FRESHWATER AQUIFERS: FALLING LEVELS, RISING CONCERN
Greetings from Department Head JOSEPH LABUZ

Dear Colleagues, Alumni, and Friends,

Engineering for service to society, which is our core mission, requires that we collaborate with the public to determine values, risks, and workable solutions. Collaboration is an essential part of work on civil, environmental, and geo-engineering projects. Some of its importance comes from the type of large, complex problems that need to be solved, and some comes from the increasing interconnectedness of our society. In CEGE, we benefit from many collaborations – among alumni, corporate partners, professionals, students, and international researchers. You will see those influences in the stories we share with you in this issue.

Alumnus Mike Spack emphasizes the importance of networking and collaboration for young engineers in developing their careers. Spack learned these skills through participation in a fraternity while on campus and through participation in professional societies.

Looking at collaboration between two faculty members, Randal Barnes and Otto Strack, who study groundwater and aquifer depletion, reveals that collaboration does not always mean agreement. Discussion and debate allow collaborators to grapple with differing views.

The Warren Lecture Series is a valuable venue in CEGE that has supported and encouraged collaborations of our faculty with researchers and practitioners around the world. The stories behind two of our visiting lecturers highlight some of the different ways these connections are made.

Teamwork and collaboration is woven through the CEGE undergraduate experience. Our two student profiles show that students gain that experience through work and even through sports.

In CEGE, we focus on professional collaborations and preparing students to contribute in valuable ways. We are also mindful of the value that our alumni and friends bring to our efforts. As you read, know that you are a vital ingredient of all that happens here.

Gratefully,

Joe

Joseph Labuz
MSES/Kersten Professor & Department Head
RESEARCH

JULIAN MARSHALL and Jason Hill’s recent research finding—which has been 5-6 years in the making—reveals that driving vehicles that use electricity from renewable energy instead of gasoline could reduce deaths due to air pollution by 70 percent. This finding comes from a new life cycle analysis of conventional and alternative vehicles and their air pollution-related public health impacts. The study was published in December 2014 in the Proceedings of the National Academy of Sciences. It was picked up by the Associated Press (reporter: Seth Bornstein), so it was in dozens of news media around the country, including The Economist, Fox Business, and Discovery. The Minneapolis Star Tribune ran a front page story on the study, and it was even covered in Popular Mechanics.

MIKI HONDZO is collaborating as a co-principal investigator on an interdisciplinary robotics project that was granted $1 million by the National Science Foundation Division of Information & Intelligent Systems to investigate robots to help with environmental research.

JOE LABUZ received $200,000 for the testing of rock and composite pile sections. The research is sponsored by the Minnesota Department of Transportation and will continue through 2018.

DEPARTMENT/PROGRAM

A New Summer Engineering Research Program for Undergraduate Students will be inviting visiting students to campus this summer to experience engineering research in CEGE. Program participants will spend ten weeks over the summer helping to solve some of our society’s most pressing problems and exploring the programs and facilities available on the University of Minnesota Twin Cities campus. http://www.cege.umn.edu/news-events/in-the-news/2015SummerUGResearchProgram.html

FACULTY

GARY DAVIS, CEGE professor and researcher for the Roadway Safety Institute, seeks to improve left-turn safety at intersections. Davis and his research were highlighted in the Summer 2014 issue of Roadway Safety Institute News. The institute is a consortium of several universities. Their goal is to prevent crashes and reduce fatalities and life-changing injuries.

EMMANUEL DETOURNAY has been chosen to receive the 2015 Maurice A. Biot Medal for outstanding research contributions to the mechanics of porous materials. The award is given by the Engineering Mechanics Institute of ASCE and will be presented at the EMI annual conference in June.

DETOURNAY was awarded $255,000 for his study “Advanced Simulation of the Stability of PDC Bits.” This project aims at developing a mathematical model and a computational tool to assess the influence of bit design on the dynamical stability of the drilling structure.
EFI FOUFOULA-GEORGIOU was chosen to be the 2016 Robert E. Horton Lecturer of the American Meteorological Society. The Robert E. Horton Lecturer in Hydrology is selected in recognition of eminence as a scientist for outstanding research on topics of interest to both hydrologists and meteorologists. The purpose of the lectureship is to encourage and foster an interchange of ideas between meteorologists and hydrologists.

CATHERINE FRENCH has been selected to receive the American Concrete Institute’s Joe W. Kelly Award for her outstanding and long-term efforts toward the education of students in behavior and design of concrete structures and for her dedicated contributions to the advancement of reinforced concrete design through distinguished service to the ACI Building Code Committee. A formal announcement will be made in April at the ACI Convention in Kansas City, Missouri.

LEV KHAZANOVICH and post-doctoral researcher DEREK TOMPKINS and their project, “Simplified Design Table for Minnesota Concrete Pavements,” have been selected to receive the 2015 CTS Research Partnership Award, which recognizes research projects within the CTS program that have resulted in significant impacts on transportation. It rewards teams of individuals who have drawn on the strengths of their diverse partnerships to achieve results. Additional members of the project team include Luke Johanneck, Maureen Jensen, Tim Andersen, and Matt Zeller. The award will be presented at the CTS Annual Meeting and Awards Luncheon Monday, April 6, at UMN’s McNamara Alumni Center.

KIMBERLY HILL and JOSEPH LABUZ participated in a Bell Museum outreach program called Saturday With a Scientist, which helps kids engage in science. A recent program about granular materials proved to be challenging as well as appealing. Labuz talked about strength of sand and angle of repose. Hill, mentioned in a story in the St. Paul Pioneer Press, used the “Brazil nut effect” to help participants understand particle flow.

PAIGE NOVAK was among the peer reviewers honored by the journal Environmental Science & Technology for consistently offering high-quality, constructive, and timely reviews. The editors acknowledge the value that peer reviewers bring to science and research, stating that “A journal exists on the goodwill and expertise of its reviewer corps.”

