perspective paper

WATER & SANITATION

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Sanitation and Water

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1. INTRODUCTION

The 2012 Challenge Paper by Frank Rijsberman and Aliz Peterson Zwane [RZ] focuses primarily on sanitation and offers three sanitation interventions, characterized as (i) community led total sanitation (CLTS++); (ii) sanitation as a business; and (iii) the reinvented toilet. In addition, RZ offer a fourth intervention aimed at improving rural water supply consisting of (iv) borehole wells equipped with handpumps. As proposed, CLTS++ calls for an investment of US$3 billion that could benefit 600 million people, corresponding to about half of the rural population currently lacking basic sanitation, with a benefit cost ratio (BCR) estimated at 4-7, and is characterized as low risk. Rural water boreholes requires an investment of US$12-23 billion, could potentially reach 700 million people, with a BCR of around 3.4, and is also characterized as low risk. Sanitation as a business involves an investment of US$320 million, could serve 200 million low-income urban people, with a BCR of 23-47, and is characterized as medium risk. The reinvented toilet involves an investment of $125 million, could serve a billion low-income urban people, with a BCR of 40, and is characterized as high risk. I certainly believe these interventions are meritorious and deserve support. While RZ are very candid about the assumptions they are making and the limitations of their analysis, I want here to note some of the complications which beset the problem of sanitation.

RZ explain their focus on sanitation by observing that the world has met the Millennium Development Goal on water five years early, but will miss its goal on basic sanitation by almost 1 billion people. As they note, “an astonishing one-third of the world population, 2.5 billion people, does not have access to basic sanitation and over one billion people defecate out in the open.” This prompts the question: why is there this problem? This is not a new problem, created by some new circumstances, such as the problems of air pollution or climate change. The lack of sanitation is an age-old phenomenon that has stubbornly resisted change. Moreover, as RZ note, the benefits of sanitation seem self-evident. They quote an editorial in the Lancet (2008): “It is already well known that improved sanitation could prevent 1.5 million deaths from diarrheal illnesses a year, enhance dignity, privacy and safety, especially for women and girls, benefits the economy – every dollar spent on sanitation generates economic benefits worth around nine more

– and is better for the environment." If the benefits are self-evident, why is there not more sanitation?

Last month, the results of the 2011 Indian Census were released. The Indian Census Commissioner reported that more than half of the population – 53.2% – have a mobile phone, and 63.2% of homes have a telephone. But only 46.9% of India's households have a toilet. The same Census reports that 47.2% of Indian households have a television, while only 19.9% have a radio.[1] One might ask, why do fewer households in India have a radio than a television, which is presumably more expensive than a radio. A natural answer would be that people in India sometimes value a television more highly than they value a radio. Could the same logic apply to toilets and mobile phones – could people sometimes value a mobile phone more highly than they do a toilet?

While it is easy to understand why a person could value a television more highly than a radio, because a television offers more benefits, visual as well as aural, it is not so easy to see why a person could value a mobile phone more highly than a toilet. One possible answer is the following: even without a toilet, everybody has *some* means to deal with defecation, however inconvenient and unpleasant. However, without a mobile phone, not everyone has a means of communicating with other people at a distance. In economic terms, what matters is not the absolute attractiveness of the commodity (toilet or mobile phone) but rather its attractiveness relative to the existing substitutes.

But even with the difference in substitutes, should not a toilet be preferred to a mobile phone given its multiple benefits – health, safety, dignity, privacy, etc? This raises several questions. Just how large are those benefits? The Lancet editorial didn't say that improved sanitation *would* prevent 1.5 million deaths, it said "*could* prevent." How much uncertainty is there about the number of deaths that would be prevented? To whom do the benefits accrue, and do they accrue to the same people as those who pay the cost of the improved sanitation? If not, how does the improved sanitation get financed? And, how much do the people to whom the benefits accrue actually value those benefits?

These questions touch on the demand side of the sanitation challenge. While RZ are fully aware of the importance of this side of the sanitation challenge, they tend to focus more on the supply side. In response to the question of why the sanitation challenge has proved so elusive, they state "the simplest answer is the cost of current technologies." At least two of their interventions, sanitation as a business and the reinvented toilet are intended, at least in part, to lower the cost of meeting the sanitation challenge.

