SUMMER 2012

IGWA UnderGround

An Iowa Groundwater Association Publication

In This Issue:

IOWA GROUNDWATER ASSOCIATION

COMMUNICATION • EDUCATION • RESEARCH

SAVE THE DATE!!

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

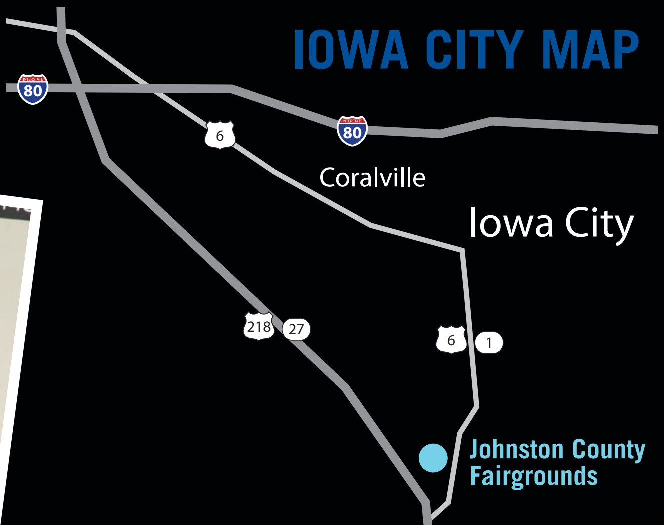
WHAT: Iowa Groundwater Association Fall Meeting

WHEN: Wednesday, October 24, 2012

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

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

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



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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

Bob Drustrup - President, Iowa Ground Water Association

Last year was the first edition of the *IGWA Underground*. It was very well received and we hope you find this second edition equally good, if not better. The theme of this edition is "Protecting Groundwater".

This spring I attended a Superfund meeting with representatives from EPA Region 7 and the four states in the region. In case you don't know, Superfund is the federal regulatory program established in 1980 to clean up the worst hazardous-waste sites in the nation. Superfund was the stimulus for many of our current groundwater protection programs. There were two recurring themes at the meeting: reduced state and federal budgets and more stringent federal standards. While these themes contradict each other, at least they offer something for everyone.

As I see it, two things are necessary to improve, or a least maintain, groundwater protection programs: securing adequate funding and using limited resources where they will provide the greatest benefit. This is just the opposite of what appears to be happening.

Securing adequate funding will likely be difficult in these times of cutbacks in government spending. Groundwater protection has not been in the headlines much in recent years; due in part to the good work of many of you. Without the public clearly seeing a need, there will likely be continued decreases in public resources for groundwater protection.

Several years ago, I was part of a groundwater sampling project in Cerro Gordo County. A nearby resident came up to us and asked if we'd test his well water. We replied "Yes". He hesitated and said "You won't make me clean it up if it tests bad, will you?" Unfortunately, his sentiment is quite common. Everyone wants clean water, but few want to pay extra for it. Most people recognize the importance of water quality, but it's often viewed as someone else's problem, especially agriculture and industry. Why should I have to pay for a problem caused by someone else? Hence, the lack of support for public funding of groundwater protection.

Using limited resources where they will provide the greatest benefit is discussed in Chad Fields' article on source water protection. Chad points out that only 1.5% of Iowa is in a source water area of a public drinking water supply. Thus, a focus on agricultural impacts in source water areas would be much less controversial than taking on agricultural practices everywhere. My article on proposed changes to Chapter 133 describes how the DNR is trying to focus on more problematic contamination. Less stringent standards may sound anti-environmental, but can actually result in improved environmental protection by not depleting limited resources on minor problems.

Major portions of the federal budget are protected by strong interest groups, such as the defense industry for the military budget and AARP for Medicare. Environmental interest groups provide support for groundwater protection. However, environmental interest groups tend to be less well funded and have more diverse concerns like global warming and impacts from fracking. *(Be sure to check out Bob Libra's article on potential fracking impacts in Iowa.)*

What better advocate for groundwater protection in Iowa than the Iowa Groundwater Association? At the IGWA meeting last fall State Senator Joe Bolkcom encouraged the organization to become more politically active. At the Spring IGWA meeting we had a forum discussing potential issues to take to the state legislature. We followed up with a survey of IGWA membership, the results of which are presented in this magazine. With your help, we hope to take the next step and turn ideas into action.

In conclusion, I hope you enjoy this magazine and I hope it encourages you to be actively involved in the IGWA and groundwater protection efforts across Iowa.

WE HEAR YOU!

IGWA Plans to Become More Involved with Legislative Issues

Groundwater is such a valuable resource that is often overlooked and misunderstood. Iowa Groundwater Association believes it is time for groundwater issues to have a stronger voice and would like to facilitate this initiative. At the spring 2012 IGWA meeting, there was discussion of IGWA pursuing legislative issues. Some examples of issues that IGWA may pursue in the future were discussed. A survey was sent out that asked the membership's opinion of possible legislative proposals to pursue. 88% of the IGWA members that responded to the survey thought IGWA should actively engage the legislature on key issues.

Even though survey participation was not overwhelming (just above 40%), the results showed quite strong support for all proposals. Members support to strongly support the following issues:

- **Establishing a state program to collect ambient groundwater level data (88.2% supports).**
- **Establishing a state program to collect ambient groundwater water quality data (86.5% supports).**
- **Expanding IOWATER to include the collection of groundwater information (74% supports).**
- **Expanding the Iowa Groundwater Professional registration beyond the underground storage tank program to include registration applicability across all groundwater-related program areas (67.3 % supports).**
- **Develop a program to address groundwater contamination problems that were not caused by illegal activities that would include a universal remedial fund (72.9% supports).**
- **Evaluating the effectiveness of the Iowa Groundwater Protection Act and find ways to modify it (79.7% supports).**

IGWA is very excited to become more actively involved with issues that affect its membership and begin safeguarding Iowa's groundwater. IGWA members are generally not accustomed to contacting their legislature about groundwater issues, but appear to be open to changing this. It's encouraging that 20 people expressed a willingness to serve on a committee to research and draft a legislative proposal. The IGWA board's plan for moving forward will likely involve the organization of one or two committees comprised of people who expressed willingness on the survey. If you would like to be on a committee please contact IGWA.

Iowa's Source Water Program: Land Use and Nitrate in Iowa's Drinking Water

INTRODUCTION

The term "source water" is used to define drinking water in its original environment, either as surface water or groundwater, prior to its treatment or distribution in a water system. The underlying concept of Source Water Protection (SWP) is that better land management of water source areas will improve water quality and better protect water supplies from contamination **(Figure 1)**. Source Water Protection efforts can help save a community money by reducing potential treatment costs and making it less likely that contamination will result in well replacement.

Since the beginning of the Source Water Protection program nearly 20 years ago, changing land use in source water areas from row crop to perennial vegetation has been a major focus for the program. Land use conversion has been accomplished through a variety of methods, the most popular being the "Wellhead Conservation Reserve Program (CRP)" offered through the Farm Service Agency. Although many publications have reported a clear relation between land use change and surface water quality, less research has been done showing the relation of land use change to groundwater quality. The purpose of this article is to explore how existing land use and land use changes have affected nitrate concentrations in public drinking water systems.

NITRATE IN DRINKING WATER

Nitrate is a common drinking water contaminant in Iowa. Although it is a naturally occurring form of nitrogen found in water and soil, nitrate is also a major component of most fertilizers. As a highly soluble compound, nitrate is readily leached from agricultural fields into the groundwater which is then transported to streams. Plants and microorganisms use nitrate as a food source and, in moderate amounts, is a harmless constituent of our food and water. Human activities have increased nitrate levels in surface and groundwater. Nitrogen fertilizer inputs are needed to sustain row crop agriculture but, due to its solubility, excess nitrate not used by the crop can migrate away from its application areas to contaminate surface water and groundwater. Common indicators of high nitrate in surface water can include algal blooms in ponds, lakes, and rivers, and it has been linked to the hypoxic zone in the Gulf of Mexico.

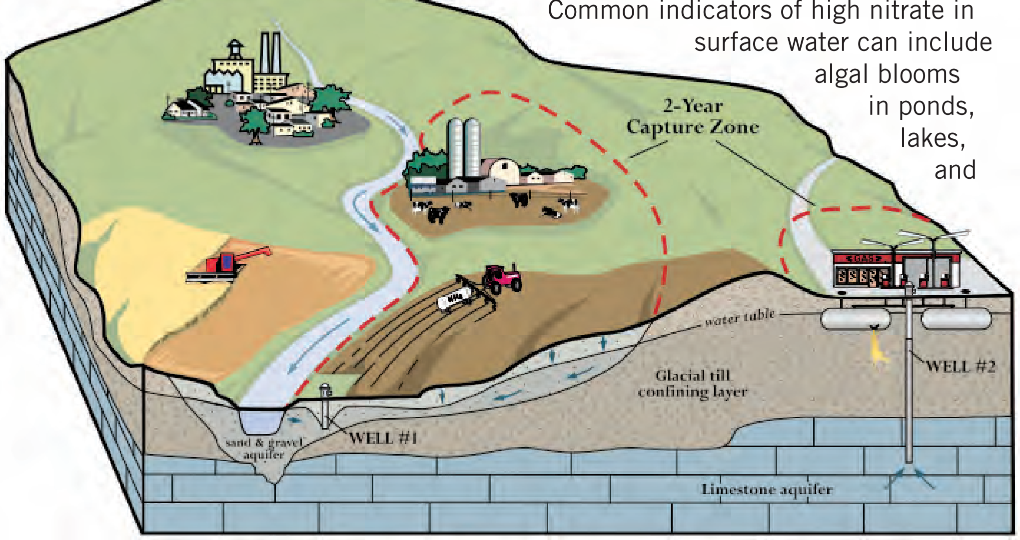


FIGURE 1. DIAGRAM OF TWO DIFFERENT SOURCE WATER AQUIFERS AND ASSOCIATED SURFACE LAND USE WITHIN A GROUNDWATER 2-YEAR CAPTURE ZONE.

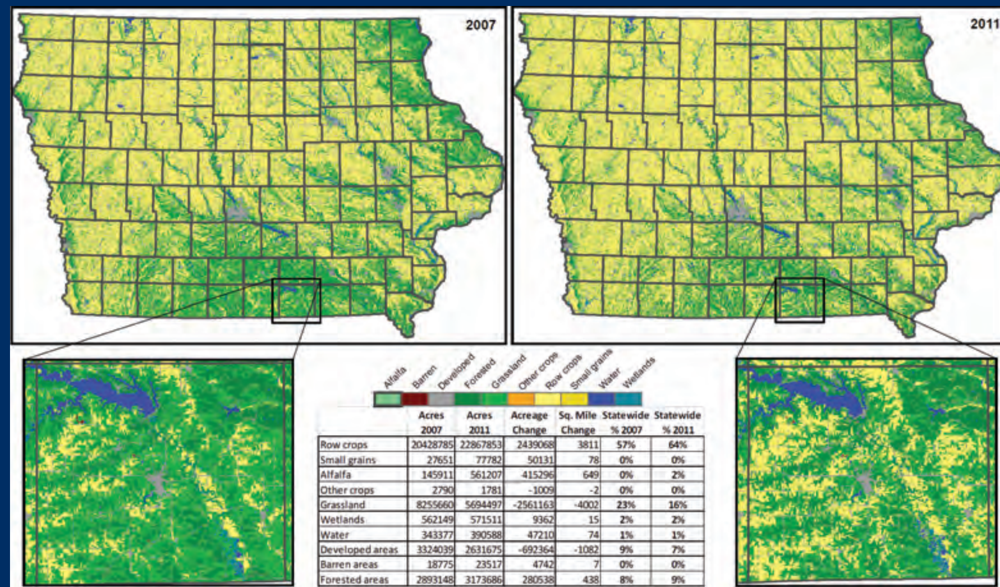
Nitrate was one of the first contaminants monitored by the Environmental Protection Agency (EPA). Elevated nitrate concentrations may cause methemoglobinemia or blue baby syndrome, an acute condition affecting the oxygen supply to the blood found in infants less than six months old. In response to this the EPA has established a maximum contaminant level of 10 mg/L (or parts per million, ppm) of nitrate-nitrogen (NO^3-N) for public drinking water systems. All public water supplies in Iowa regularly monitor for nitrate in their finished drinking water. Public water systems with higher nitrate concentrations use treatment (typically ion exchange and reverse osmosis systems) or blending of water from two or more aquifers to reduce levels in their finished water. Land use activities such as CRP enrollment, fertilizer management, and conversion to alfalfa or other crops are increasingly used to reduce nitrate concentrations in source water areas.

LAND USE TRENDS

The past 70 years have seen Iowa farming change from a variety of grains and pasture land to primarily corn and soybeans. This change has been reflected in land use, with crops like oats decreasing from nearly 5 million acres in the 1940s to less than 0.1 million acres today, and row crops (corn and soybeans) increasing from 1.9 million acres to over 10 million acres currently.

