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Aquifers over the Marcellus *"Water for Gas?"*

By Charles A. Rich

Hydraulic Fracturing ('fracking') involves injecting large quantities of water taken from surface water, purveyed municipal reserves, and/or newly-drilled water wells, mixing it with sand (proppant) and special chemicals, and then injecting it down into the Marcellus and/or older Utica Shale at extremely high pressure (psi increases with depth) to induce/increase fracture density and connectivity in deep shale & sandstone layers within these geologically gas-rich rock formations.

Fracking is designed to occur at scheduled intervals along that portion of the drill string advanced horizontally along bedrock bedding planes to hold the artificially-extended cracks open, and drive the natural gas occurring within interconnected pore spaces of the newly-cracked rock to flow back to the drill bore. Most of this injected fracking fluid remains down in the ground with only about 10% of it recovered.

It's been estimated there may be as much as 500 trillion cubic feet of natural gas within the Marcellus in West Virginia, eastern Ohio & Pennsylvania, and within the southern tier of New York (USGS). Devonian in age (some 400 million years old), the Marcellus has a variable natural permeability - with good porosity & permeability in the New York State Finger Lakes Region, but in some other drilled areas in NY, it has proven to be a relatively tight impermeable shale.

THE BENEFITS

Nationwide, shale gas represents a huge and economically-beneficial, unconventional, source of alternative clean energy. Lately, with further advances in directional drilling techniques, fracking efficiencies and the volatility of market pricing of alternative energy, natural gas is now an attractively positioned investment for long-term exploration & development. Although speculative, it would appear this huge resource will rapidly become a significant source of alternative clean fuel in decades to come. In the U.S., it has already been embraced by industry, electric utilities, transit buses, and trucking fleets and will likely serve as a growing export to energy-starved nations overseas (to those having

free trade agreements with the U.S.). Ironically as you read this, coastal gas terminals initially designed to import gas into the U.S. are now being repurposed for international sales instead. Other countries having known shale gas reserves include Canada, Mexico, England, Poland, South Africa, Australia, and northwest China. The geologic potential for finding additional shale gas elsewhere exists, but interest in doing so remains dormant for the moment.

Fracking has been going on since 1948, not only to increase yields of gas wells, but also to a lesser degree by water well drillers to increase the safe yield of water wells. Misconceptions or misunderstood environmental issues as portrayed by the media have influenced public opinion, and unfortunately, many communities are frozen in place, polarized over fracking, with the potential tsunami of legal claims arising from shale gas operations a growing threat.

THE RESOURCE TRADE-OFF

The process of fracking requires using as much as 3-7 million gallons of water per newly drilled gas well – water that must typically be trucked in to rural drill sites. Water use varies but depends upon proprietary additives, number & length of drill string laterals and their spacing (laterals as much as 1-2 miles in horizontal extent are now feasible), injection rates, fluid losses, well design/capacity criteria, flowback waste or reuse, and geologic variables.

Where will this frack water come from? In contrast to deep shale gas, fresh-water aquifers occur at relatively shallow depths over the deeper Marcellus below. However, water for gas will be taken from the nearest avail-

(*Continued on page 2*

Aquifers… Continued from page 1)

able source. Aquifers over the Marcellus are typically glacially-derived unconsolidated saturated sands & gravels found within glacial through-valleys. These valuable 'stratified drift' outwash deposits are limited in extent, and typically 75-100 feet thick. They may serve as sources of groundwater to water wells, sources of recharge to underlying bedrock aquifers, and/or contributing sources to surface water baseflow. They will need to be closely protected from the increasing water demands of fracking, and any associated accidental or incidental contamination that goes along with it.

Anti-fracking protestors

In response to the looming conflict over the value of fresh water versus natural gas, a gas-specific chemical **Baseline Sampling Program** of wells, groundwater quality and surface water quality, as well as testing natural anthropogenic or biogenic methane gas in soil, or dissolved in groundwater, must be implemented. The depths and thicknesses of aquifers must be determined in areas situated in close proximity to fracking operations. Water usage and well status and yields will become important factors to understand before gas wells are allowed to become operational. Such a database will provide sorely-needed background information to compare changes or identify water quality trends after additional gas well(s) are brought on-line – an obviously important management tool for stakeholders.

WAITING FOR THE FRACKING 'FIX'

Until one or more alternative fracking strategies utilizing other than drinking water becomes economically viable (e.g. foam, propane, CO2, ozone, etc.), large quantities of potable water will continue to be used, and frankly, 'used-up' - underscoring the need for ongoing baseline monitoring.

"Baseline Sampling must be implemented."

