Spring 2020

the **FOREFRONT**

A Review of ERDC Publications

**Engineering With Nature
for a wider audience**

**Modeling extreme flows:
a life-saving endeavor**

**ERDC publications
at your fingertips**

**Remotely assessing
ingress locations**

About The Forefront

The Engineer Research and Development Center (ERDC) is the premier civil works engineering and environmental sciences research and development arm of the U.S. Army Corps of Engineers (USACE). As such, it partners with the Army, Department of Defense (DoD), federal agencies, and civilian organizations to help solve our Nation's most challenging problems in civil and military engineering, geospatial sciences, water resources, and environmental sciences.

A special government knowledge center, ERDC Information Technology Laboratory's Information Science and Knowledge Management (ISKM) Branch is critical to ERDC's mission, fulfilling research requirements by offering a variety of editing and library services to advance the creation, dissemination, and curation of ERDC and USACE research knowledge.

Serving as the publishing authority for the ERDC, ISKM publishes all ERDC technical publications to the Digital Repository Knowledge Core, sends a copy to the Defense Technical Information Center (DTIC) and creates a press release about each publication on the ERDC website. *The Forefront* seeks to provide an additional mechanism for highlighting some of our technical publications to the ERDC, USACE, Army, and DoD communities. This publication also encourages those outside ERDC to contact us about using ERDC editing services.

For more information regarding the reports highlighted in this publications or others that ERDC researchers' have created, please contact the ISKM virtual reference desk at erdclibrary@ask-a-librarian.info or visit the ISKM's online repository, Knowledge Core, at <https://erdc-library.erdcdren.mil/>.

—Jennefer Beyl

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Contents

ERDC/ITL SR-17-1

*Publications of the U.S. Army Engineer Research and Development Center
Appendix D: FY19 (October 2018–September 2019)*

Compiled by James A. Dolan. 4

ERDC/CRREL TR-18-16

*Dynamic Modeling of Atmospheric Watch Observatory (AWO) Transport
by Greenland Inland Traverse (GrIT)*

By Arnold J. Song and James H. Lever. 8

ERDC/CERL TR-18-17

*Performance Testing of a Novel Dry-Fog Mold Remediation
and Prevention Process*

By Shane D. Hirschi and Dale L. Herron. 10

ERDC/CHL TR-18-17

*Hydraulic Modeling of Extreme Flows for the White Sands Missile Range
Using Adaptive Hydraulics (AdH)*

By Gary L. Bell, Jeremy A. Sharp, James W. Lewis, Gaurav Savant,
and Jennifer N. McAlpin. 12

ERDC/EL SR-18-8

Engineering With Nature: An Atlas

By Todd S. Bridges, E. Michelle Bourne, Jeffrey K. King,
Holly K. Kuzmitski, Emily B. Moynihan, and Burton C. Suedel. 14

ERDC/CRREL TR-18-20

*Terrestrial Geospatial Remote Assessment for Ingress Locations
(Terrestrial GRAIL)*

By Sally A. Shoop and Wendy L. Wieder. 18

ERDC/CHL TR-18-18

Physical Model Analysis of the Foster Joseph Sayers Dam

By Ben Burnham, Marshall Thomas, and Jane Vaughan. 20

ERDC/GRL TN-18-1

Non-Acoustical Variable Contribution to Military Blast Noise Annoyance

By Nicole Wayant. 22

ERDC/GSL TR-18-33

*Laboratory Evaluation of Next-Generation Backfill Materials and
Methods for Airfield Damage Repair*

By Tyler R. Johnson, Charles A. Weiss, Jr., Lulu Edwards, Jeb S. Tingle,
Whittney S. Harmon, and Trevor J. Talbot. 24

ERDC/ITL SR-18-4

*How to Prepare Technical Publications for the Engineer Research and
Development Center*

By William J. Wolfe. 26

I'm Waiting for My Technical Report to Be Published. Now What?

Help from the ISKM Branch. 28

ERDC/ITL SR-17-1

Publications of the U.S. Army Engineer Research and Development Center

Appendix D: FY19 (October 2018–September 2019)

Compiled by James A. Dolan

Abstract: Publications issued October 2018 through September 2019 by the U.S. Army Engineer Research and Development Center (ERDC) are listed. The publications are grouped according to the technical laboratories or technical program for which they were prepared. Procedures for obtaining ERDC reports are included in the Preface.

<http://dx.doi.org/10.21079/11681/34897>

A much needed compilation . . .

Prior to the formation of the Engineer Research and Development Center (ERDC) in 1999, the Cold Regions Research Engineering Laboratory, Construction Engineering Research Laboratory, Topographic Engineering Center, and the Waterways Experiment Station each produced its own list or index of publications. This practice ended with the creation of ERDC as it was generally thought that the remarkable access to publications via the internet and online library catalogs would satisfy any need for a list of publications.

However, in the 15 years that followed the creation of ERDC, the Executive Office, laboratories, divisions, and branch chiefs requested lists of ERDC publications several times a year. Producing such lists from the Library's online catalog proved to be time consuming as it required running several reports and then piecing them together. Additionally, the format produced by the library system was not aesthetically pleasing and had to be edited.

In 2015, after much discussion, then ERDC Library chief Denise Kitchens approved reviving the list of publications. Compiling began immediately; and in January 2017, the nearly 400-page report, *Publications of the U.S. Army Engineer Research and Development Center: October 1999–December 2015*, was produced as ERDC/ITL SR-17-1. To date, four yearly supplements have followed as appendices to ERDC/ITL SR-17-1, and a fifth is on its way.

The ERDC publication list includes publications from seven laboratories: Coastal and Hydraulics, Cold Regions Research and Engineering, Construction Engineering, Environmental, Geospatial Research, Geotechnical and Structures, and Information Technology. Additionally, it lists many National Program publications.

Each report entry in the publications list contains the report number, date of publication, title and authors, and Defense Technical Information Center accession document (AD) number when available. With the ERDC Library's ability to produce a permanent Digital Object Identifier (DOI) link, links to public release reports were added beginning with Appendix B. Reports with a limited

distribution are not linked.

