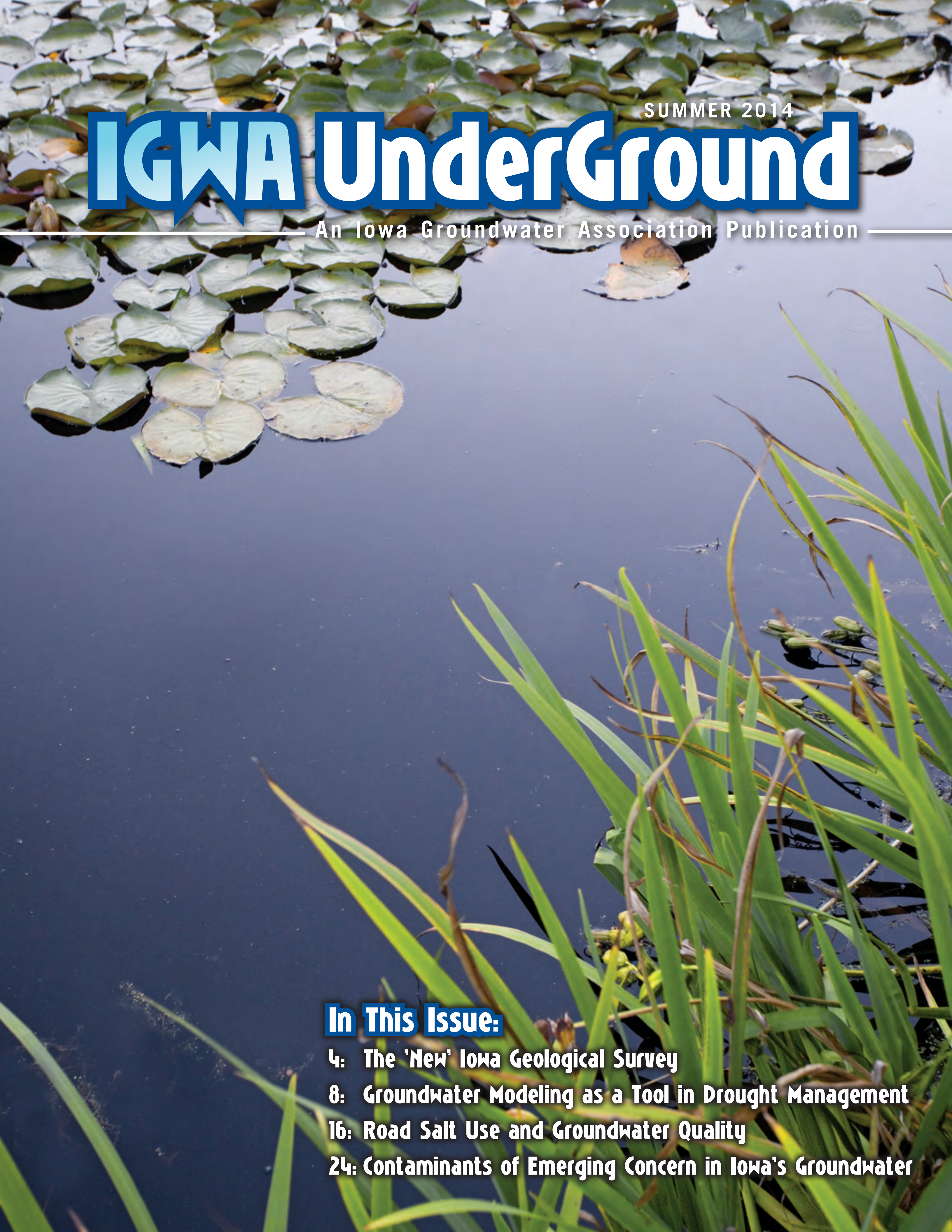


SUMMER 2014

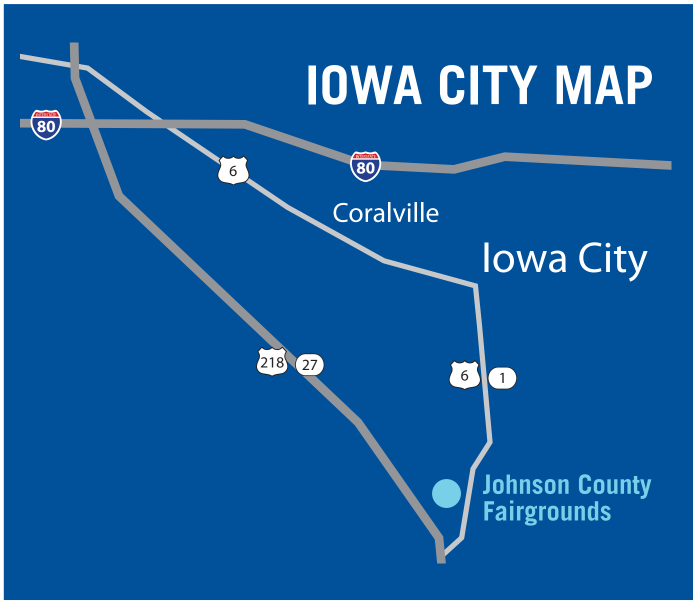
IGWA UnderGround

An Iowa Groundwater Association Publication

In This Issue:

SAVE THE DATE!!

Fall IGWA Meeting October 28, 2014



WHO: Attention all groundwater professionals, well drillers, water operators and interested persons in geology and groundwater.

WHAT: Iowa Groundwater Association Fall Meeting

WHEN: Tuesday, October 28, 2014

WHERE: Iowa State University Extension Building,
Johnson County Fairgrounds
4265 Oak Crest Hill Rd SE
Iowa City, Iowa 52246

HOW: To register, go to our website at www.igwa.org

Continuing education units will be available for Well Contractors, Groundwater Professionals, and Water Operators.

NOTICE: PRE-MEETING FIELD TRIP!

How Floodplains are Supposed to Work: Water and Nutrient Processing in the Floodplain of the Lower Cedar River, Iowa

1:00 - 5:00 PM, Monday October 27, 2014

As part our fall meeting, IGWA is pleased to offer a ½ day pre-meeting field trip to the Lower Cedar River floodplain at no extra cost. We will meet at 1:00 P.M. at the ISU Extension building, where the next day's meeting will take place. (Please bring field shoes for wet conditions.) Travel will be coordinated from the Extension building to the site, which is about 30 minutes south of Iowa City. We will tour several sites where field investigations are revealing how floodplains are supposed to work, including: a rare floodplain savanna, a terrace-fen complex, and a comparative land cover experiment. The role of floodplains in processing water and nutrients during flood and non-flood periods will be discussed and we will see first-hand how the complex microtopography and geology of floodplains influence the spatial and temporal dynamics of surface water inundation, sediment deposition, and groundwater geochemistry. The trip will be led by Dr. Keith Schilling from the Iowa Geological Survey.

SUMMER 2014

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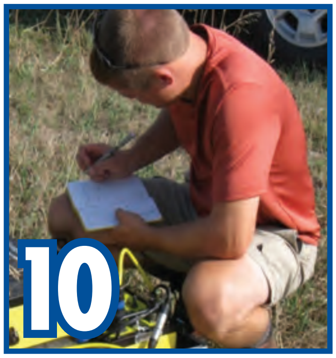


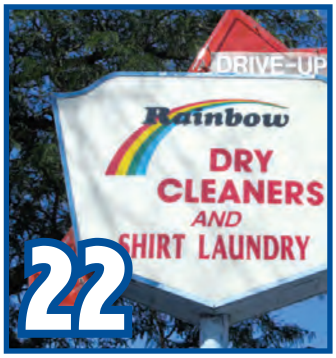


Table of Contents

COVER PHOTO: Standing water in a wetland is the surface expression of the water table. Come see surface and groundwater interaction at the 1/2-day IGWA pre-meeting field trip to the lower Cedar River floodplain.

Objectives

- Promote education and research on Iowa groundwater issues.
- Foster cooperation and information exchange throughout its membership.
- Improve communication among state regulatory officials, professionals, and technicians working with groundwater.
- Cooperate with the activities of various state and national associations organized in the interest of groundwater use, conservation, management, and protection.

IOWA GROUNDWATER ASSOCIATION
COMMUNICATION • EDUCATION • RESEARCH

We are a not for profit organization.

Iowa Groundwater Association
PO Box 5602 • Coralville, IA 52241-0602
www.igwa.org

the President's *message*

Jon Martens – President, Iowa Ground Water Association

First and foremost I need to thank the Atlantic Municipal Utilities(AMU) Board of Trustees, General Manager, and the water department employees for allowing me the opportunity to serve on the Iowa Groundwater Association (IGWA) Board. I have been working in the water business since March of 1981 and am currently the Director of Water Operations for AMU. I have been a member of IGWA for over 20 years and have also been very active in many other associations during the past several years.

As a utility that receives its water from groundwater, IGWA is a great source of information and has several members that are very knowledgeable in groundwater activities and groundwater protection. Over the last couple years I have attended my first IGWA meetings and have found them to be very informative. Like any other professional organization, the sharing of knowledge and networking are both a critical part of becoming a better professional for all of us.

The State of Iowa is making changes in the Iowa Comprehensive Nutrient Management Plan. Even though compliance with the plan is not mandatory, we are taking small steps in the right direction to help reduce nitrate in groundwater as well as surface waters. Some of us would argue that this needs to be mandatory. We as an organization of groundwater professionals need to speak up and be heard about the concerns we have with this issue.

On March 11, 2014 IGWA and the Center for Health Effects of Environmental Contamination (CHEEC) hosted a symposium on the connection of groundwater and public health. The conference provided experts, informed presentations and networking opportunities to better understand the prevalence of groundwater contaminants (nitrate, pesticides, arsenic, etc.) and resulting health effects in Iowa. Recent statewide projects looking at private well arsenic levels and public well virus levels were highlighted, as well as presentations on similar projects from neighboring Midwestern states. The presentations are available on the IGWA website @ www.igwa.org.

Iowa Department of Natural Resources:

2013 Iowa Annual Drinking Water Compliance Report

- 1899 public water supplies serve 2.76 million people in Iowa (91% of Iowa's population).

- 93% of Iowa's public water supplies have a groundwater source, which serve 64% of the state's population.

- The parameters with most water quality violations are:
  - Total coliform bacteria: 112 violations involving 82 public water supplies
  - Nitrite: 25 violations involving 7 public water supplies
  - Radium: 20 violations involving 7 public water supplies
  - Nitrate: 16 violations involving 10 public water supplies
  - Fecal coliform bacteria: 15 violations involving 12 public water supplies

- The number of nitrate violations (16) is the lowest in at least the last 10 years, having peaked at 64 in 2006.

- The only violation of a drinking water standard for an organic chemical (including VOCs and pesticides) was for trihalomethanes, a byproduct of disinfection.

Source:
http://www.iowadnr.gov/InsideDNR/RegulatoryWater/DrinkingWaterCompliance/AnnualComplianceReport.aspx

IGS

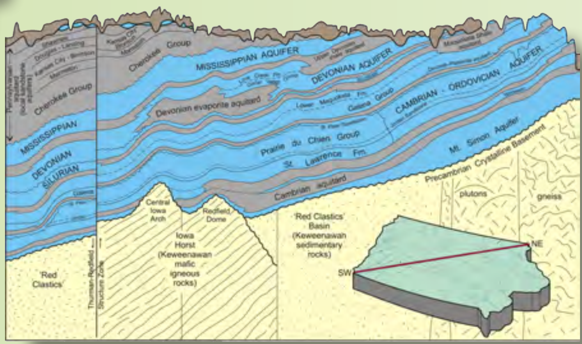
The Iowa Geological Survey

Nathan Young, Director
Iowa Geological Survey
319-384-1732
nathan-young@uiowa.edu

A New Partnership

IIHR—Hydroscience & Engineering (IIHR) is pleased to announce the transition of several Iowa DNR Iowa Geological and Water Survey Bureau components to IIHR, creating a new Iowa Geological Survey (IGS). This change provides an opportunity for IGS to strengthen its service programs and revitalize its geological research activities. IGS expertise in subsurface geology and groundwater and IIHR expertise in watershed and riverine processes will complement one another, stimulating new research advances and improving the critical services each group provides to the state.

IGS scientists bring new capabilities to IIHR, including mapping of Iowa's earth and mineral resources, innovative geophysics skills, groundwater modeling, and more. By transitioning to IIHR, the IGS scientists gain access to IIHR's broad range of equipment, instrumentation, and computational resources. They will benefit from close access to IIHR's core expertise in fluids-related research and modeling, contribute to many of IIHR's ongoing research projects, and lead new research initiatives.



Surface to Subsurface

IIHR offers expertise in monitoring, modeling, and investigating watershed and riverine processes, while IGS staff offer expertise in subsurface processes. IGS staff also curate soil and rock samples from nearly 40,000 Iowa wells and offer expertise in the interpretation of this material. Thus, the transition of IGS staff to IIHR will facilitate a broader systems-approach to the study of the connectivity between surface and groundwater resources, which will lead to more refined models and tools used to make a wide range of critical water-related decisions.

