



IT'S BEEN 51 YEARS SINCE WORK BEGAN ON THE TRANS-CANYON PIPELINE, WHICH RUNS FOR 16 MILES DOWN THE NORTH RIM, ACROSS THE COLORADO RIVER AND UP TO THE SOUTH RIM. ALTHOUGH IT STILL STANDS AS AN ENGINEERING MARVEL, THE ALUMINUM PIPELINE IS WEARING THIN, CRACKING AND LEAKING ALL OVER THE PLACE. A REPLACEMENT WOULD COST AN ESTIMATED \$150 MILLION, BUT WITHOUT THE MONEY, THINGS WILL GET WORSE, AND THE PARK COULD FACE SHUTDOWNS.

Across the GREAT DIVIDE

BY ANNETTE MCGIVNEY /// PHOTOGRAPHS BY JOHN BURCHAM

I wanted to start at the beginning, which I thought was Roaring Springs. The prolific spring gushing from a hole in the Grand Canyon's Muav limestone layer is the genesis of the Trans-Canyon Pipeline, which travels for 16 miles down the North Rim, across the Colorado River and up the South Rim to meet the drinking water needs of millions of national park

visitors each year. But as photographer John Burcham and I embark on a journey following the pipeline in the midst of an August monsoon storm, I realize that even though we are 4.5 miles away from Roaring Springs, the real beginning is

here, just below the North Rim, where abundant precipitation percolates down thousands of feet to feed the source.

Because it is buried beneath hiking trails and uses gravity, instead of electricity, to move water, the Trans-Canyon Pipeline is largely invisible to visitors. But without it, modern-day Grand Canyon National Park would be impossible. During previous hikes in the Grand Canyon on the North Kaibab and Bright Angel trails, I have wondered about the curved, rusty metal that just barely surfaces beneath my feet in a few eroded places. How could this narrow pipe be the source of hot showers at Phantom Ranch at the bottom of the Canyon, or the bountiful spigots at rest stops halfway up the South Rim, or the numerous drinking fountains throughout Grand Canyon Village? In a remote desert wilderness cut by a mile-deep canyon, how could there possibly be plumbing?

Instead of planning a trip around hiking the park's trails, this time I am in search of answers about infrastructure.

/// Silver Bridge carries the Trans-Canyon Pipeline across the Colorado River at the bottom of the Grand Canyon. The aging pipeline delivers water from a spring below the North Rim of the Canyon to facilities on the South Rim.

I am walking the pipeline from the beginning — the very beginning — to the end. And because this engineering marvel is a product of people, my rim-to-rim route encompasses not only spectacular scenery, but also the story of dedicated contractors and park employees who have kept the water flowing for five decades.

With no natural springs on the Canyon's South Rim, finding an adequate water supply to support Canyon visitation has been an issue since before the park was dedicated nearly a century ago. In 1932, the Atchison, Topeka and Santa Fe Railway built a pipeline at Indian Garden and began pumping 150,000 gallons per day from Garden Spring up 3,000 feet to South Rim storage tanks. This supply, which caused Garden Creek to dry up most of the year, was supplemented with some 300,000 gallons per day brought in by railroad tank car. But in 1956, when annual Grand Canyon visitation reached 1 million, park planners realized importing water was becoming too expensive and Garden Creek's water supply would become inadequate in less than a decade. Plus, depleting Garden Spring was damaging an inner-Canyon oasis. "To keep pace with visitation, we must find more water," a park planner noted in a 1956 report.

Under the complex system of Western water-rights law, Grand Canyon National Park cannot draw from the Colorado River, which runs through its boundaries. So the most logical source for more water was the 5.8 million gallons per day flowing from Roaring Springs. But getting that water from the North Rim spring to South Rim storage tanks would require one of the most costly and complicated construction projects ever undertaken by the National Park Service. Fortunately, the Grand Canyon's pressing infrastructure need dovetailed with the agency's Mission 66 program, which celebrated the Park Service's 50th anniversary by funding large construction projects. The \$2.4 million Trans-Canyon Pipeline became a flagship Mission 66 project, and the massive contract for building it was awarded in 1965 to Halvorson-Lent's, a Seattle joint venture.