By providing this yearly update of published reports, the ERDC library is keeping its customers' needs in the forefront while capturing the excellent research and development accomplishments of the ERDC laboratories. This easily digestible reference is the authoritative reports guide on ERDC's impact to the scientific community. □

Article contributed by James A. Dolan, Librarian for the ITL Information Science and Knowledge Management Branch.

The ERDC publication list includes publications from seven laboratories . . . Additionally, it lists many National Program publications.

Links

ERDC/ITL SR-17-1	http://dx.doi.org/10.21079/11681/21022
ERDC/ITL SR-17-1 App. A	http://dx.doi.org/10.21079/11681/22581
ERDC/ITL SR-17-1 App. B	http://dx.doi.org/10.21079/11681/27267
ERDC/ITL SR-17-1 App. C	http://dx.doi.org/10.21079/11681/31406
ERDC/ITL SR-17-1 App. D	http://dx.doi.org/10.21079/11681/34897

Left: The ERDC Library contains over 300,000 items at three sites. The Vicksburg site boasts 14,000+ linear feet of shelving.

Previous: ERDC Librarian Natalie Rich peruses hard copy ERDC reports. ERDC Library staff stand ready to assist with your research needs.

ERDC/CRREL TR-18-16

Dynamic Modeling of Atmospheric Watch Observatory (AWO) Transport by Greenland Inland Traverse (GrIT)

By Arnold J. Song and James H. Lever

Abstract: The National Science Foundation (NSF) plans to install a new Atmospheric Watch Observatory (AWO) to upgrade its research facilities at Summit Station, Greenland. The AWO welded-steel lower frame exceeds the size and weight limits for airlift transport; therefore, the only option to transport it to Summit is the Greenland Inland Traverse (GrIT) by using the newly developed Air Ride Cargo Sleds (ARCS). The study objectives were to determine whether GrIT can safely transport the AWO structure to Summit Station. The study addressed three assembly cases by estimating the transport-induced stresses and structural deformation by using the fi-nite element method (FEM). The present analyses results strongly suggest that a preassembled AWO can safely travel to Summit via GrIT, which would allow NSF to realize cost and schedule savings.

<http://dx.doi.org/10.21079/11681/29508>

Know more . . .

Transporting fuel and cargo to the National Science Foundation's (NSF) remote stations in Antarctica and Greenland is one of the most logistically difficult aspects of those programs. Researchers need facilities and equipment to successfully accomplish their missions. That is why since 2002, CRREL has been working to develop sleds and tractor systems that are as efficient as possible to move equipment and fuel to these remote locations.

Over the years, both the Greenland Inland Traverse (GrIT) and the South Pole Traverse (SPoT) have successfully transported living accommodations, science modules, vehicles, fuel bladders, and prefabricated buildings to their respective stations. The challenge came, though, when NSF considered how to transport the new Atmospheric Watch Observatory (AWO) to Summit Station, Greenland. The facility was too large for air transport, so traverse was the only option. But would the structure survive the challenging journey?

Dr. Arnold Song and Dr. James Lever set out to determine this. Previous studies have included physical and field modeling, but they created the first numerical simulation of a sled like this. By doing so, they could

determine what stresses would result from this trip for different configurations of the proposed building. The conclusion? The transport would produce stresses less than the design stresses that the building was made for.

As Dr. Lever explained, assembling the structure in the U.S. and transporting it by traverse rather than building it under harsh conditions in Greenland is more efficient. It saves labor and does not have the same time restrictions. Therefore, by investing in analysis, NSF can save cost in fabrication.

While the AWO project is currently on hold, this work created a modeling technique that can be used for any type of building or cargo that NSF (or the military) wants to transport directly over the snow. This is a major boon for NSF as they look to upgrade their stations in the future.

Through innovative research like this, CRREL continues to advance its mission of providing support, specifically in the polar regions, to other branches of government. □

Article contributed by Emily B. Moynihan, Writer-Editor for the ITL Information Science and Knowledge Management Branch.

Top: A Halley VI module being towed into place at the Halley Research Station of the British Antarctic Survey. This module is structurally similar to the proposed AWO building and as designed to be towed on the skis attached to their telescoping legs.

Middle: A three-dimensional rendering of the planned AWO building installed at Summit Station (designed by AECOM). Four telescoping legs support the building through a lower, structural space frame. The building could be preassembled to include upper frame and exterior insulated panels prior to GrIT transport.

Opposite: The AWO lower frame, a welded assembly of structural steel tubing (colors show the range of stresses from static self-weight of the frame as determined in the present analysis).

ERDC/CERL TR-18-17

Performance Testing of a Novel Dry-Fog Mold Remediation and Prevention Process

By Shane D. Hirschi and Dale L. Herron

Abstract: Mold is an ongoing problem for Army installations and contingency basing locations. This work was undertaken to demonstrate the effectiveness of a two-step dry-fog mold remediation process technology to remove mold spores and provide long-term mold prevention in two buildings at Fort Campbell, KY. Treating each test building took 5 to 6 hours and included: mobilization, air and surface sampling before and after the application, and demobilization. This work concluded that the dry-fog technology provides rapid and quantifiable improvements to indoor air quality, and reduces exposure of personnel to harmful chemicals resulting from current mold remediation practices. Results indicated that the dry-fog technology could potentially support mold remediation needs resulting from indoor air quality maintenance and from natural hazards. Current rough estimates for application of the dry-fog technology are approximately \$1.00/sq ft. Early project results were shared with Region IV of the Federal Emergency Management Agency (FEMA) and the Huntington District of the U.S. Army's Corps of Engineers.

<http://dx.doi.org/10.21079/11681/29685>

An innovative solution . . .

If moisture is present, so usually is mold, and without preventative measures or proper treatment, mold can render a building unoccupiable. That is why the successful demonstration of this two-step, dry-fog mold remediation and prevention technique from the researchers at the Construction Engineering and Research Laboratory (CERL) is so exciting.

Both commercial and residential mold removal products often address only visible mold, leaving the mold spores—and making the return of the problem only a matter of moisture plus time. But this new dry-fog treatment eliminates both visible mold and mold spores even in porous materials and other spaces that liquid products cannot reach. It is also less expensive, less labor-intensive, and less hazardous to maintenance personnel and building occupants.

