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SCOPING STUDY: IMPLEMENTATION AND EXPANSION OF CIRCUIT RIDER SUPPORTED PASSIVE CHLORINATION IN PIPED DISTRIBUTION SYSTEMS IN GUATEMALA

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ABOUT REAL-WATER:

Rural Evidence and Learning for Water (REAL-Water) was a USAID-funded applied research program that studied how to achieve safer and more sustainable rural water supply in low- and middle-income countries. Designed and originally executed as a five-year program (September 2021–September 2026) led by Aquaya, REAL-Water was terminated in February 2025 along with the vast majority of USAID's overseas development assistance programs. For further information about this and other aspects of the project, as well as to access our knowledge products, please visit https://aquaya.org/real-water-resource-hub/.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

Cova Agua (covaagua.org) is an international non-profit organization that supports community-based management of rural water systems in Central America. Cova's Circuit Rider support model for community-based management of passive chlorination is currently deployed across rural communities in Nicaragua and Honduras. Cova partners with community water boards to install simple passive chlorinators into existing piped networks and then provides ongoing support through routine water quality monitoring, technical assistance, and capacity building focused on operation and maintenance for chlorinators, financial management, watershed protection, and other relevant themes.

Between June and July 2024, Cova completed a scoping study to evaluate the feasibility of the expansion of circuit rider supported passive chlorination programs in Guatemala. This scoping study also evaluated opportunities for collaboration and implementation research with a focus on USAID program collaborations. Through site visits, desk research, and key informant interviews, we have determined that there is significant evidence that circuit rider supported passive chlorination in rural Guatemala is not only feasible but could be effective in improving access to safely managed drinking water. The enabling environment in Guatemala is quite similar to Honduras and Nicaragua, but also offers unique opportunities and challenges. Broadly, the costs associated with the Circuit Rider model would seem to remain the same, disregarding the obvious startup costs of beginning work in a new country. However, the effective demand for chlorine tablets and chlorination at the community level remains uncertain. There is a government mandate for chlorination at the rural community level, with consistent regulations that would suggest one motivation to chlorinate. Conversely, there is also demonstrated aversion to chlorination due to taste, odor, misperceptions, and uniquely Guatemalan factors such as the influence of Maya culture. Therefore, the willingness to chlorinate and willingness to pay for chlorination remain critical uncertainties to be evaluated and represent unique opportunities to evaluate the capacity building and chlorine socialization aspects of the Circuit Rider model. Finally, there is a strong need for water quality solutions as data from MSPAS sanitary inspectors in one of the departments visited showed that 37% of 1,225 water samples collected from January to June 2024 did not meet water safety standards, with some municipalities having safe drinking water proportions as low as 4%. Additionally, there has been an increase in diarrheal disease, especially among children under five.

This evaluation explicitly highlights several critical research questions that can be explored through expansion of Cova's circuit rider supported passive in-line chlorination into new contexts, but also through continued implementation research in existing Cova markets.

1. What is the effectiveness of Cova's circuit rider supported in-line chlorination model in a new context?
2. What are the costs of this model in a new context?
3. How can water boards be incentivized to improve chlorination rates in communities served by Cova's circuit rider model?
4. How do chlorine taste/odor detection and acceptability thresholds differ for users with prior exposure to chlorinated water versus those not consuming chlorinated water?

In particular, the first two questions are well suited for testing in a new to Cova context. Questions three and four, while relevant in both new and existing Cova service delivery areas, are better suited for a planned evaluation in Honduras.

There are also opportunities for alliances within the government, particularly at the municipal level and through the Ministry of Public Health and Social Assistance (MSPAS), that will enable circuit rider model success. Sanitary inspectors (MSPAS employees) are responsible for providing technical expertise and monitoring support to rural communities, on many topics, but specifically water treatment. However, these teams are understaffed and under-resourced to serve the more than one hundred communities they are often expected to serve. These inspectors and MSPAS identified one strength of the circuit rider model in that Cova circuit riders could support and develop local capacity and provide water quality monitoring support.

OBJECTIVES

The goal of this scoping study was to determine if it is feasible to expand Cova's circuit rider-supported passive chlorination program within rural Guatemala. For additional background and motivation, see Appendix 1. Through this study we aim:

1. To compile and analyze relevant agencies, laws, and regulations supporting community-operated water systems, rural water utilities, and water treatment.
2. To evaluate the enabling factors for and barriers to implementation of circuit rider-supported passive chlorination in rural communities.
3. To estimate the costs associated with implementation of circuit rider-supported passive chlorination.
4. To assess the existing chlorine supply chain (availability, quality, cost).
5. To explore opportunities for collaboration with USAID funded and other rural water programs.
6. To identify opportunities for implementation research on circuit-rider supported passive chlorination.

METHODS

Beginning in June 2024, we conducted interviews virtually and in person with key informants working in WASH in Guatemala, with a specific focus on the feasibility and opportunities for implementation research related to circuit rider supported passive chlorination in Guatemala. While in Guatemala, we were able to visit NGOs, health officials, and rural communities to conduct interviews, site visits, and meetings primarily focused on the Department of Quetzaltenango in the Western Highlands. We conducted 17 interviews across seven NGOs & Social Enterprises, two universities, two government offices, and two community water boards, for a total of 33 key informants interviewed.

FINDINGS

Guatemalan ministry officials noted difficulties in collecting and analyzing government-mandated numbers of water quality samples.

Key informants also highlighted the simultaneous overlapping but piecemeal nature of governance and regulation of water safety in rural communities in Guatemala.

