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# WARP2: Water Aid and Renewable Power

## Background

IHS, a Seattle-based “profit-for-purpose” corporation, has designed, assembled, field-tested, and deployed a water purification system that is small, sophisticated, modular, transportable, low-power, high-throughput, sensor-rich, robust, simple, and inexpensive. WARP2 is the second version of a Water Aid and Renewable Power system first engineered for the Roddenberry Foundation (supported by the Star Trek franchise) after Supertyphoon Haiyan hit the southern Philippines in 2013.

The founders of IHS have established a 501c3 Foundation, Applied Hope, to take the IHS water initiatives like the WARP2 out of the for-profit sector and onto the non-profit side to reduce the cost of clean water to populations that have no other access. Recent deployments have included eight Mayan villages in the Yucatan Biosphere Reserve, remote settlements around Kwajalein Atoll in the Marshall Islands, and two hospitals for war wounded in Yemen.

The first WARP Systems in 2017 produced about 800 gallons (~3,000 liters) of purified water daily from local water sources and relied on a tri-fuel generator to provide the required power. Our new version creates 3,000 gallons of better water each day from solar energy alone (~12,000 liters). Our subsequent disaster deployments led to a strategic partnership with MIT's Lincoln Labs and Schweitzer Engineering Laboratories and a wholly re-designed WARP2.

## Technology Advancements

WARP2, first deployed in 2019, is a smaller, lighter, more robust system centered on a disinfection process that uses a zeta-charged ( $\zeta$ -charged) electro-absorptive boehmite that requires no external power at all - the boehmite itself carries a powerful permanent charge. With a 4x flow rate improvement, our new 24-volt DC system can clean more than 3,000 gallons daily (instead of 800) with no membranes and near-zero water loss. WARP2 is also smaller, lighter, stronger, simpler, cheaper, and more effective at removing biological pathogens, organic chemicals (including fertilizers, pesticides, fuels, and pharmaceuticals), and several critical metalloid contaminants, including arsenic and lead.



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The WARP2 has sensors installed at multiple locations along the flow paths for both water and power, and it has a controller that automates several maintenance functions. In addition to the built-in sensor network, high-resolution maintenance and troubleshooting videos can be stored locally in the local language to describe what might go wrong, how to fix it, and how to contact IHS if something is unclear.

Every component within the WARP2 System is certified to meet or exceed NSF/ANSI 42 standards for drinking water, and the water produced exceeds the UN's World Health Organization criteria, German drinking water standards (among the most stringent in the world), and US EPA standards for drinking water.

That pure water is then either available for immediate dispensing at a rate of two gallons per minute, or stored internally for later distribution from a Rotoplast 1100-liter drinking water container inside our kiosk. The Dispensing panel has a rinse cycle, electromechanical Fill buttons, a touch screen showing Fill icons, and a coin acceptor that can accept payment in coins or tokens. The water can also be dispensed free of charge through Administrator settings.

The base WARP2 is an integrated system of six open and enclosed modules, with an icon-based multi-lingual touchscreen dispensing station, solar panels, a DC controller, and either AGM batteries or a graphene supercapacitor for power storage. It is designed to produce water daily for a minimum of five years, maintenance is simple, and the consumables are readily available and inexpensive. Field installation images and a data sheet are available on request.

## System Description

The WARP2 is modular and can be mixed and matched as needed from our standard configuration:

**W1-W2:** W1 and W2 contain a series of five auto-flushing spin-down filters. This filter type is the first layer of defense, and the intent is to filter out large particles, silt, and sand down to 15 microns (contaminants barely visible to the human eye). W1 contains the first three spin-down filters that start blocking particles from 152 microns down to 61. W2 continues filtering particles from 30 to 15 microns. W2 is pressure regulated to detect any blockages in modules W1 and W2. Suppose a reduction in pressure or flow is detected. In that case, the lighting in the affected modules turns from a usual soft purple to a bright red to signal the operator that it is time for an additional cleaning of the filters.



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**W3:** In W3, we take the sediment filtration down to 5 microns via a “222”-style positive-seal filtration media with more than twice the capacity of a standard filtration canister.

**W4:** The W4 module starts with carbon block filtration to remove any heavy metal contamination in the water. The carbon also reduces any chlorine that might be present and improves overall taste. After the carbon, we use the same 222-style media to filter down to a single micron, smaller than a blood cell.