Mold is an ongoing problem for military installations, and while eliminating sources of moisture does prevent mold growth, doing so in the real-world application of an active base can be difficult. People like to set their heating and air-conditioning for their own comfort, as opposed to maintaining optimal settings to prevent mold growth. Maintenance personnel might not follow the proper procedures for the application of antifungal chemicals—which means more mold in the future. Finally, the application of the chemicals themselves requires strict adherence to health and safety guidelines, and they take time and multiple personnel to apply.

Enter this dry-fog application system. Through a partnership between the Engineer and Research Development Center (ERDC) and the Army Office of the Assistant Chief of Staff for Installation Management's Installation Technology Transfer Program (ITTP), CERL researchers demonstrated that the technology developed by commercial partner Pure Maintenance was a viable and cost-effective method of treating and preventing mold.

Researchers chose two buildings at Fort Campbell in Kentucky for the ITTP demonstration, and over the course of eight months tested the efficacy of the dry-fog treatment on 6500 sq ft of interior area with high levels of mold. Even after six months, the treated area's mold level was still below background levels. In one dramatic bit of data, researchers found that while the outdoor mold spore count for the first test building increased by 3,120% over the six-month period, the treated space's spore count decreased by 95.21%.

Stachybotrys (commonly known as "black mold") and Chaetomium (a mold associated with a number of health problems, including fibromyalgia and Lyme disease) spores

were found at the staggering level of 27,767/m³ of air in the first test building before treatment. After treatment, there were zero. Even after six months had passed, there were still zero. The test results for the second building were similarly impressive: outdoor/background total mold spore count increased by 545.2%, but the treated space decreased by 99.45%.

The dry-fog treatment itself is so effective in part because of the small size of its particles: a mere 6–8 microns. These tiny particles envelope the mold spores, and because of their miniscule size can fully penetrate all spaces and porous materials in a way that current mold removal products just can't. Which means more effective, longer-lasting remediation, higher indoor air quality, and healthier living and working spaces.

The dry-fog treatment system is completely mobile, and one person can treat a 2000 sq ft facility—including mobilization and demobilization—in just three hours. It's inexpensive, too. Compared to traditional mold removal processes, it costs less at \$0.90–\$1.20/sq ft. (Current commercial mold remediation can easily run over \$20/sq ft.) And most importantly, the dry-fog treatment drastically reduces exposure of building occupants and maintenance workers to the harmful chemicals of traditional mold removal treatments.

So what's next? Researchers are excited to test the treatment on new construction as a preventative measure and current construction as a twelve- or even twenty-four-month treatment. In the near future, a two-step, dry-fog mold remediation treatment system may be on military installations around the world, helping to maintain the structural integrity of our buildings and the health and safety of our personnel. □

Article contributed by a staff writer for the ITL Information Science and Knowledge Management Branch.

Left: Air and surface sampling equipment.

Left top: Equipment to apply the dry-fog treatment.

Left bottom: Dry-fog being applied via spray nozzles in Bldg. 6733.

ERDC/CHL TR-18-17

Hydraulic Modeling of Extreme Flows for the White Sands Missile Range Using Adaptive Hydraulics (AdH)

By Gary L. Bell, Jeremy A. Sharp, James W.
Lewis, Gaurav Savant, and Jennifer N. McAlpin

Abstract: The River Engineering Branch of the U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, conducted a two-dimensional numerical model investigation of the White Sands Missile Range located approximately 24.1 kilometers east of Las Cruces, NM. The range has experienced flooding within the installation during past large rainstorm events. The floodwater flowing easterly from the Organ Mountains overtops the levee that protects the installation for extreme events in some locations. The installation becomes more flooded with increasing values of storm return period (e.g., 100-year, 500-year). Plans consist of raising the levee elevation in critical locations as well as extending the levee in other areas. Numerical calculations indicated that raising the existing levee by approximately 0.5 meter and adding an extension on the northern portion of the installation as well as a standalone levee south of the installation eliminated flooding from 100-year events.

<http://dx.doi.org/10.21079/11681/31337>

A chat with the author . . .

While conducting this research and coming up with a resolution, author Gary Bell explains that not everything went according to plan. Going over Mr. Bell's responses to a few questions we had about this research, one stood out because of how relatable and frustrating the circumstance. When asked if anything happened during the course of this research that was out of the ordinary, Mr. Bell stated "BACK UP PROJECT DATA!" He dropped the external drive that contained all of the numerical simulations, which then could not be retrieved. To make matters worse, he says "I did, however, have a sticky note on my desk that I had written just days before I lost the data that said... BACK UP PROJECT DATA!" Keep reading to see the rest of his responses about this important research.

QUESTION: What do you think this research could be used for in the future?

ANSWER: The work presented in this Technical Report provides critical information in regards to levee modifications surrounding the White Sands Missile Range that would protect the installation from flooding during storm events. It could also prove to be useful in similar potential modeling efforts in that the methodology presented in this report could be duplicated.

Q: Is this research still ongoing?

A: Yes, in the sense that here at the Coastal and Hydraulics Laboratory we are always seeking to make improvements to our modeling capabilities as well as efficiency. Although this project is complete, we will continue to pursue the ERDC mission by helping to solve our Nation's most challenging problems.

Q: If you could do it over, would there be anything you would do differently to get your results?

A: I would back up my data!!

Q: How do you envision this research keeping ERDC ahead of the game?

A: The model was difficult in that it was required to capture flow correctly coming down from the Organ Mountains located just west of the installation. The model was very large and required a hefty amount of processors utilized by the High Performing Computers (HPC). Without the use of the HPC to run the numerical code, this model study would have been nearly impossible to complete.

Q: What was your favorite part of doing this research?

A: I enjoyed getting the model results and being able to provide recommendations to the White Sands Missile Range in regards to levee modifications. These potential adjustments (either alterations or elevation adjustments or both) are important to increasing the level of protection the installation receives from the levee. It is exciting to get the

Above: The main flood control features for the White Sands installation.

Opposite: The White Sands Missile Range (left) and a 1978-year event (right).

model results, interpret them, and turn that data into information that can be used to make decisions.

