Gas Well Study, 2011

Wellhead and hydrogen sulfide warning sign for 47-039-02079 in the Kanawha State Forest. The plastic condensate storage tank sitting in its secondary containment is visible to the right. Note corrosion of casing head and production pipe. This site, like others in the state, had no security barriers to protect the public. Photo taken 29 August 2011.

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Gas Well Study is the examination of natural gas wells in West Virginia in Kanawha and Putnam counties.

Well sites are surveyed for compliance with state and federal regulations.

Well sites are also surveyed for environmental issues.

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Introduction

In past years we have looked at natural gas wells, comparing their compliance with West Virginia's state code, federal law and West Virginia Department of Environmental Protection (DEP) guidance and permit requirements.

What we have seen is ignorance of the state's requirements (or worse, willful noncompliance) in parts of Putnam and Kanawha counties. We have no reason to believe that operators behave differently in other parts of the state.

This year we have again examined wells in light of regulatory compliance but have added new areas of examination, including the state's response to non-compliance, health and safety issues, and environmental degradation.

Rather than focus on a limited set of issues, this year we will look at individual sites or clusters of sites. Discussion will be about items such as secondary containment for condensate storage tanks, surface contamination and improperly buried pit waste, site security and surface owner issues.

A conclusion at the end of the report provides a broad overview of our findings. These are supported by video, photographic, and written evidence available on the internet.[1]

Photo 1. Condensate storage tank at 47-039-05500 well in the Kanawha State Forest. The overflow prevention device is visible at the top of the tank just to the right of the 10-foot high tank's ladder. Photo taken 29 August 2011.

Well Sites Visited

Kanawha State Forest

We visited four well sites in the Kanawha State Forest, all operated by the same Pittsburgh company. Two of the sites had recently completed wells, one site had two wells drilled in the 1960s.

The Kanawha State Forest is a popular state park just south of Charleston. The state does not own mineral rights for this and some other parks and has the same basic rights as surface owners. What we found were poorly maintained well roads, an infrastructure that shows signs of negligence, surface contamination at one site, and a complete lack of security barriers to protect the public from inherent dangers at these industrial sites.[2]

Three wells shared a well access road and these will be treated first, in terms of location on that road, heading west from State Route 42.

47-039-05500

This well is sited next to the stream in Polly Hollow, with its well access road running through the stream several times before reaching the well. The location of the well in such close proximity to the stream is, in our opinion, problematic in terms of

[1] Video evidence is viewable at http://www.youtube.com/GasWellStudy. The Gas Well Study website is at http://members.citynet.net/sootypaws/gws.

[2] U.S. Chemical Safety Board, *CSB Investigators Determine that Oklahoma Oil Site Where an Explosion Killed a Member of the Public April 14 was Unsecured, Unfenced, and Likely Lacked Explosion Warning Signs*, news release for 23 April 2010. "CSB preliminary analysis released on April 13 showed that 24 similar explosions and fires occurred at oil and gas production sites between 1983 and 2009. Those accidents resulted in 42 fatalities and a number of injuries; all the fatalities occurred among teenagers and young adults under the age of 25. In most cases, the explosions were ignited by a cigarette, match, or lighter."

Photo 2. Hydrogen sulfide warning sign on the 47-039-02079 well in the Kanawha State Forest. Photo taken 29 August 2011.

Photo 3. Severe corrosion at casing head and production pipe for the 47-039-02079 well in the Kanawha State Forest. Photo taken 29 August 2011.

construction/drilling, maintenance, and access in times of high water, as well as possible pollution impacts.

Christmas tree metal work was unpainted.[3] There was secondary containment for the 100 barrel condensate storage tank (which had a solar powered overflow detection/prevention device). Secondary containment at this and other sites was being compromised by animal activity – a trail crossed the dike, eroding its height.[4] There was no security barrier for this well which is next to a popular hiking, horseback riding and mountain biking trail. The ladder for the tank, especially, is an attractive nuisance.