SANTIAGO ROMERO-VARGAS CASTRILLÓN was selected to receive a 3M Nontenured Faculty Award. This award is administered by 3M’s Research and Development Community in partnership with 3M’s Community Giving Program. For over twenty-five years, this award has recognized outstanding new faculty who were nominated by 3M researchers and selected based on research, experience, and academic leadership. The purpose of the $15,000/year award is to help recipients achieve tenure, remain in teaching positions, and conduct research. The award may be renewed up to two additional years or until tenure is achieved. Funds may be used for any purpose in the performance of basic research.

ARTURO SCHULTZ was interviewed as part of the ABC Special “In an Instant: Rush Hour Disaster,” which highlighted the I-35W Bridge collapse. The special aired on Saturday, March 7, and is now available online at http://abc.go.com/shows/in-an-instant.

CAROL SHIELD has been selected to receive the Delmar L. Bloem Distinguished Service Award from the American Concrete Institute (ACI). The award was established in 1969 to recognize noteworthy work on ACI technical committees. The award is given to a current (or recent) chair of a technical committee in recognition of outstanding performance. For the last six years, Shield has been chairing ACI Committee 440 Fiber Reinforced Polymer (FRP) Reinforcement, the Institute’s largest technical committee with 240 members (54 voting members) and 11 subcommittees. Under Shield’s leadership, the committee has developed several documents on different aspects of using FRP for reinforcing concrete that provide guidance on the use of these materials for internal reinforcement of new concrete structures, for external reinforcement of existing concrete structures, and for external reinforcement of unreinforced masonry structures.

KIMBERLY HILL
PROFESSOR EMERITUS PATRICK BREZONIK received a new grant from the University’s Professional Development Grant Program for Retirees to study the use of optical remote sensing to measure dissolved organic matter in lakes. He also was the lead author on a paper related to this topic that was published in January 2015 in a special issue of the journal Remote Sensing of Environment devoted to remote sensing of inland waters.

PROFESSOR EMERITUS TED GALAMBOS was invited for the fourth time to speak at the bi-annual conference of the Mexican Institute of Steel Construction in Mexico City in March. He presented “Stability Bracing of Steel Structures” (“Estabilidad del Sistema de Contravientos en Marcos de Acero”).

STUDENTS

JONATHAN CZUBA (Ph.D. student advised by Efi Foufoula-Georgiou) received a 2015-16 Interdisciplinary Doctoral Fellowship Award from the UMN Graduate School. Czuba’s work is entitled “Identifying Emergent Physical, Chemical, and Biological Hotspots for Guiding Sustainable Landscape Management.” Czuba also received the Edward Silberman Fellowship given by the St. Anthony Falls Research Laboratory (SAFL) to reward academically outstanding students who perform their research at SAFL.

ALI EBR AHIMIAN (Ph. D. student advised by John Gulliver) was the 3rd place winner in the 2015 Environmental and Water Resources Institute (EWRI) graduate student paper competition. ASCE will fund his attendance at the EWRI Congress in Austin, Texas, to present his paper.


KIMI GOMEZ-SMITH was awarded best student paper at the Water Quality Technical Conference of the American Water Works Association (AWWA) in November. Her paper is titled “Characterization of Drinking Water Distribution System Biofilm Communities Using Next-Generation Illumina Sequencing of 16S rRNA.” Two awardees were recognized, along with their advisors, at a special ceremony. Recipients received $1,500 each.

ANDREW MCCABE has been awarded a 2015 Graduate Student Award in Environmental Chemistry by the Division of Environmental Chemistry of the American Chemical Society. The award recognizes full-time graduate students in programs emphasizing environmental chemistry and is based on student transcripts, research productivity, and recommendation from faculty.

FATEMeh POURAHMADIAN received the Ali Daneshy Fellowship for research related to hydraulic fracturing. The purpose of Pourahmadian’s research is to understand the role of stress shadowing in the multi-stage hydraulic fracturing of horizontal wells. Distortion of the intended geometry of the hydraulic fracture system is a major issue in the petroleum industry.

GARETH WESTLER is completing the Masters International program. For his overseas experience, he worked in rural India designing food dryers to reduce spoilage, which is a way to keep more money in the farm communities. Westler described his experience at a public lecture on the UMN campus.

CEGE students won recognition at the international division of the 2015 Acara Challenge for innovative impact ventures. ERIN KAYSER led her team to a Silver Award (and Crowd Favorite) for the project Apis Krishi, which promotes beekeeping education to help rural Indian farmers leave the cycle of poverty. MALCOLM SMITH was involved with the E-Grove project, which created an accessible collection service to help citizens of Bangalore responsibly recycle e-waste. ADAM IVERSEN and his team won Bronze for their project Ripple, which helps water purification and testing companies connect their products and services with rural markets to improve health in rural communities.

UMN EERI Student Chapter hosted the 2015 EERI Friedman Family Visiting Professional Lecture in March. This year’s address was given by James O. Malley, Senior Principal of Degenkolb Engineers in San Francisco, California. Malley spoke on “Seismic Upgrade of a 15-Story Steel Moment Frame Building: Satisfying Performance Criteria with Application of Experimental and Analytical Procedures.”
UMN EWB-USA Student Chapter won the National Premier Chapter Award. The chapter was chosen by Engineers Without Borders USA for their excellence in work abroad as well as in their community. Chapters are evaluated on student involvement and leadership, mentor collaboration, project completion, and ability to raise necessary funds. The UMN student group was awarded Regional Premier Chapter in the fall, and then chosen for the national award from the pool of all regional winners. Active CEGE students include JAKE ROBOLE, HENRY CROLL, TYLER OLSON, LUKE HORSAGER, LILLY ROUILLARD, CHLOE WINTERHALTER, and KRISTIN CARLSON.