Larry Weber, Director
IIHR—Hydroscience & Engineering
319-335-5597
larry-weber@uiowa.edu

IIHR Hydroscience & Engineering

Floods to Drought

The Iowa Flood Center (IFC), a research unit within IIHR, offers unparalleled expertise and information related to flooding. But what about drought? IFC, IGS, and other IIHR researchers will work together to revive a comprehensive groundwater observation network to better monitor and model Iowa's groundwater resources. Coupling of IGS and IFC expertise will provide communities and decision-makers with better information for the management of Iowa's precious water resources, improving preparedness and response to flood and drought events.

Continuing Services

The new IGS will continue to offer a wide range of services to Iowans, including: providing geologic advice to agencies, municipalities, and other stakeholders; continuing surficial and bedrock mapping activities across the state; maintaining a repository of geological samples and data; initiating and continuing geologic research projects across the state; and offering a wide range of outreach and educational activities.

The Iowa Nutrient Reduction Strategy: Implications for Groundwater

Keith Schilling, Iowa Geological Survey

The Iowa Nutrient Reduction Strategy (INRS) is a science and technology based framework to reduce nitrogen and phosphorus delivered to Iowa rivers and the Gulf of Mexico from point and nonpoint sources. The strategy, finalized on May 29, 2013, was the product of more than 2 years of work led by Iowa Department of Agriculture and Land Stewardship, Iowa Department of Natural Resources, Iowa State University with contributions by more than 20 individuals from various agencies and organizations. The INRS included three main sections in the report, with Section 1 focused on policy considerations, Section 2 on nonpoint source strategies and Section 3 on point source strategies.

An objective of the strategy was to evaluate potential conservation practices needed to reduce nitrate-N and phosphorus by 45% through in-field, edge-of-field, and land management practices. The strategy stated that nonpoint source load reductions for nitrate-N would need to achieve a 41% load reduction with the remaining 4% coming from point sources. For phosphorus, the nonpoint source load reductions would need to achieve 29% with the remaining 16% coming from point sources. For more information, the report can be viewed and downloaded at http://www.nutrientstrategy.iastate.edu/.

Although the INRS was designed to direct efforts to reduce nutrients in surface water from point and nonpoint sources, there are implications for groundwater protection and management, particularly with respect to reducing nonpoint source contributions from nitrate-N. Since nitrate-N is very soluble and readily leached to groundwater from row crop fields of corn and soybeans, groundwater discharge to streams as baseflow, or artificial drainage from subsurface tiles, provides the main source of nitrate-N to rivers and streams. So, in reality, reducing nitrate-N delivered to surface water is principally a groundwater issue.

The INRS evaluated 14 different nitrogen reduction practices in three main categories: nitrogen management, land use changes, and edge-of-field treatment. Of the nitrogen management strategies, reducing nitrogen application rates and planting cover crops were considered the practices with greatest potential effect, with reductions of approximately 10% and 30%, respectively. In contrast, practices such as sidedressing N or moving fertilizer applications to spring were shown to have little effect (4% and 1% reduction, respectively). Wetlands and subsurface bioreactors were shown to have the greatest potential for nitrate-N reduction as far as edge-of-field practices are concerned. However, while both practices have similar reductions (22% and 18%), a substantially larger load of nitrate-N can be reduced with wetlands intercepting large drainage district tiles compared to bioreactors designed to intercept smaller tiles. Controlled drainage (managing water levels in tile drainage networks with gates and stop logs) is not a viable practice for much of Iowa since it requires land slopes less than 1% to be effective. Similarly, riparian buffers can have tremendous nitrate-N reductions but groundwater flow rates through systems limited their potential for achieving statewide nitrate-N reductions (approximately 7%).

An objective of the strategy was to evaluate potential conservation practices needed to reduce nitrate-N and phosphorus by 45% through in-field, edge-of-field and land management practices.

Land use change showed tremendous potential for reducing nitrate-N delivered to streams. Converting row crop land to perennial systems (either energy crops or CRP) achieved reductions of 70-80%, whereas utilizing extended rotations of alfalfa in 4-5 year rotations with crops would achieve reductions of more than 40%. Although data was not available to evaluate grazed pastures as an effective nitrate-N reduction strategy, the effectiveness was assumed to similar to CRP (85% reduction). However, the degree of nitrate-N reduction achieved with land use change is dependent on the overall amount of land converted to these systems, so chances are, in today's agricultural and economic climate, widespread adoption of land use change for nitrate-N reductions is not likely.

It was clear in the INRS that there was no single strategy that would achieve the 41% nitrate-N reductions from nonpoint sources. While there are endless possibilities to achieve

Photos are curtesy of USDA NRCS

the needed reductions, one scenario evaluated in the strategy combined nitrogen application reductions on all crop ground, planting 60% of the crop ground with cover crops, treating 27% of the agricultural land with a wetland, and intercepting 60% of drained agricultural lands with a bioreactor, to achieve a 42% reduction in nitrate-N. The economic cost associated with this combination of practices (note that costs were only evaluated in terms of lost agricultural productivity) was estimated to be 3.2 billion dollar initial investment (or 756 million per year as equal annualized cost). This scenario and potential cost of adoption illustrates the tremendous challenge that awaits implementation of the INRS.

The groundwater implications of phosphorus reductions are less straightforward. Pollutants like phosphorus and sediment are primarily associated with soil erosion processes and the majority of P is typically transported to streams with rainfall runoff. The contribution of dissolved P from baseflow and tile drainage to Iowa rivers and streams is not well understood but can be as high as 25% in some heavily tiled watersheds. The INRS did not explicitly examine the role of dissolved P in groundwater in the practice evaluation, but many of the N reduction strategies apply to phosphorus as well. Practices such as a cover crops, riparian buffers, and land use change reduce overland runoff and reduce P by 50%, 18% and 3-29%, respectively. Reducing the rate of P applications to crop fields reduces the potential P source for overland runoff and potential leaching to groundwater.

Overall, while the INRS does not directly address groundwater in the science assessment, the implications for groundwater are everywhere in the document, especially for nitrate-N. Implementing the strategy to reduce nitrate-N in streams will necessarily focus efforts to reduce nitrate-N in shallow groundwater that drains to the stream, either as baseflow or tile drainage. Hence, the INRS will be a major "win" for groundwater protection in Iowa if it can be implemented to the degree needed to achieve the goal of the strategy to reduce nonpoint source nutrients in Iowa's river by 41% for N and 29% for P. Although reaching the goal in any realistic timeframe is not possible, at a minimum, any progress made toward reducing nonpoint sources of N and P to Iowa's rivers will result in some improvement in Iowa's shallow groundwater quality.

GROUNDWATER MODELING AS A TOOL IN DROUGHT MANAGEMENT

Mike Gannon, IGS-IIHR

Iowa experienced a severe statewide drought starting in the fall of 2011, and continued off and on throughout most of 2012 and 2013. Northwest Iowa, especially Sioux County, was particularly hard hit by the extended drought. Although Sioux County has a relatively low population of 34,547 residents (U.S. Census Bureau, 2013), 2.97 million hogs and 0.44 million cattle were marketed in 2009 (Iowa State University Extension, 2009). In addition, Sioux County is home to over 22,000 dairy cattle. An increase in water consumption by both urban and rural users in 2012 and 2013 put an enormous strain on water utilities, especially rural water districts. One of the largest water utilities in Sioux County is Rock Valley Rural Water District (RVRWD), located approximately 10 miles southwest of the City of Rock Valley **(Figure 1)**. Over 95 percent of the water sold by RVRWD in 2012 was used by livestock. Overall, RVRWD sold an average of 2.2 million gallons per day (mgd) of water in 2012, with a peak day usage of 3.8 mgd (Iowa Department of Natural Resources – Water Use Database). In addition to RVRWD, approximately twenty-one nearby irrigation wells pumped an average of 13.7 mgd of water during the summer of 2012.

To alleviate the stress on the aquifer, and to maintain a continuous water supply to its customers, RVRWD implemented an emergency water plan in May of 2013. The emergency water plan involved pumping water from the Big Sioux River using a temporary water use permit obtained from the Iowa Department of Natural Resources. Water was pumped from the river to a nearby sand and gravel pit **(Figure 2)** at approximately 3,000 gallons per minute. Both static and pumping water levels in the RVRWD production wells began to rise, and water production increased to pre-drought levels.

To better understand the hydrology near the RVRWD wellfield, a groundwater flow model was developed in the fall of 2013. Visual MODFLOW version 2011.1 was used to simulate groundwater flow in the alluvial aquifer under severe drought conditions. RVRWD wells and the 21 irrigations wells were included in the model simulation. Water usage was obtained from the Iowa Department of Natural Resources water use database, IDNR Water Supply Section, and RVRWD.

An evaluation of the long term use of the nearby sand and gravel pit as a recharge basin was conducted using the calibrated groundwater flow model. The location of the recharge basin is shown in **Figure 3**. Water from a nearby small creek was simulated to flow into the sand and gravel pit via an excavated channel. Once the water elevation in the pit reached an elevation of 1,203 feet, the overflow from the pit would flow back into the original creek channel. For modeling purposes, the approximate water elevation in the recharge basin was assumed to be 1,203 feet above sea level at the start of the simulation, and was represented by a general head boundary. Flow from the unnamed creek was assumed to stop entering the basin at the start of the

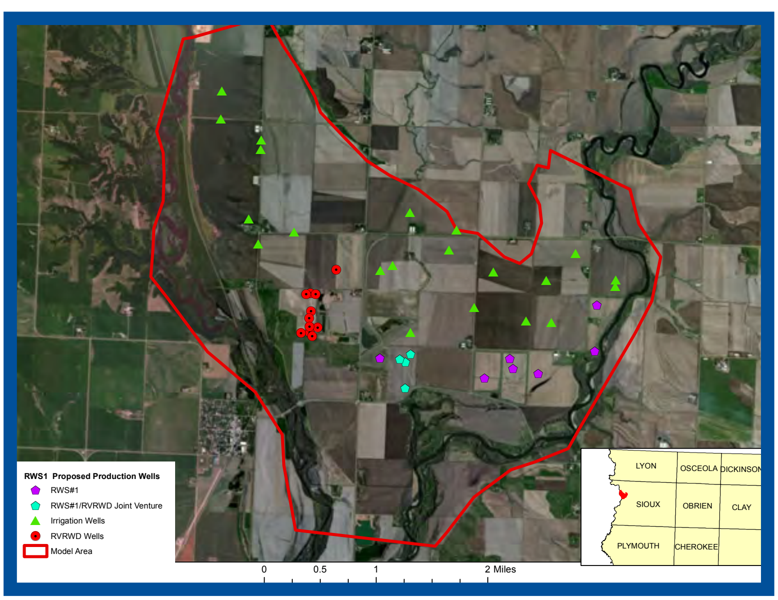


FIGURE 1. Alluvial aquifer study area.

FIGURE 2. The sand and gravel pit (recharge basin) used in the emergency drought plan.

TABLE 1. Simulated maximum pumping rates for RVRWD wellfield when the recharge basin is fully operational.

Well ID	Maximum Pumping Rate (gpm)
RVRWD 1	450
RVRWD 2	450
RVRWD 3	400
RVRWD 4	335
RVRWD 5	600
RVRWD 6	150
RVRWD 7	300
RVRWD 8	625
RVRWD 9	450
RVRWD 10	450
RVRWD 11	450
PW-1	500
PW-2	600
Estimated total Maximum Production = 5760 gpm	

drought. The induced recharge was assumed to enter directly into the aquifer.

Figure 4 shows the simulated upwelling or rise in the water table at the end of the 90-day period caused by the recharge basin. Increases in water table elevations range from 9 feet in Well 2 to 1.5 feet in Well 6. The recharge basin would allow all of the RVRWD wells to remain in use during a severe drought. **Table 1** shows the simulated maximum pumping rates for the RVRWD wells including the additional proposed wells.

Based on the model results, the recharge basin may increase the water production at the RVRWD wellfield to approximately 8.3 mgd. This is an increase of almost 2 to 3 mgd compared to present wellfield capacity. Most of the increase in water production is the result of the eleven production wells being able to pump at maximum capacity for 24 hours a day. A prolonged drought of six months or longer may require RVRWD to recharge the basin with water from an alternative water source, such as the Big Sioux River.

For additional information on drought assessments please refer to the following Iowa Geological Survey publications:

Groundwater Availability Modeling for the Hudson Aquifer, Sioux County, Iowa ftp://ftp.igsb.uiowa.edu/igspubs/pdf/OFR-2013-2.pdf,

Groundwater Availability Modeling for the City of Shenandoah, Iowa ftp://ftp.igsb.uiowa.edu/igspubs/pdf/OFR-2013-1.pdf,

Groundwater Availability Modeling Under Drought Conditions, Lower Raccoon River Aquifer, Dallas and Polk Counties, Iowa ftp://ftp.igsb.uiowa.edu/igspubs/pdf/WRI-7.pdf, and

Groundwater Availability Modeling, Des Moines River Aquifer, Palo Alto and Emmet Counties ftp://ftp.igsb.uiowa.edu/igspubs/pdf/wri-4.pdf.

