GROUND WATER SCIENCE *FLOWLINES*

Useful information for customers & friends of Smith-Comeskey Ground Water Science

10 BEST of *FLOWLINES* -- 1999-2004

Flowlines is our regular topical newsletter published about two times per year, now at our web site

www.groundwatersystems.com

This site also carries an abundance of other information and links to useful information in ground water and water supply.

This issue is a special "best of" from *Flowlines'* first five years. Enjoy.

1. Let's set standards and not lower expectations among those we serve

A few years ago, we heard a talk on a subject related to ground water services that was, to sum it up, discouraging. I think our professional and technical meetings (besides being "gatherings of the clans") should be places where we learn about new ideas, higher standards and better methods.

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So, beyond a narrow sales objective, whose needs are met when a speaker defines a "standard method" (in this case, in well cleaning) as one that is easy, yet ineffective, and then proceeds to misrepresent better methods ("they're too difficult" - when they're not)? **As professionals, shouldn't we be telling our colleagues and customers about better methods - and using them?** Are you in the service providing business? If so, and you have the responsibility of teaching a roomful of your potential clients, **as a trusted expert, your responsibility is to elevate that audience.** If your firm is tied to a tired old way of doing something - upgrade the procedure and your staff, don't depress the industry. ***And if you catch any of us being fat and happy and preaching mediocrity some day, tell us - publicly.***

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2. Ground Water Source Quality: Relationship with Surface Water and Regulation

Surface water management in the USA assumes that the source is impaired and unsafe for consumption without elaborate treatment. However, experience of the last several decades shows that ground water sources are not uniquely immune to contamination, and once contaminated by chemical or radiological agents, they are almost always difficult to remediate.

Recently, attention has refocused on the risk of pathogen transport to wells. A common outcome of all ground water contamination research is that prevention is far more effective than remediation or treatment in assuring the quality of ground water supply sources. Prevention takes the form of management.

The key to understanding and managing ground water quality in water supply planning is to understand that both aquifer hydrologic characteristics and the causes and effects of ground water contamination are complex and highly site-specific.

Changes in each of the just-mentioned hydrologic characteristics can affect ground water quality by changing local constituent concentrations. Likewise, localized differences in formation geochemistry (e.g., organic content, iron and other mineral transformation) affect water quality. A third factor is the influence of the aquifer microflora in a specific fracture or aquifer zone tapped by wells. Work in the last 20 years has revealed the extent and complexity of the microbial ecosystems that inhabit aquifers.

The extent of human impact also depends on (1) how potential contaminants are handled, (2) the physical-chemical characteristics of materials if they are released to the ground and (3) the hydrologic characteristics of the location where a release occurs. A further human impact is the presence of abandoned wells or other underground workings that provide conduits through low-conductivity soils.

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All of these factors are site-specific, but they can be understood and managed if identified. Thus, effective water supply management of source ground water (and avoiding unnecessary treatment) depends on adequate local knowledge of the ground water system being utilized.

Excerpted from Chapter 4(a), Source Water Quality Management: Groundwater, written by Stuart Smith for Water Quality & Treatment*, 5th ed, AWWA and McGraw-Hill (AWWA*).

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3. Well Rehabilitation: Thinking about what you're doing

We are past the 20-year mark of a remarkable period of research into and documentation of the causes of well problems and effective cures. The landmark reference, "Evaluation and Restoration of Water Supply Wells," co-authored by Stuart Smith, and produced by the NGWA for AWWA Research Foundation, is over 10 years old and his little book for environmental well maintenance and rehabilitation is nearly 10. Similar and very useful works have been published in England, Australia and Argentina.

We have many effective means of early-warning detection to head off well deterioration problems before they become entrenched, excellent well materials, and well rehabilitation methods that can remove the nastiest, thick, viscous biological clog from even delicate wells are available (without destroying the grass, fish or the wastewater treatment plant).

So, why are we (ever-so-gingerly) pulling badly corroded drop pipe and pieces of dead pumps from wells or seeing well rehabilitation specs that ask for treatments that will do more harm than good at significant cost and environmental impact?

If you haven't had a reality check in maintaining your well performance lately, we offer this "Cliff Notes" version of how to avoid big problems with wells:

☑ **"Ground Water Ecology 101":**

(1) All the materials life needs are present to one degree or another in aquifers.

(2) Microbial biofilms (such as "iron bacteria") are everywhere in aquifers. Biofilms serve to

protect bacteria, efficiently recycle the dead, and scavenge nutrients in short supply.

☑ **"Aquifer Chemistry/Physics 101":**

(1) Most development force dissipates quickly outside a borehole or well screen.

