NGWA Business PRO empowers businesses to succeed, page 16

June 2024

WWJ
WATER WELL JOURNAL

New Hire Hazard Training

Make sure valuable information isn't drowned out, page 21

Also:

Managing Work-Related Fatigue, page 24

Hazard Identification and Assessment, page 28

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About the cover: Yoder Drilling & Geothermal Inc. drills a well for Guggisberg Cheese Factory in Sugarcreek, Ohio. The crew used a V-100NG Versa-Drill drilling rig to help it drill a 14¾-inch well that provides approximately 70 gallons per minute. It also installed two Xylem 15-horsepower variable frequency drives for service pumps. Guggisberg is renowned for its Baby Swiss cheese. Its Guggisberg Ziller was named one of the top 20 cheeses of the world earlier this year at the 35th biennial World Championship Cheese Contest. Photo courtesy Tim Yoder, CVCLD, Yoder Drilling & Geothermal in Sugarcreek, Ohio.

June 2024

Vol. 78, No. 6

Featured **ARTICLES**

WWJ DEPARTMENTS

Featured COLUMNISTS

The views expressed in the columns are the authors' opinions based on their professional experience.

EXCEL AWARDS

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First **UP**

CLASSIC RIG GETS RESTORED

Downey Drilling Inc. of Lexington, Nebraska, recently completed the restoration of its largest drilling rig, the 1999 EDSI Ewbank M-100-RC. The reverse circulation drilling rig, which is on the cover of the long-time popular NGWA Press book, *Transfer of Technology*, was purchased by Downey Drilling in 2013 with 900 hours on it from Raymer Water Supply Contractors in Marne, Michigan.

As the rig served Downey Drilling well for 10 years, the company knew by late summer 2022 that it wanted to update and modify the rig that predominantly drills large irrigation wells (600- to 900-foot range with 30-inch borehole × 16-inch steel casing/screen). To read the full recap of the restoration, visit *waterwelljournal.com/downey-drilling-restores-1999-edsi-ewbank-m-100-rc-drilling-rig*.

Transfer of Technology was published originally in 2003 and reprinted multiple times. The content of the book was first a series of articles from 2001-2003 in *Water Well Journal*. Author John L'Espoir received the NGWA 2003 Technology Award of Excellence for his contribution of the "Transfer of Technology" series published in *WWJ*. To learn more about *Transfer of Technology*, visit NGWA.org/Bookstore. All rig photos courtesy Downey Drilling.

First Up is a page of *Water Well Journal* that showcases—you! Please send in photos and brief descriptions and you just may be "first up" in an issue of *WWJ*! And remember, if your photo is selected for the cover of *WWJ*, you'll receive $250.

If your photos are selected, you will be asked to fill out a photo disclaimer form that grants the National Ground Water Association the royalty-free right to display the photos. Please send high resolution digital photos to tplumley@ngwa.org.


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Editor's **NOTE**

SEVEN LESSONS LEARNED

Sometimes you're sitting in a workshop at a conference, watching a webinar, or dare I say, reading a book, and think, "This is what I've needed."

The message just clicks. It's a great feeling when you think you've found something that has a chance to help you.

I wore that feeling like a warm jacket when I attended a publishing conference this spring in Chicago. I came out of the event with a notebook full of scribbled down ideas that I couldn't wait to try when I returned to the office.

One of the sessions on growing revenue could have had you sitting right beside me. The longer I am the editor of *Water Well Journal*, the more I realize us editors aren't so different from all of you working at small businesses.

The session provided seven lessons and the first was a doozy for those who prefer the status quo. The speaker told everyone, "Change or become irrelevant." You have three options he said: "Change, resist, or land in the middle." It was also abundantly clear the middle seat wasn't a great spot either.

The second tip regarded viewing your competition. Two ways were presented, and I know a lot of us do the first as we keep a close eye on our competition. But I wonder if you are doing the second way presented. Are you figuring out who or what will be your future competition and preparing for it?

The third and fourth tips were related. The third was investing in talent. Pay your staff well, offer good benefits, have nice uniforms, and a professional office and equipment. People don't quit jobs; they quit bosses who don't take care of them.

The fourth is investing in learning. Send your staff to shows where they can sit in on professional development opportunities. Pay for certifications. And don't forget to do the same for yourself.

Are you figuring out who or what will be your future competition and preparing for it?

The fifth takes time. We were told data is king and to trust the data. Of course, we have to have the data to know what story the data is telling about us. Do you know your story?

Next, attendees were provided a game plan. We were told to operate FAST, which stands for focus, accountability, speed, and transparency.

I think this one is cumulative of the others. You can't move FAST if you're afraid of change, and you can only do so if you know what your competition is doing, you have the right staff, that staff is trained, and you have the data to support your plan.

Finally, we were told technology always wins. Is your technology current or are you using the same old equipment because you have it broken in just how you like it? What do you know about your competition's technology? If their tools are more efficient, you're falling behind.

I returned from the conference invigorated. I'm busy trying to apply many of the lessons I learned, and hope you do the same. You may just be able to say, "This is exactly what my business needed."

Thad Plumley is the editor of *WWJ* and the director of publications for the National Ground Water Association. He can be reached at tplumley@ngwa.org, or (800) 551-7379, ext. 1594.

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In this **ISSUE**

The June 2024 issue of *Water Well Journal* contains our annual buyers guide as well as timely articles as June is National Safety Month. Here is a preview of what is on the pages ahead.

John Fowler, CSP, CMSP

The importance of safety is addressed in a feature article, in a Q&A interview, and a column. The June cover story is written by John Fowler, CSP, CMSP, a company safety manager, and puts emphasis on how important is hands-on, at-the-jobsite training for new employees.

In the cover story titled "**New Hire Hazard Training**" on page **21**, Fowler states that in his opinion there should be two types of training: the first done in a classroom and the second done in the field.

He points out that new employees are often working in the field after a few training sessions in an office or classroom setting but little time at an actual jobsite. However, Fowler writes it is best to follow up classroom training with training at the jobsite given by someone who is not involved in actual work on the site but instead shows the employee around the site and explaining all of the potential hazards.

The "***Water Well Journal* Q&A**" is with Tim Bauerle, Ph.D., a research behavioral scientist in the National Institute for Occupational Safety and Health's Spokane Mining Research Division, and on page **24**. Since the mining industry is like the water well industry with its hard labor and long hours, which have only increased since the pandemic, *WWJ* Senior Editor Mike Price asks Bauerle about effectively managing the risk of work-related fatigue.

Tim Bauerle, Ph.D.

Bauerle, who developed an expertise on fatigue in the mining workforce with 12 publications he wrote and more than 20 invited talks on the subject, recently served as the principal investigator of several mineworker fatigue projects to develop resources to better support the industry.

Alexandra Walsh

The latest installment of the monthly Safety Matters column is titled "**Hazard Identification and Assessment**" and begins on page **28**. Columnist Alexandra Walsh explains one of the most important things a company can do is identify and recognize hazards that present the potential to cause harm or injuries.

Having a program that does such is proactive and involves identifying hazards and risk factors, analyzing and evaluating the risks associated with the hazards, and determining appropriate ways to eliminate the hazards or control the risk when the hazard can't be eliminated. In her column, Walsh walks readers through the steps it takes to create such a program.

The **2024 *Water Well Journal* Buyers Guide** begins on page **41**. The guide is divided into three sections. The first is a directory of manufacturers followed by a directory of suppliers. These are followed by an index of products and services. The index features a detailed list of products and services used in the groundwater industry. The directories feature company descriptions and complete contact information so it will be easy for buyers when it's time to make that next important purchase.

Share Your Knowledge with *Water Well Journal*

Industry experience to share? Notable project with lessons learned? We want to hear from you! Email *WWJ* Editor Thad Plumley at tplumley@ngwa.org to be considered for a feature article, *WWJ* video, or podcast.

BRAD KIRCKOF

Operations Manager and DOT/Safety Director

Traut Companies

St. Joseph, Minnesota

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MOST OVERLOOKED DOT REGULATION BY THE INDUSTRY?

Worn-out suspension or frame components. Out of sight, out of mind, and hard to repair when they go bad. It's also very costly to repair or replace. The cost continues to rise on replacement rigs and the time to repair suspension and frame is a lost day's drilling.

FAVORITE SAFETY RESOURCE?

One is OSHA's "Toolbox Talks." It's free and has many different topics for each month. We also work closely with our third-party safety partners with safety audits, plans, and changes as needed to assure our safety is current to the tasks being performed and accurate.

NEW HIRE SAFETY MEANS WHAT?

Be patient. Safety is the most important thing for our staff to understand and retain. New hire safety training also gives us an understanding of what the employee enjoys and strives to do. This helps us align them with their job and proper safety techniques to complete it.

MOST COMMON SAFETY MISTAKE YOU SEE?

Staying in the moment and maintaining focus. There are so many things happening in a person's day both internally and externally at work they forget about the risks of the task at hand. Keeping composure and focus is just as important as using the proper PPE.

HOW CAN SAFETY TAILGATE TALKS BE MOST EFFECTIVE?

We complete a safety tailgate sheet/talk prior to the start of the day/shift change. Every team member must be empowered to speak up or shut down a jobsite due to any safety concerns. A Traut safety form is submitted daily to the manager and safety director for review and follow-up if needed.

National Safety Council Lists Heat Stress, Fatigue Among Significant Safety Risks for Crane Industry

The National Safety Council released a new report, *Understanding the Current State of Safety Hazards in the Crane Industry*, highlighting lift-specific risks and best practices employers can adopt to keep workers safe.

For the report, NSC partnered with the NCCCO Foundation to survey nearly 2200 voluntary and anonymous responses from the NCCCO Foundation between July and August 2023. Notable findings include:

- **Top hazardous situations:** Working at height, vehicle-pedestrian interactions, and loading and unloading materials are the top three hazardous situations on the job. Between 55% and 89% of participants say they were likely or very likely to be exposed to these circumstances. In 2020, NSC found these three hazardous situations resulted in 30% of non-roadway occupational fatalities.
- **Most common risks:** The two most common systemic risks contributing to workplace injuries in the crane industry are heat stress and fatigue. The report also found that survey participants reported heat and stress were some of the most likely exposures on the job.
- **Most common causes of injuries:** Situational risks remain prevalent in the crane industry: falls from height and being struck by a falling object are the two most common causes of injuries.
- **Safety training and compliance:** Eight (8) out of 10 survey respondents believe they have access to appropriate safety training before starting a task, but lack of proper training still accounted for 7% of personal injuries and 8% of on-site injuries.
- **Technology implementation:** The use of safety technology—including drones, proximity sensors, and vital sign wearables—is fairly low. Depending on the specific type, only 1% to 13% of participants reported using technology at jobsites. However, many of those surveyed indicated a willingness to try new safety technology solutions while the primary barrier to adoption was concern over data privacy.

The report also notes some recommended actions and potential technology solutions that employers can implement to help reduce the top safety risks in the crane industry:

- **Heat stress:** Working in high-heat environments can lead to both serious injuries and illnesses including heat stroke, slips, trips, falls, and dropping objects. It's important employers develop heat stress prevention programs that include safety training on how to recognize the signs and symptoms. Potential technology solutions that may help reduce these risks include wearables that monitor people's vital signs.
- **Fatigue:** Fatigue can cause workers to have trouble focusing and remembering, which can lead to distractions and less muscle coordination, ultimately resulting in more injuries. Like heat stress, safety training should focus on how to recognize the signs and symptoms, and wearable technology can play an important role in monitoring this issue.

- **Struck by falling objects and falls from height:** Risks from working at height, like being struck by an object or falling, can be reduced with fall protection training and instruction on how to properly use personal fall arrest systems. Potential technology solutions include using drones for inspection and visualization purposes, which eliminate the need for a worker to be off the ground.

Research from the Census of Fatal Occupational Injuries also shows more than half of workplace deaths that occur in the crane industry involve workers being struck by objects or equipment, and an additional 27% of fatalities occur as a result of falls and transportation incidents.

To read more, visit *www.nsc.org/newsroom/nsc-releases-new-report-on-safety-hazards-in-crane*.

To read the latest *Water Well Journal* article on cranes in the groundwater industry, visit *waterwelljournal.com/changes-for-those-with-cranes.*

EPA Designates PFAS Under Superfund Law

The U.S. Environmental Protection Agency designated on April 19 two per- and polyfluoroalkyl substances (PFAS)—PFOA and PFOS—as hazardous substances under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) or Superfund law.

The EPA's final rule designates PFOA and PFOS as hazardous substances: the first PFAS regulated under the Superfund law. The EPA is taking this step to designate PFOA and PFOS under CERCLA because both chemicals meet the statutory criteria for designation as hazardous substances.

"The EPA designation provides additional clarity, but many challenges remain to balance cleanup efforts for PFAS and legacy contaminants for the best environmental outcome," says NGWA Director of Science and Technology Bill Alley, Ph.D.

Under the rule, entities are required to immediately report releases of PFOA and PFOS that meet or exceed the reportable quantity of one pound within

NEWS continues on page 12

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NEWS from page 10

a 24-hour period to the National Response Center, State, Tribal, and local emergency responders. The designation of PFOA and PFOS as hazardous substances under CERCLA enables the agency to use one of its strongest enforcement tools to compel polluters to pay for or conduct investigations and cleanup rather than taxpayers.

Designation is especially important as delay in addressing contamination allows PFOA and PFOS more time to migrate in water and soil, worsening existing contamination.

The final rule also means that federal entities that transfer or sell their property must provide notice about the storage, release, or disposal of PFOA or PFOS on the property and guarantee that contamination has been cleaned up or, if needed, that additional cleanup will occur in the future. It will also lead the Department of Transportation to list and regulate these substances as hazardous materials under the Hazardous Materials Transportation Act.

This new designation comes shortly after the EPA finalized its first-ever drinking water standard for six PFAS (*waterwelljournal.com/epa-finalizes-first-drinking-water-standard-for-pfas*).

To read more, visit *www.epa.gov/newsreleases/biden-harris-administration-finalizes-critical-rule-clean-pfas-contamination-protect.*

Representatives Introduce Legislation to Protect Water Systems from Cyber Threats

Citing cyber threats to the nation's water infrastructure, Congressmen Rick Crawford (Arizona) and John Duarte (California) introduced H.R. 7922, "The Water Risk and Resilience Organization (WRRO) Establishment Act" on April 11.

The legislation establishes a new governing body, the WRRO, that would have cyber and water-system expertise and develop and enforce cybersecurity requirements for drinking and wastewater systems. The WRRO would work in partnership with the U.S. Environmental Protection Agency to ensure cybersecurity measures are both practical and beneficial.

Water systems are cyber-hacking targets to disrupt the economy at the local level. Three-quarters of the nation's community water systems are supplied by groundwater.

"Foreign adversaries such as Russia and China have utilized cyber-attacks to target critical infrastructure such as water systems," Rep. Crawford says. "This bill is a more proactive approach to safeguarding our drinking- and wastewater from these types of attacks. These protections are vital at a time where cyber threats are constant, and technology is evolving quickly."

Cybersecurity breaches have already happened around the country. Before Thanksgiving in 2023, a small Pennsylvania water utility was breached by pro-Iran hackers. A Florida water treatment facility was hacked in 2021 and the hackers tried to increase the amount of beneficial chemicals in the water to unsafe levels. In February 2024, the U.S. intelligence community reported that hackers have had a presence in many critical infrastructure systems in the country for potentially up to five years.

"With the constant threat of cyber-attacks by our adversaries, the United States' water infrastructure must be se-

cured and defended properly," Rep. Duarte says. "I am proud to help lead this crucial legislation with Representative Crawford to ensure that our wastewater and drinking water systems are adequately prepared to deal with potential cybersecurity threats."

To read the bill, visit *www.congress.gov/bill/118th-congress/house-bill/7922/text/ih.*

EPA Forms Task Force to Protect Water Systems from Cyber Attacks

The U.S. Environmental Protection Agency announced on March 19 that it is forming a Water Sector Cybersecurity Task Force to combat threats faced by water systems throughout the country.

The announcement was followed up by a virtual meeting on March 21 with the EPA and state representatives covering current federal and state efforts to promote cybersecurity practices in the water sector, discuss priority gaps in these efforts, and emphasize the need for states and water systems to take immediate action.

"Drinking water and wastewater systems are a lifeline for communities, but many systems have not adopted important cybersecurity practices to thwart potential cyberattacks," EPA Administrator Michael Regan says. "The EPA and [the National Security Council] take these threats very seriously and will continue to partner with state environmental, health, and homeland security leaders to address the pervasive and challenging risk of cyberattacks on water systems."

The task force will consider the prevalent vulnerabilities of water systems to cyberattacks and the challenges experienced by some systems in adopting best practices.

For more information about the cybersecurity program at the EPA's Cybersecurity for the Water Sector, visit *www.epa.gov/newsreleases/biden-harris-administration-engages-states-safeguarding-water-sector-infrastructure.*

Grundfos Revolutionizes Wastewater Management with Metasphere Smart Water Sensors

Grundfos announced on March 28 the availability of the Metasphere smart sensors for water networks.

Adding Metasphere's smart water sensors to the Grundfos product portfolio fortifies water networks, preventing spills and overflows from the wastewater collection network, which have cost municipalities $194 billion annually.

Metasphere smart water sensors are used worldwide to prevent sanitary sewer overflows in wastewater collection and storm sewer systems including municipalities, real estate developers, and homeowner associations.

Featuring advanced technology and an innovative design, Metasphere sensors provide critical data for advanced hydraulic modeling, aiming to eradicate sewer system failures, a concern that grows increasingly urgent amidst the escalating challenges of climate change and extreme weather events.

For more information, visit *www.grundfos.com/us/about-us/cases/grundfos-revolutionizes-water-management-with-acquisition-of-metasphere-smart-water-sensors1.*

NEWS continues on page 14

NEWS from page 13

Ohio Launches Nation's First Statewide Takeback Program to Destroy PFAS Found in Fire Foam

Ohio Governor Mike DeWine visited Wright State University's Calamityville campus on March 18 to officially launch Ohio's new statewide program to annihilate hazardous per- and polyfluoroalkyl substances (PFAS) in firefighting foam.

The new Aqueous Film Forming Foam (AFFF) Takeback Program will use new PFAS Annihilator® (*www.battelle.org/markets/environment/investigation-remediation/pfas-assessment-mitigation/pfas-annihilator- destruction-technology*) technology capable of destroying PFAS in certain substances.

The program is the first statewide AFFF takeback initiative to launch in the nation that will destroy both firefighting foam and the PFAS it contains.

Several southwest Ohio fire departments are expected to turn in more than 1000 gallons of AFFF during the event. Fire departments will drop off totes and buckets full of AFFF and receive onsite tours of the PFAS Annihilator and learn how the AFFF is broken down and the PFAS is destroyed.