ALUMNI

MARK CHAUVIN (CivE ‘97, M.S. ’99) was promoted to the position of Unit Manager of Wiss, Janney, Elstner Associates, Inc. (WJE) Minneapolis office, effective January 1, 2015. Chauvin has significant experience with forensic investigations on a wide variety of architectural and structural problems with buildings, facades and bridges.

JON CHIGLO (CivE ’97) served 17 years with the Minnesota Department of Transportation (MnDOT) where he led a number of projects, including the reconstruction of the I-35W Bridge. Chiglo left MnDOT in November 2014 and is now the vice president of transportation and structural engineering at WSB & Associates, a civil engineering and design firm based in Golden Valley.

NANCY DAUBENBERGER (M.S. ‘97) is the new Director of the Engineering Services Division at MnDOT.

MICHAEL BEER (M.S. ’97), an 18-year veteran of MnDOT, will be the new director of the St. Croix Bridge project in Stillwater, Minnesota.

LINDSEY (PETERSON) MEEK (CivE 2003), Project Manager at the Mayo Clinic in Rochester, Minnesota, was the 2013 Minnesota Society of Professional Engineers (MnSPE) Young Engineer of the Year. Currently Meek serves on several city boards and commissions, as well as a non-profit called Design Rochester, which promotes excellence in city design.

SIU-YUE TAM (M.S. ’90, Ph.D. ’97) is co-founder of T3 Scientific LLC, which received the 2014 Tekne Award for Advanced Manufacturing from the Minnesota High Tech Association. T3 Scientific was honored for developing “a line of contaminant-resistant and long-term stable gas purification membrane products, used for separating hydrogen from fossil fuel and biomass gas streams. These technologies provide critical solutions to the long-standing problems that prevented the use of metal membrane for hydrogen purification giving long-term stability and contaminant-resisting power to the resultant hydrogen purification product line while bringing cost-effective and energy-efficient solutions to hydrogen purification.”

EERI Student Chapter members LUKE HORSAGER, LILLY ROUILLARD, ERIC HAUSER, and RYAN KELLY travelled to Boston, Massachusetts, to participate in the 2015 Undergraduate Seismic Design Competition which was held in conjunction with the 2015 Earthquake Engineering Research Institute (EERI) Annual Meeting. ANTHONY POLETTO also participated in building the model.

Kelsey Holthaus (left) returned to campus recently and met Warren Lecturer Lori Graham-Brady (right), who she discovered, had also worked at a nuclear plant.

KELSEY HOLTHAUS (CivE 2014) now works for Xcel Energy at the Prairie Island Nuclear Generating Plant. As a student, Holthaus was interested in renewable energy. She connected with Xcel at a job fair and interned there for two years. At the end of her internship she was asked to give a presentation about her experience. The best of those presenters were invited to present again for the CEO. A manager attending the presentations with another intern was impressed with Holthaus and offered her a job. Holthaus advises students, “Pursue your interests, you never know where opportunities will appear!”
MIKE SPACK (CIVE 1996, PE, PTOE) IS CHANGING THE WAY TRAFFIC STUDIES ARE DONE IN MINNESOTA AND AROUND THE WORLD. HE HAS LAUNCHED SEVERAL INNOVATIONS THAT MAKE TRAFFIC STUDIES MORE EFFICIENT, GIVING TRAFFIC ENGINEERS MORE DATA AT A LOWER COST.

SPACK’S CAREER STARTED AT UMN WHERE HE STUDIED UNDER PROFESSORS PANOS MICHALOPOULOS AND GARY DAVIS AND COMPLETED INTERNSHIPS WITH IMAGE SENSING SYSTEMS AND THE CITY OF ST. PAUL. HE GRADUATED IN 1996 WITH A BACHELOR’S DEGREE IN CIVIL ENGINEERING AND TOOK A JOB WITH BONESTROO, ROSENE, ANDERLIK & ASSOCIATES, INC. HE THEN WORKED WITH BENSHOOF & ASSOCIATES, AND WITH THE CITY OF MAPLE GROVE BEFORE STARTING HIS OWN COMPANY.
The Beginnings

Going out on my own was terrifying at the time, but I approached each step as a calculated risk. I didn’t take any wild flyers! For the first 9-10 years it was just me, a sole practice. My entrepreneurial instincts were honed at UMN in the Phi Gamma Delta fraternity. I’d thought of owning my own company and took action when I noticed an opportunity for traffic counting.

A few years ago, the city of Minneapolis was updating the timing for all their traffic signals. Our biggest project until that time had been counting 45 intersections for the University Avenue light rail line. All of a sudden we were doing 250 intersection projects. That was my impetus for adding more staff.

At the time, I was mentoring a Capstone group at UMN. That group was so amazing, so enthusiastic! I don’t know if working together brought out the best in them or how that worked, but I ended up hiring three of the four. Two came on as interns, and I hired Max Moreland (CivE 2010) outright. He is still with me.

Adding full-time staff was a hard transition; I had to get comfortable delegating. Max now handles TrafficData, Inc., start to finish. Another UMN alumnus came to work for us last fall, Bryant Ficek (CivE 1998, PE, PTOE, Vice-President of Spack Consulting). He has taken over the lead engineering role for me. We now have five full-time staff members, and my role is managing and marketing our four businesses.

I made a decision that I didn’t want to be jumping into the ring where 20 companies all go after the same engineering work. I’m a good enough engineer to compete, but I do not have the marketing machine behind me. So, we are taking a different approach, and it has opened up the world for us!

Marketing is so different now with the power of the Internet. We don’t chase jobs; we try to put out useful things that other engineers can use, and orders come in. We have more than 1500 customers in 43 countries, all 50 states, and eight Canadian provinces. We do more traffic counting revenue than we did five years ago, and our engineering consulting is up quite a bit, but the online store is where our growth is.

