Managing Water Well Construction for Success Wherever You Are

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Water well construction is a process reaching back into prehistory, and saddled with a certain amount of mysterious thinking, processes that are habits because they work some of the time, and features that seem to some like they should work, ignoring decades of experience, while proven features and processes are ignored.

Geologist-led test drilling in western Ohio

We are consultants typically representing the client/beneficiary of the well. Managing water well construction projects (speaking as the client's representative) requires thorough knowledge of technique, flexibility, determination and durability matching the other participants on the site, ability to communicate under stress, and respect along with projecting authority.

The "respect" aspect goes with the relationship with contractors. They are (if you choose well) skilled people managing expensive inventories of complex equipment, who probably have drilled many more wells than you have managed. This does not mean you assume the "junior partner" role on the site, but projecting your authority must be done with respect and a spirit of collaboration. The consultant-contractor relationship can be an excellent one benefitting the client.

All well construction is site-specific – the need for knowledge is paramount

It is the nature of our practice that we work in a variety of settings. So maybe it is more self-evident to us than others that drilling boreholes in the sand and gravel in the Miami River Valley is distinct from the dolomites of the Lake Erie shoreline, sandstone in Jordan, or volcanics in Tanzania. However, you do see people trying to impose features learned one place on tasks in another.

So the first rule of water well construction is to understand the challenges and constraints of the hydrogeologic setting. As a consultant, it is also incumbent on us to educate the client on these as well. What can the client reasonably expect? What are the risks and challenges, such as risks of contamination from activities in the area?

An attitude of due humility and willingness to learn. "Humility" is a term that is distorted in some modern use, but is best understood as being free from arrogance or excessive pride – as in "you could learn something." One approach we take is to be willing to adapt to local practices, while maintaining technical integrity, such as learning from the experience of local well contractors and geoscientists who have gone before us.

Information before designing and drilling. A common problem in many new areas is a lack of information on the proposed drilling site, something that is less of a problem in jurisdictions with long and extensive drilling log records such as our Ground Water Science

core market in the USA Midwest. In these states, you can typically research almost 70 years of drilling records. With their being online, this is relatively convenient.

However, it should always be remembered that a drilling site may not be exactly like a neighboring property or the generalized map. In the glaciated Midwest, there are large buried valleys carved into the bedrock aquifer in earlier epochs. So literally the rock can be encountered at 15 m on one side of a road and 100 m on the other side. In the same area, some very nice pockets of sand and gravel (recharged from rock) can be easy to miss.

As Ground Water Tanzania, we are also involved in well construction in Tanzania, and official borehole records can be scarce there in rural areas. It is important to do as much preliminary work as possible, because the available budget may be sufficient only to drill one or two 100-m boreholes. And there we are raising the hopes of the people and entrusted with donor money. We are typically planning drilling based solely on a local geophysical survey and area knowledge of geology. Still, on several recent jobs in Arusha and Singida, we were virtually drilling blind, except for the geophysical survey, as no other boreholes were in the area. Needless to say, the results were mixed. More local geologic and water quality information would improve results.

Managing expectations

Managing water well construction across a large geographical area requires preparation for variety in geologic conditions, contractors, rules, and even supply trains. This means not just possibly using a different drilling method but also carefully thinking through the logistics of the project to be sure that everything needed, such as spares, extra bentonite and critical components, is accessible, and not 1000 km away. Usually this is the responsibility of the drilling contractor, but project management should keep those on the checklist.

However, even when meticulous care is taken, unforeseen challenges can arise in the form of 1) insufficient quality of materials and 2) unexpected site conditions. In the USA, Australia and Europe, high-quality products, pipes, filter packs, and consumables are readily available. Likewise, sodium montmorillonite is, due to geologic circumstances, abundant in the USA. So consequently, the utilization of high quality bentonite for drilling and grouting is the norm. However, this should not be taken for granted when operating in other jurisdictions. On a project in the Middle East, we encountered lower quality product with a high percentage of calcium montmorillonite, which forms a distinctly inferior drilling mud that is much more difficult to break down in development (which was difficult due to depth and available tools). No wonder some schools of thought try to avoid bentonite altogether.

Dealing with “the need for speed”

Tighter budgets and expensive rotary rigs can cause troubling increases in demands for speed from well contractors and sales engineers. This impulse to “push it” most especially affects time devoted to well development and cutting corners on well sealing. Even in straight air drilling, time is needed for well development. A number of techniques have been developed to speed up development or redevelopment, but this essential part of well construction still takes time.

The role of standards and specifications … and the expert inspector

Perhaps disdained by some as "the paperwork" by "armchair busybodies," the two sections of "the rule books" each play a key role in managing the above-referenced challenges.