Chlorination is already widely agreed upon, as a water treatment method by most NGOs and government entities in Guatemala as a key element of rural drinking water supply services. Compared to Cova's experience in Honduras and Nicaragua, where fewer than 3% of communities were chlorinating prior to Cova's circuit rider model intervention, there are indicators that the enabling environment for chlorination in Guatemala is stronger and more open to chlorination. At the same time, there are misperceptions of the health impacts of chlorination, including that chlorine in the water can cause cancer, infertility, additional illnesses, and skin conditions. Significant concerns were noted of the taste and odor of chlorinated water, a negative perception compounded by the influence of Maya Culture across rural Guatemala.

Guatemalan community water boards appear to have a similar or slightly greater capacity to pay for chlorine compared to Honduras and Nicaragua, based on our observation of slightly higher water tariffs, though *willingness*-to-pay will may be more variable across rural Guatemalan communities than *ability*-to-pay.

Many chlorine tablet brands and specifications (calcium hypochlorite and sodium hypochlorite) were available for purchase in Guatemala, according to our interviews.

Finally, we highlight several research questions:

- How frequently can community-managed drinking water systems equipped with passive chlorinators, supported by Cova circuit riders, meet free chlorine residual targets at the point of consumption, in new communities in rural Guatemala?
- What kinds of socialization or incentivization is required to ensure chlorination rates? And to whom? I.e., the water board, community members, others?
- What are the costs of expanding the Circuit Rider model into new contexts?
- What is the effective demand for passive chlorination supported by circuit riders?
- What are the taste & odor thresholds for chlorine acceptance in rural Guatemala?
- How long does it take for people to acclimate to the taste/odor of chlorinated water?
- What kinds of community engagement and sensitization activities influence acceptability?

FULL REPORT

1. COMPILE AND ANALYZE RELEVANT AGENCIES, LAWS, AND REGULATIONS SUPPORTING COMMUNITY-OPERATED WATER SYSTEMS, RURAL WATER UTILITIES, AND CHLORINATION IN GUATEMALA

1.1 LAWS AND REGULATIONS

Several critical pieces of legislation and regulations dictate norms and expectations regarding drinking water quality, treatment, and management. One singular unifying water law or water regulating body does not currently exist. According to Guatemala's National Development Plan K'Atun 2032, the government of Guatemala plans to invest heavily in these resources and create a unifying water law in the near future.

In Decrees 90-97, published in 1997, a National Health Code was established.[12] Chapter 4, Section 2 of this code outlined expectations and guidelines for drinking water management and treatment. Specifically, Article 79 dictates that all municipalities are responsible for ensuring communities within that municipality have access to potable drinking water and Article 86 dictates that it is the joint responsibility of the MSPAS, the municipality, and the community itself to meet norms and standards for water access and water quality. Articles 87 and 88 mandate the "purification' of drinking water and name the MSPAS responsible for certifying water safety results and maintaining records of those results.

In 2005, the Guatemalan Norms Commission published "Technical Guidelines for Drinking Water," which mandate the maximum and minimum permissible levels for a full list of physical, chemical, and bacterial parameters.[13] Of specific relevance, these guidelines indicate that drinking water should have no detectable total coliform or E. coli at both the entry and exit points of a distribution system. Free chlorine residual concentration should be between 0.5 and 1.0, except in cases of emergency in which it is permitted to be higher, as necessary.

The "Manual of Surveillance and Control of Drinking Water Quality" was published as a government agreement by the Ministry of Public Health and Social Assistance in 2013.[14] This manual re-establishes the norms published in 2005 and sets guidelines for the frequency of sample collection, as well as definitions for several levels of water quality. First, the guidelines for free chlorine residual, between 0.5 and 1.0 mg/L, are reiterated. Second, the manual recommends that free chlorine residual be monitored in rural systems at least weekly by MSPAS. For microbiological testing, the manual recommends at least bi-monthly for rural communities, with full-scale water quality testing (all parameters dictated in the Technical Guidelines document) recommended annually. The guide also recommends that when testing occurs, sampling points should be within the distribution tank and at least three representative points across the distribution system, including the most distant from treatment possible. The manual also recommends three specific classifications for water safety "Excellent": 95% of water samples in a given time period (undefined) are apt for human consumption (meet all standards tested for), "Regular": 90-95% of water samples in a given time period are apt for human consumption, "Deficient": Less than 90% of samples in a given time period are apt for human consumption. If any sample at any point is not apt for human consumption, MSPAS can make use of an infraction, fine, and sanction system defined in the Health Code, but these forms of punishment are minimally defined and open to interpretation by MSPAS in the case of an infraction. The strongest recommendation is that warnings be given and communicated in the case of violation of water quality standards.

1.2 RELEVANT GOVERNMENT AGENCIES

Water systems in rural communities are managed by water boards in Guatemala, known as Comites de Agua, analogous to community water board structures in Nicaragua, Honduras, and El Salvador. These Comites are legally mandated for the management of rural water supply, though the process to legalize officially, a water committee, is often challenging and was viewed by many as unnecessary to the overall goal of water management. Therefore, very few water committees seek legalization. Water boards typically consist of 8-10 elected individuals, including the president, vice president, secretary, treasurer, and members at large. Each water board position is elected every two years, and members are not allowed to serve consecutive terms in the same position. The plumber, a permanent paid role earning 1500-1800 quetzales, is crucial for operating the water system but is not a board member and exempt from the two-year transition requirement for water board members. The water boards are responsible for the day-to-day management, operation, and maintenance of the community water system, including the costs associated with those responsibilities. They are also responsible for holding routine assemblies of the community at large for the purpose of voting on significant changes. Finally, the water boards are responsible for tariff rate setting and collection.