47-039-01939 and 47-039-02079

These two wells share the same clearing/pad at the end of the well access road. 47-039-02079 had a sign on the Christmas tree warning of possible presence of hydrogen sulfide gas, an extremely toxic gas in higher concentrations. The site had two tanks. The plastic condensate storage tank sat within secondary containment. This containment was in the process of being cut by an animal trail. The trap door was not locked. The other tank was steel, much larger, approximately 20 feet high, without secondary containment. A request for information about the purpose of this tank was unanswered by the Office of Oil and Gas.[5]

One of the two wood sheds housing metering devices for the wells was beginning to collapse. Metal work on the Christmas trees for the wells was unpainted (deterioration at 47-039-2079 was pronounced). There was a strong hydrocarbon odor at the site. The complete absence of barrier or fencing for the wells/site was troubling, especially when hydrogen sulfide may be present, when attractive nuisances like the tall tank's ladder exist, and when possibly explosive gases are present.

47-039-05772

This well is accessed by a different road. The creation of this road occasioned controversy. The operator's well permit application plan showed the road as a continuation of the road for the above three wells. In actuality the operator constructed a road coming from an entirely different direction through

[3] Research published by the Society of Petroleum Engineers indicates that poor maintenance of wellhead Christmas tree metal work, including lack of paint, is conducive to well integrity failure. See Karen Bybee, 2011, "Well-Integrity Issues in Malacca Strait Contract Area." This article is based on SPE 129083, *Well Integrity Issues in Malacca Strait Contract Are*a by Weka Janitra Calosa et al.

[4] Contaminated soil within the containment attracts deer and other wildlife. See Tyler Campbell et al, 2004, "Unusual White-tailed Deer Movements to a Gas Well in the Central Appalachians." This study found deer traveling up to 6 km to visit a spot contaminated by gas well brine.

[5] The email with two photos was sent 6 September 2011.

Photo 4. Well pad for 47-039-05772 which has a large expanse bare of vegetation between production equipment and edge of pad. This well site in the Kanawha State Forest had numerous signs of animal activity in the bare areas. Soil samples found elevated chloride. Photo taken 29 August 2011.

Photo 5. Turkeys have deeply scratched the soil on the pad at 47-039-05772 in the Kanawha State Forest. An inch or more of soil was removed around clumps of grass. Photo taken 29 August 2011.

the Forest. This road was "daylighted" according the state's faulty guidance.[6] West Virginia Department of Natural Resources which manages the state parks, in response to this operator's activity, created a new regulation for operators' activities within state parks.[7]

The portion of the road we saw was rutted and almost blocked by fallen trees. A route the width of a truck had been cut through.

Just above the pad, on the north side of the road, close to the location that on the plan was designated as the land application area for liquid drill and fracture waste, were a number of large dead trees.

We visited this site because of concern expressed by a Kanawha county resident. There is a large area on the pad (approximately 90 feet by 32 feet) that is almost entirely bare of vegetation and another smaller area on the fill slope below where there's a seep. Because of the resident's concern the state and operator took samples for laboratory tests. Appendix 1 discusses these test results.

We took samples, testing only for chloride, and found contamination on the pad soil surface (two locations with 40 and 46 ppm), slightly elevated concentration in the water sample from the seep (<29 ppm), and at background concentration for soil near the seep.

Normal background levels for chloride in West Virginia soil range from close to 0 to about 20 ppm. Normal background levels for chloride in surface water range from close to 0 to about 24 ppm. We consider soil or water with chloride at 30 ppm or more to be contaminated.

Animal activity was evident in the bare area of the pad with portions of soil removed to the depth of an inch or more in places. Turkey claw scrapes were most common. We observed finches, singly or in small groups, ingesting the soil while we stood nearby.[8] The contamination may be from a single spill in the past, inappropriate management of flowback (see page 7 below for a description of

[6] West Virginia Division of Environmental Protection, [1992], *West Virginia Erosion and Sediment Control Field Manual* is obsolete. While observance by operators is required by law, operators routinely ignore the Manual's guidance except that for daylighting well access roads. Daylighting is inappropriate and ineffective for earth roads used all seasons by heavy trucks, especially when the roads are improperly designed with inadequate or non-existent drainage.