**W5:** The W5 module takes the same 222 cartridges to sub-micron levels. Viruses average about half a micron, so many are cleared at this stage. The water then passes through our Ahlstrom Disruptor media. The Disruptor is the zeta-charged boehmite described above. It causes a profound electrical disruption of viruses, bacteria, and fungi using a powerful permanent molecular charge and yet imparts nothing to the water: no particles, no color, and no taste.

**WST:** The WST is our Water Storage Tank, usually an 1100-liter Rotoplast designed and certified to hold clean water for drinking.

**D:** D is our post-treatment dispensing module. This module will pull the purified water from storage using the integrated water pump and into our Quantum Silecte disinfection cartridge. The Silecte is another disinfection step that uses a complex surface area designed to harvest electrons from within the biological structure of microorganisms. That electron loss results in a microbial structural decomposition, with the harvested electrons transferring to the media surface. D also has an additional antimicrobial treatment using two high-intensity ultraviolet (UV) LED lights reflected into the source water that we’ve added to comply with some national regulations that require UV treatment.

That pure water is then distributed to the end user through our custom distribution module. Our distribution programming allows optional integration of a rinse cycle with purified water and a set of programmable fill cycles. We can also integrate a coin-operated mode so communities can control water distribution.

**SC:** This is our Solar Charging Module for regulating the solar input and charging the batteries. An accompanying smartphone mobile application allows staff to remotely monitor battery levels, solar charging efficiency, and system performance.





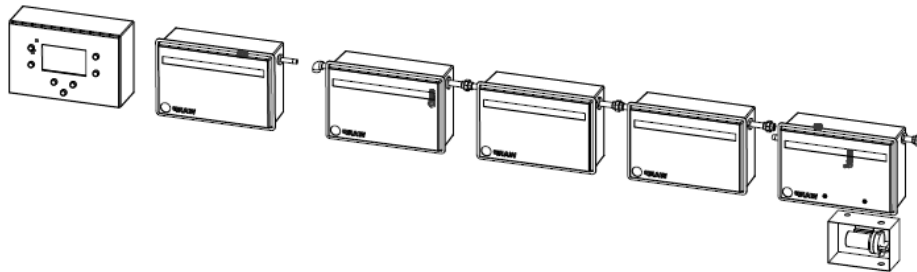
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**CP:** The Control Panel module is the brains of the WARP2 system. This module controls the sensors, the user interface, and the distribution of clean water through several possible modes.

**WX\*:** This is our “audible” module – a reference to an option called by the Quarterback at the last moment before a play in American football. This module is only used if needed to address specific water problems we discover on-site. It might be something like unusual contamination by a sewage spill, a heavy-metals leak from an upstream mine, or something else that requires we enhance the modules.

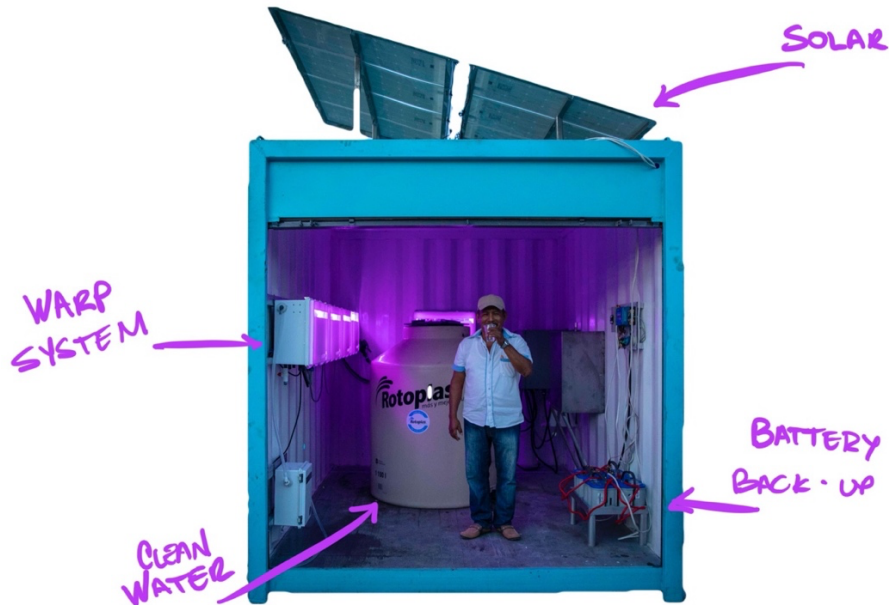
## ASSEMBLED SYSTEM LAYOUT

The system can be wall mounted or installed in a custom 10ft shipping container (CONNEX box).



