Ohio Department of Natural Resources

May 13, 2008

Linda White .
17826 Chillicothe Rd.
Chagrin Falls OH 44023

Dear Trustee White:

The Ohio Department of Natural Resources, Division of Mineral Resources Management (DMRM) has completed its evaluation regarding the cause of gas infiltration into ground-water aquifers in areas of Bainbridge Township, Geauga County. As with any ground water investigation, the DMRM evaluates evidence regarding source(s), migration pathways, and the pressure differential necessary to move contaminants from the source(s) to the affected water supplies. The DMRM has concluded that confinement of deep, high-pressure natural gas in the surface-production casing annulus of the Ohio Valley Energy Systems Corporation (OVESC) English No. I well caused over-pressurization. Over-pressurization occurs when pressure in an un-vented annulus exceeds the hydrostatic pressure of the freshwater aquifers. Once an annulus is over-pressurized, annular gas can infiltrate fractures in bedrock below the base of the cemented surface casing and migrate upward into the aquifers. These findings and conclusions are consistent with preliminary findings summarized in the January 30, 2008 letter, and presented at the February 7, 2008 Bainbridge Township meeting.

Attached is a report summarizing the findings and conclusions of the DMRM investigation regarding causation, including an evaluation of contributing factors. In summary, the DMRM concluded that the primary cement job on the production casing was deficient. Furthermore, the DMRM concludes that OVESC erred in closing the wellhead valve rather than temporarily venting or flaring the annular gas, prior to completing remedial cementing operations.

As stated in our report released on April 23, 2008, the DMRM has concluded that the conditions that resulted in annular over-pressurization at the English Well have been corrected. The well construction conditions that existed in November and early December 2007, that caused natural gas infiltration of local aquifers, have been effectively eliminated.

All listed contributing factors have been effectively addressed through new permit conditions that the DMRM implemented beginning on January 18th, 2008. DMRM inspectors have been enforcing the new requirements since January 2008, and there have not been any similar incidents.

If you have any questions, please contact Marlene Hall of the DMRM Uniontown office at (330) 896-0616. She will refer your inquiry to the appropriate party.

Sincerely,

Scott R. Kell, Deputy Chief

SRK/mh
Enc.

5/13/08

Division of Mineral Resources Management Report Conclusions about the Causation of the Aquifer Gas Invasion and Home Explosion Bainbridge Township, Geauga County

Local Geology

Geauga County lies on the western edge of the Appalachian Basin in northeastern Ohio. There is occasional seismic activity in the area. Based upon a gravity survey, Baranowski (2002) infers the presence of a fault in Pre-Cambrian metamorphic and igneous rocks that trends north northeastward through western Geauga County. Based upon a structural contour map of the top of the Onondaga Limestone, there appears to be a local structural anomaly in Bainbridge Township indicating folding or faulting. Geologic interpretation of open hole wireline logs from an offset oil and gas well (permit 2-1946) also indicates fracturing in deeper formations including the Onondaga Limestone, Lockport Dolomite and "Packer Shell". Down hole video camera pictures taken by the Division of Mineral Resources Management (DMRM) in nearby water wells show natural fracturing immediately above the Berea in the Cuyahoga Formation.

In Bainbridge Township, glacial sand and gravel deposits, the Sharon Conglomerate, Cuyahoga Formation, and the Berea provide groundwater resources. The Berea is the deepest underground source of potable water in the area. Water wells provide drinking water to homes and businesses either from individual private or public water wells, or local community water well fields. Water well drillers and well owners have noted occasional shows of low-pressure naturally occurring methane gas in some of the Berea water wells in Geauga County. The likely source of this nuisance gas is the Ohio Shale that underlies the Berea. Shale gas in water wells does not pose a health problem as long as wells are properly vented.
Knowledge of local geology, the subsurface sources of drinking water, and gas-bearing zones is essential in designing the casing plans that will protect ground water resources when issuing oil and gas drilling permits.

Oil and gas activity in Bainbridge Township

Natural gas is the main hydrocarbon component produced in oil and gas wells in Geauga County with minor amounts of associated oil. Gas has been found in the Berea, Ohio Shale, Oriskany Sandstone, "Newburg" Dolomite and especially the "Clinton" sandstone, the primary commercial oil and gas producing reservoir in the county, Since 1981, 132 permits have been issued to drill Clinton gas wells in Bainbridge Township. Of these, 82 are producing, 25 were drilled, produced and have been plugged, and 22 were permitted but not drilled. Those permits have expired. The English #1 well has been drilled and is currently shut-in. There are also two valid outstanding permits that have not been drilled. One permit application is being processed at DMRM and is pending approval by the Division.