The PFAS Annihilator is a closed-loop, on-site destruction solution that effectively destroys PFAS in AFFF to non-detectable levels via supercritical water oxidation. All participating fire stations will receive certificates of destruction.

The program is funded with $3 million in settlement money that Ohio received as part of the state's polychlorinated biphenyl (PCB) enforcement case against Monsanto, which was filed by then-Attorney General DeWine in 2018.

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NGWA Business PRO Empowers Businesses to Succeed

NGWA recognizes the need to empower business owners to secure a successful future and has developed NGWA Business PRO (*ngwabusinesspro.com*), a cloud-based software system that helps groundwater professionals streamline their operations and increase efficiency. It was developed by water well contractors for water well contractors.

Synched with QuickBooks Online, NGWA Business PRO, which is now available for purchase, was exclusively developed for any size water well business. The new program offers many functions and reporting capabilities including:

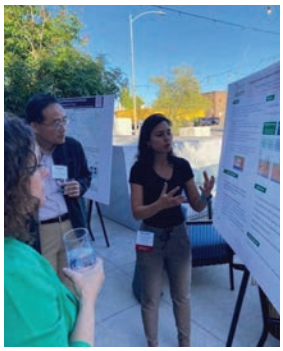
- Estimates
- Work orders
- Cost tracking
- Data mapping
- Recordkeeping
- Equipment management
- Inventory management
- Accounting (balance sheets, profit/loss, year-to-date, estimate vs. invoice cost comparison, profit margin, gross profit, and net profit)
- Tracking service work by the site, not the customer (with this feature, every well with GPS coordinates can be easily plotted to show its exact location on a map)
- Onsite contract creation
- Onsite payment processing.

NGWA Business PRO's comprehensive suite of modules and capabilities is designed to meet the accounting and resource management needs of each business—no matter how small or large the enterprise. Whether you have three users or 103+ users, it's designed to grow with you as your operation grows.

Businesses simply pay a monthly fee which provides NGWA Business PRO to three users (additional users can be added for a small fee). To kick things off, the first 30 groundwater businesses that sign up will get their first three months free as well as having their setup fee and data conversion fee waived. This is a savings of more than $1,500. All that is needed is a $150 confirmation fee which includes online training on the system.

To find out more, email tmorse@ngwa.org, or call (800) 551-7379, ext. 1504.

NGWA Conference on PFAS Provides Forum for State-of-the-Practice Approaches



With the chemistry and environmental behavior of PFAS, combined with recent and proposed regulatory actions, creating significant challenges for groundwater management and protection, cutting-edge ideas and approaches were discussed at NGWA's recent Groundwater in the PFAS Era: Stressors, Protection, and Compliance Conference.

The event, which was held April 16-17 in Tucson, Arizona, and drew more than 120 attendees, provided a forum to discuss the science and state-of-the-practice approaches to address PFAS contamination. The meeting was timely, given the recent announcement of drinking water standards for six PFAS and designating PFOA and PFOS as hazardous substances under Superfund.

Mark Brusseau, Ph.D., from the University of Arizona, provided an engaging keynote address, emphasizing the importance of physical-chemical properties and mass-partitioning processes that influence the retention and transport of PFAS in the vadose zone.

Another highlight of the conference was a panel discussion of forensic investigative tools that can help delineate the mass of PFAS present and sources of the mass.

Strong participation by students, who gave presentations or posters, was another highlight.

Topical sessions for presentations included Regulations and Risk Management, PFAS in the Hydrologic Cycle, PFAS Destruction, Site Investigations, Remediation/Treatment, and Landfills and Biosolids.

NGWA has long been an industry leader in providing PFAS research, education, and resources to the public and scientific communities. Learn more by visiting NGWA.org/PFAS, which is a complete resource center about the groundwater contaminants, featuring a recently updated top-10 facts sheet, a position paper, and more.

NGWA Comments on Listing Nine PFAS for RCRA Corrective Action

NGWA responded to the U.S. Environmental Protection Agency's proposed rule amending its regulation under the Resource Conservation and Recovery Act (RCRA) by adding nine specific per-and polyfluoroalkyl substances (PFAS).

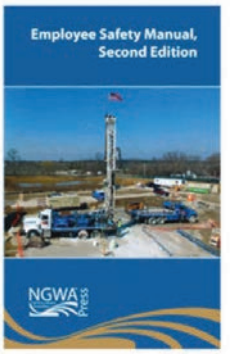
The comments were prepared by the NGWA PFAS Task Force and provided on April 2. It addressed whether to add nine specific per- and polyfluoroalkyl substances (PFAS) to the RCRA corrective list. The substances are:

- perfluorooctanoic acid (PFOA)
- perfluorooctanesulfonic acid (PFOS)
- perfluorobutanesulfonic acid (PFBS)
- hexafluoropropylene oxide-dimer acid (HFPO–DA or GenX)
- perfluorononanoic acid (PFNA)
- perfluorohexanesulfonic acid (PFHxS)
- perfluorodecanoic acid (PFDA)
- perfluorohexanoic acid (PFHxA)
- perfluorobutanoic acid (PFBA).

NGWA supports the listing of the nine PFAS and "removal from the environment to the extent possible. This removal can occur through the corrective action processes of RCRA for active sites of generation, use, transportation, storage, and disposal."

To read more, visit *www.ngwa.org/detail/news/2024/04/10/ngwa-comments-on-listing-nine-pfas-for-rcra-corrective-action.*

To read the proposed rule, visit *www.federalregister.gov/documents/2024/02/08/2024-02324/listing-of-specific-pfas-as-hazardous-constituents*.



June is National Safety Month. Check out NGWA's safety products like the *Employee Safety Manual*, Second Edition, at NGWA.org/Bookstore, or scan the QR code.

30

Certification exams administered by the National Ground Water Association in February 2024—16 passed the exam. Also administered were 84 state licensing exams—45 passed the exam.

4

Newly certified individuals recently: **David Messina** of Yellow Jacket Drilling Services LLC in Gilbert, Arizona, earned the Certified Well Driller (CWD) designation; **Eric Hutton** of Betts Drilling in Rio Vista, Texas, earned the CWD; **Robert Quagliaroli** of LaFramboise Well Drilling Inc. in Thompson, Connecticut, earned the CWD; **Dalton Russell** of Connecticut Wells/Geothermal Services Inc. in Bethlehem, Connecticut, earned the CWD/Certified Vertical Closed Loop Driller (CVCLD) designations.

6/20/2024

The day on which NGWA will host the webinar, Addressing the Risks of Viruses in Managed Aquifer Recharge, which is free to members and has a fee for nonmembers. Learn more and register at NGWA.org/Events.

171

New members NGWA registered in March 2024. The total consisted of 78 scientists and engineers, 60 water well system professionals, 29 manufacturers, 2 suppliers, and 2 associates.

More magazine is just a click away

Watch Latest Videos on Silica Hazards, Management and Communication Skills, and Geothermal Drilling Lessons

John Fowler, CSP, CMSP

Marvin F. Glotfelty, RG

David Traut, MGWC, CVCLD

John Fowler, CSP, CMSP, gives respirator tips for silica

Fowler digs into what the groundwater industry needs to understand about respirators and the hazards of silica on a jobsite. He also shares ways to fight fatigue and how fatigue affects safety on the job in another video.

Marvin F. Glotfelty, RG, offers soft skill advice for managers

Managers have a lot on their plate these days, and Glotfelty breaks down the management and communication skills needed to succeed. In another video, Glotfelty identifies core attitudes and principles for a new professional entering the industry, which includes a hunger for learning and a good work ethic.

David Traut, MGWC, CVCLD, covers geothermal lessons

The industry veteran and NGWA president shares what he's learned over the decades of geothermal drilling.

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NEWS ON THE SITE

EPA Finalizes First Drinking Water Standard for PFAS
NGWA applauds the nation's first standard for PFAS as it will bring protection to the nation's groundwater resources.

EPA Designates PFAS Under Superfund Law
This new designation comes shortly after the EPA finalized its first-ever drinking water standards for six PFAS.

National Safety Council Lists Heat Stress, Fatigue Among Significant Safety Risks for Crane Industry
Potential technology solutions include utilizing drones for inspection and visualization purposes.

NGWA Announces Launch of Water Well Loans
Contractors can offer customers a convenient choice of payment options to pay, including powerful same-as-cash loans which feature a no interest and no payment period.

Representatives Introduce Legislation to Protect Water Systems from Cyber Threats
Three-quarters of the nation's community water systems are supplied by groundwater.

EPA Releases Updated Interim Guidance on Destroying and Disposing of Certain PFAS and PFAS-Containing Materials
The EPA will accept comments on the interim guidance for 180 days following publication in the *Federal Register* to help inform a future update to this guidance.

American Industrial Partners Acquires Boart Longyear
Boart Longyear, which was established in 1890, is headquartered in Salt Lake City, Utah.

Downey Drilling Adds First Tophead Drive Rig to Aid in Safety, Workforce Development
Downey Drilling Inc. is possibly the first Nebraska customer to take delivery of a rig from tophead rig manufacturer Versa-Drill/Laibe Corp.

Bit Brokers International Acquires Colton Bit Service
The acquisition enables Bit Brokers International to extend its reach into the water well market.

DSG Breaks Ground on New Facility in Sheboygan, Wisconsin
Dakota Supply Group facility is set to open in 2025.

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Other patents are pending.

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It is important a new hire's training involves work in a classroom as well as hands-on learning at the jobsite.

New Hire Hazard Training

Think about what they need to know and not need to know so valuable information isn't drowned out.

By John Fowler, CSP, CMSP

Training is one of the most important things that a company can do to improve both its safety and productivity.

This is especially true when it comes to employees who are not only new to a company, but also new to the groundwater industry.

In my opinion, there should be two stages of new employee training: the first being in the classroom and the second should be hands-on at the jobsite. But all too often companies just focus on classroom training and neglect the important training that can be done in the field.

Most new hire training takes place in a conference room or a classroom. The training is usually focused on new hire paperwork, signing up for benefits, and general company rules and policies. Some companies will give OSHA 10 Training, but that depends on the company, client, and local regulatory requirements.

But even OSHA 10 Training, although full of useful information, is not tailored towards the kind of work that we do and the hazards that we encounter. No matter how well you train in the classroom, it is very difficult to communicate the hazards in the groundwater industry without actually being on a drill site or pump installation site.

When a visitor comes to our site for the first time, they should receive a safety orientation explaining things like areas to stay away from, emergency procedures and numbers, location of first aid kits, and other safety supplies.

We do this for visitors, but do we do anything like this for our new employees when they come onto a site for the first time? Do they really understand the hazards on that specific jobsite and what to do if there is an emergency?

The answer is all too often "No." This is why after the classroom training is completed, the new hire should be taken to the jobsite and receive hands-on hazard training. This is much more than just dropping a new employee off at a jobsite and telling the supervisor to keep an eye on him. This should be treated as a continuation of the classroom training, which means there should be someone there who is not involved in production who can show the employee around the site and explain the hazards.

Necessary Jobsite Information

Each jobsite is unique, but there are many universal topics that should always be included.

NEW HIRE HAZARD TRAINING continues on page 22

NEW HIRE HAZARD TRAINING from page 21

For example, a new employee should know what to do in the event of an emergency:

- What is the jobsite address if you need to call for help?
- Where is the muster area in the event of an emergency?
- Where are the first aid kits located?
- Where are the fire extinguishers located?
- If there is an automated external defibrillator (AED) or additional first aid supplies like a stretcher, where are they located?
- How do you access Safety Data Sheets (SDSs) if you swallow or are splashed with a chemical?
- Where is the eye wash?

This training should be more than a supervisor reading down a checklist. To be effective, the new employee should be taken on a tour around the site to see exactly where these items are located and how they function.

In addition, the new employee should be trained on the hazards of the equipment:

- Is there mobile equipment that routinely moves around the site?
- Is there any stationary equipment like an air compressor or generator, and if so, how do you shut it down in an emergency?
- What parts of the equipment are guarded, and if so, why?
- Is there anything that might automatically start or stop on the site?

Explain the hazards of hydraulics and the injuries that can come from a pinhole leak. There is also an added benefit to showing the new employee the equipment. Sometimes it takes a new pair of eyes looking at a piece of equipment for the first time to identify a potential hazard that everyone else has been overlooking for years.

Jobsite Areas of Caution

The next step of the hazard training should be to explain areas around the jobsite that may require extra caution:

- Are there raised areas with guardrails?
- Areas requiring fall protection to be worn?
- Open holes to be aware of?
- Are there any pressurized air or fluid lines?
- Wire rope under tension?
- Any trenches?
- Overhead electrical lines to be aware of?

Really think about what the new employee needs to know, but also what do they not need to know. While sharing information is important, sharing useless information can easily drown out valuable information.

Share Useful Information

Finally, share any other information that would be good for the employee to know. This can be anything from:

- Where is the nearest restroom located?
- Where is the extra personal protective equipment (PPE) stored?
- Where is the clean drinking water kept?

Fowler Talks Driver Safety, Fatigue, and Sleep in Podcast

Listen or watch the episode at WaterWellJournal.com, or scan the QR code.

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SCAN ME

More from *WWJ* and NGWA

- Fowler discusses key safety topics in videos at WaterWellJournal.com
- Read the article, "Energy-Based Hazard Identification," at *waterwelljournal.com/energy-based-hazard-identification*
- See NGWA's safety products at NGWA.org/Bookstore.

When complete, the new employee should feel comfortable to start working and you can feel comfortable that they understand the basic hazards of the jobsite and the emergency procedures.

Not only is this hands-on hazard training valuable for the new employee, but it can also serve as a safety-focused site inspection for the company.

As the trainer explains hazards and emergency procedures, they are also verifying that the equipment or supplies are where they are supposed to be and in good condition. I myself have been taken on tours as a visitor and had the person taking me around take me to where they thought the emergency numbers were posted—only to find out that someone had moved them!

We invest a lot of time and money in training, but so often overlook, in my opinion, the final part: the hands-on hazard training. Yes, these employees may have had hours of training in a classroom, but most people learn visually and hands-on.

Only giving them classroom training likely means that they aren't trained well enough to identify hazards on their own. Take the time to ensure that on day one in the field they understand the basic hazards and what to do in an emergency. This will lead to a safe and productive employee. WWJ

John Fowler, CSP, CMSP, has been in the drilling industry for more than 20 years, working on projects ranging from the Prudhoe Bay oilfield in Alaska to ice drilling in Greenland and at the U.S. South Pole Station in Antarctica. For the past 14 years, Fowler has been working as a safety manager for a large mineral exploration drilling contractor. He is a regular safety workshop presenter at Groundwater Week. He can be reached at john.m.fowler@gmail.com.

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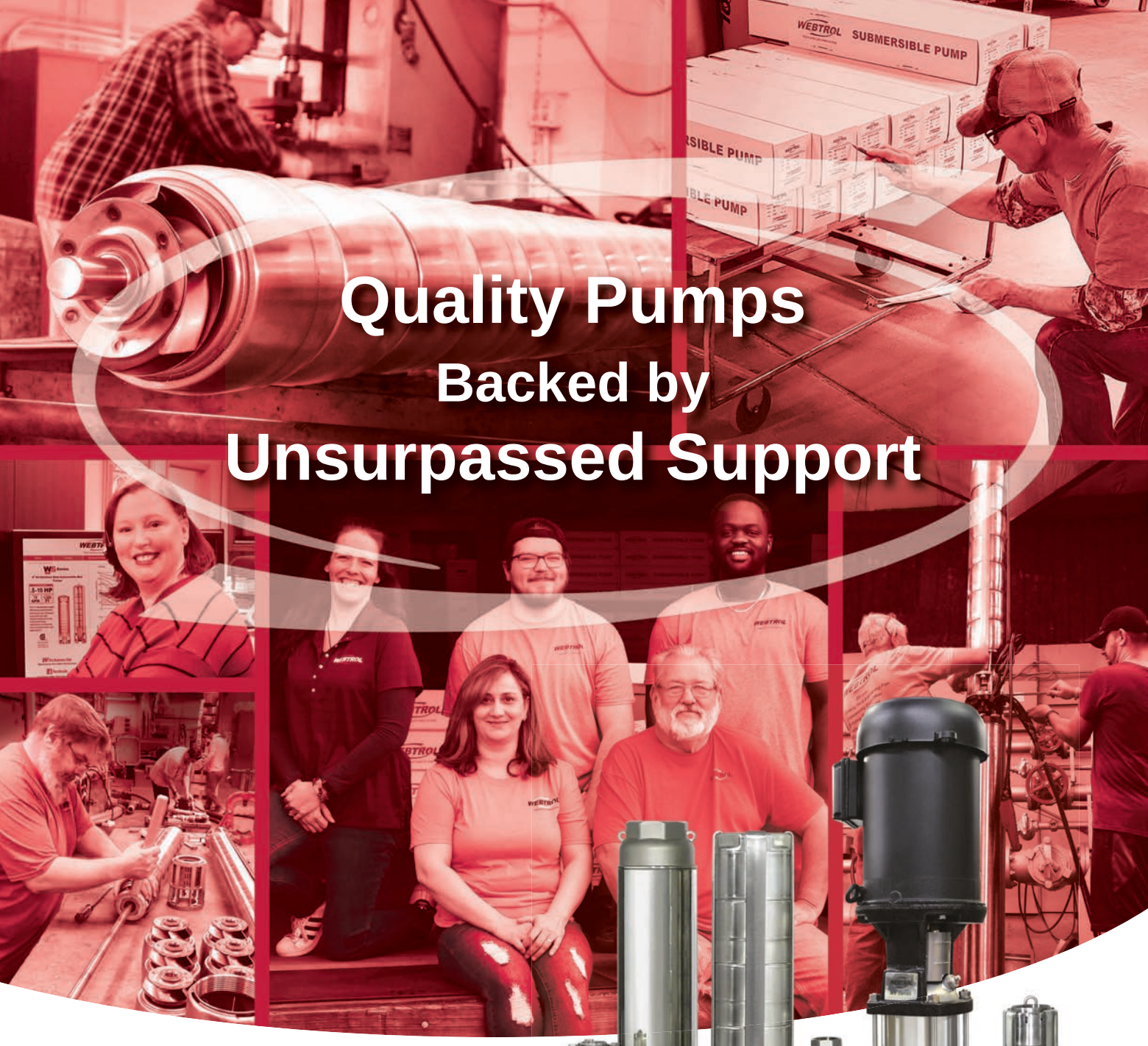

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Tim Bauerle, Ph.D., presents a workshop at the 2022 Mine Safety and Health Conference in Scottsdale, Arizona. The presentation focused on the common sources of work-related fatigue risk in mining as well as the different ways that this risk has been measured and managed. Photo courtesy Bauerle.

WATER WELL JOURNAL Q&A

TIM BAUERLE, PH.D.

The research behavioral scientist in NIOSH's Spokane Mining Research Division discusses effectively managing work-related fatigue risk.