ACKNOWLEDGEMENTS

The author would like to acknowledge the contributions of the many individuals who assisted in the project. Julie Sievers of the Iowa Department of Natural Resources provided observations and technical support. Engineering design for the project was provided by DGR Engineering, Rock Rapids, Iowa.

FIGURE 3. Aerial view of the recharge basin and excavated creek channel.

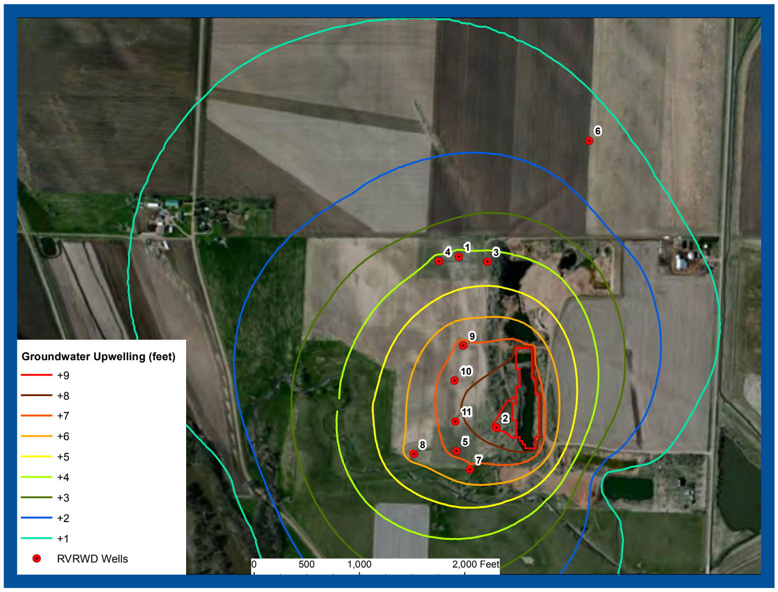


FIGURE 4. Simulated rise (upwelling) in the water table caused by the proposed recharge basin.

ELECTRICAL RESISTIVITY IMAGING

in Shallow Groundwater Investigations

Jason A. Vogelgesang – Iowa Geological Survey

Iowans rely on a continuous supply of water for drinking, irrigation, and industry. Much of the state can tap into underlying aquifers for reliable water resources. However, many areas in Iowa do not have access to these plentiful resources.

Regions of Iowa lacking access to adequate water resources rely on rural water associations for their water supply needs. Rural water associations often withdraw water from alluvial aquifers and distribute it to a wide range of customers. While alluvial aquifers have many benefits, recent drought conditions coupled with increased water use have challenged Iowa's rural water associations to create plans to address water supply issues.

The first step in creating a drought plan is to understand the geology of the aquifer. Rivers follow a path of least resistance, meandering and depositing sediment in patterns. Deposits of alluvial sediments can be difficult to interpret, especially when channel deposits cut into existing alluvial sediment. The Iowa Geological Survey (IGS) has embraced geophysical methods to assist in the characterization of alluvial aquifers. Geophysics is to geology like Magnetic Resonance Imaging (MRI) is to the medical field. Geophysical surveys produce a continuous image of the subsurface, allowing hydrogeologists to better characterize the aquifer.

The IGS recently completed a hydrogeologic investigation of the West Nishnabotna River alluvial aquifer near Manning, Iowa. This well field is utilized by the West Central Iowa Rural Water Association (WCIRWA), which has seen nearly a doubling of water use since 1993 (Iowa Department of Natural Resources – Water Use Database). The purpose of the investigation was to gather a hydrogeologic framework for the aquifer and provide recommendations on how to address water use and drought issues. The study incorporated geophysical surveying to gather and summarize geologic and hydrogeologic data. The aquifer was then modeled to determine sustainability of groundwater resources during increased use and drought conditions. Eight Electrical Resistivity (ER) transects were completed and analyzed in the study area (**FIGURE 1**).

ER imaging uses direct current as a means of modeling the subsurface. After the equipment was spread across a transect, pulses of electrical currents were introduced to the subsurface and simultaneously received, stored internally, and processed to create a final model. Generally, regions of coarse grained material are more resistive to electrical charge than fine grained material. The location and spatial arrangement of coarse and fine grained sediment regions are especially important in identifying potential productivity of alluvial aquifers, where the high permeability of coarse grained sand and gravel is preferred over confining clay and silt.

FIGURE 1. Electrical resistivity survey locations at WCIRWA's Manning well field.

The West Nishnabotna River was straightened prior to the study and old river paths were not visible. Geophysical survey locations were chosen based on 1930s aerial imagery, which was used to help determine river morphology before it was straightened. **FIGURE 3** shows how 1930s aerial imagery was used to locate an old river meander and how that channel correlates to the ER model created from that site.

Determining where productive sand and gravel exists in a well field is a critical first-step in alleviating drought and water use issues. If sand and gravel is discovered in hydraulic connection to the current river, induced recharge from the river can provide even more of a benefit to groundwater sustainability. ER geophysics has proven to be a valuable component in characterizing the alluvium and has identified several sites in the WCIRWA well field where new wells could be installed.

For additional information on how geophysics has been integrated into shallow groundwater studies, see the following recent publications from the Iowa Geological Survey:

Aquifer Characterization and Drought Assessment, Rock River Alluvial Aquifer – ftp://ftp.igsb.uiowa.edu/igspubs/pdf/WRI-9.pdf,

Groundwater Availability Modeling for the Hudson Aquifer, Sioux County, Iowa – ftp://ftp.igsb.uiowa.edu/igspubs/pdf/OFR-2013-2.pdf,

Jefferson Groundwater Investigation – ftp://ftp.igsb.uiowa.edu/igspubs/pdf/TIS-56.pdf,

Groundwater Availability Modeling for the City of Shenandoah, Iowa – ftp://ftp.igsb.uiowa.edu/igspubs/pdf/OFR-2013-1.pdf, and

The Cedar Falls Groundwater Investigation – ftp://ftp.igsb.uiowa.edu/igspubs/pdf/TIS-55.pdf.

FIGURE 2. Collecting electrical resistivity field data. Meter, switch box, batteries (main photo), cables, and electrodes (upper left).

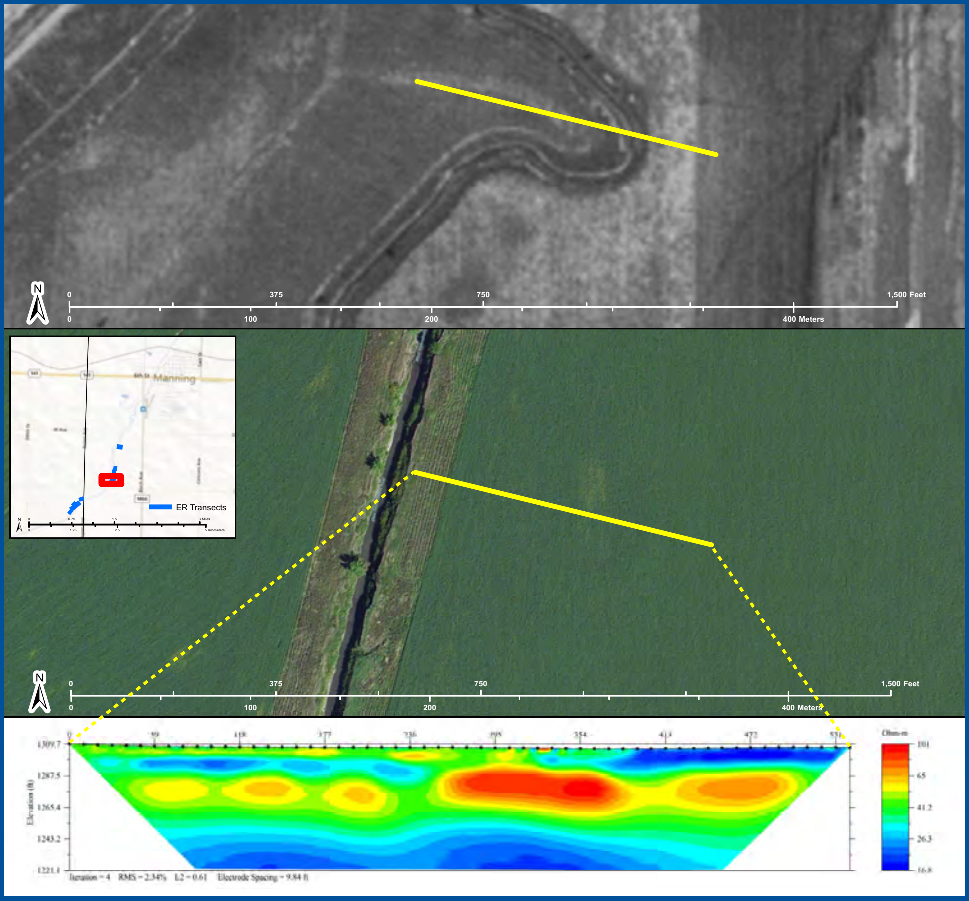


FIGURE 3. Two-dimensional ER model showing subsurface geologic variability. The upper image shows a river meander from 1930s aerial imagery. Note how the main channel in the 1930s correlates to the highly resistive material in the ER model. If the sand and gravel represented by the high resistivity extends in the orientation of the 1930s indicated channel, induced recharge from the current river could make this a productive well location.

HYDROLOGIC DROUGHT

NEAR INCISED STREAMS AND THE IMPLICATIONS FOR RIPARIAN RESTORATION

Keith E. Schilling[1*], Pauline M. Drobney[2], Thomas M. Isenhart[3], and Richard C. Schultz[3]

[1]Iowa Geological Survey, 109 Trowbridge Hall, Iowa City, IA, USA 319-335-1575, keith-schilling@uiowa.edu
[2]Neal Smith National Wildlife Refuge, United States Fish and Wildlife Service, Prairie City, IA
[3]Department of Natural Resources Ecology and Management, Iowa State University, Ames IA, USA

Riparian corridors are biologically diverse and valuable ecosystems at the interface between aquatic and terrestrial environments. Unfortunately, widespread degradation of many riparian ecosystems has occurred over the past century due, in many cases, to historical land management and stream channel changes. Practices, such as stream channelization, removal of riparian vegetation and increased flow from artificial subsurface drainage and ditches, has resulted in channel bed degradation and streams downcutting and widening into their floodplains. Incised channels are now common features in the Midwestern agricultural landscapes.

Riparian zones of incised channels represent a unique challenge for restoration because channel incision often lowers water table levels in the floodplain (Schilling et al., 2004).

Incised streams are hydrologically disconnected from their floodplains and, depending on the degree of incision, depth to groundwater (Dgw) may be greatest near the stream and shallower in more distal floodplain regions (**FIGURE 1**). In the agricultural Midwest, riparian zone buffers are a point of emphasis for reducing nutrient losses from row crop fields (Schultz et al., 1995). However, little attention has been given to the implications of water table lowering on riparian buffer restorations given that many streams in the region are considered incised. Improved understanding of water table conditions near incised stream channels is particularly important for selecting buffer vegetation appropriate for specific hydrologic conditions.

In a recently completed study at the Neal Smith National Wildlife Refuge in the Walnut Creek watershed (Jasper County), we characterized how water table depths varied in the riparian zone on an incised stream and recommended appropriate vegetation plantings best suited for riparian restoration or establishment of buffers near incised channels.

Walnut Creek, which drains a 5,218 ha watershed in Jasper County, Iowa, is incised approximately 3 m into its floodplain (**FIGURE 2**). Eight transects of monitoring wells were installed in the Walnut Creek riparian zone in the four major land cover types including cool season grass, grazed pasture, woods and reconstructed prairie. Wells were located approximately 1 m (well #1), 20 m (well #2), and 40 m (well #3) along a line perpendicular to the channel edge (**FIGURE 2**). Each well was equipped with a pressure transducer to record hourly water level fluctuations from July 2005 to March 2008.

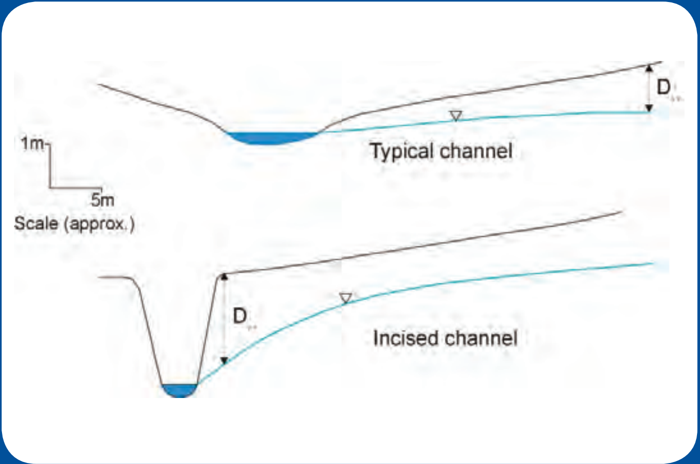


FIGURE 1. Conceptual model of water table depth near a) a typical channel; and b) an incised stream (Dgw = depth to groundwater).