For a successful solution, *both* sides of the challenge need to be addressed.

[1] This was reported by BBC News on March 14, 2012. http://www.bbc.co.uk/news/world-asia-india-17362837

2. COMPLEX PATHWAYS OF CAUSATION

Given the terrible burden of waterborne disease, what is known about sanitation interventions that reduced mortality? RZ cite three recent papers that used rigorous econometric techniques to demonstrate that an intervention actually reduced mortality. RZ are careful to note that these interventions involved *networked* water and sanitation service. Galiani et al. (2005) examined a water privatization reform in Argentina in the 1990s that led to a reduction in child mortality of approximately 8%. The privatization was associated with a reduction in deaths from infectious and parasitic diseases, and was uncorrelated with deaths from causes unrelated to water conditions. The causal pathway appears was that the privatized utilities significantly increased investment in infrastructure and expanded connections to water service and to sewer service, especially in poor areas that were least served by networked water and sewer services under the public ownership. In some cases, the privatized utilities also improved water pressure and service quality. Watson (2006) examined sanitation interventions on Indian Reservations in the US by the Indian Health Service between 1960 and 1998. She found that a 10% point increase in the fraction of homes receiving sanitation improvement reduced Indian infant mortality by 2.5%; the reductions in mortality were concentrated in waterborne gastrointestinal diseases and infectious respiratory diseases. The interventions included both networked services (building or improving water or sewer treatment plants, extending water and sewer lines, connecting individual homes to those lines) and non-networked services (digging wells, providing latrines or septic tanks), and Watson does not distinguish between them. My own understanding, having reviewed water supply and sanitation on some Indian Reservations, is that the main focus of interventions was on networked services.

The third study cited by RZ is by Cutler and Miller (2005) who found that the introduction of water filtration and chlorination for drinking water led to major reductions in mortality in American cities, explaining nearly half the overall reduction in mortality between 1900 and 1936, and three quarters of the decline in infant mortality. Cutler and Miller estimate that the rate of return to investment in filtration and chlorination was about 23 to 1.They go on to state: “[I]nexpensive water-disinfection technologies can have enormous health returns—returns that reach beyond reductions in waterborne diseases—even in the absence of adequate sanitation services. … [If] only 1% of the roughly 1.7 million annual deaths from diarrheal diseases worldwide could be prevented by water disinfection, the corresponding social rate of return for one year alone would be about $160 billion.” This is a misleading comparison because the context in the US in 1900 was significantly different from that in the areas where most of the 1.7 billion deaths occur today. By 1900, all of the urban population in the United States was served by a networked water service, and in most cases had been so served for 30 or 40 years. In addition, by 1900 over 80% of the urban population was served by networked sewer service. Habits of personal hygiene were well established. The only thing lacking was treatment: there was no treatment of either sewage or drinking water. Sewage was collected and discharged untreated into water bodies that often served as the source of drinking water for other communities. The removal of sewage from places of residence removed the health threat to the people who generated it, but the absence of treatment of the sewage prior to water-borne disposal combined with the absence of treatment of drinking water created a maelstrom of disease

downstream. If there had been treatment of drinking water but without networked collection of sewage – which is closer to the situation in some developing countries – there would have been a much larger burden of disease after 1900 than what was observed by Cutler and Miller. To make the same point in another way, the efficacy of the investment in the treatment of drinking water after 1900 was boosted by the prior investment in networked sewage collection whose cost was overlooked by Cutler and Miller because it had occurred prior to 1900.

While these studies provide rigorous evidence of the health benefits from investment in a system with networked water and sewage systems, this is hardly of relevance for the populations targeted by RZ's four proposed interventions, which eschew networked systems. This is done with good reason. Jenkins and Sugden (2006) observe that "it is unrealistic to believe that anything but a small percentage of the world's urban poor will be served by sewered systems in the next 20 years. Most of the increases in access to safe excreta disposal over the last decade are due to on-site technologies, not through the expansion of sewer systems and household connections. … On-site technology should not be regarded as being a sub-standard solution, just a different solution suitable for a different context."[2]