Above a water committee, at the community level are the community development council, Consejos Comunitarios de Desarollo Urbano y Rural (COCODEs), which oversee all development projects within a community, with a particular focus on the development of infrastructure such as roads or construction, but also including social development programs. These councils can then therefore sometimes oversee projects related to drinking water and sanitation systems. There is some overlap in responsibilities between COCODEs and Water Boards, but the precise impact of this overlap is often variable and highly community or municipality-dependent. For example, some interviewed noted that members of the water board can also be members of the COCODE, or in other cases, the COCODE may directly operate and maintain the water system instead of a water board. However, the most standard governance arrangement is that the water board is below the COCODE, with COCODEs having the more direct line to request municipal funds for projects overseen by the water board. COCODEs are community-specific but report up to and meet routinely with the governing municipality above them hierarchically. Each COCODE's budget is determined by the municipality, as directed by the mayor's office.

Within each municipality lies a variety of offices responsible for different aspects of oversight, one of which is the Office of Water and Sanitation, Oficina Municipal de Agua y Saneamiento (OMAS). These offices have direct oversight of water treatment in rural communities belonging to the municipality in which they sit. Each OMAS typically has three key positions: one head of office, one responsible for drinking water, and one responsible for sanitation. OMAS technicians are tasked with providing technical assistance to and sometimes regulatory oversight of water quality monitoring in rural communities. However, not all municipalities have OMAS, so the responsibilities and influence vary. Interviewees noted that in municipalities with OMAS, OMAS can direct funds to communities for water-related development, can stand as liaisons between community water boards and municipal officials, and provide key technical assistance and guidance to communities. Interviewees also noted that OMAS is highly variable in effectiveness and utilization and is often severely understaffed and underequipped to provide the scale of support necessary across an entire municipality.

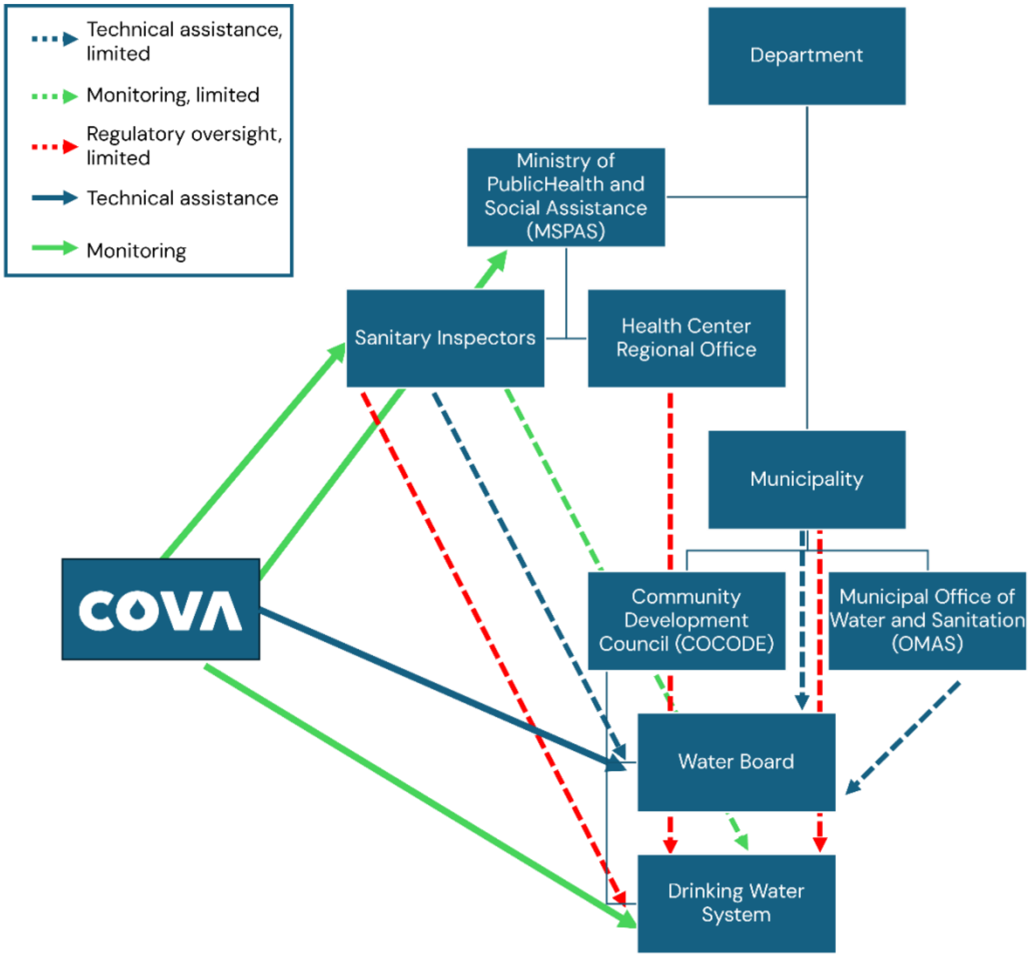

Figure 1. Government entities in Guatemala. Arrows indicate reporting relationships within the context of water treatment and water quality.

Each municipality is responsible for ensuring that drinking water systems within that municipality deliver safe drinking water. Specifically, as noted above in the norms and standards established by the Guatemalan government, municipalities are responsible for ensuring that communities are chlorinating their drinking water and providing routine monitoring services. In turn, MSPAS (see Figure 1) is responsible for regulating the efforts being delivered by municipalities. For example, MSPAS employs Sanitary Inspectors at the municipal level who provide routine inspections that include, but are not limited to, routine water quality monitoring. MSPAS is responsible for oversight and monitoring of water quality, and diarrheal disease, amongst other health-related responsibilities. MSPAS maintains Direcciones Servicios de Salud (DRISS) offices at the departmental and sometimes municipal level, where various MSPAS and MSPAS-affiliated entities can jointly coordinate efforts for monitoring and regulation. Various MSPAS employees, including Inspectores Sanitarias, noted that their responsibilities often entail monitoring the water quality across more than two hundred communities in a given municipality without the financial or physical resources to do so. The inspectors also noted that the number of monitoring samples that they are mandated to collect is not possible without transportation to community sites, and they frequently lack the testing materials to carry out full water quality analysis.