Future Business

My 9-year-old dreams of taking over the family business. I don’t know what it will be then. Thirty years from now, our business will look—well, not the way it does now! I don’t know if traffic engineers will exist in 30 years. People will still design roads and still have signs, but changes are already happening. Certainly within 15 years most cars will be driving themselves, and that could happen as soon as five years from now. Once self-driving cars are ubiquitous, everything changes.

The car becomes a pod to get me from point A to point B; it drops me off at a restaurant and parks itself, and I call it up when I’m done. The whole landscape will look different. So we are always trying to think, what is the next revolution?

Innovative Approaches

Spack Consulting makes and sells proprietary traffic counting equipment that we sell in our online store, CountingCars.com. One of the products we sell is a new process for doing traffic counts. The old fashioned way of counting cars is that a person sits on a corner and has a clicker board with a button for the rights, the throughs, the lefts.

Coming out of my experience at Image Sensing Systems, I’d always thought we should be coming up with some kind of camera-based method to do the counting, but the technology wasn’t there. We ended up building our own cobbled-together, do-it-yourself system. Very coincidentally, a programmer tangential to the industry called me. He had a keyboard thing that would allow us to watch video and do the counts from our office. We partnered with him and ended up buying him out.

We’ve developed this system that makes it cost effective to record 48 hours or 5 days’ worth of video and count for 13 hours or 24 hours or 48 hours. Instead of two-hour counts trying to capture “the” rush hour, most everyone in Minnesota is now counting from 6 A.M. to 7 P.M., which gives traffic engineers more data to look at. We are nudging the industry toward longer data counts so we can start averaging between the days and looking at different snapshots. We think better decisions will be made. We have lowered the pricing of traffic counting by about 75%. These are all great enhancements from sitting out on the corner, and it is cost effective. It is catching on around the world.
We are upping the game on all our products. We are redesigning our boxes on lithium ion batteries so they will be smaller and cheaper. We are working with a designer to develop 3D printed parts. Alibaba.com, the big Chinese IPO of the last year, allows us to connect with factories to get parts. Another website, mfg.com, allows us to put a bid out there—"We need one hundred metal widgets"—and get quotes from around the world. Sometimes companies in China win a bid, but we have an order right now that is being processed by a metal shop in Rochester, Minnesota. I didn’t know of them, but they were the low bidder and they are local — small-world!

We have launched a new service called CountCloud, where customers send us video and we conduct counts. We bring our quality control process, our vetting, and all of that. We partner with people in India and Ireland to do that.

We recently launched SpackAcademy.com to offer books and training materials for transportation professionals. All profits from SpackAcademy are donated to charities, like Engineers Without Borders. All of this is possible within the last five years!

A Pedestrian’s View

I walk ¾ of a mile to work every day. I do a lot of thinking while I’m walking, really good thinking. And it has made me a better traffic engineer. I’m not just a car-focused engineer. I see traffic from the vantage point of a pedestrian or sometimes a bike rider.

For example, St. Louis Park is probably in the top 5-10% of cities in Minnesota about plowing streets and clearing sidewalks. Yet I often walk to work on an ice rink. I am an able bodied person, and I slip on the ice probably every other day. I look out at the bone-dry street that the city does such a good job plowing, but a person in a wheelchair could not navigate through St. Louis Park in the winter. That perspective bothers me.

I also walk over a smaller interchange. People are so focused on driving that they just don’t see pedestrians. The roadways were designed from a car-centric perspective. The sight lines could be improved to be safer for pedestrians. It is not difficult, but designers have to think from a slightly different angle. We can improve the experience for pedestrians and bikers.

Advice for students

My advice for students is two-pronged. Of course they need to work hard and become a good, competent engineer. They are getting a great foundation in CEGE, and they will learn to apply those foundational skills on the job. Along with that foundation, they need to build a network to move up in their career. As we progress as engineers, we end up writing and speaking and going to meetings. Engineers hit a career ceiling if they cannot be social. The Institute of Transportation Engineers (ITE) has been an important aspect of my career. I have a lot of good friends in the organization. We like each other, which is great, but also I can pick up the phone and say, “what would you do in this situation?” That was super helpful for me as a sole practitioner for so many years, when I didn’t have anyone else in the office. Membership and participation really open up opportunities.

Haven for Millennials

Our office is a haven for millennials. We have no set office hours, we wear jeans, we have a beer fridge, and all that. We get a lot done and none of us works 50 hours a week. The shift to that work style was organic. Most of our employees are in their 20s. They are on their phones and available all the time. The young guys are great at working until 7 P.M., taking a tech support call at 9 P.M. on a Friday, and staying in touch via email. It can frustrate the younger guys because I have broken myself of the habit of continually watching email. They are working all the time, but may not be in the office more than 35 hours a week.

LIFELONG LEARNING

“I created a book club with a bunch of my buddies who were business owners or high up in their companies. Every month we would read a book about business and then meet up at a bar and talk about it. I have written several authors of the books we have read. One was John Kenneth Galbraith, Kennedy’s economist, who wrote The Great Crash, 1929. I told Galbraith that I enjoyed his book and thought it was still timely. He wrote me back—in his 90s from his office at Harvard. He died a week later. I still have that note.”
CEGE PROFESSORS OTTO STRACK AND RANDAL BARNES BOTH STUDY GROUNDWATER, BOTH LIKE MATH AND BELIEVE THAT MODELS ARE AN ESSENTIAL INGREDIENT IN ENGINEERING DECISIONS, AND BOTH BELIEVE AQUIFER DEPLETION IS A SERIOUS PROBLEM. HOWEVER, EACH PROFESSOR APPROACHES THE TOPIC FROM A UNIQUE VIEWPOINT, AND THEY OFTEN ARGUE ABOUT THE BEST APPROACH. YET ABOUT 20 YEARS AGO, THE TWO PROFESSORS BEGAN MEETING WEEKLY, TOGETHER WITH THEIR ADVISEES, FOR WHAT THEY CALLED THE GROUNDWATER COLLOQUIUM. MOST OFTEN THE TOPIC IS MATHEMATICAL MODELING OF GROUNDWATER. THEIR COLLABORATIONS AND DEBATES HAVE GIVEN RISE TO TWO LINES OF ATTACK.