(2) If you keep using the same tools on the same wells, and you encourage biofilm growth by your choice of chemicals, you can get persistent clogs at the outer edge of your radius of effective force.

(3) Most well treatment chemicals do not work well in high-hardness, high-alkaline, cold ground water.

(4) Lower hydraulic conductivity formations and screens clog more quickly than higher ones. *This should be no mystery*.

☑ **"Well Salvation 101":**

(1) Know what your problems are likely to be and plan for them.

(2) Prevent with good construction and material choices. Prevent with efficient design, and gravel packs that can be developed with conventional tools.

(3) Monitor to identify problems early, then react in a timely fashion (cheaper over time).

(4) Actively *plan* your rehabilitation process based on good information about the actual well environment, what is present causing problems, and the effectiveness of a method on a particular known problem. *This does not have to be expensive or complicated.*

(5) Do NOT base your decisions solely on what the chemical salesperson told you, promised you, fed you....

(6) *Everything has limits. No exceptions.*
(7) If the engineers give you the "same-old-same-old" in a specification, tell them to go back and do some actual work for a change, or *hire someone who will*.

(8) Prevention through design and material choice is better than rehabilitation. Think about your current truck and compare it to its 1971 counterpart (yes, the '71 Chevy you remember so fondly, but rusted out in all the strategic places). Unlike your 1971 truck, your new truck has good corrosion resistant materials and sun-resistant paint, and should never need a ring job. But you still have to keep an eye on it, and take care of it. That's maintenance. Rehabilitation is like restoring the truck after you let it all go.

The same goes in wells. There is no excuse any longer for well owners not to maintain wells for decades.

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4. "How do we Really Know...?" or Employing Actual Science in Problem Solving and Planning

There are numerous methods available in the ground water technical field that require skill and care to actually

- Describe with quite a bit of confidence what can be expected of a well or wellfield.
- Construct a quality well that will last many years and pump water efficiently.

It probably should not be a surprise that it is important to do them properly to actually accomplish the ground water related task you set out to do.

Examples:

Tests: Done to determine a valid number for well specific capacity, well loss and aquifer loss (using the properly run step test), before and after well cleaning to see if it did any good. Aquifer pumping tests employ slightly different methods to gauge aquifer properties.

Well design: This should be specific to the well site, based on drilling logs and not based on engineer "boilerplate" alone, and focus on informing the well construction.

However, we take more than a little on faith in our daily work, don't we? Now faith is a good thing in this writer's worldview, but when the writer of Hebrews stated "Now faith is the assurance of things hoped for, the conviction of things not seen," the "not seen" topic was spiritual and not ground water.

Sometimes it is better to become the "Skeptical Inquirer," lose your faith and to actually check things out. As not everyone can do this their selves, you sometimes do have to trust (have faith in) others to be professional and competent, and sometime to trust the advice of others.

Science, along with effective engineering, and the hard work and ingenuity of our colleagues the water well professionals improves your results. Read. Be skeptical of what you read and are told. Test it yourself. Ask questions. Don't assume that all those "water well guys" do things the same way or know what they are doing.

But, to really know, the testing has to be done. The process of conducting such investigations is science. Science is conducting a systematic investigation of facts, and can be done by anyone. It does not always require a highly educated (or paid) "professional." But if you do "put faith" in someone's advice, base that faith in the science that backs up the advice. *Make them do their job*.

Here are a few select examples for your consideration (and don't just take my word for it…):

- **"How do we really know if this is a good well site and how much water will we obtain?"** In some places, getting good quantities of water is almost guaranteed if a well is constructed. In others, especially fractured rock or terrains, an investigation may be needed. At some point, you need "ground truth." Sometimes drilling a borehole is enough, but sometimes the $15,000 or so you spend on geophysics is a lot better than sinking and testing 10 marginal wells.

- **"Are we going to get good water?"** Pumping test wells for sampling can provide the means to know. Some aquifer areas seem to be plagued with contaminant plumes in some of the best-yielding areas. Ingenuity has given us instruments to measure many important parameters quickly *at the well site*. On-site testing of test wells can avoid the costly embarrassment of having to explain to the reporters why the utility had to install stack tower aerators on expensive new production wells. *Test, don't guess*.

- **Then there is the "siren song" of "Oh, this is too hard, we can't trust the ground water. We're just going to give up on this and go to surface water (or link to another big system)."** Here the science can be economics in convincing the city council to stay with the wells or to tell the EPA (politely) to take a hike.