Q: Why is this research so important?

A: In the past (1978), there was a road that overtopped when the water got to a certain stage during a major rainfall event. During this storm, a military policeman lost his life attempting to provide aid to another vehicle that was in danger of being washed away. What we do here at ERDC is provide solutions to problems that help people and save lives. It is important that we continue our research and model development in order to continue to meet this objective. □

Article contributed by Karen Taylor, Writer-Editor for the ITL Information Science and Knowledge Management Branch.

ERDC/EL SR-18-8

Engineering With Nature: An Atlas

By Todd S. Bridges, E. Michelle Bourne, Jeffrey K. King,
Holly K. Kuzmitski, Emily B. Moynihan, and Burton C. Suedel

Abstract: The Engineering With Nature (EWN) initiative formally began in 2010 within the US Army Corps of Engineers. EWN is the intentional alignment of natural and engineering processes to efficiently and sustainably deliver economic, environmental, and social benefits through collaboration. The initiative is building upon good past practices while advancing current and future capabilities that support more sustainable water resources practices, projects, and outcomes. Over the years, EWN has grown to include a number of partner organizations and collaborators in the US and abroad. This book highlights successful projects and the contexts in which these projects were developed; it also introduces the reader to the wide range of organizations advancing worldwide progress in this field today. Through its striking project photographs and its brief narrative descriptions, the book gives interested readers and practitioners alike a tangible sense of the potential to engineer with nature.

<http://dx.doi.org/10.21079/11681/27929>

Ms. Michelle Bourne managed the publication project. “The USACE EWN initiative as a whole enables more sustainable delivery of economic, social, and environmental benefits associated with water resources infrastructure (referred to as a triple win).” She continued, “This publication was the first of its kind, not just for ERDC, but for the USACE. The *Atlas* provides 56 successful EWN projects as proof-of-concept. The case studies will hopefully give ERDC researchers reassurance to aim for the ‘triple win’ and fully consider natural infrastructure solutions when dealing with flood defenses and ecosystem restoration projects in lieu of traditional approaches.”

Kuzmitski and Ms. Emily Moynihan. “I positioned myself with experienced team members that worked extremely well together to ensure the project goals were met.” While EWN is a USACE initiative, started in 2010, nature-based

solutions are happening globally. Therefore, the team compiled case studies from both USACE and international organizations. Kuzmitski tirelessly assembled, edited, and rewrote (and translated, in some cases) content. Moynihan designed the book and curated the images. The result is an aesthetic and well-written book that effectively communicates the success and future of EWN projects.

To celebrate the publication, Dr. Todd Bridges, EWN National Lead, organized a book launch in Washington, DC. Attendees were enthusiastic and eager to praise the book, and printed copies were in high demand. Mr. James Dalton, the Director of Civil Works for USACE, spoke: “The challenge for the Corps is trying to explain what a project’s total value is. With the *Atlas*, we

“With the Atlas, we communicate the multiple benefits—social, economic, and environmental—EWN projects deliver.”

—Mr. James Dalton, Director
of Civil Works for USACE

communicate the multiple benefits—social, economic, and environmental—EWN projects deliver.”

“Nature offers us so many solutions to minimize flood risk,” said Catherine Wright of the United Kingdom Environment Agency. “A publication like this book gives us, in a very digestible format, a clearer picture of what we mean when we say this.”

The EWN initiative is already planning a second volume of the *Atlas* in 2020 as part of the 10th anniversary of the EWN initiative.

For ore about the *Atlas*, visit www.engineeringwithnature.org. □

Article contributed by Emily B. Moynihan, Writer-Editor for the ITL Information Science and Knowledge Management Branch.

Previous: The USACE Philadelphia District pumps sand onto Brant Beach, NJ, in 2013. The work is part of an effort to restore the coastal storm risk management project from damages associated with Hurricane Sandy. (Photo by USACE Philadelphia District)

Left: Mr. James Dalton (upper) and Dr. Todd Bridges (lower) speaking at the DC book launch in January 2019.

Bottom: An aerial panoramic view of Missouri River Levee L-575, 2012. (Photo by Dave Crane, USACE Omaha District)

ERDC/CRREL TR-18-20

Terrestrial Geospatial Remote Assessment for Ingress Locations (Terrestrial GRAIL)

By Sally A. Shoop and Wendy L. Wieder

Abstract: The Terrestrial Geospatial Remote Assessment for Ingress Locations (GRAIL) portion of the Army Terrestrial Environmental Modeling and Intelligence System Science and Technology Objective–Research (ARTEMIS STO-R) program was developed to use remote methods of terrain analysis to search for areas suitable for vehicle or aircraft maneuverability, based on slope, roughness, vegetation, soil type, and wetness, and to also perform direct classification of imagery based on soil strength. The product of the GRAIL project was a software program entitled GRAIL Tools. Using a series of filters, GRAIL Tools first eliminates areas of unsuitable slope, land use, obstacles, and vegetation. The algorithms for these filters, using both unsupervised and supervised classification approaches, were applied and trained by a limited amount of ground truth strength measurements to improve GRAIL Tools' site selection capabilities. GRAIL Tools then searches for sites that meet geometric criteria for landing and drop zones, the final result being a map of potential landing and drop zones superimposed over satellite imagery. The first generation of GRAIL Tools has proven capable of identifying austere landing and drop zones using remote assessment techniques. GRAIL Tools has been integrated in to the U.S. Army's Situational Awareness Geospatially Enabled (SAGE) software platform.

<http://dx.doi.org/10.21079/11681/29927>

Top: Soil strength in terms of California Bearing Ratio (CBR), left, calculated using United Soil Classification System (USCS) soil class, middle, and the soil moisture data from GeoWATCH, bottom..

Promoting agility . . .

The U.S. Army supports missions across the world, which means that it can find itself in any type of environment at any time. When entering new locales, troops need to know exactly what kind of terrain they will encounter and how that will affect their mobility. This assessment can be complicated and dangerous, especially in hostile areas. Therefore, the Terrestrial Geospatial Remote Assessment for Ingress Locations (GRAIL) portion of the Army Terrestrial Environmental Modeling and Intelligence System Science and Technology Objective–Research (ARTEMIS STO-R) program worked to create GRAIL Tools, a program for remote terrain analysis. With this software, users can find areas suitable for vehicle or aircraft maneuverability and can eliminate terrain that does not meet certain requirements.