By Mike Price

Fatigue continues to be one of the top safety concerns in the water well industry with its hard labor and long hours, which have only increased since the pandemic.

It's a serious threat that has long been examined by researchers at the National Institute for Occupational Safety and Health (NIOSH). They estimate that close to one in eight of all workplace injuries may relate to fatigue. More than one in five of all fatal vehicle crashes involves a drowsy driver.

Tim Bauerle, Ph.D.

Tim Bauerle, Ph.D., is a research behavioral scientist in NIOSH's Spokane Mining Research Division and has become an expert on fatigue in the mining workforce with 12 publications and more than 20 invited talks on the subject.

With the water well industry like the mining industry, *Water Well Journal* reached out to learn more about effectively managing work-related fatigue risk from Bauerle. He recently served as the principal investigator of several mine-worker fatigue projects to develop resources to better support the industry (see images).

"What makes me the most proud is when I get to hear that my research is helping to make a real difference," says Bauerle who most enjoys getting a boots-on-the-ground perspective in the field.

"Not having an engineering or technician background, I always appreciate the opportunities to be welcomed into that world, to be educated by the operators and laborers who are

Images courtesy Centers for Disease Control and Prevention and National Institute for Occupational Safety and Health.

experts in their own work domain and get a small glimpse of the everyday role they play and the significance of their experiences.

"I usually learn something every time that I could never have read in a textbook, and I receive crucial feedback on my research from the workers whose opinions matter the most."

June is National Safety Month and *WWJ* appreciates Bauerle taking the time to answer our questions.

Water Well Journal: How should fatigue management be viewed by water well contractors and their employers?

Tim Bauerle, Ph.D.: There are many ways to think about managing work-related fatigue, but here I'll focus on three big topics to consider: shared responsibility, work schedules, and worker health.

Shared responsibility is a foundational component of fatigue management and refers to how both workers and their companies [owner and contractor] have joint accountability in reducing fatigue-related risk in the workplace, given that factors for fatigue can occur both inside and outside of the work environment. In conversations about fatigue, the tendency among some health and safety professionals is to concentrate on what the worker can do and really drill in on getting enough sleep and showing up ready to work.

However, the employer role in prevention is also critical: enabling the time and opportunity for workers to get enough quality sleep, providing workers with accommodations for adequate rest and recovery, developing effective training on sleep and fatigue topics, and actively identifying and controlling fatigue risks in the workplace.

While workers unquestionably have vital roles and responsibilities in the management of fatigue, it is also important for contracting and owner companies to support workers in reducing risk by enacting solid policies and procedures and providing resources.

A work schedule that works: As mentioned, providing adequate opportunity for rest, recovery, and quality sleep is a key component of managing fatigue-related risk. In general, workers need sufficient time off between consecutive work shifts to obtain a minimum of seven hours of sleep, commute to and from work, and tend to other non-work responsibilities (family, household, etc.).

Although some shift work guidelines recommend around 10 to 12 hours between shifts, there are no universally agreed upon standards that will apply to every worker or every jobsite. Therefore, it's important to involve relevant parties—workers, owners, contracting companies, safety professionals, unions, managers, sleep and fatigue scientists—to determine a work schedule that can accomplish operational demands safely, and put strong contingency policies and practices in place for what actions both the worker and the employer need to take if hours worked extend beyond hours scheduled. It should also be noted that the amount of time off needed may be greater for some conditions than others, such as extreme temperatures or physically and mentally demanding work.

Keeping both health and safety in mind: While it is com-

WATER WELL JOURNAL Q&A continues on page 26

mon to treat fatigue as predominantly a risk factor in vehicle collisions and injuries, it is important to note that adequate sleep—or lack thereof—contributes to worker *health* as well as safety.

For example, poor sleep fundamentally impacts work-related fatigue risk and risk of injuries on the job and has also been associated with increased rates of disease (cardiovascular, metabolic, neurocognitive, cancer), mortality, and poorer mental health.

Moreover, many of the same workplace contributors to poor mental health—job demands such as overexertion, workload, pace, repetitive/monotonous tasks, dim/hot/loud work environments—can also increase worker fatigue. Although it is categorically important to put adequate controls in place to mitigate fatigue-related safety incidents, maintaining an increased awareness of the mental and physical health aspects of sleep and fatigue is also critical for worker's longevity.

Fatigue can increase feelings of stress and lower the ability to effectively regulate emotions, and in turn, stress can negatively affect sleep quality through worry and rumination, creating a negative feedback loop.

WWJ: Is there data that shows worksite accidents due to fatigue are on the rise?

Bauerle: The precise role of fatigue in many safety incidents is difficult to determine with much certainty. The data needed to establish whether a particular injury or safety incident was predominantly fatigue-related is often not recorded in a meaningful way in many large-scale data sources.

For example, some studies have found general trends in injury rates based on the number of work hours (e.g., less than eight hours of work) or shift type (e.g., night). While this research helps in identifying longer working hours and night shifts as risk factors, it is possible that fatigue may not be the sole source or even a contributing factor in many of these injuries.

That said, some researchers have suggested that fatigue may be one of several contributors to the annual increases in motor vehicle fatality rates in the United States since 2020. Another consideration is that some industries are reporting experiences in post-pandemic labor shortages which can indirectly affect fatigue by restricting the available pool of employees that companies are able to schedule, thereby potentially increasing overtime, call-outs, and other unplanned schedule changes.

WWJ: What are the most common signs of fatigue? What are the action steps to take if a worker is showing signs of fatigue?

Bauerle: First, while there is no single commonly used definition, several descriptions characterize fatigue as a decrease in the functional capacity for activity or effort that is often associated with tiredness and reduced performance. Therefore, checklists for fatigue symptoms will often point to recognizable signs of lower-than-normal performance (e.g., poor communication, slow reaction time, trouble remembering things) and exhaustion or sleepiness (e.g., yawning, trouble keeping eyes open, nodding head).

Before workers show signs of fatigue, companies may consider having open-ended conversations with workers, managers, and others on how fatigue risk can be identified across different jobs and worker groups (e.g., checklists, monitoring equipment), and what should happen if elevated fatigue risk is identified. Effective strategies rely on non-punitive reporting systems, fatigue-related toolbox talks or safety shares, and treating fatigue similar to other occupational safety risks.

Based on the information on hand, solutions can range from further monitoring to rotating into a lower risk task to taking time off work to rest and recover. Part of this process relies on a resilient work culture built on trust, which can be difficult to maintain across different jobsites and companies that may diverge in how they view fatigue management. For that reason, fostering open and honest dialogue between workers and their supervisors can help with consistency. [See image of signs of fatigue.]

WWJ: How might a company monitor fatigue management with its work crews?

Bauerle: There are many different ways to monitor fatigue. Generally, more effective fatigue risk management systems tend to measure and manage fatigue underneath three broad categories: predictive, proactive, and reactive.

Predictive: Determining fatigue-related risk in advance of a workday. Examples include work schedule analysis, biomathematical modeling, and sleep disorder screening.

Proactive: Preemptively assessing fatigue-related risk during day-to-day operations. Examples include surveys and checklists, psychomotor tests (e.g., reaction time), vehicle monitoring, in-cab video monitoring, and physiological measures (e.g., heart rate, brain wave activity).

Reactive: Investigating fatigue post-incident as a contributing factor in safety incidents. Examples include Root Cause Analysis or other retroactive incident investigation strategies.

WWJ: How does the summer heat affect fatigue management?

Bauerle: Heat stress and fatigue have several shared symptoms, such as increased tiredness and decreased vigilance. Additionally, heat is one of several work-related environmental demands that can increase fatigue.

Standard controls for physically intensive work that are relevant to fatigue—such as more work breaks and access to cold water—may need to be ramped up depending on the heat, humidity, and exposure to direct sunlight.

WWJ: How does fatigue lead to stress?

Bauerle: The difficult thing about fatigue and stress is that there is at least some evidence for a bidirectional relationship.

In other words, fatigue can increase feelings of stress and lower the ability to effectively regulate emotions, and in turn, stress can negatively affect sleep quality through worry and

rumination, creating a negative feedback loop. Compounded over time, long working hours, high job demands, and elevated levels of work stress may lead to a condition referred to as burnout, which is characterized by physical exhaustion, mental disengagement from work, and reduced effectiveness.

WWJ: What do you recommend if stress is affecting someone's sleep?

Bauerle: The answer to this is highly dependent on the source and intensity of stress as well as other contextual factors.

First, talking to a primary care provider or a sleep health specialist can help determine whether an underlying medical condition (e.g., diabetes) may be making the problem worse. Along these lines, seeking help from a trusted mental health counselor can assist in providing targeted, effective coping and stress management strategies. Given the potential overlap that can exist between stress and insomnia symptoms, determining whether Cognitive Behavioral Therapy for Insomnia (CBT-I) is a good fit may be worthwhile.

A recent meta-analysis in 2022 that looked at nearly 6000 people across 43 studies found that CBT-I and other similar non-pharmacological sleep treatments were also effective in reducing anxiety symptoms.

Apart from medical-based solutions, focusing extra attention on establishing good sleep practices, such as developing a consistent sleep schedule and bedtime routine, may be beneficial especially during times of distress.

Additionally, there is some limited evidence that sleep outcomes may be improved through conventional stress reduction strategies such as lavender aromatherapy, a warm shower or bath, relaxation exercises, meditation, and avoiding excessive smartphone usage before bed.

WWJ: What are some physical issues that can impact someone with severe fatigue?

Bauerle: After 18 to 24 hours without sleep, cognitive psychomotor performance can start to mimic that of someone with a blood-alcohol concentration (BAC) of 0.05 to 0.10 percent, respectively. As the duration of sleep deprivation increases, the biological drive for sleep becomes stronger and involuntary sleep in the form of "microsleep" events may be observed. These events can occur quickly and the person experiencing them may not be aware of it or recall the episode later on.

According to a 2016 report of fatigue video monitoring technology in mining haul truck cabs, over the course of 107.75 million miles travelled, operators were asleep for 570 hours. This equates to an average of one second of sleep every 52.5 miles.

WWJ: Lastly, you've developed 10 sleep tips for miners [see image of list] that are applicable to water well contractors. How can contractors follow these tips while working away from home?

Bauerle: This is an excellent question that is difficult to fully address.

First, because of the absence of familiar external cues that normally prompt us when to go to bed, it is especially important for people in these situations to prioritize restful sleep and make specific, proactive, tailored plans for when to go to bed and when to wake up. Research on mine workers in "Fly-In-Fly-Out" (FIFO) work arrangements indicate that sleep is shorter and of poorer quality away from home.

Therefore, extra effort should be made to improve the non-home sleeping environment, such as comfortable bedding in a room that is dark (e.g., blackout shades, sleep mask), quiet (e.g., ear plugs, white noise machines), and cool (e.g., 60° to 68°F, well ventilated). Workers should also plan for ways to rest and recover away from electronic screens, as excessive use can reduce time set aside for sleep and the backlight can have an awakening effect.

While this is relevant in the home environment as well, FIFO workers may be especially reliant on smartphones and other similar technologies for entertainment and keeping in touch with family and friends back home. Dimming lights or practicing relaxing bedtime routines may be considered.

Lastly, other research on FIFO mine workers suggests that different shift patterns can influence the mental health of those working away from home, particularly when it comes to work-life conflict (especially for parents) and loneliness. Given the overlap between mental health and fatigue mentioned earlier, these types of workers may benefit from effective mental health resources and workplace initiatives such as traditional Employee Assistance Programs, peer-based programs, or utilizing extended social networks. WWJ

Mike Price is senior editor of *Water Well Journal*. In addition to his *WWJ* responsibilities, Price also contributes to the Association's scientific publications. He can be reached at mprice@ngwa.org, or at (800) 551-7379, ext. 1541.

ALEXANDRA WALSH

HAZARD IDENTIFICATION AND ASSESSMENT

Proactively identifying risks before accidents happen is good business.

One of the root causes of workplace injuries, illnesses, and incidents is the failure to identify or recognize hazards that are present or could have been anticipated.

A critical element of any effective safety and health program is a proactive, ongoing process to identify and assess these hazards.

Hazard assessment is a term used to describe the overall process or method whereby a business:

- Identifies hazards and risk factors that have the potential to cause harm (*hazard identification*)
- Analyzes and evaluates the risk associated with that hazard (*risk analysis and risk evaluation*)
- Determines appropriate ways to eliminate the hazard or control the risk when the hazard cannot be eliminated (*risk control*).

A risk assessment is a thorough look at your workplace to identify the situations and processes that may cause harm, particularly to people. After identification is made, you analyze and evaluate how likely and severe is the risk. When this determination is made, you can next decide what measures should be in place to eliminate or control the harm from happening.

Such hazards as falls and tripping should be fixed when they are found. Fixing hazards on the spot emphasizes the importance of safety and health.

Collect Existing Information

Information on workplace hazards may already be available to employers and workers from both internal and external sources.

Information should be collected, organized, and reviewed with employees to determine what types of hazards may be present and which workers may be exposed or potentially exposed.

Information available in the workplace includes quite a number of sources:

- Equipment and machinery operating manuals
- Safety data sheets (SDS) provided by manufacturers of chemicals
- Self-inspection reports and inspection reports from insurance carriers, government agencies, and consultants
- Records of previous injuries and illnesses such as OSHA 300 and 301 logs and reports of incident investigations
- Workers' compensation records and reports
- Patterns of frequently occurring injuries and illnesses
- Exposure monitoring results, industrial hygiene assessments, and medical records
- Existing safety and health programs (lockout/tagout, confined spaces, process safety management, personal protective equipment)
- Input from workers, including notes from safety meetings and safety toolbox talks
- Results of job hazard analyses, also known as job safety analyses.

Inspect for Hazards

Hazards can be introduced over time as work areas and processes change, equipment or tools become worn, maintenance is neglected, or housekeeping practices decline. Setting aside time to regularly inspect the workplace for hazards can help identify shortcomings so they are addressed before an incident occurs.

- Conduct regular inspections of all operations, equipment, work areas, and facilities. Have workers participate in the inspection and talk to them about hazards they see or report.
- Document inspections so you can later verify that hazardous conditions are corrected. Take photos or video of problem areas to facilitate later discussion.
- Include all areas and activities in these inspections such as storage, facility, and equipment maintenance; purchasing and office functions; and the activities of any part-time or temporary employees.
- Regularly inspect work vehicles (forklifts, powered industrial trucks) and transportation vehicles (rigs, trucks).

Use checklists that highlight what things to look for. Typical hazards fall into several major categories:

- General housekeeping
- Slip, trip, and fall hazards
- Electrical hazards
- Equipment operation
- Equipment maintenance
- Fire protection
- Work organization and flow (staffing and scheduling)
- Work practices
- Workplace violence
- Ergonomic problems
- Lack of emergency procedures.

Before changing operations or introducing new equipment, materials, or processes, seek the input of workers and evaluate the planned changes for potential hazards and related risks.

Many hazards can be identified using common knowledge and available tools. By way of example, you can easily identify and correct hazards associated with broken railings and frayed electrical cords.

Workers can be a useful internal resource, especially if they are trained in how to identify and assess risks.

Identify Health Hazards

Identifying workers' exposure to health hazards is typically more complex than identifying physical safety hazards. For example, gases and vapors may be invisible, often have no odor, and may not have an immediately noticeable harmful effect on health.

Health hazards include *chemical hazards* (solvents, adhesives, paints, toxic dusts), *physical hazards* (noise, radiation, heat), *biological hazards* (infectious diseases) and *ergonomic risks* (heavy lifting, repetitive motions, vibration).

Reviewing workers' medical records (redacted to ensure patient/worker privacy) can be useful in identifying health hazards associated with workplace exposures.

- Identify chemical hazards. Review SDS and product labels to identify chemicals in your workplace that have low exposure limits, are highly volatile, or are used in large quantities or in unventilated spaces. Identify activities that may result in skin exposure to chemicals.
- Identify physical hazards. Identify any exposures to excessive noise, elevated heat (indoor and outdoor), or sources of radiation.
- Identify biological hazards. Determine whether workers may be exposed to sources of infectious diseases, molds, toxic or poisonous plants, or animals capable of causing allergic reactions or occupational asthma.
- Identify ergonomic risks. Examine work activities that require heavy lifting, work above shoulder height, repetitive motions, or tasks involving significant vibration.

Also helpful is to conduct quantitative exposure assessments. When possible, use air sampling or direct reading instruments. Likewise, review medical records. Identify cases of musculoskeletal injuries, skin irritation or dermatitis, hearing loss, or lung disease that may be related to workplace exposures.

Identifying and assessing health hazards may require specialized knowledge. Small businesses can obtain free and confidential occupational safety and health advice services, including help identifying and assessing workplace hazards, through OSHA's On-site Consultation Program.

Conduct Incident Investigations

Workplace incidents—including injuries, illnesses, close calls/near misses, and reports of other concerns—provide a clear indication of where hazards exist. By thoroughly investigating incidents and reports, you will identify hazards that are likely to cause future harm. The purpose of an investigation must always be to identify the root causes (there are often more than one) of the incident or concern in order to prevent future occurrences.

- Develop a clear plan and procedure for conducting incident investigations so that an investigation can begin immediately when an incident occurs.
- Plan who will be involved; lines of communication, materials, equipment, and supplies needed; reporting forms and templates.
- Train investigative teams on investigation techniques, emphasizing objectivity and open-mindedness.
- Conduct investigations with trained representatives of both management and workers.
- Investigate close calls and near misses.
- Identify and analyze root causes to address underlying shortcomings that allowed the incidents to happen.

- Communicate the results of the investigation to managers, supervisors, and workers to prevent recurrence.

Effective incident investigations do not stop at identifying a single factor that triggered an incident. They ask questions such as "Why?" and "What led to the failure?"

Similarly, a good incident investigation does not stop when it concludes that a worker made an error. It asks, "Was the worker provided with appropriate tools and time to do the work?" "Was the worker adequately trained?" and "Was the worker properly supervised?"

Emergency and Nonroutine Situations

Emergencies present hazards that need to be recognized and understood. Nonroutine or infrequent tasks, including maintenance and startup/shutdown activities, also present potential hazards.

Identify foreseeable emergency scenarios and nonroutine tasks, taking into account the types of material and equipment in use and the location within the facility. Scenarios such as the following may be foreseeable:

- Fires and explosions
- Chemical releases
- Hazardous material spills
- Startups after planned or unplanned equipment shutdowns
- Nonroutine tasks such as infrequently performed maintenance activities
- Structural collapse
- Disease outbreaks
- Weather emergencies and natural disasters
- Medical emergencies
- Workplace violence.

Control Measures

The next step is to assess and understand the hazards identified and the types of incidents that could result from worker exposure to those hazards. This information can be used to develop interim controls and to prioritize hazards for permanent control.

