Sustaining the Future

Organizations work to ensure water well hand pumps continue to operate after installation in developing nations.

By Mike Price

David Powell can't explain it.

The 55-year-old, type-A personality is calmer working in Ghana than he is managing his third-generation family business of 20-plus employees here in the United States. It's a head-scratcher.

"To some degree, the stakes are life and death in Ghana, and I'm just totally different," says Powell, CWD/PI, president of Edward Powell Pump & Well Drilling Inc. in Aston, Pennsylvania. "I thought I'd be crazier over there but I'm not. Some things are out of my control because of working with the government so I have to take a back seat and chill a little bit."

Powell is cofounder and president of Wells for Relief International Inc., an organization with a mission of providing safe drinking water throughout the world. It was established in 2004. In that time Powell has learned this: "Working with people—it's more *that* than it is physical and putting the borehole in and installing the hand pump. That's really just the start of the whole process."

This philosophy is shared by many working in the groundwater industry—water well contractors, manufacturers and suppliers, and scientists and engineers. How water relief organizations confront this challenge is where differing opinions emerge along with their definition of sustainability.

Regardless, the sustainability of hand pumps is of great concern in both developing and developed nations, says Michael E. Campana, Ph.D., professor of hydrogeology and water resources management at Oregon State University.

Congo Frontline Missions drills with a Little Beaver LS200H portable rig in Obilo, a village in the Orientale Province in the Democratic Republic of the Congo in June 2012. The drilling formation was sand. Photo courtesy Congo Frontline Missions.

"Hand pumps endure a tremendous amount of wear and tear and researchers are constantly seeking to improve durability," explains Campana, a board member of the National Ground Water Research and Educational Foundation and past chair of the National Ground Water Association Scientists and Engineers Division Board of Directors.

"The problem is very durable materials are likely more expensive and perhaps heavier than less durable ones, although advances in material science are producing more durable yet lighter materials. But these materials could put the cost of pumps beyond the realm of those in developing regions or make pumps more susceptible to vandalism and scavenging."

Sensing a need to change, Powell is now forging a new path in the way Wells for Relief International fosters self-sufficiency in poverty-stricken villages in Ghana. No doubt it's an exciting chapter in the organization's history, Powell rests in the fact only time will tell if it succeeds.

Mapping out hand pumps

In a unique partnership beginning in spring 2014, the Villanova University College of Engineering has begun conducting geographic information system (GIS) mapping of all the

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David Powell, CWD/PI, helps with a hand pump installation in the Volta Region of Ghana.

Because women and children are responsible for obtaining most of the water for households in Ghana, the pumping systems need to be easy to use. Photos courtesy Wells for Relief International Inc.

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village well sites for Wells for Relief International. Powell doesn't know of any other partnership like it.

It's quite an undertaking since there are a little more than 1000 wells drilled as of September. They are mostly in the Volta Region, located in the eastern part of the country, and the rest in the Northern Region, in the northeast.

The purpose of the GIS mapping is to establish basic information about each well site: village name, date installed, pump and model, depth of well, water quality, number of people using hand pump, and contact person in the village. Information is gathered by interviewing village leaders.

The team from Villanova that traveled to Ghana in October 2014 consisted of a professor, graduate student, and undergraduate student. With the assistance of one of Wells for Relief International's pump mechanical teams and a district water and sewage official, they mapped nearly 250 village wells in one week.

Powell and the Villanova team returned to Ghana last month to complete more mapping of the well sites. Powell hopes the team can return again in spring 2016 and stay for three months to complete all of the well mapping.

Wells for Relief International subcontracts with Ghanaian-trained pump mechanics who will be able to access this database to fix non-working pumps. Soon they'll be able to click on a red dot where a well is located on a Google map and have the data appear.

The preliminary report of the 250 wells mapped, located in the Ketu South District in the Volta Region near the Gulf of Guinea, showed an operation rate of nearly 75%, according to Powell. The wells produced more saltwater than anticipated, leading pipelines to be constructed to villages from high production wells.

"I want to get that number up to 90 percent," Powell says of the operation rate. "We're never going to hit 100 percent. I want that number to be in the 90s."

