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Statement of Basis, Specific Statutory Authority, and Purpose

New Rules and Amendments to Current Rules of the Colorado Oil and Gas Conservation Commission, 2 CCR 404-1

This statement sets forth the basis, specific statutory authority, and purpose for new rules and amendments to the Rules and Regulations and Rules of Practice and Procedure ("Rules") promulgated by the Colorado Oil and Gas Conservation Commission ("COGCC") on December 11, 2008. These rules are promulgated to protect public health, safety, and welfare, including the environment and wildlife resources, from the impacts resulting from the dramatic increase in oil and gas development in Colorado. They also implement new statutory authority and update existing regulations where appropriate. They are intended to foster the responsible and balanced development of oil and gas resources.

Unless otherwise specified, the new rules and amendments become effective on May 1, 2009 on federal land and April 1, 2009 on all other land.

n adopting the new rules and amendments, the Commission relied upon the entire administrative record for this rulemaking proceeding, which formally began in March 2008 and informally began in the summer of 2007. This record includes the proposed rules and numerous recommended modifications and alternatives; thousands of pages of public comment, written testimony, and exhibits; and 12 days of public and party hearings. The Commission spent another 12 days deliberating on the rules before taking final action.

Statutory Authority

The additions and amendments to the rules are promulgated pursuant to the authority granted to COGCC by House Bills ("HB") 07-1298 and 07-1341, codified at sections 34-60-106 and 34-60-128, C.R.S., of the Oil and Gas Conservation Act ("Act"). Additional authority for the promulgation of the rules is provided by sections 34-60-102, 34-60-103, 34-60-104, 34-60-105, and 34-60-108, C.R.S. of the Act. The Commission also adopted the following statement of basis and purpose consistent with section 24-4-103(4), C.R.S., of the Administrative Procedure Act. This statement is hereby incorporated by reference in the rules adopted.

The rulemaking hearing for these rules was held on May 22, 2008 (initial motions); June 10, 2008 (public testimony); June 23-27, 2008 (public and party testimony); June 30-July 1, 2008 (party testimony); July 15-17, 2008 (party testimony); August 19-20, 2008 (deliberations); September 9-11, 2008 (deliberations); September 22-23, 2008 (deliberations); October 26-27, 2008 (deliberations); and December 9-11, 2008 (deliberations).

Purpose

Address Growing mpacts of ncrease in Oil and Gas Activity

A ma or reason for adopting these regulations was to address concerns created by the unprecedented increase in the permitting and production of oil and gas in Colorado in the past few years. n 1996, the COGCC, through its Director, approved 1,002 applications for permits to drill ("APD"). In 2004, that number increased to 2,915 approved APDs. In 2007, the COGCC approved 6,368 APDs. The COGCC anticipates that it will approve approximately 7,500 APDs in 2008. This increase in permitting levels generally corresponds to an increase in drilling activity, particularly in the Piceance Basin, where drilling has extended into new areas with more extensive wildlife and water resources, more challenging terrain, and additional people. These

increases require the COGCC to re-evaluate its regulatory scheme to ensure that its rules are appropriate for the heightened level and broader geographic extent of development activity in Colorado. n addition, as the level and extent of drilling activity has increased, so has the public concern for the health, safety and welfare of Colorado's residents. The level of public concern for Colorado's environment and wildlife resources has also risen with the increase in permitting and drilling over the past few years. With the number of approved APDs increasing by approximately 750 in twelve years (and 257 in ust four years) and the public concerns engendered by the increased activity, the COGCC's re-evaluation was necessary and appropriate.

mplement 2007 egislation

n 2007, upon the urging and initiative of the Colorado Department of atural Resources, the General Assembly passed legislation to increase the Commission's regulatory authority and oversight obligations to better address the potential adverse impacts that can accompany oil and gas development. The General Assembly declared that it is in the public's interest to foster the *responsible, balanced* development of Colorado's oil and gas resources consistent with the protection of public health, safety, and welfare, *including protection of the environment and wildlife resources*. C.R.S. 34-60-102(1) (emphasis added).

The new rules comply with the legislative mandate to (1) foster oil and gas development consistent with the protection of public health, safety, and welfare, including the environment and wildlife resources; (2) promote the conservation of wildlife habitat in connection with the development of oil and gas; and (3) minimize adverse impacts to wildlife resources affected by oil and gas operations and ensure proper reclamation of wildlife habitat. C.R.S. 34-60-106, 34-60-128.

n order to protect the health, safety, and welfare of the general public, the COGCC staff developed the rules in consultation with the Colorado Department of Public Health and Environment ("CDPHE"). C.R.S. § 34-60-106(11)(a)( ). As directed by the legislature, the rules provide a timely and efficient procedure by which the CDPHE has an opportunity to provide comments during the COGCC's decision-making process. *Id*.

n order to minimize adverse impacts to wildlife resources and ensure proper reclamation of wildlife habitat, the COGCC staff developed the rules in consultation with the Colorado Division of Wildlife ("CDOW"). C.R.S. § 34-60-128(3)(d)( ). As directed by the legislature, the rules (1) develop a timely and efficient consultation process with the CDOW governing notification and consultation to minimize adverse impacts and other issues relating to wildlife resources; (2) encourage operators to utilize comprehensive drilling plans and geographic area analysis strategies to provide for orderly development of oil and gas fields; and (3) minimize surface disturbance and fragmentation in important wildlife habitat by incorporating appropriate best management practices in certain COGCC orders and decisions. *See* C.R.S. 34-60-128(d)(-).

Update Existing Rules Where Appropriate

The COGCC staff also identified existing rules to update in order to enhance clarity, respond to new information, and reflect current practice and procedure. Although the Commission has annually adopted or amended particular rules, the last set of comprehensive amendments occurred more than a decade ago and various rules had become outdated. For example, before amendment some of the environmental and financial assurance rules no longer adequately addressed current needs and conditions. Similarly, before amendment some of the procedural rules did not reflect current COGCC practices. Therefore, the Commission used this as an opportunity to update existing rules where appropriate.

Class commercial in ection well and used prior to the disposal of E P wastes into such well. A separate financial assurance requirement still applies for the plugging and abandonment of such wells as specified in Rule 706.

As one example of the need for this rule, there was testimony during the hearing that Conquest Oil Company operates five commercial Class U C wells in Weld County. Operations at these facilities have resulted in impacts to soils and shallow groundwater beneath two of these sites. n each case, there has been a Site nvestigation and Remediation Workplan, Form 27, submitted to and approved by COGCC staff. Remediation and groundwater monitoring at these sites is ongoing. Currently, Conquest Oil Company only has a 30,000 blanket plugging bond posted with the COGCC, which is not sufficient.

800-Series Aesthetic and Noise Control Regulations

Amendments to the 800-Series

The following rules were amended

1. Rule 803., GHT G

   Basis The statutory basis for this amendment is section 34-60-106(11)(a)( ), C.R.S.

   Purpose: Rule 803. used to refer to "occupied" buildings. There was no definition for "occupied", which created a potential for misinterpretation of set back and high density requirements. This term was amended to "building unit", which is defined in the 100-Series.

2. Rule 804., SUA MPACT M T GAT O

   Basis The statutory bases for this amendment are sections 34-60-106(11)(a)( ) and 34-60-128(3)(d), C.R.S.

   Purpose Prior to amendment, Rule 804. exempted production facilities constructed or substantially repainted prior to May 30, 1992, from mitigating visual impacts. As amended, the rule mandates that all long-term production facilities be painted to minimize visual impacts from a location typically used by the public such as a public highway. This amendment is consistent with the recent legislative mandate to protect public welfare and minimize adverse impacts to wildlife resources. Mitigating visual impacts will improve the appearance of the scenic landscape and thus benefit the general public. n addition, production facilities painted with uniform, non-contrasting, non-reflective color tones, and with colors matched to but slightly darker than the surrounding landscape may lessen impacts upon wildlife activity. Recognizing the need for operators to have sufficient time to implement this requirement, the Commission deferred its effective date until September 1, 2010.

Additions to the 800-Series

The following Rule 805. was added

Rule 805., ODORS A D DUST

Basis The statutory basis for this rule is section 34-60-106(11)(a)( ), C.R.S.

Purpose The Commission adopted Rule 805. to respond to increasing concern over odors and nuisance-like conditions where oil and gas development occurs near residences, neighborhoods, and other occupied structures. Testimony during the hearing confirmed

that growth in oil and gas development has caused noteworthy increases, particularly in the Piceance Basin (Garfield, Mesa, and Rio Blanco Counties), in complaints about odor and impacts on the use and en oyment of property. For example, state and local government complaint logs showed that from 2004 to 2007, Garfield County received 374 complaints, 94 of which were oil and gas-related odors (25). From 2006 to the present, the COGCC received 496 complaints, 121 of which were oil and gas-related odors (24.3). The Commission believes Rule 805. strikes a balance between allowing resource development and protecting public welfare by allowing the oil and gas development to occur near residences and other populated buildings, provided that certain development activity/equipment employ air emissions controls and work practices that reduce odor causing pollutants to enter the air.

Odors can emanate from day-to-day operations of the oil and gas equipment. Rule 805. addresses odor-related concerns from day-to-day operations in the three Piceance Basin Counties Garfield, Mesa and Rio Blanco, by requiring emission controls to be placed on certain odor causing equipment (tanks, pits and glycol dehydrators) located within mile of residences or occupied dwellings. The rule also requires operators to hold a valid permit from the CDPHE for affected tanks and glycol dehydrators to assure rule effectiveness and enforcement capabilities. The Commission recognizes that without such a permit requirement, there would be little assurance that required emission control devices are installed and operated properly, rendering the rule essentially ineffective and unenforceable. The Commission understands that the operational requirements that are typically in Air Pollution Control Division permits to ensure rule effectiveness would include (1) a requirement that control equipment be correctly piped to the control devices; (2) a requirement that control equipment be correctly sized to handle the emissions being controlled; (3) a requirement that all vents or thief hatches be appropriately sealed; (4) confirmation that the control devices are operational; and (5) verification that the pilot lights for the equipment are working.

Odors can also emanate from "flowback" occurring during the well completion phase. Prior to the adoption of Rule 805., well completion practices included allowing well contents to flow into open tanks or pits, thus allowing natural gas and condensate to disperse into the atmosphere. This practice not only creates odors but also disperses methane, a greenhouse gas, to the atmosphere, which can be a waste of valuable natural resources. The rule addresses this by requiring operators to use green completion practices, where practicable, to reduce odors and methane emissions associated with well development.

Compliance with certain provisions of Rule 805.b.(2)A, B, and C requires purchase and installation of control equipment on both existing and new oil and gas equipment if the operations are in certain locations and if certain conditions are met. Because existing condensate tanks, crude oil and produced water tanks and glycol dehydrator are sub ect to this rule, the Commission decided to phase in the rule's effectiveness to allow for equipment to be ordered and installed. Specifically, operators will not be required to comply with requirements for condensate, crude oil and production tanks, or glycol dehydrators until October 1, 2009, giving operators ample time to order and install the control equipment.

Compliance with Rule 805.b.(2).D is required only for qualifying pits constructed after May 1, 2009 on federal land or after April 1, 2009 on all other land because the

Commission does not intend for pits in existence on those dates to be moved or eliminated.

The Commission wrote Rule 805.b.(2). A, B and C to expressly apply to existing equipment. This approach is necessary because it is the best way to respond to existing odor complaints and public welfare concern, raised repeatedly in hearing testimony. The Commission believes applying these rule sections retroactively is not only necessary, but strikes a balance between oil and gas development and public health, safety, and welfare protection. The Commission also notes that because the legislative declaration in the Act represents a remedial change, it thereby allows rules that pertain to the protection of public health, safety and welfare to be applied to existing operations. *See In re Estate of Moring v. Colo. Dep't of Health Care Policy & Fin.*, 24 P.3d 642 (Colo. App. 2001). n short, the evidence presented during the hearing regarding the existing negative impacts odors are having on public health, safety, and welfare bolstered the Commission's belief that this problem is best remedied by applying this rule to existing oil and gas operations.