Permitting and Drilling the English # 1 well

On October 2, 2007, a permit (API 34-055-2-1983-00-00) *was* issued to Ohio Valley Energy Systems Corporation (OVESC) to drill the English #1 well in Lot 21', Tract 2, Bainbridge Township, Geauga County. The permitted target formations were the Ohio Shale through the "Clinton". The permit was issued subject to urban area drilling conditions. OVESC *was* required to drill the English #1 well using a fluid circulating medium due to a gas show encountered in the "Newburg" section of the Lockport Dolomite on a nearby offset well that *was* drilled the previous month (permit 2-1946). Fluid drilling through known *gas* bearing zones can suppress gas flow into the well bore and will help control *gas* when drilling through those zones.
In addition, urban permit conditions require the driller to install a well control device or "blowout preventor". The device is pressure tested prior to drilling out from under surface casing. This equipment is designed to control and divert any high-pressure gas that may-be encountered while drilling. On the English #1 well, OVESC complied with all well-control conditions required by the permit.

OVESC commenced drilling the English #1 well on October 18,2007. In accordance with the permitted casing plan, 88 feet of new 321b/ft API standard 11 % inch diameter steel conductor casing was set through the glacial drift into bedrock. To further protect groundwater resources, 253 feet of new 23 lb/ft API standard 8 5/8 inch diameter steel surface casing was set more than 50 feet through the Berea aquifer and cemented to surface. The well was conditioned prior to cementing, circulation *was* established and there were good cement returns to the surface. The cementing *was* witnessed and approved by Tom Hill, the DMRM oil and gas well inspector for Geauga County.

Following a 10 hour waiting period to allow the cement to set up, drilling proceeded without incident to a total depth of 3926 feet on October 26. Because the well was drilled on fluid, no shows of oil or *gas* were noted during the drilling; however the driller did report a slight odor of "sour gas" at total depth while mixing gel to condition the well bore. An attempt to run an open hole geophysical log *was* unsuccessful due to an obstruction in the well bore at 3658 feet that would not allow the logging tool to reach the bottom of the well. The OVESC consultant believed that the obstruction *was* caused by a filter cake in the well at 3658 feet, the depth of the "Packer Shell", a shaley dolomite that overlies .the "Clinton" sand. Filter cake is a build up of drilling mud on the borehole wall and can be caused by an extremely porous and permeable zone where the mud accumulates adjacent to zones that are "thieving" fluids. The density component of the logging tool also did not work and the logging effort *was* abandoned.

OVESC then proceeded to set and cement production casing. New lO.5lb/ft API standard 4 ~ inch diameter steel production casing was run in the hole but could get no deeper than 3659 feet and had to be washed down to a depth of 3873 feet where the casing became differentially hung. Circulation of the borehole was established prior to cementing, but during the cementing operation, circulation was lost and the pump pressure increased to 1100 psi. Most of the remaining water on location *was* used to try to re-establish circulation and to complete the cement job. Circulation of the borehole *was* not re-established but cementing of the casing *was* accomplished. Due to the lost circulation during cementing, the OVESC consultant recommended that a cement bond log should be run to determine both the bond quality and the amount of cement outside the production casing.

Completion of the English # 1 well

On November 1, Appalachian Well Surveys ran a cement bond log. The log indicated that the top of the cement was at 3640 feet, the depth of the "Packer Shell". Based upon the quantity of cement ordered by OVESC, the calculated fill up in the 4 ~ inch casing-borehole annulus should have been at least 700-800 feet above the "Clinton" and would have effectively sealed off the "Newburg" zone of the Lockport Dolomite, the formation where gas was released when drilling the offset well (permit 2-1946). The "Newburg" in the English #1 is approximately 3350 feet deep. The level of cement in the English #1 well indicates that most of the cement went into the "Packer Shell" at about the same depth where bore hole problems were noted on October 26 with the logging tool and the production casing. The consultant for OVESC believes that these occurrences give evidence of natural fracturing of the "Packer Shell" in the English #1 well.
Despite the fact that the cement behind casing was insufficient by standard industry practice, OVESC proceeded with the completion of the well. On November 5, the well was perforated by Appalachian Well Surveys in the "Clinton" section from 3720-3740 feet with 56 shots. Approximately 80 feet of cement covered the "Clinton" above the top perforation. Following perforation, Producers Service Corporation performed an acid breakdown of the "Clinton" in accordance with standard industry practice. The formation broke down at 1450 psi and 250 gallons of acid and 7500 gallons of fluid were displaced into the formation. Nothing out of the ordinary was noted during this acid job and OVESC decided to proceed with a full hydraulic fracture stimulation treatment.