[7] The regulation is 58CSR35, *Rules for Conditions Upon Which Oil and Gas Operators May Access State Forests*. The rule focuses on permit requirements including a rudimentary environmental impact study and extensive road construction and site and road reclamation guidelines.

[8] See Don Bleitz, 1958, "Attraction of Birds to Salt Licks Placed for Mammals," *The Wilson Bulletin*, March 1958, 7(1), page 92. The author used a block of salt to attract finches, grosbeaks, and other species in order to capture and band them.

Photo 6. Well pad for 47-079-01288 vertical Marcellus well. Brown, barely vegetated area in left center of photo lies between large pieces of pit liner (pieces at one end are barely visible above brown area). Photo taken 14 April 2011.

Photo 7. Pieces of pit liner lying in tilled area on the pad of 47-079-01200. Some pieces were firmly anchored in the ground, others were torn fragments lying loose on the surface. Photo taken 14 April 2011.

another operator's well site), or contamination from buried pit waste (see page 5 below for more about this common problem at well sites).

As at other sites in the Kanawha State Forest there was no security barrier, in spite of the well's proximity to a popular hiking and mountain biking trail. Metal work, especially at the well head, was rusted.

Surface owner issues at these four sites in the Kanawha State Forest include: lack of maintenance of roads or equipment, lack of fencing or other security barrier, significant surface contamination at one site. The inappropriate location of roads and wells within a few feet of waterways and construction of roads/sites in locations other than given in the well permit application are all too common problems for surface owners.

Sites with Surface Contamination

We visited three sites in the spring that we had first visited in 2008, two in Putnam county and one in Kanawha county, all operated by the same Houston company. Two of the wells revisited were found to have signs of possible surface contamination by pit waste (47-079-01288 and 47-079-01200 in Putnam county). The Kanawha county well (47-039-05714) had been remediated in 2010 because of surface contamination by pit waste.[9]

Evidence of surface contamination at 47-079-01288 was a bare area (approximately 57 feet long) between two places where large pieces of pit liner were visible jutting up from the soil. Evidence of surface contamination at 47-079-01200 was a substantial area (approximately 84 feet long) of pit liner fragments and larger pieces where the surface owner had tilled for a garden on the pad.

Pieces of pit liner were still evident at the Kanawha county site (47-039-05714) after remediation. It is not known how remediation was accomplished. In spring 2011 most of the site was poorly vegetated; in summer 2011 vegetation coverage was improved.

Soil samples from these three sites did not show the presence of chloride. These samples were all taken from the top inch of the surface, not at root level or lower where there may be contamination.

The secondary containment for 47-079-01200 was filled with water negating its effectiveness; there is no rainwater drain. The metal at this site was severely corroded, the API number was lying on the ground, and the road here (as at 47-079-01288) was badly rutted showing poor maintenance.

[9] The perimeter of exposed pit liner in 2009 was roughly 100 by 15 feet. See George Monk and Molly Schaffnit, 2009, *Environmental Assessment for 47-039-05714, Raymond City #11, Kanawha County, West Virginia*.

Surface contamination is evident at over 25% of the sites we have examined, determined either by elevated chloride, presence of pit liner or both. In most cases the contamination is due to pit waste which is buried on site in spite of a high concentration of chloride and heavy metals (treatment of liquid waste before land application is performed in order to precipitate out barium and other metals). Laboratory testing of a sample from 47-039-05714 found arsenic at 41 times the EPA's and state's residential soil screening level and almost three times the screening level for soil to groundwater contamination. The soil chloride concentration at 47-039-05714 was 2,550 ppm. It's known that chloride in soil above 1,000 ppm adversely affects groundwater.[10]

The general permit requires waste be buried at an "adequate" depth to protect surface water.[11] That depth is not stated, a common problem. West Virginia regulatory and other requirements for drillers tend to be vague and lack quantified requirements. Prudence would suggest a depth of at least 2 feet, below plow and footer/water line depth. The Argonne National Laboratory suggests 3 feet.[12] Waste needs to be buried so it is *above* groundwater. West Virginia ignores this requirement.