The Commission also included provisions requiring operators of control equipment installed pursuant to 805b.(2)A, B and C to hold a valid permit from the CDPHE Air Pollution Control Division (APCD). The Commission believes an APCD permit is necessary to assure odor control equipment is not only installed at the site, but operated in a manner that actually reduces the odor causing OCs. Without this provision there would be no mechanism for requiring the emission control equipment to operate properly; in other words there would be no method for enforcing against an operator who does not operate the control equipment in compliance with these provisions. The Commission's intent here is to ensure that APCD issued permits for this equipment contain uniform and reasonable conditions that address the requirements described above.

After hearing testimony from a variety of parties during the hearing, the Commission concludes that adoption of Rule 805. will result in greater public welfare protections in the three counties within the Piceance Basin where such protections are most needed. t also believes that the adopted provisions provide the basis for protections elsewhere if and when the need arises and would consider using Rule 805. as a foundation for expanding its applicability through a subsequent rulemaking. The public welfare protections reflected in these amendments result from reduced emissions of volatile organic compounds from the larger-emitting oil and gas production sources located near human-occupied structures. imiting the dispersion of these compounds benefits people living in the area with cleaner air that has a much lower likelihood of affecting the use and en oyment of their property in proximity to oil and gas operations. The Commission also notes the additional benefit of limiting the greenhouse gases released to the atmosphere, and preserving the natural resources of the state that would result from these regulations. Applying a mile radius for application of the relevant emissions control requirements will afford a significant benefit for persons in occupied structures within that area in this region, and will also provide a benefit to persons beyond that radius, for example, in such structures between and mile radius of that same equipment.

The Commission also finds that Rule 805. will not hinder the oil and gas industry's ability to develop oil and gas resources. The control equipment contemplated by Rule 805. is commonly used, and the record shows operators voluntarily use this equipment to reduce impacts on the nearby populations. Rule 805. does not require specialized equipment on wells that do not produce at a sufficient volume and pressure to flow

through this equipment, making it a narrowly tailored rule. Rule 805. also allows operators to request a variance if they believe employing control equipment or green completion practices or other control equipment is not feasible. n instances where green completions are not technically feasible or are not required, operators shall employ BMPs to reduce odor causing emissions.

After reviewing the record, the Commission believes Rule 805. effectively balances the protection of public welfare with the development of oil and gas resources by minimizing hydrocarbons released to the atmosphere in proximity to occupied structures while allowing operators to continue to complete wells and operate in a normal manner. Upon consideration of all of the evidence, the COGCC concludes that these regulations as adopted are responsive to the directives set forth in HB 07-1341.

The Commission also heard testimony regarding the need for, and recognizes the value of, studies to better understand the impacts on Colorado citizens of oil and gas development. The evidence in the record reflects questions and concerns about public health effects of oil and gas operations. The Commission believes that it would be beneficial to develop additional information regarding the relationship between oil and gas development and public health, particularly where such industrial development occurs in close proximity to residential developments. The Commission therefore is instructing staff, in collaboration with the CDPHE, to initiate a public health literature review to determine the status or current information and knowledge about this issue, identify data gaps, and guide the definition and scope of future targeted public health studies; and to report back and offer recommendations to the Commission during in the last quarter of 2009.

The Commission also acknowledges a need to fill significant air quality data gaps from oil and gas activities in the oil and gas regions of Colorado, especially in the western Colorado oil and gas basins. This is true both for air quality monitoring data, as well as pro ected air quality loading and airshed impacts, typically evaluated via modeling exercises. These data gaps need filling to facilitate effective air quality planning. Specifically, the Commission believes there is a need for monitoring data to characterize current air quality conditions and to monitor the air quality impacts of oil and gas-related activities into the future. This need stems from the rapid and broad growth in oil and gas activities in the last five years in western Colorado and neighboring states, and the pro ected future rapid growth in oil and gas activities over the next 20 or more years, combined with the new, more stringent national ambient air quality standard for ozone. The collection of this data can provide a scientific basis for further mitigation efforts if necessary to prevent degradation of the state's air quality or addressing potential non-compliance with health-based air quality standards that could arise from this significant and widespread industrial activity.

The Commission directs staff to work with parties to this rulemaking to define air quality information needs and methods and costs for meeting them; and report back by the fall of 2009. The Commission intends for staff to develop recommendations in collaboration with CDPHE and using appropriate means. The Commission understands that agency resources are limited at this time, and that resources from the oil and gas industry as well as those of other government agencies may be available. The Commission expects that, if appropriate, recommendations may include a strategic plan for conducting and funding monitoring and studies.

Condensate tanks, crude oil and produced water tanks, and glycol dehydrators within mile of certain building units that are in existence on May 1, 2009 on federal land and April 1, 2009 on all other land must be in compliance with amended Rule 805. by October 1, 2009.

900-Series Exploration and Production (E&P) Waste Management

General ntroduction to 900-Series

The rules and regulations of the 900-Series establish the permitting, construction, operating and closure requirements for pits, methods for managing E P waste, procedures for spill/release response and reporting, and sampling and analysis requirements for remediation activities. These rules have been developed to fulfill the COGCC's mission to foster the responsible development of oil and gas resources and to protect public health, safety and welfare including protection of the environment and wildlife. The 900- Series rules are applicable only to E P waste, as defined in section 34-60-103(4.5), C.R.S., or other solid waste where the CDPHE has allowed remediation and oversight by the Commission. The COGCC is an implementing agency for water quality standards and classifications adopted by the Water uality Control Commission (W CC) for groundwater protection. This authority was provided by Senate Bill 89-181, and is restated and clarified by a Memorandum of Agreement between the agencies. The urisdictional authority over exploration and production waste was granted to the COGCC through Senate Bill 95-017.

The occurrence and distribution of Colorado's water resources are linked to its geography and underlying geology. The ultimate source of groundwater is recharge through precipitation. Precipitation that does not evaporate or immediately flow into surface waters percolates into groundwater. Groundwater is the primary water source for 75 of the public water supply systems in the state. The increasing reliance on groundwater by public and domestic water wells and private water systems in a water-short state mandates a greater degree of protection for groundwater quality.

Retroactive Applicability of 900-Series

The Commission expressly intends that the amendments to the 900-Series Rules not be retroactive, except where specifically stated (e.g., skim pits). Moreover, the Commission notes that the future closure and remediation of pits existing on or after May 1, 2009 on federal land or on or after April 1, 2009 on all other land will be sub ect to the concentration levels of Table 910-1, as amended. onetheless, the Commission recognizes that there is a large and growing number of E P waste management operations in Colorado, including more than 10,000 pits. The Commission also acknowledges that pits existing at the time these rules become effective (May 1, 2009 for federal lands and April 1, 2009 for all other lands) must be managed such that public health and the environment are protected. To this end, the Commission directed staff to exercise, where appropriate, its existing authority under Rule 901.c., which allows the Director to, with reasonable cause, impose additional requirements on existing pits. This rule establishes that, if the Director observes an act or practice being performed which may violate Table 910-1 or water quality standards or classifications established by the W CC, he may impose additional requirements, including but not limited to sensitive area determination, sampling and analysis, remediation, monitoring, permitting and the establishment of points of compliance.

NEW YORK STATE | Department of Health

A Public Health Review of

High Volume Hydraulic Fracturing for Shale Gas Development

December 2014

NEW YORK
state department of
HEALTH

Howard A. Zucker, M.D., J.D.
Acting Commissioner of Health

Sally Dreslin, M.S., R.N.
Executive Deputy Commissioner

December 17, 2014

Hon. Joseph Martens
Commissioner
ew ork State Department of Environmental Conservation
625 Broadway
Albany, 12207

Dear Commissioner Martens

n September 2012, you asked Dr. Shah, then Commissioner of Health, to initiate a Public Health Review of the Department of Environmental Conservation's draft Supplemental Generic Environmental mpact Statement for High olume Hydraulic Fracturing (H HF). assumed responsibility for this review when Dr. Shah left. t became clear during this assessment that DOH's Public Health Review needed to extend beyond the scope of the initial request to consider, more broadly, the current state of science regarding H HF and public health risks. This required an evaluation of the emerging scientific information on environmental public health and community health effects. This also required an analysis of whether such information was sufficient to determine the extent of potential public health impacts of H HF activities in ew ork State (S) and whether existing mitigation measures implemented in other states are effectively reducing the risk for adverse public health impacts.

As with most complex human activities in modern societies, absolute scientific certainty regarding the relative contributions of positive and negative impacts of H HF on public health is unlikely to ever be attained. n this instance, however, the overall weight of the evidence from the cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with H HF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health. Until the science provides sufficient information to determine the level of risk to public health from H HF to all ew orkers and whether the risks can be adequately managed, DOH recommends that H HF should not proceed in S.

appreciate the opportunity to conduct this Public Health Review. t furthers the long history of close collaboration between the two Departments carrying out our shared responsibility to protect human health and the environment.

Sincerely,

Howard Zucker M.D.

Howard A. ucker, M.D., J.D.
Acting Commissoner of Health

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| Executive Summary

The New York State Department of Health (DOH) is charged with protecting the public health of New Yorkers. In assessing whether public health would be adequately protected from a complex activity such as high volume hydraulic fracturing (HVHF), a guarantee of absolute safety is not required. However, at a minimum, there must be sufficient information to understand what the likely public health risks will be. Currently, that information is insufficient.

In 2012, the New York State Department of Environmental Conservation (DEC) requested that DOH review and assess DEC's analysis of potential health impacts contained in DEC's draft supplemental generic environmental impact statement (SGEIS) for HVHF. In response to the original request from DEC, DOH initiated an HVHF Public Health Review process. In conducting this public health review DOH: (i) reviewed and evaluated scientific literature to determine whether the current scientific research is sufficient to inform questions regarding public health impacts of HVHF; (ii) sought input from three outside public health expert consultants; (iii) engaged in field visits and discussions with health and environmental authorities in states with HVHF activity; and (iv) communicated with multiple local, state, federal, international, academic, environmental, and public health stakeholders. The evaluation considered the available information on potential pathways that connect HVHF activities and environmental impacts to human exposure and the risk for adverse public health impacts.

Based on this review, it is apparent that the science surrounding HVHF activity is limited, only just beginning to emerge, and largely suggests only hypotheses about potential public health impacts that need further evaluation. That is, many of the

published reports investigating both environmental impacts that could result in human exposures and health implications of HVHF activities are preliminary or exploratory in nature. However, the existing studies also raise substantial questions about whether the risks of HVHF activities are sufficiently understood so that they can be adequately managed. Furthermore, the public health impacts from HVHF activities could be significantly broader than just those geographic locations where the activity actually occurs, thus expanding the potential risk to a large population of New Yorkers.

As with most complex human activities in modern societies, absolute scientific certainty regarding the relative contributions of positive and negative impacts of HVHF on public health is unlikely to ever be attained. In this instance, however, the overall weight of the evidence from the cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF to all New Yorkers and whether the risks can be adequately managed, DOH recommends that HVHF should not proceed in New York State.

Scope of the Public Health Review

DOH evaluated whether the available scientific and technical information provides an adequate basis to understand the likelihood and magnitude of risks for adverse public health impacts from HVHF activities in New York State. DOH reviewed how HVHF activities could result in human exposure to: (i) contaminants in air or water; (ii) naturally occurring radiological materials that result from HVHF activities; and (iii) the effects of

HVHF operations such as truck traffic, noise, and social changes on communities. DOH also reviewed whether those exposures may result in adverse public health outcomes.

Public Health Review Process

The initial component of the Public Health Review focused on understanding how public health concerns were addressed in the draft SGEIS. Three nationally recognized experts participated as consultants to the initial phase of the review process. The expert consultants reviewed elements of the draft SGEIS and documentation developed by DOH, and provided extensive input through multiple rounds of communication.

As a result of this input, as well as broader consideration, it became clear that DOH's Public Health Review needed to extend beyond this initial assessment to consider, more broadly, the current state of science regarding HVHF and public health risks. This required an evaluation of the emerging scientific information on environmental public health and community health effects. This also required an analysis of whether such information was sufficient to determine the extent of potential public health impact of HVHF activities in NYS and whether existing mitigation measures implemented in other states are effectively reducing the risk for adverse public health impacts.

In addition to evaluating published scientific literature, former Commissioner Shah, Acting Commissioner Zucker, and DOH staff consulted with state public health and environmental authorities to understand their experience with HVHF. Former Commissioner Shah, Acting Commissioner Zucker, and DOH staff also engaged in a number of discussions and meetings with researchers from academic institutions and government agencies to learn more about planned and ongoing studies and assessments of the public health implications of HVHF. In total, more than 20 DOH

senior Research Scientists, Public Health Specialists, and Radiological Health Specialists spent approximately 4500 hours on this Review.

