piped water and sewerage system in a large informal settlement, Soweto, Kayole.

The study will explore the extent to which demand for sanitation is affected by price and information about the link between sanitation and health by partnering with Nairobi Water and the Water and Sanitation Program (WSP) to implement two cross-cutting interventions: a targeted hygiene campaign and varying subsidy levels designed to promote take-up of household connections to the sewage system. After connecting households to the water and sewer systems however, many households are not repaying service and loan fees and NCWSC is developing a set of different interventions that can improve repayment behavior across 9 informal settlements in Nairobi. These are Kayole Soweto, Matopeni, Riverbank, Mowlem, Canaan, KCC, Kibera, Makongeni, Mbotela.

To address low sanitation coverage in these informal settlements, the Government is investing in municipal sewage systems to bring sewage pipes to the door of households so that human waste can be removed from the slum. Piped water and sewerage services will be offered to all compounds through a single connection within the informal settlements included in the project areas. Services will be offered to compound landlords on a first-come, first-serve basis. Each compound has around 6-10 dwellings. The landlord resides in one of the dwellings is about 70% of compounds and is absent in the remainder. The rest of the dwellings are leased to independent households.

Data Collection:

The main source of data to determine the demand for sanitation will be a combination of household questionnaires and administrative data. The main outcome of interest to be measured will be take-up of sanitation services and how this relates to various baseline covariates. The physical structure of each compound will be mapped and quality of water and sanitation facilities will be assessed through direct observation. These characteristics will be used as controls in the rent analysis.

All tools, data collection protocols and survey instruments will rely on what has already been extensively tested. Survey instruments will draw from other tested survey instruments used in previous projects participating in the DIME urban program (ur-DIME), as well as recent WSP studies (for example the structured observation protocol used in the WSP global evaluation program for scaling up hand washing as well as protocols for collection and analyses of water).

Between August and October 2014, we successfully conducted listing exercise on 4023 compounds in Soweto, Kayole. This was followed by the first phase of baseline activities from September through December 2015 which was the Landlord Survey which was done on 2,760 compounds out of 4,023 listed. The baseline survey on 2,295 compound landlords collected socio-economic information, wealth, credit history, ownership and value of the compound, rents and policy for late payment, knowledge and attitudes towards hygiene and health, and interaction with and knowledge of tenants.

From June – October 2016 (with follow-ups to March 2017), we administered a Tenant survey with up to 3 household heads (male or female) per compound, resulting in about 4430 household surveys from 2097 compounds. This survey collected data on socio-economic characteristics; sanitation facilities, use, practices, and satisfaction; water sources, use, storage, treatment, and cost; hygiene and hand-washing knowledge and practice; altruism, reciprocity, and risk preferences; and limited health outcomes such as diarrhea and child weight for height to be able to assess power for the possible health impact follow-on study.

When available, administrative data will be used to cross-check information on take-up rates. Administrative data will also be collected and used to measure costs of the interventions. Direct costs include the subsidies, the administrative costs to deliver them, and the cost of the information campaign. We will use these costs to measure the cost-effectiveness of alternative subsidy and promotion campaigns in terms of take-up.

We will also conduct a short follow-up survey after the intervention to verify the proper installation and use of sanitation facilities, satisfaction with the new sanitation facilities, other investments in housing that might have been made, changes in rent, and changes in tenants.

We will study two interventions deigned to promote take-up of household connections to the sewage system:

1. Three subsidy amounts – a low subsidy, a medium subsidy, and a large subsidy. The low subsidy amount is the subsidy being offered by GPOBA. The medium and high subsidy amounts will be decided based on the results of formative research on willingness to pay for sanitation services, which will be conducted as part of this study. The subsidies will be delivered in the form of vouchers that will be difficult to sell in a secondary market. The operational aspects of the voucher program will be designed and implemented by a local NGO with oversight from the research team.

2. An information campaign that promotes hygienic practices such as sanitation facility use, hand washing, and drinking water. The promotion campaign is being designed and delivered by the Water and Sanitation Program (WSP) in the World Bank and will explicitly incorporate learning from previous WSP activities including a recent series of impact evaluations exploring the effectiveness of these campaigns.