***This is actually pretty simple*: It costs more money to operate a surface water treatment plant than a ground water plant, and it costs lots to run pipelines.**

In other words, it (usually) pays to rehabilitate wells. We have a saying around here: "Why solve a $100,000 wellfield problem with a $5 million pipeline?" But sometimes it does not pay, and you have to rely on good information to make that decision.

Do some research. Read. Ask for informed opinions. There is often a better way to do something than the way it has always been done before. And by all means, test in such a way that you can obtain valid information, so you really know, instead of guessing.

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5. Wellhead security -- Worry more about Jimmy and Skeeter than Osama?

Since at least the mid 1990s, we have consistently recommended that our clients install passive security even on smaller wells in rural locations: locking caps or shields, or something. So far, we haven't been very persuasive. Many of you have those pitless units with the heavy bolt-down caps that defy entry -- both to vandals and water operators, but the ones with the little set screws remain common.

A story that came over the Associated Press wire in February 2002 should be a cautionary tale: At Kenyon College in Gambier, Ohio, about 40 mi (65 km) northeast of Columbus, their environmental education center has a well serving the center. Animal hair coming out of the faucets and in toilet water was the clue that something was wrong. This led to discovery of the remains of a groundhog (or woodchuck if you prefer, our common burrowing marmot) in the well. Someone unscrewed the cap and stuffed the creature in there. The animal was removed, the well cleaned and repaired and put back into service. **No health effects were reported.**

Obviously someone had sufficiently great indifference toward (or bad feelings for) both the animal and the users of the well to do such a thing. This person probably wasn't some foreign terrorist. He or she probably was a local resident in the Gambier area or a student at this small, liberal arts college that attracts the same sort of students that Ivy League colleges do. While they are not taught in polite society to stuff groundhogs in wells, lead horses to bell towers, etc., some of our young educated elite does such things. This is especially true for those who have too much time on their hands and poorly developed values systems.

What do we do as a result of such an incident? We would hope that heightened education and attention to values development would turn out people who respect God's creatures (burrowing and tool-using) enough not to do this sort of thing. However, until that time, it would be prudent to secure your wells better.

One key to security is making it difficult for unauthorized people to gain entry to the well. First, landscaping can further obscure the natural low visibility and obscurity of the modern cased well. However, avoid landscaping that makes service difficult or which harbors earwigs and other insects or rodents. Lockable well caps are available that make entry more difficult. However, they should be able to accommodate lock shanks that will foil the tools typically available to vandals. PVC casings should be fitted with steel or aluminum lockable covers anchored in concrete. Something fabricated from casing stubs is discouraging enough. Add fencing, removable fiberglass buildings and other obstacles.

Watching one of our clients drilling an exposed well discharge line for a sample tap (like a phlebotomist installing an IV needle) made us think again about the vulnerability of aboveground well discharge lines. While you may not need them in your warmer-weather location for freeze protection, perhaps it is time to install pitless adapters feeding buried pipe lines on your isolated cased wells for security reasons (and bury power cables, too).

To catch vandals in the act or to assure a rapid response to a successful entry, either a means of signal generation to a security control center or frequent inspection is necessary. Installing a sensor on a well cap such as that used for detecting window entry in home security is one way. Adding well site inspection to locked door checking and other security inspections is another.

Of course, as our national security "experts" have learned all over again recently, "humint" (human intelligence) is the most valuable of all. Interest a neighbor in your well security. That observant retired person checking out the well at your school, church or environmental education center every day (or watching for lights out the window when they get up at night) perhaps is the best security of all.

Action items:

☑ **There are numerous lockable well caps and covers that can make such pranksterish**

vandalism more difficult. We'll be glad to make recommendations.
☑ **Fence and add surveillance of critical remote facilities.**
☑ **We have a short training program (approved for Ohio EPA contact hours) that we can provide.**

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6. Terrorism comes to our door: Smart responses in water supply

We're sure you are thinking hard and long about how to make sure your facility or water supply is as safe as it can be from attack by the wide variety of evil or disturbed people out there. **May we suggest the following?**

1) Wherever technically feasible, abandon surface water sources in favor of ground water sources. You can protect wells in ways that you cannot protect a reservoir or intake. It is possible to treat even very nasty ground water.
2) If surface water is indispensable, use directional drilled wells, infiltration galleries, or "riverbank" filtration. Studies show very pronounced changes in water quality within a few feet of ground filtration, including drop offs in organics. **Directional drilling technology permits use of permeable formations under rivers and lakes. Galleries act as prefilters -- note that they must be properly designed, and permit rehabilitation in the future.**

3) Disperse water sources. It is time to reverse the trend toward centralized sources of water. Yes, it is a pain for regulators to keep track of thousands of wells, but single treatment plants serving large areas such as entire counties are vulnerable to attack, especially if served by surface water sources. **It is time to be creative institutionally so that multiple sources can be regulated as conveniently as single sources.**

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7. The differences between oil and water?