The targets of RZ's interventions are "the rural poor in low income countries … and the urban poor in the informal settlements or slums that characterize the places where the underserved live" for whom "networked service is largely irrelevant."[3] The evidence for the health impacts of non-networked investments in those locations is more heterogeneous and less clear cut. For example, a recent review of the literature on impacts on diarrhea mortality by Cairncross et al. (2010) concluded that most of the evidence is of poor quality. Three types of intervention were considered: handwashing with soap; measures to improve the microbial quality of drinking water (for example, household-based point-of-use treatment); and measures to dispose of human excreta so as to reduce direct or indirect human contact (including pit latrines, bucket latrines, hanging toilets and composting toilets). The evidence was most consistent for handwashing with soap, which was estimated to provide a 48% reduction in diarrhea risk. For water quality improvement some of the studies were problematic; the review assessed a 17% reduction in diarrhea risk for this intervention. For excreta disposal, there was very little rigorous evidence of health benefit; the review assessed a 36% reduction in diarrhea risk for this intervention.

Two points should be noted about these assessments. First, the largest impact was associated with a change in behavior (handwashing). The importance of behavioral change has been emphasized by many researchers. For example, Yacoob and Whiteford (1994) state that infrastructure improvements such as the provision of sanitary facilities "rarely result in the anticipated health improvements. Changes in hygiene behavior, that is in the way people utilize their existing resources along with improved infrastructure, are critical to achieving sustained

[2] Jenkins and Sugden point out that 50% of households in Japan are not sewered, and there is little intention to get the remainder connected.
[3] Rijsberman and Zwane (2008).

improvements in public health conditions." Second, the type of excreta handling and disposal envisaged by RZ in connection with sanitation as a business and with the reinvented toilet is considerably more sophisticated than the excreta disposal interventions considered by Cairncross et al. (2010). Therefore, the health benefits that could be attained by RZ's interventions could be substantially larger. Nevertheless, there is a degree of uncertainty at this stage regarding the health outcomes that will be attained through RZ's interventions. The reinvented toilets are currently at an early stage and, as RZ note, investments in the development of this solution are at a high risk And, while most of the various elements associated with sanitation as a business have been, or are being, developed and tested individually in a variety of locations, they are now being put together and tested at scale in Dakar over the next five years with funding from the Gates Foundation. The intervention proposed here would support further development and testing on a larger scale. So, much remains to be learned about the effectiveness of these interventions.

The advantage – in principle – of a networked system of water supply and sewerage is that there are fewer "moving parts" than with a non-networked system – there are fewer separate components that need to be coordinated and kept in sync. With a non-networked system, such as RZ's sanitation as a business, there are more junctures at which something can go wrong, potentially leading to water contamination and the spread of disease. These include keeping the excreta in an isolated containment, desludging/emptying the container, transporting the effluent, and disposing of it in a safe manner. RZ propose important new technologies to deal with these stages of the system. But, at each stage, there is a substantial human behavioral component. Not only does there need to be a reliable technology but also there needs to be the right incentives – and monitoring – to ensure that it is applied properly and that adverse third-part effects are avoided. RZ point out, correctly, that small-scale private service providers may have a greater incentive than municipal governments to be responsive to the needs of their customers and to service them efficiently. However, without some monitoring and regulation they may not have as strong an incentive to avoid any harmful third-party effects.

The behavioral elements are a fundamental feature of sanitation and disease prevention. They introduce an inherently contingent component into the assessment of outcomes from interventions. Let me illustrate this with a non-health example. As noted earlier, the privatization of municipal water and sewer utilities in Argentina in the 1990s led to an 8% reduction in child mortality. How did this come about? According to Galiani et al. (2005), the municipally owned utilities were overstaffed and inefficiently operated. The new private owners reduced the overstaffing and improved the efficiency of operations. They invested more in physical infrastructure than the previous management. They restructured the charge for water service, in one case lowering the initial connection fee to one-tenth of the previous level and adding a fixed charge to the water use bills for all customers as a cross subsidy. And they improved the quality of service.[4] How, then, should one characterize the causal link between privatization and reduced

[4] Davis et al. (2008) and Devoto et al. (2011) confirm the importance of financing to overcome the hurdle of the initial connection fee for joining a water and sewer network.

child mortality? Privatization by itself was hardly a sufficient condition for the reduction in mortality. If the privatized owners had operated the system more efficiently but had not invested in new infrastructure, there would not have the reduction in mortality. If they had invested in infrastructure but had not modified the rate structure, many poorer families would have been unable to afford networked water and sewer service, and therefore the health benefits would have been lower. Thus, the health outcome cannot be attributed to privatization alone. If privatization was not a sufficient condition, can we say that it was a necessary condition for the health outcome? Perhaps not – can we be certain that *no* municipally owned utility could invest heavily in physical infrastructure and could restructure rates so as to reduce the initial connection fee?