To assess and corroborate remote data, researchers leveraged opportunities to gather field data. The desert field work for this project was atypical for many researchers at the Cold Regions Research and Engineering Laboratory (CRREL). “Reviewing field books from the desert southwest,” said Wendy Wieder, “I was surprised to see a note that one of the researchers ‘almost stepped on a sidewinder.’ Not a typical hazard CRREL researchers encounter.” However, because mobility is a global issue, there are endless possibilities of where extensions of this project may go; and new efforts will be continuing this work into the far north.

The GRAIL project allowed researchers to collaborate across a wide range of fields: pure science to applied engineering, pavements and geotechnical work, modeling to remote sensing, and machine learning to satellite imaging of ground surfaces. This diversity created an engaging experience for the researchers, a robust deliverable, and a foundation for future work. “This work provided an initial platform to help incorporate remote sensing into models that can help guide planners on various siting issues for mobility purposes,” Wieder explained. “We can’t be everywhere. We need to be able to focus efforts to ensure the best use of resources for mobility planning for U.S. military operations.” GRAIL Tools accomplishes that. □

Article contributed by Emily B. Moynihan, Writer-Editor for the ITL Information Science and Knowledge Management Branch.

Top: WV3 image of an open field with intermittent trees (top). The 10 m (33 ft) land classification suitability filter does not identify trees, such as the two circled in red, and therefore classifies the area as a “suitable” region (middle). The 1 m (3 ft) land classification suitability filter includes the trees correctly in a therefore “unsuitable” region.

ERDC/CHL TR-18-18

Physical Model Analysis of the Foster Joseph Sayers Dam

By Ben Burnham, Marshall Thomas, and Jane Vaughan

Abstract: Concrete degradation issues due to riprap entrainment have been observed in the stilling basin at Foster Joseph Sayers Dam. This entrapment occurs during normal flows. The original stilling basin has experienced excessive degradation, and repairs to restore it to original specifications are needed. A physical model study has been performed to determine the flow characteristics of the stilling basin and to develop a design modification to minimize riprap entrainment. The riprap originates in an area that could be replaced with a concrete pad to prevent further riprap entrainment in the stilling basin. A final stilling basin design modification recommendation is provided.

<http://dx.doi.org/10.21079/11681/31365>

Left: A movable bed exit channel with a discharge of 2,000 cfs.

Right top: Foster Joseph Sayers Dam and Outlet Works (Google Earth).

Right bottom: A dry bed view looking upstream of the movable bed exit channel.

An author's insight . . .

The analysis is complete, recommendations made, and the research published. With the success of his first physical model project, author Benjamin Burnham was willing to let us in on a few details that we did not see in this published report.

QUESTION: Was there anything out of the ordinary that happened during this research that did not make it into the report?

ANSWER: I wouldn't say anything out of the ordinary happened with this research other than it was very difficult to determine the location that the rip rap was coming from that was being entrapped in the stilling basin to begin with. Along with our recommendation, we provided the district with a couple of theories of where the rip rap might have come from, but more field tests would need to be completed to help justify those theories.

Q: What could this research be used for in the future?

A: Rip rap and debris, in general, being entrapped in stilling basins and causing damage is a known issue with many dams across the Corps. This research could be reviewed by other projects with similar issues to determine if our recommendation would also be applicable to them. The physical model was also designed so that other projects Outlet Works stilling basin could easily be installed to perform more research. Furthermore, it's possible the guidance for Outlet Works dams might be updated in the future due to the outcomes of the research.

Q: Is this research still ongoing?

A: No, in fact the district is satisfied to the point they are currently drafting plans and construction specifications to modify their existing stilling basin from our recommended stilling basin design change.

Q: If you could do it over, would there be anything you would do differently to get your results?

A: One theory we gave to the district is rip rap could be getting pulled from the upstream of the gate structure, through the structure, and into the stilling basin. I would like to appropriately build the upper approach channel with actual scaled rip rap identical to what we did on the exit channel, to determine if this is possible or not. With the space and time available, we were unable to make this modification during actual testing of the dam.

Q: How will this research keep ERDC ahead of the game?

A: This type of research is why ERDC is and should maintain to be one of the premier physical modeling experts in the world. We have the experts and facilities to perform these types of large scale models that a computer program cannot perform for you.

Q: What was your favorite part of doing this research?

A: Being that this was my first physical model project, I enjoyed learning about all the different aspects that it takes for a physical model to be designed, tested, and concluded appropriately. I very much look forward to creating more physical models for more of our customers. □

Article contributed by Karen Taylor, Writer-Editor for the ITL Information Science and Knowledge Management Branch.

ERDC/GRL TN-18-1

Non-Acoustical Variable Contribution to Military Blast Noise Annoyance

By Nicole Wayant

Abstract: Every year the U.S. military faces training curfews, restrictions, and range-closures as a result of community annoyance to military blast noise. Indeed, training restrictions due to noise is one of the factors predicted to negatively impact military installations out to 2025. Several factors other than noise exposure can contribute to an individual's annoyance to noise. In fact, non-acoustical variables, such as an individual's ability to habituate to noise or their personal feeling of importance towards the noise source, can have an equal or larger impact upon noise annoyance than the noise itself. Most of the studies that pertain to non-acoustical variables contributing to noise annoyance have focused on airplane, road, railroad, or wind turbine noise. While the results of these studies have been similar, there have been a few differences in the relationship between non-acoustical variables and noise annoyance based on the noise type. Additionally, none of the annoyance studies focused specifically on non-acoustical variable contribution to annoyance for military blast noise.

The examined coefficients that contributed the most to the predication of probability of annoyance were as follows: Neighborhood Noise, Frequency of Blast Noise, Noise Awareness, Noise Sensitivity, Habituation, and Installation Importance, with Noise Sensitivity having the largest coefficient. Sleep Disruption and CDNL both had relatively small coefficients. The demographic variable House Type was not significantly correlated with annoyance. In order to predict probability of annoyance, it is recommended to use the non-acoustical variables Noise Sensitivity, Neighborhood Noise, Frequency of Blast Noise, Noise Awareness, Habituation, and Installation Importance.