### Aquifer Depletion: Two Views

#### FALLING LEVELS, RISING PROBLEM

Not many people realize how important groundwater aquifer levels are going to be, or how quickly they decline. I am convinced that the groundwater problem is going to hit us long before climate issues do. The acceleration of groundwater pumping will catch up with us very quickly.

#### TWICE AS MUCH

Groundwater can be an uncomfortable issue because of the possible consequences or required fixes. People do not like being told to restrict their water use.

One area of concern is that in the Twin Cities, twice as much water is being pumped out of aquifers in June, July, and August than in December, January, and
Farms are the big concern. Irrigation is possible because the aquifers are accessible. The farmer just drills a hole, puts in a pump, and can irrigate. But as aquifer levels go down, it becomes harder and harder to irrigate.

It is true that the hydrologic cycle is closed and water is not lost, but it can become unusable or unavailable for irrigation. The increase of intense rainfalls and the practice of using drain tile to control water levels in irrigated fields sends a lot more water to runoff. Thus, infiltration is decreasing. If pumping goes up, aquifer levels will go down and less groundwater will be available for irrigation. Without aquifers, getting water to farms would be prohibitively expensive because farms are far apart and transporting water is costly. Groundwater does not require transportation.

The problem is not drinking water—we can clean effluent, as is done in San Diego, for example. Drinking water is not a problem because the quantity is so much less and the users are grouped close together.

When the aquifers are gone, we will not be able to farm, at least not with irrigation. That is what happened in southern Kansas. Depletion of the Ogallala Aquifer is affecting farming and economics in that area. Kansas faces serious problems. In Minnesota, it is not quite so bad, yet.

**CHOICES**

Farmers say, “We know we are drawing down the aquifer, but what other option do we have? How can we farm without water?” Without water, we cannot farm. We can, however, have fewer cows. We can use our resources more carefully. Reducing the size of farms is a choice. Right now we are in a state of denial, but reality is going to catch up. Drawing down the aquifers is a hard “not possible.”

**AWARENESS**

One solution might be changing the laws, but before that we have to raise farmers’ awareness. Modern machinery

February. Most golf courses have their own heavily-regulated, monitored wells, so they are not part of this equation. Looking only at domestic use, we see twice as much pumping in the summer. One cause might be that many urban communities require residents to have lawns and to mow weeds. Short, green lawns are embedded in our laws, and those lawns require water in the summer. It may not be as much as agricultural use, but it adds up and depletes urban aquifers.

**WHITE BEAR LAKE**

Another concern raised in the Twin Cities is the issue of “mining” groundwater. White Bear Lake (WBL), for example, saw historic low levels two years ago. Other lakes in the area are seeing dropping levels, too, but WBL, with its many homes, is getting a lot of attention. The White Bear Lake Restoration Association is suing the DNR claiming that the DNR has given out too many well permits, depleting the aquifer below WBL. The DNR argues that aquifer depletion is not the problem. My students and I have been studying the lowering lake level since well before the lawsuit was filed.

**COMING TO A HEAD**

The issues around WBL’s water level are related to a concept called head. Daniel Bernoulli, the famous scientist-mathematician, said we need to look at a combination of pressure and elevation to understand groundwater flow. In a swimming pool, for example, the pressure at the surface is essentially zero or same as the atmosphere. If you go to the bottom of the pool, the pressure is greater; you can feel that in your ears. So, if water flows from high pressure to low pressure, why doesn’t the water flow up out of the swimming pool? Water flows—not only from high elevation to low elevation, nor only from high pressure to low pressure. Both elevation and pressure have to be considered. That is head. Water flows from high head to low head. Head is at work in WBL.

Bedrock aquifers often have material above and below that keep the water within the aquifer under pressure.
is incredibly efficient. Once the farmers have the machines, they can deal with a lot of acreage. So, they are tempted to grow. Farm volumes increase and water needs also increase.

We have to tell the stories of farmers who have experienced a lack of water. I talked to a farmer in Idaho who lost 1,000 steers in one year due to lack of water. All he had left was a flock of sheep, which he couldn’t afford to ship. So he drove his sheep—the old-fashioned way, cross-country all the way to Texas! This farmer has experienced the consequence of drawing down our aquifers. These are the stories we have to tell.

Continuing these large, sophisticated farms is difficult. Farmers need 2-3 years warning to make changes to their operations. We need to warn them: If you want your family farm to continue, adjust the size of your farm now, reduce the number of cows now!

SIMPLE MODELS
Another way to move this issue forward is to help farmers think about what can be done. We have complicated hydrologic models, but such models are difficult to build, the data is difficult to gather, and the results are difficult to understand. The focus of my research is developing a relatively simple model that can be implemented with minimal data, yet could still give relevant answers.

I propose to choose a given area, a farm or town for example, and focus on the amount of water entering through recharge and irrigation. Simple models could be developed that require a minimum of hydrogeologic information; farmers could run such models themselves. The modeling approach that I pioneered, the analytic element method (AEM), is ideally suited to build and distribute such simple groundwater models.

My approach will help farmers to see for themselves the effects irrigation, well discharges, and well placements would have on groundwater flow. These areas can also be linked together to obtain a larger-scale picture of agricultural practices. AEM models will be sufficiently simple so that farmers can run them, yet they will provide important insights for water management.

So, in these cases, if you drill a hole, the water would be pushed up above the “normal” underground level by the pressure in the aquifer. That is what causes artesian wells—the pressure in the aquifer forces water up to the surface creating a spring.