These 250 wells were drilled nearly 10 years ago by Ken Wood, Powell's longtime drilling colleague. Wells for Relief International is a strategic partner with Wood's organization, Lifetime Wells For Ghana Inc., featured in the November 2013 issue of *Water Well Journal*.

The little more than 1000 wells being mapped for Wells for Relief International were drilled by Wood and his team (600 wells) and Powell and his team (400 wells).

"We estimate between 750,000 and one million people now have clean groundwater to drink instead of swamps, rivers, and mud holes," Powell says. "The key now is to help them keep the pumps functioning."

Keep 'em pumping

Like any other piece of equipment, a hand pump is vulnerable to breaking down over time through steady use of it.

The most common problems Powell has seen are broken rod couplings, seals in the plunger, and cracked drop pipe. He has installed the widely used India Mark II and III hand pumps, but now chooses the Afridev, designed for heavy-duty use.

In a 2013 Rural Water Supply Network report, *How Three Hand Pumps Revolutionized Rural Water Supplies*, the India Mark II/III, Afridev, and Zimbabwe Bush Pump are listed as the three most successful and widespread pump designs in the world. The report states over the last quarter century hundreds of thousands to possibly millions have been installed.

Because women and children are responsible for obtaining most of the water for households in Ghana, the pumping systems need to be easy to use.

Find out about the Developing Nations Fund

The National Ground Water Research and Educational Foundation's Developing Nations Fund provides small assistance grants to benefit the quality of life for people in developing economies around the world without access to plentiful supplies of potable groundwater.

To learn more about projects that receive funds, visit *www.NGWA.org/Foundation/developing_world*.

Struggles with Installation Lead to Development of New Water Well Hand Pump

Nathan Rittenour's growing frustration with installing hand pumps in the Democratic Republic of the Congo spurred him to action.

The director of development for Congo Frontline Missions believed a better alternative could be created—prompting him to design his own hydraulic hand pump with the help of two engineers and a machinist. In testing, the hand pump has pumped more than 150,000 gallons of groundwater with more than one million hand strokes without any major breakdown.

"My original plan was to produce the pump for my own use, but after seeing the poor quality of pumps in use in other countries, I want to make my pump available for sale for worldwide use," says the 34-year-old Rittenour who lives in Kasson, Minnesota.

The pump's key component is its bladder design. Being hydraulic, Rittenour eliminated the need for the drop rod that goes to the bottom of the well. This and other moving components have been removed, eliminating potential problems, according to Rittenour.

Here is how the pump works: As the handle is pushed down, water is pushed into the bladder, expanding it. You can think of this bladder like a balloon. The bladder is inside of the lower main water cylinder. As the bladder expands, the water is pushed out of the cylinder into the output line, and thus out of the pump spout. As the handle is raised, the bladder shrinks and water is drawn into the cylinder, and the process is repeated. The cylinder has two valves, one at the top and bottom, and an expanding bladder inside of it.

Rittenour has drilled 38 water wells since February 2010 in the Democratic Republic of the Congo (DRC) with a Little Beaver LS200H portable rig with an 11 hp hydraulic unit, 11 hp mud pump, and 5-foot drill stem. The average depth of the 38 wells is 125 feet. The drilling formation is sand, gravel, or shale.

His experience installing hand pumps includes the Afridev and India Mark III models, both manufactured in India for export to Africa. He found the DRC government-installed U2/U3 Modified Deep Well pumps—similar to India Mark models—to be well designed but poorly manufactured. This led most to last only three to nine months on average unless the manufacturing defects were corrected and the pump was properly installed.

He also had fits working with the Afridev polyvinyl chloride (PVC) pipe due to the bell end being manufactured too large—so the riser pipe on the pump leaked, forcing him to heat the pipe and re-bell it to fit properly. The machining of the pipe threads with the India Mark style pumps also gave Rittenour headaches. He had to cut off the ends and rethread them by hand and replace the couplings with new ones purchased in the United States.

"I feel like I shouldn't have to be remanufacturing in the bush when all I have are limited supplies," Rittenour says.