Similarly with water and sanitation interventions. Having a source of clean water in the home is not a sufficient condition for avoiding illness if one does not practice good personal hygiene. Nor is it a necessary condition since, with good hygiene practices, including boiling water before ingesting it and handwashing, illness can be avoided. The behavioral practices are intertwined with other elements of sanitation interventions in such a manner as to render inaccurate the characterization of a sanitation intervention by itself as a sufficient (or a necessary) condition for reduced morbidity or mortality.

This is worth emphasizing because the analytical approaches commonly adopted in economic theorizing and, more recently, in econometric modeling specifically represent causal factors as sufficient conditions for the outcome being modeled. This is true of both the conventional production function formalism and also the 'treatment effect" approach to program evaluation based on randomized controlled experiments or on quasi-randomization through instrumental variable techniques or natural experiments. As conventionally modeled, adoption of the treatment is interpreted as a sufficient condition for obtaining the average treatment effect. I certainly agree that an experiment where one controls for the factor of interest through the experimental design or through statistical analysis is a desirable source of knowledge regarding which interventions work. But, I do not agree with the tendency to focus on the estimation of the mean impact (the mean treatment effect) as the exclusive object of interest. By way of qualification, if it is the case that there is little variation in the magnitude of the treatment effect across different experiments and different sets of data, then the mean treatment effect becomes of more interest. But, if there is considerable variation in its magnitude, which is typical of water and sanitation interventions in the literature, then just knowing the average treatment effect is not enough. More important is to understand what factors account for the variation in treatment effect, which subpopulations exhibit the greatest (or smallest) effect, and why.[5] The analogy is to know the average reduction in child mortality conditional on the privatization of water supply, without knowing anything about the particular investments and pricing policies adopted by those privatized utilities.

[5] This point is made forcefully by Deaton (2009) and Heckman and Urzua (2009).

The need to go beyond the average treatment effect is illustrated by the evaluation of piped water for rural households in India by Jalan and Ravallion (2002). The authors found that the prevalence and duration of diarrhea among children under five are significantly lower on average for families with piped water than for observationally identical households without it. However, they also found that the health gains largely by-pass children in poor families, particularly when the mother is poorly educated. The implication is that unsanitary behaviors in poor households, and especially households where mothers are poorly educated, nullify the potentially beneficial effect of piped water.

3. BEHAVIOR CHANGE

These findings of Jalan and Ravallion (2002) highlight the pivotal role of behavior, and behavior change, in reducing waterborne disease. Our knowledge of what triggers behavior change is woefully limited. Recognizing this, Zwane and Kremer (2007) call for more research targeted at the design of behavioral interventions: "Identifying cost-effective ways to facilitate long-term behavior change and technology adoption requires additional research comparing alternative messages and message delivery avenues in several cultural contexts. For example, rigorous evaluations are needed that compare health education messages directed toward women emphasizing family health and those emphasizing children's well-being in particular. The comparative usefulness of positive and negative messages should also be explored, as has been done in other campaigns aimed at inducing behavioral changes in developed countries."

Because human motivation and behavior is multifaceted, there are numerous potential points of attack. Zwane and Kremer (2007) identify several possibilities, for example programs working through maternity clinics or schools to provide messaging and education and/or to distribute soap for handwashing. Another possibility is programs targeting community opinion leaders (most probably males) or targeting women's groups. The point is that behavior change is an exercise in marketing – social marketing – and should be approached in that spirit, using insights from market research. This viewpoint is strongly advocated by Jenkins and Sugden (2004) who characterize the goal as "enhancing the demand for sanitation."