Pit waste is not being buried properly under the permit's rudimentary requirements. We don't believe that operators are able to bury pit waste properly under more stringent requirements, such as those normally used for hazardous waste. Pit waste, therefore, should not be buried on site.

Surface owner impacts due to soil contamination are varied. Surface owners are not told that the pad and surrounding area will never be suitable for agricultural use or for a residence after the well is plugged.[13] FHA requirements create distinct liabilities for those who wish to sell or buy a home near a well or well site because of buried pits.[14]

Photo 8. Inadequate secondary containment on river side of 47-079-00570 is no more than 8 inches high. The Pocatalico River is 47 feet downslope. Photo taken 16 October 2008.

Health and safety issues due to surface contamination vary. Contaminated ground and surface water are likely. Pets that roll in or ingest contaminated soil can bring the contamination into a home or in contact with people. Animals ingesting contaminated soil or water, that are hunted and eaten by humans, provide another pathway for toxics.

Secondary Containment Issues at Three Wells

We returned to three wells that were part of a 2009 complaint to the DEP because of inadequate or non-existent secondary containment and found no change.[15]

[10] Mary Daily, 2005, *Investigation and Remediation of Salt (Chloride)-Impacted Soil and Ground Water*, uses a Dilution Attenuation Factor of 20.

[11] See West Virginia Office of Oil and Gas, *General Water Pollution Control Permit,* GP-WV-1-88 (referred to as General Permit). The General Permit requires "adequate" cover of unspecified thickness in G.4(f). Inadequate cover is considered a violation of the permit.

[12] Argonne National Laboratory, *Fact Sheet – Onsite Burial (Pits, Landfills). Drilling Waste Management*. They also recommend the waste be at least 5 feet above seasonally high ground water level.

[13] A surface owner in Lincoln county told us of how, when they began digging footers for their home on their property, near a plugged well, they encountered noxious material from a supposed buried pit. They had to move the location of their home from this preferred spot.

[14] The Federal Housing Administration has site evaluation requirements for homes near wells, including distance from well site perimeter and locating buried pit waste. *Changes to Handbook 4150.2, Valuation Analysis for Single Family One- to Four-Unit Dwellings*, Chapter 2: Site Analysis, 2.2.D and 2.2.E.

[15] The initial complaint was emailed on 10 January 2009. Subsequent complaints have been solely for 47-079-00570, the site, in our estimation, with inadequate containment most likely to affect the environment negatively.

Photo 9. No secondary containment for the condensate storage tank exists at 47-079-00735. Photo taken 16 October 2008.

The three wells are in Putnam county on or near the Pocatalico River. One of the wells, 47-079-00570, is a clear violation of state and federal (40CFR112) requirements because the secondary containment for its condensate storage tank is grossly inadequate and its proximity to the river. Complaints about this well, notice of the problem in our 2008 Gas Well Study given to the DEP, operator, state industry association, and notice to the EPA have shown no correction of the noncompliance.[16] (Other issues at this site include rusted metalwork and the API number lying on the ground.)

A well near but not actually on the River, 47-079-00735, has no secondary containment for its 50 barrel condensate storage tank. The site is littered with the operator's and others' trash. This and 47-079-00570 are operated by a Houston company.

A locally operated well, 47-079-00583, is on a flood plain (high water the spring of 2011 came within feet of the tank's inadequate secondary containment). The tank is only feet away from a permanent stream flowing into the Pocatalico River. The 100 barrel tank has steel cables that are not tethered to the ground; nothing will prevent the tank's leaving its location in a serious flood.

[16] Most recently information about this well was sent to the EPA regional office on 7 April 2011. This and the other wells appeared in our 2009 and 2010 Gas Well Study reports given to the DEP.

Photo 10. Moat type secondary containment for the 100 barrel tank at 47-079-00583. The tank's tethers hang unattached to the ground. The containment is partially filled with water and the dike is severely eroded on the side facing the permanent stream (on the left in the photo). Photo taken 12 January 2009.