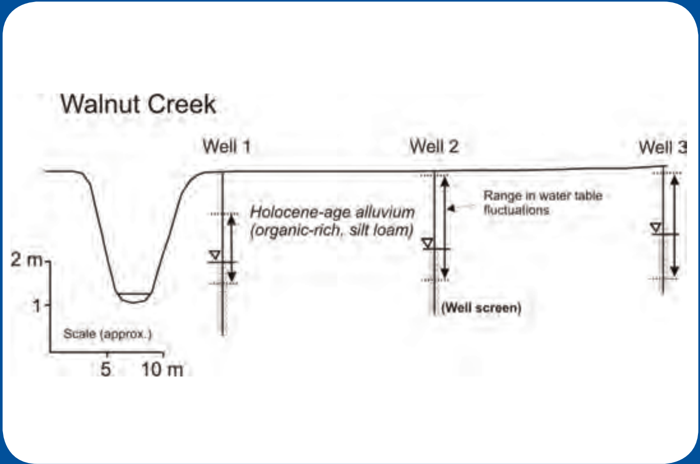


FIGURE 2. Generalized cross-section of well transects. Arrows indicate range of water table fluctuations observed in the wells.

HYDROLOGIC DROUGHT

Monitoring results indicated that mean water table depths near the incised channel (1-m) were significantly deeper (2.19±0.27 m) than wells located at 20-m (1.64±0.44 m) and 40-m (1.24±0.49 m) (Figure 3). Average minimum water table depth (highest water table surface) remained more than 1-m deep near the incised channel, but was at or above the land surface on occasion at the #3 well positions on several occasions. Maximum water table depths ranged from 2.62 m at well #1 to 1.91 m at well #3, yet the greatest range in water table fluctuation across the monitoring period was observed at well #2. Since the water table at well #1 was largely controlled by stream elevation, and water table in the floodplain at well #3 was indicative of more perennially wet floodplain conditions, the intermediate well at 20-m fluctuated between the two end members.

Lower groundwater tables and drier conditions near Walnut Creek is consistent with the urban "hydrologic drought" concept of Groffman et al.(2003) who first coined this term in response to dry riparian zones observed near incised urban streams in Maryland. In our study, we adopted the "hydrologic drought" concept to describe the role of channel incision to affect water table dynamics in the riparian zones of incised agricultural streams. Hence, our findings broaden the scope of hydrologic droughts to agricultural regions where channel incision occurred in response to historical land use practices and stream channelization.

IMPLICATIONS FOR RESTORATION

A better understanding of riparian water table behavior can help improve the success of riparian restorations (**FIGURE 4**). Near the incised stream we recommend that species selections be based on their ability to: 1) tolerate of dry and occasionally episodic wet soil moisture conditions; 2) form a tight network of roots to stabilize soil and resist erosion, 3) facilitate rapid reestablishment of vegetation after extreme erosional events, and, 4) provide a vegetative buffer between the stream and the developing native riparian community or cropfield. In distal floodplain zones beyond the hydrologic drought influence of channel incision, restoration can be focused on wet prairie species or more riparian forest tree species that may have existed in these areas pre-settlement. Restoration species are selected that are adapted to high water tables and saturated conditions that have developed in the flat, and poorly drained floodplain.

Results from our study reinforce the need to match species and planting strategies to hydrologic conditions at restoration sites. Near incised channels, variable soil moisture conditions and water table depths may lead to zonal planting schemes, whereby one zone is focused on native plantings capable of colonizing and thriving in a harsher near-stream region and another, more distal zone is planted with native wet prairie or forest vegetation more representative of pre-settlement conditions. Depending on the width of the hydrologic drought zone species selection for riparian buffers can also be modified to respond to the variations in water table depths.

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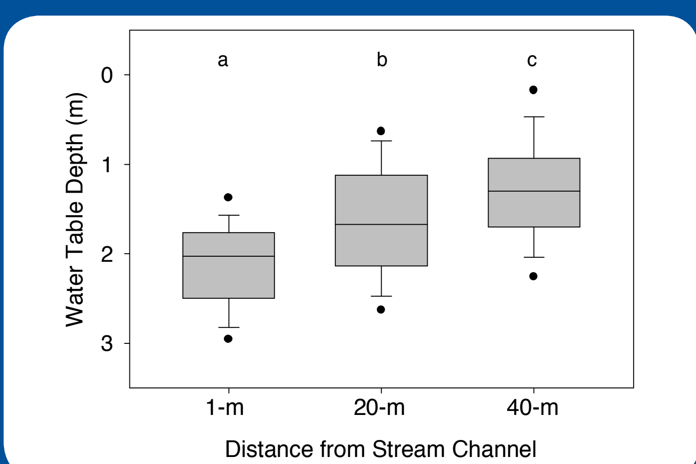


FIGURE 3. Classification of water table depths by well position. Box plots illustrate the 25th, 50th, and 75th percentiles, the whiskers indicate the 10th and 90th percentiles and the points represent data outliers. Letters denote significant differences at p<0.05.

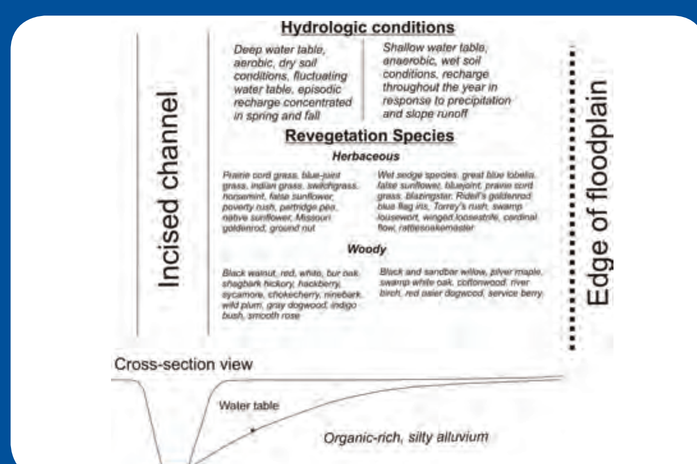
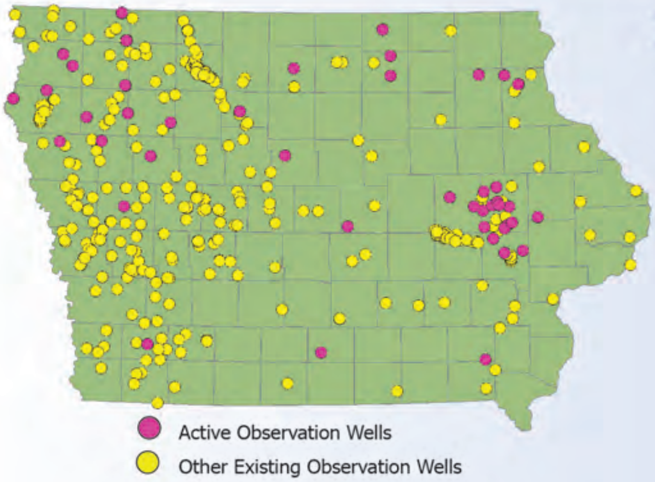
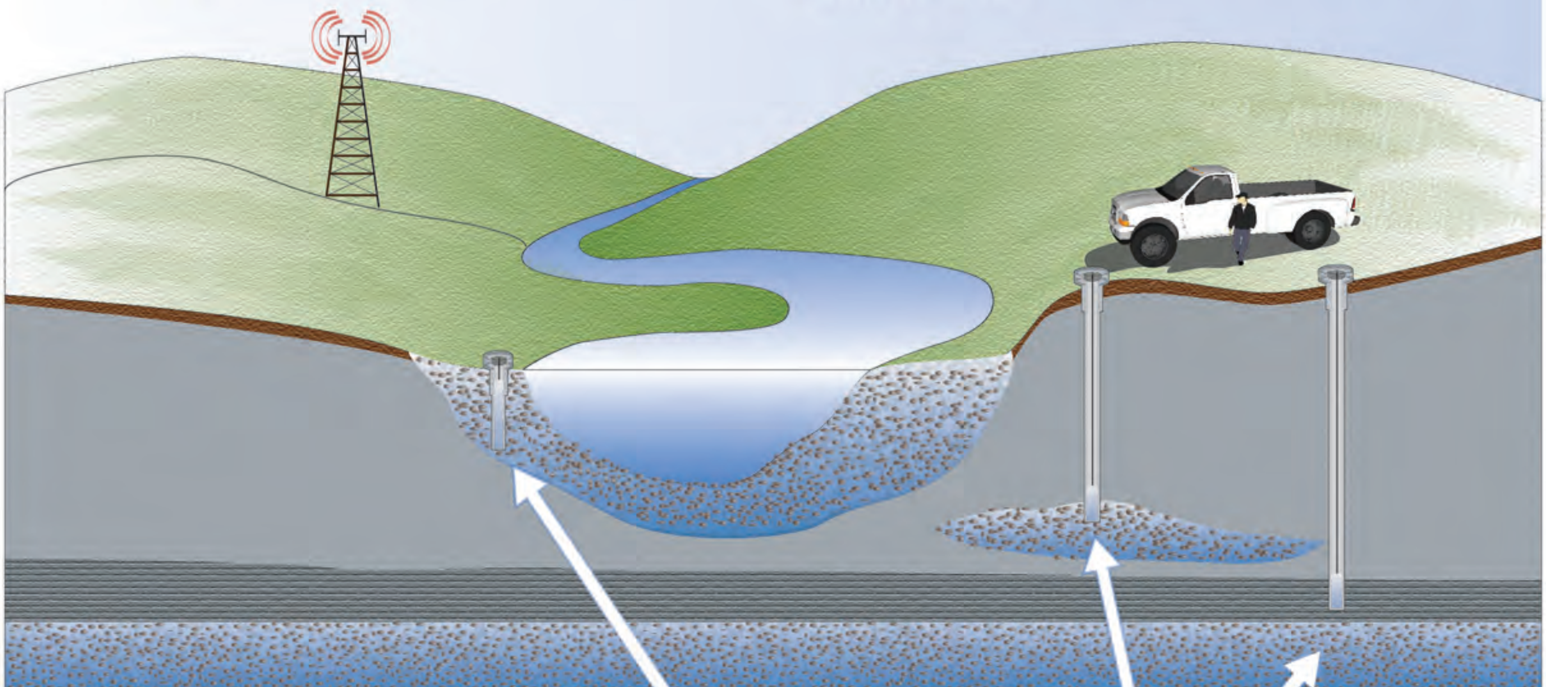


FIGURE 4. Summary of hydrologic conditions and recommendations for specific herbaceous and woody species suitable for the hydrologic drought zone that develops near incised Midwestern streams. The plan view is projected downward on a typical riparian zone cross-section showing water table depth variations.



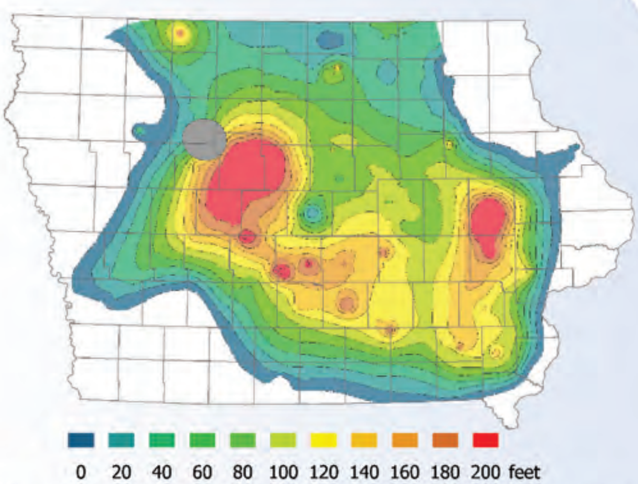
Iowa Groundwater Observation and Forecasting Program

Current Iowa groundwater observations are inadequate. However, numerous existing observation wells can be used to expand upon available information. Restoration and sampling of wells carefully selected to ensure a complete and accurate characterization of Iowa's aquifers will inform appropriate use of this valuable and limited resource.



Alluvial aquifers are well connected to rivers and streams, and respond quickly to changes in rainfall. Automated measurement systems can frequently capture changes in water levels and transmit them to a central database.

Deep aquifers respond slowly to changes in precipitation. They are slowly replenished and are susceptible to overuse. Quarterly manual measurements are sufficient to capture trends in their water levels.



Simluated decrease in Cambrian-Ordovician Aquifer water levels through 2034

Observations will provide information necessary to create computer simulations of regional groundwater levels. Computer simulations will be used to forecast aquifer changes and aid in planning and management of groundwater resources.

IIHR Hydroscience & Engineering

Iowa Groundwater Observation and Forecasting Program

Groundwater is a valuable but limited resource

A more complete understanding of Iowa's groundwater resources is necessary to ensure they remain a reliable source for municipal, industrial, and private water needs.