Most lakes have visible inflow and outflow, but WBL is unique in that it has no streams. It is replenished only by rainfall; water leaves only through evaporation or through its “leaky” layer—a layer of clay and glacial till-type material that sits between the bottom of the lake and the top of the first bedrock aquifer. WBL has been leaking slowly throughout the recorded history of the area.

Essentially what has happened recently at WBL is that pumping has reduced the pressure pushing up, thus reducing the head in the aquifer. Pumping has not drained the aquifer, the aquifer is still fully saturated, but the pressure has been reduced, so the lake surface level falls.

AQUIFERS AS A RESOURCE
Like all natural resources, aquifers can have many purposes. It may be that our current use of groundwater in the Twin Cities is what the majority wants. It is not up to me to dictate how we use our aquifers. My concern is to help people understand the consequences of their choices and actions.

Difficulty comes in because we cannot be certain about consequences in a geologic setting. No magic device can tell us what is going to happen under the surface of the earth. Another difficulty is that the world continually changes—climates change, populations change, values change. Add to that predictions about anthropogenic climate change, and there is a lot of uncertainty.

People like to think that the world is a steady state, and when things are good, they can stay good. I see the world as constantly changing. My area of expertise is helping people understand consequences and the certainty, or uncertainty, of
Otto Strack is the original developer of the Analytic Element Method (AEM), which is based on the superposition of analytic elements, that is, mathematical expressions capable of representing physical phenomena. Although the method is not restricted to groundwater flow, most applications have been in that field. The method has been applied to numerous practical groundwater flow problems, such as a National Groundwater Model of the Netherlands (NAGROM), the first Metropolitan Groundwater Model of the Twin Cities in Minnesota, and the Yakama Indian Nation groundwater model. The analytic element method is implemented in a number of commercial groundwater flow problems by various authors, as well as via public domain implementations. A conference on the AEM is held once every two years in conjunction with the MODFLOW and More conference organized by the National Groundwater Modeling Center.

Flow around five impermeable objects.

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CONCLUSION

Strack and Barnes may disagree about approach, but they agree on key points about groundwater. All actions have consequences. If groundwater depletion is to be stemmed, we have to take action now. If no action is taken, none of us will be able to continue using water as freely as we have. They both agree that positive action is possible.
Art (CivE 1953) & Zana Sehlin, with Tammy and Mark (CivE 1979) Magney

Charlie Vermace (CivE 2014) with Becca Mattson

John (CivE 1989, M.S. 1992) and Becky Siekmeier with their son

Chelsey Palmateer (CivE 2014) with Steve (CivE 2014) and Kristin Borntrager

Lanny Betterman (CivE 1992)

Siu-Yue Tam (M.S. 1990, Ph.D. 1997) and family

Dennis Martenson (CivE 1967) with one of his grandsons

Don (CivE 1989) and Kristine Elwood and sons
Dale Forsberg (CivE 1978), Mark Magney (CivE 1979) and Nate Robitschek (CivE 2010)

Nicole Delahanty with Mike Frankberg (CivE 2008)

A young Gopher fan shows her colors

Alumnus James Nystrom with Alex Miller (CivE 2014)

David Urke (CivE 1986, M.S. 2004) with Davy Urke and Jeremy Nelson

Bob McPartlin (CivE 1971) with Joe Labuz

Liang Chow (CivE 2011)
While many alumni, family, and fans gathered in the Civil Engineering Building on Homecoming Day, one CEGE student was on the field with the Gophers. Junior JARED HARTMAN is a long snapper.

Long snapping has many nuances, but the main point is to be consistently fast and on target. The position, says Hartman, often goes unnoticed unless something goes wrong, but that doesn’t seem to happen for Hartman. In the 2014 season, Hartman hit his target on all of his 62 snap punt attempts. He’s also been to three bowl games.

“I grew up going to all the Gopher games. My dad was a strength and conditioning coach for the hockey team and was on the football staff with Coach Glen Mason. Playing football here feels like I have come full circle. To actually play as a Gopher is pretty special.”

Hartman suffered some injuries in high school and almost gave up on football. Anyone familiar with the concept of repeated loading can appreciate Hartman’s analysis. But in the spirit of engineering—and fortunately for the Gophers—Hartman kept searching for a solution. Long snapping allowed him to keep playing football and limit his exposure to further stress.

He will play one more season before he graduates.

Hartman is currently the only civil engineering major on the team, but when he started, Patrick Sveum and Chris Bunders were playing (both completed their CivE degrees in 2011). “If they can do it, I can do it,” he told himself. Hartman finds that his experiences on the field and his studies in engineering complement one another. “At the end of the day, football is just a game, but it is a tough game. In football we are taught to approach life one day at a time, to be in the moment. If you get too far ahead of yourself, you are going to forget about what you are trying to do now. For me, that applies to classes, too.

“I’ve had a couple internships and learned a lot in those experiences. In the summer of 2013, I worked with the MnDOT Office of Materials in the Geotechnical Engineering, Foundations Unit. We worked on a bridge in Rock County, and went to Jay Cooke State Park where a road had a couple slope failures. Having that experience really helped me connect the dots when I took the Soil Mechanics class.

“In 2014 I worked with the City of St. Paul Public Works. I was outside every day, inspecting old sidewalks and curbs. If a citizen called with a problem, I pulled the permit for that property and looked at where the waterlines and the piping were located. Then I would go to the site and try to figure out what was going on. I would talk to property owners or other people affected about how we might address the problem. I also did some AutoCAD drawings to track where everything was for new permits. That internship let me see the maintenance side of civil engineering. Once you put something up, you have to make sure it still works.