It is particularly worth noting that nearly every interviewee highlighted the simultaneous overlapping but piecemeal nature of governance and regulation of water safety in rural communities. Management responsibilities overlap between entities, but in most cases, even where there is overlap, neither entity responsible for the management of drinking water supplies has sufficient capacity (technically or financially) to fulfill those responsibilities fully. Further, many interviewees called out the extreme variability in the practiced functionality of the entities described here. Although in some municipalities all elements may exist and cooperate as described, in others, some may be fully absent, for example, the OMAS is entirely nonexistent in some municipalities but is a critical actor in others.

2. EVALUATE THE KEY CONTEXT-SPECIFIC ENABLING FACTORS FOR AND BARRIERS TO IMPLEMENTATION OF CIRCUIT RIDER SUPPORTED PASSIVE CHLORINATION IN RURAL COMMUNITIES ACROSS GUATEMALA

Several critical enabling factors already exist within Guatemala, indicating in many ways a similar context to regions of Honduras & Nicaragua where Cova has already expanded and been successful. Other factors emphasize an environment that may be more suited for Cova's circuit rider support chlorination model. Barriers to this model also exist, many of which have been previously overcome in other contexts, but some of which we anticipate being novel to Guatemala. None of the barriers we describe below are indicated as being gravely consequential or insurmountable, but instead are expected outcomes of expansion in a new region.

2.1 CHLORINATION

Chlorination, as a water treatment method, is already widely agreed upon by most NGOs and government entities in Guatemala as a critical component of rural drinking water services. Multiple pieces of legislation dictate that chlorination be maintained across all water systems providing drinking water, in both rural and urban, and publicly and privately owned systems (see Question 4). Tied to these pieces of legislation, multiple government entities, many of which are within MSPAS, are responsible for ensuring chlorination is maintained within drinking water systems and for ensuring routine monitoring and reporting of chlorination and other water quality outcomes. Further, chlorine is readily available for purchase in most major city centers (see Question 3). Further, we observed several self-constructed and commercially available passive in-line chlorinators both in use and available for use in rural communities, including the A'jin model[8] and the Pentair Rainbow 320 pool chlorinator.[9] Compared to Cova's experience in Honduras and Nicaragua, where fewer than 3% of communities were chlorinating prior to Cova's circuit rider model intervention, there are indicators that the enabling environment for chlorination in Guatemala is stronger and more open to chlorination.

Chlorination at the rural community level, on the other hand, presents a different, more complicated, and nuanced perception of chlorination for water treatment. Nearly every interviewee noted that there is significant resistance to chlorination within rural communities. There are misperceptions of the health impacts of chlorination, including that chlorine in the water can cause cancer, infertility, additional illnesses, and skin conditions. Rural community members noted that chlorine was perceived as being reserved for cleaning clothes and, therefore, poisonous or toxic if consumed. Significant concerns were noted due to the taste and odor of chlorinated water, in comparison to unchlorinated water. The water board members interviewed noted that community members were wary of the taste and smell of chlorinated water and disliked or did not wish to pay for chlorinated water. The negative perception of chlorine is further compounded by the influence of Maya Culture across rural Guatemala, which includes the fundamental belief that water is a sacred component of life and therefore, should not be tainted or polluted by chemicals such as chlorine.

There is also a wide range of community perceptions around the benefits of chlorination. One rural community water board member interviewed indicated that water testing conducted on their water source (groundwater) indicated that there was no bacteria present and therefore, chlorination was unnecessary. Another water board that actively chlorinated expressed the belief that chlorination had improved their access to safe water and health outcomes. The community that did not chlorinate still noted the need for safe drinking water free of contamination, indicating a desire for safe drinking, but no association between chlorinated water and water that is therefore safer to drink. This dichotomy closely resembles opinions and beliefs commonly found in rural communities where Cova already works in Honduras and Nicaragua.

2.2 PHYSICAL WATER SYSTEMS, WATER QUALITY & DIARRHEAL DISEASE

In rural communities, the kinds of water systems compatible with Cova's passive chlorinator & circuit rider model (groundwater or surface water, piped schemes with household connections) are prevalent. This is especially true of the Western Highlands, which was the focus area of our scoping study and other USAID-funded work such as I-WASH. Most community water systems consist of a conduction system conveying source water to a storage tank where treatment, if implemented, is located, and a piped distribution system with direct household or on-premises connections. Much of the highland region has access to gravity-fed *nacimientos* or shallow spring sources that can be trapped and connected to these piped conduction systems. However, multiple interviews indicate that these *nacimientos* are vulnerable to seasonal variability and climate-induced variability, leading to dry seasons without consistent access to water. Therefore, communities have increasingly begun to rely on groundwater in addition to surface water to supplement existing supplies, even in regions thought to have consistent access to surface water. In one community, a USAID "Proyecto Comunidades Liderando Su Desarrollo (CLD)"[10] funded water system rehabilitation (sponsored jointly by Catholic Relief Services) was completed in 2023, which added a pumped, groundwater well source to two existing spring sources and rainwater harvesting to increase water availability to 24/7 access. Before this rehabilitation, the community only had access to water consistently 3 days per week. These anecdotes suggest that climate-induced variability, as well as human usage and source degradation, are going to continue to introduce challenges for rural communities in rural Guatemala, as we have already seen in Honduras and Nicaragua.