Groundwater resources are publicly-owned, not privately-owned, and as such, legislated at the State level. NYSDEC presently regulates (permits) water "takings". In addition, as much as 35% of the land area subject to Delaware River Basin Commission (DRBC) compliance overlies the Marcellus across several NYS counties. DRBC reviews ground or surface water withdrawals for any purpose in excess of 100,000 gallons/30 days, and/or any diversion from the Basin greater than 100,000 gpd.

MISCONCEPTIONS & FUTURE ISSUES

Shallow water-bearing fractures in bedrock water wells can quickly become 'dewatered' due to competing interwell pumpage interferences, overpumpage, limited water-bearing fracture density, and/or drought. Alternatively, when water wells are drilled into unconsolidated, fully-saturated, glacial valley-fill aquifers, relatively higher yields are encountered with fewer quantitative problems – yields typically in the 25-50 gpm range (36,000-72,000 gpd). These shallower aquifer areas will become increasingly preferred (over lower yielding bedrock water wells) to satisfy the water demands of 'thirsty' gas well operators. Therefore, periodically-updated water budgets will be important to avoid deleterious water table declines and resulting water quality problems associated with reduced aquifer recharge. Moreover, over-pumpage or excessive water level drawdown in wells situated above deeper shale gas hydrocarbon-bearing formations is problematic, even leading to methane degassing which is easily misunderstood. For example, methane gas can occur naturally-dissolved in older groundwater at trace (1-3 mg/L) levels in wells located near old peat layers, hydrocarbon-bearing rock units, or wetlands. So methane dissolved in tap water may not necessarily be wholly attributable to any nearby fracking operation.


Hydrofracking operation

Yields in fractured bedrock aquifers decrease with depth - significantly at depths greater than 1,000 ft. due to increasing overburden pressure restricting secondary permeability. This condition naturally buffers shallow uppermost groundwater from contamination by fracking at depth. In New York, fracking the Marcellus will occur at the 3,000 - 7,000 ft. depth horizon (e.g. it

is 4,000 ft. deep between Binghamton and Monticello). Thus, it must be appreciated that almost all water used from source well(s) or from combined source water areas near gas wells, or trucked-in from more distant sources will be 'consumptively' lost and will not be returned/ recycled back up into the watershed from whence it came. Consequently, cumulative water-taking impacts from shale gas drilling will increase.

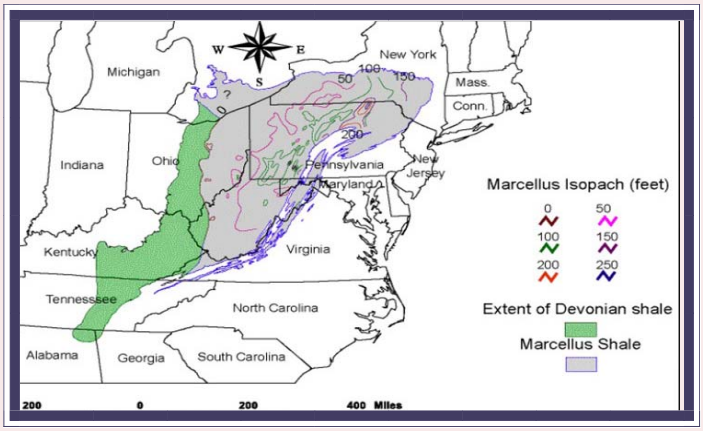
> ***"Frack water must be integrated into water budgets..."***

WHAT TO DO ABOUT IT

It's clear that shale gas developers should be encouraged to embrace exploration & development policies that move away from their historical dependency upon potable water supplies to promote fracking and instead, entertain a growing trend toward efforts to blend fracking fluids from both fresh water, flowback fluid, and produced water. The sources and volumes of groundwater used for fracking must be quantified and integrated into hydrologic water budgets as part of the permit approval process.

Formerly proprietary additives used in fracking can be regulated, monitored, and limited to simple biocides, scale inhibitors and friction reducers. In fact, the oil & gas industry is already acknowledging their need to eliminate the potential health hazards associated with some of their additives. Assuming a growing competition for fresh water in the future, best management practices should include: 1) blending, 2) recycling/ reuse and treatment of flowback water, 3) using impotable brackish surface or ground water, 4) converting unused gas wells to water wells, and 5) adoption of shared water agreements to enable flowback water reuse at multiple drill sites, regardless of gas operator ownership.

Water for gas is not an acceptable trade-off, but clean water and shale gas can co-exist through cooperative and diligent aquifer management practices.