This led Rittenour to dedicate his time to developing his own pump last year when he returned to the United States. His goal is to guarantee the pump for three years without maintenance. Rittenour is also working on designing a frost-free option hand pump so it can operate in colder regions.

Congo Frontline Missions, a manufacturer member of the National Ground Water Association, is exhibiting at the 2015 NGWA Groundwater Expo and Annual Meeting, December 15-17 in Las Vegas, Nevada. A developmental pump model will be on display at the Expo.

To learn more about Congo Frontline Missions, visit *www.congofrontlinemissions.org*.

Nathan Rittenour and his wife, Starla, with workers from left to right: Saele, Kayumba, Keetah, and Azariah in the Democratic Republic of the Congo on April 13, 2014.

Rittenour's hydraulic hand pump has pumped more than 150,000 gallons of groundwater with more than one million hand strokes without any major breakdown in testing. Photos courtesy Congo Frontline Missions.

"Ensure the hand pump you choose is suitable for the hydrogeologic and socio-cultural conditions," Campana says.

The Afridev configuration includes an open top cylinder where the piston can be removed from the cylinder without dismantling the rising main. The foot valve is retractable with a fishing tool. These design features have eased the burden of servicing them for Powell and his pump mechanics.

"We've had some of the dry rods where one of the joints broke, which is a manufacturing defect, not a design issue," Powell says. "Some wells have pumped sand, so we've had to replace the seal in the plunger. They're pretty reliable pumps."

The Ghanaian government tests the water before Powell installs a pump, which can take 30-35 minutes to install in a 100-foot setting. A cement pad is constructed in two days to prevent contaminated surface water from entering the well and to prevent the area around the well from becoming muddy and unsanitary.

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One day is needed to drill a 6½-inch borehole with the average depth in the Northern Region of sandstone and shale about 200 feet; flow rates range from dry holes to 50 gpm. If water isn't produced by 200 feet, Powell's drilling team quits since hand pumps don't work well after that depth.

In the war-torn Democratic Republic of the Congo (DRC), Nathan Rittenour has also found the manufacturing of hand pumps to be the issue, not their design.

The director of development for Congo Frontline Missions has worked with the Afridev and India Mark III hand pumps, both manufactured in India for export to Africa. Rittenour has drilled 38 wells since February 2010 in the DRC with a Little Beaver LS200H portable rig. He found the DRC government-installed U2/U3 Modified Deep Well pumps—similar to India Mark models—to be well designed but poorly manufactured. This led most of them to last only three to nine months on average unless the manufacturing defects were corrected and the pump was properly installed.

Rittenour also had trouble with the Afridev polyvinyl chloride (PVC) pipe due to the bell end being manufactured too large—so the riser pipe on the pump leaked, forcing him to heat the pipe and re-bell it to fit properly. He agrees with the pump manual's recommendation of checking casing centralizers on a yearly basis to extend the life of the pump.

An Afridev hand pump is installed and ready for operation following the drilling of a well to nearly 200 feet in Yanongi, 22 miles south of Kisangani in the Orientale Province in the Democratic Republic of the Congo on April 22, 2011. Photo courtesy Congo Frontline Missions.

Next, the poor machining of the galvanized pipe threads with the India Mark style pumps was troublesome. He had to cut off the ends and rethread them by hand and replace the couplings with new ones purchased in the United States.

This led Rittenour to design his own hydraulic hand pump with the help of two engineers and a machinist (see accompanying sidebar article). The key component of the pump is its bladder design. Being hydraulic, Rittenour eliminated the need for the drop rod that goes to the bottom of the well. This and other moving components have been removed, eliminating potential problems, according to Rittenour.

His goal is to guarantee the pump for three years without maintenance. Rittenour is also working on designing a frost-free option hand pump so it can operate in colder regions.

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It takes a village

To move villages toward self-sufficiency, Powell hosted a three-day workshop last month in the town of Dzodze, located in the Akatsi North District in the Volta Region.

Nearly 1000 stakeholders were expected to attend over the three days—ranging from Ghana's environmental

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