The identification strategy is to generate exogenous variation through random assignment of the two interventions. The study site consists of 2,335 eligible compounds that each have between 6-10 dwellings. The connection to the sewage system is at the compound level. Given the density of the slum, there may be spillovers in both the information campaign and knowledge of subsidies that may affect take-up and health outcomes in a follow-up study. To minimize potential contamination, we will group the compounds into neighborhood clusters called blocks (about 10 compounds each). The unit of intervention will be the compound and we have 234 blocks.

The evaluation design consists of randomly assigning blocks into the two interventions, creating five treatment groups and one pure control group. There will be 3 different levels of subsidies—low, medium and high[1]—randomly offered to landlords. The different levels of subsidies will be accompanied with a hygiene promotion campaign. Specifically, the blocks will be randomly assigned into arms of the study as presented in the table below. The sample sizes are also specified in the figure.

The random assignment into these groups will be stratified by whether the landlord is resident or absentee and by number of households in the compound. We will define large compounds as those with more households than the median compound and small ones as the remainder.

Table 1: Experimental Design

	No info / hygiene campaign	Info / hygiene campaign

1   The low subsidy amount is the subsidy being offered by GPOBA. The medium and high subsidy amounts will be decided based on the results of formative research on willingness to pay for sanitation services, which will be conducted as part of this study.

Low subsidy (Standard subsidy)	C - Pure control: Low subsidy (389 Compounds)	T1- Treatment 1: Low subsidy + info/hygiene campaign (389 Compounds)
Medium subsidy (Commitment fee)	T2- Treatment 2: Medium subsidy (389 Compounds)	T3- Treatment 3: Medium subsidy + info/hygiene campaign (389 Compounds)
High subsidy (Commitment fee ++)	T4- Treatment 4 High subsidy (389 Compounds)	T5- Treatment 5 High subsidy + info/hygiene campaign (389 Compounds)

Since treatment assignment will be random we assume treatment and control groups will be balanced and comparable. Thus, the causal impact of the intervention will be estimated by using differences in mean outcomes between treatment and control groups. We will also estimate a series of models that condition on landlord and tenant characteristics to attempt to reduce residual variation and increase statistical power.

For sample size calculations, we use latrine connection rates as our main indicator of interest for take-up. At baseline, none of the households were connected to the sewage system. Assuming intra-cluster correlation of 0.01, a significance level of 0.05, and 0.80 power, we can detect .05 differences between each of the arms of the study. The landlord and up to three households in the compound were surveyed.

We expect the demand for sanitation to be price elastic. One reason for such high price elasticity might be that households do not sufficiently value proper sanitation because they don't understand the relationship between proper sanitation and health outcomes. In fact, there is evidence that awareness of potential benefits from a product may interact with the associated demand curve (Ashraf et al., 2013), as well as the identified importance of appropriate hygienic behavior (Luby et al., 2013), and water quality in influencing health outcomes (Kremer et al., 2010).

This hypothesis will be tested by examining whether an information and promotion campaign raises the demand for sanitation at each subsidy level. In this case, subsidies combined with an information campaign would best encourage take-up. However, another reason for low take-up could be that households value sanitation but have hyperbolic discount rates causing them to procrastinate. In this case, even though they know sanitation is good for them, people may put off the investment because they believe that they will have time to do so later since the benefits only accrue to them later. In this case, the information campaign will add little.

The demand for sanitation services is also likely to be confounded with collective action problems. Moral hazard and free riding problems typically arise when the sanitation infrastructure is shared. In many urban slums, multiple households live in compounds that share a single connection to the sewage network. Landlords may be unwilling to pay the cost of connection if they cannot recoup all or some of the cost from tenants either through increased rent or cost sharing. The per-household cost sharing needed to cover costs will be smaller in larger compounds. Hence, larger compounds might require a smaller subsidy in order to induce the landlord to connect. In this case, a policy that has smaller subsidies for larger compounds would achieve higher connection rates than uniform subsidies for the same total budget for subsidies. On the other hand, larger compounds may lead to more free riders so that some tenants may refuse to participate in the payments and thereby freeze collective action to pay for the connection. In this case, a policy that had larger subsidies for larger compounds would achieve higher connection rates than uniform subsidies for the same total budget for subsidies.