- Evaluate each hazard by considering the severity of potential outcomes, the likelihood that an event or exposure will occur, and the number of workers who might be exposed.
- Use interim control measures to protect workers until more permanent solutions can be implemented.
- Prioritize the hazards so that those presenting the greatest risk are addressed first. Remember, employers have an ongoing obligation to control all serious recognized hazards and to protect workers. WWJ

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MARVIN F. GLOTFELTY, RG

CEMENT OR BENTONITE ANNULAR WELL SEALS

Which to choose?

I receive inquiries periodically from drillers, regulators, hydrologists, or other folks around the country asking whether a cement or bentonite annular seal is preferable. As with almost all other issues we face in the water well industry, the answer is "It depends."

A couple of years ago, I wrote a The Art of Water Wells column, "Effective Cement Annular Seal Installation," in the February 2022 issue of *Water Well Journal* (*waterwelljournal.com/effective-cement-annular-seal-installation*) on effective annular seal installation, but that column focused only on installation techniques for cement seals. This column will address the broader topic of selecting the right annular seal material for specific water well situations and considerations.

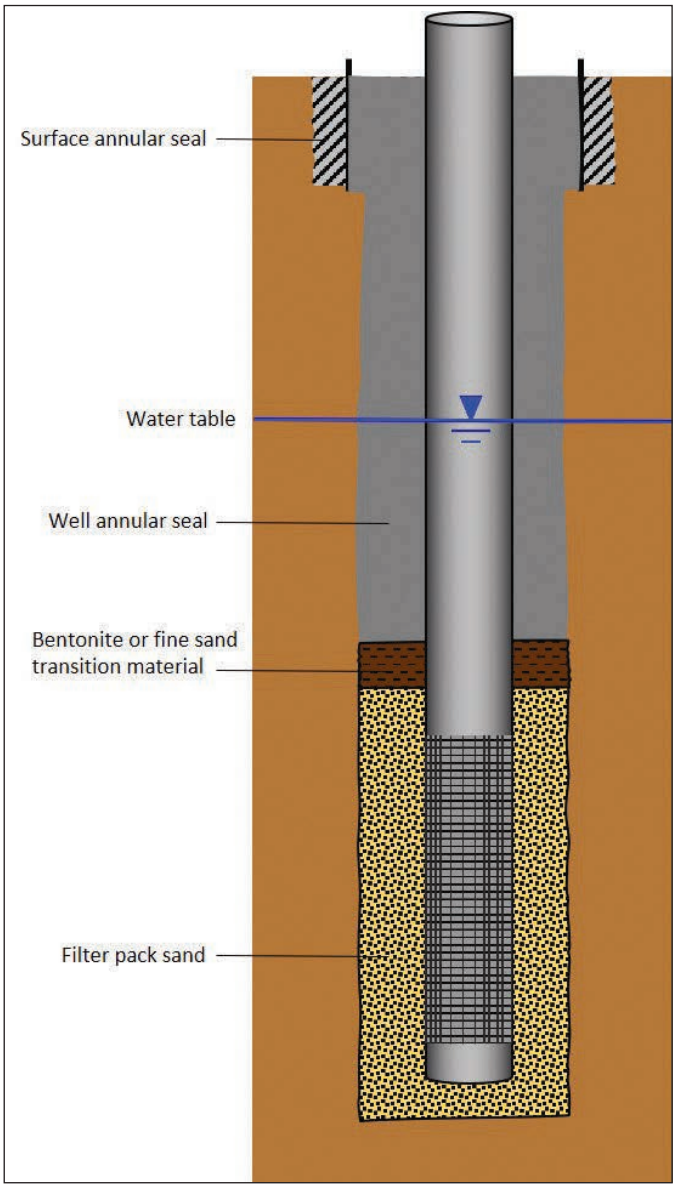

Figure 1. Well annular seal barrier to cross-contamination.

The Most Important Seal

Most states require a cement annular seal in the upper 20 feet to 100 feet of water wells to provide an annular seal outside the surface casing. Although the surface seal is important, the well seal (Figure 1) is actually even more important than the surface annular seal since it will provide the barrier to potential cross-contamination of poor-quality water between the upper aquifer and the area around the well screen.

The well annular seal is typically composed of cement or bentonite clay, and both these materials have advantages and disadvantages depending on the site-specific conditions of the well.

The surface annular seal of a water well is installed to meet regulatory requirements, provide wellhead protection, and to stabilize the work area around the drilling rig during well construction. The rationale for the design and installation of the well annular seal is more focused on functionality of the well rather than on land surface conditions or regulatory issues.

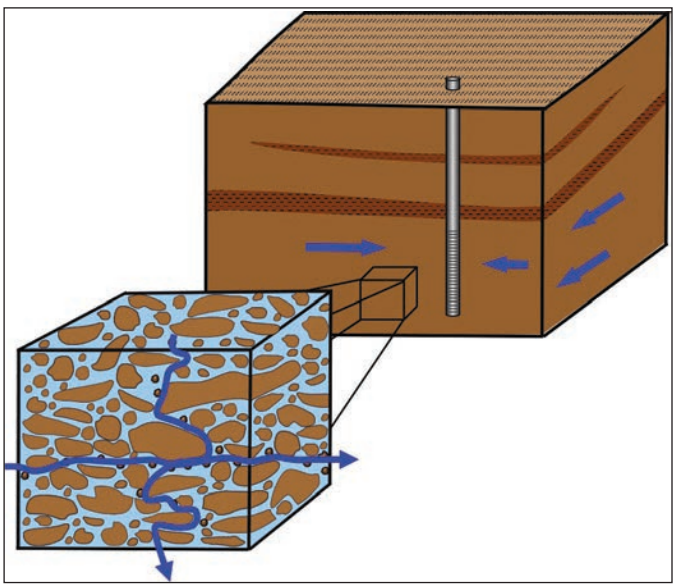

Figure 2. Alluvial aquifer horizontal water flow.

Table 1. ASTM Standards for Common Cements Used in Water Wells

	ASTM Standard		Equivalent API Class
	Ordinary Portland Cement	Portland-Limestone Cement	
General purpose cement	C150, Type I	C595, Type IL	A
Moderate sulfate resistance	C150, Type II	C595, Type IL(MS)	B
High early strength, and shorter curing time	C150, Type III	C595, Type IL(MH)	C
Low heat of hydration*	C150, Type IV	C595, Type IL(LH)	
High sulfate resistance	C150, Type V	C595, Type IL(HS)	

*ASTM Type IV or IL(LH) cement has a long curing time, so it is not commonly used in water wells.

As shown in Figure 2, alluvial aquifers will have preferential groundwater flow in the horizontal direction parallel to geologic bedding planes rather than vertically across those stratigraphic boundaries. This is the hydrologic effect of formation stratigraphy.

Within each individual bedding layer, the sediment is typically composed of elongate-shaped grains that also cause groundwater to follow preferential flow paths in a horizontal direction. This is the hydrologic effect of anisotropy. The effects of stratigraphy and anisotropy are shown by the blue arrows in Figure 2.

The influence of stratigraphy and anisotropy can cause aquifers to develop slightly different water table pressure heads at different depths of a well, which may result in a vertical hydraulic gradient (Figure 3). Although the natural geologic formation will inherently have characteristics of stratigraphy and anisotropy, the well annulus does not have these characteristics, so water movement through the annulus will not be impeded from migrating vertically as would be the case in the adjacent formation.

In cases where a vertical hydraulic gradient is present, the well annulus must be sealed off to prevent the well from becoming a pathway for the flow of water (potentially poor-quality water) from one depth interval to another.

Comingling of waters from different depths of an aquifer is almost always problematic. If the source area of groundwater inflow is of poor quality, cross-contamination will result. Even if the source area of groundwater inflow is of good quality, variabilities in the water chemistry and biological attributes will cause the mixing of the two waters to exacerbate scale formation or casing corrosion.

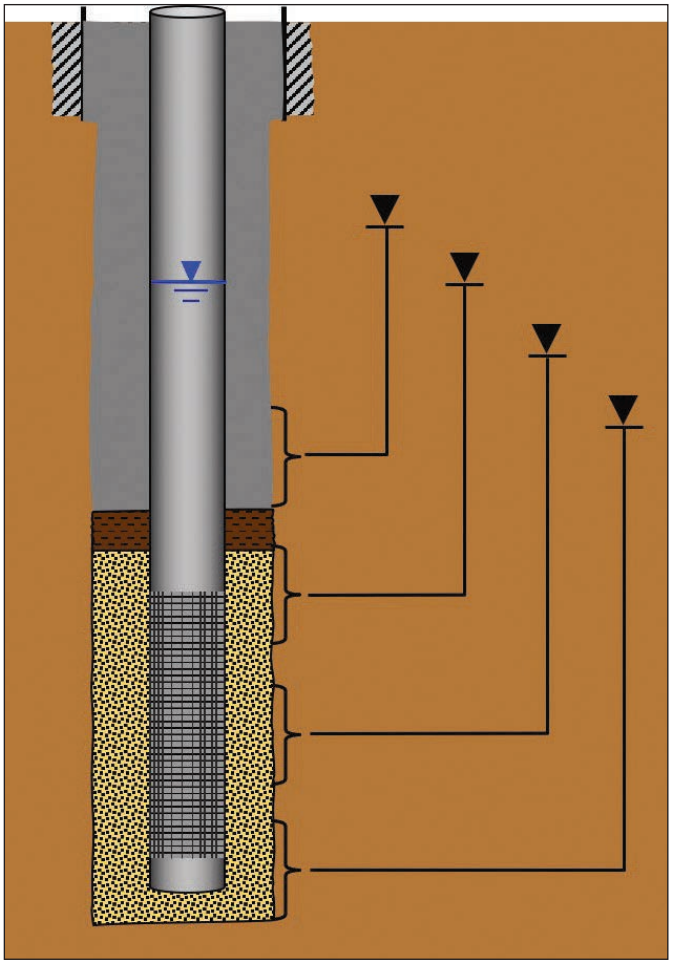

Figure 3. Vertical hydraulic gradient water flow.

Cement Seals: Standards and Additives

A variety of cement types have been designated by the American Society for Testing and Materials (ASTM) that are available to the groundwater industry. Ordinary Portland Cement has been used for many years, but the manufacturing of cement involves operation of high temperature kilns, which emit greenhouse gases. Since cement is the world's leading construction material, it represents a major source of greenhouse gas emissions and accounts for about 8% of all such releases (according to MIT researchers).

To address this, Portland-Limestone Cement has become common, which contains 5% to 15% of ground and uncalcined (unfired) limestone that is blended with the other cement ingredients. The resultant Portland-Limestone Cement reportedly provides similar performance as traditional Portland Cement but with a carbon footprint up to 10% lower. The ASTM Standards for common types of cement, along with some of their equivalent American Petroleum Institute (API) Classifications, are presented in Table 1.

Cement slurries generally contain 5.2 to 6 gallons of water per 94-pound sack of Portland Cement or Portland-Limestone Cement. This mix is variable depending on the specific well design, but it generally accommodates the desired cement properties, while providing a pumpable cement slurry that can be efficiently installed to seal the well annulus.

There are several cement additives that can be used to adjust

THE ART OF WATER WELLS continues on page 32

THE ART OF WATER WELLS from page 31

various properties of the cement slurry, including:

- **Bentonite** added as an extender to increase cement slurry volume
- **Pozzolan (fly ash)** added to increase strength and chemical resistance of the cement
- **Sand** added as an extender to increase the slurry volume and reduce cost
- **Accelerator ($CaCl_2$)** added to reduce the cement curing time
- **Retardants** added to increase the cement curing time
- **Dispersants** sometimes added as a friction retarder to make the cement more pumpable
- **Fluid loss agents** added in some cases to reduce the bleed water volume as the cement cures
- **Lost circulation materials** sometimes added when the cement slurry will be in contact with very porous formations.

Bentonite Seals: Certifications and Material Options

Bentonite annular seals, as with other construction materials for water wells, should have National Sanitation Foundation and American National Standards Institute (NSF/ANSI 61) Certification.

Various sources report that bentonite will swell 8 to 15 times its dry volume when hydrated. Bentonite's swelling and sealing properties along with its inert chemistry make it a good option for use as an annular seal in water wells. However, bentonite is sometimes considered difficult to install since it can sometimes swell prematurely and clog tremie pipes or bridge within the annulus above the desired seal depth.

Three common types of bentonite annular seals used in water wells are high-solids bentonite grout slurry, bentonite chips, and bentonite pellets (which are also called bentonite tablets and can be either coated or uncoated).

High-solids bentonite grout is a slurry mixture of powdered bentonite and water that generally contains about 20% solids by weight. Since high-solids grout contains 20% solids, it is also 80% water. This means the bentonite grout slurry can be readily pumped into place, but if the high-solids grout is not kept hydrated, the slurry volume will be greatly reduced, and the sealing characteristics will be compromised.

Bentonite chips are quarried granules of naturally occurring bentonite that do not contain additives. Bentonite chips are commonly provided in ¼- to ⅜-inch or ½- to ¾-inch granule sizes. This bentonite seal material (at least in my area) is probably the most used for water well seals, although installation of the chips to significant depths can sometimes be challenging.

Bentonite pellets (tablets) are a good alternative to bentonite chips in some cases. Bentonite pellets are made with high-quality bentonite that is first field dried, and then further kiln dried and compressed into pellets of uniform shape and size, typically ranging from ¼-inches to ½-inches. Since the pellets are rounder and denser than bentonite chips, they tend to be easier to install through a tremie pipe.

However, pellets are generally more expensive than chips. Due to their higher-quality bentonite composition and their compressed nature, bentonite pellets reportedly have greater swelling capabilities and faster swelling rates than bentonite chips. The rapid swelling rate of pellets can be advantageous if speedy sealing of the annulus is desired, but that fast swelling rate also makes the pellets susceptible to bridging or clogging problems during their installation.

Bentonite pellets are available with a biodegradable non-stick coating that provides a time-released extension of the swelling time. The coating allows the pellets to be installed with less susceptibility for sticking, but a recent study by the Society of American Military Engineers found concentrations of PFAS in the coated bentonite pellets that were tested.

PFAS is a group of synthetic compounds that may cause detrimental health effects, so several PFAS compounds were recently assigned a maximum contaminant level (MCL) by the U.S. Environmental Protection Agency. Therefore, great care should be taken to assure that coated bentonite pellets used in any water well do not contain any PFAS.

Lessons Learned from the Nebraska Grout Task Force Research

Operated by NGWA, the Groundwater Foundation's 2011 McEllhiney Lecture was presented by Tom Christopherson on the Nebraska Grout Study, which involved testing wells that had been constructed with a clear plastic PVC casing so that the actual effects of various annular seal materials could be observed and evaluated. This study provided a good comparison of cement grout, high-solids bentonite slurry, and bentonite chips. Some of the primary conclusions of the Nebraska Grout Study were:

- High-solids bentonite grout appeared stable below the water table, but would not rehydrate if it dried up, so the material was found to be ineffective for the vadose zone.
- Bentonite chips perform well and will rehydrate if dewatered, but they were considered time-consuming to install.
- Cement grout seals provide structural stability, but are prone to cracking or forming a micro-annulus from cement shrinkage.

The Nebraska Grout Study generally determined that the subsurface condition we imagined existing in the annulus of a well was incorrect. Several examples of voids in annular seals were recognized, either due to material deficiencies (e.g., poor seal against the well casing, cracks in cement seals, etc.) or due

to installation problems (e.g., void areas within annular seals).

Poor annular seals that result from ineffective installation techniques is an avoidable issue within our control. In cases where a high-solids bentonite grout is appropriate, the bentonite slurry can be pumped into place via a tremie pipe. For bentonite chips or pellets, the installation can be challenging, but many drillers have developed methods to achieve that installation by either pumping the dry bentonite in place through a tremie pipe or with an added stream of polymer solution to reduce the bentonite's hydration time.

Again, installation of cement seals was discussed in my February 2022 *WWJ* column (*waterwelljournal.com/effective-cement-annular-seal-installation*).

Having effective annular seals that are located where needed is a critical element of proper water well design. There is no single annular seal material or installation technique that is best for every well, but it is important to select and install annular seals in such a manner as to address the site-specific conditions and functionality of the individual water well being installed. WWJ

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LATISHA SHIPMAN

MORE TROUBLESHOOTING TIPS

Here are some tips to keep the hammer going at the jobsite.

In continuing with the troubleshooting tips from my March 2024 column "Troubleshooting Tips" (*waterwelljournal.com/troubleshooting-tips*), I recently had a call where someone's brand-new hammer wouldn't fire.

There was a lot of back-and-forth between me and the customer, and then between me and the hammer manufacturer as we tried to assess the issue and troubleshoot the problem.

I'm grateful to the customer for enduring the endless line of questioning, and the same with the manufacturer. I know it can be both difficult and frustrating for everyone involved when new products don't work the way they were envisioned.

I want to share some of the questions that were asked in order to identify the problem. I think this is a good example of what to expect when calling in to troubleshoot a hammer problem. Remember, the complaint came in that the hammer doesn't seem to fire.

My first question was, "Above the hole or in the hole?" to which the response was both; it wasn't firing at all.

I asked if air was blowing through the hammer. Yes, it was blowing air, but wouldn't fire. The reason for this question was to determine if air was exiting the hammer. If it isn't, then we need to work our way backwards to see where the airflow is being disrupted. For example, it could be a blown hose.

I checked to make sure the bit he had on the hammer had a blow tube in it as this particular hammer requires a blow tube. His bit had the blow tube, but for good measure, he decided to change out the bit.

The next comment I got from him was that they had gotten the hammer to fire! It wasn't ever a hammer issue at all, and it had taken someone else on their team investigating everything further.

I mention this because sometimes we overlook things. It's just part of our human nature. When you are having issues with a hammer, you might consider having someone else on your team work on it with you. They just might catch something you've overlooked.

Now, here are some more DTH problems and tips.

Problem 1.

I'm running into high heads of water. What can I do to keep my hammer from stalling out?

The Cause

The pressure from the water outside the hammer creates backpressure for the air inside the hammer. We must increase air pressure to unload the water from the hole.

One (1) foot of water in the hole is equal to 0.434 PSI. If you have 100 feet of water in the hole, there will be 43.4 PSI of backpressure that we need to overcome to maintain the minimum operating pressure of the hammer.

What Can I Do?

If possible, it's best to increase the air pressure, or consider adding a booster to continue drilling. You can also implement foam to assist in lifting the cuttings through the water.

Problem 2.

I don't have enough air on my rig to run the hammer. What other options do I have other than buying a larger air compressor?

Possible Causes

Believe it or not, we get this question a lot!

Drillers sometime inherit hammers larger than what they have air to run the hammers efficiently. This can be due to project requirements on occasion. Perhaps they need to set 16-inch casing. A 10-inch or 12-inch hammer would be required to do that, and the driller may only have a 350/900 compressor on the rig. In a project like that, we're going to need to consider uphole velocity and run calculations for that.