One distinction is between behavior change programs targeted at individuals versus programs targeted at groups of individuals simultaneously. An example of the latter is Community Led Total Sanitation (CLTS), which is one of RZ's proposed interventions. CLTS aims to trigger "change in collective sanitation behavior, which is achieved through a process of collective local action stimulated by facilitators from within and outside the community. The process involves the whole community and emphasizes the collective benefit from stopping open defecation, rather than focusing on individual behavior or on constructing toilets. People decide together how they will create a clean and hygienic environment that benefits everyone."[6] It is

[6] Kar and Milward (2011) as quoted by RZ.

interesting to contrast this with a program targeted at individuals, the "No Toilet, No Bride" program launched by Haryana state authorities in India in 2005. The context is the fact that women suffer from widespread and entrenched social constraints and discrimination in rural Haryana, which the state authorities wished to counteract. Roughly 70% of rural households in Haryana engaged in open defecation. More than men, women prefer toilets to open defecation because they suffer from male staring and harassment when they urinate, defecate or attend to menstrual hygiene in the open. For this reason, private latrines generate benefits that accrue disproportionately to women. One time in their lives when women have a degree of power is in the selection of a husband during marriage negotiations. The Haryana state authorities seized on this and mounted an advertising campaign with billboards, posters and radio advertisements encouraging the families of marriage-age girls to demand that potential suitors' families construct a latrine prior to marriage. "No Toilet, No Bride" and "No Loo, No I do" were slogans used in the advertising campaign. Stopnitzky (2012) analyzed the effects using a comparison of households with and without marriageable boys, and in Haryana versus other states, before and after the campaign. He found that male investment in sanitation increased by 15% due to the program. The program effect was four times larger in marriage markets where women were scarce (26%) as compared to marriage markets where women were abundant (6%).

While "No Toilet, No Bride" is merely one data point, in my mind it raises the question of whether the collective approach represented by RZ's CLTS proposal is adequate as their only intervention focused on behavior change.

There are potentially three steps in motivating behavior change: (1) motivating an individual to stop doing what he/she has typically done; (2) motivating an individual who has decided to make a change to select the targeted alternative as his/her new behavior; and (3) motivating the individual to sustain that change in behavior over time. Sometimes steps (1) and (2) occur at the same time: the decision to make a change occurs simultaneously with the decision to adopt an alternative behavior. Sometimes there is a sufficient degree of commitment that, once the decision in (2) occurs, that in (3) follows automatically. However there are many examples in the water and sanitation sector where a community initially made a change but later (for example, when a subsidy ended or funds ran out) returned to the former behavior. One factor that can be important in sustaining a behavior change is if there is a shift in expectations or norms: what the person used to accept is now seen as inappropriate or unacceptable. A striking example of a change in behavior sustained by a change in norms is the decline in smoking over the past four decades. In the United States, smoking rates declined from 42% of adults in 1965 to 18.5% in 2006. While this is a large change in behavior, it certainly did not occur overnight. The question is whether a similar change in attitude with regard to, say, open defecation could occur in developing countries over a similar or longer span of time. And, what would it take to promote such a change in attitude? "No Toilet, No Bride" suggests that empowering women in society is one contributing factor.

4. PERCEIVED BENEFITS

RZ identify a variety of economic costs from poor sanitation, with corresponding economic benefits from improved sanitation. Following the methodology of the Economics of Sanitation Initiative (ESI) reports, they classify the economic impacts of inadequate sanitation into five categories: (1) Health-related impacts, including premature deaths, costs of treating diseases; productive time lost due to people falling ill, and time lost by caregivers who look after them. (2) Domestic water-related impacts: including costs of household treatment of water; use of bottled water; a portion of costs of obtaining piped water; and time costs of fetching cleaner water from a distance. (3) Access time impacts: cost of additional time spent for accessing shared toilets or open defecation sites; absence of children (mainly girls) from school and women from their workplaces. (4) Tourism impacts: potential loss of tourism revenues and economic impacts of gastrointestinal illnesses among foreign tourists. (5) Amenity and environmental costs of water pollution. The first two categories account for the lion's share of the impacts. For the four Asian countries listed by RZ, health effects account for 53.5% of the economic impact of poor sanitation, and domestic water effects account for 25.3%. The other effect categories combined account for 21.2% of the economic impact.