Analysis of recent land use in Iowa indicates that row-crop land use continues to rise during the past half-decade. Comparing land-use statistics from the Farm Service Agency's crop data from 2007-2011 reveals a statewide increase of 600,000 acres per year in row crop, with most of the increase coming from a reduction in grasslands. This land use change represents an increase in 2.4 million acres (7%) in just four years. The most drastic changes have occurred in areas with greater topographical relief, such as south-central and northeast Iowa. **Figure 2** illustrates the sweeping change in landscape seen at a statewide scale and includes a close-up of Appanoose County, one of the south-central Iowa counties that have undergone some of the more dramatic land-use shifts during the past four years.

The statewide land use trend of increasing row crop does not directly translate to land use change in groundwater capture zones for public water supplies. Only 1.5% of the total area of Iowa (roughly 550,000 acres) is estimated to be within a groundwater capture zone. An increase in row crop acreage within groundwater capture zones from 190,000 acres in 2007 to 210,000 acres in 2011 represents a change of approximately 3% per year (half of the statewide change). Similar to statewide trends, grassland decreased from 110,000 acres in 2007 to 90,000 in 2011, or 4 % per year. Most of the difference between the statewide trends and groundwater capture zones can be attributed to increasing developed areas in capture zones, as most public wells are near population centers. Other land-use categories remained consistent from 2007 to 2011; wetland acres decreased from 18,000 acres to 17,000 acres whereas forested areas increased slightly from 35,000 to 38,000 acres.



	Acres 2007	Acres 2011	Acreage Change	Sq. Mile Change	Statewide % 2007	Statewide % 2011
Row crops	20428785	22867853	2439068	3811	57%	64%
Small grains	27651	77782	50131	78	0%	0%
Alfalfa	145911	561207	415296	649	0%	2%
Other crops	2790	1781	-1009	-2	0%	0%
Grassland	8255660	5694497	-2561163	-4002	23%	16%
Wetlands	562149	571511	9362	15	2%	2%
Water	343377	390588	47210	74	1%	1%
Developed areas	3324039	2631675	-692364	-1082	9%	7%
Barren areas	18775	23517	4742	7	0%	0%
Forested areas	2893148	3173686	280538	438	8%	9%

FIGURE 2. STATE OF IOWA LAND USE COMPARISON 2007 AND 2011, WITH CLOSE-UP OF APPANOOSE COUNTY.

OVERALL NITRATE TRENDS IN IOWA'S FINISHED PUBLIC DRINKING WATER

Results from nitrate samples collected from Iowa public water supplies were reviewed to identify possible trends. Sampling intervals varied from system to system. Public supplies with low nitrate concentrations are required to sample every year, but high-nitrate systems are required to sample monthly. All submitted results are stored in the EPA's publically accessible SDWIS database. The following evaluation criteria were applied to all SDWIS results:

- Nitrate results above 0 mg/L were used
- Nitrate concentrations less than detection values were estimated to be one-half the detection limit
- Sample range was limited to the 2006-2011 period
- More than one water quality sample was needed to determine the slope of the trend
- All analyses were performed on 'finished' drinking water (including mixed and treated)

A total of 1,650 public water supply systems met the requirements for analysis. Overall, results from the analysis show that nitrate levels in Iowa's public water supply systems were relatively stable from 2006 to 2011, even with the slight increase in row-crop land use in groundwater capture zones. Of the total water systems analyzed, 195 (12%) showed a decreasing trend that was greater than 0.2 mg/L per year. Only 8% or 132 systems showed a trend that was increasing greater than 0.2 mg/L per year. The vast majority of systems (80%) showed no significant change throughout the 5 year period.

NITRATE & LAND USE CHANGE

In the past eight years, more accurate water quality analyses and a statewide completion of groundwater capture zones for public water supply systems have become available. This allows scientists and engineers to better correlate land use and water quality trends at specific sites and test the fundamental principle associated with the wellhead CRP program. An analysis was completed on land use vs. nitrate concentration in finished water from public water supplies that met the following criteria:

- The capture zones were classified as "Highly susceptible" (i.e. <25 ft. of impermeable clay, till, shale separating the source water aquifer from the land surface)
- The capture zones were modeled within the past ten years
- Land-use coverages were available for the capture zones (2007 land coverage data)
- Nitrate-concentration samples were collected at regular intervals from 2005 through 2010 (averaged for analysis)
- The capture zones were evaluated for systems in the Raccoon River watershed
- No extensive mixing or treatment of raw water was conducted by the water supply

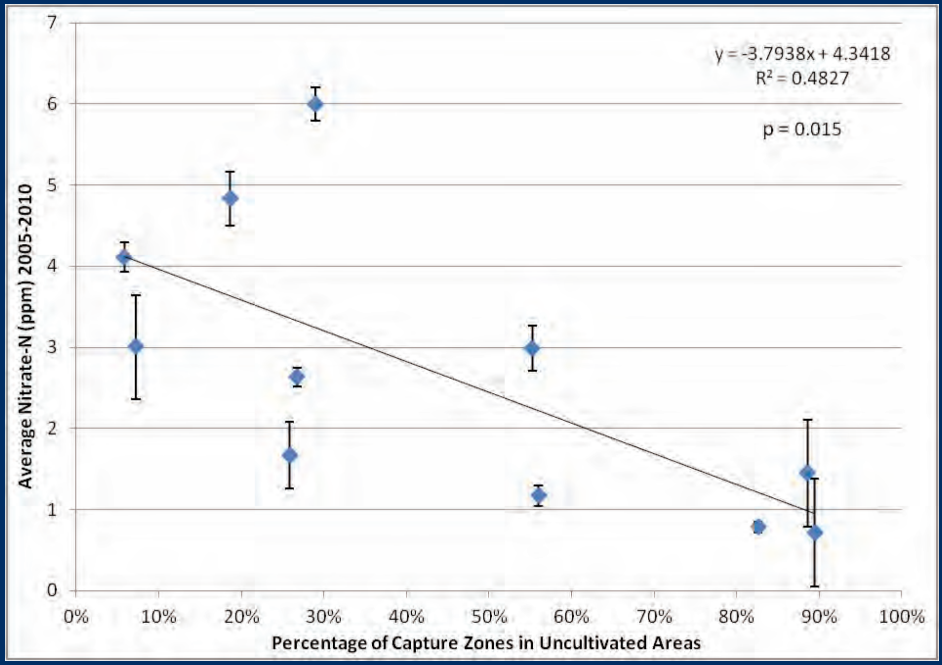


FIGURE 3. RELATIONSHIP OF GROUNDWATER CAPTURE ZONES IN 'UNCULTIVATED AREAS' (WETLAND, GRASSLAND, FOREST) AND FINISHED WATER NITRATE-N VALUES. ALL ARE ALLUVIAL SYSTEMS WITH 'HIGH SUSCEPTIBILITY' IN THE RACCOON RIVER WATERSHED.

A simple regression model was used to compare the percentage of uncultivated land (combined forest, water, wetlands, and grasslands) to average finished-water nitrate levels for systems in the Raccoon River watershed **(Figure 3)**. With a confidence level of over 98%, we can conclude that changing land use in groundwater capture zones to perennial vegetation serves to decrease nitrate concentrations. These results are not linear (r^2 of only 0.48), most likely due to other influencing variables, including pumping rate and surface-water infiltration. Public water systems currently using susceptible aquifers might consider row-crop conversion as a cost-effective option for lowering nitrate concentrations in their source water.

In addition, there are many examples of individual communities that have changed land use around their wells to perennial vegetation under the wellhead CRP program, using either Iowa Department of Agriculture's Watershed Improvement Review Board (WIRB) funds, or purchasing the land outright from the land owner. Many of these communities have shown decreasing trends in nitrate in their raw water. For example, the City of DeSoto Iowa converted nearly 52 acres of their groundwater capture zone from row crop to perennial vegetation through the wellhead CRP program in 2010. Since the conversion, nitrate concentrations from both wells #1 and #2 have decreased 1 mg/L from an average of more than 3 mg/L to nearly 2 mg/L (33%) **(Figure 4)**. The City of Remsen converted most of its capture zone to perennial vegetation in 2008, and has observed a decrease in maximum nitrate concentrations from 27 mg/L in 2007 to 15 mg/L nitrate-N in 2012. The City of Marengo added more land to CRP when new alluvial wells were drilled in 2007 and has observed nitrate decreasing from 2-3 mg/L in 2008 to less than 1 mg/L currently.

CONCLUSIONS

With current high commodity prices there is increasing pressure to convert areas that are currently perennial to row crop. Statewide trends toward increasing row-crop agriculture are even noticeable in the small subset of public groundwater capture zones. While there is a drift towards a more agricultural landscape, a few Iowa communities have converted their source water areas back to perennial vegetation through purchasing or receiving outside support from services like wellhead CRP.

Converting land to grassland or other native vegetation has been proven to help protect public water systems' source aquifers and to and improve drinking water quality. Many systems have shown nitrate levels decreasing in raw water samples taken after land conversion. Land use overlying susceptible source water aquifers correlates with measured nitrate concentrations. Source water areas with more perennial vegetation have significantly lower nitrate concentrations.

Although water quality improvements from land conversion may take longer than the immediate effects of installing nitrate-removal equipment, ultimately the land-use changes may be more cost effective in the long-run. Please visit www.iowasourcewater.org if you believe your community could benefit through land-use changes in your source water area or if you have any questions about your source of drinking water.

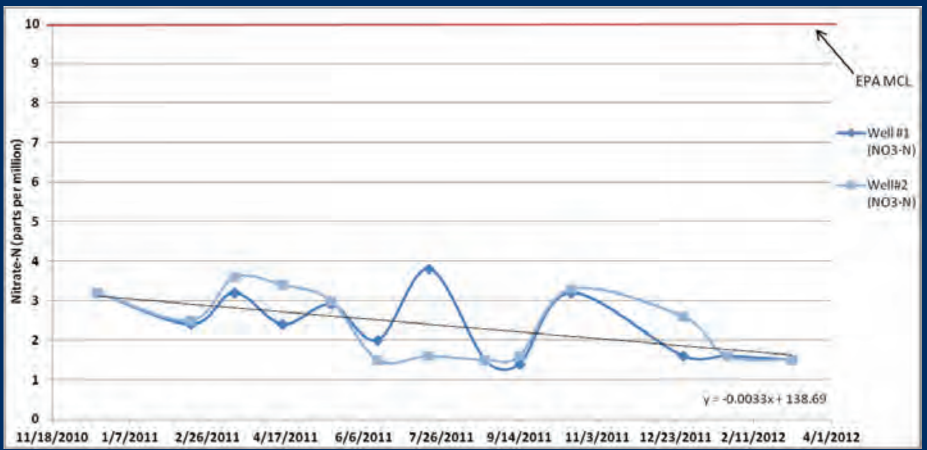


FIGURE 4. NITRATE-N CONCENTRATIONS THOUGH TIME AFTER WELLHEAD CRP ENROLLMENT IN DESOTO WELLS #1 AND #2.

Hydraulic Fracturing for Natural Gas – Implications for Iowa

Robert Libra, State Geologist - Iowa Department of Natural Resources

The boom in natural gas production by the 'fracking" process has fundamentally changed the U.S. energy outlook. Today fracking produces about 25% of the U.S. natural gas supply, while only 5 years ago it was an insignificant contributor. It seems likely the U.S. will be a significant gas exporter within the coming decade. While this energy boom has many positives, fracking comes with an array of environmental and societal problems, and the process has generated a large amount of controversy.

Fracking involves injecting water, sand, and chemical additives under high pressure into horizontal wells that penetrate largely impermeable shales. The pressure fractures the shales, and the sand is propelled into the myriad of small fractures and serves to holds them open. The chemicals act as a carrier and lubricant for the sand. A typical fracking operation uses several million gallons of water with about a half-pound of sand in each gallon. The shales that are fracked are usually at a fairly significant depth, typically 3,000 to 8,000 feet below the surface, well below the depths of most freshwater aquifers.

Environmental issues with fracking include:

- ***The injected chemicals.*** The chemical formulations are "proprietary" information, so local residents are kept in the dark about potential hazards.
- ***Groundwater contamination.*** Contamination can occur from the injected chemicals, deep saline groundwater intrusion from the fracking shales, and released methane. This appears to largely result from improper handling of water at the surface, and poorly constructed gas wells that allow fluid and gas to escape into drinking water aquifers.
- ***Air quality impacts.*** Fracking operations are big operations. Emissions from diesel-fueled trucks, rigs, and generators have resulted in air quality violations.
- ***Surface water discharge.*** In some places the produced water has been disposed of in streams, causing significant damage to aquatic life.
- ***Earthquakes.*** Much of the produced water is injected into deep disposal wells, a common practice in the oil and gas industry. The increased amount of water being injected because of fracking appears to have generated a significant increase in the number of small to moderate earthquakes in some locales.
- ***Greenhouse gas emissions.*** The immense increase of gas operations has caused concerns for significant methane loss to the atmosphere. Methane is a potent greenhouse gas, and methane leakage may overcome natural gases CO_2 emissions benefits relative to coal.