An issue I address regularly is that the customer has a 200/400 compressor, and they are asking what hammer they can run with that. I always check the minimum air compressor requirements on the air consumption chart for the hammers to make sure it will operate at 200 PSI, and not just meet minimum requirements.

I prefer to see the hammer in the mid-range on the PSI requirements. If we start a hammer out on the minimum operating requirements, we can expect the hammer to drill slow. And as we drill deeper, we can expect to encounter the problem of not having sufficient air to bring the cuttings to the surface and the risk of burying the tooling.

What Are My Options?

You don't necessarily have to have the biggest air compressor on the market to run your hammer, but it is important to match the hammer requirements with your air compressor as closely as possible. You may consider downsizing the hammer and running an oversized bit. There are multiple ways to tackle this issue.

If you have a hammer that uses a choking mechanism, we want to make sure you are using the correct choke for the amount of air pressure you have available. Choking the hammer properly can allow hammer pressure to build up inside the hammer, even in lower air pressure applications.

Secondly, you can implement drill foam or soap to help evacuate cuttings from the hole. Using a high-quality, heavy foam will allow for better hole cleaning. The consistency to look for is like shaving cream with small little bubbles. A lower-quality foam

will break down quickly, and a lighter foam would have larger bubbles and the consistency of your wife's bubble bath.

Note: It is necessary when running foam to double the amount of rock drill oil that you use as the foam and water mixture negates the lubricity of the oil and any benefits to oiling the hammer are lost.

When running foam, it's also important at the end of your drilling day to flush the hammer out with clean air and water as the foam is corrosive. You need to rinse the hammer clean to prevent premature wear on internal hammer parts.

When you know you are running with a lower air pressure than recommended, it's important to keep the hole clean at regular intervals. Drill slow and steady.

Problem 3.

I hear squealing coming from the hole. What causes that?

Possible Causes

This is often due to a too high rotation speed. Faster isn't always better. Rotating faster does not always increase penetration rates. Hammer and bit life is directly affected by rotation speed. Over-rotation causes scraping of the rock formation and not crushing as the DTH hammer and bit are designed to do, resulting in premature wear and possible failure.

What to Know

A good rule of thumb is RPM = ½ penetration rate per hour in feet. For example, if you're drilling 60 feet/hour, RPMs should be around 30. Most 6-inch hammers will run between 12-40 RPM depending on drilling conditions, particularly the hardness of the formation you're drilling in.

Drillers can learn to feel what the best RPM is for good penetration rate without sacrificing bit life. Ground conditions, formation hardness, and abrasiveness all must be taken into consideration.

Another cause of squealing can be a too low feed force. Recommended feed force for a 6-inch hammer is approximately 1300 to 4500 pounds. You will want to reference your hammer manual for the manufacturer recommendations.

Sometimes the squealing is due to difficult drilling conditions, and it is the formation that is causing the issue. In this case, just drill carefully. Make sure you follow the hammer manufacturer recommendations and flushing often.

A broken drill bit or broken carbide at the bottom of the hole can also cause odd sounds coming from the borehole. Check to see if the bit needs to be repaired or replaced. If you have lost buttons in the hole, you can try to extract them with a magnet. If you put a new bit on and haven't extracted the lost buttons, you can ruin your new bit as well.

Problem 4.

I lost my chuck and drill bit in the hole!

Possible Causes

Normally, the first thing we ask when we get this call is, "Did you reverse rotate?"

If everything is engaged at the bottom of the hole and you reverse rotate—even inadvertently—you may unscrew the driver sub from the piston case. This will leave everything at the bottom of the hole: your bit, chuck, bit retaining rings, and bearing. Usually, the piston retainer ring will keep the piston from falling out, but even that is not always the case.

This is caused on occasion by hammering without rotating, which can wiggle everything loose over an extended period of time. Back hammering can also be the culprit. Over time, the threads can become worn, so you can encounter this more often with an older hammer or chuck.

What to Remember

Be careful to keep rotating to the right or clockwise while hammering and check threads often for excessive wear, and replacing at regular intervals.

These problems as well as the ones recounted in the March 2024 column show there are countless issues that can happen and countless tips to remember. Hopefully, I've shared some tips that keep the downtime to a minimum at your jobsite. WWJ

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ED BUTTS, PE, CPI

VARIABLE FREQUENCY DRIVES

Part 4a. Concepts and applications.

During the past three months, we introduced variable flow and head systems and the various types of variable speed drives for pumping systems. With this column and the one next month, we will continue the series with an overview on the most popular method: variable frequency drives.

Introduction

Although variable speed drive systems are comprised of various methods of motor and pump speed regulation, for our purposes, we shall generally limit our discussion to electronic, low-voltage (less than 600VAC), three-phase variable frequency drives (VFDs). Medium-voltage VFDs will also be briefly discussed, albeit less than low voltage units.

VFDs are a remarkable and often perfectly matched control device for most pumping applications that adhere to the affinity laws. However, they are not a panacea or without potential issues and problems. Water system designers and engineers must recognize VFDs' potential strengths as well as their limitations and implement them with consideration of these operating characteristics.

Although VFDs are currently still more expensive than most comparable fixed-speed three-phase motor controls, the increased cost comes with benefits. Here are just a few of the many possible benefits of using a VFD.

Improved Power Factor: This is achieved using direct current (DC) bus capacitors within the VFD. The DC bus capacitors provide the reactive current to the motor needed to induce the rotor's magnetic field. Therefore, the power drawn from the input supply line will consist of the real power only with the voltage and current almost perfectly in phase with power factors up to 97%.

The benefits of improving the power factor include avoiding power factor penalties and demand charges from the utility and reducing the current on the distribution network.

Extended Motor and Pump Life: This is from controlling the motor's starting and running current while moderating the starting and stopping functions, thus reducing the degree of shock and motor and pump wear.

This can lead to lowered replacement costs by reducing the frequency in which a unit cycles and providing a smoother operating transition. However, long VFD motor feeder lengths can result in reflected waves, plus the slower shaft speed of the motor can cause cooling issues for submersible motors and totally enclosed fan-cooled (TEFC) enclosures. These are potential issues which must be addressed.

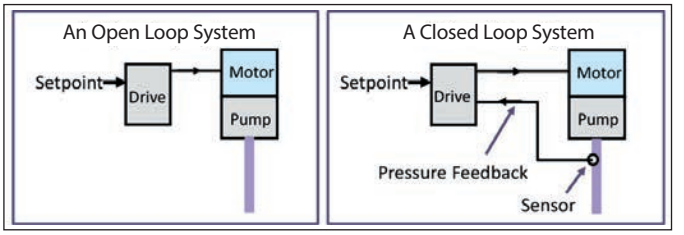

Figure 1. Open loop and closed loop VFD control.

Speed and Flow/Pressure Control: A VFD can produce a varied output frequency, which in turn can be used to control the speed of a motor and pump's output to match its needed demand as well as controlled starting and stopping ramping speeds to control undue stress and system water hammer. Due to the impact of the affinity laws, flow and pressure delivery rates can be controlled with precision throughout a wide operating performance band. This can be performed using an open loop or closed loop control method (Figure 1).

For the open loop control method, the volts per hertz (V/Hz or V/f) output to the motor is controlled independent of feedback from the motor. This can be done using linear or custom nonlinear output curves. To ensure the VFD provides accurate speed control, a tuning mode can be used to compensate for speed as needed.

For the closed loop control method, the VFD will directly monitor and control the voltage and current of the motor by utilizing a pressure or flow feedback signal (i.e., process variable) from an external analog sensor.

Reduced Energy Consumption and Starting Stress: Energy consumption is lowered by reducing the speed for motors that do not need to continually run at 100% speed and output load (pump). This benefit is often the single most important and valuable benefit and can provide more cost savings than other typical motor starting or variable flow/head control methods.

This is because of how the affinity laws work for centrifugal pumps, which was discussed in last month's Engineering Your Business. These affinity laws express mathematical relationships between flow, head, and horsepower variables involved in pump performance and are useful for predicting the effect of speed on pump performance.

Based on the affinity laws, a 50% reduction in rotational speed will typically reduce the input power used to 12.5% of that at 100% speed. Even a slight change in the pump's rotational speed to 90% full speed will reduce the power required

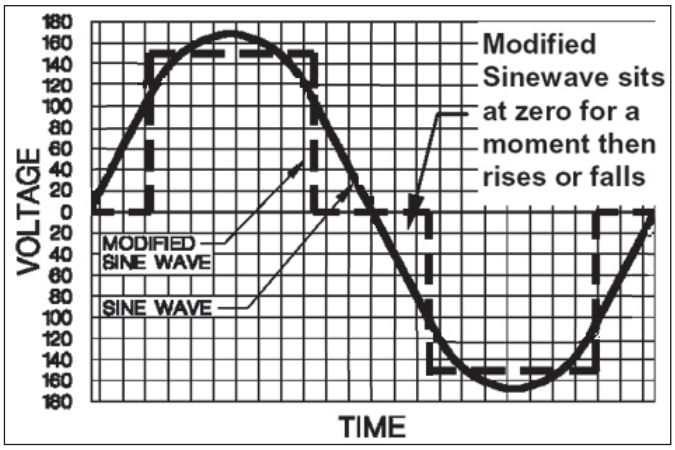

Figure 2. True and VFD modified sinewaves.

to 73% of that required at full speed. This obviously means that even small reductions in motor and pump speed can still provide a major potential in energy savings.

In addition, VFDs provide inherent soft-starting characteristics to motors, reducing accelerating stress on the motor and pump components.

Phase Conversion Capability: When properly applied, a VFD can be used to convert single-phase to three-phase power. This combines the roles of a motor control with phase conversion and eliminates the need for rotary or static phase converters.

When used as phase converters, the single-phase line will theoretically draw 173% greater power than the motor amperage from each line. However, after adding internal losses and an overload factor, this value typically rises to approximately 185% of the motor's full load current per line.

For an added margin of safety, doubling the motor's current for design is generally recommended and is what should be planned and anticipated. Thus, for a 30 HP, 460 VAC, 3-phase motor rated at 40 amps, the two single-phase line currents should be estimated to draw 40 amps × 2.0 or 80 amps per line.

VFD Waveform Shapes

VFDs, also known as inverters, do not generate power. Rather, they transform power from a standard AC waveform to DC and then back to a modified AC power waveform. They use solid state components with no moving internal parts other than perhaps a cooling fan.

Most inverters are available in the *modified sinewave* version, which is the least expensive way to manufacture an inverter. However, the waveform generated does not replicate true utility power, but rather an approximate version of it. The quality of this waveform will vary greatly between inverters, depending upon the type and model of the inverter.

Higher quality inverters are now available at reasonable prices that are labeled as *true sinewave* inverters. The true sinewave inverters still use solid state circuitry to create this modified waveform, but advances in technology now allow that waveform to be virtually equal to utility grade power.

So, what's the difference? Figure 2 shows the two waveforms, examining the utility power true sinewave first. As the sinewave shows, the peak voltage is around 170 volts, but it only touches this value for a brief instant. Electrical equipment needs exposure to that voltage for a longer time in order to use it. Therefore, typical household electrical equipment is designed to run on 120 volts RMS voltage. (RMS is root mean square and is a true measurement of power.)

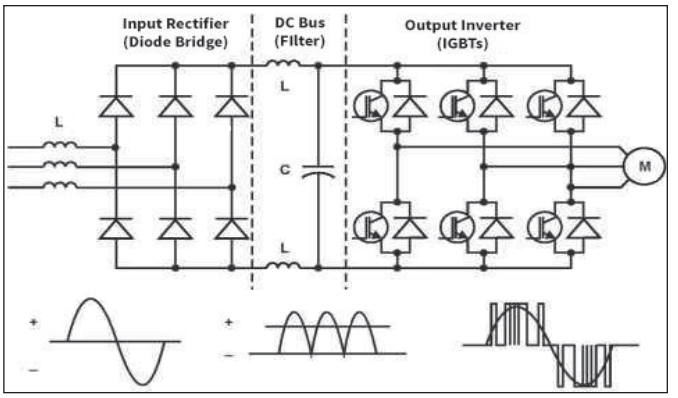

Figure 3a. Simplified six-pulse VFD schematic and waveforms.

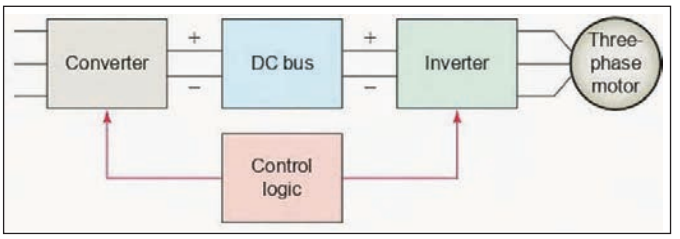

Figure 3b. VFD components and flowchart.

All electronic voltmeters and test instruments will generally measure the RMS voltage. This RMS value is measured at a lower point than the peak voltage on the waveform. This is determined by squaring the value to make sure it is always positive, averaging it, then taking the square root of the average to compensate for squaring it to begin with. The modified sinewave generally follows the path and intensity of the true sinewave, but in a square waveform.

Operating Principle of VFDs

A typical pulse type of variable frequency drive operates on the fundamental principle of *power conversion*, using three separate power conversion sections: AC power initially enters from the source and is initially converted to DC power in the *rectifier* section. The converted DC power then flows through a *filtering* capacitor section over a positive (+) and negative (–) DC bus. Finally, the power flows through the *inverter* section where it is inverted back to a modified form of AC power and thereafter delivered to the motor.

This train is illustrated on a simplified six-pulse VFD flowchart and waveforms in Figure 3a. Each separate voltage conversion generates pulsations of different waveforms to simulate a sinusoidal wave, similar in shape to an actual AC power cycle. These components are illustrated on the simplified flowchart in Figure 3b.

For water pumping applications, input AC power is ultimately converted to mechanical output power using this same type of train. As illustrated in Figure 4, standard, three-phase 60 Hertz sinewave of AC power is supplied to the VFD, which

ENGINEERING continues on page 38

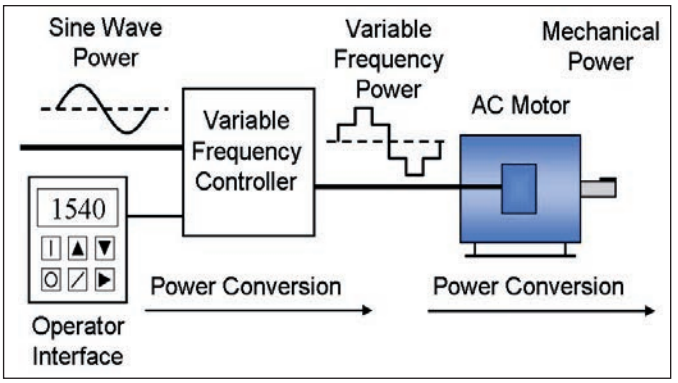

Figure 4. VFD power conversion train.

ENGINEERING from page 37

then converts the power internally to a DC bus voltage and then back to a square wave AC output to the motor to provide variable speed mechanical output power.

This process is highly efficient with typical total losses of 5% or less. There are two basic functional torque delivery types of VFDs in common use: constant torque and variable torque.

Constant torque units are used to drive loads needing consistent torque such as conveyor belts, presses, and other similar units where the horsepower and torque requirement does not necessarily vary with the driven speed. In constant torque applications, the load, and therefore the horsepower, will not usually decrease substantially at lower speeds. For these applications, VFDs are primarily beneficial for their ability to precisely vary and control the speed of a process and not necessarily for energy savings.

Variable torque units are mainly used to drive loads in which

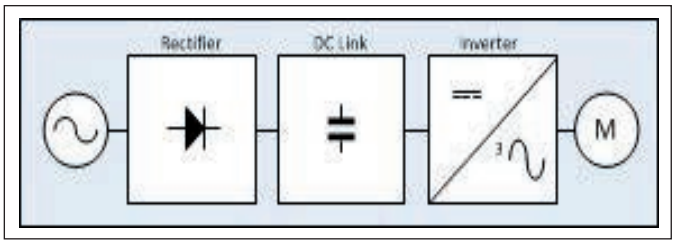

Figure 5a. VSI power flow train.

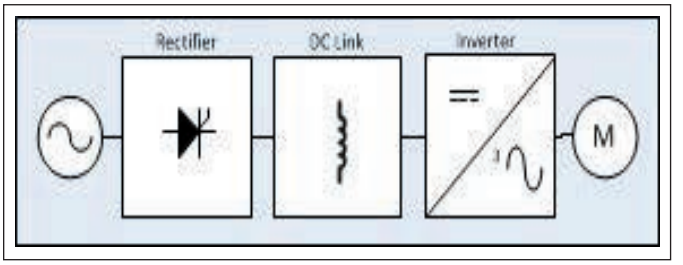

Figure 5b. CSI power flow train.

the power demand varies with speed, such as fans and pumps. According to the affinity laws, the horsepower demand will vary as the cube in direct proportion to the speed of the process.

In addition to the torque output, there are three basic electronic types of VFDs in common use. The first, *voltage source (or voltage) inversion* (VSI) or (VVI) drives (Figure 5a) have a higher power factor and produce less harmonic distortion than the second most common type, *current source inversion* (CSI) (Figure 5b), which are non-regenerative in operation.

In a VSI drive, the DC output of the diode-bridge converter stores energy in the capacitor bus to supply stiff voltage input to the inverter. The CSI types have been successfully used in signal processing and industrial power applications for several years. The CSI style is the only type that has regenerative power capability. In other words, they can absorb regenerative power from the motor and deliver it back into the power supply.

The CSI types provide a clean current waveform but require large and expensive inductors in their construction and can cause a condition known as cogging (i.e., a continually pulsating movement that occurs during motor rotation) below a frequency of 6 Hz. In a CSI drive, the DC output of the SCR-bridge converter stores energy in a series-inductor connection to supply stiff current input to the inverter.

CSI drives can be operated with either pulse-width-modulated (PWM) or six-step waveform outputs. Consequently, CSI and VSI drives have not been widely used for industrial or water-related three-phase motor applications.

This concludes the first installment on the concepts and fundamentals of variable frequency drives. Next month, we will wrap up the series with an examination of the third and most common type of VFD: pulse-width-modulated VFDs, their applications, and the available control methods. WWJ

Ed Butts, PE, CPI, is the water and wastewater design manager at 4B Engineering in Salem, Oregon. He has more than 45 years of experience in the water well business, specializing in engineering and business management. He can be reached at epbpe@juno.com.