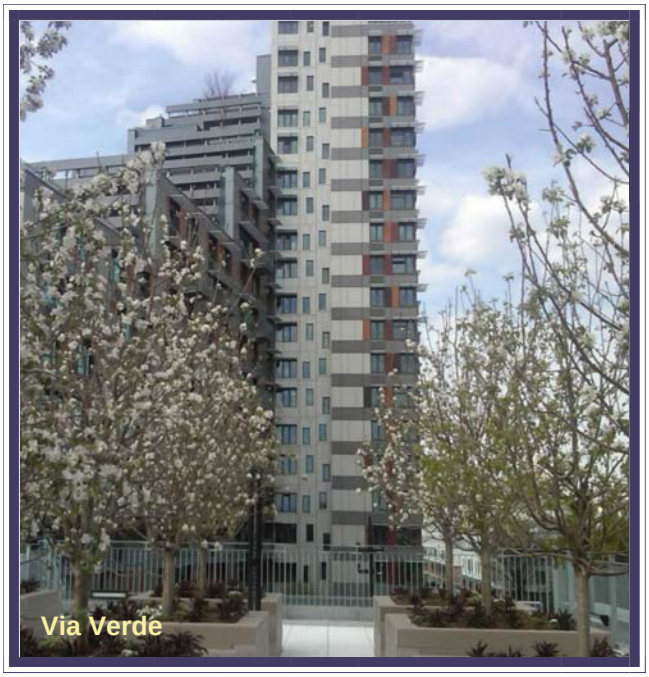


VIA VERDE wins the New York City Brownfield Partnership Big Apple Brownfield Award!

CA RICH is proud to announce that on May 3rd, the Via Verde Development Team was the recipient of the 2012 New York City Brownfield Partnership Big Apple Brownfield Award for Green Building. Our team includes Phipps Houses, Inc., Jonathan Rose Companies, Dattner Architects, Grimshaw Architects and CA RICH Consultants, Inc.

Via Verde located in the South Bronx, is a 151 rental and 71 co-op residential development designed and constructed to exceed the United States Green Building Council's LEED® Gold standard (as well as the standards of the New York State Energy Research and Development Authority's (NYSERDA's) Multifamily Performance Program and the Enterprise Green Community) for environmentally responsible and energy-efficient building design.

CA RICH successfully steered the project through New York State's Brownfield Cleanup Program with the investigation and remediation of residual contaminants associated with the Site's former industrial usage as a railroad yard provisions facility and a gas station/automobile repair shop. Cleanup included soil excavation and disposal, underground storage tank removal, groundwater treatment via in-situ chemical oxidation, installation of a composite cover system as well as a sub-slab vapor barrier and active sub-slab depressurization system (all seamlessly integrated into site construction). Congratulations Team!



What's new at CA RICH

Charles Rich recently Chaired a well-attended Symposium entitled: "*Magnet Long Island, The Attraction & Retention of Young People"* convened on behalf of the Real Estate Institute at Stony Brook University's College of Business. Featured were two panels of leading experts discussing outdated zoning, employment, and affordable housing - aimed at helping 'Generation Y' on Long Island. Notable speakers included: Dr. Samuel Stanley, M.D., President of Stony Brook University; Kevin Law, President of the Long Island Association; and Lee Koppelman, renowned regional Planner.

On May 31st, CA RICH will be participating in The NY City Mayors Office of Environmental Remediation (OER) Turbo Training to further enhance our Firm's qualifications in providing remediation services under the New York City Brownfield Cleanup Program.

CA RICH will be sponsoring and/or attending the following events, so stop by and say hello!: The New York State Association for Affordable Housing (NYSAFAH) NY City Conference on May 17th at the Marriott Marquis in Times Square; The Sustainable Long Island 6th annual Sustainability Conference on June 1st at the Carlyle on the Green in Bethpage State Park, Farmingdale, NY; The Long Island Real Estate and Business Renaissance Convention on June 1st and 2nd at the Hilton in Melville, NY; The 4th annual Northeast Sustainable Communities Workshop on June 7th at John Jay College in Manhattan; and The 11th Annual Smart Growth Awards on June 15th at Crest Hollow Country Club, in Woodbury, NY.

CA RICH is pleased to announce the recent hire of Geologist, Tom Brown. Welcome aboard, Tom!

For more information about CA RICH or the ENVIRONMENTAL BULLETIN, please call (516) 576-8844 or write to:

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The Firm supplies environmental consulting, Phase I and II assessments, audits, investigation and remediation, expert testimony, groundwater, storage tank, air quality and hazardous waste management, and all other services related to meeting evolving environmental regulations.

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