“I am really proud of being a student at UMN and being a civil engineer. I think it’s cool that civil engineers can do so much with math and science. I came to civil engineering because, when I’m outside, just about everything I see is related to civil engineering in some way. Civil engineers have a hand in just about everything that goes on in the built environment. Driving around, I’ll say, ‘Yeah, you can thank a civil engineer for that!’ I guess I talk about it a lot because my family gives me a hard time about it. But civil engineering gives me the ability to improve the lives of so many people in the world—in any country, in any place. I take pride in that. It is a big responsibility, but I think it is really cool.”
MEAGHAN MCGINN studies civil engineering in the Department of Civil, Environmental, and Geo-Engineering. When she graduates in May, she will have a considerable amount of work experience.

Before returning to school, she had earned a degree in Environmental Science and was working at the USDA in St. Paul. “I was doing a lot of lab work there. The other lab managers could tell I wasn’t 100% satisfied; they encouraged me to go back to school and get an engineering degree. I want to be less lab-oriented and more client-oriented.”

Her engineering education is helping McGinn fill in the gaps she experienced. “The critical thinking background I’m learning in CEGE is new. With Environmental Science, there are many rules, and the training is to follow what the guidelines say. With engineering you have to think more critically. The program has opened me up to a lot of new ideas.”

Currently, McGinn is working at American Engineering Testing (AET). She has contributed to work on the Humphrey Terminal expansion at Minneapolis International Airport and the new Vikings Stadium. McGinn also writes reports based on information supplied by the supervising engineers. “Our reports are usually one-page letter reports. We send analytical information along with a recommendation. The engineer will give me a short run-down, the general gist of what they want to say. Then I write it up, send it to back to the engineers, and they make any amendments.”

“Last summer (2014) I left AET to do a summer internship at the ASARCO copper mine in Arizona. I was supposed to shadow their water engineer. I got there on Monday, and they canned their engineer on Tuesday, so I kind of stepped into his duties. I wrote so many papers: agency communications, sample submittals, and required permit inspections. I wrote SWPP instructions that the mine workers follow. There was a lot on my plate, but it was fun. One of the things I started before I left was going through all of their records. It’s an old mine, started around 1900. They have a huge amount of records that I organized to meet compliance goals. I also worked with one of the engineers on a water database. I still work for them as a subcontractor.”

In addition to providing experience, her work in Arizona nurtured McGinn’s curiosity about cleaning up water pollution. “The mine had high levels of selenium in its waters. I presented a couple of our ideas to help negate that. I discovered I like water permitting and hydrologic remediation. I’m thinking about possibly going into the field in the future.”

Working while receiving an education keeps McGinn busy, but she feels it is worth the extra effort to earn another degree. “My work depends on when we have big projects. During the school year, work calms down, but then I have classes. I don’t have a lot of free time, but I am learning a lot.”

Through her work experience and internships, McGinn discovered that she is good at communicating with clients and would like to continue with client-oriented engineering in the future. “It can be hard to appease clients, so I think that’s why some engineers try to avoid consulting. Or if they do it, they do it for a short amount of time. I enjoy working with clients at AET, making sure that they like what we do for them and that we’re doing the best we can for them.”

McGinn believes the experience she gained through her internships and classes will provide her with footing for achieving her future goals. “This program has really filled in the gaps of my education as far as engineering. We were provided classes that explained how to approach problems. I’ve been pretty happy with my classes.”

Reflecting on what would be the most helpful for current students, McGinn was adamant about internship experiences. “Definitely get one. You get a lot of work and experience that way. You get to apply concepts that you learned in class in a professional setting. I really enjoy the experience my engineering internships have given me.”

After her education in CEGE, McGinn feels confident in her ability to analyze problems and come up with creative solutions, and much more confident that she is on her way to a satisfying career.
For over 30 years, engineering scholars from around the world have been gathering in the Civil Engineering Building to share research and discuss important issues in civil engineering, environmental engineering, and geoengineering as part of the Warren Lecture Series. These sessions highlight the broad array and far-reaching effects of research discussed within the department. In addition, the lectures create and maintain connections among professors, researchers, students, alumni, and friends of CEGE.

The 2015 Spring Warren Lecture Series kicked-off with a lecture by Assistant Professor Ming-Chen Hsu. Hsu was invited by CEGE Assistant Professor Dominik Schillinger. Hsu, from Taiwan, and Schillinger, from Germany, met while working together as post-doctoral researchers at the University of Texas at Austin. Schillinger joined CEGE in 2013. He researches the development and implementation of novel discretization techniques for the analysis of solids, structures, and fluids that overcome limitations of today’s standard numerical tools. The main applications driving his work are from biomechanics, engineering mechanics, and structural dynamics.

Hsu is an Assistant Professor of Mechanical Engineering at Iowa State University, where his work focuses on computational mechanics and fluid-structure interaction, with an emphasis on contemporary engineering problems, such as wind turbine analysis and biomedical application.

Often collaborations are motivated by research questions. Professor Lev Khazanovich and post-doctoral researcher Kyle Hoegh developed ultrasonic array-based reconstruction methods to image internal characteristics of pavement structures. When they discovered their techniques could be applied to non-destructive evaluation of nuclear power plant concrete structures, they reached out to Professor Laurence Jacobs at the Georgia Institute of Technology. The three had met and talked at various professional conferences. Jacobs has been working on the development of quantitative methodologies for the nondestructive evaluation and life prediction of structural materials, including the application of nonlinear ultrasound for the characterization of fatigue, creep, stress-corrosion, thermal embrittlement, and radiation damage in metals. His work in cement-based materials includes the application of linear and nonlinear ultrasonic techniques to quantify microstructure and progressive micro-cracking in concrete.

Jacobs came to CEGE in February to learn more about Khazanovich’s research, share ideas and resources, and to share his work through the Warren Lecture.
Spring 2015

This spring we are highlighting the collaborations that happen through the Warren Lecture Series. Lectures are held most Fridays (3:30 p.m.) during the fall and spring terms in the George J. Schroepfer Conference Theater (Civil Engineering Building 210). Please join us for intellectual stimulation and social connections.