While many familiar with process say the negatives of fracking are overblown and can be readily overcome with modest regulation and best management practices, the density of fracking operations and associated heavy truck traffic, landscape disruption, and a large influx of workers puts a strain on local natural resources, roads, public institutions, and quality of life – factors that don't fit into regulatory silos.

What does this mean for Iowa? The shales in Iowa's Paleozoic sedimentary sequence are not viewed as being gas-producers. They were not buried deep enough or hot enough to "cook" organic matter into gas. There is some interest in the deep shale bed that lies within the Precambrian Midcontinent Rift, but that is a largely unexplored geologic terrain, and it seems like a long shot that the industry will risk the investment to assess the potential.

The greatest impact we have seen in the upper Midwest is the mining boom for "frac-sand". Sandstones, such as the St. Peter and Jordan, are ideal for the racking process and almost 75% of the sand used in fracking is mined around here. This has become a hot issue in parts of southeast Minnesota and western Wisconsin. In Iowa, the sand "gold-rush" has only resulted in the re-opening of an existing St. Peter mine on the Mississippi River in Clayton. The Iowa Geological and Water Survey has had numerous inquiries regarding sandstone resources for fracking, but at this point no new operations are planned. The outcrop belt of these sandstones is limited to the far northeast part of the state and it appears that the near-surface exposures of the sandstones in neighboring states are receiving most industry interest.

Looking into the future of fracking is like gazing into a cloudy crystal ball. With current estimates that shale gas production will double in the next 15 years, any predictions for Iowa should be taken with a healthy grain of salt (or sand). Stay tuned.

UNIQUE SOFT AND VERY OLD WATER WITHIN THE MANSON IMPACT STRUCTURE PRESENTS A SOURCE WATER CHALLENGE

Keith Schilling[1], Raymond Anderson[1], Calvin Alexander[2], David Peate[3], Jeffrey Dorale[3]
[1]Iowa Department of Natural Resources, Geological and Water Survey
[2]University of Minnesota Department of Geology
[3]University of Iowa Department of Geoscience

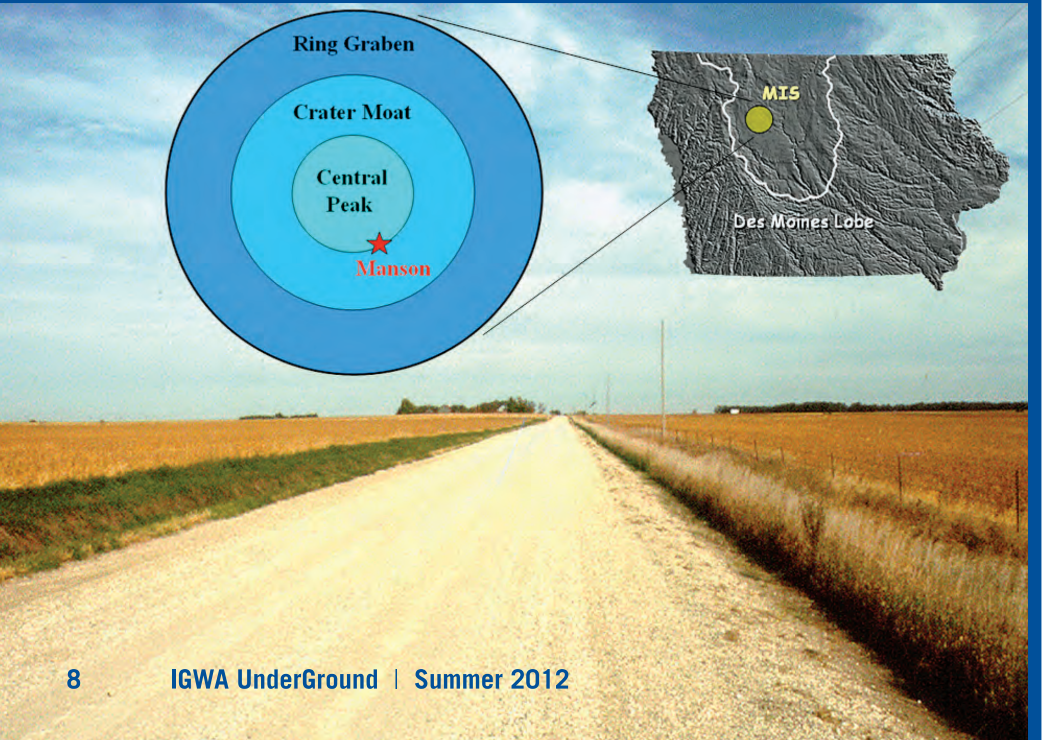
INTRODUCTION

Water resource sustainability promises to be one of the great challenges of future generations. When high quality groundwater supplies are finite, a source water conundrum arises: how best to provide high quality drinking water to citizens while maintaining sustainability for future generations? Groundwater occurrence within the Manson Impact Structure in north-central Iowa illustrates this source water challenge. Seemingly blessed with unusually soft water in a region known for water hardness and high dissolved solids, we report that the residents of Manson, Iowa have been, in fact, mining unique, very old groundwater from an impact structure that will not be replenished with similar high quality water.

HYDROGEOLOGICAL SETTING

The town of Manson lies near the center of the Manson Impact Structure (MIS), a Cretaceous meteor impact crater that formed about 74 million years ago. The MIS is a subsurface feature that is present at the bedrock surface, but it is completely buried by 70 – 300 feet of glacial till and displays no surface expression (Figure 1). The MIS is characterized as a complex crater, displaying an outer ring (***ring graben***) composed of down-dropped and rotated blocks of rock strata, a ***central peak*** of crystalline rocks (granites, gneisses, and related rocks) lifted up from depths in excess of 10,000 feet during crater formation, and a ***crater moat*** area between them, filled with impact resurge materials. The resurge materials (called Phanerozoic-Clast Breccia or PCB) is a shale-dominated mixture of rocks from all areas of the crater that has almost no capacity for yielding water. The PCB not only fills the crater moat area, but also caps much of the central peak and most of the ring graben region. This makes the area within the MIS a very difficult region from which to obtain groundwater. The one area of the crater that has been the most dependable source of water is the central peak. The central peak is, in effect, a giant pile of broken crystalline rocks that is saturated with water and confined by the impervious PCB. The two Manson town wells penetrate into the brecciated (broken) crystalline rocks on the southern edge of the central peak (Figure 2).

FIGURE 1. Scenic overview of the Manson Impact Structure (MIS) area.



GROUNDWATER GEOCHEMISTRY

Groundwater quality from the various aquifer sources around the Manson area is distinctly different. Wells that tap the central peak aquifer, including the Manson town wells and other private wells, have high pH (> 8.1), and low calcium (<22 mg/l), magnesium (<4.8 mg/l), and alkalinity (<127 mg/l as $CaCO_3$). Central peak groundwater also contains high concentrations of fluoride (>3.7 mg/l with a maximum concentration of 10.0 mg/l) that exceed USEPA limits and reverse osmosis water treatment is required.

In contrast to the central peak aquifer, groundwater collected from overlying unconsolidated sand and gravel aquifer wells were very hard (high Ca and Mg), with high alkalinity (>261 mg/l as CaCO3) and high sulfate concentrations (58 to 485 mg/l). Groundwater from the shallow sand and gravel had elevated nitrate (as N) concentrations (6 mg/l) whereas fluoride concentrations were significantly lower (<0.3 mg/l). Four domestic wells thought to be screened in the central peak aquifer had groundwater concentrations resembling a mix between the central peak aquifer and the two sand and gravel units (Figure 2).

GROUNDWATER AGE

Groundwater contained within the Manson Impact Structure at Manson#1 city well appears to be very old as suggested by 14C and 36Cl isotopes. While 14C analyses indicated a groundwater age greater than 35,000 years, longer half lives associated with 36Cl (300,000 years) extend the groundwater age beyond 1,000,000 years. Comparing the 36Cl abundance in Manson#1 to modern 36Cl water suggests that Manson city water is at least 1.8 million years older than modern recharge water. In other wells, groundwater ages of other water sources were less definitive and point to cross-communication among sources. In shallower central peak wells, water quality data showed evidence of recent recharge. These mixed results suggest mixing of old and young water and makes resolving the true groundwater age in shallower central peak wells extremely difficult. Only the City of Manson well results unambiguously indicated very old groundwater contained within the central peak aquifer.

SOURCE WATER CHALLENGE

Evidence from reconnaissance sampling of groundwater wells near the Manson Impact Site indicates that the City of Manson is tapping an aquifer containing very old water that is being depleted by long-term pumping. Recharge to the central peak aquifer is likely occurring where the rock unit lies at the bedrock surface north of Manson. In this area, downward flux of water from the glacial drift aquifers is replacing the old “soft” water mined from the aquifer at depth. Recent

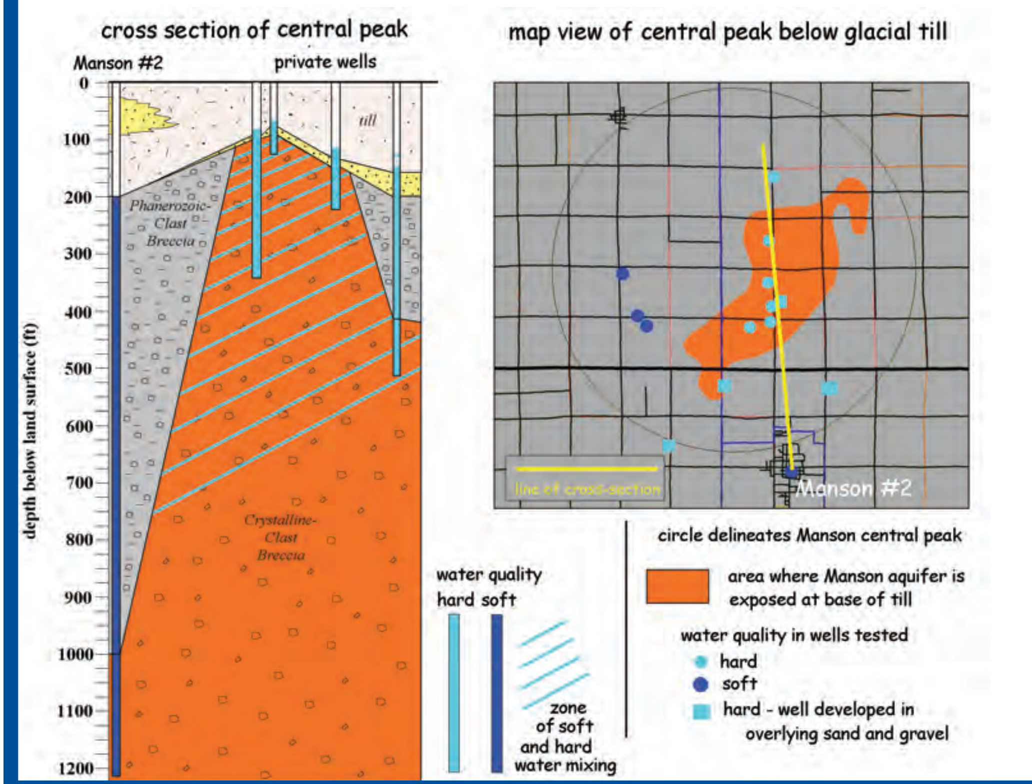


FIGURE 2. Cross-section view across the Manson Impact Structure. Note that groundwater pumping from City of Manson wells appears to be drawing shallow groundwater downward into the central peak aquifer.

groundwater ages and detections of nitrate concentrations in several of the central peak wells support the hypothesis of recent groundwater migration into the central peak. Some migration of recent groundwater into the central peak aquifer is likely occurring through poor well construction conduits that are providing conduits for downward migration of glacial drift water into the central peak. Evidence for this is the apparent mixing of groundwater ages in several central peak wells.

Since the City of Manson wells were constructed in the early 1900’s, pumping records suggest that approximately 1.05×10^{10} gallons of water have been removed from the aquifer. If we assume a conical central peak shape, a depth of 1100 feet from the top of the aquifer to the Manson city wells (cone height), a bottom central peak radius of 10,000 feet, and an aquifer porosity of 0.1 (similar to granite), the total volume of water contained in the central peak aquifer can be estimated using the simple formula:

$$V = 1/3 * \varpi * r^2 * h * n * CF \qquad (1)$$

Where V = aquifer volume, ϖ is pi, r is the aquifer radius, h is the aquifer height, n is the aquifer porosity and CF is the conversion factor to convert cubic feet to gallons. Using equation 1, the total volume of water contained in the central peaks is estimated to be approximately 8.6×10^{10} gallons. This order-of-magnitude estimate suggests that pumping by the City of Manson may have depleted approximately one-eighth of the soft water from the aquifer. Evidence of recent water in the central peak suggests that modern water has penetrated approximately 500 feet into the aquifer.

Although the remaining quantity of groundwater in the aquifer will be sufficient for many future generations, historical pumping of the Manson city wells has drawn modern water hundreds of feet down into the old water of the central peak aquifer. The source water challenge posed by the Manson Impact Structure is to balance the ongoing use of central peak aquifer by rural and urban users with the realization that the supply is finite and subject to future deterioration.