Standards and standard practices serve as the sector's written memory of what works. They have various purposes, but define what is right: Casing types and wall thicknesses, metal and plastic standards, material quality that is in contact with liquid, concentrations and weights of fluids. Such standards and standard practices (usually developed by professionals by consensus) help to set the tone, and allow everyone to be "all on one page." States, nations and local jurisdictions also have enforceable rules, which may rely on standards. Where these exist, they must be followed. Our practice is to follow the more stringent path: standard or rule as the case may be.

The specification is written to protect the client and set standards for the contractor. The casing shall be this …. Development at ____ for ___ hours…. Sometimes details such as "the rig shall not be squirting oil everywhere" or "repairs made on the contractor's time." Clients usually do not know well construction, and over 99 % of it disappears into the subsurface.

Finally, where possible, we stand over the work and document it. We also interpret how the specs apply in real time and conditions. The expert inspector is essential on many jobs.

Explaining use of a new handpump (Ground+Water Tanzania)

Being people savvy

"Savvy" is an English word that entered common use literally in a multi-cultural context, probably derived from Spanish *sabe usted* (you know) by way of pidgin Spanglish and implies being shrewd and knowledgeable; having common sense and good judgment. One can be technically beyond compare, but still fail without the people skills and knowing the local situation. You need to "fit in" somewhat (for an American in Tanzania, that can be a stretch) or at least establish rapport. For safety's sake, there has to be common working language so translation is not in the way. Know what people expect and manage expectations. "No, the well will not be done today..." Maybe you need to know if there is a local feud. Like, respect, and collaborate with the people you work with and the end users to the extent possible.

New challenges in old territories

Resource competition, for instance, can cause changes in existing ground-water use development practices. For example, coal seam gas development in eastern Australia presents new potential challenges to ground-water users. There, the coal beds are interbedded with aquifers. So far, in the case of Queensland, at least in our experience, everyone is being really responsible and watching the situation closely. However, in

Demonstrating new well testing methods in Queensland

the spirit of watchfulness, professional and citizen-led monitoring programs are essential to water resource protection. We'll always need good water, but maybe not gas.

Under our feet around our Appalachian Plateau office in eastern Ohio is the Utica shale play and its cousin, the Marcellus, mostly in Pennsylvania. Evaluating and responding to this oil and gas development of unprecedented scale is difficult. U.S. oil and gas development literally began in this region in the 1850s, so it is perforated with over 150 years' worth of wells and pipelines, most developed long before modern regulatory rules. Additionally, some aquifers are dirty and with high iron and sulfide, and in Pennsylvania, there are no private water well construction rules. How do you sort out the cause of a local problem? Answering such questions requires analysis that just is not getting done.

Another subtle challenge to groundwater resources is low-temperature (heat pump based) geothermal. Geothermal heating and cooling is a valuable part of the push toward energy conservation and conversion to renewable power sources. However, a geothermal system for a commercial structure can involve dozens to hundreds of boreholes into or through aquifers. It is necessary to seal these boreholes properly, but contractors make their money by the foot or meter. A steady diet of geothermal work can affect contractor attitudes toward well construction, with less patience for its slow, careful nature.

The knowledgeable and people-savvy on-site inspector armed with standards and specifications is more valuable than ever. We have these skill sets so let's get together.

Preparing for water well projects (the Ground Water Science and Ground Water Tanzania checklist for client representatives):

1) Understand the local hydrogeologic setting.

2) Strive for optimal water well construction sites via the practice of geology and geophysics.

3) Pre-qualify well contractors and understand their capabilities.

4) Get to know local rules and procedures and work with clients to help them understand the needs, how the process works, and realistic budgets.

5) Write good, practical construction specifications.

6) Enforce these through site inspection and documentation.

7) Know who owns and controls the well site – Make sure it is the intended party free and clear of encumbrance, and security is assured.

8) The consultant's rep onsite should understand the local culture and have a common work site language with site workers.

Further reading:

ADEKILE, D. 2014. *Supervising Water Well Drilling.* A guide for supervisors , RWSN/UNICEF , Rural Water Supply Network , St. Gallen, Switzerland http://www.rural-water-supply.net/en/resources/details/392

Australian Drilling Industry Training Committee Limited, eds. 2015. *The Drilling Manual*, currently Fifth Edition, CRC Press. Stuart Smith edited or contributed to 3 preceding editions. http://www.crcnetbase.com/doi/book/10.1201/b18303

Stuart Smith, ed. *Manual of Water Well Construction Practices*, National Ground Water Assn.

Various authors including Stuart Smith. Water Supply Well Guidelines for Use in Developing Countries (several languages) http://www.seidc.com/pdf/Hydrophilanthropy_Well_Guidelines.pdf

Standards: American Water Works Assn. ANSI/AWWA A-100, National Ground Water Assn. ANSI/NGWA 01, ASTM: Various in the environmental field.