Water quality data is not widely accessible or publicly available for rural communities. However, data collected by MSPAS sanitary inspectors, and shared directly across Quetzaltenango, indicated that 37% of the 1,225 water samples collected from January to June 2024 did not meet water safety standards, exceeding total, fecal, and/or E. coli limits set by the Guatemalan government.[11] At the municipal level, some municipalities had proportions of samples indicating safe drinking water as low as 4%.[11] In this same department, diarrheal disease, as monitored by MSPAS, has increased in the last year across the general population and remains particularly high for children under the age of five.[11] These levels of fecal contamination and consequent diarrheal disease suggest a critical need for water treatment across rural communities.

With regards to turbidity, many interviewees mentioned turbidity as a problem, particularly in the rainy season, for surface water-fed systems, as would be expected. Existing solutions to this challenge also follow expectations, with pre-filtration or flushing the system after rainfall events being the most mentioned. Both communities interviewed also noted the added benefit of multiple sources, allowing them to rely exclusively or more dominantly on groundwater in the rainy season to avoid turbidity.

2.3 MAYA CULTURE

The historic significance and influence of Maya religion and culture is a critical consideration when working in rural Guatemala. Twenty-two of the languages, aside from Spanish, spoken in Guatemala are of Mayan origin. Although Spanish is the national language, regional dialects often dominate in rural areas, with official meetings sometimes held in multiple languages. Multiple interviewees suggested the importance of future Cova Circuit Riders speaking both Spanish and local dialects for ensuring communication is both possible and successful for capacity building and training in rural communities.

Additionally, even though Catholicism and Evangelicalism are prominent in Guatemala, Maya religious beliefs remain culturally important. These beliefs are especially relevant to water, as water is considered sacred in the Maya religion. Therefore, some traditional beliefs suggest that water should not be contaminated with any chemicals. Water is also considered a right due to water's religious importance, and some therefore do not believe that anyone should be required to pay money for access to drinking water. These beliefs vary depending on the indigenous groups present in each community, but should be considered in plans for implementing community-level organization and chlorination.

2.4 COMMUNITY ORGANIZATION

In a report for the USAID-funded "Community Led Development" project, water was listed as the top priority identified by communities for local development and quality of life improvement.[10] This evidence supports our interviews which suggest that communities and in particular the community structures responsible for water management are aware of and desire treatment opportunities to improve their access to safe drinking water. However, interview results indicated that community water boards are often lacking in the training necessary to maintain and operate drinking water systems, or further, are lacking the knowledge to make decisions on what kind of drinking water treatment should be implemented.

A pilot study conducted by Universidad Del Valle Del Guatemala (UVG) in partnership with MSPAS, implemented chlorine dosers in MSPAS health posts and conducted community workshops to develop action plans for continued implementation of community-level chlorine dosers. One critical finding of this study was that though chlorinators were implemented by UVG, they required plans for sustainability if the community was to assume responsibility, and within these sustainability plans, there needed to be continued support from some external entity for ongoing monitoring, technical assistance, and capacity building. This need was especially strong during the changeover between water board elections. The pilot results also recommended establishing financial management practices to maintain available funds for the operation and maintenance of the chlorination systems. Overall, this pilot study reports community-identified demand for opportunities to implement water treatment and the support necessary to maintain water treatment systems, such as chlorinators.

3. IDENTIFY THE POTENTIAL COSTS ASSOCIATED WITH IMPLEMENTATION OF CIRCUIT RIDER-SUPPORTED PASSIVE CHLORINATION

3.1 CIRCUIT RIDER MODEL COSTS & EFFECTIVE DEMAND

Our scoping study indicates that the costs associated with implementing the Circuit Rider-supported passive chlorination model in Guatemala would be similar to Honduras and Nicaragua. The mountainous terrain of Guatemala mirrors that of Honduras and parts of Nicaragua. The misconceptions around chlorine in drinking water may pose an additional challenge, however, our Circuit Riders have overcome similar challenges in Nicaragua and Honduras.

Cova's circuit rider model relies on community water boards buying calcium hypochlorite tablets for passive chlorination. Though sold with a small profit, these sales are vital for the model's financial sustainability. Hence, the willingness and ability of Guatemala water boards to pay for these tablets is crucial for future expansion goals.

Operational expenses for Cova's established Circuit Rider model in Honduras and Nicaragua amount to approximately $650 per community per year, or around $1.19 per person per year during the first two years of implementation. Costs to start operations will be higher in Guatemala for several years while the team is learning the strategies to build capacity within communities and clarify misconceptions about chlorine usage as well as establish connections with strategic government agencies. After covering the initial startup expenses, we expect the operational costs to align with those incurred in Honduras and Nicaragua.

Preliminary findings from this scoping study suggest that community water boards may have a similar or slightly greater capacity to pay for chlorine compared to Honduras and Nicaragua. This hypothesis is supported by the observation of slightly higher water tariffs. While the community sample size was relatively small, initial indicators from this scoping study found monthly community water tariffs ranging from 15 to 60 quetzales or $1.93-$7.73 per household per month (depending on water system type and volumetric vs. uniform tariffs).[1i] Across communities that Cova works with in Honduras and Nicaragua, the average water tariff for gravity-fed water systems is $1.78/month, while the average pumped water system tariff is $3.39/month.

Based on our experience working with Honduran and Nicaraguan water systems, chlorine costs represent approximately 9% of the total operational expenses in gravity-fed systems and about 18% in pumped systems. Given these estimates, the tariffs are within a range that could potentially cover the routine purchase of chlorine tablets. Additionally, both communities interviewed utilized volumetric tariff payments, indicating that these communities were outfitted with household water meters, which, based on evidence from Cova's work in Honduras and Nicaragua, can improve water conservation efforts and tariff collection rates.