More groundwater observations are needed

Numerous wells have already been installed throughout the state and can be used to observe groundwater levels. Manual and automated measurements at up to 120 wells, carefully selected to ensure a complete and accurate characterization of Iowa's aquifers, will capture current conditions and trends in Iowa's groundwater levels.

Groundwater forecasting will aid in planning and resource management

The observation program will provide information necessary to create computer simulations of regional groundwater resources. Computer simulations will be used to forecast aquifer response to changes in rainfall or groundwater withdrawals.

Groundwater information is valuable in understanding droughts and floods

Measurement and simulation of Iowa's groundwater resources will complement ongoing and developing programs at the Iowa Flood Center by providing a complete characterization of atmospheric, surface water, and groundwater systems affecting water quantity. Alluvial wells will allow Iowa Flood Center researchers to better understand surface water / groundwater connectivity and its importance in flood processes, improving their ability to forecast short-term flood risks.

Scope of work

The Iowa Geological Survey, a unit of the University of Iowa's IIHR–Hydroscience & Engineering, will

- develop a groundwater measurement program to track water levels in Iowa aquifers using manual and automated measurement techniques at up to 100 sites;
- drill up to 20 new wells in targeted areas to better understand how withdrawals associated with municipal, industrial, and private activities may interact, and to create nested well groups that allow sampling from multiple aquifers at different depths;
- perform computer simulations of regional groundwater resources to predict groundwater availability;
- and make measurement and simulation data available via a web-based portal.

Budget

• Drilling of new wells in targeted areas of intense withdrawal or geological significance	$ 100,000
• Automated groundwater level measurement instrumentation (up to20 sites)	$ 100,000
• Quarterly well measurement and maintenance (up to 100 sites)	$ 100,000
• Computer simulation of Iowa's groundwater resources	$ 100,000
Total	**$ 400,000**

IIHR Hydroscience & Engineering

Road Salt Use and Groundwater Quality: Cedar Falls, IA

Brian Gedlinske

This long-term, intense deicing use has created environmental concerns – typically over surface water quality, aquatic life, and vegetation.

Since 1940, road salt use in the United States has escalated from roughly 0.28 to over 16 million metric tons annually. This long-term, intense deicing use has created environmental concerns – typically over surface water quality, aquatic life, and vegetation. Recent work, however, also ties road salt use to rising chloride (Cl^-) concentrations in groundwater supplies.

Cedar Falls is located in a potential karst region of northeast Iowa and relies on the Devonian aquifer for its groundwater supply. Eight active municipal wells interspersed throughout the city tap the aquifer. The University of Northern Iowa (UNI) is also located in the western metro area. UNI operates several geothermal wells which withdraw Devonian aquifer groundwater during summer months for campus building cooling needs. Cedar Falls and UNI also rely heavily on deicers to maintain roads and provide safe pedestrian travel during winter months. Given these characteristics, Cedar Falls presented an excellent opportunity to 1) assess the effect of long-term road salt use on groundwater quality in a potential karst landscape; and 2) evaluate spatial attributes and well characteristics associated with groundwater salinity trends.

METHODS

A number of resources were used to assess recent deicing practices and evaluate groundwater quality trends and conditions. Seasonal road salt and brine application rates were obtained from the Cedar Falls public works department and UNI facility management. Historic Na^+ and Cl^- groundwater quality data were obtained from Cedar Falls Utilities (CFU) and the USGS's National Water Information System for the city's eight water supply wells. When compiled, this produced groundwater quality datasets that spanned 30 to 40 years for some wells. Finally, to evaluate groundwater Cl^- concentration gradients, groundwater samples were collected from eight of UNI's geothermal wells for Cl^- analysis.

To characterize the hydrogeology of the area, city well drilling logs were obtained from the Iowa Geological Survey (IGS) for review. Information collected included well depth, depth-to-bedrock, stratigraphy, and depth-to-groundwater during well construction. Groundwater elevation data from UNI's geothermal wells was also integrated into the study to compare groundwater flow with Cl-concentration gradients.

TABLE 1.

Table 1
LULC – Road Salt Usage Summary

Area	Approximate Area	Impervious Surface	Average Road Salt Use	Road Salt Use per Total Area	Road Salt Use per Impervious Surface Area
Cedar Falls	66.25 km^2	21 percent / 13.91 km^2	1430.1 metric tons/yr	21.6 metric tons/km^2	102.8 metric tons/km^2
Developed UNI Campus Area	1.92 km^2	45 percent / 0.86 km^2	544.5 metric tons/yr	283.6 metric tons/km^2	633.1 metric tons/km^2

GIS analyses were performed to assess spatial attributes that may contribute to rising groundwater salinity trends. This included a land use-land cover (LULC) assessment of the Cedar Falls city limits, UNI's developed campus area, and a 1,000 m radius surrounding each municipal well. LULC analyses were primarily used to identify and quantify impervious surfaces, providing an indication of areas receiving the greatest use of decier. CIR imagery and Light Detection and Ranging (LiDAR) data were also used to evaluate topography and surface drainage characteristics for each well location. Finally, ArcGIS Spatial Analyst was used to interpolate and illustrate Cl^- concentration data obtained for groundwater samples collected from UNI's geothermal wells.

RESULTS AND DISCUSSION

Although dependent on winter severity, roughly 1,406 metric tons of granular road salt are applied to Cedar Falls' streets each season along with over 23,300 gallons of 23 percent brine (roughly 24.1 metric tons of rock salt). Road salt use by UNI was approximately 454 to 635 metric tons per season. **FIGURE 1** illustrates the spatial extent of Cedar Falls and the developed portion of UNI's campus on 2010 CIR imagery. LULC analysis found that 21% (or 13.9 km^2) of the Cedar Falls area consists of impervious surfaces while UNI's campus area (approximately 1.9 km^2) has an impervious surface area of 45 percent. A summary of road salt use per total area and impervious surface area is presented in **TABLE 1**. As presented, UNI's campus represents a very concentrated source of road salt. **TABLE 2** summarizes the LULC results for the 1,000 m radius surrounding each well. As shown, the amount

(continued on page 18)

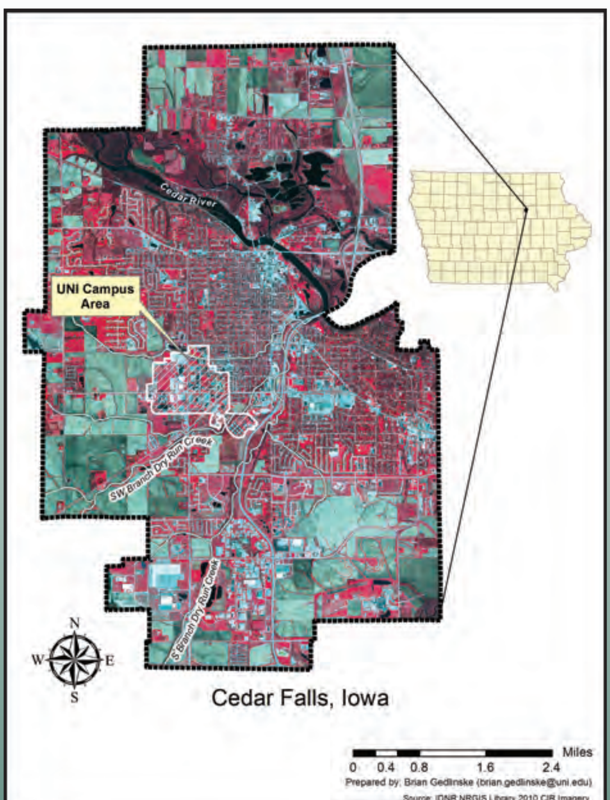


FIGURE 1.

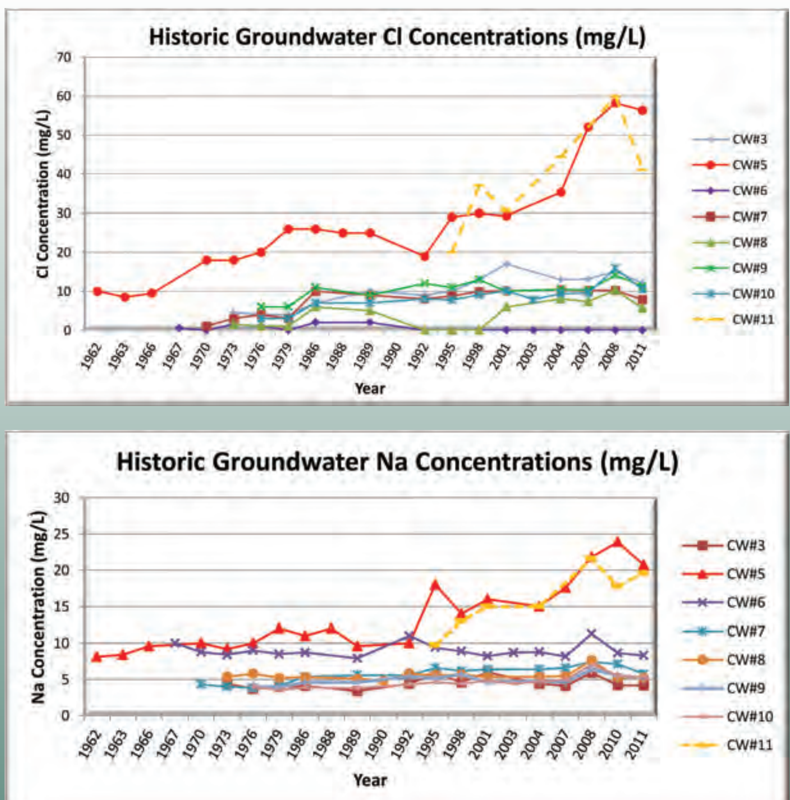


FIGURE 2.

Table 2
City Well Land Use - Land Cover Highlights
within a 1,000 m radius of each well

City Well	Percent Impervious Area	Topographic Description / Distance to Perennial Drainage (m)
CW#3	25	Upland Area – Head Slope Swale / 427 m
CW#5	40	Lowland Area - Alluvial Terrace / 152 m
CW#6	18	Upland Area - Interfluve / 700 m
CW#7	32	Upland Area - Interfluve / 640 m
CW#8	17	Upland Area - Interfluve / 457 m
CW#9	13	Lowland Area - Alluvial Terrace / 795 m
CW#10	13	Lowland Area - Alluvial Terrace / 762 m
CW#11	29	Lowland Area – Base Slope / 67 m

(continued from page 17)

impervious surface area in this region ranged from 13 percent for CW#9 and CW#10 to 40 percent for CW#5.

Historic Na^+ and Cl^- groundwater quality data compiled for each municipal well is illustrated in **FIGURE 2**. Municipal wells CW#5 and CW#11 clearly stand apart with marked climbs in Na^+ and Cl^- since the early to mid-1990s. Although CW#5 and CW#11 share similar Na^+ and Cl- trends, it should be noted that these wells are roughly 3.5 km apart and are situated in different twelve-digit hydrologic unit code watersheds. CW#5 is located just southeast of UNI's campus area while CW#11 located along the city's eastern fringe. These wells also have quite different landuse histories in their immediate surroundings. CW#5 is in a well-established region (i.e., > 50 years old) largely surrounded by commercial development. CW#11, however, resides in a newly developed residential area that was mostly farmland less than a decade ago. The rapid climb in Na^+ and Cl^- suggests these wells are most susceptible to contaminants associated with urban development.

A review of drilling logs found: 1) municipal wells were 20 to 54 years old; 2) bedrock is at depths of 9.1 to 38.7 m; 3) depth to groundwater (at the time of well construction) ranged from 7.9 to 34.7 m; and 4) the Devonian aquifer at CW#5, CW#9, and CW#10 is overlain by alluvial sands and gravels while a confining layer of clay-rich till overlies the aquifer at the remaining well locations. Distances to a perennial stream ranged from approximately 70 m for CW#11 to 789 m for CW#10.

An empirical comparison of each municipal well's spatial, chemical, and physical attributes suggest CW#5 and CW#11 share the following characteristics:

- They are situated in topographically low-lying areas;
- Groundwater is relatively shallow (i.e., <19 m); and, perhaps most importantly,
- They are in close proximity to a perennial stream that receives surface drainage from highly developed areas with extensive impermeable surface areas.

