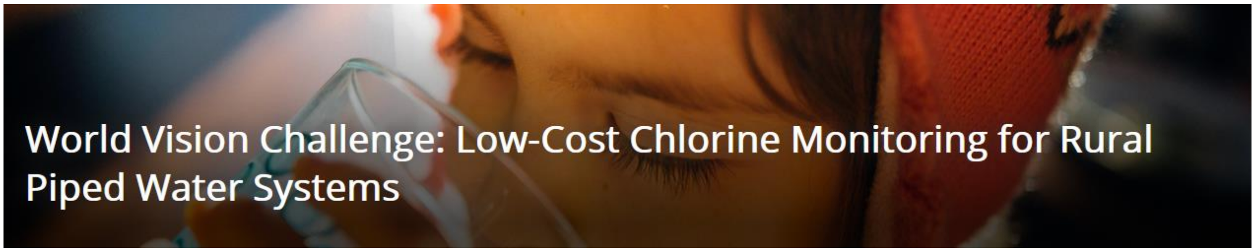

Card image

Detailed Description and Requirements:

BACKGROUND

Drinking water disinfection. The availability of chlorinated drinking water is one of the most impactful public health advances in recorded history. Chlorine has been used to disinfect water in distribution systems for well over one hundred years. It is widely available, generally inexpensive, and is effective against viruses, bacteria, and other pathogens often present in water. No matter the form of chlorine used (liquid solution or solid tablet), its addition to water leads to the formation of hypochlorous acid (HOCl) and hypochlorite ions (OCl^-), which are the two primary active disinfecting agents present in chlorinated water. Hypochlorous acid is the most effective of the two and the ratio of these compounds depends on the pH of the water when the chlorine was added. The combination of the two comprises the 'free residual chlorine' in the water and it is the concentration of this free chlorine that determines the effectiveness of chlorine in disinfecting the water.

Water systems that utilize chlorination employ various technologies to add the chlorine to the water and then monitor the level of free residual chlorine to ensure that it remains within the dosing range recommended by the World Health Organization (WHO). While "manual" approaches to monitoring free residual chlorine are readily available (test strips, for example), they require frequent site visits and are prone to misinterpretation, making them less practical in rural, resource-constrained settings. Automated monitoring systems, on the other hand, can provide continuous, accurate monitoring of free residual chlorine levels; such systems are expensive, however, and generally rely on proprietary technology that requires service from the manufacturer to ensure proper operation.

The potential of chlorination in the developing country context. Rural water points in developing countries have faced well-documented challenges with both functionality and water quality while household point-of-use (POU) water disinfection has proven equally problematic. In part due to these persistent challenges, government and nongovernment organizations alike are increasingly moving away from the promotion and construction of individual handpumps, shifting instead to mechanized, small-scale piped water systems that deliver water closer to communities (if not directly to households). Along with this shift to piped water systems comes a new opportunity to address entrenched water quality issues by testing and deploying disinfection technologies adapted to rural systems in low-resource environments. More specifically, the expanded use of chlorination technologies such as tablet-based, in-line chlorinators[1] has the potential to greatly improve the safety of piped water given that it continues to combat bacteriological contamination during the storage and distribution of water to collection points or household taps. As noted above, the capacity of "free residual chlorine" to protect drinking water all the way to the tap is an advantage that has long bolstered the safety of water supplies in developed countries.

Despite the potential of in-line tablet chlorination, widespread use of tablet chlorination remains limited in the developing country context. One important constraint is that dosing by in-line tablet chlorinators is harder to control, making the regular monitoring of free residual chlorine levels especially critical. More specifically, the very nature of tablet-based chlorination means that dosing is less precise at the point of deployment as water passes around the tablet and continues into the storage container and/or reticulation system. As such, the service provider/operator must reliably and regularly verify the level of free residual chlorine to ensure that such levels comply with World Health Organization (WHO) guidelines in drinking water. Given the expense and maintenance requirements of automated chlorine monitoring systems this need to regularly verify the level of free residual chlorine represents a significant roadblock to the widespread introduction of safe and clean piped water systems to resource-constrained rural areas.

REFERENCES

Many helpful resources exist that discuss the chlorination of water, such as:

1. World Bank Water and Sanitation Program. 2004. Technologies applied for drinking water treatment in rural communities. Available at: https://www.rural-water-supply.net/en/resources/details/277
2. World Health Organization. 2018. Guidelines for Drinking-Water Quality. Fourth Edition. Available at: https://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines-4-including-1st-addendum/en/
3. https://www.safewater.org/fact-sheets-1/2017/1/23/what-is-chlorination
4. https://www.cdc.gov/healthywater/drinking/public/chlorine-disinfection.html
5. https://en.wikipedia.org/wiki/Water_chlorination
6. https://akvopedia.org/wiki/Chlorination_in_piped_systems

[1] While solution-based, drip chlorinators represent another popular option for administering the needed dose of chlorine to the water supply, they are not well-suited for water supply systems that have an intermittent supply—a common characteristic or rural systems in less developed countries—in that they cannot be easily turned off to prevent over-dosing.