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[1] $7.73/household/month appears quite high in comparison to average tariffs in Nicaragua and Honduras, so we temper this range with the possibility that this is an outlier, though at least two key informants indicated tariffs that high were normal.

Evidence also indicates that willingness to pay will be more variable across rural Guatemalan communities than ability to pay. One community, which was receiving donated chlorine tablets from the Ministry of Health at the time of the scoping visit, indicated that if chlorine tablets were no longer available for free, they would not be inclined to purchase chlorine tablets. Another community had a chlorinator installed but was not interested in chlorinating due to a variety of perceptions (see above). Though neither of these observations are fully representative, they do indicate the degree to which willingness to pay for chlorination services has many contributing factors, a key one of which is willingness or desire to chlorinate.

4. ASSESS THE EXISTING CHLORINE SUPPLY CHAIN (AVAILABILITY, QUALITY, COST) IN GUATEMALA

Cova relies on the NSF 60 standard to determine which chlorine tablets should be used for drinking water treatment. According to those guidelines, no NSF 60 compliant tablets are currently manufactured or directly distributed in Guatemala. At least three separate key informant interviews indicated that much of the chlorine being used for drinking water treatment was not designed for, nor was it apt for, drinking water treatment or human consumption. However, many brands and specifications (calcium hypochlorite and sodium hypochlorite) were available for purchase in Guatemala, according to interviews with organizations purchasing chlorine. Further, initial costs observed suggest similar pricing for chlorine available to purchase versus the cost of chlorine tablets sold by Cova in Honduras and Nicaragua.

5. IDENTIFY AND DEVELOP OPPORTUNITIES FOR POSSIBLE IMPLEMENTATION RESEARCH ON CIRCUIT-RIDER SUPPORTED PASSIVE CHLORINATION IN GUATEMALA

Several NGOs, government entities, and one university interviewed for this scoping study expressed significant interest in the opportunity to collaborate and pursue implementation research on circuit rider supported passive chlorination in Guatemala. Aside from the possible opportunities with I-WASH and Global Communities described above, we identified several possible implementation research opportunities.

Related to this opportunity in several rural municipalities of Quetzaltenango, we met with the Universidad del Valle del Guatemala research partners who have worked closely with these municipalities through MSPAS to investigate: 1. The implementation of passive chlorinators in rural health centers, and 2. The spread of antimicrobial resistance genes in drinking water (and other environmental sources). Results from the passive chlorinator pilot indicate that there is a need for chlorination, but that community-level chlorination, rather than implemented at a health center post, would be more beneficial for the community at large. The pilot study identified several crucial elements for oversight and management that neither the University nor MSPAS could sustain independently. These elements may necessitate external support from an NGO such as Cova and include ongoing monitoring, capacity building, and technical assistance for communities implementing chlorination. The pilot was, critically, largely successful in providing access to safe drinking water; before and after tests showed a reduction in the proportion of E. coli positive samples in drinking water at the health centers where chlorinators were installed.

As a part of the much larger CDC-funded Antibiotic Resistance in Communities and Hospitals (ARCH)[15] study, the University, led by Dr. Brooke Ramay, is involved in studying antibiotic resistance in communities and health posts in Guatemala. Although the evaluation of microbial resistance in waterborne bacteria is not explicitly a part of this ARCH study, their team is continuing to evaluate this possibility, but is interested in the possible outcomes of chlorination on the control of these bacteria and expressed a desire to see chlorination implemented further in these municipalities alongside their ongoing study. The UVG team explicitly indicated an interest in collaboration, particularly if antimicrobial resistance was of interest, or at a minimum, measurement of waterborne disease-causing pathogens.

As a part of this scoping visit, we also independently met with the sanitary inspectors (MSPAS employees) serving the municipalities described above, two of whom had implemented chlorination at the health center level. These inspectors emphasized to us the collaborative possibilities for working in these municipalities and offered to share baseline water quality and diarrheal prevalence data for future use. Both meetings indicate the potential for implementation research, particularly at a pilot scale or larger in the department of Quetzaltenango, with a focus on one or more rural municipalities. The existence of interested and involved partners, both in academia and at the local MSPAS level, is advantageous to implementation research focusing on this geographic region, regardless of topic.

Based on this scoping study and interviews with potential partners and collaborators, the following questions are critical for future programmatic expansion and for the rural water management sector. These questions were utilized in the development of an implementation research plan for 2025, with emphasis on piloting expansion in El Salvador (see El Salvador report) and a larger scale RCT in Honduras (where Cova is already implementing at scale). Specifically, the questions noted with asterisks below will be researched during that pilot and RCT in 2025 and 2026.

TABLE 1: RESEARCH TOPICS RELEVANT FOR ESTABLISHING SUSTAINABLE CIRCUIT RIDER SUPPORT FOR WATER SAFETY MANAGEMENT AT RURAL WATER SYSTEMS IN GUATEMALA. QUESTIONS MARKED WITH AN ASTERISK (*) ARE SUGGESTED PRIORITIES

TOPIC	QUESTION	OTHER DETAILS
Model Effectiveness in a Novel Context	• How frequently can community-managed drinking water systems equipped with passive chlorinators, supported by Cova circuit riders, meet free chlorine residual targets at the point of consumption, in new communities in rural Guatemala? * • Does passive chlorination, supported by a Circuit Rider model, reduce the prevalence of diarrheal disease-causing pathogens and antimicrobial resistance in drinking water? • What kinds of socialization or incentivization is required to ensure chlorination rates? And to whom? I.e., the water board, community members, others? *	Possible pilot option of municipalities in rural Quetzaltenango or with I-WASH Data could be paired with diarrheal disease data available from local health centers. UVG is interested and willing to provide support for water quality testing beyond standard measurements (pathogen-specific, antimicrobial resistance, etc.) which could be interesting to pair with chlorination and other effectiveness measures.
Costs	• What are the costs of expanding the Circuit Rider model into new contexts? * • What is the effective demand for passive chlorination supported by circuit riders? *	Effective demand could be studied at the household and water board level, and at the municipal level given the municipal responsibility to chlorinate.