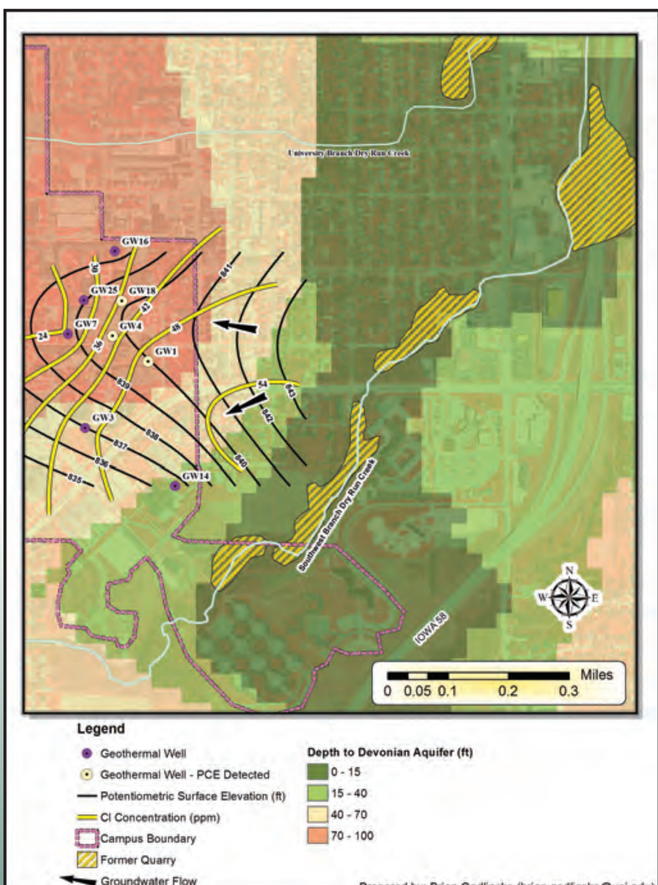
The remaining municipal wells appear less vulnerable to urban contaminants because they are located in upland areas, situated well away from perennial urban drainage, and/or are located in less developed areas. The age of the well and its construction did not appear to be a significant contributing factor.

Cl^- found in groundwater samples collected from UNI geothermal wells ranged from 17.1 to 56.3 ppm (Note: these levels are well above the median Cl^- concentration of 6.6 ppm found for the Silurian-Devonian aquifer in a 2004 USGS groundwater quality study report for Iowa municipalities). **FIGURE 3** illustrates Cl^- concentration isolines interpolated from the sampling data. It also includes other pertinent geospatial information such as former quarry locations, depth-to-bedrock data, and aquifer potentiometric surface isolines compiled for the area in previous studies. As shown, Cl^- concentrations decrease to the west-northwest away from Dry Run Creek (DRC) toward a highly productive portion of UNI's geothermal well field, paralleling the direction of groundwater flow. The Cl^- gradient suggests $NaCl$-laden surface runoff (from road salt applied to impermeable campus and urban surfaces) recharges the aquifer through the leaky streambed of DRC's Southwest Branch, a tributary once known for its numerous quarries and karst features. The resulting Cl- plume then appears to follow groundwater flow paths influenced by UNI's geothermal well field.

CONCLUSIONS

Findings suggest Cl^- and Na^+ groundwater quality data could be beneficial in urban planning, well siting, public health, and source water protection efforts. Due to its simplicity, Cl^- and Na^+ monitoring holds promise as a cost-effective first step to more detailed groundwater quality work, assessing aquifer vulnerability, and identifying wells more prone to urban groundwater contamination. Additionally, Cl^- spatial distribution patterns may prove useful in determining urban groundwater flow pathways, particularly in settings where: 1) meaningful groundwater elevation measurements are difficult, if not impossible, to obtain; 2) groundwater modeling results are suspect; and 3) groundwater flow patterns have become difficult to define due to the spatial distribution and temporal use of an ever-growing number of public, private, and commercial wells installed for drinking water and geothermal use.

FIGURE 3.



the effects of URBANIZATION ON WATER QUALITY OF STREAMS IN LINN COUNTY

Karleigh Schilling, Prairie Point Middle School and 9th Grade Academy, Cedar Rapids, Iowa

Editor's Note: Karleigh is the daughter of Keith Schilling, Research Scientist, at the Iowa Geological Survey and co-editor of IGWA Underground. Karleigh was one of five students selected to represent Iowa at the National Junior Science Symposium in Washington D.C. in April, 2014. The following is an abridged version of her research paper.

Urbanization is becoming an increasing problem in the United States and understanding the effects on water quality is becoming increasingly important. The objective of my project was to examine the amount of total dissolved solids in streams within Linn County, Iowa and assess whether the city is affecting water quality. My hypothesis was that streams within Cedar Rapids would have higher total dissolved solids (TDS) levels than streams in the rural countryside. TDS is the amount of material dissolved in the water. It could be calcium, magnesium, nitrate, chloride, or a myriad of other elements.

I used three different methods to evaluate the effects of Cedar Rapids on water quality. The first method was comparing a population of 10 urban streams to a population of 10 rural streams (**FIGURE 1**). These streams were chosen at random, and they were all small in size, approximately 1-2 meters in width. The second approach was to measure one stream in multiple locations as it flowed from the rural countryside through an urban area. For this purpose, my testing was done at Indian Creek. (Figure 1). The final method of evaluating TDS was comparing the upstream and downstream areas of a larger body of water, the Cedar River, which would

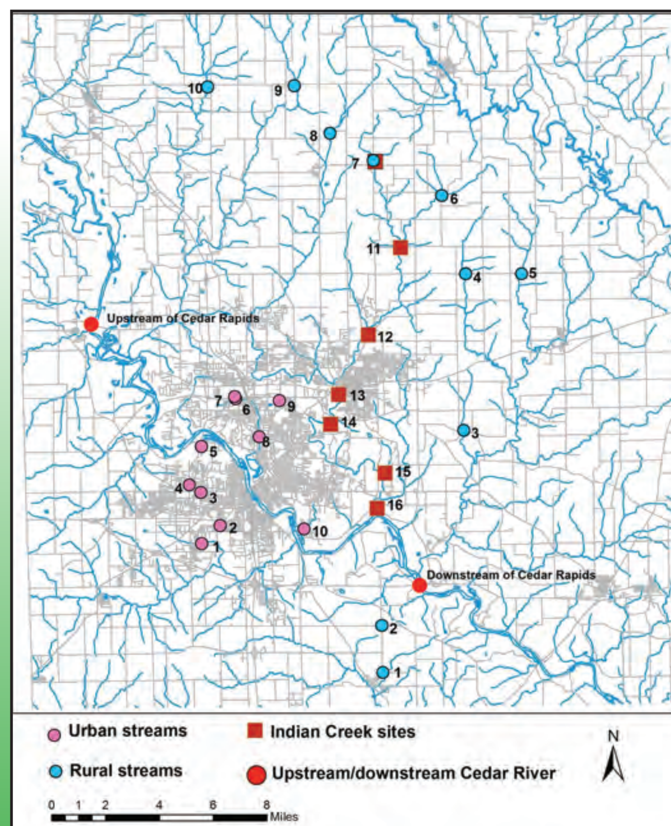


FIGURE 1. Map of locations where data was collected.

show if the river is affected by city discharge. I obtained upstream and downstream specific conductance levels from the Iowa Department of Natural Resources water quality monitoring database (https://programs.iowadnr.gov/iastoret/). Monthly samples have been collected since 2000 and analyzed by the State Hygienic Laboratory.

My data was collected using a YSI specific conductance meter. Specific conductance (SC) refers to the ability of water to conduct an electric current and is reported in units of umhos/cm. SC is proportional to TDS. The more dissolved substances in the water, the more conductive the water is and studies have shown that the correlation of specific conductance to TDS is very good. Finding the true TDS level of the water was not my main goal. I wanted to compare the difference between urban and rural streams.

Results showed that SC was higher in urban streams compared to rural streams (**FIGURE 2**). In urban areas, SC ranged from 739 to 1361 and averaged 963.5 umhos/cm, but in rural streams, the values ranged from 394 to 639 and averaged 524.3 umhos/cm. SC also increased as Indian Creek flowed from rural area to urban area (**FIGURE 3**). At rural Site 7 (**FIGURE 1**), the SC was 394 umhos/cm, compared to a maximum at Indian Creek Site 15 (**FIGURE 1**) of 686 umhos/cm. SC increased 292 umhos/cm as Indian Creek flowed through Cedar Rapids. On a much larger scale, SC levels upstream of Cedar Rapids ranged from 340 to 890 umhos/cm and averaged 544 umhos/cm. Downstream, the SC levels ranged from 180 to 710 umhos/cm and averaged 587 umhos/cm. Based on 99 samples collected over 10 years, SC values were approximately 43 umhos/cm higher downstream of Cedar Rapids.

All three of these methods showed similar results: an increase in TDS as the stream flowed through urban areas. However, the magnitude of the difference varied among methods. The contrast between urban and rural populations, (Method 1) was 439 umhos/cm, but the difference in SC levels in Indian Creek as it flows from urban to rural was 292 umhos/cm. Even lower was the change in SC as the Cedar River flows downstream, with a difference of only 43 umhos/cm. The reason for this is not known for sure, but may be related to the ability to isolate the differences between populations. Method 1 had the best results, because the urban and rural streams were clearly separated. Testing Indian Creek (Method 2) didn't produce as good of results as testing different populations, because the urban and rural waters mixed together as the rural water flowed into the urban areas. The effect was even more watered down in the Cedar River, because the river flows though many urban and rural areas before it even arrives upstream of Cedar Rapids. The influence of Cedar Rapids was hard to measure in a large river, but my data showed the same effect was still occurring, just to a lower degree.

I measured SC during December when stream water levels were very low. This means that the water I tested was groundwater seeping into the streams, not rainwater running off the land. Testing during low water levels gave me more accurate data on the urban influence on water quality than testing rainwater would have.

SC is a general measure of TDS in water but it does not tell you precisely what is causing the increase. Further study is required to determine what the causes may be, but possible factors could include road salts, wastewater, and fertilizers.

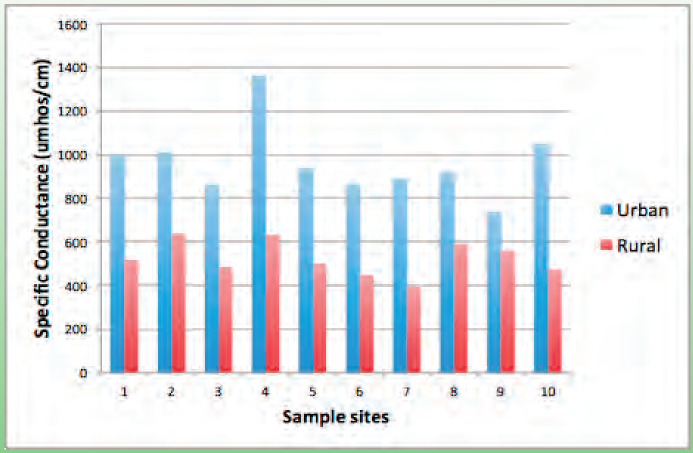


FIGURE 2. SC levels of urban and rural populations in Linn County.

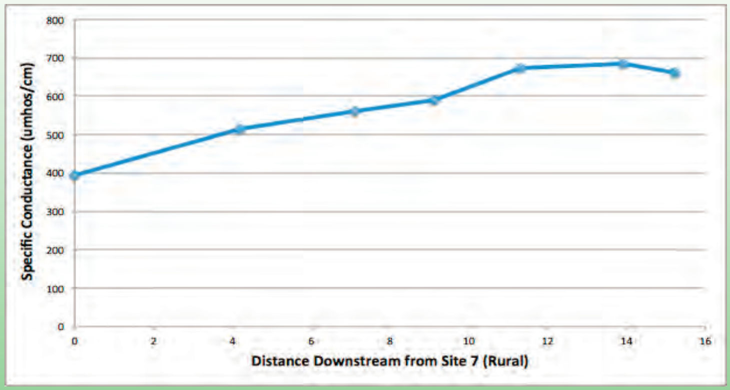


FIGURE 3. SC levels increasing from upstream to downstream Indian Creek.

Vapor Intrusion Issues
(Perchloroethylene and Trichloroethylene)

Stuart C. Schmitz, M.S., P.E. - State Toxicologist, Iowa Department of Public Health

All of us who have worked in the environmental field for some time are acutely aware of environmental issues involving the presence of chemicals in groundwater and within surface and sub-surface soil. With the passage of the Groundwater Protection Act in 1987, most of our work in environmental investigation and cleanup has involved issues related to groundwater and soil. But chemicals do not necessarily remain dissolved within the groundwater or adsorbed to the soils. Volatile organic chemicals (VOCs) are also present in the air void spaces within the soil (soil gas) which migrate upwards into the atmosphere, or possibly into buildings through a process called vapor intrusion.

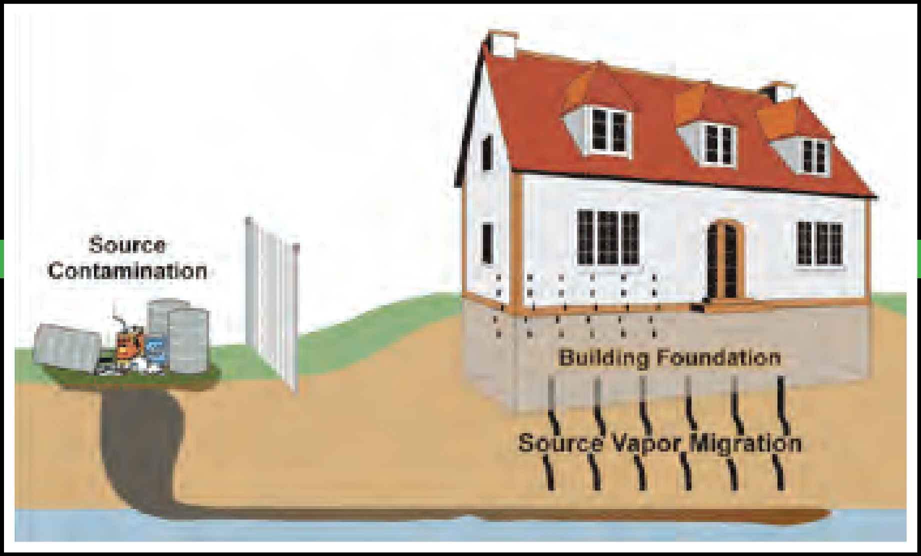
Two of the common organic solvents that can be present within groundwater and soils in our modern age are perchloroethylene (PCE) and trichloroethylene (TCE). PCE is a manufactured chemical that is widely used for dry cleaning of fabrics and for metal-degreasing. TCE is a manufactured chemical that is used mainly as a solvent to remove grease from metal parts, but it is also an ingredient in adhesives and in paint removers. These two VOCs have recently been the focus of both federal and state environmental and health agencies in the development of risk-based cleanup standards, screening levels, or comparison values.