UP FOR DISCUSSION

Point vs. Nonpoint Pollution

While the classical point/non-point definitions work well when dealing with surface-water contamination, I believe they fail to recognize some important distinctions in the sources of groundwater contamination.

This article is an email conversation between Keith Schilling and Bob Drustrup. Keith is a geologist with the Iowa DNR Geological and Water Survey and has worked extensively on nonpoint source pollution issues. Bob is an engineer with the Iowa DNR Contaminated Sites Section and has investigated point source contamination for more than 25 years.

KEITH: Before we begin, let's make sure we're talking about the same thing. I think of point and nonpoint sources in terms of watersheds and impairments associated with the Clean Water Act. In this context, point sources are those locations where pollutants are discharged directly into a stream such as pipe effluent from a wastewater treatment plant, whereas nonpoint sources are associated with pollutants discharged diffusely across the landscape from a large geographical area, such as with surface water runoff or groundwater discharge as baseflow. How would you define these terms?

BOB: Your definitions are the classical ones and I don't disagree with them. While the classical point/non-point definitions work well when dealing with surface-water contamination, I believe they fail to recognize some important distinctions in the sources of groundwater contamination. There are extremely few cases of classic point-source groundwater contamination (e.g., injection wells) that I can think of. If this is true, nearly all groundwater contamination would be classified as non-point source and this discussion is *pointless*. Can you think of other examples of point sources of groundwater contamination that meet your definition?

KEITH: In terms of groundwater, it might make more sense to consider point sources to be those locations where contamination can be traced to a specific source, like a leaking UST or a release of PCE from a dry cleaner. In this sense, groundwater point sources are similar to my earlier definition. Both the direct discharge from a pipe into a stream and a leaking UST impacting groundwater identify a well-defined source of the pollution (i.e., point source). On the other hand, by definition, nonpoint sources are not well-defined because sources of contamination are everywhere. So let me turn your question around, can nonpoint sources also be point sources?

BOB: First of all, I agree that *"locations where contamination can be traced to a specific source"* accurately describes point sources in a groundwater context. Consequently, my response to your question is "yes", I think there are situations where nonpoint sources can also be point sources. I know this sounds like doubletalk. Let me try to explain by use of the following example. Let's say a 40-acre corn field is located next to a shallow drinking-water well and commercial fertilizer is applied to the field at the "recommended agronomic rate". Let's say manure is also applied to the field resulting in a doubling of the nutrient load. I'd call this 40-acre corn field a point source with respect to resulting nitrate contamination in the adjacent drinking-water well. I'd call the same field a nonpoint source relative to regional groundwater quality or nutrient loading of the surface stream that drains the area.

A city well located near an agricultural-chemical dealer (source: Wilkens, Iowa DNR).

Runoff from a heavy rain contributes to nonpoint source pollution (source: Lynn Betts, NRCS).

KEITH: Unfortunately, regulations regarding point vs. nonpoint sources do not respect this definition. Point sources by my classical definition are regulated but non-point sources are not. Point sources discharging to a stream must meet specific discharge criteria and not adversely impact the stream's designated uses. For example, for nitrate impairment in the Raccoon River watershed, point sources discharging into the stream were given specific wasteload limits, but nonpoint sources from agricultural activities were collectively lumped together, despite contributing to most of the nitrate impairment in the river. So, in your example, we may all know that the localized farm with poor nutrient management is contributing to surface or groundwater contamination, but there are no laws regulating these agricultural nonpoint source releases.

BOB: Keith, you ignorant geologist. Section 455E.6 of the Groundwater Protection Act states that an agricultural producer cannot be liable for nitrate contamination of groundwater resulting from fertilizer application *"provided that application has been in compliance with soil test results and that the applicator has properly complied with label instructions for application of the fertilizer."* Other statutory provisions make similar reference to use agricultural chemicals (e.g., 455B.390). I think our statutes do give us the authority to regulate groundwater contamination that is the result of "excessive" agricultural use of chemicals (i.e., fertilizer and pesticides); however, we lack specific rules for doing so. Who is going to argue that we should not regulate agriculture when a localized "excessive" use of agricultural chemicals results in contaminating a nearby drinking-water well?

KEITH: Bob, you pompous engineer. The agriculture community may argue against any legislation of agriculture. I'm not aware of any instance in Iowa where groundwater regulations have been used in this way. In fact, this highlights the major distinction between point and nonpoint source pollution, that is, the use of regulations in dealing with point source releases and voluntary approaches and financial incentives for addressing nonpoint source releases. For example, when the City of Rock Valley experienced increasing nitrate concentrations in their water supply and a feedlot located in their 2-year capture zone was implicated as a potential source, the state did not use Section 455E.6 to require that the farmer address the nitrate source at his own expense. Instead, public nonpoint source monies (319 funds) were used to move the feedlot with little expense to the farmer. In the end, I think this explains why we have such different levels of pollution mitigation. There are rules, regulations and financial consequences applied to point source pollution, but there is little support to apply a similar approach to address potential nonpoint source pollution. So, wrapping up our conversation, what do you consider a greater threat to Iowans, point or nonpoint source pollution?

BOB: I'm sure most will agree that nutrient overloading of lakes, impoundments, and the Gulf of Mexico is predominantly a problem of non-point origin. Therefore, it's fairly obvious that non-point contaminant sources pose the biggest threat to drinking-water sources that utilize surface water or shallow, large capacity wells in close proximity to surface waters. However, in my opinion, point sources pose a larger threat (especially in terms of a drinking-water violation) to other shallow wells water-supply wells. I say this both with the traditional understanding of point sources and my expanded interpretation of point sources; what I prefer to call "localized sources". Three facts are the basis for my opinion: 1) a substantial majority of shallow drinking-water wells are not compromised by contamination, 2) localized sources of contamination (e.g., fertilizer dealers in small towns, feedlots on farmsteads) commonly exist near water-supply wells, and 3) only point sources exist for contaminants other than agricultural chemicals (unless you count fallout from air). What is your answer to the same question?

KEITH: I think you highlight a key distinction between point and non-point sources, that point sources may impact more people if a drinking water supply is affected (especially with your expanded definition), but nonpoint sources affect a much larger area (by traditional definition) and have a larger scope of impact. Effects of nonpoint source pollution extend beyond drinking water impacts, affecting recreational opportunities in surface water bodies, biological integrity and stream channel morphology and flooding. Further, nonpoint source impacts extend beyond well capture zones to include entire watersheds, ranging from your local catchment to the Mississippi River. Although I've highlighted agricultural nonpoint source issues, urban systems are not off the hook for their contributions to the problem, so really, nonpoint source pollution is a pretty all-inclusive problem. In the meantime, I think we've made the case that both point and nonpoint source pollution are important issues for Iowans that deserve attention. Bob, it's been my pleasure to discuss the issue with you (even though you're an engineer!).

BOB: Keith, this has been enjoyable; let's do it again. (While I normally avoid deep discussions with geologists, I'll make an exception in your case.)

contaminant spotlight:

Perchlorate in Groundwater and Water Supplies – Health Impacts

Stu Schmitz - Iowa Department of Public Health

During the past decade perchlorate has been a chemical of concern among environmental regulators, public water supply officials, environmental activists, and concerned citizens within the United States and within Iowa. It is been found to be present within just over 4 percent of the public water supplies nationally. Perchlorate has been found in and confirmed in only one small community in Iowa – Hills. The entire community of Hills is served by shallow private wells.

Perchlorate is an ionic compound made up of chlorine and oxygen molecules (ClO_4^{-1}) that can be either naturally occurring or man-made. It may be present in ground and surface waters as a breakdown of ammonium, potassium, magnesium, or sodium salts that contain perchlorate. Perchlorate salts have been used as oxidizing components in solid propellants for rockets, missiles, and fireworks for over 50 years. Perchlorates are also used in tanning and leather finishing, electroplating, aluminum refining, and rubber manufacturing. Perchlorate can also be found as an inert constituent in some fertilizers. The source of perchlorate found in the private wells of Hill, Iowa is somewhat uncertain, but is suspected to be due to disposal or the use of fireworks within the city property on the west side of the town.

Human Health Impact From Perchlorate

Human exposure to perchlorate occurs through ingestion of drinking water that contains perchlorate. Absorption of perchlorate through the skin does not readily occur. In addition, perchlorate does not volatilize easily from water or stream so that the presence of perchlorate in well water poses no health concern due to inhalation.

High doses of perchlorate are known to impact the function of the thyroid gland in humans, and in the past have been used as a pharmaceutical. Over 50 years of use as a medication has provided much information about perchlorate's interaction with body chemistry, and possible health risks (1). Perchlorate does not cause cancer in humans, cell mutagenesis or genetic damage, and it does not cause harm to the human immune system. In adults, perchlorate has limited biochemical effects, and these effects are limited to the thyroid gland (1).

Exposure to high doses of perchlorate, (in the milligrams per day range) are needed to interfere with the iodide uptake into the thyroid gland sufficiently enough to produce hypothyroidism in the affected individual. The following sequence of events, are necessary for adverse health effects to occur in the case of perchlorate exposure. 1) A threshold amount of perchlorate must be ingested to inhibit iodide uptake into the thyroid gland. 2) A large percentage of normal iodide uptake must be prevented for a long time to deplete the thyroid gland's iodine reserve, and cause a reduction in the thyroid hormone, thyroxine.
3) A reduction in thyroxine must be large enough to overwhelm the body's homeostasis process in which the pituitary gland releases thyroid stimulating hormone to cause the thyroid to produce more thyroxine. If all this happens, then hypothyroidism could result (1).

In adults, the thyroid helps to regulate metabolism. When the thyroid is affected, thyroid hormone production may decrease which can negatively affect metabolic rate. This may cause signs of hypothyroidism, such as enlargement of the thyroid gland (a goiter).

Perchlorate is not stored in the body, and impacts to the thyroid gland from exposure to high amounts of perchlorate will be reversed once the exposure to these high levels of perchlorate is discontinued.

Human Health Studies

The following paragraphs summarize information obtained from several human health studies involving perchlorate. Information from these studies can be used to provide information on impacts to human health from exposure to perchlorate and can be used to determine if the levels of perchlorate found within water could potentially cause adverse health impacts.

Two health studies of the effects of perchlorate in drinking water in the states of Nevada and California were completed. In one study, an analysis of the Medicaid database from Nevada was undertaken to determine whether an increase in the prevalence of any thyroid disease was associated with levels of perchlorate in drinking water at 4 to 24 parts per billion (ppb) or micrograms per liter (2). This study found no evidence that perchlorate-containing drinking water at levels ranging from 4 to 24 ppb increases the prevalence of acquired hypothyroidism or of any other thyroid condition. In the other study, data from the state health departments in California and Nevada were analyzed for any increase of congenital hypothyroidism (hypothyroidism acquired during fetal development) in counties that had levels of perchlorate in drinking water supplies at levels ranging from 4 to 16 ppb (3).
The study found no evidence that perchlorate-containing drinking water at levels ranging from 4 to 16 ppb increased the incidence of congenital hypothyroidism.

An additional study was conducted to investigate the potential effects of perchlorate in drinking water on thyroid function in newborns and school-age children in northern Chile (4). The level of perchlorate in drinking water in northern Chile can be as high as 100 to 120 ppb. The findings of this study indicated that perchlorate in drinking water as high as 100 to 120 ppb did not suppress thyroid function in newborns or school-age children.

EPA's Perchlorate Action Level

In an effort to provide some measure of protectiveness to the public, the U.S. Environmental Protection Agency (EPA) has established a reference dose (RfD) for perchlorate. The RfD is defined as, "an estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime".

The current RfD is 0.0007 mg/kg/day (milligrams of perchlorate per kilogram body weight per day of exposure) (5). Using this RfD, the EPA has also established an interim health advisory level (IHAL) of 15 ppb. This IHAL takes into account perchlorate exposure from food, as well as drinking water, and is assumed to be safe for pregnant women and their fetuses (6).

Exposure to Perchlorate within Hills, Iowa

Perchlorate has been found within the private well water within Hills, Iowa at levels ranging from < 4 to 230 ppb. Perchlorate at the high end of this range may have the potential for some adverse health impacts, but currently all of Hill's residences with levels of perchlorate above 15 ppb within their wells have been provided with whole-house treatment units to remove perchlorate at levels where no adverse health impacts could occur.

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WHAT ARE IOWA'S STATEWIDE GROUNDWATER STANDARDS AND HOW ARE THEY DETERMINED?

Released from Iowa Department of Natural Resources, Contaminated Sites Section

In simple terms, groundwater in a useable aquifer (high K, low TDS) has a higher level of protection than groundwater that is not likely to be used (low K, high TDS).

Chapter 137 of the Iowa DNR rules prescribes statewide standards (SWSs) for groundwater. Two classes of statewide groundwater standards are prescribed: protected groundwater sources and non-protected groundwater sources. The two classes are distinguished by the hydraulic conductivity (K) of the aquifer and the naturally occurring total dissolved solids (TDS) content. In simple terms, groundwater in a useable aquifer (high K, low TDS) has a higher level of protection than groundwater that is not likely to be used (low K, high TDS). This discussion focuses on SWSs for groundwater in a protected groundwater source.