On November 13, Producers Service Corporation was scheduled to hydraulically fracture (frac) the well with 105,000 gallons of water and 600 sacks of sand. After displacement of approximately 46,700 gallons of water and 290 sacks of sand, circulation of fluid from the 8 5/8" annulus was observed indicating communication between the "Clinton" and the annular space between the surface and production casings.. At that point, the pump pressure and fluid displacement rate were reduced and another 4000 gallons of water was pumped to flush and recover the sand that had been displaced. The frac operation was then discontinued and the pumps shut down. OVESC personnel estimated total of 20 barrels of fluid including one-to-three barrels of oil was circulated out of the annulus.

Over the next three days, the well was swabbed and most of the fluid that had been displaced into the well during the frac treatment was recovered. Pressure on the production casing appeared to be normal for a "Clinton" well and tubing was run in the well on the third day. At this point, the annulus was shut in while work proceeded to complete the well for production.

Post-Completion History of the English # 1 well

From November 17 to December 14, 2007 there was no reported construction activity at the English #1 well. OVESC recorded periodic pressure reading~ taken on the surface-production casing annulus. On the first day after the frac job, the recorded pressure was 90 psi. On the second day, the pressure increased to 180 psi. On the third day, the pressure increased and stabilized at 320 psi. Gas was periodically blown off to reduce the pressure, but the annulus was closed when company personnel were not on site.

On December 14, there were reports of methane gas in the water wells of some of the homes on English Drive. The pressure on the annulus of the English #1 well was recorded at 360 psi. Early on the morning of December 15, methane gas entered the basement of a home at 17975 English Drive and ignited causing an explosion that seriously damaged the house. Local fire officials, DMRM inspectors and OVESC personnel responded shortly after being alerted that there was a problem and began checking gas levels in surrounding homes and water wells. A number .of other homes in the area had abnormally high gas level readings and the Bainbridge Fire Department ordered evacuation of 26 homes.

Subsequent to the explosion, it was reported that on December 12 gas had been detected in the water well at the Bainbridge police station. This well is 280 feet deep, draws water from the Berea and is approximately 4700 feet to the northeast of the English #1 well.

Remedial Action Taken in Response to Gas Invasion of the Aquifers

On the morning of December 15, OVESC determined that the probable source of the gas in the annulus on the English #1 was from the "Newburg" member of the Lockport Dolomite. ~. "Newburg" gas has a distinctive smell that was consistent with the odor noticed coming from the annulus. Remedial action called for cementing off the "Newburg" which would prevent the gas from entering the well bore. Water was pumped down .the production casing to kill the "Clinton" gas and the tubing was removed from the well. The casing was then perforated from 3600-3602 feet with 9 shots and 800 sacks of cement were squeezed through these perforations to shut off the "Newburg" gas. Calculated fill up based on the amount of cement used should have returned the cement to surface. This did not occur but the job was successful in killing approximately "9598%" of the gas in the annulus and the presence of "sour" smelling "Newburg" gas was no longer detected. DMRM oil and gas well inspectors, Tom Hill and Bob Worstall, witnessed this remedial phase. The annulus was not closed after this operation and the well was to be monitored by OVESC personnel.

On December 17,2008, the annulus was still producing minor amounts of gas that was "not sour". A second Appalachian Well Surveys cement bond log was run indicating that the squeeze had filled the annulus with cement to 2656' or well above the "Newburg" zone. A temperature log was also run that indicated several possible gas zones in the Ohio Shale.
To eliminate the remaining gas in the annulus, a second squeeze job was performed. The well was perforated with 9 shots from 2628-2630' and another 800 sacks of cement was squeezed through these perforations. This second squeeze cement job returned 41 barrels of cement to the surface.

On December 19, it was reported that there was a "very minor flow" of gas in the cemented surface-production casing annulus. Another Appalachian Well Surveys bond log was run. This log indicated there was possible gas channeling in the cement at 330' which could account for the continued presence of gas in the annulus. .