Secondary containment for a condensate storage tank normally (when done properly) consists of a substantial earth dike around the tank with a rainwater drain to allow the containment to be kept free of water. An older method of containment, moat-type, is sometimes found.[17] The containment is created by excavating a moat around the tank and using that dirt for a dike. The volume within the dike and moat is considered to be the containment area. In reality, because there is no rainwater drain, the moat is often filled with water, as observed at 47-079-00583 every time we have been to the site. Moat-type containment should be replaced by above-surface-level containment.

These three sites are typical of our experience. Only 32% of sites that have condensate storage tanks have had adequate secondary containment when we first visited. The rest are in violation of state code.[18]

[17] In a stakeholder meeting with the DEP in 2010 an inspector said he'd never seen this type of containment. It is used, when a tank is present at a well site, at about 10% of the sites seen by us.

[18] See George Monk and Molly Schaffnit, 2011, *Thirty Wells*. Data is from sites visited from 2008 through May 2011.

Photo 11. One of two large bare spots on the pad of 47-039-06155, a vertical Marcellus well. Pit liner was visible in the bare area here. Photo taken 30 April 2011.

Photo 12. The large plastic condensate storage tank for 47-039-06155 floating within its water-filled secondary containment. Containment has a rainwater drain that appears to never have been used. Cattails are visible within the dike between the tank and the blue truck. Photo taken 30 April 2011.

A Vertical Marcellus Well Site

We have visited a number of vertical Marcellus wells in 2008-2010.[19] We began an examination of just one in 2011, 47-039-06155. Our study of this well has included lengthy interviews with the surface owner and comparison with a published news report about this Houston company's activities in Pennsylvania.[20]

The news report depends on an interview with a former well worker. It states the company "tried to hide, minimize or ignore at least five diesel spills." The company's "pits leaked or their plastic liners were carelessly torn before their contents were buried on 13 occasions [Pennsylvania law requires encapsulation of waste within unbroken liners if it is buried]. The earliest, haphazardly constructed pits were used to catch toxic fluids that flowed from wells, but the spray frequently missed the pits or blew out of them." The article goes on to describe the company's endeavors to hide spills and other problems. This behavior was not peculiar to its activities in Pennsylvania (nor, we believe, to this particular company).

According to the surface owner at 47-039-06155 problems at this well include: deliberately uncontrolled release of flowback onto the pad and into the woods beyond; land application of waste that killed vegetation and prohibited regeneration; spraying of flowback onto roads to minimize dust; air emissions from the well for a year afterward that made those living nearby seriously ill; poorly cased or cemented well that has contaminated the domestic drinking water supply of at least one family;[21] severe depletion of local deer population; improperly done reclamation requiring a court order to fix the site for cut slope slips and other problems; and the unresponsiveness of the DEP to the problems encountered.

The surface owner described the venting of flowback from the well through straight lengths of pipe that did not extend to the pit. Some of this spray entered the woods beyond.

Our preliminary site investigation found the following problems: the condensate storage tank was floating within its water-filled containment; large areas of the pad were bare of vegetation; pit liner was visible in one of these bare areas; beyond the pad at one end and along part of the fill slope were a large number of dead trees (dead trees followed a clearly visible drainage line down to the stream that flows below the pad).

[19] For example, 47-079-01288 and 47-039-05714 mentioned above are vertical Marcellus wells.

[20] Laura Legere, November 20, 2011, "Gas Company Whistle-Blower Details Spills, Errors." *The Times-Tribune*.

[21] Twelve families' domestic water supplies are adversely affected by this or other nearby company wells according to the surface owner.

Photo 13. A large number of dead trees are beyond the end of the pad and alongside, going down the hillside to a stream at 47-039-06155. This is the area where, according to the surface owner, the operator let uncontrolled flowback from this vertical Marcellus well spray into the woods. Photo taken 30 April 2011.

Satellite imagery from 2007, before site construction, shows no dead trees. That for 2009 does, after the well was completed.