There is a hierarchy for applicable SWSs for groundwater contaminants. If the contaminant has an enforceable drinking-water standard (Maximum Contaminant Level or MCL), this standard is used. If a contaminant does not have an MCL, the lifetime health advisory level (HAL) is used. If neither an MCL nor a HAL exists, the SWS is calculated in a manner similar to that used to establish MCLs and HALs. The method used to calculate a SWS is based on a contaminant's cancer-causing potential, that is whether a contaminant is classified as a known or probable carcinogen, a possible carcinogen, or there is no evidence of human carcinogenicity.

SWS for Non-Carcinogens

SWSs for contaminants with no evidence of cancer-causing potential are based on the contaminant's oral reference dose (RfD). An RfD is an estimate of a daily oral exposure to the human population that is likely to be without an appreciable risk of deleterious effects during a lifetime of exposure. An RfD has the units of mg/kg/day: milligrams per day of an orally ingested contaminant per kilogram of body weight of the exposed individual. An RfD is usually determined from animal studies where animals are exposed to varying doses of the contaminant and possible adverse effects are observed.

Uncertainty/safety factors are factored into RfDs to account for things like extrapolating from animal studies to humans, ensuring protection of sensitive human subpopulations (e.g., infants and elderly), and recognizing potential deficiencies in the animal studies (e.g. e.g., the lowest dose had an adverse effect). Uncertainty factors for contaminants typically range from 3 to 10, with a factor of 10 most frequently used. When there are multiple uncertainties for a contaminant, the uncertainty factors are multiplied together.

The SWS for a contaminant with no evidence of carcinogenicity is based on ingestion of 2 liters of water a day (L/day) by a 70-kilogram (kg) person. Only 20% of the acceptable exposure to the contaminant is allowed to come from drinking water with the remaining 80% assumed to come from other sources, like food and air. The SWS is determined as follows. SWS (in mg/L) = 0.2 x RfD (mg/kg/day) ÷ 2 L/day x 70 kg or simplified as:

SWS (mg/L) = 7 x RfD
(non-cancer risk) (1)

As an example, consider ethylbenzene which has shown no evidence being a carcinogen. The RfD for ethylbenzene is 0.1 (http://www.epa.gov/iris/), so the SWS is 7 x 0.1 = 0.7 mg/L. (In the case of ethylbenzene, the SWS is the same as the MCL and the MCL is actually the SWS by default.)

It is worthwhile to consider the factors of safety built into the RfD. The RfD for ethylbenzene is based on a study where rats were given various contaminant doses and certain levels of exposure were found to cause adverse effects to the liver and kidney . A collective uncertainty factor of 1,000 was assigned: 10 for use of animal data, 10 to protect sensitive human subpopulations, and 10 due to shortcomings in the study. With the 5 times factor (i.e., only 20% of contaminant allowed from water), the resultant SWS represents a dose that is 5,000 times less than the highest dose found not to have an adverse effect in the rat study.

SWSs for Known or Probable Carcinogens

SWSs for contaminants that are known or probable human carcinogens are based on the cancer slope factor (CSF). The CSF is based on studies where laboratory animals are fed various doses of the contaminant and the CSF is then determined using the dose that causes cancer in 10% of the laboratory animals (Dose10): CSF = 0.1 ÷ Dose10. Dose has units of mg/kg/day and CSF has units of $(mg/kg/day)^{-1}$.

Cancer risk can be calculated for any contaminant dose by multiplying the exposure dose (ED) by the CSF (Cancer Risk = ED x CSF). SWSs are based on an acceptable cancer risk to be 5 x 10-6 (five cases of cancer in a million people exposed) based on a lifetime ingestion of 2 liters per day by a person weighing 70 kilograms. The exposure dose (ED) from an assumed lifetime exposure to water containing a contaminant at a concentration equal to the SWS is: ED = SWS (mg/L) x 2 L/day ÷ 70 kg. Substituting "SWS (mg/L) x 2 L/day ÷ 70 kg" for "ED" in the above cancer risk equation yields:

5 x 10-6 (unitless) = SWS (mg/L) x 2 L/day ÷ 70 kg x CSF (mg/kg/day)-1

Solving for SWS yields: SWS (mg/L) = 5 x 10-6 x 70 kg ÷ 2 L/day ÷ CSF (mg/kg/day)-1, or it can be simplified to:

SWS (mg/L) = 1.75 x 10-4 ÷ CSF
(SWS based on cancer risk) (2)

For example, DDT is a probable human carcinogen and does not have an MCL or a HAL. The CSF for DDT is 0.34 (mg/kg/day)-1 (http://www.epa.gov/iris/). The SWS for DDT can be calculated as follows. SWS = 1.75 x 10-4 ÷ 0.34 = 5.1 x 10-4 mg/L SWSs for contaminants classified as possible human carcinogens that do not have an MCL or a HAL and do not have a CSF are calculated based on non-cancer impacts using Equation 1. SWSs for contaminants classified as possible human carcinogens that do not have an MCL or a HAL but do have a CSF are calculated as the larger of a SWS using Equation 2 or 1/10th of the SWS determined by using Equation 1. The 1/10th factor replicates how MCLs have been established for this class of contaminant.

For known or probable carcinogens, MCLs and SWSs are different. The EPA typically sets non-enforceable MCL goals (MCLGs) at zero for cancer-causing contaminants. However, this standard is technically impracticable so the EPA takes into account the ability of laboratory analyses to detect the contaminant and limitations in the technical ability to remove a contaminant from water. As a result, the cancer risk associated with MCLs varies among contaminants, ranging from about 4.3×10^{-4} (arsenic) to 1×10^{-6} (methylene chloride) (average = 6×10^{-5}). There is a provision in Chapter 137 that SWSs can be no lower than the practical quantification limit (laboratory detection limit), which has a similar effect.

If an RfD and/or CSF is not available from one of the previously mentioned sources, the DNR consults with the Iowa Department of Public Health who recommends appropriate toxicity values.

Richland's New Jordan Well – A Twist on an Old Favorite

Klint Gingerich - Owner of Gingerich Well and Pump, Kalona, IA

They decided the lower cost of PVC casing made it possible for them to afford retaining their municipal water system.

Richland thought it had found an economical way to drill a replacement for its 1,870-foot deep steel-cased well – the use of a Polyvinyl Chloride (PVC) casing. Not only would the lower cost make it more feasible for the city to retain its own municipal water system, but the PVC would be more resistant to corrosion than traditional steel. The only problem was that the Iowa Department of Natural Resources (IDNR) had never approved the material for public wells of this depth.

The standard approach to lengthening well life is to either enlarge casing size to allow for re-casing the well with a smaller casing at a later date, or utilize stainless steel casing. While both of these approaches are valid use, both come at considerable expense.

Gingerich Well and Pump was approached by the small Keokuk County community about the alternative material for replacing its current 50-year-old well. Since the early 1980s, Gingerich Well & Pump had been using PVC casing on most residential water wells. Though residential wells in the area are typically 250 feet in depth, Gingerich had completed well projects using PVC into the deeper Saint Peter and Prairie Du Chien formations.
City council members spent more than a year researching two options – keeping their relatively new water plant or connecting to a rural water supplier. They decided the lower cost of PVC casing made it possible for them to afford retaining their municipal water system.
The city hired Ed Brinton of MMS Consultants to design the well and pumping system. MMS quickly began discussions with the IDNR to obtain a construction permit. The state agency was skeptical.

A major concern with use of PVC casing at such a depth is the amount of pressure placed upon the casing during the grouting process. This could lead to collapse of the casing. Grouting is the placement of a sealing material, such as bentonite or neat cement, between the well casing and the borehole. Grout prevents leakage into the well, keeps contaminants from moving down along the well casing, and prevents mixing of groundwater from one aquifer to another.

The City of Richland, IDNR Water Supply Section and Geological Survey Bureau and MMS, and the Iowa Geological Survey Bureau (IGSB) were involved in the final design and selection of materials for the well . Initially IDNR had reservations. As discussions progressed, items such as warranties, follow-up testing, and pump protection entered in.
During the beginning phases of these discussions, a fortuitous twist of fate occurred via a well failure at the Ainsworth Four Corners truck stop. Gingerich Well & Pump was contacted to construct a new 6-inch diameter PVC-cased Prairie Du Chien well for the truck stop. MMS applied for emergency construction permits and IDNR officials were on hand through the construction process, including the grouting.

Through the years, Gingerich Well and Pump has worked with Certainteed Corporation to develop a product that would allow them to construct deeper wells using PVC products. They also developed a grouting process that would equalize the fluid pressures inside and outside the casing thereby reducing the chances of a collapse. Though created for private wells, they were able to adapt the grouting process for deeper public wells. The truck stop "test case" was a success and served to ease the reluctance of the IDNR in granting the required variances for the Richland project. Gingerich Well and Pump was the low bidder and was awarded the project. Construction began in October of 2005. A 21-inch hole was constructed into the competent Mississippian limestone at 172 feet. Inside this borehole, a 16-inch steel casing was cemented into place to stabilize the upper clays and sands. Following the proper curing process, a 15-inch diameter borehole was constructed to a depth of 50 feet below the bottom of the Saint Peter formation at 1,372 feet. Certaineed Certilock® 10-inch diameter casing **(Figure 1)** was installed to this point **(Figure 2)**.

The grouting process was initiated using Baroid Benseal® as the grouting material. A modified Halliburton style of grouting was selected that equalized the pressure on the inside and outside of the casing during the grouting process. Ed Brinton of MMS, Russ Tell of IDNR, and Tom Hoekstra of Richland were on hand during the grouting. IDNR personnel stayed until the last bag was pumped to the bottom of the casing and bentonite returned to the surface **(Figure 3)**.

Once allowed to cure, remaining grout was removed from the center of the casing and the borehole was advanced using an 8 7/8-inch bit to achieve a total depth of 1,875 feet.

After development, the well was test pumped and found to have a specific capacity of 14.5 gpm/ft of drawdown.

Additional tests were performed to verify plumbness and alignment and to ensure that the casing was intact. The inner diameter of the Certilock casing is a nominal 9-inch. An 8.885-inch 'dummy' was lowered through the entire casing length and retrieved without restriction. A video profile was also performed to verify the condition of the completed well. All phases of construction were a success. An additional verification took place in 2010, 5 years after construction. The same 8.885-inch dummy was lowered through the casing to 1,370 feet again without incident.

The author credits the tenacity of the Richland City Council and Ed Brinton of MMS with making the deepest PVC cased municipal well in Iowa a reality. In addition, the openness of IDNR to adapting proven technology to today's marketplace will allow Richland to be served by a new Jordan well that should not suffer the same fate as the previous one. This well will last 'well' into the future and minimize the debt load for future inhabitants of the town. In addition, they helped pioneer the way for additional communities to construct similar projects.

FIGURE 1. PVC casing.

FIGURE 2. Installing casing.

FIGURE 3. Drill site: Taylor 4000 HRT drilling rig – center; mud pit and Continental Emsco mud pump – left center; Ingersoll air compressors and booster compressors – left; various support vehicles for pipe, bentonite, tools, etc.

Need An *A* Syst?

Rick Robinson - Iowa Farm Bureau Federation

Iowa farmers and rural landowners will be getting more help this summer so they can avoid impacts to surface water and groundwater.

Much has changed in the last decade since the Iowa Farm Bureau Federation developed Iowa Farm*A*Syst in 2003 as a series of fact sheets and self-evaluations available on the web that helps farmers and rural homeowners identify and reduce the risk of groundwater and surface water pollution on their farms and rural homesteads. Laws, rules, and management practices have changed greatly in recent years. That's why the Iowa Farm Bureau Federation is updating the program this summer. A new and improved version of Iowa Farm*A*Syst should be available by August 1.

Not only have environmental laws and rules changed, but also has the way people get their information. Ten years ago, many farmers did not have access to the internet and all the web-based information it provides. People now get much more information via laptops, tablets and smart phones. Also, while much of the information found in Farm*A*Syst is still relevant today, some new information, new technology, and new research have surfaced since the initial publications were developed more than a decade ago.

These Iowa Farm*A*Syst fact sheets and self-evaluations provide information that helps farmers better understand the positive actions they can take to reduce environmental risks on their farmsteads. Iowa Farm*A*Syst provides confidential, easy-to-use risk assessment tools, considers regional differences in natural resource concerns, and provides expert contact information for technical assistance on 12 risk topics.

In addition to being a helpful tool for farmers, Iowa Farm*A*Syst has been used as a field training tool for farmer groups, state and local environmental health workers, ISU Extension and DNR field staffs, and commodity organizations.