Cleanup standards, screening levels, or comparison values are all calculated levels of chemicals within environmental media (groundwater, soil, and air) that are determined safe for human health based upon our current knowledge of the toxicological impact of these chemicals. Recent toxicological work led mostly by two federal agencies, the U.S. Environmental Protection Agency (EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR), has produced new screening levels or comparison values for both PCE and TCE. I would like to take some time to describe what these levels are and what they mean when applied to vapor intrusion concerns.

There are several types of screening levels or comparison values that have been developed for inhalation exposure to both PCE and TCE. In the development of these levels, toxicologists are concerned both with non-cancer and carcinogenic health impacts. The screening levels developed by EPA for non-carcinogenic health impacts from inhalation exposure are called reference concentrations (RfCs) and are based upon either the lowest level of adverse health impact seen in animal studies or in human exposures, or the level where no adverse health impact is seen. Additional safety factors are utilized in the establishment of RfCs (from 10 to 1,000 fold) to provide an adequate buffer for human health. In determining carcinogenic health impacts from inhalation exposure the EPA estimates levels of chemicals in

Table 1 – EPA Screening Levels for Inhalation Exposure to PCE and TCE (Residential Setting)

	Levels of Chemicals within Air ($\mu g/m^3$)	
Chemical	Non-Cancer Impacts	Carcinogenic Impacts
Perchloroethylene (PCE)	40	3.8
Trichloroethylene (TCE)	4	0.24



the air that would cause an increase in cancer of a one case in one million people in a community. This is a very small statistical increase in the incidences of cancer when you consider that about one of every three people will be diagnosed with some type of cancer in their lifetime. Table 1 includes the current screening levels utilized by the EPA for inhalation exposure to PCE and TCE in a residential setting.

These screening levels should not be viewed as levels where adverse health impacts will occur for the exposed individual, but levels at which we can confidently say, with a good margin for safety, that no adverse health impacts will occur even with a lifetime of exposure. Sometimes these levels are adjusted by a regulatory agency if more information about the actual exposure is known or that agency is comfortable with lower margins of safety.

The carcinogenic screening levels shown above can be higher than the average levels of PCE and TCE that we find in cities across the United States. From a review of the Toxicological Profiles available from the Agency for Toxic Substances and Disease Registry (one of the premier sources for toxicological information) the average level of PCE in urban communities in this country ranges from 0.2 to 9 μg/m^3. The average level of TCE in urban communities in the country ranges from 0.05 to 1.7 μg/m^3. This becomes problematic if a regulatory agency would be requiring vapor intrusion issues to be addressed to such an extent that levels of PCE or TCE within indoor air be lowered below levels that everyone is exposed to everyday in the outside air. We need to be reasonable and apply common sense with our environmental cleanup programs.

Another difficulty with vapor intrusion issues is determining what level a person may be exposed to and how much of that exposure is actually due to the presence of the volatile chemical in sub-surface soils, groundwater, or soil gas. Both PCE and TCE are common solvents and can be present in a variety of commercially available products that people keep within their homes. The mere presence of these chemicals within a home does not mean that its presence is caused by vapor intrusion. The sampling of soil gas below a foundation can be conducted and then a modeled estimate can be made to determine the indoor concentration of either PCE or TCE. These modeled or estimating processes are subject to much uncertainty and may not represent an accurate measurement of the true health risk to people.

The new ASTM standard 1527-13 "Standard Practice for Environmental Site Assessments: Phase I Environmental Site Assessment Process" recommends that vapor intrusion issues be considered by environmental professionals conducting a Phase I Environmental Site Assessment, but little guidance is offered as to the scope of investigating potential vapor intrusion

issues. This leaves the door wide open for environmental professionals to either over or under investigate a site. It is my hope that the environmental community (environmental regulators, responsible parties, consultants, health agencies, and community members) take a close look at the true potential of health impacts from vapor intrusion of PCE and TCE make responsible decisions balancing our concern for the public health with our limited resources to address these issues.

A SOURCE WATER PROTECTION PERSPECTIVE ON CONTAMINANTS OF EMERGING CONCERN IN IOWA'S GROUNDWATER

Chad Fields[a], Claire Hruby[a], Robert Libra[a], and Dana Kolpin[b], a - Iowa Department of Natural Resources (IDNR), b - United States Geological Survey (USGS)

INTRODUCTION

New sophisticated and sensitive analytical techniques have detected the presence of previously unknown and unregulated contaminants in groundwater, normally at concentrations of parts per billion (ppb) or less. These pollutants include pesticides and pesticide degradates used extensively in row crop production; pharmaceuticals, including common stimulants, prescription and over-the-counter drugs, and narcotics compounds typically originating from urban wastewater; and micro-organisms such as viruses and bacteria that can be from both rural and urban sources. The term 'contaminants of emerging concern' (CECs) is commonly used to refer to these types of compounds that were previously not considered or known to be significant in groundwater, but are now becoming more widely detected.

Last year (2013), 66 public wells were volunteered for an intensive four-hour source water sampling process to help better understand the occurrence of CECs in Iowa's groundwater. The wells, while representing a small percentage of the total population of Iowa's public water wells, characterize the diversity of climate and hydrogeologic conditions in the state. The selected wells were spaced regionally across Iowa to include all of Iowa's major landform regions, aquifers, well construction types, geologic conditions, and land use (**FIGURE 1**). Water quality results from this project will help scientists and policy makers better understand the prevalence of CECs within Iowa's groundwater and establish benchmarks for the state's Source Water Protection Program. This study is one of the first of its kind in the United States to characterize CECs in groundwater at the statewide level.

A total of 208 water quality parameters were measured in 66 public wells for the study. Parameters included 109 pharmaceutical compounds, 35 pesticide compounds, 19 metals, five microbial indicators, three bacterial pathogens, and 10 groups of viruses. Basic water quality parameters including nutrients, metals, anions, and cations were also sampled and analyzed concurrently with CECs. Tritium was also analyzed on a subset of samples as an indicator of groundwater age.

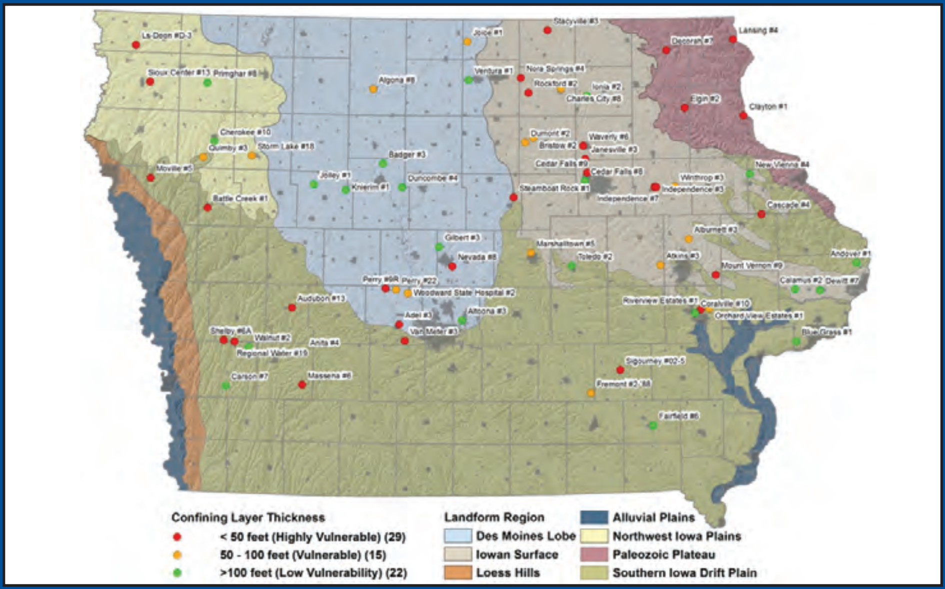


FIGURE 1: Map showing CEC wells, land use, and geologic vulnerability for contaminants of emerging concern in Iowa's groundwater.

Public Well Selection Criteria

Due to budget and project constraints, only 66 out of roughly 3,246 active public wells in Iowa (2% of the total population) were selected for this study. Since part of the project's goal was to conduct a statistical analysis of well system characteristics to CECs and other water quality parameters, it was necessary to select wells based on known characteristics for later correlation and analysis. For this reason, all wells selected actively pump water and have available location, construction, and hydrogeologic information to correlate with CEC detections

Four different well categories were used in the statistical analysis:

1) Well production (<40,000 gpd, >40,000 gpd)
2) Well age (<1980, 1980-2000, >2000)
3) Dominant land use around the well (developed, row crop + grasses)
4) Confining layer thickness between land surface and aquifer (<50 ft., 50-100 ft., >100 ft.)

RESULTS

For the statistical analysis, CEC results were grouped according to major categories in Table 1 with binary (yes, no) detection results aggregated for each category: pharmaceuticals and lifestyle, pesticides and degradates, viruses and pathogens, microbial indicators. Nitrate-nitrite-N was also included in the analysis as it has historically been documented to be a frequent groundwater contaminant in Iowa. **(FIGURE 2)**

Well Production: Although the differences were not statistically significant (i.e. $p<0.05$), a higher percentage of wells had detections of nitrate + nitrite in the high pumping category (31%) than the low pumping rate category (20%). The same was true for the pesticide and pesticide degradate group, with a detection frequency of 44% in wells in the high pumping rate category, compared to 36% in the low pumping rate category. No statistically significant differences between pumping rate categories were noted for microbial indicators, pharmaceuticals, or viruses and bacteria detected using genetic methods, and the detection frequencies in each category.

Well Age: Nitrate + nitrite as nitrogen occurrence decreased significantly as well ages decreased ($P = 0.05$). 71% of wells drilled before 1980 had nitrate + nitrite detections, while 31% of wells drilled between 1980 and 2000, and 11% of wells drilled after 2000, had detectable levels of nitrate + nitrite. The relationship between well age and pesticide occurrence is similar to nitrate + nitrite, but not significant. These trends may result from improved well construction, source water protection activities, and required separation distances from contaminant sources. Recently, there has been an emphasis on properly installing casings to depths that take advantage of existing geologic confining layers as a natural protective layer. All other water quality categories showed no visible or significant relationships between well age and contaminant occurrence.

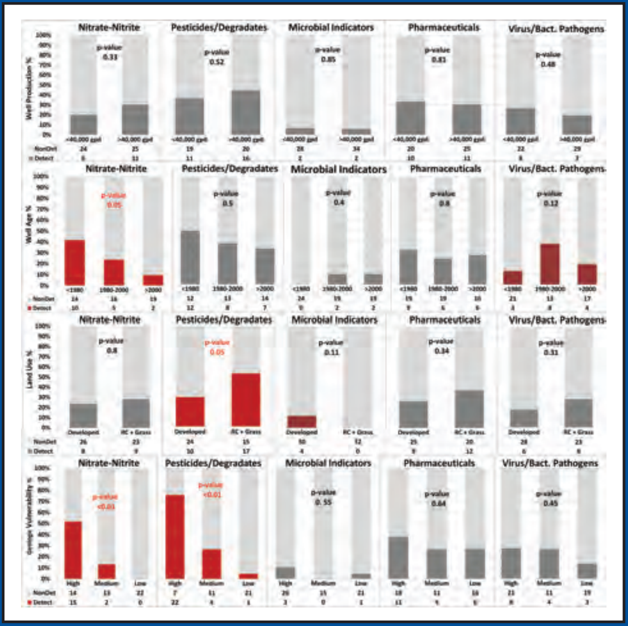
Well Area Land Use: Pesticides and pesticide degradates have a much higher occurrence in wells with primary nearby land use in row crop and grasses (at nearly 50%), compared to wells located in urban or developed settings (only 28%). Although all of the microbial indicators found in this study were from wells in urban areas, the small number of detections (only 4) prevented the results from being statistically significant ($P = 0.11$).