We also propose to measure how the cost is shared between tenant and landlord, and whether the connection results in increased rent that the landlord might be able to get from the market for the improved housing. If the sewage connection allows landlords to raise rent to tenants and current tenants are not willing to pay the increased rent, then they may be forced to move, thereby further disadvantaging the poor. We will also assess the extent to which altruism and reciprocity traits on the part of both landlord and the tenants affect the distribution of costs, and the extent to which the landlord living in the compound affects the distribution of the costs. Altruistic landlords may not pass on much of the cost, where reciprocal landlords will likely pass them on. If most or all the costs are passed onto tenants and rents raised, then rather than subsidizing the landlord, it might be better to subsidize tenants' cost-sharing conditional on being able to maintain residency in newly connected compounds.

There also may be differences in willingness to pay when the landlord is resident versus absentee. Absentee landlords might benefit from increased rent that they could charge by connecting their property to the sewage network, and resident landlords should additionally benefit from the health value of having sanitation in their homes. Moreover, an absentee landlord is probably less likely to be able to solve the collective action problem to be able to pass on the costs to the tenants. If the demand for sanitation is substantially different, pricing policies might have to be different not only depending on the size of housing compounds but also based on whether the landlord is resident.

In the additional component of the study focused on compounds that have already connected to the sewer line, the following interventions will be rolled out:

The NCWSC has developed a self-reading, mobile-based billing system together with the World Bank to help simplify invoicing and payments, but this depends heavily on customers' compliance with submitting readings and paying bills. NCWSC has a standard disconnection notice used in more affluent, stable areas of Nairobi (offering a 15 day notice and then disconnecting the water line) but has not rolled it out consistently in informal settlements. The main outreach is done through community development assistants (CDAs) who are NCWSC staff and go door-to-door to discuss repayment issues with households. The interventions will test different approaches to enforcement and encouragement that will be communicated through CDAs.

Project area:

The activities will cover the customers that have accounts with NCWSC in 9 informal slums in Nairobi, Kenya including Kayole Soweto, Canaan, Kibera, KCC, Makongeni, Matopeni, Mbotela Mowlem, River Bank. Our original sample in Kayole Soweto constitutes approximately half of this population.

Identification:

The identification strategy relies on a cluster-randomized experiment. All informal settlement customers in Nairobi Water's utility database will first be called to confirm contact details and receive the base intervention. Eligibility criteria into the study will include: (i) customers can be contacted and their contact details can be updated; and (ii) customers do not hold multiple accounts (multiple property owners) – which is expected to yield an eligible sample size of approximately 5,500 customers. After the base intervention has been implemented and contact details have been updated, all compounds with tenants (approximately 2600 customers) will be randomly assigned to receive face-to-face tenant sensitization (Treatment 1). Randomization will be stratified by location (settlement), whether landlord resides in the property, and whether the landlord has ever made a payment. After completion of the outreach campaigns, all customers in the study will be grouped into clusters which will reflect the street they live on (approximately 166 clusters). Half of the clusters will be randomized into treatment and half into control, stratified by settlement and cluster size. Within treatment clusters, half of all compounds eligible for disconnection based on their balance and repayment history, will be randomly assigned to receive disconnection notices, resulting in approximately 420 compounds receiving notices and subsequently disconnected if they fail to make payment. To test for direct effects of receiving disconnection notices, we will compare disconnection treatment customers in treatment clusters to disconnection-eligible customers in control clusters. To test for spillovers, we will compare repayment rates of control customers in treatment clusters to disconnection-eligible customers in control clusters. To test the effectiveness of bottom-up accountability through increased tenant pressure in low and high enforcement settings, we will compare compounds with tenants that receive treatment 1 (tenant sensitization) to compounds with tenants that don't receive the treatment, in disconnection vs. non-disconnection clusters, effectively estimating the interaction effect size of treatments 1 and 2.

Data:

The research team has access to the billing data for all NCWSC account holders in Nairobi slums. The data includes (i) date and amount of all invoices; (ii) date, amount and type of payment; (iii) outstanding service balance; (iv) outstanding loan balance; (v) water usage; (vi) location and contact details of account holder. Data are recorded in real-time and are available from when accounts were opened. In addition, we plan to administer a short survey from a sample of approximately 650 compounds that were in disconnection notice randomization targeting both tenants and landlords that will collect information on connection status, perceptions of service quality, relationships with tenants and other socioeconomic measures. Only one tenant will be randomly selected for a survey in any given compound. The survey will draw heavily from the original tenant survey conducted in 2016 with slight modifications. The survey will be conducted face-to-face, unless landlords are not available, at which point a telephone survey will be conducted to increase response rates.