	• What is the effective demand for chlorine tablets, purchased by community water boards in rural Guatemala? • What kinds of subsidies are required for chlorine or programmatic efforts to maintain positive outcomes? • Who might subsidize these efforts in rural Guatemala? • How much and what kinds of community-level factors influence effective demand for chlorination? I.e. tariff setting, system type, population, etc.	We could compare operating costs more explicitly between Guatemala and Honduras to evaluate whether subsidy necessities differ. Some qualitative research could be done to evaluate whether there is openness to government. level subsidies. Municipalities are required to support safe drinking water in communities but are often underfunded themselves so it could be interesting to evaluate what funds are available.
Chlorine Acceptance	• What are the taste & odor thresholds for chlorine acceptance in rural Guatemala? * • How can we optimize taste & odor acceptability across an entire distribution system? • How long does it take for people to acclimate to the taste/odor of chlorinated water? * • What kinds of community engagement and sensitization activities influence acceptability? *	There is a strong body of evidence for the variability of taste & odor thresholds[16–18] particularly when indigenous communities are compared to non-indigenous communities.[19] It would be especially interesting in this context with many culturally Maya communities to evaluate how taste and odor impact the effectiveness of chlorination programs. The national norm of 0.5 mg/L is quite high given the expressed distaste for chlorine.
Climate Resilience & Source Switching	• To what extent is source switching, secondary source usage, and water storage taking place? • To what extent is chlorination affecting the above? • To what extent is climate variability, overuse, or seasonal variability impacting the above? • To what extent is permanent source switching, i.e., connecting to a different, often groundwater source, due to surface water variability, occurring? • How is the above permanent source switching making systems more or less compatible with in-line chlorination in Guatemala?	We noted multiple communities that had switched sources, permanently to account for seasonal variability (climate or overuse influenced). The implication is that before this switch water was insufficient some of the time, what kinds of source-switching behaviors were taking place during those times at the household level? Is this influenced by chlorination? Permanent source switching to groundwater sources may make chlorination even more feasible so understanding the prevalence of this could be valuable.

Limitations:

We were unable to meet with the Global Communities I-WASH team until late July and were unable to meet or visit I-WASH communities in country due to scheduling challenges. Therefore, the possibility of collaborating with I-WASH does not appear as strong as some of the other implementation and collaboration opportunities. This is not necessarily representative of the strength of the opportunities, but truly due to the recency with which conversations with Global Communities have begun.

Further, we primarily focused on scoping visits with partners in the Quetzaltenango Department. Therefore, our research recommendations are focused on this region. This is not to suggest that implementation research could not take place elsewhere, but these are some of the strongest connections identified and visited in person. Despite the geographic limitations of our visit, we do believe that the conclusions drawn and results presented here (aside from geographic recommendations for implementation research) are broadly representative of the rural water sector and not just one department.

APPENDIX

BACKGROUND AND MOTIVATION

1.1 WASH CONTEXT IN GUATEMALA

In Guatemala, only 56% of the country has access to safely managed drinking water, and the need is far greater in rural areas and among indigenous populations.[2] This lack of safely managed access continues despite the prevalent access to drinking water via gravity-fed water systems. Since naming Guatemala a priority country in 2021, USAID has committed to supporting the government of Guatemala's plans to invest in WASH as a part of their National Development Plan: K'atun 2032.[2] They plan to invest heavily in the financial and technical capacities of national and municipal actors to achieve 90% access to improved water and sanitation services and by 2030 achieve universal and equitable access to safe and affordable drinking water.

1.2 COMMUNITY-BASED MANAGEMENT

There is a growing research priority to identify and amplify the service delivery models that result in access to safely managed drinking water. Specifically, as the WASH sector continues to evolve in its perspectives on community-based management to understand that external support or "community-based management +" arrangements are necessary additions to typical community-based management, interest in understanding what those arrangements look like has grown.[3] Further, a critical remaining question is how external support organizations, such as NGOs and professionalized utility entities, can expand their reach to communities not otherwise part of an external support network currently using a CBM strategy. Important implementation-level questions for the rural water sector include:

- How do communities join existing external support networks?
- How do water treatment service providers support communities as they move along the spectrum from non-networked to fully integrated into service provision and support?
- What is an effective balance of water user payments and public and/or philanthropic subsidy to financially sustain external support services?

In Central America, many rural communities have existing water supplies that meet "at least basic" access levels but are not served by any kind of maintenance or external support entity. There is an opportunity to develop research and resources around how these communities can be elevated to safely managed supply through external support provision, governmental support, and water treatment. However, the actual service models necessary to pursue this transition remain under-evaluated and/or under-reported.

1.3 CHLORINATION

Passive chlorinators are a relatively simple and affordable class of water treatment technology that dose chlorine into existing water supply infrastructure without requiring electricity, machinery, or burdensome input and behavior change from water users.[4] A large variety of passive chlorinators exist that are compatible with many kinds of water provision infrastructure, but they are particularly compatible with gravity-fed systems. A growing number of NGOs and service providers are developing passive chlorination programs, and they have been implemented in at least sixteen countries to date.