Soil samples from the surface in the two largest bare areas on the pad had a chloride concentration of 595 ppm. One of these samples was taken in the location, according to the surface owner, of the original pit. The other was taken much closer to the wellhead just beyond a line (38 feet long) of exposed pit liner. The length of pit liner visible on the surface was not near the material buried in the pit, according to the surface owner.

Water samples showed chloride in the ditch at the base of the cut slope increasing in concentration toward the area with the dead trees. A puddle on the site in a vegetated expanse had a chloride concentration of 46 ppm (several times normal background level).

Photographs taken by the surface owner demonstrate reclamation problems. The DEP issued Notifications of Violation for reclamation issues at this site (8314, 8315, 8316, 8328, and 8329).

Typical of most of this company's sites, metalwork is unpainted and rusted.

Condensate Tank Overflow

A well site (47-039-02026) has recurring problems with condensate tank overflows. One in winter 2007/08 was before the Houston company constructed the required secondary containment. That containment was constructed after a complaint by us in 2008. There was another overflow in 2010, appearing to be brine, different than the earlier crude petroleum spill. A more recent spill in December 2011 included crude petroleum that appears to have seeped through the containment in two spots. The major seep was to a ditch below the tank and into the woods.

The company applied "moss" to the seepage, cut a dead pine and placed limbs and logs over a large pool to minimize the spill visually. Straw was placed inside the containment and the tank cleaned. A scrub brush was left behind.

Issues with the State's Regulatory Program

Surface owner issues are intimately related to industry non-compliance and DEP's activities as regulator. Industry non-compliance has been well documented in our area in previous Gas Well Study reports, summarized in our *Thirty Wells* report.

The DEP's activities as regulator are less easy to describe because of its complex relationship with industry. The DEP's primary function appears to be permitting the drilling of new wells, even to operators who have not filed annual production reports, well completion reports, or have abandoned wells that must be plugged, all examples of non-compliance by industry of state law and the agency's seeming blind eye. Violations are infrequently handed out, financial penalties even less frequently. Meaningful financial penalties for blatant disregard of the state's spill reporting requirements are non-existent in our experience.

The state's complaint-based inspection system is not working if compliance is so poor and poor compliance is so widespread.

What this means for surface owners is that maintenance of roads is rare, sites often show negligence, surface contamination is to be expected and the DEP lacks the will or the tools for enforcement. If a well pollutes groundwater it is up to the surface owner to sue the operator for

replacement of lost drinking water supply. We know of no wells which are polluting ground water that have been remediated or plugged.[22]

When surface owners talk about inspectors and the DEP they have expressed, almost uniformly, a negative opinion. Issues include the agency's unresponsiveness, inspectors who appear to be ill-trained, and inspectors who whitewash industry's activities. The agency shows no interest in investigating sites where land application has resulted in death of vegetation and trees. At sites where there is a spill or an inspector is responding to a complaint, the agency seems to have no policy for inspectors, including such simple matters as maps, photographs, and records of laboratory sample locations.

This is the reality of the situation. Overwhelmingly what surface owners want is compliance with regulations, considerate behavior by operators, and commonsense care for the environment. Neither industry nor the agency seem to be able to do this.

General Water Pollution Control Permit

The 1988 General Permit was flawed when it was created and nothing has been done since to correct it.[23] The permit covers pit construction, maintenance, waste treatment, land application of liquid waste and burial on site of solid waste.

We know of no follow-up studies by the DEP to demonstrate the effectiveness of the permit or to examine issues such as persistent problems with the land application program where vegetation (including large trees) is killed. When land application problems do occur the state seems to have no apparatus or policy to determine the cause,

Photo 14. Vegetation showing severe chlorosis after application of fracture gel solution with 5,000 mg/l chloride. Application was made 8 days previous. Photo taken 6 August 2011.

leaving surface owners, if they're able, to try to resolve the issue through the courts.

In our area, 20% of the wells drilled after 2000 that we know of have had land application problems. This percentage is similar to the 27% of well sites having exposed pit waste, a violation of the permit.