Elling Halvorson, 33 at the time, had a background in civil engineering, a love of helicopters and a penchant for building in impossible locations. A few years earlier, he had completed the construction of the Echo Summit Microwave Project atop a 9,400-foot peak in the Sierra Nevada. But the Trans-Canyon Pipeline was more complex than anything he had tackled — not only because of the roadless, rugged terrain, but also due to the strict construction specifications from the Park Service. The pipeline would follow the Bright Angel Fault from Roaring Springs to Indian Garden, running along the Bright Angel Creek drainage on the north and then along the Pipe Creek and Garden Creek drainages on the south side of the Canyon. Along the entire route, construction could not disturb an area more than 6 feet wide, and in all places visible to visitors, the pipe had to be buried, mostly under 8 miles of newly constructed hiking trails.

Halvorson moved his family from Seattle to Tusayan so he could oversee construction. He proposed building the waterline from lightweight aluminum pipe that could be flown in by helicopter; consequently, he pioneered the use of helicopters for remote construction projects. Halvorson invented a dig-

ging machine that fit the narrow trench specifications, and he designed a portable pipe-bending machine that allowed the pipe to be customized to the constantly changing terrain. The completed line had 700 horizontal bends and 1,400 vertical bends in pipe that ranged from 6 to 8 inches in diameter. Halvorson also built five aluminum bridges where the pipeline crossed Bright Angel Creek, and he subcontracted the construction of the steel-cable suspension bridge that straddles the Colorado River with the pipeline tucked underneath.

An article published August 9, 1965, in *The Arizona Republic* described the Trans-Canyon Pipeline as "strictly space age" and reported that "construction men call it one of the most difficult pipeline jobs ever undertaken."

By November 1966, the project was mostly completed, with just a few final touches left. Halvorson told his crew to go home for the holidays and leave the tools and equipment in Bright Angel Canyon, above the 100-year floodplain. They planned to finish up in January. But in December, a 1,500-year flood swept through that canyon, raising the creek by 30 feet. It destroyed the pipeline between Roaring Springs and Phantom Ranch, as well as most of Halvorson's equipment. And Halvorson was seriously injured in a helicopter crash near Phantom Ranch while surveying the damage.

After a protracted dispute with the Park Service over who was financially responsible for the "act of God," Halvorson was awarded the contract to rebuild the project. Work began in 1968, and the Trans-Canyon Pipeline was finally completed in 1970. The 1932 Garden Creek pump house was supplemented by a second pump house that more than tripled the amount of water going to the South Rim, to 500,000 gallons per day. And the ever-resourceful Halvorson was on his way to becoming a millionaire after founding Papillon, the first helicopter-tour company in the United States. It had begun offering flights over the Grand Canyon in 1965.

As Burcham and I splash down the slippery, muck-filled North Kaibab Trail on the descent to Roaring Springs, the rain is relentless. New waterfalls tumble from cliffs above and below, flowing red with dirt. In some places where the trail traverses slick-rock cliff bands, the path has turned into a flowing creek 5 inches deep. We cautiously plant our trekking poles with every step to avoid slipping while dirt and pebbles rain down on us. Experiencing the Canyon when Mother Nature turns on the faucets full blast is spectacular, but also a little frightening.

"So I guess this was Bruce's commute," Burcham shouts over the downpour, trying to lighten the mood. He's referring to Bruce Aiken, a key figure in the Trans-Canyon Pipeline's interesting history.