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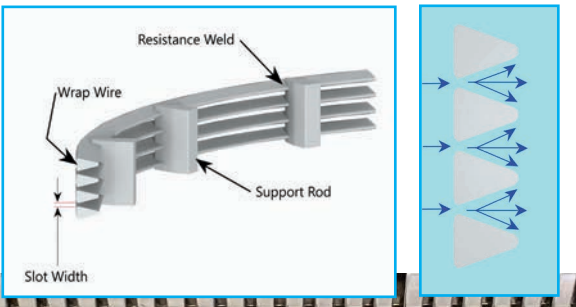

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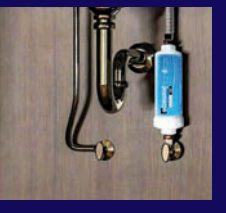

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Wolf currently offers a strong line of products ranging from 4 to 8-inch submersible pumps with the capability of testing up to 100 HP/75 KW motors. With a national sales force in place, Wolf expects to expand its current product line to new markets, some of which will require line shaft turbines.

*Wolong Electric America

222 E. 2nd St.
Dixon, IL 61021
www.wolongamerica.com

*Woodford Manufacturing Co.

2121 Waynoka Rd.
Colorado Springs, CO 80915-1602
(719) 574-0600
www.woodfordmfg.com

*WorldWide Drilling Resource Inc.

P.O. Box 660
Bonifay, FL 32425-0660
(850) 547-0102
www.worldwidedrillingresource.com

*Wyo-Ben Inc.

P.O. Box 80687
Billings, MT 59108-0687
(406) 652-6351
www.wyoben.com

Wyo-Ben Inc. has been in business since 1951 and is a leading producer of Wyoming bentonite clay-based products. Our materials are used globally in applications such as oil, gas, and water well drilling, environmental construction and remediation, hazardous wastewater treatment, and cat litter, as well as many other industrial and consumer-related products.

*Zilmet USA

240 Commerce Park Rd.
North Kingstown, RI 02852
(401) 884-4943

Directory of Suppliers

* National Ground Water Association member.

*101 Pipe & Casing Inc.

30300 Agoura Rd., Ste. 240
Agoura Hills, CA 91301
(818) 707-9101
www.101pipe.com

*Acker Drill Co.

P.O. Box
Scranton, PA 18501-0830
(570) 586-2061
www.ackerdrill.com

*Alvarado Bit Service

841 Hill County Road 1136
Rio Vista, TX 76093
(817) 240-4996

*America West Drilling Supply Inc.

3720 Plumas St.
Reno, NV 89509
(775) 825-1199
www.awds.biz

*Analytical Technology Inc.

6 Iron Bridge Dr.
Collegeville, PA 19426
(610) 917-0991

*Applied Process Equipment

9332 N. 95th Way, Suite B106
Scottsdale, AZ 85258
(480) 998-4097
www.apewater.com

*Aquaflow Pumps Inc.

1561 Pulaski Highway
P.O. Box 98
Bear, DE 19701-1303
(302) 834-1311

*Aquateck West Ltd.

4344 81 Ave.
Edmonton AB T6B 2M2
Canada
(780) 435-5919
www.aquateck.com

*Ascend Strategic Partners - Eaton Square

2603 Camino Ramon
San Ramon, CA 94583
(925) 381-2269
www.ascendsp.com

*Austin Pump & Supply Inc.

3803 Todd Lane
Austin, TX 78744-1027
(512) 442-2348
www.austinpump.com

*Axia Water Services

Axia Water Services
1 California St., Suite 2900
San Francisco, CA 94111
(502) 216-6851

*Banner Service Corp.

494 E. Lies Rd.
Carol Stream, IL 60188
(630) 868-1258
www.bargrind.com

*Benson Pumps Corp.

P.O. Box 1321
Conway, AR 72033-1321
(501) 329-2969

*Bill Johnson Equipment Co.

21 South 40th St.
Phoenix, AZ 85034-2901
(602) 275-5415
www.billjohnsonequipment.com

*Bit Brokers International Ltd.

5568 Logan Rd.
West Frankfort, IL 62896-4317
(800) 441-5451
www.bitbrokers.com

Bit Brokers International is a family-owned-and-operated company since 1988. BBI's staff has more than 185 years of combined experience in the drilling industry. BBI prides itself on providing the best quality bits and tooling in the drilling industry, all the while keeping our customers under budget and ahead of schedule. Our products and services include tricone bits, PDC bits, roller cone reamers/hole openers, PDC reamers/hole openers, dirt reamers, paddle bits, hammers and hammer bits, drag bits, centralizers/stabilizers, PDC repair, reamer/hole opener repairs, and subadapters.

*Bitco Inc.

P.O. Box 80547
Bakersfield, CA 93380
(661) 834-4348
http://bitcoinc.com/

*Black Bear Drill Service

9 Bond St.
Brookline, NH 03033
(603) 721-5414
www.blackbeardrill.com

*Blake Equipment

6 New Park Rd.
East Windsor, CT 06088
(860) 218-1051
www.blakeequip.com

*Bronco Companies

2072 Three Lakes Parkway,
Suite 300 & 400
Tyler, TX 75703
(903) 216-4771
www.broncocompanies.com

*Buckhorn Pumps Inc.

1786 County Rd. 490
Stephenville, TX 76401
(254) 965-2555

*C & N Supply Co. Inc.

1654 S. M-37
Hastings, MI 49058
(269) 948-9414

*Cal-Sierra Pipe LLC

3033 S. Highway 99
Stockton, CA 95215-8034
(209) 466-0988
www.calsierrapipe.com

*Central Drilling Supply Co.

P.O. Box 206
Mills, WY 82644
(307)262-3205

*Charger Water Treatment

4788 Longley Lane
Reno, NV 89502
(877) 627-9976

*Civista Leasing & Finance

680 Andersen Dr., Suite 505
Pittsburgh, PA 15220
(888) 834-3278
www.civista.bank/business/borrow/equipment-lease-finance

*CMC Supply Inc.

P.O. Box 12058
Roanoke, VA 24022-2058
(540) 982-1095
www.cmcsupply.com

*Coast Pump Water Technologies

210 Center Ct.
Venice, FL 34285
(941) 484-3738
www.floridapump.com

*Connecticut Winpump Co.

40 Callender Rd.
Watertown, CT 06795-1628
(203) 753-9829
www.ctwinpump.com

*Control Chemical Corp.

7016 30 St. Southeast
Calgary, AB T2C 1N9
Canada
(403) 720-7044

*D & S Pump & Supply Company Inc.

3784 Danbury Rd.
Brewster, NY 10509-4512
(845) 279-3784

*Darcy Solutions

5115 Industrial St.
Maple Plain, MN 55359

*Delco Western

2559 S. Decker Lake Lane
West Valley City, UT 84119
(801) 972-0900
www.delcowestern.com

*Delta Pump & Systems Inc.

P.O. Box 338
Eighty Four, PA 15330-0338
(724) 225-1995

*Dempsey Steel Pipe Co. Inc.

511 Route 17K
Walden, NY 12586
(845) 564-1230

*Denver Winpump

3725 Salem St.
Denver, CO 80239-3433
(303) 424-3551

*Drillers Service Inc.

P.O. Box 1407
Hickory, NC 28603-1407
(828) 322-1100
www.dsidsi.com/index.aspx

*Drillers World Australia Pty Ltd.

Unit 9, 2 Marina Close
Mount Kuring-Gai NSW 2080
+612 9457 0255

*Drilling Equipment Resources

5153 S. 94th East Ave.
Tulsa, OK 74145
(254) 813-8482
www.drillingequipmentresources.com

*Drilling Equipment Sales Inc.

P.O. Box 1417
Hildebran, NC 28637-1417
(828) 322-3056
www.drillingequip.com

*Drilling Supply & Manufacturing Inc.

7301 US Highway 183 South
Austin, TX 78744-7831
(512) 243-1986

*DrillingWorld

1458 Mariani Ct.
Tracy, CA 95376-2825
(510) 895-1650
www.drillingworld.com

*Drillworx

P.O. Box 150
Randolph, WI 53956-0150
(715) 350-1580
www.drillworx.us

*DuraTrac Products, Division of Elbi of America

1210 N. Red Gum St.
Anaheim, CA 92806
(714) 674-0590
www.duratracinc.com

*E&M Supply Group

1647 Miles Highway
Breaux Bridge, LA 70517
(337) 332-0239
www.drillpipesupply.com

*ECT Manufacturing

11 Black Forest Rd.
Hamilton, NJ 08691
(609) 631-8939
www.ectmfg.com

*ESI Supply LLC

P.O. Box 180759
Richland, MS 39218
(601) 933-4910
www.esisupply.net

*E-Water Solutions

429 Texas St.
Redlands, CA 92374
(909) 748-5814
https://ewaterllc.com

E-Water Solutions was born out of the need to provide consistent, accurate, and efficient water handling solutions in a timely and professional manner. We start by revolutionizing the customer service experience by utilizing our 130-plus years of combined practical know-how to work for you. E-Water Solutions stands ready 24/7 from three stocking locations to help with all your fluid handling requirements clean to black for residential, commercial, and industrial applications along with drilling projects small to large.

*Forestry Suppliers Inc.

205 W. Rankin St.
Jackson, MS 39201-6126
(601) 354-3565
www.forestry-suppliers.com

*Gammastream Technologies Inc.

P.O. Box 131
Fairview, OK 73737
(918) 289-2977
www.waterwellmap.com

*Geo-Hydro Supply Ltd.

201 Factory St. Southeast
Sugarcreek, OH 44681
(330) 852-1005
www.geohydrosupply.com

*Geothermal Supply Co. Inc.

106 Cherry St.
Horse Cave, KY 42749-1200
(270) 786-3010
www.geothermalsupply.com

*Givens International Drilling Supplies Inc.

P.O. Box 53
Corydon, KY 42406-0053
(270) 533-6378
www.givensinternational.com

*Global Drilling Suppliers Inc.

12101 Centron Plaza
Cincinnati, OH 45246-1704
(513) 671-8700
www.globaldrilsup.com

*Global Windmill & Supply LLC

4776 Dan Hanks Lane
San Angelo, TX 76904
(325) 651-4951
www.aermotorwindmill.com

*Goodin Co.

2700 N. 2nd St.
Minneapolis, MN 55411-1602
(651) 489-8831

*GTD Group Ltd.

Masons Farm, Queen Street,
Paddock Wood
Kent
TN12 6PJ
United Kingdom
www.gtdgroup.co.uk

*Gulf Coast Pump & Supply

428 Martin St.
Houston, TX 77018-3308
(713) 692-6233
https://gcpumpinc.com

*Gulf Coast Sand

105 St. A
Picayune, MS 39466
(800) 947-7263
www.pioneersands.com

*H D Fowler Co. Inc.

3633 136th Place Southeast,
Suite 100
Bellevue, WA 98006
(425) 746-8400
www.hdfowler.com

*Hard Metal Industries Pty Ltd.

P.O. Box 1467
Kenmore, Qld. 4069
Australia
+61 7 3714 5700

*Headwater Wholesale

6402 Odana Rd., Suite 201
Madison, WI 53705
(608) 772-0429
www.headwaterwholesale.com

*Hole Products LLC

309 13th Ave. NW
Little Falls, MN 56345
(320) 616-0701
www.holeproducts.com

Hole Products is a manufacturer and supplier of high-performance drilling supplies, tools, and equipment that service the construction, direct push, environmental, geotechnical, geothermal, HDD, mineral exploration, rotary, sonic, and water well drilling industries.

*Hydronix Water Technology

8630 Rochester Ave.
Rancho Cucamonga, CA 91730
(909) 527-6996
www.hydronixwater.com

*Impact Water Products

2101 E. Francis St.
Ontario, CA 91761-7723
(909) 939-8008

*Independent Pipe

5303 Rosedale Hwy.
Bakersfield, CA 93308

*Innovative Pump Solutions

4050 S. Farm Rd. 223
Rogersville, MO 65742
(417) 343-2211

*J & B Industrial Services Inc.

521 Northeast Loop 289
Lubbock, TX 79403-2806
(806) 749-4300
www.jandbindustrial.com

*Jentech Drilling Supply Inc.

195 Ingenuity Ave.
Sparks, NV 89441-5205
(775) 424-3045

*Johnston Supply Inc.

184 North Main St.
Marion, OH 43302-3055
(740) 383-5291

*Karam Pump & Supply Co.

820 West Geneva Dr., Suite 101
Tempe, AZ 85282-3357
(602) 233-2988

*Keller America Inc.

351 Bell King Rd.
Newport News, VA 23606-1341
(757) 596-6680
www.kelleramerica.com

*Keystone Drill Services Inc.

P.O. Box 716
Somerset, PA 15501
(814) 938-8220

*Layne of Washington Inc.

P.O. Box 610
Pasco, WA 99301-0610
(509) 545-9546

*Matzke Sales

3902 West Valley Highway North
Suite 404
Auburn, WA 98001
(253) 872-2029
www.matzkecompany.com

*M H Pump & Supply Inc.

610 S. Winter St.
P.O. Box 457
Adrian, MI 49221-3307
(517) 263-9062

*Mid-America Pump & Supply

P.O. Box 1287
Hastings, NE 68902-1287
(402) 463-5658
www.mid-americapump.com

*Midland Implement Co. Inc.

P.O. Box 30358
Billings, MT 59107-0358
(406) 248-7771

*Midland Winpump

2400 Commerce Drive
Midland, TX 79703
(432) 697-0488

*Mid-South Drillers Supply Inc.

P.O. Box 297
Lebanon, TN 37088
(615) 444-0423

*Milan Supply Co.

7125 E. Pickard Rd.
P.O. Box 309
Mount Pleasant, MI 48804
(989) 773-5933
www.milansupply.com

*Milby Co.

6201 South Hanover Rd.
Elkridge, MD 21075-5651
(410) 796-7700
www.milbyco.com

*Mill Man Steel Inc.

1441 Wazee St., Suite 104
Denver, CO 80202-5912
(303) 220-8545

*Milspec Industries

5825 Greenwood Ave.
Los Angeles, CA 90040-3846
(800) 234-8910
www.milspecind.com

*Mitchell Lewis & Staver Co.

9935 SW Commerce Circle
P.O. Box 621
Wilsonville, OR 97070
(503) 682-1800
www.mitchellewis.com

*Morris Industries Inc.

777 Route 23
Pompton Plains, NJ 07444
(973) 835-6600
www.morrispipe.com

Morris is a manufacturer and distributor of steel pipe, water well casing, groundwater, geothermal and environmental products for more than 60 years. Morris is partnered with industry leaders such as Amtrol, A.Y. McDonald, Baker, Baroid, Franklin, GeoPro, Grundfos, Kalas, North American Pipe, and Oil Creek Plastics.

*Moti-Vitality LLC

4345 Meigs Ave., Suite 107
Waterford, MI 48329
(810) 655-9600
www.moti-vitality.com

*Mountain Supply Co.

534 S. Billings Blvd.
Billings, MT 59101
(406) 259-2909
www.mountainsupply.com

*Mountainland Pump & Drilling Supply

1505 W. 130 South
Orem, UT 84058
(435) 610-5977
www.linkedin.com/company/72995599/admin

*Myron L Co.

2450 Impala Dr.
Carlsbad, CA 92010-7226
(760) 438-2021
www.myronl.com

*NDS Supply

26041 Newton Circle Dr.
Elko, MN 55020
(612) 461-3400

*Near North Supply Inc.

191 Big Bay Point Rd.
Barrie, ON L4N 0M6
Canada
(705) 721-9112

*Nelsen Corp.

3250 Barber Rd.
Norton, OH 44203-1012
(800) 362-9686
www.nelsencorp.com

*North South Supply

686 3rd Place
Vero Beach, FL 32962
(772) 569-3810
www.northsouth.net

*Northwest Pipe Fittings Inc.

P.O. Box 1258
Billings, MT 59103-1258
(406) 252-0142
www.northwestpipe.net

*O-K Bit Service Inc.

307 Thunderbird Rd.
Tonkawa, OK 74653-1042
(580) 628-3093
www.okbit.com

*Omaha Hydro Winpump

3616 South 138th St.
Omaha, NE 68144-3346
(402) 333-2039

*Orchard Pump & Supply Co. Inc.

P.O. Box 473
Lewisburg, PA 17837-0473
(717) 733-6151
www.orchardpump.com

*Paragon Sales

8605 I St.
Omaha, NE 68127
(563) 590-1886
www.paragonsales.com

*Phase Technologies LLC

222 Disk Dr.
Rapid City, SD 57701
(605) 343-7934
www.phasetechnologies.com

*Pinnacle Drilling Products Inc.

72 Techology Way Southeast
Calgary AB T3S 0B2
Canada
(403) 236-3393

*Preferred Pump & Equipment

2201 Scott Ave., Suite 100
Fort Worth, TX 76103-2238
(817) 413-2601
www.preferredpump.com

*Premier Pump & Supply Inc.

37 Riverside Rd.
Northfield, NH 03276
(603) 528-3100
www.premierpumponline.com

*Premium Rock Bit Corp.

P.O. Box 643
Mount Carmel, IL 62863-0643
(618) 262-4921

*Professional Technical Support Services Inc.

4211 Rhoda Dr.
Baton Rouge, LA 70816-7105
(225) 293-0136
www.envirodepot.com

*Progressive Environmental Services LLC

P.O. Box 880
Gaffney, SC 29342
(704) 764-1357
www.protectingwhatsbuilt.com

*Pumps of Houston Inc.

10239 Cossey Rd.
Houston, TX 77070
(281) 448-1352
www.pumpsofhouston.com

*Pumps of Oklahoma

1220 Northwest 3rd St.
Oklahoma City, OK 73106-7610
(405) 235-2695
www.pumpsofoklahoma.com

*R.E. Prescott Co. Inc.

10 Railroad Ave.
Exeter, NH 03833-2037
(603) 772-4321
www.represcott.com

*Ram Alloys

18250 Kieth Harrow Blvd.
Houston, TX 77084
(713) 466-1890

*Red Point Services LLC

4763 Kyle Ave.
Fort Worth, TX 76133
(512) 797-6767
www.redpointservices.llc

*Resource Monitor

616 E. St. NW
Washington, DC 20004
(888) 589-5773
www.resourcemonitor.com

*Rig Source Inc.

700 Hicks Dr.
Elburn, IL 60119-9059
(877) 365-1649
www.rigsourceinc.com

*Roberts Pump & Supply Co. Inc.

P.O. Box 2560
Grand Island, NE 68802-2560
(308) 381-7736

*Rock Dog Enterprises

185 Angelfire Dr.
Dripping Springs, TX 78620

*Rodgers & Co. Inc.

2615 Isleta Blvd. SW
Albuquerque, NM 87105-5810
(505) 877-1030

*Rotary Drill Service Inc.