Major Findings

Summarized below are some of the environmental impacts and health outcomes potentially associated with HVHF activities:

- **Air impacts** that could affect **respiratory health** due to increased levels of particulate matter, diesel exhaust, or volatile organic chemicals.
- **Climate change impacts** due to methane and other volatile organic chemical releases to the atmosphere.
- **Drinking water impacts** from underground migration of methane and/or fracking chemicals associated with faulty well construction.
- Surface spills potentially resulting in **soil and water contamination**.
- **Surface-water contamination** resulting from inadequate wastewater treatment.
- **Earthquakes** induced during fracturing.
- **Community impacts** associated with boom-town economic effects such as increased vehicle traffic, road damage, noise, odor complaints, increased demand for housing and medical care, and stress.

Additionally, an evaluation of the studies reveals critical information gaps. These need to be filled to more fully understand the connections between risk factors, such as air and water pollution, and public health outcomes among populations living in proximity to HVHF shale gas operations (Penning, 2014; Shonkoff, 2014; Werner, 2015).

Some of the most significant environmental and health-outcome studies are briefly summarized here.

Air Impacts

Studies provide evidence of uncontrolled methane leakage, emissions of other volatile organic chemicals, and particulate matter from well pads and natural-gas infrastructure. State authorities in both Texas and Pennsylvania have documented methane leakage from natural gas infrastructure by the use of infrared cameras. A recent West Virginia study also determined that heavy vehicle traffic and trucks idling at well pads were the likely sources of intermittently high dust and benzene concentrations, sometimes observed at distances of at least 625 feet from the center of the well pad (McCawley, 2012, 2013; WVDEP, 2013). These emissions have the potential to contribute to community odor problems, respiratory health impacts such as asthma exacerbations, and longer-term climate change impacts from methane accumulation in the atmosphere (Allen, 2013; Bunch, 2014; CDPHE, 2010; Macey, 2014; Miller, 2013; Petron, 2012; Weisel, 2010).

Water-quality Impacts

Studies have found evidence for underground migration of methane associated with faulty well construction (Darrah, 2014; EPA, 2011). For example, a recent study identified groundwater contamination clusters that the authors determined were due to gas leakage from intermediate-depth strata through failures of annulus cement, faulty production casings, and underground gas well failure (Darrah, 2014). Shallow methane-migration has the potential to impact private drinking water wells, creating safety concerns due to explosions.

Other studies suggest additional sources of potential water contamination, including surface spills and inadequate treatment and disposal of radioactive wastes (Warner, 2013). A recent review paper presented published data revealing evidence for stray gas contamination, surface water impacts, and the accumulation of radium isotopes in some disposal and spill sites (Vengosh, 2014). One recent study also suggests that chemical signals of brine from deep shale formations can potentially be detected in overlying groundwater aquifers (Warner, 2012). These contaminants have the potential to affect drinking water quality.

Seismic Impacts

Recent evidence from studies in Ohio and Oklahoma suggest that HVHF can contribute to the induction of earthquakes during fracturing (Holland, 2014; Maxwell, 2013). Although the potential public health consequence of these relatively mild earthquakes is unknown, this evidence raises new concerns about this potential HVHF impact.

Community Impacts

There are numerous historical examples of the negative impact of rapid and concentrated increases in extractive resource development (e.g., energy, precious metals) resulting in indirect community impacts such as interference with quality-of-life (e.g., noise, odors), overburdened transportation and health infrastructure, and disproportionate increases in social problems, particularly in small isolated rural communities where local governments and infrastructure tend to be unprepared for rapid changes (Headwaters, 2013). Similar concerns have been raised in some communities where HVHF activity has increased rapidly (Stedman, 2012; Texas DSHS, 2010; Witter, 2010; WVDEP, 2013).

A recent study from Pennsylvania also reports that automobile and truck accident rates in 2010–2012 from counties with heavy HVHF activity were between 15% and 65% higher than accident rates in counties without HVHF. Rates of traffic fatalities and major injuries were higher in 2012 in heavy drilling counties in southwestern Pennsylvania compared to non-drilling counties (Graham, 2015).

Health Outcomes near HVHF Activity

Although well-designed, long-term health studies assessing the effect of HVHF activity on health outcomes have not been completed, there is published health literature that examines health outcomes in relation to residential proximity to HVHF well pads. One peer-reviewed study and one university report have presented data indicating statistical associations between some birth outcomes (low birth weight and some congenital defects) and residential proximity of the mother to well pads during pregnancy (Hill, 2012; McKenzie, 2014). Proximity to higher-density HVHF well pad development was associated with increased incidence of congenital heart defects and neural-tube defects in one of the studies (McKenzie, 2014).

Several published reports present data from surveys of health complaints among residents living near HVHF activities. Commonly reported symptoms include skin rash or irritation, nausea or vomiting, abdominal pain, breathing difficulties or cough, nosebleeds, anxiety/stress, headache, dizziness, eye irritation, and throat irritation in people and farm animals within proximity to HVHF natural gas development (Bamberger, 2012; Finkel, 2013; Steinzor, 2012). Federal investigators have also reported that sub-standard work practices and deficient operational controls at well pads contributed to elevated crystalline silica exposures among workers during HVHF operations (USDOL, 2012). While this report focused on worker exposures, it highlights

a possible exposure concern for residents living close to HVHF operations if silica emissions from onsite operations are not properly controlled.

Substantial Gaps Remain

Systematic investigations studying the effects of HVHF activity on groundwater resources, local-community air quality, radon exposure, noise exposure, wastewater treatment, induced seismicity, traffic, psychosocial stress, and injuries would help reduce scientific uncertainties. While some of the on-going or proposed major study initiatives may help close those existing data gaps, each of these alone would not adequately address the array of complex concerns related to HVHF activities.
For example:

Marcellus Shale Initiative Study

Geisinger Health System, the lead organization in the collaborative Marcellus Shale Initiative, cares for many patients in areas where shale gas is being developed in Pennsylvania. They began pilot studies in 2013 using well and infrastructure data to estimate exposures to all aspects of Marcellus shale development in Pennsylvania. According to the National Institutes of Health (NIH) abstract, they will use these exposure estimates to evaluate whether asthma control and pregnancy outcomes are affected by Marcellus shale development by studying 30,000 asthma patients and 22,000 pregnancies in the Geisinger Health System from 2006-13. Results from this study are not expected to be available for several years.

University of Colorado at Boulder, Sustainability Research Network

A five-year cooperative agreement funded by the National Science Foundation (NSF) under NSF's Sustainability Research Network competition, this program involves a multidisciplinary team of investigators and is intended to address:

> *"the conflict between natural gas extraction and water and air resources protection with the development of a social-ecological system framework with which to assess the conflict and to identify needs for scientific information. Scientific investigations will be conducted to assess and mitigate the problems. Outreach and education efforts will focus on citizen science, public involvement, and awareness of the science and policy issues"* (Univ. Colorado, 2012; Shonkoff, 2014).

Published research has been produced from this program investigating associations between HVHF activity and birth outcomes and potential for methane leakage from natural gas infrastructure. The cooperative agreement extends to 2017.

EPA's Study of Hydraulic Fracturing and Its Potential Impact on Drinking Water Resources

Begun in 2011, the purpose of the study is to assess the potential impacts of hydraulic fracturing on drinking water resources, if any, and to identify the driving factors that may affect the severity and frequency of such impacts. The research approach includes: analyses of existing data, scenario evaluations, laboratory studies, toxicity studies, and case studies. US EPA released a progress report on December 21, 2012 and stated that preliminary results of the study are expected to be released as a draft for public and

peer review as soon as the end of 2014, although the full study is not expected to be completed before 2016.

Pennsylvania Department of Environmental Protection (PA DEP) Comprehensive Oil and Gas Development Radiation Study

Started in early 2013, PA DEP is analyzing the radioactivity levels in produced and flowback waters, wastewater recycling, treatment sludges, and drill cuttings, as well as issues with transportation, storage, and disposal of drilling wastes, the levels of radon in natural gas, and potential exposures to workers and the public. According to a July 2014 update from the PA DEP, publication of a report could occur as soon as the end of 2014.

University of Pennsylvania Study

A proposed study of HVHF health impacts was announced several months ago. The study is led by researchers from the University of Pennsylvania in collaboration with scientists from Columbia University, Johns Hopkins University, and the University of North Carolina.

Pennsylvania Department of Environmental Protection

Recently proposed community air monitoring will determine concentrations of fine and coarse (silica-sized) particles near a transfer facility that handles hydraulic fracturing silica sand.

These major study initiatives may eventually reduce uncertainties regarding health impacts of HVHF and could contribute to a much more complete knowledge base for

managing HVHF risks. However, it will be years before most of these major initiatives are completed.

Other governmental and research institutes have also recently conducted health impact assessments of HVHF (Institute of Medicine, 2014). These include: the European Commission; University of Michigan, Graham Sustainability Institute; Research Triangle Environmental Health Collaborative; Nova Scotia Independent Panel on Hydraulic Fracturing; Inter-Environmental Health Sciences Core Center Working Group on Unconventional Natural Gas Drilling Operations funded by the National Institute of Environmental Health Sciences; and the Maryland Institute for Applied Environmental Health, School of Public Health, University of Maryland. While these assessments identify many of the same potential environmental impacts mentioned above, more importantly, they reiterate that significant gaps exist in the knowledge of potential public health impacts from HVHF and of the effectiveness of some mitigation measures.

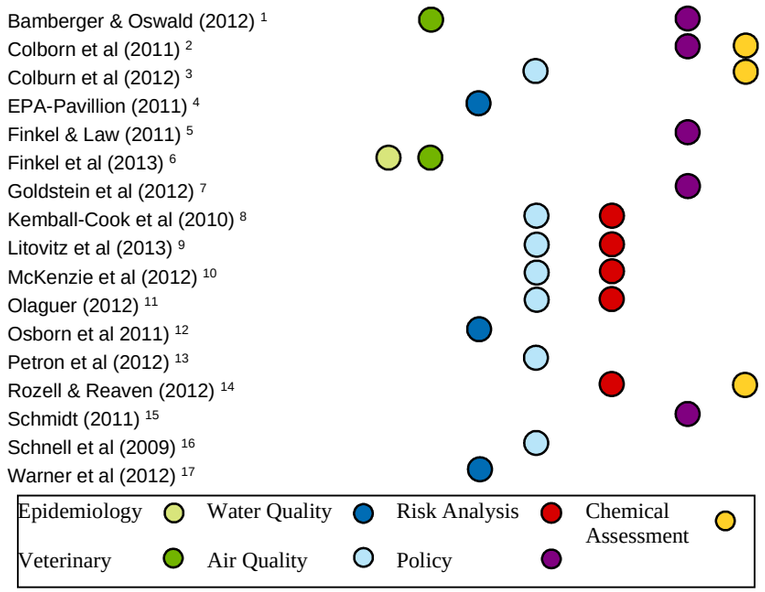
Conclusions

HVHF is a complex activity that could affect many communities in New York State. The number of well pads and associated HVHF activities could be vast and spread out over wide geographic areas where environmental conditions and populations vary. The dispersed nature of the activity magnifies the possibility of process and equipment failures, leading to the potential for cumulative risks for exposures and associated adverse health outcomes. Additionally, the relationships between HVHF environmental impacts and public health are complex and not fully understood. Comprehensive, long-term studies, and in particular longitudinal studies, that could contribute to the understanding of those relationships are either not yet completed or have yet to be initiated. In this instance, however, the overall weight of the evidence from the

cumulative body of information contained in this Public Health Review demonstrates that there are significant uncertainties about the kinds of adverse health outcomes that may be associated with HVHF, the likelihood of the occurrence of adverse health outcomes, and the effectiveness of some of the mitigation measures in reducing or preventing environmental impacts which could adversely affect public health.

While a guarantee of absolute safety is not possible, an assessment of the risk to public health must be supported by adequate scientific information to determine with confidence that the overall risk is sufficiently low to justify proceeding with HVHF in New York. The current scientific information is insufficient. Furthermore, it is clear from the existing literature and experience that HVHF activity has resulted in environmental impacts that are potentially adverse to public health. Until the science provides sufficient information to determine the level of risk to public health from HVHF and whether the risks can be adequately managed, HVHF should not proceed in New York State.