On March 3, 2008, following the recommendation of DMRM, OVESC had a Baker-Hughes Segmented Bond Log run in the well. This log showed what appears to be channeling in the cement from about 550 feet to surface. Below that level there appears to be good to excellent bond between the production casing and well bore. This would confirm that the deep high-pressure gas from the "Newburg" or other sources has been isolated from the surface-production casing annulus.

DMRM has determined that the gas still present in the annulus is near-surface low-pressure gas emanating from natural fractures in the Ohio Shale. In northeastern Ohio, it is common for small volumes of low-pressure shale gas to accumulate in the surface-production casing of oil and gas wells.

Conclusions about the Cause of the Gas Invasion of the

The DMRM has determined that confinement of deep, high-pressure gas in the surface-production casing annulus of the English #1 well, prior to December 15, resulted in over-pressurization of the annulus. This over-pressurized condition resulted in infiltration of natural gas from the annulus into fractures in the bedrock below the base of the cemented surface casing. This gas migrated vertically through fractures into the overlying aquifers and discharged through water wells. Three successive events in the drilling and completion of the English #1 well are believed to be the primary contributing factors that led to the gas invasion of the shallow aquifers and subsequent home explosion on English Drive.

The first contributing factor was inadequate cementing of the production casing prior to remedial cementing on December 15. The industry standard for cementing production casing calls for sufficient cement to fill the annulus between the well bore and the casing 600-800 feet above the "Clinton". At this height, the "Newburg" zone, which can be gas and/or brine bearing, is effectively sealed from the well bore and presents no further problem in completing the well. 175 sacks of Unitropic cement was ordered and run for the primary cement job for the English #1. Theoretically, this amount should have provided more than enough fill up to cover and seal the "Newburg" at 3350 feet. However, the bond log run on November 1 indicates the top of cement was only at 3640 feet, the level of the "Packer Shell" and approximately 300 feet below the "Newburg". It appears from the record that the "Packer Shell" in the English #1 well is naturally fractured to the extent that it "thieved" most of the cement that was pumped into the well. The result was that the borehole was exposed to high pressure gas from the "Newburg" and any other deep seated sources of gas.

The second contributing factor was the decision to proceed with stimulating the well without addressing the issue of the minimal cement behind the production casing. Hydraulic fracture stimulation normally involves injecting fluids and sand into the oil and gas reservoir to enhance the flow of hydrocarbons to the well bore. When a well is properly constructed, the hydraulic fracture is confined between the permitted reservoir formation and the production casing. The abnormal circulation that was observed during the stimulation of the English # 1 well indicates that the frac communicated directly with the well bore and was not confirmed within the "Clinton" reservoir. This communication would also have provided a conduit for "Clinton" gas to enter the annulus of the well.

While the out-of-zone hydraulic fracturing operation may have provided an avenue for "Clinton" gas to migrate up the surface-production casing annulus, the DMRM has concluded that it is highly unlikely that fluids used in the hydraulic fracturing process, or flow back fluids escaped from the borehole or entered into local aquifers. Based upon consideration of all records and available information, the DMRM has determined that the valves on the surface production casing annulus remained open before, during, and after the hydraulic fracturing operation in accordance with standard industry practice. Producers Services and OVESC appropriately terminated the hydraulic fracturing operation as soon as fluids circulated to surface. Producers Services immediately reduced the pump rate and pressure, completed the sand flush, and shut the operation down. According to eyewitness accounts and job records, fluid circulation rates responded to pump rates, and when the pump shut down, annular flow stopped as soon as hydraulic equilibrium was attained.

Finally, the third and most critical contributing factor leading to the incident was the 31 day period after the stimulation during which the annular space between the surface and production casings was mostly shut in. This confined the deep, high-pressure gas from "Newburg" and/or "Clinton" within this restricted space. Readings taken during this time were consistently 320 psi or greater. Typically, shallow shale gas does not register more than 30-50 psi on the annulus and can be closed in or vented without problem. Pressures of the order that were observed would indicate a deeper source of the gas present in the annulus. This was not recognized and OVESC personnel opened the valve to blow off the pressure but continued to close the annulus when not on site. As pressure on the annulus built up, the gas migrated laterally and vertically through natural fractures in the surrounding bedrock. This over-pressurized gas infiltrated the local aquifers, discharged through local water wells, allowing gas to enter some area homes in varying concentrations, and resulting in the explosion at one