The current Iowa Farm*A*Syst topics include:

- *Assessing Your Farmstead Characteristics*
- *Assessing Your Water Well Condition & Maintenance*
- *Assessing Your Household Wastewater Management*
- *Assessing Your Open Feedlot Manure Management*
- *Assessing Your Confinement Livestock Manure Management*
- *Assessing Your Milking Center Wastewater Management*
- *Assessing Your Dead Animal Management*
- *Assessing Your Pesticide Storage & Management*
- *Assessing Your Fertilizer Storage & Management*
- *Assessing Your Petroleum Storage & Management*
- *Assessing Your Hazardous Materials Storage & Management*
- *Assessing Your Emergency Response Planning for Manure Spills*

Each of the Iowa Farm*A*Syst web publications have recently been reviewed by natural resource agencies and professionals for accuracy and relevance. In addition, the publications are being reformatted to make them easier to read, understand and use. Not only will the updated units be available for Farm Bureau members to view and download from the Iowa Farm Bureau's Iowa Farm*A*Syst website, they will be more searchable by key phrases. The publications will also be available via a "mobile site" that will allow users to access the units through their laptop, tablet, or smart phone.

So look for an announcement of the updates and improvements around August 1. More help will only be a click away.

Editor's Note: *Rick Robinson is the Environmental Policy Advisor at the Iowa Farm Bureau Federation. For more information about Iowa Farm*A*Syst, go to www.iowafarmasyst.com, or contact Rick at 515-225-5432, rrobinson@ifbf.org.*

GROUNDWATER HERO

PAUL HORICK

The American Heritage dictionary gives one definiton of "hero" as, "a person noted for special achievements in a particular field." As far as IGWA is concerned, there is only one "Groundwater Hero," our founder, our mentor, our inspiration, PAUL HORICK. Beginning in 1945 as a student, Paul joined the Iowa Geological Survey (IGS) and eventually became a mainstay as the person most likely to answer questions about groundwater supplies and wells, thus earning the sobriquet, "Iowa's Water-Well Forecaster."

During his tenure at the IGS, Paul authored or co-authored several landmark publications, including the three major state-wide bedrock aquifers (Mississippian, Silurian-Devonian, and Jordan), Water Atlas No.8, and The Minerals of Iowa. His greatest contribution may have been the hundreds, possibly thousands, of well forecast letters he wrote which provided site-specific information on the availability of groundwater.

So dedicated was Paul to groundwater science, that he and other like-minded individuals founded the Iowa Groundwater Association (IGWA) in 1984. He initiated the IGWA quarterly newsletter and was its first editor (from 1984 to 1992). The newsletter was well received and even won laudits from the publishing community.

With Paul's leadership, IGWA routinely hosted two educational events per year and co-hosted events with the Iowa Water Well Association, Iowa Department of Public Health, Iowa Environmental Health Association, Illinois Ground Water Association, and the Midwest Ground Water Conference.

In addition to the *IGWA Quarterly*, Paul also compiled *Iowa's Principal Aquifers*, *A review of Iowa geology and hydeogeologic units* which was a compilation of reprints formerly in the Quarterly. Naturally, Paul authored or co-authored five of the seven chapters.

Five presidents award commemorative *Iowa Groundwater Quarterly* plaque to Paul Horick, editor 1984-1992. *(Left to Right: Jerald Schnoor, Monica Wnuk, Tom Glanville, Paul Horick, Nancy Hall, Mike Lustig.)*

In the 1982 issue of *Iowa Geology*, Paul was the subject of a feature article on "Iowa's Water-Well Forecaster." Paul had this to say, "This work, both service and research, is geared to help people upgrade the quality of their life in Iowa." At his retirement celebration in 1992, Paul went on, "Geology is an interesting and enjoyable career and the state geological surveys are where much of the action is… but don't expect to get wealthy as a public servant."

There is more than one way to measure wealth. Paul, you have provided an astounding wealth of information to those who would utilize Iowa's groundwater resources. Paul, you are indeed our true GROUNDWATER HERO!!!

Legislative Review:
Proposed Revisions to Groundwater Rules

Bob Drustrup – Iowa DNR Contaminated Sites Section

The Iowa Department of Natural Resources (DNR) is working on major revisions to Chapter 133 of the Department's rules. Chapter 133—mandated by the 1987 Groundwater Protection Act—requires investigation and cleanup of groundwater contamination by the party or parties responsible for the contamination. Chapter 133 has been the primary set of rules for regulating site-related (i.e., point source) contamination that is not under the purview of another regulatory program.

The current version of Chapter 133 loosely prescribes non-degradation and universal-cleanup groundwater-protection policies. That is, it has a goal of removing all contaminants from groundwater, if possible, or at least to groundwater action levels. Groundwater actions levels are prescribed as being equal to or more stringent than drinking water standards. However, Chapter 133 also provides for deviation from a strict non-degradation or universal cleanup approach when such a goal is not reasonable and practical.

There are several reasons the DNR is proposing to revise Chapter 133. Chapter 133 has not been significantly revised since its adoption in 1989. The non-degradation approach specified in Chapter 133 has in practice given way to a risk-based approach (i.e., cleanup required only when contamination poses a significant risk). In 1995 the Iowa Supreme Court "Blue Chip" decision changed liabilities of responsible parties from what is currently prescribed in Chapter 133. In the early 1990's the federal Superfund program began considering risks from exposure to contaminants in environmental media other than groundwater, especially soils and vapors, which are not under the scope of the current Chapter 133. Major changes are thus needed for Chapter 133 to accurately reflect current approach to the regulation of contaminated sites and the known risks of exposure to contaminated sites in Iowa.

A major deficiency with the existing Chapter 133 is that it is extremely vague. A huge number of minor contamination situations can be labeled unnecessarily problematic under the current chapter. The resulting uncertainty is a deterrent to reuse of many properties. An objective of re-writing Chapter 133 is to greatly reduce this uncertainty. Provisions are being proposed to clarify when contamination is problematic, outline actions necessary to address problematic contamination, and determine who is responsible.

In 1997 the Department adopted rules (Chapter 137) for a voluntary cleanup program (VCP) for contaminated sites. These rules were adopted in accordance with a mandate in the 1996 Iowa Land Recycling and Environmental Remediation Standards Act (Iowa Code Chapter 455H). Nationally VCP rules have become the basis for regulating contaminated sites that are not under the purview of another regulatory program. In Iowa, Chapter 137 standards for soil, vapors, and groundwater not likely to used as drinking water have become default standards for general use, despite their lack of clear, legal applicability.

Revisions to Chapter 133 are being proposed to make Chapter 133 similar to Chapter 137 with the following differences.

- Actions prescribed by Chapter 133 will be required not voluntary.
- Responsible parties will be specified.
- Cleanup standards may not be as stringent.
- Compliance will not result in liability protections (The voluntary compliance outlined in Chapter 137 does offer liability protections).

A primary benefit of enrollment in a state VCP is the federal EPA's agreement to defer federal CERCLA/ Superfund action. Therefore, clean-up standards were prescribed in Chapter 137 to satisfy EPA. The DNR believes the resultant Chapter 137 standards are sometimes more stringent than necessary. These (what the DNR believes in some cases to be) overly stringent groundwater, soil and vapor standards result in a large number of commonplace situations being labeled problematic. This causes undue concerns and costs for property transactions and redevelopment, i.e., brownfield issues.

Chapter 133 standards are being proposed that the DNR and the Department of Public Health believe will be protective, but not excessively overprotective. The proposed standards will result in situations where minor amounts of contamination are less likely to be labeled problematic.

The revised chapter will not change how contamination is identified—which is often by environmental assessments that are not required by the DNR—but will clarify when it must be reported.

Current information regarding changes to Chapter 133, including a draft of the chapter, is available for viewing at http://www.iowadnr.gov/InsideDNR/RegulatoryLand/ContaminatedSites/Ch133Rulemaking.aspx

Having a conversation with a Chinese famer about fertilizer applications and planting schedules. Pictured from right to left, Mary Weber, Keith Schilling, You-Kuan Zhang and a Chinese colleague.

a comparison of nonpoint source NITROGEN POLLUTION IN THE DES MOINES RIVER WATERSHED (IOWA) AND THE SHAYING RIVER WATERSHED (CHINA)

Mary Weber - Department of Geoscience, University of Iowa

Agricultural production is often concentrated in "breadbasket" regions of countries where climate, topography and soils are most amenable. In the United States, agricultural intensity is greatest in the Midwest and typified by conditions in the Des Moines River (Iowa). In China, agricultural production is concentrated in the Huai River basin where 16.5% of Chinese grain comes from 3% of the total land area. The Shaying River is a tributary of the Huai and is typical of intense agricultural regions of China. Nonpoint source agricultural nitrogen pollution is a well-documented problem in the Des Moines River, but has been less investigated in the Shaying River. My project reports the results of data collected in the Shaying River basin in the fall of 2011 and compares aspects of agricultural production systems and surface and groundwater quality to the intensely-agricultural Des Moines River watershed in Iowa.

As part of my study in China, groundwater samples were collected from domestic (n=15) and irrigation wells (n=117) in the Shaying River basin. Irrigation wells are common in many fields but farmers reported that they were rarely used. Water samples were analyzed for NO_3-N, NH_3-N and chemical oxygen demand (COD). Results indicated that NO_3-N concentrations were highly variable, ranging from 0-52 mg/l, with 18 samples showing concentrations greater than 10 mg/l. Mean concentrations were 4.2 mg/l. NH_3-N concentrations were also elevated with an average concentration of 0.55 mg/l. Interestingly, COD values were quite high in groundwater, averaging 32 mg/l. Nitrate concentrations measured in China were similar to those found in the Des Moines River watershed where mean values reported in the Iowa DNR database were 6.5 mg/l (n=6258; private well sample results). COD concentrations are not routinely measured in Iowa groundwater and suggest that point source impacts are likely affecting groundwater in China.

This study was conducted for my senior thesis at the University of Iowa under the under the guidance of Dr. You-Kuan Zhang and his ongoing research of pollution in the Huai River basin.

student bio

I'm originally from the area near Jesup, Iowa. I'm a senior in Geoscience at the University of Iowa, and after I graduate I plan to continue researching water quality issues. I enjoy camping, fishing, and photography. My favorite foods from the Des Moines River watershed are sweet corn and morel mushrooms, and my favorite foods from the Shaying River watershed are baby bok choy and the various mushrooms. I'd like to greatly thank Dr. You-Kuan Zhang, his graduate students at Nanjing University, and Dr. Keith Schilling, for offering their time and insight to help make this thesis possible.

Sampling an irrigation well with help from Chinese students.

characterizing shallow and deep GROUNDWATER FLOW AND NUTRIENT FLUX TO DEER AND POKEGAMA LAKES NEAR GRAND RAPIDS, MN

Jacob Smokovitz - Depart. of Geological and Atmospheric Sciences, ISU

A diagnostic study of water quality in Deer and Pokegama Lakes was initiated in 2010 under a Clean Water Partnership with Minnesota Pollution Control Agency (MPCA) to estimate groundwater nutrient flux to the lakes. Deer and Pokegama Lakes are 36-m-deep, 1600-ha and 34-m-deep, 2675-ha lakes, respectively, near Grand Rapids, Minnesota. Thirteen seepage meter and minipiezometer sites were installed along the shoreline in both lakes to characterize the shallow groundwater system in 2011. Lake water was sampled monthly, minipiezometers were sampled biweekly, and private well groundwater (18 at Deer Lake and 14 at Pokegama Lake) was sampled in summer and winter of 2011. Groundwater was analyzed for TN, NO_3-N, SRP, TDP, TP, $\delta^{18}O$ and δ^2H; some samples in private wells were analyzed for enriched ^3H. Precipitation was collected from May to August 2011 in order to establish a local meteoric water line (LWML). Results from topography and lake stage elevation relationships suggest that a shallow water-table flow system supports Deer Lake as a flow-through lake and that Pokegama Lake as a discharge lake. However, seepage meters and minipiezometers on both lakes demonstrate inflow from the shallow groundwater system. Shoreline seepage rates range from 100 to 1100 m^3/d at Deer Lake to 200 to 25000 m^3/d at Pokegama Lake. Nutrient concentrations (N and P) and fluxes in both lakes are very low and near their respective detection limits. However, well logs suggest that multiple sand and gravel aquifers are present at depths between about 90 to 300 ft. Because hydraulic head relationships in these systems are not known, stable isotope samples from groundwater in private wells were used to help assess the groundwater flow directions. Mean $\delta^{18}O$ values of Deer and Pokegama lake water are -4.97‰ and -7.03‰, respectively, and their positions on the LMWL suggest evaporative enrichment. Using this relationship, it appears that lake water is flowing into and mixing with deeper groundwater on the east side of Deer Lake. At Pokegama Lake, $\delta^{18}O$ values in groundwater suggest that meteorically-derived groundwater in the deeper aquifers discharges to the lake in all areas. Enriched ^3H analyses of deep groundwater sampled in eight private wells on both lakes showed values from <0.8 to 17.2 TU, suggesting the presence of pre-bomb, modern, and bomb-era water, with no strong trend of age with depth. In summary, isotopic data suggest that groundwater in both shallow and deeper groundwater flow systems could be feeding the two lakes, while lake water could mix with deeper groundwater and exit the lake through those aquifers. With the possibility that nutrients enter and exit the lakes from multiple sources and multiple aquifers, it is important to characterize each potential source and its water/nutrient contribution. Work in summer 2012 is directed towards better characterizing the geology, geochemistry, and hydraulic head relationships in the deeper aquifers.