## Field Installation in the Yucatan Rainforest of Mexico

WARP2 installed in a 10ft shipping container for an indigenous Mayan village near Calakmul, Mexico.



## WARP + (WARP Plus options)

As part of our continuous innovation processes, we have identified three pressing social needs that we have now built as expansion options for our WARP2 system:

1. Access to additional power.
2. Purification of brackish (moderately salty) water sources.
3. Improved access to a safe, natural, potent disinfectant in the same WARP container.

We have developed two add-on system modules to address these social needs: the WARP+POWER (with additional solar and battery banks), and WARP+BRACKISH (capable of purifying brackish water).



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## WARP + POWER

As we become more digitally connected, energy poverty is creating an even deeper divide than in previous generations. Charging devices, refrigerating medications and vaccines, or providing nighttime lighting are just three of many transformative changes in communities when access to electricity is improved. We have added options in the WARP+POWER system to expand our solar array and battery systems to enhance the WARP2 and make it capable of storing and distributing more power with a base addition of 3,000 Watts (3kW). We have also teamed up with a company specializing in rugged portable refrigeration to add vaccine and pharmaceutical refrigeration where desired.

## WARP + BRACKISH

During our system installations worldwide, we have learned that many communities only have access to brackish water sources. Brackish water is naturally occurring salty water with about a tenth as much salt as seawater. The taste is unpleasant (though generally not physiologically harmful), and it's not considered desirable for drinking or cooking, and can be irritating even for simple personal hygiene. In addition, the treatment of brackish water has historically been complex and required significant power, so the usual commercial systems are expensive, require extensive training, and are difficult to maintain.

After months of research across our global network of scientific and technical partners, and then with multiple evaluations of candidate ideas under real-world conditions, we've now developed a simple and robust system that can treat brackish water and produce clean, safe, and delicious drinking water that meets or exceeds the highest international standards.

Normal drinking water has less than 200 parts per million (ppm) salts. Brackish water has about 3,000 - 4000 ppm of salt, and we can make that water perfect for drinking. Seawater has about 35,000 ppm of various salts, which requires true desalination. The WARP+BRACKISH is NOT a desalination system and cannot treat seawater. But, with this added brackish elimination capacity up to about 3,500ppm, our WARP system can address a broader range of natural water sources but at half the production rate (6,000 liters per day instead of 12,000).



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## WARP2 Systems Summary

WARP Systems are designed to produce 3,000 gallons of water daily, at least 350 days/year, for at least five years. At that rate, annual maintenance supply costs are about \$1,000/year for filters and cartridges. Over five years that calculates to about 5.25 million gallons for about \$32,000 plus installation, so about half a penny per gallon delivered on site, plus any cost for the contaminated source water.

Note: All prices are FOB San Diego, California, and **DO NOT** include shipping, Customs, Duty, or installation.

	Water Production (liters/day)	Feedwater Capabilities	Solar Power	HOCl Production (liters/day)	Price (USD)
WARP2	12,000	Natural fresh water source (river, lake, well); Untreated tap water; Stored fresh water source (cistern, rain collector)	400 watts @ 24 V DC min.	-	Wall Mount: \$27,000 Container: \$34,000
WARP2 + POWER	12,000	All of the above	3,000 watts @ 24V DC min.	-	Wall Mount: \$29,000 Container: \$35,000
WARP2 + BRACKISH	6,000 <i>Note less/day</i>	All of the above + brackish water sources to 3,500 ppm.	1,200 watts @ 24V DC min.	-	Floor Mount: \$28,000 Container: \$34,000

We welcome questions. They can be addressed to the Managing Director of the Foundation, Eric Rasmussen, MD, MDM, FACP, at the address on the letterhead or on text at +1-360-621-3592.

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