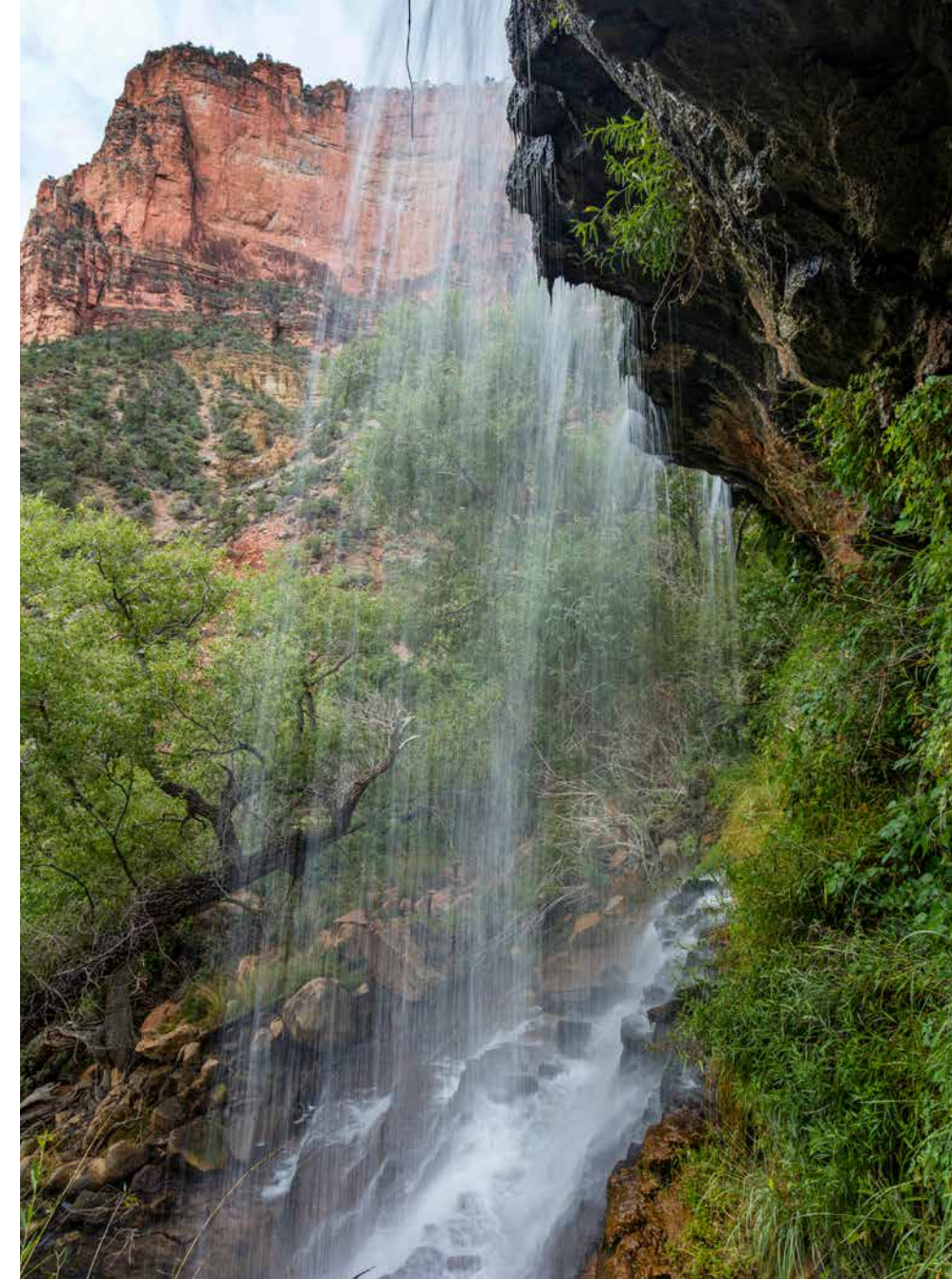
After the ribbon was cut on the pipeline in 1970, someone needed to be stationed round-the-clock at the Roaring Springs pump house to make sure the complex water system ran smoothly. Aiken had been working on the park's North Rim trail crew and "just wanted to do anything to be in the Grand Canyon all the time," he says. A native of New York City with an art-school education, Aiken knew nothing about operating a pipeline, but he didn't blink when the position of water-plant operator at Roaring Springs became available. In 1972, at age 22,

he and his wife, Mary, loaded all their belongings onto a five-mule pack string and hiked down the North Kaibab Trail to their new home. "We turned the key on the front door, and we stayed for 33 years," Aiken says.