THE CHALLENGE

World Vision, supported by SeaFreight Labs, is seeking low-cost, easily maintainable technologies and/or devices to monitor free residual chlorine in piped water distribution systems and points of delivery located in rural areas of sub-Saharan Africa. While some of the requirements derive from conditions in the targeted use area, it is envisioned that a solution to this Challenge will be useful for rural water supply systems in many parts of the world and will positively impact tens of millions of people worldwide.

Any proposed solution should address the following **Technical Requirements**:

1. Must provide an approach to the automated monitoring of the concentration of free residual chlorine (FRC) at points within a piped water distribution system. Monitoring does not need to be continuous, but ideally the solution should allow for at least two (2) to four (4) automated FRC measurements every 24 hours.

2. Must measure free residual chlorine in the range of 0.2-1.0 milligrams per liter with an accuracy of ±0.1 milligrams per liter.

3. Free residual chlorine measurement data must be logged and allow for reading of the data without removal of the device from the system. The proposed solution should have sufficient memory to hold at least one week's worth of readings.

4. To the maximum extent possible, the use of parts commonly available in urban areas in sub-Saharan Africa should be prioritized, including the use of open-source development boards.

5. The bill of materials (BOM) should be less than $500 per monitoring device with a preferred BOM cost target of $250 per device.

6. Solution must be waterproof and weatherproof and have a projected lifespan of 3-5 years.

7. Must be locally serviceable, ideally allowing for the replacement of modular parts as needed.

The solutions would preferably satisfy the additional following criteria (but not essential):

1. Capable, or possible to be made capable, of operating off battery power, ideally using a replaceable battery or a rechargeable battery in combination with a solar panel.

2. Capable, or possible to be made capable, of digitally transmitting logged data to a remote location using a variety of transmission modes such as narrow band (LoRa-based) radio signals, GSM, or satellite.

With the goal of fostering further collaboration and development of technologies in this important field, World Vision encourages the release of all proposed solutions under the Creative Commons Attribution-ShareAlike License (4.0). Solvers with winning solutions must release the solution under this license to receive an award.

Project Deliverables:

The submitted proposal should include the following:

1. **Detailed description** of a device/technology that can meet the above **Technical Requirements**. This should include a description of the overall design as well as programming sketches, printed circuit board designs, hardware bill of quantities, auto-cad designs, and other schematics as needed.

2. **Rationale** as to why the Solver believes that the proposed system will meet the requirements of this Challenge. This rationale should address each of the **Technical Requirements** described in the Detailed Description and should be supported with any relevant examples.

3. **Experimental proof-of-concept data** demonstrating operational range and accuracy as outlined in the Detailed Description of the Challenge. If requested by the Seeker, the experimental proof-of-concept may include delivery of a prototype.

The Seeker may wish to partner with the Solver at the conclusion of the Challenge. Solver should describe their expertise and include a statement indicating their interest in this opportunity.

The proposal should not include any personal identifying information (name, username, company, address, phone, email, personal website, resume, *etc*.) or any information the Solvers may consider as their Intellectual Property they do not want to share.

The Challenge award is contingent upon theoretical evaluation and experimental validation of the submitted solutions by the Seeker. If multiple proposals meet all the **Technical Requirements**, the Seeker reserves the right to award only the solution which they believe is [add criteria of choice].

To receive an award, the Solvers will not have to transfer their exclusive IP rights to the Seeker. Instead, Solvers will grant to the Seeker a *non-exclusive license* to practice their solutions and **release their solution under the Creative Commons Attribution-ShareAlike License (4.0)**.

PLEASE NOTE: In addition to monetary awards, winning Solvers, with their consent, will **receive recognition in a public announcement made by World Vision** and will have the **potential for follow-up engagement and collaboration with World Vision** and other stakeholders to support the scaling of the proposed technology.

Submissions to this Challenge must be received by 11:59 PM (US Eastern Time) on Month Day, Year. **Late submissions will not be considered**.

ELIGIBILITY

Employees of World Vision and their immediate families, as well as any individuals involved in the judging of this Challenge and their immediate families, are ineligible to receive an award for this Challenge.

ABOUT THE SEEKER

World Vision is a Christian humanitarian organization conducting relief, development, and advocacy activities in its work with children, families, and their communities in nearly 100 countries to help them reach their full potential by tackling the causes of poverty and injustice. World Vision serves all people regardless of religion, race, ethnicity, or gender. For more than 35 years, World Vision has been bringing water, sanitation, and hygiene services to the most vulnerable children around the world. Our 2021-25 Business Plan aims to leverage $1 billion of investments into 41 priority countries, bringing sanitation to more than 13 million people. Our strategy includes market-based approaches, developing viable business models with tiered product offerings to leave no one behind, as well as increasing consumer demand.

Committed to making a positive and lasting difference in the world, and driven by our desire to serve God, World

Vision has become a global leader in improving and transforming the lives of children, their families, and their communities.

World Vision is supported in this project by SeaFreight Labs (www.seafreightlabs.com), an open-innovation consultancy using global challenges to cost-effectively deliver breakthrough innovation. Participation in this project is a direct result of the recent SeaFreight Labs decision to join the Pledge 1% movement.