<http://dx.doi.org/10.21079/11681/29534>

Improving understanding . . .

Blast noise from military bases directly affects public perception of that base, often in a negative way. However, exposure to the noise itself is not the only factor that contributes to an individual's annoyance. Researcher Nicole Wayant of the Geospatial Research Laboratory (GRL) set out to study the role of specific non-acoustical variables on noise annoyance, and her results suggest that the largest contributor to a community's level of annoyance with military blast noise might not be the noise itself, but rather these non-acoustical factors.

Pinpointing which factors contribute most strongly to the probability that an individual will be annoyed by blast noise will have far-reaching effects for military installations. Wayant's hope is that creating a more accurate prediction model will help prevent or mitigate training curfews, restrictions, range closures, and even some lawsuits. This potential for saved money and saved time is part of why Wayant's superiors were so interested in her results. As Wayant explained, "My division chief retired from the army as a colonel. Due to her military experience, she had a lot of questions and opinions about what made individuals annoyed." Wayant believes that, armed with this new data, installation managers will be better prepared in their efforts to balance public opinion and personnel readiness.

Part of what makes Wayant's research unique is that previous models had not included the frequency of blast noise or the local community's perception of the military installation, producing inaccurate predictions of the percentage of people who are likely to be highly annoyed (or %HA) by a particular noise. Using data from a community survey originally part of a Strategic Environmental Research and Development Program (SERDP) project, Wayant found that the non-acoustical variables of frequency of blast noise, house type, sleep deprivation, habituation, and installation importance (that is, how important people felt the installation was to their community) were significantly correlated to %HA. House type (whether someone lived in a single-family detached home, multifamily home, mobile home, or other type of house) as a variable was particularly surprising, as previous studies had shown that it does not contribute to level of annoyance.

"It was fascinating to me that the actual level of noise was one of the smallest contributing factors to military blast noise annoyance,"

—Nicole Waylant,
GRL researcher

In keeping with previous models, the largest contributor to the likelihood that a person was annoyed by military blast noise was noise sensitivity. On the opposite side, habituation (or how much an individual felt they could get used to the noise), noise awareness (or how knowledgeable an individual was that the noise had occurred), and installation importance all decreased the likelihood that a person was annoyed. Most interestingly, the results of the data analysis raise questions about whether the noise itself is the largest contributing factor to %HA. Wayant herself was surprised by the result. "It was fascinating to me that the actual level of noise was one of the smallest contributing factors to military blast noise annoyance," she

said, although further research will be needed to understand the exact role the noise itself plays in the probability of annoyance.

In future studies, Wayant would like to use ordinal analysis to complement the Pearson's correlation analysis (a measure of the strength of association between variables) she used here, since including some ordinal analysis of the data would catch any significant factors that this study may have missed. She would also like to survey military personnel about their responses to and opinions on blast noise to find out the effect that noise annoyance has on the people living at the installation. It could be that, because of the significance of factors like installation importance, military personnel give very different responses from the community at large. Studies have focused on only the surroundings communities' opinions, which is why the idea of surveying the military personnel is so interesting to Wayant. Combined with the data from this study, it could point the way for new initiatives to educate the community about the importance of the military installations, leading to fewer range closure and training restrictions. Overall, Wayant's findings fill a gap in the data on the role of non-acoustical variables in noise annoyance for military blast noise, and they highlight several exciting avenues for future research. □

Article contributed by a staff writer for the ITL Information Science and Knowledge Management Branch.

Opposite: Pinpointing annoyance factors helps mitigate community concerns.

ERDC/GSL TR-18-33

Laboratory Evaluation of Next-Generation Backfill Materials and Methods for Airfield Damage Repair

By Tyler R. Johnson, Charles A. Weiss, Jr., Lulu Edwards,
Jeb S. Tingle, Whitney S. Harmon, and Trevor J. Talbot

Abstract: During the period March through October 2016, research was conducted at the U.S. Army Engineer Research and Development Center in Vicksburg, MS, to develop alternative backfill materials for rapid airfield damage repairs using a variety of commercially available products. The performance of a variety of additives, including 15 traditional and nontraditional materials, and a control comprised the test matrix of stabilization additives. The types of additives included cement, polymer, polyurethane, petroleum emulsion, and silicates. This report presents the technical evaluation of the laboratory and field performance of alternative backfill materials used in the subgrade of concrete repairs using Rapid Set Concrete Mix. The additive performance criteria focused on bearing capacity, unconfined compressive strength at two hours and at seven days, and durability of the specimen when partially submerged in water. Laboratory testing included mixing silty, clayey sand soil with each of the additives at specified application rates; compacting; curing; and conducting unconfined compressive strength and California Bearing Ratio testing. For the field evaluation, a repair consisted of preparing the subgrade with a selected additive and overlaying it with Rapid Set Concrete Mix. Passes-to-failure rates for each repair were determined by using an F-15E load cart at a maximum of 3,500 passes.

<http://dx.doi.org/10.21079/11681/31445>

Expedited solutions . . .

An airfield with severely damaged pavement cannot function. Whether it is a crater from a large blast or many small ones from multiple munitions, damaged pavement needs quick, effective repairs to return to operation.

But filling a hole in the pavement, even a small one, is not so simple when that pavement has to endure the weight of a fully loaded F-15E aircraft. And when a base is recovering from an attack, minimizing the time spent bringing it back into operation is crucial. Enemy bases seized by friendly forces, too, may need repairs, and damage due to natural disasters or accidental causes are no less exigent for being noncombat scenarios. Finally, repairs need to last. Base technicians cannot afford to be refilling holes in the pavement every two weeks—never mind the requisite curing time that takes a runway out of operation.