Our application studies show that vegetation mortality can be expected from sprayed waste containing chloride.[24] A maximum chloride concentration of 3,000 mg/l (contrasting with the permit's 12,500 mg/l) must be enforced, with a load of 1,232 kg/ha.[25] Application cannot be done by spraying. Preliminary research in 2011 indicates that the presence of fracture gel in liquid waste enhances chloride's negative effects.[26] If fracture flowback or chemicals are in the waste, then the load must be lowered considerably. We believe land application of liquid pit waste and burial of solid waste on well sites under the current permit must be halted.

[22] It is questionable whether such wells can be effectively remediated or plugged. That is no excuse for the state's inaction.

[23] West Virginia Office of Oil and Gas, *General Water Pollution Control Permit*, GP-WV-1-88. Amongst the flaws is the lack of load requirement for chloride. Without a load requirement, the permit allows tons of chloride to be dumped on a small area. Vegetation kills and degradation of ground and surface water are the result.

[24] See George Monk and Molly Schaffnit, 2010, *Chloride Appliation Study* and 2011, *Fracture Gel's Possible Synergistic Influence for Chloride's Effects on Vegetation*.

[25] Land applications of waste currently average about 6,000 mg/l for chloride with no load. 100,000 gallons of waste at that concentration applied on one acre would deposit 5,000 pounds of chloride. We are unaware of any scientific support for this activity.

[26] See George Monk and Molly Schaffnit, 2011, *Fracture Gel's Possible Synergistic Influence for Chloride's Effects on Vegetation*.

New Tools

We began in 2009 to expand our study using tools and methods created by USGS scientists for government bodies that allow inexpensive examination of well sites for pollution.[27] This year we have augmented these tools with video recording of site visits. The video record provides a visual and verbal narrative showing what we are seeing or have found. This narrative is more comprehensive than a written one.

We have begun this year collecting and having a laboratory test samples from a variety of water sources (surface water and domestic water supplies) to determine local background levels and impacted surface and ground water locations. The tests are for chloride and a range of metals and volatile organic compounds including benzene, toluene, ethylbenzene and xylenes.

Conclusions

The vertical Marcellus well site in Kanawha county, 47-039-06155, demonstrates the range of problems we typically encounter at well sites. There is pit liner exposed in one of two large areas bare of vegetation. Significant chloride was found in soil samples from both areas, 595 ppm. Maintenance issues include lack of paint on rusting metal at wellhead and a water-filled secondary containment for the condensate storage tank. When we visited the tank was floating in its containment, surrounded by cattails. The rainwater drain apparently was never used.

The surface owner's description of the operator's activities helps explain some of the things we saw. The large number of dead trees beyond the pad were due to the operator deliberately spraying flowback toward but not directly into the pit. The surface owner's description is substantiated by a news report of the operator's activities in Pennsylvania.[28]

What we see at well sites provides just a glimpse of the total range of operators' activities and the DEP's response, if any. Non-compliance with state and federal laws and permit requirements is the norm.

Compliance with any regulation, when it drops below 80% indicates a problem. The state seems to deem 32% compliance acceptable.

This is troubling in light of the state's vague requirements for handling liquid and solid drill waste and fracture flowback, materials that we believe, based on our examination of sites, are negatively affecting the environment and human health.

Violations are rare in West Virginia according to the DEP. That's wishful thinking. The state abandons citizens whose domestic water supplies are compromised by improperly cased and cemented wells. Families have to buy drinking water, pay for medical expenses (the family near 47-039-06155 is receiving treatment for heavy metal poisoning), and are sometimes forced to leave their homes because of catastrophic health consequences brought about due to drillers' activities.

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[27] James K. Otton and Robert A. Zielinski, 2000, *Simple Techniques for Assessing Impacts of Oil and Gas Operations on Federal Lands: A Field Evaluation at Big South Fork National River and Recreation Area, Scott County, Tennessee (online edition)*.

[28] The surface owner described the spraying of flowback in April and July 2011, long before the appearance of the newspaper article relating operator's similar activity in Pennsylvania.