On the other hand, in a study of why some people want latrines in Benin, Jenkins and Curtis (2005) found that "[h]ealth considerations played only a minor role, and had little if anything to do with preventing fecal-oral disease transmission." Jenkins and Sugden (2006) similarly observe that "overwhelming evidence and common sense have clearly shown that households decide to change their sanitation practices to gain a variety of different benefits, mostly having little to do with avoiding excreta-related diseases." Jenkins and Sugden continue: "There is a good reason for this. From the perspective of an individual household, changes in illness may be difficult to obtain and impossible to attribute with certainty to sanitation when other fecal-oral transmission routes both inside and outside the home are operating. Thus, the health benefits at the household level tend to be the least reliable to obtain amongst the private benefits of improved sanitation."

Thus, there appears to be some divergence between the benefits of sanitation as seen by the experts, such as are tabulated in the ESI reports, and the benefits as perceived by the people on the ground who actually experience the improvement in sanitation. This raises two questions. First, what is the explanation for the divergence in perceptions – in effect, a divergence between the private and the social benefits of improved sanitation? Second, what is the significance of this divergence – should it be ignored, and should attention be focused solely on the social benefits as perceived by the experts?

RZ are aware of these issues. They identify two factors as explanations for the divergence between private and social perceptions of the benefits of sanitation. One explanation is intra-family distributional inequities, whereby the preferences and interests of women and girls tend to be devalued by males in the household. A second factor is the externality of disease: if a household receives access to improved sanitation, not only is there a reduced burden of disease for the members of the household but, because other people outside the household can be caught in the cycle of disease transmission, there is also a reduced burden of disease for those other

people. The disease externality creates a market failure leading to inefficiently low private investment. Both explanations are valid. But, I don't believe that they are the full story. Not only may individuals overlook the health benefits accruing to people outside their family and household, but the findings of Jenkins and Curtis (2005) and Jenkins and Sugden (2006) suggest that people may assess the health benefits to themselves and to their family members as smaller than the health experts would account them.

Against this must be set the fact that the recipients of improved sanitation discern benefits to themselves that the experts usually do not consider. Jenkins and Curtis (2005) group these into three categories: prestige; well-being; and situational goals. Prestige includes improved social status, being seen as modern and more urbanized, being able to achieve "the good life," and leaving a lasting monument and legacy to your descendants. Well-being includes not only reduced illness, but also increased comfort, increased privacy, increased convenience, increased safety for children and for women, especially at night, and less embarrassment with visitors. Situational benefits include reduced conflict with neighbors, help with restricted mobility that generates physical difficulty with walking to the bush and squatting, increased property value and increased income from any renters in the house. Jenkins and Curtis note that the weight placed on the non-health motives vary with gender, occupation, life stage, travel experience, education and wealth.

The fact that the recipients of improved sanitation see the benefits differently than the experts has several important implications. If the prospective recipients of a sanitation improvement project are being asked to pay for it, the benefits that they perceive are a crucial determinant of their willingness to pay, and hence of their uptake of the project. If they perceive the benefits as being low, and less than what they must pay, they won't adopt the project, or they will abandon it as soon as they can. The user perceptions, therefore, provide a roadmap to the successful marketing of sanitation. The challenge is to identify forms of improved sanitation that the recipients see as bringing a benefit to themselves and are willing to pay for.

Not everyone would agree with the last sentence. A common argument is that investment in water and sanitation services should be based on the assessment of their social benefits, not their private benefits. This is a valid argument if water and sanitation are viewed as merit goods, and if there is a funding source, other than the direct beneficiaries, that is available to finance the provision of this merit good. I have no doubt that the provision of some level of water and sanitation service to some people *is* a merit good. But, I am not sure that the provision of any level of water and sanitation service to all the people not currently served, for the indefinite future, is a merit good. While there are spillover benefits from disease externalities, as noted above, the enjoyment of water and sanitation is largely a private good, like food, clothing and housing. It certainly may be appropriate to subsidize water or sanitation during an interim period until there is sufficient economic growth that the recipients would be able and willing to pay for it themselves. It strikes me as less reasonable to commit to financing water and sanitation projects that will have to be subsidized indefinitely because, while there are social benefits, the private benefits are lower than the recipients are willing – now and in the future -- to pay for.

For this reason, I believe it would be prudent for RZ to give a little more thought to the private benefits of some of the sanitation interventions they propose, to the demand side of sanitation, and to the stimulation of a demand for sanitation among the populations they quite rightly wish to serve.

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