Jan 23  "Immersogeometric Analysis with Applications to Flow over Complex Geometries and Fluid–Structure Interaction of Heart Valves"
MING-CHEN HSU
Mechanical Engineering, Iowa State University
Hosted by Dominik Schillinger

Jan 30  "Groundwater Depletion: An Assessment and Some Suggestions for Action"
OTTO STRACK
Civil, Environmental, and Geo- Engineering, University of Minnesota

Feb 6   "Nonlinear Ultrasonics for Material State Awareness"
LAURENCE J. JACOBS
College of Engineering, Georgia Institute of Technology
Hosted by Lev Khazanovich

Feb 13  "Learning the Sparse Code of Solids with Anomalies: A Model-Agnostic Approach to Wave-Based Diagnostics"
STEFANO GONELLA
Civil, Environmental, and Geo- Engineering, University of Minnesota

Feb 20  "Probabilistic Analysis of Reinforced Concrete Buildings Against Progressive Collapse"
JIA-LIANG LE
Civil, Environmental, and Geo- Engineering, University of Minnesota

Mar 6   "Visco-Elastic Fracture Mechanics Model for Crack Propagation in Asphalt Mixtures"
GABRIELE TEBALDI
Civil Engineering, University of Parma
Hosted by Mihai Marasteanu

Mar 13  "Failure Starts Small: The Role of Stochastic Mechanics in Multi-Scale Modeling"
LORI GRAHAM-BRADY
Civil Engineering, Johns Hopkins University
Hosted by Jia-Liang Le

Mar 27  "Nanotechnology-Enabled Water Disinfection and Microbial Control: Mechanisms, Applications and Implications"
PEDRO ALVAREZ
Civil and Environmental Engineering, Rice University
Hosted by Santiago Romero-Vargas Castrillón

Apr 3   KONSTANTIN KORNEV
Materials Science and Engineering, Clemson University
Hosted by Sonia Mogilevskaya

Apr 10  "A Grand Challenge for Civil and Environmental Engineering: Climate Change Adaptation for Infrastructure"
DAVID DZOMBAK
Civil and Environmental Engineering, Carnegie Mellon University
Hosted by John Gulliver

Apr 17  DAN GIVOLI
Aerospace Engineering, Technion, Israel
Hosted by Bojan Guzina

Apr 24  KEN KAMRIN
Mechanical Engineering, MIT
Hosted by Kimberly Hill

May 1   ERIK JOHNSON
Civil and Environmental Engineering, University of Southern California
Hosted by Lauren Linderman

Updates and live streaming are available on our website at www.cege.umn.edu.
FAREWELL TO GIL HUIE

The end of 2014 also saw the end of Gil Huie’s reign over the CEGE shop. Huie served as machinist extraordinaire for over 30 years. Huie was instrumental in equipment design and fabrication, STEM competitions—including an annual robotics event, and mentoring of Native American students. Many friends old and new visited during a farewell luncheon to wish Huie well. Huie’s ready smile will be missed by all who worked with him.

Gonella receives NFS CAREER Award

STEFANO GONELLA received the prestigious CAREER award from the National Science Foundation (NSF) for his work on programmable metamaterials. The Faculty Early Career Development (CAREER) Program is the National Science Foundation’s most prestigious award in support of junior faculty who exemplify the role of teacher-scholars through outstanding research, excellent education and the integration of education and research. The award comes with a grant worth $500,000 over a period of five years.

Metamaterials are a new class of synthetic structural materials which, thanks to the intelligent design of their internal architectures, display properties that are not achievable by conventional materials and are far superior to those exhibited by their individual constitutive components. The objective of Gonella’s project, “CAREER: Adaptive Acoustic Metamaterials with Switchable Functionality: A Design Platform Enabled by Nonlinearity,” is to design innovative programmable metamaterials for acoustic and elastic wave control. He is developing metamaterials that can switch back and forth between sets of complementary mechanical functionalities. Ultimately, Gonella and his fellow researchers envision metamaterial architectures that can reconfigure the material’s behavior in response to external tuning parameters or autonomously adapt their performance to evolving operational conditions. This study has the potential to impact a number of problems across many fields of engineering, including vibration control, blast protection, sound manipulation, and cloaking of underwater vehicles and structures.
Our donors and partners are essential to the work we do in the Department of Civil, Environmental, and Geo-Engineering. In this issue we wish to express special gratefulness for those who have been donors for five or more consecutive years (marked with an asterisk). Your support means so much! Thank you!

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CALE ANGER (M.S. 2012) was an excellent researcher and helpful teaching assistant, who displayed a strong work ethic and positive attitude. Anger passed away unexpectedly January 28, 2015. Anger worked closely with Professor William Arnold on the project that led to the Minnesota legislature’s statewide ban on triclosan in consumer products. His work earned the recognition of the department’s Best Master’s Thesis Award. He was also recognized at the University level with the Best Master’s Thesis Award for Physical Sciences.

A fund has been created to memorialize Cale Anger and honor his contributions. The Department of Civil, Environmental, and Geo-Engineering has renamed the thesis award as the Cale Anger Best Master’s Thesis Award, which will grant a cash prize to one recipient per year.

You can contribute to this fund to honor Anger and support excellence in engineering graduate education. The goal is to reach an endowment level that will sustain the award in perpetuity. Donations received will be doubled up to $1,500, due to a generous matching donation from Professor William Arnold.

Contributions to the Cale Anger Best Master’s Thesis Award can be made online at www.give.umn.edu/giveto/caleanger. Any questions about giving to the Department of Civil, Environmental, and Geo-Engineering can be directed to Sally Euson at 612-625-6035 or euson@umn.edu.