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Appendix 1

Kanawha State Forest Well with Surface Contamination

Two groups of laboratory tests of samples from 47-039-05772 by the operator and DEP were made in 2010. We have received only vague indication of the precise locations where the samples were taken.

Three samples were taken in February 2010 and tested for the operator, from the pad, fill, and water. The soil chloride concentrations show severe contamination.

Two samples were taken by the DEP in September 2010 from the base of the fill slope and away from the pad near or at the location of land application of waste. Samples were not taken from the same locations as the February samples. These two samples show normal background levels.

We took four soil samples and one water sample in August 2011 to test for chloride. Two of the samples, those from the pad in the bare area, show surface contamination, though not as high as the February 2010 operator's samples. Depth of where the sample was taken from might be a reason for the discrepancy; our samples were taken from the top inch of soil. Soil samples from the bare area on the fill slope showed normal background levels of chloride.

We do not know if the chloride concentration in our samples taken in August 2011, compared to the operator's February 2010 samples, indicates remediation or dilution of chloride by rainfall (chloride moves through soil like water).

The site still shows contamination.

Table 1: Analyses of Soil and Water at 47-039-05772

All concentrations are parts per million

	2/2010 Operator Pad	2/2010 Operator Fill	2/2010 Operator Water	9/2010 DEP Base of Fill	9/2010 DEP Background	8/2011 GWS
Chloride	849	965	31	13.1	ND	40 & 46 soil <29 water
Arsenic				ND	5.66	
Barium				24.5	61.2	
Cadmium				ND	ND	
Chromium				7.71	9.14	
Iron	7,170	11,300	46.2	17,900	12,400	
Lead				9.61	22.6	
Manganese				72.7	29.9	
Selenium				ND	ND	
Silver				ND	ND	
Sodium				29.8	27.7	
Mercury				ND	ND	
TPH Gas				ND	ND	
TPH Diesel				ND	12.4	
TPH Oil				ND	64	

Appendix 2
Tables Showing Site Issues

Below are three table showing issues for the sites we visited in 2011. None of the sites had fencing or other security measures to protect the public.

Sites in the tables are indicated by API number. Sites organized according to sections of this report are:

Kanawha State Forest
47-039-01939, 47-039-02079, 47-039-05500, 47-039-05772
Surface Contamination
47-079-01200, 47-079-01288, 47-039-05714
Inadequate Secondary Containment
47-079-00570, 47-079-00583, 47-079-00735
Vertical Marcellus Well
47-039-06155
Condensate Tank Overflow
47-039-02026

Photo 15. Wellhead for 47-079-01200 leaking oil-like substance. This leak has progressed from what we saw in 2008. Photo taken 14 April 2011.

Table 2

API Number	Missing or Incorrect API Number	Lacking or Inadequate Secondary Containment for Condensate Storage Tanks
Putnam County		
47-079-00570	Not on wellhead	**X**
47-079-00583		**X**
47-079-00735		**X**
47-079-01200	Not on wellhead	Water Filled
47-079-01288		
Kanawha County		
47-039-01939		
47-039-02026		
47-039-02079		
47-039-05500		
47-039-05714		
47-039-05772		
47-039-06155		Water Filled

Table 3

API Number	Maintenance Issues	Trash	Leak or Spill
Putnam County			
47-079-00570	X		
47-079-00583			
47-079-00735		X	
47-079-01200	X		X
47-079-01288			
Kanawha County			
47-039-01939	X		
47-039-02026			X
47-039-02079	X		
47-039-05500	X		
47-039-05714			
47-039-05772	X		
47-039-06155	X		

Table 4

API Number	Vegetation Issues	Drainage and Sedimentation Control	Road Issues
Putnam County			
47-079-00570			
47-079-00583			
47-079-00735			
47-079-01200	X	X	X
47-079-01288	X	X	X
Kanawha County			
47-039-01939		X	X
47-039-02026			
47-039-02079		X	X
47-039-05500			X
47-039-05714	X		
47-039-05772	X		X
47-039-06155	X		