P.O. Box 1470
Newton, NC 28658
(828) 465-0132
www.rotarydrillservice.com/index.html

*Smarter Equipment Finance

500 N. Rainbow, Suite 120
Las Vegas, NV 89107
(702) 330-3147
www.smarterfinanceusa.com

*Solar Power and Pump Co. LLC

301 West 12th St.
Elk City, OK 73644-6740
(580) 821-2860
www.togosolar.com

*Southwest Drill Bits LLC

279204 E. 1710 Rd.
Duncan, OK 73533
(580) 606-0477
southwestdrillbits.com

Southwest Drill Bits LLC is a second-generation family-owned company dedicated to supplying customers with the quality of bits you desire. Whether it be new, rerun, or rebuilt in either TCI (button), mill tooth, PDC, seal bearing, or open bearing, our objective stays the same – supplying you with the exact bit

needed for the job. With a large inventory of bits at any given time we have the capability to fill your order, whether it be just one piece or five hundred pieces. We also can meet your specifications with a complete machine shop that has the capabilities to build custom hole openers and subs.

*Terry Warren Enterprises

2134 Tanglewood Lane
Odessa, TX 79761

*The Pump House, a Ferguson Enterprise

401 6th St. North
Nampa, ID 83687
(208) 466-8908

*The Rideau Group Inc.

78 Wright Blvd.
Stratford ON N4S 1H3
Canada
(519) 272-1005
www.rideaupipe.com

*Tigerflow

4034 Mint Way
Dallas, TX 75052
(972) 310-7514
www.tigerflow.com

*TMC Sales

P.O. Box 660
Snohomish, WA 98291
(425) 236-8386
www.tmcsalesinc.com

*Tom Evans Environmental Inc.

3200 Flightline Dr., Suite 302
Lakeland, FL 33811
(863) 619-3789

*T-P Pump & Pipe Co.

P.O. Box 25144
Albuquerque, NM 87125-0144
(505) 247-4036
www.tppump.com

*Tufts Grinding

79 E. 34th St.
South Chicago Heights, IL 60411-5501
(708) 755-8900
www.tuftsgrinding.com

*US Water Systems

1209 Country Club Rd.
Indianapolis, IN 46324

*Valley Farms Supply Inc.

16713 Industrial Parkway, Suite 1
Lansing, MI 48906
(517) 703-0400
www.valleyfarmsupply.com

*Vertical Flow Industries

202 31st St. South
Texas City, TX 77590
(409) 242-6505
http://vfipumps.com

*Victory Steel Products Corp.

P.O. Box 4370
Saint Louis, MO 63123-0170
(314) 849-7272
www.vicsteel.com

*Villarreal Division Equipos

Morelos 905 Sur
NL 67350 Allende
Mexico
+52 826 2680 800

*Warren Pump & Supply Co.

2926 Commonwealth Ave. NE
Warren, OH 44483-2831
(330) 372-2610

*WaterColor Management

251 Johnston St. SE, Suite 404
Decatur, AL 35601-1908
(256) 260-0412
www.watercolormanagemment.com

*Waterra USA Inc.

P.O. Box 576
Peshastin, WA 98847-0576
(360) 738-3366
www.waterra.com

*Webtrol Pumps

8417 New Hampshire Ave.
Saint Louis, MO 63123-2505
(314) 631-9200
www.webtrol.com

*Western Hydro LLC

P.O. Box 80610
Billings, MT 59108
(888) 584-8660
www.westernhydro.com

*Wholesale Pump & Supply Inc.

P.O. Box 1079
Shreveport, LA 71163-1079
(318) 221-4275
www.wpspump.com

*Willis Ide & Son

696 Main Rd.
Dallas, PA 18612
(570) 675-8212

*Winsupply

3100 Kettering Blvd.
Dayton, OH 45439
(937) 294-5331

*Winsupply Lubbock TX Co.

2304 120th
Lubbock, TX 79423
(806) 784-2005

*Yaskawa America Inc.

2121 Norman Dr.
Waukegan, IL 60085-6751
(847) 887-7000
www.yaskawa.com

Index of Products and Services

This index is a listing of products and services and the companies that provide them. All of the companies listed below are ONLY the firms that have purchased premier or platinum listings in the NGWA Online Buyers Guide at *https://buyersguide.ngwa.org*. For contact information, go to the company listing in the Directory of Manufacturers on page 42 or the Directory of Suppliers on page 55. Also go to the Online Buyers Guide as some listings feature images, video, and more.

elevators, pipe fishing tools
Hole Products

geothermal equipment
Hole Products

gravels
Hole Products

grout, bentonite
CETCO
Hole Products
Morris Industries
Wyo-Ben

grouts/sealants
CETCO
Hole Products
Wyo-Ben

manhole covers
Hole Products
Morris Industries

reamers
Bit Brokers

rotary, bits
Hole Products
Palmer Bit

sonic drill tools
Hole Products

DRIVES AND DRIVE COMPONENTS

drives, shoes
Morris Industries

drives, variable frequency
E-Water Solutions
Franklin Electric
Fuji Electric
Morris Industries
SJE Rhombus

ENVIRONMENTAL EQUIPMENT AND SERVICES

core boxes
Hole Products

core drilling tools
Hole Products
Mobile Drill

data logging equipment
SJE Rhombus

environmental supplies
Baker Water Systems

samplers, liquid-groundwater
Baker Water Systems

soil sampling tools
AMS
Hole Products

HAMMERS AND HAMMER COMPONENTS

hammers, bit blow tubes
Eastern Driller Manufacturing

hammers, down-the-hole
Bit Brokers
Eastern Driller Manufacturing
E-Water Solutions
Hole Products

hammers, fluid
Hole Products

hammers, rotary
Hole Products

LUBRICANTS

lubricants, bentonite
CETCO

lubricants, drilling fluids
CETCO
E-Water Solutions

lubricants, foam
CETCO

lubricants, polymers
CETCO

MUD SYSTEMS

mud systems
Hole Products

muds, polymers, and additives
CETCO
Hole Products
Morris Industries
Wyo-Ben

portable mud kits
Wyo-Ben

PIPES, PIPE FITTINGS, AND COMPONENTS

pipe, drill
Hole Products

pipe fittings, brass
A.Y. McDonald Manufacturing
Baker Water Systems

pipe fittings, metal
Baker Water Systems

pipe fittings, nonmetal
Baker Water Systems
Westlake Pipe & Fittings

pipe fittings, plastic
Baker Water Systems
Westlake Pipe & Fittings

pipe fittings, steel
Baker Water Systems

pipe fittings, threaded PVC accessories
Baker Water Systems
Hole Products
Westlake Pipe & Fittings

pipe, joint compound
Eastern Driller Manufacturing
Hole Products

pipe, perforators
Malco Saw

pipe, threaded PVC drop
Westlake Pipe & Fittings

PUMP COMPONENTS AND MOTORS

boosters
A.Y. McDonald Manufacturing
Goulds Water Technology

cable, submersible pump-motor
E-Water Solutions
Morris Industries
Shakti Pumps

check valves
Baker Water Systems
Franklin Electric

controls, constant pressure
Franklin Electric
Goulds Water Technology
Shakti Pumps
SJE Rhombus
Morris Industries

controls, variable speed pumping
Franklin Electric
Goulds Water Technology
Morris Industries
SJE Rhombus

electric motor controls
A.Y. McDonald Manufacturing
Franklin Electric

hydrants-faucets
Baker Water Systems

motors, electric
A.Y. McDonald Manufacturing
Franklin Electric

motors, jet pump
A.Y. McDonald Manufacturing
Franklin Electric

motors, submersible pump
A.Y. McDonald Manufacturing
Flint & Walling
Franklin Electric
Hitachi
Shakti Pumps

motors, vertical turbine
Franklin Electric

mounting brackets
Franklin Electric

vapor extraction caps
Baker Water Systems

vents
Baker Water Systems

wireless controls
SJE Rhombus

PUMPS

irrigation equipment
Franklin Electric

pump hoists
Morris Industries

pumps, booster
A.Y. McDonald Manufacturing
Franklin Electric
Flint & Walling
Webtrol Pumps

pumps, centrifugal
A.Y. McDonald Manufacturing
Flint & Walling
Franklin Electric
Goulds Water Technology
Hole Products
Shakti Pumps
Webtrol Pumps

pumps, chemical feed
Webtrol Pumps

pumps, constant pressure
Franklin Electric
Goulds Water Technology
Shakti Pumps

pumps, high pressure
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Hole Products
Webtrol Pumps

pumps, jet
Flint & Walling
Franklin Electric
Shakti Pumps

pumps, mud
Hole Products

pumps, multiple systems
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pumps, municipal
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Hole Products

pumps, sampling
Hole Products

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Webtrol Pumps

pumps, solar
Franklin Electric
Shakti Pumps

pumps, specialty
E-Water Solutions

pumps, submersible, industrial
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Flint & Walling
Franklin Electric
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Webtrol Pumps
Wolf Customized Pumps

pumps, submersible, irrigation
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Wolf Customized Pumps

pumps, submersible, residential
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Goulds Water Technology
Shakti Pumps
Webtrol Pumps

pumps, sump
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Flint & Walling
Franklin Electric
Milan Supply
Webtrol Pumps

pumps, vertical turbine
Franklin Electric
Goulds Water Technology
Wolf Customized Pumps

pumps, yard hydrants
Merrill Manufacturing

RIG COMPONENTS

generators
Vanair

generators, hydraulic
Vanair

hoist plugs
Hole Products

rods, drill
Hole Products

stabilizers
Hole Products

switches
Merrill Manufacturing

wrenches
Hole Products

SAFETY EQUIPMENT

alarms
SJE Rhombus

TANKS AND TANK COMPONENTS

tank fittings
Baker Water Systems

tank tees
Baker Water Systems
Merrill Manufacturing

tanks, diaphragm
E-Water Solutions
Goulds Water Technology
Morris Industries

tanks, fiberglass
Enpress

tanks, pressurized
Goulds Water Technology
Morris Industries

tanks, stainless steel
Morris Industries

tanks, steel
Baker Water Systems
Morris Industries

tanks, water
Baker Water Systems
Morris Industries

VALVES

valves, air release
A.Y. McDonald Manufacturing
Flomatic Valves

valves, backwash
Flomatic Valves

valves, ball
A.Y. McDonald Manufacturing
Baker Water Systems
Flomatic Valves
Merrill Manufacturing

valves, butterfly
Flomatic Valves

valves, bypass
A.Y. McDonald Manufacturing
Flomatic Valves

valves, check
A.Y. McDonald Manufacturing
Baker Water Systems
Flomatic Valves
Merrill Manufacturing

valves, drain
A.Y. McDonald Manufacturing
Baker Water Systems
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valves, flow regulating
Flomatic Valves

valves, foot
Flomatic Valves
Merrill Manufacturing

valves, freeze protection
Flomatic Valves

valves, gate
Flomatic Valves

valves, nonmetal
Flomatic Valves

valves, pressure regulators
A.Y. McDonald Manufacturing
Flomatic Valves
Merrill Manufacturing

valves, pump control
E-Water Solutions
Flomatic Valves

valves, relief
A.Y. McDonald Manufacturing
Flomatic Valves

valves, solenoid
Flomatic Valves

WATER FLOW CONTROL EQUIPMENT

ASR flow control valves
Baski

liquid level controls
SJE Rhombus

low flow controls
SJE Rhombus

piezometers
Hole Products

sensors, flow
Fuji Elecrtric
In-Situ

sensors, level
In-Situ
SJE Rhombus

sensors, pressure
Fuji Elecrtric
In-Situ

WATER QUALITY

filter media
Applied Process Equipment
Enpress
Franklin Elecrtric

filters, bacteria removal
Baker Water Systems
Enpress
Franklin Elecrtric

filters, carbon
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
Enpress
Franklin Electric

filters, cartridge type
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
Enpress
Franklin Electric

filters, miscellaneous
Applied Process Equipment
Baker Water Systems
Franklin Electric

filtration media
Canature WaterGroup

ion-exchange media-equipment
Applied Process Equipment
Canature WaterGroup
Franklin Electric

lead removal, water treatment
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
Enpress
Franklin Electric

PFAS removal
Applied Process Equipment
Baker Water Systems
Enpress
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reverse osmosis
Canature WaterGroup
Franklin Electric

rust removal
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
Franklin Electric

softener conversion kit
Franklin Electric

softeners
Applied Process Equipment
Canature WaterGroup
Franklin Electric

taste, odor removal
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
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In-Situ

telemetry systems
In-Situ

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testing labs
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test strips
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ultraviolet systems
Enpress
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water level measurement equipment
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water level meters
Hole Products

water quality instrumentation
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water treatment systems-commercial-industrial
Applied Process Equipment
Baker Water Systems
Canature WaterGroup
E-Water Solutions
Enpress
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water treatment-component parts for equipment
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water treatment-drinking water systems
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Baker Water Systems
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well casing depth indicator
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well rehabilitation, repair equipment
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Baker Water Systems

WATER TREATMENT AND CLEANUP

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Franklin Electric

arsenic removal
Applied Process Equipment
Franklin Electric

brushes, rehabilitation
Hole Products

chemical feed equipment
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Franklin Electric

chemicals, water treatment
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Franklin Electric

chlorinators, water treatment
Canature WaterGroup

conditioning, water treatment
Canature WaterGroup
Franklin Electric

deaeration and degasification
Franklin Electric

desanders
Hole Products

disinfection equipment
Canature WaterGroup

mineral tanks-water treatment
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Enpress
Franklin Electric

monitors, water treatment
Franklin Electric

nitrate removal
Canature WaterGroup
Franklin Electric

remediation pumping equipment
Baski

WATER WELL PARTS AND TOOLS

controls
SJE Rhombus

couplings, PVC
Baker Water Systems
Westlake Pipe & Fittings

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gaskets
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gauges
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E-Water Solutions
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heat shrink
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nipples
Baker Water Systems

packers
Baski
Hole Products

perforators
Malco Saw

pitless adapters
Baker Water Systems
Baski
Hole Products
Merrill Manufacturing

sand traps and separators
Malco Saw

screens and points, fiberglass
Malco Saw

screens and points, metal
Baker Water Systems
Malco Saw

screens and points, nonmetal
Malco Saw

screens, slotting blades
Malco Saw

screens, threaded PVC
Baker Water Systems
Hole Products
Malco Saw
Westlake Pipe & Fittings

seal vents
Baker Water Systems

seals
Baker Water Systems

slotting machines
Malco Saw

washers, break-out
Baker Water Systems

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Pursue and advance a career in the groundwater industry with support from our NGWA University Franklin Electric Scholarship Program.

The scholarships are given annually to five emerging groundwater industry professionals to provide critical continuing education through complimentary access to the NGWA University's comprehensive **Drilling Basics Course**.

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Each student will be given access to the full suite of groundwater courses within the Driller Safety Onboarding program, including:

- **Groundwater 101**
- **Geology and Groundwater**
- **Rig Types & Well Design**
- **General Workplace Safety**
- **Drill Rig Safety**
- **Hydrogeology & Fluid Mechanics**

The industry-leading online training program, powered by Oklahoma State University, is designed specifically to improve the safety and skills of drilling industry members and train the next generation of drillers to address the critical shortage of professionals in the industry.

SCAN TO LEARN MORE & APPLY ONLINE

- Scholarships are limited to a first-come, first-serve basis and require participants to submit an application prior to registering for courses or programs.
- NGWA University will reach out to those eligible for funding assistance.
- Courses vary in length and competencies all based on the NGWA licensing exams. Some states will also issue continuing education units (CEUs) per course. Contact Oklahoma State University to learn if your state is one of them.

GEFCO/BAUER America's Drill School Returns

In response to the growing demand for skilled professionals in the water well drilling industry, **GEFCO/BAUER Equipment America Inc.** reprised its Drill School, a comprehensive five-day training course designed to equip students with the theoretical and practical skills necessary to excel in the field. The last Drill School was hosted in 2019.

GEFCO's Drill School, which was held February 26–March 1 and April 29–May 3 this year at BAUER Equipment America in Conroe, Texas, had a combined 60 students attend both sessions. Organized by BAUER Certified Training Partner Bruce Bradley, Drill School provided students with a unique opportunity to receive hands-on training and professional instruction from

industry experts such as Jim Smith of the Resources Drilling and Blasting Program at Fleming College in Ontario, Canada.

During Drill School, a GEFCO 90K drill rig, owned by Skytech Drilling in Phoenix, Arizona, was used to perform live demonstrations. The GEFCO 90K is a heavy-duty, diesel-powered, air/mud hydraulic topdrive drill designed for large water well drilling.

The students witnessed the upgraded GEFCO flagship. With the mast lifted 35 feet in the air, the operators successfully demonstrated various drilling techniques, including air drilling and mud drilling. During the final day, the instructors focused on air drilling, showing the students how deep boreholes can be drilled into rock formations and may be effective where other drilling methods aren't feasible.

"This Drill School is well organized, well thought out, and informative," says David Helgeson of Drillworx. "As a salesman, I hope to learn information here to better help my customers."

BUSINESS GROWTH

Tim Thomas, owner of **Bit Brokers International Ltd.**, and **Terry Colton**, owner of **Colton Bit Service**, finalized an agreement for the acquisition of Colton Bit Service. The agreement allows BBI to establish a distribution point for the horizontal directional drilling (HDD) market, enhancing its ability to supply pilot bits and reamers as well as Baroid Industrial Drilling Products to its existing customer base. Additionally, it enables BBI to extend its reach into the water well market, serving customers across the New England region of the United States, spanning from West Virginia. The location of the BBI warehouse in West Virginia significantly expands the selection and availability of products for the water well market in the New England area. Read more at *waterwelljournal.com/bit-brokers-international-acquires-colton-bit-service.*

DSG (Dakota Supply Group) celebrated a major milestone with the groundbreaking ceremony for its new facility on April 9 in Sheboygan, Wisconsin. The event marks the start of construction on the new facility. The facility is set to open in 2025. The new 39,000-square-foot facility will offer a comprehensive range of products and solutions from top manufacturers to professionals in the electrical, plumbing, and HVAC industries.

American Industrial Partners announced on April 10 it completed its purchase of **Boart Longyear**. Established in 1890, Boart Longyear is headquartered in Salt Lake City, Utah, and was previously listed on the Australian Securities Exchange in Sydney, Australia.

QED Environmental Systems Inc., a manufacturer of innovative environmental products and a subsidiary of Graco Inc., has increased the production capacity at its U.S. manufacturing facility in Dexter, Michigan, as part of a global transition to centralize all production under one roof.

The company's extensive portfolio of pumps, skimmers, wellheads, groundwater and soil sampling, treatment, and gas analyzer/detection products will now be designed and manufactured at the headquarters in Dexter, Michigan. The transition will also see the Dexter facility become QED's global calibration and service hub.

NEW TECHNOLOGY

AquiSense Technologies, a global provider of ultraviolet LED water disinfection systems, announced that the company's UV-C LED technology has been successfully integrated into NASA's Potable Water Dispenser aboard the International Space Station and has been operational since August 2023. This marks a major advancement in space-based water disinfection capabilities and underscores the vital role of advanced water treatment technologies in supporting human life beyond Earth.