Park mechanics showed Aiken how to monitor the pump house, inspect and repair pipeline breaks and "make sure the water flowed." The Aikens raised three children, who were home-schooled and maintained a legendary lemonade stand catering to an endless stream of thirsty hikers. Over three decades, Aiken became an expert on the mechanical nuances of the pipeline and mentored many Park Service utility employees. But in his free time, he pursued his career as an artist and became internationally renowned for his paintings of Grand Canyon landscapes, which appeared in *Arizona Highways* in the 1980s and '90s. "I learned everything I could about the plants and the geology, so I could paint them," he says. "The Canyon was my muse, especially the light. I was always paying attention to the pools of light, the reflected light, the seasonal light."

Burcham and I hear Roaring Springs before we see it. The rain has finally stopped, and we wonder if the sound is wind or falling water. After rounding a switchback, we look across a ravine to see a ribbon of white exploding from the middle of a limestone cliff and dropping 100 feet down algae-covered terraces. As Burcham makes photos, patches of blue sky

/// RIGHT: Water pours from a limestone cliff at Roaring Springs, where the Trans-Canyon Pipeline originates. **BELOW:** A 12-inch-diameter steel pipe diverts water from the spring to the Trans-Canyon Pipeline and another pipeline that serves the North Rim.



appear and I watch clouds shaped like submarines drift just below the Redwall limestone. Running out of daylight, we hike another mile to reach the house, in a grove of cottonwood trees, where the Aiken family used to live.

Since Aiken retired from the Park Service in 2006, the two-bedroom Roaring Springs house (now called Manzanita Day Use Area) has been converted into a ranger residence and a bunkhouse for park employees. In our quest to get the full pipeline experience, Burcham and I will spend the night at the bunkhouse; by fortuitous coincidence, we're sharing it with two interns, Hampton Childres and Noah Hoffman, who are studying Roaring Springs. Both are pursuing science degrees and working at the Grand Canyon over the summer as part of the Geological Society of America's GeoCorps America program.

What used to be Aiken's kitchen now is draped

with our wet gear. Over a dinner of various freeze-dried entrées, we discuss the findings Childres and Hoffman have made during the previous two days of data collection. “The springs are actually more like an underground river that flows through one of the biggest karst caves in Arizona,” Hoffman explains. He and Childres have been donning wet suits and wading inside the cave, where the water is 40 degrees.

“We call it ‘the womb,’” Hoffman adds. “The cave is very biodiverse. It has many species of insects, spiders, crickets, bats, fungi and lichen.”

Getting to the cave requires a near-vertical scramble and then pulling yourself up a cliff using a fixed rope. At the gated entrance, a 12-inch-diameter red steel pipe sucks water, like a subterranean straw, for the Trans-Canyon Pipeline and a pipeline serving the North Rim. Only about 17 percent of Roaring Springs’ average flow is diverted for human use, which leaves most of the water to tumble out of the cliff face and into Bright Angel Creek. “The pipeline is amazing,” Childres notes, “because it draws enough water for park operations without depleting natural resources.”

The next day, Burcham and I continue our journey into Bright Angel Canyon, following the gentle grade of the North Kaibab Trail, built by Halvorson. Lining the path are patches of prickly pear cactuses crowned with plump purple fruit. I am periodically reminded of what is underfoot by round pipeline access points, labeled “Water,” protruding from the middle of the trail. After we pass through Cottonwood Campground, the canyon begins to narrow and we enter a 4-mile passage, called The Box, where midday heat radiates off ancient granite walls. In several places along the trail, hairline cracks in the pipeline cause water to bubble up through the dirt like a spring.