Recent years have seen a surge of scientific studies on the public health dimensions of shale gas development. However, data gaps continue to persist and efforts to fill these gaps are hampered by a variety of regulatory, governmental, and research obstacles.



Obstacles in Governance

Lack of Health Expertise

There is a lack of environmental health expertise in the National Advisory Committees. While public health concerns related to shale gas and tight oil development are certainly recognized, the state and national advisory committees designed to respond to and investigate these concerns lack personnel with environmental public health expertise (7). This lack of expertise functions as a barrier to adequate scientific investigations and to subsequent science-based health policies.

Lack of Capacity and Resources

Governmental departments are understaffed and funding shortages are exacerbated by the economic recession. Thus, governmental monitoring of public health and environmental dimensions of shale (tight) oil and gas production has been limited. For instance, in 2011 the Pennsylvania Department of Environmental Protection (PA DEP) failed to inspect 66,000 of its active oil and gas wells (18). A lack of monitoring inhibits data collection, data analysis, and the growth of scientific understanding of public health concerns.

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May 2013

PSE

Impediments to Public Health Research on Shale (Tight) Oil and Gas Development

Over the past several years there has been a surge of scientific studies on the public health dimensions of unconventional gas development. However, data gaps continue to persist and efforts to fill these gaps are hampered by a variety of regulatory, governmental, and research obstacles.

- A full understanding of the risks to human health from shale gas and tight oil development is not yet known due to a dearth of environmental science and epidemiologic research, yet l**ack of data is not an indication of an absence of harm.**
- Despite considerable known risks to human health, the burden of proof regarding health and safety of shale gas and tight oil development currently falls on scientists and the public as opposed to industry. This creates a **bias towards the increased development of shale gas and tight oil with limited public health and environmental protections.**
- Industrial, legislative, and regulatory development have historically outpaced scientific consensus on these types of topics, resulting in human harm. Examples where health-damaging industrial activities were scaled much more rapidly than the science of its health effects and subsequent evidence-based policy development include, tobacco, PCBs, asbestos, and leaded gasoline. **The science should be put before risky industrial processes are allowed to be scaled.**

Methodological Obstacles & Exposure Assessment

Exposure Considerations

Even with full disclosure of chemicals added to frac fluid, the ability to link chemicals to specific health outcomes remains difficult:

- Frac fluid mixes with compounds found underground including heavy metals, salts, associated hydrocarbons, and, sometimes, naturally occurring radioactive materials (NORMs). **Flowback and produced fluids are a complex soup of chemicals with individual, cumulative, and synergistic properties that are often difficult to predict and safely dispose of.**
- **Many health outcomes are not specific to chemicals associated with the shale gas and tight oil development process** (e.g., headaches can be caused by a number of factors), complicating the ability for researchers to link exposures to health outcomes.

Temporal Considerations and Causal Inference

Shale gas and tight oil development is a relatively recent development and **the most rigorous epidemiologic study designs can take several years to complete**.

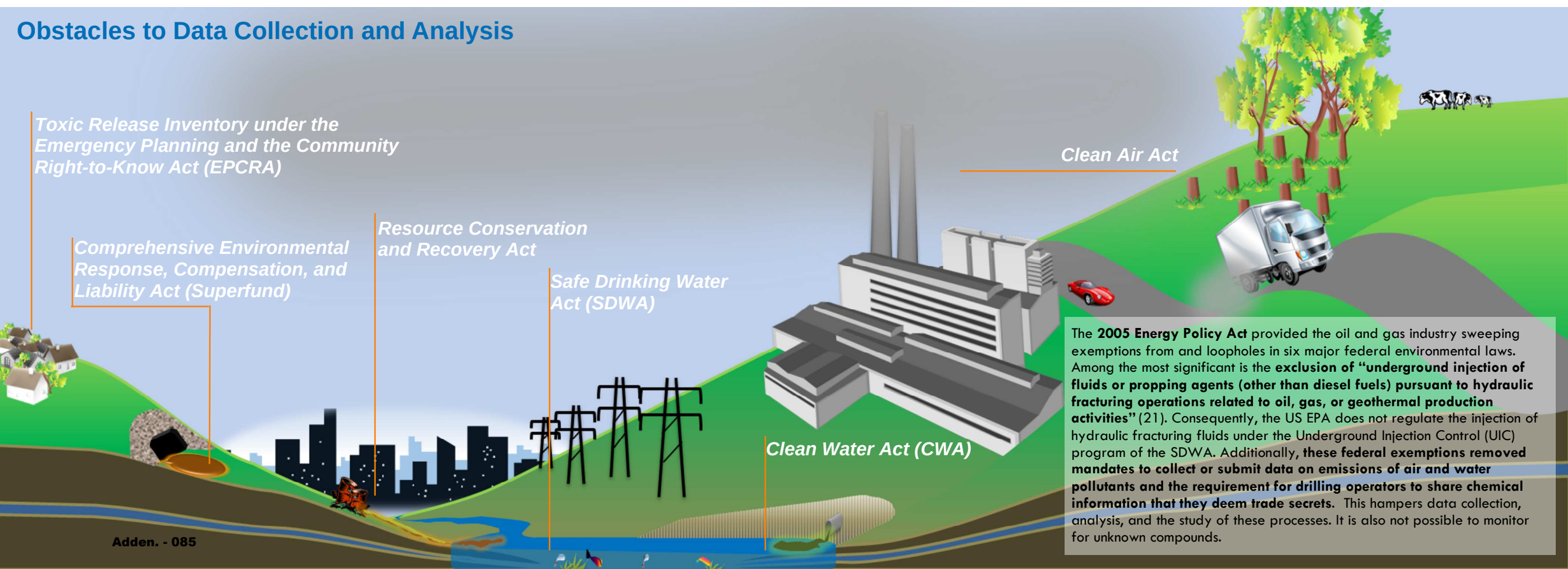
- For instance, prospective cohort studies, that follow groups to measure their exposures and their health outcomes, can take 15-20 years to generate quality data.
- Other studies that focus on diseases, such as cancers and cardiovascular illnesses, associated with long latency periods and chronic low-level exposures to environmental pollutants may not produce results for many years.

Non-Disclosure Agreements

Anecdotally, the **acquisition of environmental and health data is made difficult due to obscured data sources and hidden evidence of health outcomes and damages due to non-disclosure agreements** signed by impacted landowners in exchange for payments aimed to recoup economic losses associated with water contamination, soil degradation, illness, and/or death of livestock.

Several states have legislated **"physician gag orders"**, e.g., § 3222.1 (b)(10) of Act 13 in Pennsylvania (20). Under these policies, health professionals are required to sign confidentiality agreements in exchange for information on chemicals a patient may have been exposed to but are deemed proprietary by a drilling operator. These non-disclosure laws interfere with data sharing among health professionals, public health researchers, public health departments, and communities at large. They also hinder the abilities of researchers to conduct studies.

Obstacles to Data Collection and Analysis



The **2005 Energy Policy Act** provided the oil and gas industry sweeping exemptions from and loopholes in six major federal environmental laws. Among the most significant is the **exclusion of "underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities"** (21). Consequently, the US EPA does not regulate the injection of hydraulic fracturing fluids under the Underground Injection Control (UIC) program of the SDWA. Additionally, **these federal exemptions removed mandates to collect or submit data on emissions of air and water pollutants and the requirement for drilling operators to share chemical information that they deem trade secrets.** This hampers data collection, analysis, and the study of these processes. It is also not possible to monitor for unknown compounds.

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Lifelong Gag Order Imposed on Two Kids in Fracking Case

AUGUST 1, 2013 | 12:16 PM

BY SUSAN PHILLIPS

MARK SCHMERLING / COURTESY OF PROTECTING OUR WATERS

Stephanie Hallowich with her two children. A court order forbids the children from speaking about fracking or Marcellus Shale for the rest of their lives.

Two young children are forbidden from speaking about Marcellus Shale or fracking for the rest of their lives. The court action stems from a settlement in a high-profile Marcellus Shale lawsuit in western Pennsylvania.

The two children were 7 and 10 years old at the time the Hallowich family settled a nuisance case against driller **Range Resources** in August 2011. The parents, Chris and Stephanie, had been outspoken critics of fracking, saying the family became sick from the gas drilling activity surrounding their **Washington County** home.

According to court testimony released Wednesday, the parents were desperate to move and reluctantly agreed to a gag order that not only prevents them from speaking of Marcellus Shale and fracking, but also extends to their children.

Stephanie Hallowich told Washington County Common Pleas Court Judge Paul Pozonsky that she agreed to the gag order in order to get enough funds to move out of the house. But she said she didn't fully understand the lifelong gag order on her children.

"We know we're signing for silence forever, but how is this taking away our children's rights being minors?" she asked the judge. "I mean, my daughter is turning 7 today, my son is 10."

Judge Polonsky didn't have an answer for her. And the family's attorney, Peter Villari, questioned whether the order would be enforceable.

"I, frankly, your Honor, as an attorney, to be honest with you, I don't know if that's possible that you can give up the First Amendment rights of a child."

Villari told StateImpact that it's the first time he's seen this in his 35 years of practicing law.

"That someone would insist on confidentiality of a minor child," he said, "or that it would be discussed within the context of a proposed settlement was unusual. I have not encountered it before and I have yet to encounter it again."

Villari says his own research has turned up no case law related to gag orders placed on children.

At the hearing, Villari questioned his own clients vigorously in order to establish they understood the bizarre nature of the confidentiality agreement.

Range Resources attorney James Swetz told the judge that when it came to the settlement agreement, the family was defined as the “whole family,” referring to the questions by the parents, the judge, and the parents’ lawyer as “ancillary.”

“That’s what we’ve agreed to,” Swetz told the court. “Putting aside all these other issues and sort of ancillary topics, that’s what the settlement says, and that’s what we’ve agreed to at this point.”

Range Resources seems to now be distancing itself from its lawyer’s remarks, insisting the gag order applies only to the parents.

“Those comments are not accurate from our former outside counsel and are not reflective of our interpretation of the settlement,” wrote spokesman Matt Pittzarella in an email to StateImpact. The seven and ten year olds are free to discuss whatever they wish now and when they are of age.”

The Hallowich case against Range Resources, MarkWest Energy and Williams Gas settled for $750,000. The Hallowichs have since moved. Their attorney says their health has improved significantly.

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Fracking
Gas Drilling's Environmental Threat

EPA's Abandoned Wyoming Fracking Study One Retreat of Many

by Abrahm Lustgarten
ProPublica, July 3, 2013, 10:58 a.m.

In this photo taken Nov. 8, 2007, John Fenton and others examine neighbor Louis Meeks' water in Pavillion, Wyo. (AP Photo/Casper Star-Tribune, Dustin Bleizeffer)

When the Environmental Protection Agency abruptly retreated on its multimillion-dollar investigation into water contamination in a central Wyoming natural gas field last month, it shocked environmentalists and energy industry supporters alike.

In 2011, the agency had issued a blockbuster draft report saying that the controversial practice of fracking was to blame for the pollution of an aquifer deep below the town of Pavillion, Wy. – the first time such a claim had been based on a scientific analysis.

The study drew heated criticism over its methodology and awaited a peer review that promised to settle the dispute. Now the EPA will instead hand the study over to the state of Wyoming, whose research will be funded by EnCana, the very drilling company whose wells may have caused the contamination.

Industry advocates say the EPA's turnabout reflects an overdue recognition that it had over-reached on fracking and that its science was critically flawed.

But environmentalists see an agency that is systematically disengaging from any research that could be perceived as questioning the safety of fracking or oil drilling, even as President Obama lays out a plan to combat climate change that rests heavily on the use of natural gas.

Over the past 15 months, they point out, the EPA has:

Closed an investigation into groundwater pollution in Dimock, Pa., saying the level of contamination was below federal safety triggers.
Abandoned its claim that a driller in Parker County, Texas, was responsible for methane gas bubbling up in residents' faucets, even though a geologist hired by the agency confirmed this finding.
Sharply revised downward a 2010 estimate showing that leaking gas from wells and pipelines was contributing to climate change, crediting better pollution controls by the drilling industry even as other reports indicate the leaks may be larger than previously thought.
Failed to enforce a statutory ban on using diesel fuel in fracking.

"We're seeing a pattern that is of great concern," said Amy Mall, a senior policy analyst for the Natural Resources Defense Council in Washington. "They need to make sure that scientific investigations are thorough enough to ensure that the public is getting a full scientific explanation."