Installing a well at the ISU water field station in Ames, IA.

student bio

I am currently an M.S. candidate in both Geology and in Environmental Science at Iowa State University working under the supervision of Dr. Bill Simpkins. I was born in New Baltimore, Michigan but grew up in Savage, Minnesota and graduated with a B.A in Psychology and Environmental Studies from the University of St. Thomas in St. Paul, MN in 2007. My research interests are groundwater/surface water interaction, microbial/chemical degradation processes and effects of water chemistry on home brewing.

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contaminant spotlight:

ISSUE RAISED BY THE 2011 NOVEMBER ARSENIC CONFERENCE

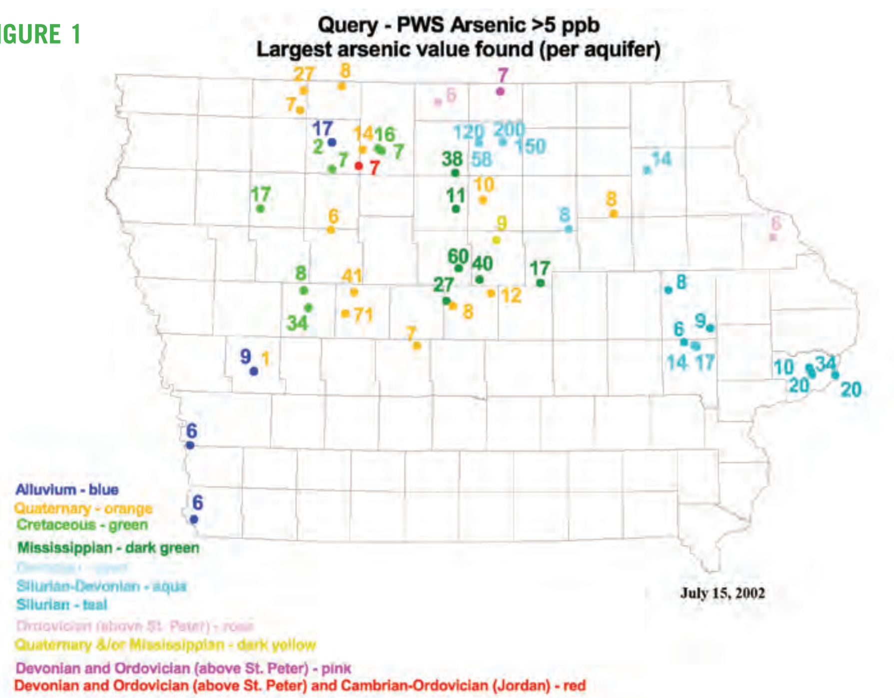
Paul VanDorpe - Iowa Geological and Water Survey

In November, 2011, researchers from across the Midwest got together in Des Moines, Iowa to discuss one of the "hot topics" in groundwater research, namely, arsenic. Arsenic is a naturally occurring, tasteless and odorless element found in soil and groundwater.

Although only five public water supplies (PWSs) are not in compliance with the arsenic standard (Moles, 2011), it is unknown how many unregulated private water supplies are also not in compliance. Nevertheless, we have an idea of the extent of the problem. In 2006 through 2008, a state-wide survey (SWRL II) of 475 private wells showed that nearly half had arsenic and about 8% of those had arsenic above the maximum contaminant level (MCL) for public wells (10 ppb). High arsenic in both shallow and deep wells was documented in 31 Iowa counties. Earlier investigations, utilizing two different data sets, clearly showed that arsenic occurs in every major aquifer in Iowa (VanDorpe, 2000, 2001a, 2001b, 2002a, 2002b).
In Cerro Gordo County, two PWSs had persistent arsenic problems. After further evaluation and recommendations, the county established an arsenic exclusion zone in which new wells would be drilled deeper, below a shale-bearing unit, and hopefully be arsenic-free.
After EPA proposed lowering the MCL in 2001, new or revised operations permits required each PWS to collect a one-time sample for arsenic to determine which PWSs have arsenic above the new MCL (Vedder, 2002). Arsenic above the new MCL appears to be associated with PWSs whose source water is from aquifers less than 400 feet deep. Most of the PWSs with elevated arsenic also appear to have elevated iron. Also, there appeared to be some geographic segregation of the high arsenic wells.

After a year of monitoring, John Vedder saw a pattern of high arsenic wells and wells with elevated iron.

FIGURE 1



An EPA grant was acquired to study the effectiveness of iron removal in removing arsenic. The University Hygienic Laboratory assisted with sample collection and analysis (Vedder, 2003). Several iron-removal treatments were evaluated for removal of arsenic. Between 50% and 90% of arsenic was found to be removed by conventional iron-removal techniques.

These two unpublished reports fell far short of characterizing the possible sources or aquifers adequately (VanDorpe, 2002b; 2003). Vedder referenced nearly every well or PWS in north-central Iowa with arsenic above 10 ppb as having some relationship with the Des Moines Lobe landform.

In July, 2002, the Iowa Environmental Council (IEC) queried PWSs with arsenic > 5 ppb and showed the highest arsenic value found per aquifer **(Figure 1)**.

In 2005, Vedder published a final report (Vedder, 2005) with PWS wells containing arsenic ≥ 10 ppb as occurring in only three geographic areas: Scott County, Johnson County, and on the Des Moines Lobe footprint. It is not clear if the portion of the IEC query above 10 ppb is the same PWS wells that Vedder was evaluating **(Figure 2)**.

In John Vedder's 2002 – 2003 iron and arsenic study there were 62 PWSs participating in the study encompassing approximately 243 wells. Of these PWSs 69% (43/62) had arsenic at or above the proposed arsenic MCL of 10 ppb. Fourteen (32%) of these PWSs with arsenic above 10 ppb are completed in Wisconsin-age materials, however, only 10 of these PWSs (23%) had wells that are likely truly late Wisconsinan, Des Moines Lobe wells (Surine, 2012, personal communication).

The IGWS water-quality database provides an accurate assessment of the arsenic situation. Risk can be interpreted in different ways (Chad Fields, 2011, personal communication). About 10% (223/2289) of the wells in the water-quality database that were sampled for arsenic contained arsenic ≥ 10% (223/2289). Wherever possible, these wells were sorted by aquifer (48 wells did not fit the major aquifers classification). These aquifers in stratigraphic order and their percentage of the total number of wells in the database are:

Iluvium: 33.8% (774/2289)

Quaternary: 15.9% (364/2289)

Cretaceous/Dakota: 8.2% (188/2289)

Pennsylvanian: 1.1% (25/2289)

Mississippian: 8.3% (190/2289)

Silurian-Devonian: 17.8% (407/2289)

Cambrian-Ordovician: 12.8% (293/2289)

The distribution of wells for each aquifer can be mapped. Space considerations preclude their inclusion here, however, copies are available from the author.

This map shows all the wells which were sampled for arsenic. **(See above Map)**.

The aquifers in order of percentage of wells in the aquifer containing arsenic ≥ 10 ppb (number of wells containing arsenic ≥ 10 ppb divided by the total number of wells sampled from the aquifer):

Quaternary: 23.4% (85/364)

Pennsylvanian: 20% (5/25)

Cretaceous/Dakota: 17% (32/188)

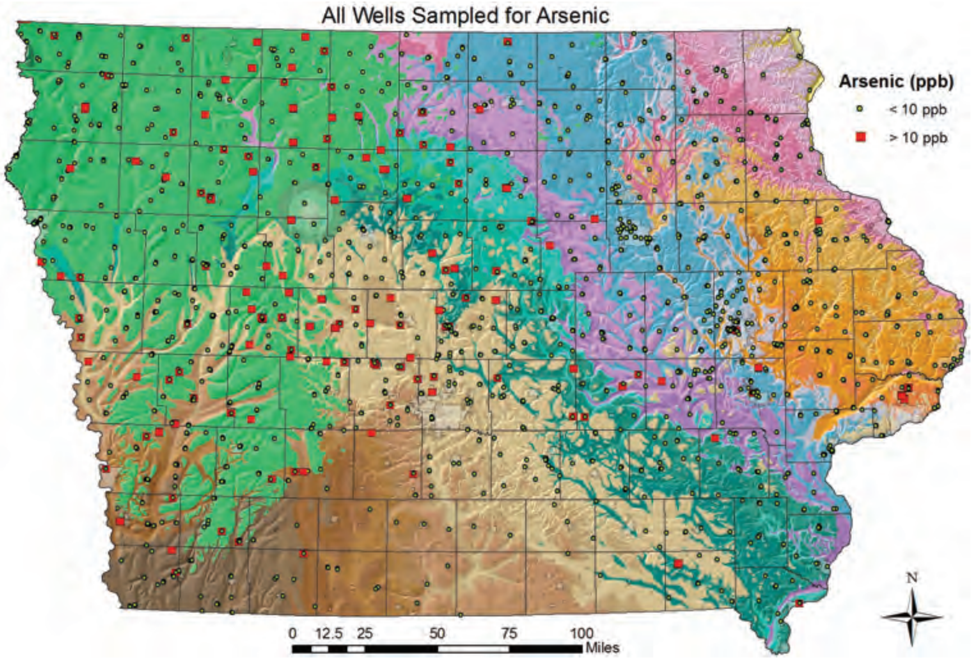
Mississippian: 14.7% (28/190)

Alluvium: 5.9% (46/774)

Silurian-Devonian: 3.7% (15/407)

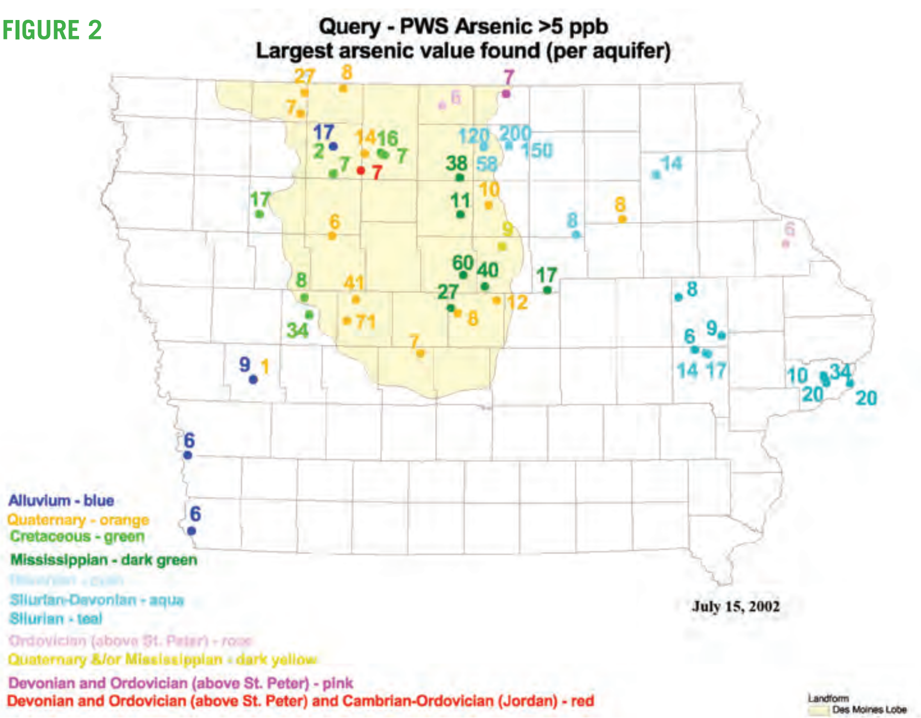
Cambrian-Ordovician: 2% (6/293)

MAP



Note that on this map there is a vast area in south-central Iowa without very many wells. Groundwater resources are scarce in this area, so fewer people rely on groundwater.