Even though the Trans-Canyon Pipeline is an engineering marvel, it’s also become a maintenance headache due to its many bends and the fussy nature of the highly pressurized, gravity-fed water flow. At an average pressure of 1,200 pounds per square inch, the subterranean water gushing into the pipe at Roaring Springs drops 2,650 feet to the Colorado River and then rises 1,300 feet to Indian Garden, pulled all the way by a natural siphon. Over time, this sediment-filled, pressurized water scouring the aluminum pipe wears it thin and causes breaks, especially in the bends.

“The number of pipeline breaks has been steadily increasing,” says Diane Chalfant, the deputy superintendent of Grand Canyon National Park. “Over the last decade we have been experiencing between five to 30 per year. Constantly repairing the pipeline has just become our normal state at this point, but it is not sustainable. When the pipeline was designed in the 1960s, it was meant to have a life expectancy of 30 years, and we are so far beyond that now.” Chalfant notes that every time a break occurs, heavy welding equipment and new aluminum pipe must be flown in by helicopter to make a Band-Aid-type repair. That costs about \$25,000, on average. And the frequency of breaks varies, but one recent year saw about 18 of them.

By the time Burcham and I make it to Phantom Ranch in the late afternoon, the temperature exceeds 100 degrees and we are drenched in sweat. I head straight to the bathhouse for a cold shower. As I stand under the refreshing flow, I think of Roaring Springs.

Grand Canyon National Park planners estimate that the cost to replace the aging Trans-Canyon Pipeline is in the neighborhood of \$150 million. “This is one of the biggest infrastructure needs in the National Park Service, and the cost is just bigger than what the agency can handle,” Chalfant says. The funding, she adds, will need to come “from another pot of money,” probably through an act of Congress. Grand Canyon planners say the goal of a new pipeline would be to continue to use the same amount of water, or less, from Roaring Springs, but transport it more reliably and efficiently to the South Rim. “We hope that with the 100th anniversary of the Park Service in 2016, more attention will be paid to infrastructure, the way it was during the agency’s 50th anniversary,” Chalfant says.

In the meantime, the park is doing what it can within its limited budget. In 2015, it stuck its toe in the water of the massive pipeline-replacement project by installing a half-mile of new pipe at Phantom Ranch. The original plan was to replace 1 mile of pipeline through the area, but the \$3 million that was budgeted was enough to replace only a half-mile. Then, numerous difficulties and delays ran up the price tag to approximately \$3.6 million. It took nearly a year to complete.

“I’ve been managing construction projects for more than 30 years, and this is by far the most difficult and challenging project I’ve ever had,” says park project manager Greg MacGregor, who’s been at the Canyon for 11 years and oversees jobs employing outside contractors. “We are learning a lot from this first replacement project that will help us in the future.”

While pipeline breaks are repaired with aluminum pipe aligned to the extremely crooked existing system, the new pipeline at Phantom is straighter and made from heavy-gauge, coated steel. And it’s buried deeper than the original pipeline. The half-mile section of new pipe is in an area where breaks happen frequently and have the potential for the greatest visitor impact — such as when failures cause Phantom Ranch and Bright Angel Campground to close due to a lack of drinking water. Park engineers expect the new section of pipeline will last longer and have fewer problems than what was installed 50 years ago. The contract for installing the pipeline was awarded to Ortega Plumbing and Heating, a small, minority-owned business based in Albuquerque, New Mexico.

Burcham and I spend the day with the Ortega construction crew at Phantom during our August 2015 hike. The seven-member group, made up of plumbers, mechanics, carpenters and laborers from New Mexico, had never visited the Grand Canyon before January 2015, when they first hiked down the South Kaibab Trail to the job site. They work nine days on and get five days off, hiking in and out every time. In mid-August, they’re on their 15th tour, with 135 days, including weeks of record-breaking heat, at the bottom of the Canyon so far.