The EPA says that the string of decisions is not related, and the Pavillion matter will be resolved more quickly by state officials. The agency has maintained publicly that it remains committed to an ongoing national study of hydraulic fracturing, which it says will draw the definitive line on fracking's risks to water.

In private conversations, however, high-ranking agency officials acknowledge that fierce pressure from the drilling industry and its powerful allies on Capitol Hill – as well as financial constraints and a delicate policy balance sought by the White House -- is squelching their ability to scrutinize not only the effects of oil and gas drilling, but other environmental protections as well.

Last year, the agency's budget was sliced 17 percent, to below 1998 levels. Sequestration forced further cuts, making research initiatives like the one in Pavillion harder to fund.

One reflection of the intense political spotlight on the agency: In May, Senate Republicans boycotted a vote on President Obama's nominee to head the EPA, Gina McCarthy, after asking her to answer more than 1,000 questions on regulatory and policy concerns, including energy.

The Pavillion study touched a particular nerve for Sen. James Inhofe, R-Okla., the former ranking member of the Senate Environment and Public Works committee.

According to correspondence obtained under the Freedom of Information Act, Inhofe demanded repeated briefings from EPA officials on fracking initiatives and barraged the agency with questions on its expenditures in Pavillion, down to how many dollars it paid a lab to check water samples for a particular contaminant.

He also wrote a letter to the EPA's top administrator calling a draft report that concluded fracking likely helped pollute Pavillion's drinking water "unsubstantiated" and pillorying it as part of an "Administration-wide effort to hinder and unnecessarily regulate hydraulic fracturing on the federal level." He called for the EPA's inspector general to open an investigation into the agency's actions related to fracking.

When the EPA announced it would end its research in Pavillion, Inhofe – whose office did not respond to questions from ProPublica -- was quick to applaud.

"EPA thought it had a rock solid case linking groundwater contamination to hydraulic fracturing in Pavillion, WY, but we knew all along that the science was not there," Inhofe said in a press release issued the day of the announcement.

Others, however, wonder whether a gun-shy EPA is capable of answering the pressing question of whether the nation's natural gas boom will also bring a wave of environmental harm.

"The EPA has just put a 'kick me' sign on it," John Hanger, a Democratic candidate for governor in Pennsylvania and the former secretary of the state's Department of Environmental Protection, wrote on his blog in response to the EPA news about Pavillion. "Its critics from all quarters will now oblige."

**

Before fracking became the subject of a high-stakes national debate, federal agencies appeared to be moving aggressively to study whether the drilling technique was connected to mounting complaints of water pollution and health problems near well sites nationwide.

As some states began to strengthen regulations for fracking, the federal government prepared to issue rules for how wells would be fracked on lands it directly controlled.

The EPA also launched prominent scientific studies in Texas, Wyoming and Pennsylvania, stepping into each case after residents voiced concerns that state environmental agencies had not properly examined problems.

The EPA probe in Pavillion began in 2008 with the aim of determining whether the town's water was safe to drink. The area was first drilled in 1960 and had been the site of extensive natural gas developmentsince the 1990's. Starting at about the same time, residents had complained of physical ailments and said their drinking water was black and tasted of chemicals.

The EPA conducted four rounds of sampling, first testing the water from more than 40 homes and later drilling two deep wells to test water from layers of earth that chemicals from farming and old oil and gas waste pits were unlikely to reach.

The sampling revealed oil, methane, arsenic, and metals including copper and vanadium – as well as other compounds --in shallow water wells. It also detected a trace of an obscure compound linked to materials used in fracking, called 2-butoxyethanol phosphate (2-BEp).

The deep-well tests showed benzene, at 50 times the level that is considered safe for people, as well as phenols -- another dangerous human carcinogen -- acetone, toluene, naphthalene and traces of diesel fuel, which seemed to show that man-made pollutants had found their way deep into the cracks of the earth. In all, EPA detected 13 different compounds in the deep aquifer that it said were often used with hydraulic fracturing processes, including 2-Butoxyethanol, a close relation to the 2-BEp found near the surface.[1]

The agency issued a draft report in 2011 stating that while some of the pollution in the shallow water wells was likely the result of seepage from old waste pits nearby, the array of chemicals found in the deep test wells was "the result of direct mixing of hydraulic fracturing fluids with ground water in the Pavillion gas field."

The report triggered a hailstorm of criticism not only from the drilling industry, but from state oil and gas regulators, who disagreed with the EPA's interpretation of its data. They raised serious questions about the EPA's methodology and the materials they used, postulating that contaminants found in deep-well samples could have been put there by the agency itself in the testing process.

In response, the EPA agreed to more testing and repeatedly extended the comment period on its study, delaying the peer review process.

Agency officials insist their data was correct, but the EPA's decision to withdraw from Pavillion means the peer-review process won't go forward and the findings in the draft report will never become final.

"We stand by what our data said," an EPA spokesperson told ProPublica after the June 20 announcement, "but I do think there is a difference between data and conclusions."

Wyoming officials say they will launch another year-long investigation to reach their own conclusions about Pavillion's water.

Meanwhile, local residents remain suspended in a strange limbo.

While controversy has swirled around the deep well test results -- and critics have hailed the agency's retreat as an admission that it could not defend its science -- the shallow well contamination and waste pits have been all but forgotten.

The Agency for Toxic Substances and Disease Registry, the federal government's main agency for evaluating health risk from pollution, has advised Pavillion residents not to bathe, cook with, or drink the water flowing from their taps. Some have reported worsening health conditions they suspect are related to the pollution. They are being provided temporary drinking water from the state in large cisterns.

**

The EPA opened its inquiry in Dimock, Pa., after residents provided it with private water tests detecting contaminants and complained that state regulators weren't doing enough to investigate the cause.

When an elderly woman's water well exploded on New Year's morning in 2009, Pennsylvania officials discovered pervasive methane contamination in the well water of 18 homes and linked it to bad casing and cementing in gas company wells. In 2010, they took a series of steps against the drilling company involved, citing it for regulatory violations, barring it from new drilling until it proved its wells would not leak and requiring it to temporarily supply water to affected homes.

But residents said state officials hadn't investigated whether the drilling was responsible for the chemicals in their water. The EPA stepped in to find out if residents could trust the water to be safe after the drilling company stopped bringing replacement supplies.

Starting in early 2012, federal officials tested water in more than five dozen homes for pollutants, finding hazardous levels of barium, arsenic and magnesium, all compounds that can occur naturally, and minute amounts of other contaminants, including several known to cause cancer.

Still, the concentration of pollutants was not high enough to exceed safe drinking water standards in most of the homes, the EPA found (in five homes, filtering systems were installed to address concerns). Moreover, none of the contaminants – except methane -- pointed clearly to drilling. The EPA ended its investigation that July.

Critics pointed to the Dimock investigation as a classic example of the EPA being overly aggressive on fracking and then being proven wrong.

Yet, as in Pavillion, the agency concluded its inquiry without following through on the essential question of whether Dimock residents face an ongoing risk from too much methane, which is not considered unsafe to drink, but can produce fumes that lead to explosions.

The EPA also never addressed whether drilling – and perhaps the pressure of fracking – had contributed to moving methane up through cracks in the earth into their water wells.

As drilling has resumed in Dimock, so have reports of ongoing methane leaks. On June 24, the National Academy of Sciences published a report by Duke University researchers that underscored a link between the methane contamination in water in Dimock and across the Marcellus shale, and the gas wells being drilled deep below.

The gas industry maintains that methane is naturally occurring and, according to a response issued by the industry group Energy In Depth after the release of the Duke research, "there's still no evidence of hydraulic fracturing fluids migrating from depth to contaminate aquifers."

**

In opening an inquiry in Parker County, Texas, in late 2010, the EPA examined a question similar to the one it faced in Dimock: Was a driller responsible for methane gas bubbling up in residents' water wells?

This time, though, tests conducted by a geologist hired by the agency appeared to confirm that the methane in the wells had resulted from drilling, rather than occurring naturally.

"The methane that was coming out of that well ... was about as close a match as you are going to find," said the consultant, Geoffrey Thyne, a geochemist and expert in unconventional oil and gas who has been a member of both the EPA's Science Advisory Board for hydraulic fracturing, and a National Research Council committee to examine coalbed methane development.

The EPA issued an "imminent and substantial endangerment order" forcing Range Resources, the company it suspected of being responsible, to take immediate action to address the contamination.

But once again, the EPA's actions ignited an explosive response from the oil and gas industry, and a sharp rebuke from Texas state officials, who insisted that their own data and analysis proved Range had done no harm.

According to the environmental news site Energy Wire, Ed Rendell, the former Governor of Pennsylvania, whose law firm lobbies on behalf of energy companies, also took up Range's case with then-EPA Administrator Lisa Jackson.

Internal EPA emails used in the EnergyWire report and also obtained by ProPublica discuss Rendell's meeting with then-EPA Administrator Lisa Jackson, though Range has denied it employed Rendell to argue on its behalf. Neither the EPA nor Rendell responded to a request for comment on the Parker County case.

In March 2012, the EPA dropped its case against Range without explanation. Its administrator in Texas at the time had been assailed for making comments that seemed to show an anti-industry bias. He subsequently lost his job. An Associated Press investigation found that the EPA abandoned its inquiry after Range threatened not to cooperate with the EPA on its other drilling-related research.

Agency critics see a lack of will, rather than a lack of evidence, in the EPA's approach in Parker County and elsewhere.

"It would be one thing if these were isolated incidents," said Alan Septoff, communications director for Earthworks, an environmental group opposed to fracking. "But every time the EPA has come up with something damning, somehow, something magically has occurred to have them walk it back."

**

So where does this leave the EPA's remaining research into the effects of fracking?

The agency has joined with the Department of Energy, U.S. Geological Survey and the Department of Interior to study the environmental risks of developing unconventional fuels such as shale gas, but those involved in the collaboration say that little has happened.

That leaves the EPA's highly anticipated national study on hydraulic fracturing.

When the EPA announced it was ending its research in Pavillion, it pointed to this study as a "major research program."

"The agency will look to the results of this program as the basis for its scientific conclusions and recommendations on hydraulic fracturing," it said in a statement issued in partnership with Wyoming Gov. Matt Mead.

That national study will concentrate on five case studies in Pennsylvania, Texas, North Dakota and Colorado.

It will not, however, focus on Pavillion or Parker County or Dimock.

Nor will it devote much attention to places like Sublette County, Wy., where state and federal agencies have found both aquifer contamination and that drilling has caused dangerous levels of emissions and ozone pollution.

It will be a long time before the EPA's national study can inform the debate over fracking. While the agency has promised a draft by late 2014, it warned last month that no one should expect to read the final version before sometime in 2016, the last full year of President Obama's term.

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Most oil, gas measures die during Colorado Legislature's 2013 session

By John Fryar Longmont Times-Call
Updated: 05/08/2013 08:02:49 PM MDT

TimesCall.com

House Majority Leader Rep. Dickey Lee Hullinghorst, right, D-Gunbarrel, talks with House Speaker Mark Ferrandino, D-Denver, in the House chambers on

- Fracking
- Aug 27:
- COGA 'disappointed' with Longmont council's move
- Aug 26:
- Longmont City Council votes unanimously to appeal judge's decision on fracking ban
- Jul 24:
- Boulder County judge strikes down Longmont fracking ban

State Rep. Mike Foote charged Wednesday that the "very powerful oil and gas industry" and its lobbyists, along with Gov. John Hickenlooper and his staff, combined to defeat many of the 2013 legislative session's proposals for stricter oversight of the industry.

"It's tough to fight with two hands tied behind your back," said Foote, a Lafayette Democrat who saw one of his own House-approved oil and gas bills die in a Senate floor vote and who refused to accept the Senate's amendments to the second.

At least nine oil and gas-related bills were introduced during the four-month-long session. Only two gained approval from the full Legislature.

The Legislature approved two bills proposing laws tightening state oversight over oil and gas development during the 2013 legislative session that ended Wednesday. Those measures now await Gov. John Hickenlooper's decisions whether to sign them, veto them or allow them to become law without his signature:

Senate Bill 202, sponsored by Sen. Matt Jones, D-Louisville, and Rep. Jonathan Singer, D-Longmont, would require the Colorado Oil and Gas Conservation Commission to use a risk-based strategy for inspecting wells, targeting phases of well operations most likely to experience spills, excess emissions and other types of violations of state regulations. As originally introduced, the bill would have required the COGCC to staff up to the point that it could inspect each of the more than 50,000 active wells in the state annually, but the sponsors dropped that requirement after the Legislature included several additional inspectors' positions in the state's 2013-2014 budget.