Power calculations:

The component of the study is primarily focused on repayment rates. The main indicator will be whether or not the compound landlord made a payment in full for the water and sewer fees in a given month, and

this will be tracked over multiple months to assess sustainability. Fees for the month of March 2018 had been fully paid by 8.6% of compounds. The sample will be roughly split equally across the three main treatment arms and control group, yielding sample sizes of slightly more than 2000 per arm. Since landlords are resident in the dwelling approximately 50% of the time, this suggests we will have approximately 1000 compounds per treatment arm subgroup. Assuming 80% power, 5% significance threshold, and the 8.6% base repayment rate, the proposed sample size will be able to detect a 4-percentage point improvement in repayment for a single month. Beyond look at month-by-month comparisons, we will also pool repayments over a period of 3 months to further increase power. The cluster treatment of disconnections is powered to detect an 8pp difference in repayments across treatment clusters.

12. Ethical considerations

Information collected from Nairobi City Water and Sewerage company will be de-identified and stripped of personal identifying information (PII). Before any study participants were recruited into the study where primary data collection was required, their consent was sought. All staff handling survey data will undergo valid human subjects' certification. The project will obtain all appropriate ethical clearance from Kenyan and home institution authorities prior to survey administration, including a home institution IRB, a local IRB and a research permit. All enumerators will also take the human subjects test and be trained in maintaining confidentiality.

The household and tenant surveys do not ask any information from the participants that might be sensitive in nature. It was also be communicated to community members through formal meetings and informal interactions that the study is based on a random selection of participants.

There are some risks to the staff working in an impoverished area like the targeted informal settlements. Study staff will work closely with Nairobi Water social workers to understand how to mitigate risks and to identify community liaisons who will be able to guide surveyors. Additionally, staff will only work in the settlements during day time to avoid any dangers that might come in the evening hours.

The additional activities proposed present 2 important ethical concerns:

1. Potential harmful effects of the disconnection intervention: The disconnection intervention will follow standard NCWSC policies used by the company. Since they currently have more people eligible for disconnection than they are able to actually perform, the study will only direct the disconnections to follow along the randomized treatment design. As such, we don't anticipate that the study will add additional risk beyond what currently exists.
2. Use of Nairobi Water utility data for analytical purposes: The study requires that we link interventions to utility data responses. NCWSC has provided us with access rights to the utility database. Since this represents standard administrative data we do not currently plan to require informed consent from individuals for the use of these data, but rather, privacy will be protected as part of a non-disclosure agreement with NCWSC, as is standard in other similar settings where administrative data is used for research purposes. All other data confidentiality protocols will be upheld as described in other sections of this submission.

a) Consent explanation

Informed consent was collected from all study participants prior to household / landlord survey administration. The consent document was available in English and Swahili and participants could choose in which language it is delivered. Enumerators read the informed consent document to participants and will ensure that respondents understand the information before proceeding. If the respondent consented to participate, he/she indicated this and signed the informed consent document. Each participant was provided with a signed copy of the informed consent document.

Enumerators explained the purpose of the study and stressed that all responses would be kept in confidence. They further explained that there is no penalty for non-participation and that participants can skip questions which they do not wish to answer. Information and contact details of the Project Associate and the Research Manager were provided. Consent forms are stored securely by the Project Associate in the event that they need to be produced for any reason.

In case of landlord surveys administered on phone, we will seek verbal consent. If the respondent agrees to participate, the enumerator will write his/her name and the respondent's (landlord's) name on the consent form and sign to indicate that the respondent has given verbal consent to participate in the study.

Households will be contacted 3 times for data collection purposes (listing, baseline, and follow up) and up to 3 times for the treatment interventions. Study participants will receive between KSh 50 and KSh 100 worth of airtime to compensate for their time, depending on length of survey.

13. Data management and statistical analysis plans

Data Management:

All household-level data will be collected electronically using SurveyCTO and stored on the server. Data will be uploaded by the enumerators and downloaded and archived by the Research Associate every evening. All administrative billing data will be downloaded from the NCWSC server on a bi-weekly basis by the PIs and shared only with the research team conducting analysis. All data will be stored in an encrypted folder on box and/or dropbox. When sharing data between the project partners, the NCWSC and the World Bank, data will be both encrypted and password protected. All personally identifying information (PII) is stored in a separate file from the non-PII

We will obtain all appropriate ethical clearance from Kenyan authorities prior to survey administration. Only the core impact evaluation team members will have access to the data. All enumerators will take the human subjects test and be trained in maintaining confidentiality. Each person with access to personally identifying data will sign a confidentiality agreement.