However, passive chlorinators require sustained operation and maintenance from trained individuals to maintain consistent dosing at concentrations necessary for disinfection.[4–6] Therefore, evaluating the kinds of service delivery models compatible with chlorination has been identified as a priority research area necessary to scale passive chlorination.[8] This is particularly critical, given that an estimated 2.32 billion people in need of safely managed drinking water supply have systems compatible with passive chlorination.[7]

1.4 COVA AGUA

Cova Agua (Cova) is an NGO working in Honduras, El Salvador, and Nicaragua that provides sustained, external technical support to rural community drinking water systems through its Circuit Rider model, including the implementation and ongoing maintenance of passive chlorinators. Multiple peer-reviewed and internal reports indicate the effectiveness of the Cova Circuit Rider program on chlorination and disease outcomes,[5] in Nicaragua and Honduras, where Cova has operated since 2008. A recent study indicated a chlorination rate across operational data collected between 2013 and 2021 of 77% at the point of collection.[5] Across the two countries, Cova currently works in 2,109 rural communities, each with an in-line chlorinator served by Cova's Circuit Rider model. In 2023, Cova (EOS International) began a small-scale expansion into El Salvador, where it currently works in sixty-three communities, alongside partner organizations.

With an on-the-ground staff in Nicaragua, Honduras, and El Salvador, Cova is a locally managed organization dedicated to comprehensively implementing drinking water solutions that ensure a long-term, positive impact. Strong partnerships with ministries of health, local communities, private entities, universities, NGOs, and governmental organizations have helped expand Cova's reach and effectiveness.

All solutions are locally operated and require co-financing from rural community clients. Cova's program explicitly targets rural communities in Nicaragua, Honduras, and El Salvador, where most residents are subsistence farmers earning $3-6 per day and lack access to safe drinking water. The goal of Cova's Circuit Rider model is to empower rural communities with access to safe drinking water, resulting in an improved standard of living, poverty reduction, and increased educational and economic opportunities.

1.4.1 THE CIRCUIT RIDER MODEL

Cova Agua's model follows three distinct phases. Prior to entering any new communities, our Circuit Riders meet with municipal leaders and local government health offices to identify communities and travel "circuits" to explore expansion into. Once explicit agreements have been reached, Circuit Riders begin delivering Phase 1.

Phase 1: Implement

The Circuit Rider model aims to build the capacity of rural community water boards by equipping them with the necessary skills, knowledge, and resources to provide safe drinking water for their community and to operate their water utilities efficiently and effectively. Activities of Circuit Rider include baseline water quality analysis to assess contamination in the community water source, installation of passive chlorinators, water board capacity building, routine free chlorine residual monitoring at the tank and households, and ongoing chlorine tablet distribution. During Phase 1, a Circuit Rider typically works in 40-50 communities. At this stage, communities sign agreements specifically outlining the responsibilities of the water board and the responsibilities of the Circuit Rider. At this stage, community water boards begin to purchase chlorine tablets for the chlorinators using funds available through water tariffs paid by each household connected to the piped scheme. Water tariffs are legally mandated structural components within water board governance; however, Circuit Riders also include financial capacity building in the early phases of their engagement to support water boards without tariffs or without sufficient tariffs.

Phase II: Transition

In Phase II, monthly water quality monitoring activities are transitioned to community leaders and other professional entities. Cova identifies and trains community leaders, such as municipal WASH technicians and government public health promoters, to monitor and report free chlorine residual monthly, eventually eliminating the dependency on Cova to identify water quality issues. Cova provides the communities with tools and equipment to report monthly water quality metrics, which can be shared with the Ministry of Health or other local partners. This transfer of monitoring responsibilities can only begin after the community meets key sustainability metrics, especially sustained high rates of chlorination.

Phase III: Scale

With the training provided in Phase I and Phase II, communities and government entities can troubleshoot and respond to most water quality issues identified (i.e., through preventative maintenance, repair, and/or chlorinator calibration). This allows a Cova Circuit Rider to transition from supporting 50 communities to supporting up to 150 rural communities, continuing to act as a technical resource on an as-needed basis and chlorine distributor, providing technical assistance, and laboratory-level analyses for the community. At this stage, communities remain responsible for the purchase of chlorine, and if the chlorinator (or other system components) requires replacement or repairs, the water board is responsible for paying for those repairs.

Cova has found that with two years of community investment, year three can be sustained entirely with the communities' support (see chlorine sales below), providing a financially viable and sustainable model. This program investment requires multiple years to build up the capacity of the communities and the local institutions, and an operational plan to achieve sustainability without outside funding. Cova also maintains recognition that there is some feedback between phases, particularly as new water boards are elected, communities that have otherwise moved on to Phase III may require additional capacity building to rebuild knowledge lost during the transition of power. However, this emphasizes the importance of Cova working at both the water board level and at the municipality and secretary of health levels.

1.4.2 FINANCIAL MODEL

To cover a portion of the costs of these services and ensure that communities have access to chlorine necessary for the operation of the chlorinator, Cova Circuit Riders sell chlorine tablets to the water boards. Cova also leverages philanthropic support and results-based funding to cover the remaining costs of the circuit rider model. The cost of the circuit rider program shifts over time depending on the length of time they have worked in a community, the frequency of community visits, and the capacity of the water board. In Phases I & II, Cova's operational cost to support 50 communities in Honduras and Nicaragua is approximately $1.19/person/year on average. However, as Circuit Riders continue to build the capacity of the community and the visit frequency is reduced, allowing the Circuit Rider to support more than one district, our operational costs are reduced to approximately $0.54/person/year or less, depending on the number of districts served.

1.4.3. EXPANSION

As Cova seeks to expand across Central America, both into new countries and new regions in Honduras, El Salvador, and Nicaragua, there is an opportunity to study the factors that enable the expansion of these services. Exploring expansion in Guatemala will allow for future comparison and generation of research questions, as well as a determination of where future implementation research should focus between new and already established country programs (El Salvador, Guatemala, and Honduras).

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