House Bill 1278 would require an oil and gas well operator to report, within 24 hours, any incident when one or more barrels of oil -- or exploration and production wastes -- have spilled outside of berms or secondary containment areas.

Seven bills dealing with state oversight of oil and gas development died during the legislative session:

House Bill 1267, sponsored by Rep. Mike Foote, D-Lafayette, and Sen. Jones, would have increased daily fines for violations of state oil and gas regulations from $1,000 to $15,000 for each violation and would have removed a $10,000 maximum cap on violations that don't result in a significant adverse impact.

Foote and Jones also wanted to set a minimum penalty for violations resulting in a significant adverse impact on public health, safety or welfare, including the environment and wildlife resources.

House Bill 1268 would have required the sellers of real estate to disclose when the underlying mineral rights, such as rights to any oil and gas under the surface property, are owned or have already been leased to entities other than the owner of the surface rights, and that oil and gas activity may occur on or near the property up for sale.

House Bill 1269, sponsored by Foote and Jones, would have targeted potential conflicts of interests of Colorado Oil and Gas Conservation Commissioner members employed by the oil and gas industry and would have mandated that the state ensure that oil and gas development protects the public's health, safety and welfare, and the protection of the environment and wildlife resources.

House Bill 1273 would have required oil and gas operators to pay a state fee to offset local governments' costs of having a designated person work with the Colorado Oil and Gas Conservation Commission on reviewing applications for drilling and operating permits within those governments' jurisdiction. One version of the measure would also have allowed municipalities and counties to collect impact fees to offset their costs for locally inspecting and monitoring oil and gas operations.

House Bill 1275 would have required the State Board of Health to review existing data to determine whether oil and gas operations can have an adverse effect on human health, based on studies previously conducted in or near Larimer, Weld, Boulder and Arapahoe counties.

House Bill 1316, sponsored by House Majority Leader Dickey Lee Hullinghorst, D-Gunbarrel, and Jones, would have required the Colorado Oil and Gas Conservation Commission to apply the same groundwater quality sampling rules for oil and gas development in the Greater Wattenberg Area -- a region that includes parts of Weld, Boulder, Larimer, Broomfield, Adams, Jefferson and Denver counties -- that the COGCC now requires for new wells elsewhere in the state.

Senate Bill 284, carried in the House by Hullinghorst, would have expedited the Colorado Department of Public Health and Environment's permit review process for oil and gas operators willing to observe enhanced air and water pollution-control standards.

Foote said in an interview that proponents of new oil-and-gas laws found themselves up against "a very well-organized, very well-funded oil and gas lobby" as well as a Hickenlooper administration that Foote contended was "opposing virtually everything" those lawmakers were proposing.

"I've got to say I'm disappointed," said Sen. Matt Jones, the Louisville Democrat who carried Foote's two now-dead bills in the Senate.

Jones said he'd hoped to get a more balanced membership on the Colorado Oil and Gas Conservation Commission, the state agency that regulates the industry and enforces those regulations.

Colorado Petroleum Association president Stan Dempsey, however, said "some of the issues need to be better defined."

Dempsey said, "I don't think there was agreement on what the problem was" that led to the introductions of some of those bills.

Doug Flanders, the Colorado Oil and Gas Association's director of policy and external affairs, said Wednesday afternoon that "the lack of communication between some legislators and industry has been the

most disappointing aspect of this legislative session."

Added Flanders: "Confrontation is easy. However, successful collaboration takes effort and diligence. Whether we are discussing energy development in Boulder County, which has seen three new-well starts in the last five years, or Weld County, with over 6,000 new starts, these early and often discussions are critical since oil and gas development occurs all across Colorado."

The final oil and gas bill to die during the session was a Foote-Jones measure that would have increased potential maximum fines for most violations of state regulations, taking them from $1,000 a day -- a level they've been at since the mid-1950s -- to $15,000 a day.

Foote and Jones had wanted the proposed law to set a minimum daily fine for the most serious kinds of violations -- those that would have a significant impact on the public's health, safety or welfare, including the environment and wildlife resources.

Jones was unable, though, to get a Senate majority to go along with a minimum $2,500 daily fine for serious violations. And Foote refused on Wednesday afternoon to have the House consider the Senate majority's preferred version of the bill -- a version without minimum fines that Foote and Jones contended would allow the state agency to decide against imposing any fines at all in such serious situations.

After the Foote-Jones fines bill died as the session concluded on Wednesday afternoon, Hickenlooper issued an executive order directing the Oil and Gas Conservation Commission to review its enforcement program, its penalty structure and its imposition of fines.

"Penalties are designed to discourage violations and encourage prompt response in environmental or public health and safety concerns in the event that violations occur," Hickenlooper wrote in that order. "For these reasons, Colorado requires strong and clear enforcement of the rules and assessment of fines and penalties accordingly."

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< 'Close Encounters' With Gas Well Pollution

MAY 15, 2012 3:31 PM ET

MELISSA BLOCK, HOST:

This is ALL THINGS CONSIDERED from NPR News. I'm Melissa Block.

ROBERT SIEGEL, HOST:

And I'm Robert Siegel.

America's natural gas industry is thriving. And hundreds of thousands of new wells have given a vital boost to the nation's sputtering economy. But today, we ask: At what cost? A debate is raging about whether these wells, in addition to creating jobs, are also creating harmful air pollution.

NPR's Elizabeth Shogren takes us now to Garfield County, Colorado. There, gas wells are being built so close to people's homes that residents are increasingly disturbed by what they call close encounters.

ELIZABETH SHOGREN, BYLINE: Living in the middle of a natural gas boom can be pretty unsettling. Let me tell you about this one neighborhood in Silt.

(SOUNDBITE OF MACHINERY)

SHOGREN: It used to be the kind of sleepy, rural place where the tweet of birds was the most you'd hear. Now you can hardly make out the birds because of the rumbling of drilling rigs.

(SOUNDBITE OF MACHINERY)

SHOGREN: The land here is all steep cliffs and valleys. But bare splotches of earth called a well pad are all over the place.

TIM RAY: Yeah, that's the one I'm worried about 'cause it just went in.

SHOGREN: We're on Tim Ray's front porch just after sunset. You can see the lights of drill rigs all around his small house.

RAY: And there's actually one up here over the hill that they just put in. There's one - three or four of them up there.

SHOGREN: People around here say the air stinks. They complain about itchy eyes, scratchy throats, and getting sick to their stomachs.

RAY: I worry about my health. I worry about my kids' health.

SHOGREN: Companies can drill 20 wells or more from a single site. They come back again and again over the course of years. Each time there's an onslaught of fumes. There are exhausts from drilling machines, vapors from storage tanks, and lots of chemicals in the millions of gallons of water drillers use to get the wells flowing faster.

Tim wonders: What's in those fumes that blow into his yard?

RAY: Nobody has told us anything about the quality of our air, as far as what we're smelling or anything. I would feel better if I knew that the gases weren't bad.

SHOGREN: People are asking these same questions wherever natural gas is being drilled around the United States. Tresi Houpt has been too. for a long time.

TRESI HOUPT: There's a great frustration. I'm hearing the same stories today that I heard nine years ago.

SHOGREN: That was when she left her pretty log home on a ski mountain and went to campaign to be a Garfield County commissioner. Tresi sounds low-key but really she's a fighter. As she went around the county campaigning, she got really charged up because she just couldn't believe what she saw.

HOUPT: In Colorado, you can have a drill rig 150 feet from a home. The original thought was if the rig falls it won't hit the house.

SHOGREN: She didn't want this county, this rural refuge, to be sacrificed, to be developed for energy for the rest of the country. In 2002, she won her election and here's one of the first things she wanted to know: Did scientists have any answers for what was in the air around here? Let me tell you, she was shocked by what she found.

HOUPT: There really were no good studies out there at the time.

SHOGREN: Not local ones, state ones or from the Environmental Protection Agency. Not about this gas field or any others in the United States. So she got busy trying to figure out what was in the air.

But Tresi was only one of three commissioners - those are the people who run the county. She had to get the others on board, as well. The same was true when she was part of a state committee that regulates drilling.

HOUPT: The conversation was always a question of how far we should push the industry. It was a question at the county level. It was a question when I was on the Oil and Gas Commission and we were rewriting the rules.

SHOGREN: The industry was bringing a lot of jobs and a lot of money to Garfield County. Still, the commissioners did agree to start spending some of the county's gas royalties to try to get answers. They hired Jim Rada in 2005 to create an environmental health office.

JIM RADA: So, I'm going to take you guys down to the west.

SHOGREN: He's gives us a ride around the county in his hybrid SUV. He wants to show us the gas industry spreads out all over the place.

RADA: There are pipelines, there are storage yards, compressor stations, gas plants...

SHOGREN: He's spent a good seven years studying the air here. He has monitors on top of a school, a fire station and historic buildings. They tell him the air is pretty good for most people in his county. But what about the people with front-row seats to the drilling?

RADA: How close can people be to these operations, you know?

SHOGREN: So, in 2008, Jim Rada got the chance to examine just how close. He put air sampling canisters around eight wells that were being drilled. For 24 hours they captured chemicals.

Now that seems like an obvious thing to do but it hadn't been done before - not anywhere in the United States.

RADA: We were pretty much breaking new ground, you know, in terms of trying to do the science that needed to be done in order to answer some of these questions.

SHOGREN: Jim found very large amounts of chemicals. Some of them, like benzene, can cause cancer. Others, like xylenes, can irritate eyes and lungs. But no matter what data he came up with everyone said he needed more. Jim realized he needed back up.

RADA: To get to the bottom line and answer that big nagging question of what is this air quality doing to the health of the community, that takes a whole lot more resources than a single county can devote to this.

SHOGREN: OK, so this was 2009. Nearly 3,000 wells had gone in the year before. And the commissioners' next move, who they called, turned out to have some pretty

painful consequences. You see, they moved beyond looking at what was in the air to whether gas industry pollution could make people sick.

They called in the Colorado School of Public Health. They wanted to see if researchers could take Jim's data and predict whether lots of drilling in a neighborhood could hurt people's health.

John Adgate chairs the school and worked on the project.

DR. JOHN ADGATE: We used what little data that Garfield County had collected around the well sites to estimate those effects.

SHOGREN: They predicted small increases in risks of cancer, head aches and lung problems. And when that study went public, all hell broke loose. Everything became too...

UNIDENTIFIED MAN #1: Political.

UNIDENTIFIED MAN #2: Political.

UNIDENTIFIED WOMAN #1: Political.

UNIDENTIFIED WOMAN #2: Political.

UNIDENTIFIED WOMAN #3: Political.

UNIDENTIFIED WOMAN #4: Political.

SHOGREN: Nearly everybody we talked to said that, including John Martin. He's another long-time Garfield county commissioner. John Martin says it became political because people who live near wells used the report to attack the industry in lawsuits. And gas companies didn't like it.

JOHN MARTIN: Both sides were fighting. They wanted to use this document in both arguments that it didn't hurt anything and it killed everyone.

SHOGREN: The companies argued that the researchers were jumping to conclusions. David Ludlam is the executive director of the regional industry trade group.

DAVID LUDLAM: They used what we believe was questionable data, at best. You can't make assumptions about health impacts if you don't have the data to support it.

SHOGREN: Now, the Colorado School of Public Health stands behind its study and so do other academic experts. But the controversy got too hot for the county. This is how John Martin remembers it.

MARTIN: We said this is a football in the arena of global warming and anti-oil and gas, or anti-environment. We said enough is enough, people.

SHOGREN: He says there was only one thing to do. The county commissioners called a meeting.

MARTIN: Gentleman, decision time. All those in favor of the motion to end the contract and to leave as an unfinished document.

UNIDENTIFIED MAN #5: Aye.

UNIDENTIFIED MAN #6: Aye.

UNIDENTIFIED MAN #7: Aye.

MARTIN: Leave it at that point.

SHOGREN: The commission voted to end the project.

And Remember Tresi Houpt, the commissioner who started the big push for answers? Well, she didn't have a vote because she had lost her re-election. So she stood on the sidelines, watching all her years of work unraveling.