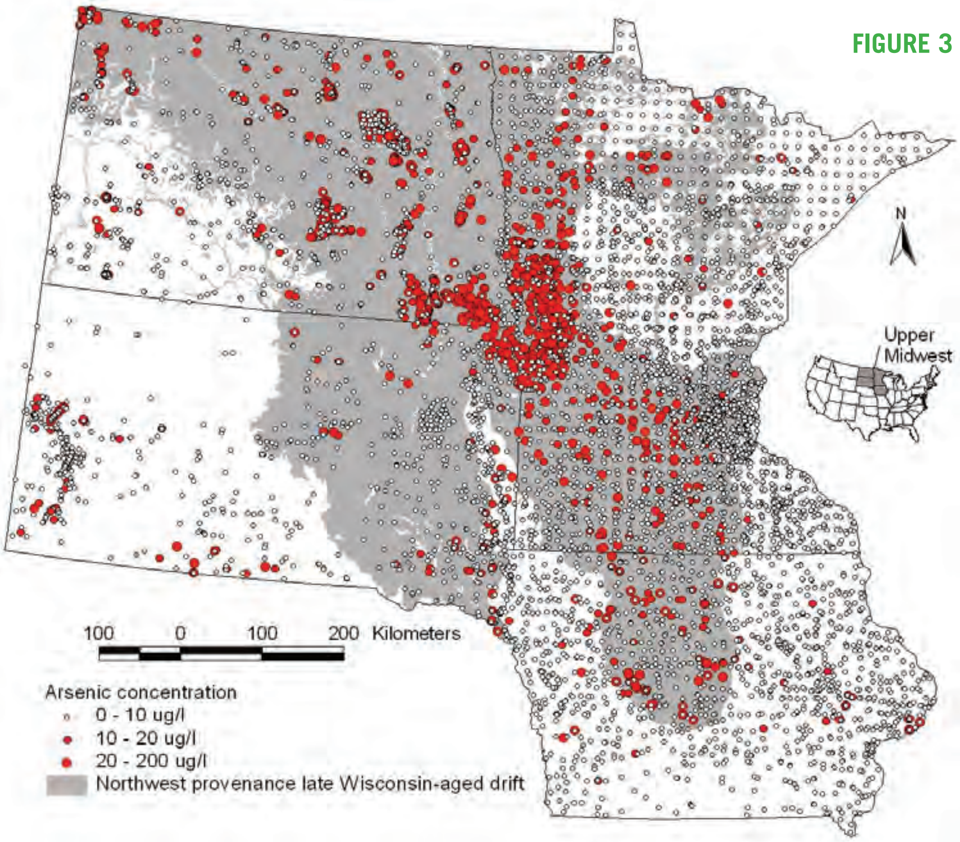
FIGURE 2



These data generally show that, with the exception of wells in alluvium, deeper wells tend to have less arsenic than shallow or intermediate depth wells. It is also suspected that aquifers with interbedded units such as sand, shale, till, etc. may have a deleterious effect on the presence of arsenic in groundwater. An on-going study of arsenic in Cerro Gordo County groundwater may show this to be true in their arsenic exclusion zone.

(continued on next page)

FIGURE 3



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At the arsenic conference, two speakers from neighboring states (Wisconsin and Minnesota) discussed the arsenic dilemma in their state. Interestingly enough, Mindy Erickson from Minnesota depicted the occurrences of elevated arsenic within the footprint of the Northwest Provenance, late Wisconsinan till in Minnesota. In west-central Minnesota, the Minnesota Arsenic Study focused its effort on high arsenic wells where biomarkers may prove useful. These were not randomly selected wells.

In her regional compilation of adjacent states (North and South Dakota and Iowa), she considered the Northwest Provenance late Wisconsinan tills to be associated with elevated arsenic. Of course, this approach coincides with John Vedder's assertion that the preponderance of high arsenic wells in north-central Iowa are connected to the Des Moines Lobe landform. However, at least for the Iowa wells Mindy Erickson shows on her map (Figure 3), neither she nor John Vedder distinguishes wells that derive their water from the uppermost glacial deposits and deeper glacial deposits and Paleozoic aquifers **(Figure 2)**.

CONCLUSIONS:

- While high arsenic wells (>10 ppb As) are found throughout the state, there is a strong association with high arsenic wells in north-central Iowa.
- With the exception of wells in alluvium, high arsenic wells tend not to be in deep aquifers.
- In Cerro Gordo County, an arsenic exclusion zone has requirements for new wells to be drilled deeper, beneath the Lime Creek Shale.
- An on-going study in Cerro Gordo County is aimed at determining the hydrogeologic controls for arsenic in groundwater.
- Conventional iron removal techniques are successful in removing arsenic from groundwater.

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HOLY SMOKE!
Helping Iowans Figure out Oddities

Paul VanDorpe - Iowa Geological and Water Survey, Iowa Department of Natural Resources

It was a fine Friday morning in the middle of May in rural Muscatine County when Wayne Brannen, whisking out the door on his way to work, saw steam emanating from the ground in his front yard at his Eight Ball Acres property. He took a quick snapshot of the waist-high plume with his cell phone. In the afternoon when he returned home, the vent was still steaming – the ground was warm – the surrounding grass was dead – and the temperature several feet down the vent was measured at 200 degrees by a silage thermometer. So... time to call for assistance! Dreading a volcano in his front yard like the one in a Mexican corn field (Paricutin Volcano in 1943), he called the Iowa Geological and Water Survey's (IGWS) Ray Anderson. Ray assured him that a volcanic eruption was very improbable, since there hasn't been an erupting volcano in Iowa for over a billion years.

WHAT'S COOKIN'?

So…what's burning underground? Wayne asserted that he had no knowledge of underground pipelines or other subsurface utilities near the steam vent. An understanding of the area geology suggested a smoldering coal seam as a reasonable explanation for the phenomenon. Coal seams in other areas of the country have been known to catch fire and smolder for years, but none had previously been reported in Iowa. Ray discussed the mining history of the area with IGWS geologist Mary Howes. She confirmed that abandoned underground coal mines were present in that general area of Muscatine County. Rock samples had been collected during the drilling of the Brannen water well (about 100 feet from the steam vent) and studied by the IGWS, who had produced a log of the geologic units encountered. That log showed that coal-bearing rocks were present, but no coal was noted by the driller or the geologist who logged the samples. What were the odds that a coal seam, thin and discontinuous in this neck of the woods, could have been set on fire and burned undetected for many years to reach its present location? Ray advised Wayne to inform the county sheriff and the utilities of the situation.

The next day (Saturday, the ides of May) I made a trip to the site. Sure enough – steam, warm ground, 140 degrees, dead grass – and everyone was still puzzled. Acting on the premise that a coal seam outcrop was set afire years ago, Wayne took me on a field trip up a nearby creek to look for outcropping coal seams. We found Pennsylvanian shale and siltstone but no coal. So it seemed highly unlikely for the vent to be the result of a burning coal seam. Besides, a burning coal seam at this location could be below the water table. Now that would put a damper on a fire!

On the following Monday morning Ray, Tom Marshall, and I from IGWS, met Terry Jones from IDNR field office #6 in Washington at the vent, which still registered 110 degrees. Wayne explained that the area of the vent was formerly a cattle yard with barn. About eight years ago the barn was razed, taken off-site, and burned. Further investigation in the office revealed old aerial photography that confirmed a structure – probably the cow barn – at the vent site. Could something combustible– hay, silage, wood, manure – been overlooked and set afire? Underground? How?

SHOCKING DEVELOPMENTS!

The vent was monitored during the week, as the steam and temperature slowly declined. On the following Saturday, family members were sliding down the hillside on a slip-n-slide when one of them stuck her foot in the vent hole and received an electrical shock. All the kids had to try it out! Wayne said it was like "grabbing a hot fence."

Well, you've guessed it by now: after the barn was razed, someone failed to disconnect an underground electrical line leading from the barn to the circuit breaker box in the house. An electrical wire got overlooked, was routed across the house to a newer circuit breaker box, and reconnected. When rain saturated the area, electricity arced through the moist ground, turning groundwater into steam. According to Wayne, the arcing never tripped the circuit breaker. The circuit was also connected to the Brannen's garbage disposal, which, I suppose, is a fitting conclusion to the mystery of the underground fire in Muscatine County: no volcano, no coal seam fire, no burning refuse, just a live "garbage" wire --- and groundwater!

FRIDAY MORNING STEAM VENT.

FOSSILIFEROUS SHALE FROM OUTCROP.

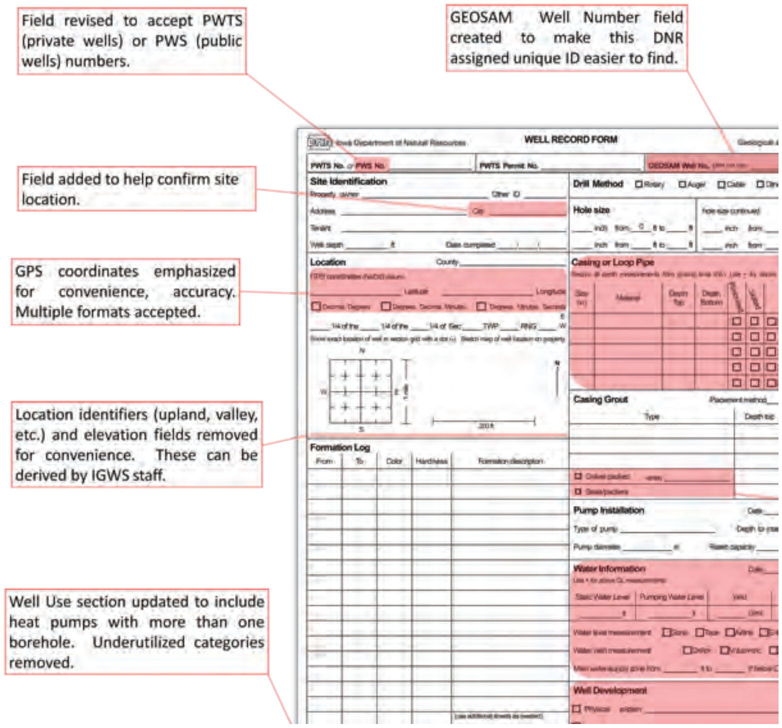
IGWA Member News

NEW DRILLER'S LOG

Well drillers in Iowa are required (IAC 567-82.12(3)) to submit well records to IDNR – Geological and Water Survey (IGWS). This requirement provides IGWS with data that is then processed and compiled to be beneficial to Iowa municipalities, industries and residents. For example, if a city or individual had trouble with a water well (quantity, contamination, construction, etc.), well records are a tremendous resource for identifying problems. Well records are available to the public on our website: www.igsb.uiowa.edu/webapps/geosam

The well record form was improved in 2011 to take advantage of new technologies, place an emphasis on more accurate GPS locations and simplify the form entry process. Underutilized fields were removed from the form and many other fields were merged together.

The form can now be filled and sent electronically, and is available for free download from our website: www.igsb.uiowa.edu



MEMBERSHIP RECOGNITION

New Members

- Matt Culp, Des Moines, IA • Keith Potts, Omaha, NE
- Nancy Suby-Bohn, Des Moines, IA
- Lee Grimm, Fredericksburg, IA
- Ron Cunningham, Fredericksburg, IA
- Gerald Hentges, Des Moines, IA • Ryan Clark, Iowa City, IA

5-Year Members

- Gary Everman • Eric Mueggenberg

10-Year Members

- Edward Bertch • James Gastineau

15-Year Members

- Greg Brennan

20-Year Members

- Bill Gross • Joseph Smith

DID YOU KNOW

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

Contact an IGWA Board member for details.

Upcoming Events

IRWA Fall Conferences | **Okoboji – September 11-12, 2012 & Dubuque October 16-17, 2012**
www.iowaruralwater.org/events_fall_conference.html

2012 AWWA - IAWEA Fall Short Course | **September 11-12, 2012**
Des Moines Area Community College, FFA Enrichment Center – 1055 SW Prairie Trail Parkway, Ankeny, IA
www.iawea.org

2012 National Association of Abandoned Mine Land Programs (NAAMLP) and the Annual Conference
sponsored by the State of Iowa | **September 23-26, 2012**
www.2012NAAMLP.com

IAMU Water Distribution Training Workshop | **September 26, 2012**
Iowa Association of Municipal Utilities – 1735 NE 70th Ave., Ankeny, IA
www.iamu.org/calendar OR Jill at jsoenen@iamu.org OR 515-289-1999

57th Annual Midwest Groundwater Conference | **October 1-3, 2012**
Minneapolis, MN
www.mwgwc.org/

Iowa Environmental Council Annual Conference | **October 4, 2012, 8 a.m. - 4 p.m.**
Scottish Rite Consistory – 519 E. Park St., Des Moines, IA
http://iaenvironment.org/conference/2012/index.php

2012 Iowa Science Teachers Fall Conference | **October 15-16, 2012**
Scheman Building, ISU Campus, Ames IA
www.iacad.org/ists/fall-conference/index.html

Iowa Groundwater Association Fall Meeting | **October 24, 2012**
ISU Extension Building, Johnson Co Fairgrounds – 4265 Oak Crest Hill Rd SE, Iowa City, Iowa
www.igwa.org

Basics of Onsite 101 | **November 6, 2012**
Ankeny, IA DMACC – Bldg 18, Rm 35 | Registration is at 8:00am. Class: 8:30am - 3:30pm
Register on-line by going to www.wastewatertraining.com/Event/28

Time of Transfer Training | **November 7-8, 2012**
Registration at 8:00 AM Class 8:30 AM to 4:00 PM | DMACC - Ankeny campus Bldg 18 Rm 35
www.wastewatertraining.com/Event/31

2012 EPI Fall Symposium | **November 12-13, 2012**
Stoney Creek in Johnston, IA
www.epiowa.org

18th Annual Water/Wastewater Operator's Training Workshop | **November 13-15, 2012**
Holiday Inn NW on Merle Hay Road in Des Moines
www.epiowa.org

2012 NGWA Ground Water Expo and Annual Meeting | **December 4-7, 2012**
Register on or before November 9 to save on registration!
http://groundwaterexpo.com/

IWWA 84th Annual Convention & Trade Show | **January 31 – February 1, 2013**
Coralville Marriott Hotel & Conference Center – Coralville, Iowa
www.iwwa.org

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