Data Analysis:

Since this is part of a randomized control trial, the evaluation will rely on the fact that the intervention is exogenous and thus can be estimated accurately through the simple equation:

$$Y_i = \alpha + \sum_{j=1}^{5} \gamma_j \, T_{ij} + X_i + \varepsilon_i \hspace{3cm} [1]$$

Where Y_i is the outcome interest for participant *i* (in our case the primary outcomes are take up of the sanitation voucher and connection, and whether the loan and service fees were paid for the month), and T_{ij} is the treatment status for person *i* with regard to treatment *j*. X_j is a vector of exogenous control variables collected at baseline or time-invariant variables collected in the Endline survey. This applicable only for the sample where baseline data is available. For the larger sample of compounds where only administrative data are available, we will use Equation [1] without an X_j vector. The estimated impact of treatment *j* for individual *i* on outcome *Y* will be measured by the coefficient γ. All standard errors will be clustered at the unit of random assignment (block level for clustered interventions and compound level for individual-compound interventions). Further analysis exploring heterogeneity of impact and other outcomes related to sustainability and use will be measured within the same econometric framework using follow up data.

Data will be analyzed using STATA 14.

14. Study limitations and how to minimize them

One challenge for the study is the possibility of a high refusal rate by potential participants. To keep the non-response rate as close to zero as possible, enumerators built rapport with respondents and attempt to gently persuade them to participate. Records for the reason of refusals are kept so that new strategies may be implemented if necessary. We will also offer an incentive to complete the survey, which is estimated at approximately 50 Kenya shillings per thirty minutes of surveying time.

Another issue was the ability to maintain contact with the non-resident landlords. It is estimated that 30% of landlords are not residents, and these landlords were surveyed in person if living in Nairobi or over the phone. IPA staff scheduled appointments with non-residential prior to surveying them outside of their study areas. This reduced attrition of non-resident landlords.

Missing or out of range values in surveys are a threat to high data quality. We programmed limits, skip patterns, and error checking into electronic surveys to minimize errors.

We will measure and control for information spillovers: First, although imperfect, we will assume that information diffuses with geographical proximity to the treatment households. This would allow us to control for any spillover by including the distance of control households to the nearest treated compound. Distance is exogenous because of the random assignment of treatment.

Attrition of landlords is not a major concern for measuring take-up. Household attrition is also expected to be low because of the short exposure period and migration out of these urban areas is not typically high. However, migration and other types of attrition will be closely monitored in the study through the panel data collection.

15. Timeline/time frame

The project successfully conducted listing exercise of 4023 compounds in Soweto, Kayole between August and October 2014. From September through December 2015, Landlord Survey. Between September and December 2015, the project screened and sampled 2,760 compounds out of 4,023 listed and set out to survey the landlords eventually reached 2,295 compounds. From June – October 2016 (with follow-ups to

March 2017), the project followed up with the second phase of baseline activities with Tenant Survey targeting 2295 compounds whose landlords were reached during Landlord Survey were sampled. At the end of the exercise, the project finally interviewed 4,430 from 2,097 compounds

After completion of the main sewerage trunk in May 2016, sewerage hook-ups began at the price set by Nairobi Water. This is ongoing as Nairobi Water receives expression of interest and deposits for connection from compounds. Since then the project has been monitoring and tracking applications, deposit payment and connection works in the 7 zones already opened. IPA conducted an updated tracking exercise in March 2018 and found that a larger number of compounds have connected at unsubsidized rates than originally anticipated. As such, the additional subsidy rollout has been delayed until more information is available about possible options for pursuing the existing strategy. In the meantime, the study will continue tracking connected compounds, and plans to conduct the repayment interventions with these connected households from August – October 2018. The research team has real-time access to the utility billing data to track outcomes, which will be tracked for 3 months post-intervention. The short follow up landlord and tenant surveys will run from June –July 2019 and data will be analyzed with a report written up by end of 2019.

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