Geologic Vulnerability: Both nitrate-nitrite, and pesticides & pesticide degradates had strong declining frequency of detections from "High" to "Low" vulnerability categories. These were the most significant correlations from any of the categories. While 50% of the wells with confining layers less than 50 feet had nitrate-detections, only 12% had detections from 50-100 feet, and no nitrates were detected at all in wells that had over 100' of confining beds. A very similar trend was noticed in pesticides, with only one well having detectible pesticides (no nitrates).

CONCLUSIONS

Overall, out of all the water quality variables measured in this study, pesticides/degradate, and nitrate-nitrogen showed the strongest correlations with the well classification schemes. The other three CEC categories had either too few detections (microbial indicators) or established no significant trends (pharmaceuticals and viruses) or correlation with any of the descriptive variables. Unfortunately, the historic drought conditions present in Iowa during much of the sampling most likely influenced the results from both viruses and microbial indicators.
Results from this study suggest that well geologic vulnerability was an important driver for both nitrate and pesticides/degradates concentrations in groundwater. As the confining layer thickness increased, there was a corresponding decrease in the frequency of detection for nitrate-nitrite and pesticides/degradates. Land-use has a strong correlation with pesticides, with more wells in row crop and grassy areas having higher pesticides. There is also a fairly strong indication that wells located in urban or developed regions tend to have higher microorganism detections. A more expanded study that includes additional wells might yield enough information to make conclusions about the near significant correlations found with most CECs during this study. With a total of only four microbial indicator detections, even when correlations seem apparent there were not enough values to get significant correlations.

FIGURE 2: Tables with numbers of wells in each category, and plots showing frequency of detections (Detect) and non-detections (NonDet) for relationships between well categories and water quality groupings associated with contamination from the surface. P-values represent results of chi-squared and Fisher exact test statistical analyses.



Future groundwater studies should consider both well surroundings and geologic vulnerability and an increased number of sampled wells to better determine relations between CECs and ancillary factors.

ACKNOWLEDGEMENTS

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GROUNDWATER HERO

Paul Van Dorpe

RUSS TELL

On January 13, 1959 Wayne and Marilyn Tell were not celebrating that Elizabeth I had been crowned Queen of England. Nor were they celebrating Galileo's discovery of Calisto, the fourth moon of Jupiter. The National Geographic Society was founded on this date in 1988, but what Mr. and Mrs. Tell were rejoicing was the birth of their fourth child, a son, Russell.

Russ, an Iowa native, spent his early years on a farm near Dayton. His family moved into town (Dayton) before his teenage years. Wayne, a farmer who needed a well, became a well driller and found some success in this line of work.

Wayne believed that idle hands were the devils handmaiden and Russ was encouraged to work from a young age. He delivered newspapers, mowed lawns, and shoveled snow. When he was unruly, he got put to work pulling weeds in two large family gardens.

Russ worked in his father's shop, first tearing things apart, then putting them back together. He eventually began repairing and maintaining drill rigs and related equipment. On weekends and school breaks, he drilled wells with his father.

Russ attended Iowa Central Community College in their automotive, diesel, and welding program. After a couple of years laboring, Russ partnered with his father in the family drilling business, eventually purchasing Tell Well Company. Russ worked as a well driller for 25 years.

Russ, having learned the lessons of his youth well, applied his work ethic as he attended ISU as a non-traditional student, majoring in business and environmental science. While at ISU, he took on the opportunity to work for Don Nolting with the Story County Public Health, Sanitarian's Office.

It didn't take long before Russ's talents were recognized by the leadership team at the Iowa Department of Natural Resources (DNR). Russ came to the DNR to manage the Private Well Program as Brent Parker planned for retirement. Russ' understanding of the practical applications of groundwater protection through his years as a water well drilling professional and his experiences working in regulation have proven valuable, again and again.

Russ prides himself in being a resource for groundwater professionals, county staff, home owners, regulators from other states, and the regulated public. Russ began his experiences writing or collaborating on rules in 1986 when he was a volunteer on the Chapter 49 Committee. Since that time he has continued to work helping to ensure that Iowa Code keeps pace with the industry and developing the water well contractor examination and related educational materials.

He is a frequent speaker at meetings including regular appearances at the Iowa Water Well Association and the Iowa Groundwater Association.

Russ has countless other skills that he lends to the industry including conducting meetings, mediating divergent opinions, leading, following, and even standing in the middle, if necessary to promote the advancement of the private well program.

Russ is married to Marsha Peterson. Together they have raised 9 children: 7 girls and 2 boys. The recent years have been very busy for the family: adding 5 son-in-laws, one daughter-in-law, and three beautiful and talented granddaughters. Russ and Marsha anticipate an additional "population explosion" in the coming years. The family get-togethers are already difficult to contain, but a lot of fun.

Russ is a hero to his large family and, to the larger community, he is a groundwater hero! Join us in congratulating Russ on this new title.

Engineers Without Borders

Mike Saeugling, Project Engineer, VJ Engineering

Engineers Without Borders (EWB) is a non-profit humanitarian organization that partners with developing communities worldwide. Our mission is to improve quality of life by implementing environmentally and economically sustainable engineering projects. In 2010, EWB-USA sent 1,297 students and 729 professionals to partner with 240 communities in 45 countries around the world. We sent 145 teams to implement engineering solutions including safe water, sanitation, schools & clinics, irrigation systems, bridges, and power.

The Iowa Professional Chapter of Engineers Without Borders (EWB) has been involved in El Salvador since 2010. We work in the Department of Usulután (similar to a state in the U.S.), which is located in the Lower Lempa River area (Bajo Lempa) in south central El Salvador. Our primary partner is the Mangrove Association, a non-governmental organization that serves 88 communities, comprising approximately 35,000 people who are primarily subsistence farmers and fisherfolk.

Few of the communities in the Bajo Lempa are served by public potable water systems. Most people obtain water from individual shallow wells. A typical well is hand-dug by excavating inside an approximate 2-foot diameter by 3-foot high concrete casing pipe. As the excavation advances, the casing sinks and additional sections are placed until the water bearing strata is reached, generally to a depth of 20 to 25 feet.

These shallow wells are often contaminated with bacteria, nitrates, and various chemicals including herbicides and pesticides. Contaminant sources include inadequate human sanitation facilities and livestock in close proximity (i.e., in the home owners yard), and historic large-scale cotton and sugar cane operations, both heavy users of organic chemicals. The problem is exacerbated by frequent flooding of the area with thousands of shallow wells susceptible to surface water intrusion.

Since 2010 various members of our chapter have made 6 trips to the Bajo Lempa. Our first trip was following up on a previous assessment trip completed by the EWB chapter from Clemson University. The Clemson chapter identified a rural site to locate a water tank to provide safe drinking water to numerous small communities from a deep well, 2 kilometers away.

During our trip we performed a topographic survey of the site and completed several borings to evaluate soil conditions for the tank design. Because resources are limited in the country, the survey was completed with a tape measure and hand level. Borings were advanced with a hand auger. Interestingly, an M-16 bullet, an artifact of the civil war that ended in 1992, was unearthed near the surface.

On two subsequent trips our members worked alongside local citizens to construct the reinforced concrete block tank and install the final leg of piping from the well. Again, with limited resources, the gravel base for the tank was hand placed and compacted, concrete was hauled up hill by workers tethered to wheel barrows, and the pipe trench was hand excavated.

We are currently working with a small island community on the Lempa River at its mouth at the Pacific Ocean. Previously, a charitable organization provided a water treatment system for the community well that included canister-type sand and carbon filtration, reverse osmosis, and ultra-violet disinfection. No source water quality data were collected prior to installation. Presumably their assumption was brackish water intrusion, necessitating reverse osmosis. However, the technology and cost are beyond the community's resources.

EWB is collecting data to evaluate water quality and determine the nature and extent of brackish influence on the island's groundwater. Preliminary results indicate that total dissolved solids concentrations are well below maximum allowable concentrations for potability. This effort is being supported by individuals from the Geological Survey and UI Department of Geoscience volunteering their expertise.

Another of our chapter's missions is to involve and mentor students from various universities. Our trip in May 2014 included 8 students, 6 from the University of Iowa and 2 from the University of Oklahoma.

The needs of these communities are on-going and much of the focus is on groundwater resources. If you would like to lend your expertise, either here or in El Salvador, please feel free to contact Mike Saeugling at 319-338-4939 or saeugling@vjengineering.com.

IGWA Member News

MEMBERSHIP RECOGNITION

New Members
• Amanda Husband • Brian Hanft • Sophia Walsh • Doug Haney • Claire Hruby • Rose Admunson • Emily Smart

5-Year Members
• Keith Schilling • Thomas Marshall • Deb Williams • Fred Stebbins • Nandita Basu • Ronn Beebe

10-Year Members
• Lisa Walters • Skipp Slattenew • Dave Hume

20-Year Members
• Thomas Correll • Laurie Moody • Dave Wombacher • Warren Riekenberg

25-Year Members
• Bill Simpkons • Jim Caldwell

30-Year Members
• Don Koch • Harold Jensen • Nancy Hall • Paul VanDorpe • Mike Burkart • Reed Kraft • Bob Drustrup • Hillary Maurer • Mike Lustig • Gary Shawver • Jerry Schnoor

Corporate Members
• Apex Companies LLC • Downhole Well Services, LLC • Stanley Consultants Inc. • HR Green Inc.

DID YOU KNOW

that IGWA accepts government groups, such as Iowa DNR sections or county public health departments, as corporate members?

Contact an IGWA Board member for details.

IOWA GROUNDWATER ASSOCIATION

COMMUNICATION • EDUCATION • RESEARCH

Upcoming Events

2014 AWWA - IAWEA Fall Short Course August 26-27, 2014
Des Moines Area Community College, FFA Enrichment Center • 1055 SW Prairie Trail Parkway, Ankeny, Iowa
http://www.ia-awwa.org/conferencesandtraining/shortcourse.html

IAMU Water Distribution & Water Leak Detection Workshop September 3-4, 2014
1735 NE 70th Ave., Ankeny, Iowa • *http://www.iamu.org/en/events/events_calendar/*

IRWA Okoboji Fall Conference September 9-10, 2014
Arrowwood Resort, 1405 Hwy 71 • *http://www.iowaruralwater.org/events_fall_conference.html*

2014 National Association of Abandoned Mine Land Programs (NAAMLP) Annual Conference September 21-24, 2014
Columbus, Ohio • *http://naamlp.net/*

Wisconsin Environmental Health Association 2014 Joint Education Conference September 24-25, 2014
Stoney Creek Hotel & Conference Center, Rothschild, Wisconsin • *http://www.weha.net/professionaldevelopment.php*

IRWA Dubuque Fall Conference September 30-October 1, 2014
Grand River Center, 500 Bell Street, Dubuque, Iowa • *http://www.iowaruralwater.org/events_fall_conference.html*

59th Annual Midwest Groundwater Conference September 30-October 2, 2014
Holiday Inn Convention Center, Lawrence, Kansas • *http://www.kgs.ku.edu/mwgwc/index.html*

2014 Iowa Section AWWA Annual Conference October 7-9, 2014
Altoona, Iowa • *http://www.ia-awwa.org/conferencesandtraining/annualconference.html*

Aquifer Testing for Improved Hydrogeologic Site Characterization October 8-9, 2014
In-Situ, Inc. Headquarters, Ft Collins, Colorado • *http://www.midwestgeo.com/upcomingcourses.php*

2014 Iowa Environmental Health Association Fall Conference October 14-15, 2014
Best Western Regency Hotel, Marshalltown, Iowa • *http://www.ieha.net/page-1825119*

2014 Iowa Science Teachers Fall Conference October 21-22, 2014
Scheman Building, ISU Campus, Ames, Iowa • *http://www.ictm-ists-conference.info/*

Iowa Groundwater Association Fall Meeting October 28, 2014
ISU Extension Building, Johnson Co Fairgrounds, 4265 Oak Crest Hill Rd SE, Iowa City, Iowa • *www.igwa.org*

Minnesota Ground Water Association Fall Conference November 12, 2014
University of Minnesota St Paul - Continuing Education and Conference Center, St Paul, Minnesota
http://www.mgwa.org/meetings.php

IAMU 2014 Water/Wastewater Operator's Workshop November 18-20, 2014
1735 NE 70th Ave., Ankeny, Iowa • *http://www.iamu.org/en/events/events_calendar/*

2014 EPI Fall Symposium
Details unavailable, check web site *www.epiowa.org*

2014 NGWA Ground Water Expo and Annual Meeting December 9-12, 2014
Las Vegas, Nevada • *http://groundwaterexpo.com/*

IWWA 86th Annual Convention & Trade Show January 29-30, 2015
Coralville Marriott Hotel & Conference Center, Coralville, Iowa • *http://www.iwwa.org/calendar.htm*

2015 Nebraska Water Industries Annual Convention and Trade Show February 10-12, 2015
Kearney, Nebraska • *http://www.nebraskawelldrillers.org/*

Iowa Water Conference March 2-3, 2015
Scheman Bldg, Iowa State University, Ames, Iowa • *http://www.water.iastate.edu/content/iowa-water-center-events*

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Coralville, IA 52241-0602

Photos shown are examples of algae in Saylorville Lake. See related article on the Iowa Nutrient Reduction Strategy on page 6.