In this study from the Geotechnical and Structures Laboratory (GSL), researchers first gathered forty cubic yards of soil to use for their tests. They chose commercially available additives for soil strengthening in both liquid and powder form, including cement, polymer, polyurethane, petroleum emulsion, and silicates. They prepared the additives according to manufacturers' guidelines, mixed them with the soil, and added water at three levels: optimum moisture content, two percent below optimum, and two percent above. The result was hundreds of sample mixtures for quickly creating a lasting pavement repair with enough compressive strength to handle an aircraft. Their goal was to find the cheapest, strongest mixture that was quick and easy to make, quick to reach load-bearing strength, and durable enough to last. So they got to testing.

They tested each mixture at two hours of curing time and again at seven days to determine which ones held the most promise, and all of the additives proved capable of increasing the performance of the soil itself. However, some products yielded superior compressive strength at two hours only to fall behind others at seven days, and all of the additives required careful calculation depending on the silt, clay, sand, and moisture in the soil. In the end, though, they were able to select the top five strongest, longest-lasting products and perform a field evaluation. These five additives were Portland limestone cement (PLC); Rapid Set Concrete Mix, a calcium sulfoaluminate from CTS Cement; Base-Seal, a soil additive from Base Seal International, with lime; RR 600 Soil Stabilizer Polymer, a soil additive from HMI, at reduced concentration; and Soil-Sement Engineered Formula, a soil stabilizer from Midwest Industrial Supply. For a control, the researchers used a full-depth flowable fill (a grout-like cement).

Unfortunately, even after all the strength tests and durability tests and even California Bearing Ratio tests (a test designed to provide an index strength for materials), the researchers concluded that there is no one, single additive or ratio that will work in all airfield repair scenarios. Even using the most common soil type in the world as they did—silty sand—does not guarantee a cure-all formula.

The value in the study lies, however, in the GSL team's data: hundreds of tests with hundreds of ratios providing strength and durability information for each mixture at two hours and again at seven days. It fills a tremendous gap in the literature about the actual performance of potential airfield damage repair solutions. Their data provide important new information in the form of precise, detailed testing of how each material performs under rapid exposure and curing. Most importantly, their study gives the exact numbers for each solution type—how much to reduce the polymer or chemical additive if the soil has a high water content, how much to mechanically mix the soil to evaporate moisture, what percentage of PLC to use per dry weight of soil—the list goes on.

The next step for the GSL researchers is performing the same study with longer cure times, such as twenty-eight days, alongside more field tests, to determine if one particular mixture does, in fact, rise above the rest. They would like, too, to test the various additives and formulas on less common soil types so that no matter where an airfield is in the world, repair technicians have the exact formula they need to get it up and running as quickly as possible. For now, though, these data give installation managers a variety of options with proven strength and proven durability. Just one more example of ERDC research making a tangible impact in the field. □

Article contributed by a staff writer for the ITL Information Science and Knowledge Management Branch.

Opposite left: Compacted soil specimen for 2-hour testing.

Opposite center: Soil sample with RR 600 (reduced amount) additive after 7 days of soaking.

Opposite right: Scanning electron photomicrograph of silty, clayey sand with Soil Sement (2-hour cure).

ERDC/ITL SR-18-4

How to Prepare Technical Publications for the Engineer Research and Development Center

By William J. Wolfe

Abstract: U.S. Army Engineer Research and Development Center (ERDC) researchers are required to document and publish the results of U.S. Department of Defense (DoD) funded research and development projects, both for purposes of public accountability and technology transfer. The ERDC publication series provides one avenue for researchers to create professional quality publications that meet the demands of sponsoring organizations and regulatory requirements. This updated author's guide, which supersedes ERDC/ITL SR-04-1, guides principal investigators or lead writers through all phases of document preparation.

<http://dx.doi.org/10.21079/11681/32004>

An author's best friend . . .

Whether you're trying to publish your first ERDC document or your fiftieth, this new guide developed by Mr. William J. Wolfe is your definitive resource for any and all aspects of the writing, editing, and publication process here at ERDC. With input from the editing staff, ISKM (Information Science and Knowledge Management Branch) leadership, and ERDC leadership, Wolfe oversaw the complete overhaul of the guide, which covers all document series, report content, and even special workflows and distributions for things like conference proceedings and journal articles previously published elsewhere.

The guide walks principal investigators—and anyone else involved in the writing, editing, or publication of ERDC research—through the process from start to finish, beginning with the planning phase and ending with the final dissemination of the completed project. It offers descriptions of each type of document to help you decide whether your research is best published as a special report or a technical note, for example, and shows you how to take that book chapter and turn it into a miscellaneous paper. Since all ERDC researchers are required to publish the results of their DoD-funded projects, it's an essential reference for ERDC scientists and engineers.

Further, the guide provides detailed information about the publication sequence, so you as the author know who is responsible for each step and what to do next if you're not sure. It offers advice on composing your report with your audience in mind as well as a plethora of samples so you can see exactly how your document is going to look on the published page. It includes a section of frequently asked questions and an extensive sample bibliography so you can ensure that all of your sources are properly cited. From abstracts to appendices, *How to Prepare Technical Publications for the Engineer and Research Development Center* has the answers.

For more information on how to turn your technology or project into an ERDC publication, contact the ISKM staff at erdclibrary@ask-a-librarian.info. □

Article contributed by a staff writer for the ITL Information Science and Knowledge Management Branch.

Left: ISKM branch members at their 2018 on-site branch meeting in Vicksburg, MS.

Frequently Asked Questions

Q: I've already published my results as a journal article. Do I still need to publish it with ERDC?

A: Yes. Simply send the ERDC Library a PDF copy of the peer-reviewed and accepted journal article. (That is, the camera-ready proof, not the copyrighted final version.) With the author's permission, library staff will archive the article and send it to DTIC in accordance with the DoD Public Access Plan (DoD 2015). You can even request a 12-month embargo from the date of publication on the ERDC Library copy, free of charge.

Q: Can I substitute a short summary of my results in a technical note (TN) to the sponsors instead of publishing a TR?

A: Unfortunately, no, a TN cannot serve as the sole close-out documentation for any DoD-sponsored research. In fact, the TR is the only ERDC publication that can serve as the sole documentation of DoD-sponsored research. While other types of documents may accompany and be published as a result of the research's findings, a TR is used to document the final results of a project.