- **"Oil" is water from wells with a little oil in it that people seek on purpose.**
- **"Water" from wells is (we hope) free of hydrocarbons.**
- **Money spent on oil exploration is viewed as an investment, hoping for a return on investment, but accepting a percentage of failure as the cost of doing business.**
- **Money spent on water exploration, definition and delineation (and the construction and maintenance of wells) is typically viewed as a cost, even if the water is sold, or used to make a product that is sold for a price, not as an investment in that sale.**

Water, like oil, is a resource that people need (they can live without oil, though), that is extracted, treated and sold to consumers. Action item: Train your money people to start thinking of water as a resource with value. If you have good,

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8. Quality and services

You there in the water supply trenches, how do you decide how to choose services for your ground water supply?

It's easy to go to your "one stop" multi engineering firm or big well services contractor. Both offer simplicity in lines of communication. The client mostly speaks to one project manager.

However, we have noticed that the quality of services can be uneven.

1) Planning to get the desired result: Let's just say it is DIFFICULT to go straight from designing a wastewater treatment plant to planning ground water resource planning or protection, and hard to keep up on new developments. An effective option is to have your ground water specialists (who do keep up with new

developments and efficient methods in wells) advise your engineers on well matters. Warning - some engineers can find this offensive.

2) Standing in witness: In a lot of firms, the time of experienced professionals is tightly regimented so you may NEVER see the guys with 20 years experience supervising your well test or service project. This becomes a decay cycle -- If you aren't observing well tests, you don't know the quality of the data.

3) What gets brought to the job: Some well service firms have forgotten what is required to do something like a well step test: proper accurate flow measurement, pumps that provide constant output, and no leaks. Do you know what is required when you see it?

4) What is delivered to you: What are you getting from your tests and precious funds?

Action item: Include ground water professionals in the loop who do not have a financial stake in well services profitability, and who are willing to have experienced people on site on your job or involved in your troubleshooting.

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9. Exploration:

Exploration for ground water in the humid U.S. East can often be limited to "drill here" but "stealth" droughts have been identified in Pennsylvania and New York states that have impacted ground water levels and dried up streams, and Ohio also had low and spotty rainfall. It was only two years ago that significant drought hit Ohio. Forensic history shows that we have been lucky in precipitation throughout the U.S. during the period of nation building, but that decades-long droughts can happen. Ask those Depression survivors while you can. Plus, we have more people and a legacy of ground water contamination in places. Exploration may be needed. If done well, ground water sources are optimized and more value is gained from the investment in a ground water supply. Examples:

- Tracing promising alluvial aquifer deposits
- Delineating high-conductivity fracture zones in a variable rock body like limestone
- Finding the extent of contaminated zones.

Exploration for water requires investment and some risk, just as with other types of resource exploration.

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10. Food for thought from "The Water Page"(www.thewaterpage.com), The Water Policy Institute, U.K.:

"Taking South Africa as an example [and not by any means the most poverty-stricken, ed.] *and using very rough figures just to illustrate the point, it is estimated that about 16 million people have no operating water supply with their source of water an average distance of 1 km away. If an average of 2 trips to fetch water are made each day at a conservative round trip distance of 2 km each, that makes a distance of 12.8 million km walked each day, day after day, by South African women, just to fetch water. So,* ***South African women walk the equivalent of to the moon and back 16 times a day just to fetch water.*** *If each trip takes an average of 1 hour to walk to the place, wait in a queue, collect the water and walk back, 6.4 million trips take 6.4 million hours a day fetching water. This is just South Africa - if you think of the rest of Africa, it is staggering - and this for only about 10 litres of water each and usually of suspect quality."* Len Abrams.

Action item: Be generous to Water for People or another favorite water charity. Some are listed on our web site: www.groundwatersystems.com and volunteer your time and talents. You will never be more satisfied or more rewarded.

How do we get *Flowlines* and access to such good information and more?

1. Easy - It's posted on the web at

www.groundwatersystems.com

Just check there regularly for updates or send us your email so we can inform you when the next issue comes out. We're busy, so it's a little irregular.

2. While you're there - cruise through the web site for the large number of articles and links available.

3. Take advantage of our training:

- **Look out for our courses put on for OTCO or at other events near you.**
- ***Schedule* our training at your location, customized to your needs. We also train as we consult.**

Why do we put out this kind of effort writing and training? Simple: When you are better informed and motivated to seek quality in ground water supply, you appreciate us and what we do and stand for more.

Thanks for your attention GWS