HOUPT: I was stunned. I was absolutely stunned.

SHOGREN: All that momentum the county had built up? It came to a screeching halt. They tried a couple more times to study air near wells, but gas industry rep David Ludlam objected.

LUDLAM: I sent an email indicating that our operators and our organization would be uncomfortable moving forward working with this Colorado School of Public Health, because things had become so polarized that we didn't see a pathway forward.

SHOGREN: David Ludlam says there's a new study in the works, with different researchers on the job. Results won't come for at least three years.

So a decade has passed since Garfield County started seeking answers. Back then, the county had 800 wells. Now there are more than 8,000.

As for the people who live near wells - whether they're in Colorado, Texas, Pennsylvania or Utah - they still don't know what they're breathing.

Elizabeth Shogren, NPR News.

Health Impact Assessment for Battlement Mesa, Garfield County Colorado

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Disclaimer

The research team that performed this work has no conflicts of interest to report, financial or otherwise. The statements made in the Health Impact Assessment and Human Health Risk Assessment are the work product of the authors and do not represent the position of any university, private company, government agency, community group or any other organization.

Acknowledgements

The authors of this report would like to thank the following groups and individuals for their helpful support with this Health Impact Assessment: Garfield County Public Health for their previous and continuing work to promote public health in their county, for their assistance in identifying and maintaining contact with stakeholders, for their assistance with the scope of work and for the feedback on the HIA process; Colorado Department of Public Health and Environment for their previous and continuing work in Garfield County and throughout the state of Colorado, for providing the analysis and data for the description of the health baseline of the Battlement Mesa community and for review of the use of this material; The Battlement Mesa Concerned Citizens and the Grand Valley Citizens Alliance for their concerns about public health and their participation in the stakeholder process; Garfield County Board of County Commissioners for their financial support of this HIA; Antero Resources for providing us with details of the natural gas project in Battlement Mesa and for assistance with understanding how natural gas development and production processes occur; Colorado Oil and Gas Conservation Commission for providing the database related to water monitoring, as well as other technical materials; Battlement Mesa Metropolitan District for their assistance in understanding the water sources for the community; Garfield County Oil and Gas Department for their feedback and technical assistance; Habitat Health Impact Consulting for assistance with HIA fundamentals and review of the HIA document; Pew Health Impact Project for funding the HIA consultation with Habitat Health Impact; Teresa Coons for review of the HIA document; Mountains and Plains Education and Research Center for assistance with outreach activities; Courtney Hanlon for providing research assistance for the Economic Assessment; Garfield County Department of Geographic Information System for mapping in Battlement Mesa; Colorado Hospital Association for the hospital discharge data; Battlement Mesa Service Association for their participation in the stakeholder process; and Battlement Mesa Company for their participation in the stakeholder process.

This project is supported by Garfield County and also in part, by the Health Impact Project, a collaboration of the Robert Wood Johnson Foundation and The Pew Charitable Trusts.

Executive Summary

This Health Impact Assessment (HIA) was conducted by members of the faculty and staff of the Department of Environmental and Occupational Health, Colorado School of Public Health (CSPH) at the request of the Garfield County Board of County Commissioners (BOCC), to help address community concerns regarding future land use decisions. The purpose of this HIA is to provide the BOCC with specific health information and recommendations relevant to Antero Resources Corporation (Antero) plans for natural gas development and production in the residential community of the Battlement Mesa Planned Urban Development (PUD), Garfield County, Colorado. To this end, CSPH worked in collaboration with Garfield County Public Health (GCPH) to conduct a qualitative and quantitative analysis of existing environmental, exposure, health, and safety data pertinent to the Battlement Mesa community. CSPH offers the BOCC specific recommendations for its consideration in Antero drilling permit decisions. In addition, the HIA provides baseline information for use in the design of a future prospective exposure and health monitoring project.

ES1 Introduction

Recent domestic energy production has brought industrial processes, and potentially exposures, into close proximity of residential urban, suburban and rural communities across the United States. Garfield County, Colorado is at the epicenter of natural gas development in the Piceance Basin and experienced rapid growth of the industry from 2003 – 2008, and a sudden downturn in 2009. Now, in 2010, permitting for the purpose of development and production is resuming and is expected to continue to increase.

Natural gas development and production is known to produce a variety of physical and chemical hazards that may cause negative health effects. In 2008, CSPH completed a white paper and literature review, outlining potential environmental hazards, vulnerable populations, and possible health outcomes in Garfield County. The 2008 Community Health Risk Analysis of Oil and Gas Industry Impacts in Garfield County, Colorado (referred to as the Saccomanno Study) documented baseline health status and negative health outcome trends potentially linked to natural gas development in Garfield County. Air monitoring in Garfield County has documented levels of some air toxics in ambient air that increase the risk of negative health effects for citizens. Furthermore, recent review of large scale "boom and bust" natural gas development in small and rural communities, such as those found in Garfield County, have the potential to affect community infrastructure. Taken together, this information suggests that natural gas permitting decisions within the residential community of Battlement Mesa has the potential to adversely affect health.

Battlement Mesa is community with a large number of retired citizens as well as young families. According to the 2000 United States Census estimates, the total population of the Battlement

Mesa/Parachute zip code was 5,041; the median age was 37.five years; 26.0 percent of the population were under 18 years of age, 7.2 percent under five years, and 19.8 percent were 65 years and older. In 2000, the County population was 43,791, rising 30% to 56,298 in 2009.

The Antero project is anticipated to include 200 natural gas wells on 9 pads, a centralized water storage facility with a covered/lined waste pit, and 8.4 miles of water and gas pipeline. Preliminary plans indicate that well pads and pipelines will be distributed throughout the PUD, raising the probability that health impacts could affect the entire community.

Community groups, including Battlement Mesa Service Association (BMSA, the homeowners association) and Battlement Mesa Concerned Citizens (BCC) and Grand Valley Citizens Alliance, expressed concerns about the proximity of natural gas development to homes, recreational areas and schools. At stakeholder meetings, citizens have expressed concerns regarding airborne volatile organic compounds (VOCs), diesel and other particulate matter (PM); hydraulic fracturing (also know as fracking) fluid, hydrocarbons, and VOCs in soil and water; increased risk of fires, explosions, and motor vehicle accidents; and changes in community "livability."

In November 2009, Battlement Mesa Concerned Citizens formally requested BOCC and GCPH address health concerns before Antero development activities begin. (Attachment 1) The BOCC expressed a desire for the HIA to be conducted by CSPH expeditiously, so that results could be available prior to permitting decisions. At that time, it was anticipated that Antero would be submitting their Major Land Use Impact Review (also known as MLUIR) and Comprehensive Drilling Plan in late spring 2010 and that these documents would be available as part of the basis for the HIA. At this time, however, Antero had not submitted either document. Therefore, we have used public meeting minutes, slides from power point presentations, the Surface Use Agreement with the surface owners the Battlement Mesa Company (BMC) and other information provided to us by Antero as sources for this report. Should Antero ultimately submit permit proposals that substantially differ from this information, our assessments may not necessarily reflect those differences.

The stakeholders for the Antero drilling plan include the residents and citizen groups of Battlement Mesa and nearby communities, Antero and other operators, GCPH, BOCC, the Battlement Mesa Consolidated Metropolitan District which provides drinking water and waste water services to Battlement Mesa, BMC, the Grand River Hospital District and other medical services providers, Colorado Department of Public Health and Environment (CDPHE), and Colorado Oil and Gas Conservation Commission (COGCC). There has been broad support for the HIA from all stakeholders, reflecting a common search for a means to address the concerns of potentially impacted residents in a systematic and impartial manner.

GCPH has been extremely instrumental in helping CSPH accomplish the HIA, by facilitating meetings with stakeholders and Antero; providing local contacts and context, environmental data, review and input on the scope, and analysis of the HIA; acting as the liaison between the

CSPH and the BOCC; providing web support for HIA related minutes, presentations, and this report; and providing information to local media. In addition, at the CSPH, the Mountain and Plains Educational and Research Center has provided outreach support. The Pew Health Impact Project provided funding for consultation with Habitat Health Impact Consulting, a Canadian firm with expertise in HIAs related to resource extraction.

ES2 The HIA Process

An HIA involves several defined steps: screening, scoping, assessment, recommendations and implementation, reporting and monitoring.

This HIA was screened and scoped using information from the white paper and literature review previously conducted by CSPH, concerns raised by the citizens (Table 3), the 2008 Saccomanno Report, as well as input from the BOCC, GCPH, CDPHE, COGCC and Antero obtained in meetings over the course of the last nine months. As a result, the HIA focuses on eight areas of health concern (stressors) associated with natural gas development and production: air emissions, water and soil contaminants, truck traffic, noise/light/vibration, health infrastructure, accidents and malfunctions, community wellness, and economics/employment.

Assessment of each stressor includes a review of its general impact on physical, mental and/or social health as described in relevant medical and social science literature; a compilation and analysis of existing environmental and health data describing current conditions in Battlement Mesa; the means by which Antero plans for drilling might alter the current conditions, and finally a characterization of the stressor's impact on health. Several physical health outcomes linked to potential exposures are considered, including respiratory, cardiovascular, cancer, psychiatric, and injury/motor vehicle-related impacts on vulnerable and general populations in the community. The Battlement Mesa Baseline Health Profile (Appendix C) provides supporting documentation of baseline physical and social health determinants. In addition, a Human Health Risk Assessment (Appendix D) provides a comprehensive review of available air quality and water contamination data and a systematic assessment of related health risk.

The HIA offers recommendations to the BOCC to help it address mitigate some of impacts of the Antero plan. It is important to recognize that it is not possible to mitigate all impacts. We have provided a relative rank for each stressor, to help emphasize where the most important impacts may occur.

Adoption of any recommendations of the HIA is at the discretion of the BOCC. We will assist in implementation, if requested by the BOCC, by continuing with stakeholder and professional presentations. We will continue to monitor how this HIA is used, in order to measure its value as a public health tool.

ES3 Battlement Mesa Baseline Health Profile

Several measures of health are best determined by using zip code to define a community. We use the zip codes 81635 and 81636, which are used by the residents of Battlement Mesa, Parachute and surrounding areas. Because these zip codes are shared, Parachute is included along with Battlement Mesa in the descriptions of physical health determinants and some social health determinants. Some of the social health determinant measurements were not available at a zip code level and so we provide descriptions of these at a county level. While the assessments of stressors focus on the impacts to those living within the Battlement Mesa PUD, others living nearby may experience some effects as well. The Battlement Mesa Baseline Health Profile is available in Appendix C.

ES3.1 Vulnerable Populations

Greater than 45% of the population may be considered to be more vulnerable to certain exposures, based on age. Additional factors, such as pre-existing disease, pregnancy and behaviors such as smoking history, alcohol use, nutrition, and genetic factors can also influence vulnerability to disease. Furthermore, occupational and residential exposures may also contribute to risk of disease. Although these factors can contribute considerably to vulnerability to disease, such information was not available to the HIA team and represents an important information gap that will need to be addressed in the future.

ES3.2 Physical Determinants of Health

To assess the baseline physical health of the Battlement Mesa/Parachute area, the CSPH team obtained and analyzed inpatient hospital diagnoses, cancer, birth, and death information from the CDPHE for the years 1998-2008. The analysis included health diagnoses, birth outcomes, and causes of death with a known association between disease and the exposures of concern, as well as those for which community members voiced concerns of elevated occurrence of disease. Major categories of disease and death included depression and those involving the nervous system, ear/nose/throat, vascular system and pulmonary system. Major categories of cancer included: Hodgkin lymphoma and non-Hodgkin lymphoma, multiple myeloma, leukemia, melanoma, breast cancer, prostate cancer, bladder cancer, colorectal cancer, and cancer of the adrenal gland. Birth outcomes included low birth weight and preterm delivery. Health for Battlement Mesa/Parachute residents was compared to the health of Colorado residents.

Overall, the citizens of Battlement Mesa appear to be generally healthier than other citizens of Colorado. They experienced fewer hospitalizations and fewer deaths. Battlement Mesa women experienced the same rates of cancer and of negative birth outcomes as other women in Colorado. In Battlement Mesa men, we observed a slightly higher than expected rate of prostate cancer, which we felt is an observation likely due to variability of small numbers or statistical chance (when multiple independent tests are compared, there is a statistical probability that 5 % of the tests will be abnormal by chance alone). No other differences were noted between men in Battlement Mesa when compared with other Colorado men.