Q: When writing up my research, what style guide and referencing format should I use?

A: There are so many out there! ERDC uses Chicago and Chicago's author-date referencing style. And remember: you can always ask a librarian or one of ERDC's editors if you have questions!

Q: Can I reference material that is still in draft form?

A: Unfortunately, no. All the draft content is subject to change and, in fact, may never be published at all. Citing it would introduce errors to your document and might well refer your readers to a source that does not exist.

Q: Where do I even start if I want to get my document published?

A: The publication guide has a complete rundown of each and every step of the process, including who is responsible for what, but the short answer is to contact the ERDC editing staff! The editors are there to help you figure out what you need to get the process started, whether it's how to get funding or whose signatures you need to get things moving.

I'm Waiting for My Technical Report to Be Published. Now What?

Help from the ISKM Branch

So your report has gone through peer review and you're waiting for it to go through the final editing, formatting, and publication process so you can get your research out there. Did you know that there are a variety of other ways you can share your results in the meantime? Increased research dissemination means increased opportunities for collaborations, so consider some of these options the next time you're thinking about outreach.

Audio

Did you know ITL has a podcast service available for researchers? They're looking for anyone interested in sitting down for a brief (five minutes or less) interview about the state of their research—especially if you have some exciting preliminary results! This service is available to researchers wherever they're based, so don't worry if you're not in Vicksburg. Just head over to <https://livestream.erdcdren.mil> and click on Request Media Work. Fill out the form, and a member of the team will contact you to set up the interview.

Video

Most people think of YouTube when they think of published videos, but the JoVE Science Education Library is another option if you'd like a professional-quality video article that will be published online and indexed in PubMed/MEDLINE, Web of Science, SciFinder, and Scopus. JoVE handles all aspects of the video production process, including filming and editing. All you need to do is submit your original manuscript. Contact the ERDC Library or go to <https://www.jove.com/publish> for more information.

And right here at ERDC, you can also request a video project from the same team that coordinates our podcasts. It's the same process as the one mentioned above. Go to <https://livestream.erdcdren.mil> and click on Request Media Work. Fill out the form, and a member of the team will contact you to get rolling.

Finally, the Public Affairs Office runs ERDC's official YouTube channel, and the staff there are always excited for new opportunities to share ERDC's research with the world! If you think your project could benefit from a little cross-promotion, contact David Jackson, David.W.Jackson@usace.army.mil.

Text

Getting that journal article acceptance is always exciting, but that's not the only way you can publish your results. While many researchers already know that journal articles can be turned into miscellaneous papers and published by ERDC, you may not know that you can publish your data set as a miscellaneous paper, too. So long as the data set has already been peer reviewed as part of your full report, you can publish it separately as is in a miscellaneous paper while you wait for the technical report to come online.

And don't limit yourself to peer-reviewed journals. Writing for nontechnical audiences is another invaluable way to increase STEM engagement and literacy—and the change of format might be just the thing to help you think about your own research in a new way!

Opposite: There are many ways to share your work with the world!

Presentations

When people think of presenting their research, many think first about conference papers, but have you considered submitting a workshop, seminar, or panel proposal? These three options are a more interactive way of presenting your research, which provides for a great opportunity to get feedback from your audience. Feedback that highlights future avenues of research and pinpoints opportunities for collaboration. And like journal articles and data sets, after you present you can publish a copy through ERDC via a special workflow, making this option an excellent way to get your research out there.

Another great way to share your expertise is by becoming a guest speaker at your local school, college, or university. Teachers and professors are delighted when someone working in their subject field wants to provide some practical advice and real-world experience to their students. And you never know: you could be the inspiration for the STEM innovators of tomorrow.

Special Events

Why not organize a roundtable discussion, hosted by ERDC, with academic and industry partners? Or a knowledge transfer day to teach other experts in your field how to use the new technique, tool, or technology you and your team have just developed?

There are so many ways to share your results with the people who need them most, so don't limit yourself to text on a page. It may require a little creative problem-solving—and a lot of trial and error—but just because it hasn't been done yet doesn't mean it can't be done at all.

So if you're trying to figure out what to do now, or you just want to make your results as widely available as possible, hopefully this list has sparked an idea or two. Don't feel limited, either, to exploring these options only for the research you haven't yet published. Just because the results of your research are already in a technical report online doesn't mean you can't also make a video about the project or host a field demonstration day. Providing a variety of opportunities for people to engage with your findings will increase knowledge transfer, and the very act of presenting your research in a different way can help you gain a new perspective on the project.

And remember, whether it's a journal article, abstract submission, workshop proposal, or project plan, the editing staff at ISKM are here to help. Contact the ERDC Library or your lab's editor for more information on how you can get your research out into the world.

REPORT DOCUMENTATION PAGE

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14. ABSTRACT <p>The Engineer Research and Development Center (ERDC) is the premier civil works engineering and environmental sciences research and development arm of the U.S. Army Corps of Engineers (USACE). As such, it partners with the Army, Department of Defense (DoD), federal agencies, and civilian organizations to help solve our Nation's most challenging problems in civil and military engineering, geospatial sciences, water resources, and environmental sciences.</p> <p>A special government knowledge center, ERDC Information Technology Laboratory's Information Science and Knowledge Management (ISKM) Branch is critical to ERDC's mission, fulfilling research requirements by offering a variety of editing and library services to advance the creation, dissemination, and curation of ERDC and USACE research knowledge.</p> <p>Serving as the publishing authority for the ERDC, ISKM publishes all ERDC technical publications to the Digital Repository Knowledge Core, sends a copy to the Defense Technical Information Center (DTIC) and creates a press release about each publication on the ERDC website. <i>The Forefront</i> seeks to provide an additional mechanism for highlighting some of our technical publications to the ERDC, USACE, Army, and DoD communities. This publication also encourages those outside ERDC to contact us about using ERDC editing services.</p> <p>For more information regarding the reports highlighted in this publications or others that ERDC researchers' have created, please contact the ISKM virtual reference desk at erdclibrary@ask-a-librarian.info or visit the ISKM's online repository, Knowledge Core, at https://erdc-library.erdcdren.mil/.</p>					
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