“We work all day from 6 a.m. to 3 p.m., no matter how hot it is,” says Mario Sandoval, Ortega’s construction supervisor. “Sometimes the guys may stop to dip their shirt in the creek, but we keep going even when it’s 122 degrees in the sun.”

Ortega’s crew has endured the same difficult, off-the-grid working conditions as Halvorson’s men did 50 years ago, but there have been additional challenges. The sections of steel pipe are far heavier than the aluminum used before, and while



Halvorson used dynamite for excavating, the Ortega crew moves rocks by hand to minimize visitor disturbance. “We have pulled out boulders the size of Volkswagens,” says company owner Billy Ortega, who is digging alongside his crew.

Like Halvorson, Ortega is constantly innovating solutions to daunting and potentially dangerous problems. As all seven men struggle to carry a 900-pound section of pipe up a twisting trail, Ortega tells them to stop: “Guys, there has got to be a better way to do this. I don’t want anyone to get hurt.”

Within 30 minutes, the crew has sawed the front off a two-wheeled grasshopper cart, inserted pipes to make the wheels pivot and attached it to an all-terrain vehicle. Then, with the heavy pipe section suspended from the contraption, they drive it up the hill.

That night, the men gather around a picnic table next to their makeshift kitchen — composed of a barbecue grill, several large coolers and a refrigerator — under the open sky. As bats and stars appear overhead, the workers eat burritos and crack jokes. Then, they smoke cigarettes before retiring to their cabin tents. They miss their kids but say they enjoy being in the Grand Canyon. “The Canyon is beautiful,” says Matt Lorato as he exhales smoke. “If the park decides to put in more pipeline, I would take the job in a second.”

Burcham and I depart for the South Rim the next day at 4 a.m. to try to get a jump on the heat. Under a new moon, we are surrounded by inky darkness. Walking across Silver Bridge, built 50 years ago as the crowning structure of the Trans-Canyon Pipeline, I follow the narrow tunnel of my headlamp beam. With every step, I see the pipeline, snugged beneath the metal grate of the bridge’s floor. Far below, whitecaps from the rushing Colorado glow in my dim light. At Pipe Creek, the Bright Angel Trail veers up the creek drainage while the pipeline continues along the river. As we

toil up the endless switchbacks of the Devil’s Corkscrew, the pipeline takes a more direct route, climbing 1,600 feet straight up and out of view of the trail, onto the Tonto Plateau.

Just before Indian Garden, the pipeline rejoins the Bright Angel Trail and delivers water to Garden Creek, the two trail rest houses and all of Grand Canyon Village above. When we reach Indian Garden around 8 a.m., it’s already 90 degrees. Like horses at a trough, we sit with a dozen other hikers gathered around the spraying spigot.

Following the pipeline buried beneath the trail for 4 more miles, and chugging water at each rest stop, we finally top out at Bright Angel Trailhead on the South Rim just before noon. A water station is crowded with a line of people filling bottles and sticking their feet and heads under the water to cool off. I think about what it would be like if the water weren’t there.

“The pipeline is the lifeblood of this park,” Chalfant says. “It is plausible that with a really bad series of breaks, we might have to close the park until we could get it fixed.”

An 8-year-old boy named Ben sticks his mouth under the faucet at the filling station and lets water run over his head and arms. “Do you know where that water comes from?” I ask him.

He scrunches up his face while he thinks about an answer. “The Colorado?”

I tell him that’s a very good guess, but as I motion toward the North Rim and the cavernous folds of Bright Angel Canyon some 15 miles away, I describe the journey of the water. “It comes from a spring, fed by rain and snow, that roars out of a cave on the other side of the Canyon, and it travels through a pipe all the way to here.”

“Wow!” he exclaims, cocking his head as he looks at the Canyon. “That is amazing.” **AH**

/// A sign at Indian Garden, one of the spots along the Bright Angel Trail where the Trans-Canyon Pipeline is exposed, warns hikers against damaging the aging aluminum conduit.