The Potable Water Dispenser, designed by Leidos and equipped with AquiSense Technologies' PearlAqua Micro point-of-use UV-C LED water disinfection system, was launched into space aboard the SpaceX Falcon 9 rocket. Designed to provide safe and clean drinking water for astronauts on the International Space Station, this innovative system represents a successful collaboration between AquiSense Technologies and Leidos, a global provider of aerospace and defense solutions.

IN MEMORIAM

The New Jersey Ground Water Association announced the passing of **Richard H. Stothoff** on March 15. A licensed New Jersey Master Well Driller, Stothoff worked for the family business, Samuel Stothoff Co. Inc., and was co-owner. Among his volunteer work, he sat on the New Jersey Department of Environmental Protection and was a member of the Advisory Board of the Well Drillers Association.

The Ontario Ground Water Association announced the passing of member **Murray Stephen Jones** on March 14. Jones worked alongside his parents and brother and sister at Mervin Jones Drilling for more than 50 years.

Worthington Enterprises/AMTROL announced that **Jeffrey R. Wellen**, 74, of Voluntown, Connecticut, passed away on March 4. For more than 50 years, Wellen served as a support technician at AMTROL. Wellen and his wife, Liz, dedicated more than 100 years of service in their careers with AMTROL. For the past 15 years, Wellen served as a senior technical service representative where he focused on product training and education. He volunteered for the Water Systems Council and Water Well Trust, serving as chairman of the tank committee and member of the technical committee.

Raymond Dean Felder, 82, of Angleton, Texas, passed away on February 13. Felder obtained his master electrician license while drilling and servicing water wells on the weekends with his father. He obtained his master water well driller and pump installer's license and took over the reins of the water well business around 1973. Felder was involved with and served on various boards and was a past president for the Texas Ground Water Association. He served on the board of the Brazoria County Groundwater Conservation District for many years.

David Earl Williams

David Earl Williams, a fourth-generation water well contractor and past president of the Arizona Water Well Association, passed away February 9. He was 70. Williams served several terms as district director for Pima, Pinal, and Santa Cruz counties and drilled hundreds of private and commercial water wells in the state.

W. Roger Goold of Chatham Center, New York, passed away on January 18. He worked at W. Gordon Goold Well Drilling, a family business that began in 1928. He and his siblings would run that business until it was turned over to the present generation.

Lester Eugene Funk

Lester Eugene Funk, 82, of Newville, Pennsylvania, passed away on September 9, 2023. Funk was the former owner of Funks Drilling and Water Treatment that he passed on and is now owned and operated by his sons. Aside from the drilling business, Funk was the current owner of Funk Manufacturing/Up-Z-Dazy, which is a manufacturer of well pump pullers.

Leonard George Kropp, (100 and a half), of Gills Pier, Michigan, passed away on May 1. Kropp established his own well drilling business in 1947, a venture he dedicated himself to until his retirement in 2005. A lifelong member of the Michigan Ground Water Association, Kropp received the Distinguished Service Award in 1993.

Coming EVENTS

June

4. **NGWA Members Exclusive Webinar: Safety Inspections of the Drill Site** (800) 551-7379, fax (614) 898-7786, customerservice@ngwa.org, NGWA.org/Events

6-7. **Mississippi Ground Water Association Summer Convention** Biloxi, Mississippi. *www.mgwainc.com*

11-12. **American Ground Water Trust Texas Groundwater Conference** Austin, Texas. *www.agwt.org*

11-13. **Baroid Mud School** Grand Island, Nebraska. *www.nebraskawelldrillers.org*

20. **Addressing the Risks of Enteric Viruses in Managed Aquifer Recharge** (webinar). (800) 551-7379, fax (614) 898-7786, customerservice@ngwa.org, NGWA.org/Events.

July

10-11. **American Ground Water Trust New Mexico Groundwater Conference** Albuquerque, New Mexico. *www.agwt.org*

12. **American Ground Water Trust New Mexico Water Well Workshop** Albuquerque, New Mexico. *www.agwt.org*

19-20. **Empire State Water Well Drillers Association Summer Meeting** Penn Yan, New York. *www.nywelldriller.org*

25. **NGWA's Hydrogeology of States Webinar Series: Nebraska** (800) 551-7379, fax (614) 898-7786, customerservice@ngwa.org, NGWA.org/Events

27-29. **South Atlantic Jubilee** Myrtle Beach, South Carolina. *www.jubileewatershow.com*

September

10-12. **Ground Water Protection Council 2024 Annual Forum** Nashville, Tennessee. *www.gwpc.org*

16-18. **National Safety Council Safety Congress & Expo** Orlando, Florida. *congress.nsc.org/nsc2024/public/enter.aspx*

18. **NGWA's Hydrogeology of States Webinar Series: Louisiana** (800) 551-7379, fax (614) 898-7786, customerservice@ngwa.org, NGWA.org/Events

23-24. **Meeting the Challenges of Groundwater in Fractured Rock Conference** Burlington, Vermont. (800) 551-7379, fax (614) 898-7786, customerservice@ngwa.org, NGWA.org/Events

25-27. **National Drilling Association 2024 Convention** Aurora, Ohio. *www.nda4u.com*

Events subject to change. Contact the listed association or agency hosting the event for up-to-date information or go to NGWA.org to view the full groundwater industry calendar of events.

For 100-plus hours of CEU content including live and on-demand events, visit NGWA.org/LearningCenter, or scan the QR code.

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*Event titles in red are National Ground Water Association events.

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NGWA

Campbell Ultrafiltration+ Whole House System Reduces PFAS While Maintaining Flow Rate

The Campbell Ultrafiltration+ Whole House System three-stage filtration system is certified to the NSF/ANSI 53 2022 standard for PFAS reduction.

The system effectively reduces bacteria, viruses, cysts, PFAS, heavy metals, microplastics, chlorine, and more while maintaining flow rate.

The system is also certified to NSF/ANSI 42, 61, and 372. Testing the Campbell Ultrafiltration+ POE underwent, meets, and exceeds EPA National Primary Drinking Water Regulations on some compounds and is lower than the 2022 standard of 20 parts per trillion for all compounds.

Enjoy quality water from your faucet with no wastewater discharge or added salt.

www.campbellultrafiltration.com

Johnson Screens' Shur-Align® Stainless Steel Couplings for PVC Drop Pipe Minimize Hang-Up Issues

Johnson Screens' Shur-Align® stainless steel coupled drop pipe for PVC has a long entry bell, allowing for a quick connection for water well applications. The patented design reduces cross-threading and the pipe's beveled ends minimize hang-up issues.

The Shur-Align couplings design includes built-in ribs to provide secure tool placement for tightening connections. The couplings are made of lead-free 304 stainless steel, have superior strength, and are suitable for deeper set installations.

The Shur-Align Stainless Steel Couplings are available in 1, 1.25, 1.5, or 2 inches and come pre-installed on Schedule 80 or 120 PVC pipe.

www.johnsonscreens.com

Calgon Carbon Introduces AquaKnight™ to Remove PFAS

Calgon Carbon Corp. introduces AquaKnight™, the ultimate solution for clean and safe drinking water.

With the demand for clean water becoming increasingly vital, AquaKnight is the standalone guardian in the ongoing battle against PFAS for both municipal plants and their wider communities.

Engineered with 35 years of experience, AquaKnight's Gold Certified system boasts a two-vessel system optimized for granular activated carbon (GAC) use and certified by the National Sanitation Foundation to Standard 61 for Drinking Water System Components.

Partnered with Calgon Carbon's FILTRASORB® GAC, it is the gold standard in water treatment, offering superior PFAS-removal capabilities.

www.calgoncarbon.com

IPEX USA's Silver-Line® PVC Well Casing and Drop Pipe Withstands Soil and Rock Conditions

IPEX USA LLC produces Silver-Line® PVC Well Casing and Drop Pipe that withstand different well depths and also soil and rock conditions. These products have the industry's IC-2 rating.

The well casing and drop pipe are made of a PVC compound with a cell classification of 12454; available in Schedule 40; SDR 17, 21, 26; and specialty sizing. Drop pipe is available in both Schedule 80 and Schedule 120.

The threaded pipe comes with a plastic cap on each end. Well casing pipe is certified to ASTM F480, with impact ratings of IC-0 or IC-2, depending on the dimension ratio and size.

IPEX is a manufacturer with an NSF-listed PVC well casing that meets or exceeds the IC-2 rating.

www.ipexna.com/en-us

RIDGID® B-500 Transportable Pipe Beveller Produces Quick, Consistent Bevels

The RIDGID® B-500 Transportable Pipe Beveller produces high quality bevels in 45 seconds without flames or sparks.

The compact design quickly mounts to pipe 4 inches and up with a maximum wall thickness of half-inches and creates consistent bevels in a single pass. It produces a machined finish due to six replaceable cutter inserts working simultaneously. Pipe is cool to touch immediately following bevelling.

Patent-pending clamp system firmly secures tool to the pipe. Speed monitoring with LED indicators for optimal cutter performance. Grinding spark-free operation. Adjustable at 1/32-inch increments.

www.ridgid.com

QED Environmental Systems Announces Single-Use Soil Sampler for Analyzing VOCs and PFAS

QED Environmental Systems Inc. announces the new single-use Combo Core™ soil sampler for field preservation VOC analysis.

The Combo Core system is set to succeed the popular Terra Core® soil sampling tool, specifically designed for collecting core samples for VOC analysis using field preservation.

Molded from virgin-grade polypropylene, the Combo Core is the first tool from QED that carries the PFAS-free designation, making it ideal for the collection of soil core samples for PFAS analysis under EPA Method 537M.

The system is also suitable for the collection of VOCs and SVOCs under EPA Method 8260 and EPA Method 8270, respectively.

www.qedenv.com

Van Essen Instruments' TD-Diver Makes Borehole Deployments Easier

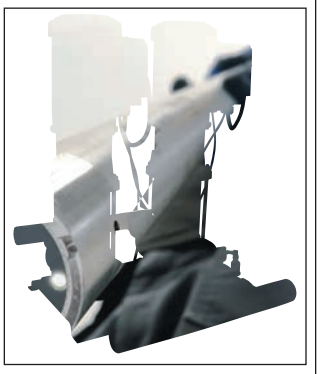
Van Essen Instruments' TD-Diver is a submersible datalogger for long-term, uninterrupted, real-time water level monitoring using a pressure sensor when submerged at a fixed level under the water surface.

The pressure sensor measures the equivalent hydrostatic pressure of the water above the sensor diaphragm to calculate the total water depth. The TD-Diver autonomously measures pressure and temperature and records both in its internal memory. The datalogger is ideal for groundwater and surface water level applications.

It is designed for up to 10 years of use, a solid enclosure to make borehole deployments easier, and its large memory enables users to take a sample every 15 minutes for two years.

www.vanessen.com

Robertson Geologging USA's RGeo-eye® Downhole Camera Views Full Borehole Image



Robertson Geologging USA Inc.'s RGeo-eye® is a full color downward view borehole logging camera (10,000 feet), operating on a 4-core or coaxial cable at a high transmission rate.

Application software supplied with the system enables control of camera functionality and real-time deep subsurface video feed for the operator.

RGeo-eye provides a full 360° image of the borehole and records the complete sidewall or casing, leaving nothing to chance.

www.robertson-geo.com

World's First Bio-Based Ear Plugs from PIP® Are Easy to Fit, Deliver Performance and Comfort

Protective Industrial Products (PIP®) Inc. creates ECOSeries™ Bio-Soft™ ear plugs, the world's first bio-based sustainable ear plugs. The ear plugs' unique stem enables easy insertion with a revolutionary design that requires no rolling and provides an easier, more hygienic fit.

The bio-based materials are made in North America. All parts—the earplug, the cord (PF-30 only), the stem, even the bag—are bio-based. Soft, smooth, low pressure for excellent comfort.

The BioSoft ear plug foam material provides the same fit and performance as conventional polyurethane or PVC materials, but with a lower carbon footprint.

us.pipglobal.com/en

RefrigiWear® HiVis Super Grip Gloves Offer Comfort, Flexibility, and Safety

The RefrigiWear® insulated HiVis Super Grip gloves are the ultimate companion for tackling tough tasks.

Boasting a silicone dot pattern on the palm for superior grip and flexible neoprene, spandex, and mesh back for flexibility, these gloves offer comfort and functionality. With high visibility features and reflective knuckles and fingertips, these gloves will keep workers safe on the job.

The gloves' insulation and fleece lining give workers' hands the protection they need on those seriously cold days. HiVis gloves' reflective knuckles and fingertips offer the added advantage of helping workers be seen while they work.

www.pro.refrigiwear.com

Fully Adjustable StaCool Vest™ Provides All Day Comfort

The StaCool Vest™ Core Body Cooling System presents its fully adjustable over-vests which provide comfort all day long, keeping its wearers cool and productive despite the heat of the day.

Velcro straps at the shoulders, chest, and stomach provide a comfortable fit and unparalleled mobility for wearers of all body types and sizes.

Advanced cooling technology provided by the ThermoPaks keep core body temperatures at safe levels for hours of use. A spare set of ThermoPaks are included with each StaCool Vest to extend cooling time and comfort when the initial set thaws.

Weighing 6½ pounds when fully hydrated, the vest weight is evenly distributed across the worker's body.

www.stacoolvest.com

New DENIOS BatterySafe™ Cases Allow Safe Transporting of Lithium-Ion Batteries

DENIOS-US introduces a complete line of BatterySafe™ cases designed specifically to transport lithium-ion batteries in accord with international regulations.

The batteries are surrounded by cushions filled with Pyrobubbles®, an extinguishing agent which provides protection against thermal runaway and exothermic reactions.

Reusable and easy to use, BatterySafe cases have an operating temperature range from –4°F to 176°F, and a storage temperature range from 60°F to 86°F.

Compliant with international regulations, including special regulation 376; packaging instruction 908 ADR for damaged and defective lithium-ion batteries; special regulation 310; packaging instruction P 910 for transport of prototypes; and special regulation 377.

www.denios-us.com

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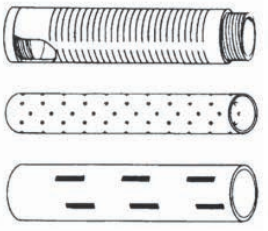

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Put your company's message here!
Classified advertising is a great way to reach the water well industry. Call Sales to make arrangements at 1-800-551-7379 ext 5.

22 BUSINESS OPPORTUNITIES

Sulfur Removal System

If your well has sulfur, that's the rotten smell in your well water, we have the solution. Our system has been working, with no problems for over 30 years in 46 states. It is the least expensive system on the market and does it without adding chemicals to your well water or filters to buy and change. It saves you from buying bottled water, so eventually it will save you enough money to pay for itself.

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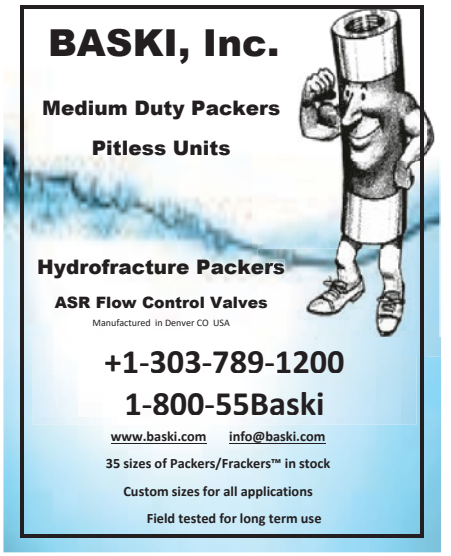
It is a great and profitable business to add to any well business or anyone who just wants to start a business.

Call or email Henry Dickinson at 843-812-3229 or wellservice@gmail.com

184 WELL PACKERS



187 WELL PLUGS

Didn't find what you were looking for?

Try NGWA's Career Center at *careers.ngwa.org* for more opportunities. Whether you are looking for the right job or the right employee, the NGWA Career Center can provide you with an industry-specific listing to hone your search.

Questions?

Call NGWA membership at (800) 551-7379, ext. 1553 or email customerservice@ngwa.org.

DID YOU KNOW?

Water Well Journal classified advertisements appear online (at no additional cost) each month at WaterWellJournal.com.

CHECK IT OUT!

Index of **ADVERTISERS**

We complete a safety tailgate sheet/talk prior to the start of the day/shift change. Every team member must be empowered to speak up or shut down a jobsite due to any safety concerns.

Brad Kirckoff
in "*WWJ* Closeup", page **9**

Setting aside time to regularly inspect the workplace for hazards can help identify shortcomings so they are addressed before an incident occurs.

Alexandra Walsh
in "Hazard Identification and Assessment", page **28**

Many of the same workplace contributors to poor mental health—job demands such as overexertion, workload, pace, repetitive/monotonous tasks, dim/hot/loud work environments—can also increase worker fatigue.

Tim Bauerle, Ph.D.
in "*Water Well Journal* Q&A", page **24**

The well seal is actually even more important than the surface annular seal since it will provide the barrier to potential cross-contamination of poor-quality water between the upper aquifer and the area around the well screen.

Marvin F. Glotfelty, RG
in "Cement or Bentonite Annular Well Seals", page **30**

When complete, the new employee should feel comfortable to start working and you can feel comfortable that they understand the basic hazards of the jobsite and the emergency procedures.

John Fowler, CSP, CMSP
in "New Hire Hazard Training", page **21**

You don't necessarily have to have the biggest air compressor on the market to run your hammer, but it is important to match the hammer requirements with your air compressor as closely as possible.

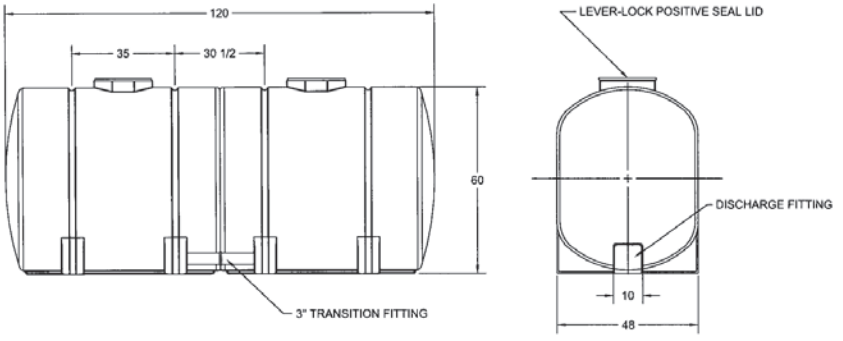
LaTisha Shipman
in "More Troubleshooting Tips", page **34**

WWJ
WATER WELL JOURNAL

The July issue of *Water Well Journal* focuses on geothermal and solar pumps. Look for multiple feature articles on the subjects, including one on the value of the geothermal market to the drilling industry.

Coming Summer 2024

Extra Heavy Duty Polyethylene Leg Tanks



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