ES3.3 Social Determinants of Health

To evaluate the baseline community health in Battlement Mesa/Parachute, the CSPH team obtained available information regarding sexually transmitted infections, crime, substance abuse, and education. Where information concerning Battlement Mesa was not available, we looked at Garfield County data.

Overall, the incidence of sexually transmitted infections in Garfield County rose during the years 2005- 2008, peaking between 2007 and 2008. Between the years 1992-2005, for adults, violent crime arrests doubled; property arrests fluctuated throughout the period, and increased slightly; and drug violations increased almost ten-fold. In the same time period, for juveniles, violent crime arrests increased; property arrests fluctuated but did not change significantly; and drug violations increased almost ten-fold. Substance abuse information extracted from the GCPH's 2006 assessment on community needs indicates depression, anxiety and stress along with tobacco smoking and alcohol abuse appear to be the top indicators of the burden of mental health and substance abuse, respectively, in Garfield County.

ES4 Assessment of Health Impacts

The HIA team developed a method for assessing and comparing potential health impacts for several areas of concern (stressors) by identifying and defining seven attributes relevant to the importance of potential health effects: direction of potential health effects (i.e., a positive or negative impact on health); the relationship of geography to health effects (i.e. proximity to natural gas development and production activities); the likelihood of health effects occurring as a result of Antero development plans; the presence of people considered especially vulnerable to the effects of the stressor; the estimated duration of exposure; the frequency of exposure when it does occur; and severity of the potential health effect.

To assist in characterizing the relative importance of health effects within this HIA, we assigned a numerical rank to each stressor. The lowest possible rank is 6 and the highest possible rank is 15 (six stressors are assigned values of 1 to 2 or 1 to 3). A negative (-) number indicates that the stressor is likely to produce negative health effects, a positive (+) number indicates that the stressor is likely to produce positive health effects. Some stressors may produce both negative and positive health effects and are therefore given a mixed (+/-) numerical rank. These rankings may be used to help describe the relative importance of each potential health effect within the context of this HIA only. It is important to note that these ranks do not represent a quantitative estimate of risk and have no relevance outside the context of this HIA.

These assessments take into account Antero's proposed control plans and mitigation strategies, to the extent that they are known (from public presentations, Surface Use Agreement, and other

information provided by Antero). Any significant deviation from the available information will not necessarily be reflected in this HIA.

ES4.1 Summary of Air Quality Assessment

The Air Quality Assessment relies upon the Human Health Risk Assessment (Appendix D) to determine the potential for air quality compromise. Plans for drilling throughout the community suggest that all areas within the PUD have the potential to be impacted by local emissions.

The Antero natural gas development plan is likely to change air quality and produce undesirable health impacts in residents living in close proximity throughout the community. Air quality is most likely to be acutely impacted during well pad construction and well completion stages and by truck traffic. Long term compromise of air quality is possible if fugitive emissions from production equipment are not controlled and the impacts to air quality are expected to occur constantly and/or reoccur. Children, older adults, and individuals with respiratory diseases may be more vulnerable to the air contaminants and could experience short-term and/or long-term disease. Health impacts may include respiratory disease, neurological problems, and there may be an increased risk of cancer. Medical attention would be necessary for some of these conditions. Some of these health consequences would not be reversible, and therefore should be considered moderate to high magnitude impacts. Using the numerical ranking scheme, air quality impacts on health are expected to produce a negative rank of -14.5 on a scale of ±6-15.

ES4.2 Summary of Water and Soil Quality Assessment

The primary drinking water source for Battlement Mesa is the Colorado River and the intake is upstream of areas potentially impacted by the Antero drilling plan. The primary drinking water source is therefore not likely to be impacted by Antero's Battlement Mesa natural gas development and production plans. The secondary water source is a series of ground water wells located "downhill" from some of the planned well sites. Since the hydrology of the area is not well understood, the likelihood that these wells could be compromised by drilling in the PUD is unclear, but their location suggests that they could be compromised by natural gas development and production activities.(See Appendix D for supporting documentation).

Impact on water quality in Battlement Mesa is not expected to occur frequently and it is unlikely that contamination of drinking water will occur as a result of Antero development plans. However, should water and soil contaminant exposures occur, these changes would produce undesirable health impacts. Areas in close proximity to the development areas would be most likely to show contamination of soil and shallow water. Impacts could be community-wide, should the need for compromised secondary water wells arise. Localized effects of wind erosion and surface run-off may impact children more than adults. Children, older adults, and individuals with pre-existing illnesses may be more vulnerable to water and soil contaminants. Reversal of water quality degradation could take years, and thus any impacts could be enduring. Should exposure occur, health impacts may include cancer, skin and eye irritation, neurological

problems. It is likely that medical attention would be needed for some of these resulting conditions and that some of these health consequences would not be reversible; therefore an impact would be considered moderate to high in magnitude. Using the numerical ranking scheme, compromise to water and soil quality would produce a negative rank of -11.5 on a scale of ±6-15.

ES4.3 Summary of Traffic Assessment

The traffic assessment relies on estimated average traffic counts provided to us by Antero. While such numbers are somewhat useful for the purpose of this HIA, the estimates may not reflect true numbers of vehicles on any given day. The Garfield County Geographic Information Systems Services is working on a map with the traffic routes Antero anticipates using for their natural gas development and production. This map also will contain information concerning school bus stops in Battlement Mesa, provided to the CSPH team by the Garfield County District 16 transportation office.

When considering safety risks to residents of Battlement Mesa, increased traffic is likely to create negative health impacts. Because the haul routes include the entire circle of the Battlement Mesa Parkway as well as other roads within and on the perimeter of the PUD, the impact of the traffic is likely to be community wide. Certain parts of the community will experience a greater impact for the entire duration of the Antero project (i.e., those homes next to CR300/Stone Quarry Road) while others will be impacted by very high volume traffic during the construction of some of the pads (i.e., along River Bluff Road). Because children often walk and ride bicycles and are not as safety conscious, children are considered more vulnerable than most adults to the impacts of traffic. The duration of exposure to increased traffic will likely be long, spanning the entire duration of the development the gas wells, at this time expected to be at least five years. The traffic will be frequent in some cases (River Bluff Road) where it is estimated that several hundred trucks passing a day for several months. Increased traffic is associated with increased risk of traffic accidents. Traffic accidents can cause minor to severe/fatal injuries and as such, there is wide range of potential health impacts. Using the numerical ranking scheme, impact due to traffic produces a negative rank of -13 on a scale of ±6-15.

ES4.4 Summary of Noise, Vibration, and Light Assessment

Anticipated noise, vibration and light exposures associated with the Antero development within the PUD may produce negative health effects. Of the three, noise is likely to have the most important impact on health. Increased noise is expected to be associated with construction and development phases and with truck traffic on haul routes. While all or most parts of the community may be near noise sources at different times, it is not likely that the entire community will be affected by noise during the development of an individual pad or by truck traffic. There are some residences that are close to haul routes and may experience elevated noise due to truck traffic for the entire development period (five years). Children may be more vulnerable to noise disturbance associated with truck traffic passing by the St. John Elementary School and the

Grand Valley Middle School during school hours. In addition, persons working at home may also be more vulnerable to noise disturbance. The elderly, particularly those with impaired hearing, may also be more vulnerable to noise pollution. Pad development will last several months, while nearby truck traffic may last several years for some residents, and thus, duration of exposure is expected to be medium to long, depending on location. On the other hand, major elevations in noise levels are not expected to occur during normal production phases in the 20 years subsequent to well development. Should well maintenance (workover) be conducted, noise levels are expected to increase during the reworking phase, which can last several days per well. When noise occurs, it is expected to be constant (e.g. diesel generators) and/or frequently reoccurring (e.g. truck traffic), depending upon the source. It is unlikely that noise exposure will cause noise-induced hearing loss or other noise-related health effects. In general, health impacts are likely to result from annoyance due to noise above background and may cause sleep disturbance, displeasure, fatigue, etc. It is not likely that medical attention will be necessary for most people, although some may seek medical assistance. Therefore the impacts are rated as low- medium magnitude. It is possible that in some individuals, noise levels will produce significant annoyance and may produce larger health effects. Using the numerical ranking scheme, impacts to safety due to noise, vibration, and light increases produces a negative rank of -10.5 on a scale of +/-6-15.

ES4.5 Summary of Community Wellness Assessment

Community wellness is difficult to define and more difficult to measure. We describe crime rates, mental health, substance abuse and suicide, occurrence of sexually transmitted infection and enrollment in K-12 education as measures of community wellness. Other factors, such as recreational opportunities and social cohesion do not lend themselves to measurement, but were considered in the assessment. Antero estimates an average of 120-150 persons to be working in Battlement Mesa. This estimate was used to evaluate the impacts on these aspects of community wellness.

Effects on community wellness are expected to be mixed. Positive effects might include less stress over finances, if increased demand for local business benefits the local economy, and increased access to social resources, services and infrastructure that expand to support a growing and changing population. For example, increased school enrollment can lead to more educational opportunity (Jacquet, 2009). Negative effects may include increased substance abuse, crime, sexually transmitted infection, demands on the education system beyond current capacity, interference with recreational activity and decreased social cohesion. Community impacts would be expected to be community wide, affecting the entire geographic extent of the Battlement Mesa PUD. It is possible that the elderly or youth of the community are more vulnerable to impacts on community well-being. Elderly may be more vulnerable to crimes of theft or burglary, and are the likely group most affected by changes in social service availability and accessibility. Children would be most affected by changes in school enrollment and class size. They may also be affected by changes in outdoor areas used for play, which may overlap with areas prone to more industrial activity or along haul routes. We expect the community impacts

to continue for the duration of the development phase of Antero's project (five years). However, because the Antero project is relatively small, it is expected that exposure to factors that impact community wellness will actually be infrequent and unlikely. If impacts do occur, they are anticipated to have low to medium impacts on citizens in the community. The overall magnitude of negative health effects are expected to be low to medium and may be related to distress over changes to the community, to increased availability of illegal substances, and more widespread sexually transmitted infection. The overall magnitude of positive health effects are expected to be low and related to decreased financial stress for some residents and possible increased resources for schools. Given adequate coverage and support offered by social infrastructure, we expect the residents of Battlement Mesa will be able to successfully adjust to the impact on community well-being. Using the numerical ranking scheme, impacts to community wellness produce a mixed rank of ± 11.5 on a scale of ±6-15.

ES4.6 Summary of Economic and Employment Assessment

The economic and employment assessment is based upon Antero's estimate of an average of 120-150 workers, (both direct Antero employees and subcontracted workers) for a 2 rig operation over the five year development period. It is important to note that these numbers represent an estimate of the average number of workers and may not reflect employment on any given day.

The economic and employment changes related to Antero gas development in Battlement Mesa may produce mixed health effects. Positive effects would be related to higher wages for some residents, while negative effects would be related to higher inflation and no wage increase for others. Economic impacts would be experienced community wide and those on fixed incomes would be more vulnerable to the negative effects of inflation. The impacts of increased economic activity are likely to last the duration of the five year development period. The frequency health impact (stress, sleep disturbance) as a result of the economic activity is likely to be infrequent to constant, depending upon the individual circumstances. It is, however, unlikely that there will be large positive or negative economic impacts from the Antero development, given the relatively small economic scale of project and the probability that such impacts will be absorbed into Garfield County as a whole. Health impacts due to changing economic conditions are expected to be of low magnitude. Using the numerical ranking scheme, impacts on the economy and employment produce a mixed rank of ± 10.5 on a scale of ± 6-15.

ES4.7 Summary of Health Infrastructure Assessment

The assessment of changes to health infrastructure impacts on health is also based upon Antero's estimate of an average of 120-150 workers, on a two rig operation over the five year development period.

Changes to local health infrastructure associated with an increase in workforce and population in Battlement Mesa and the associated potential increase in health care utilization could have mixed

health impacts on Battlement Mesa community. Positive impacts could occur if the workers are insured and therefore support the existing healthcare system when it is used. On the other hand, if workers are uninsured, their use of medical services could strain the health system. However, like the economic impacts, health care system impacts are anticipated to be small given that Antero estimates an average workforce of 120-150 workers. Health care utilization is likely to be spread into Garfield County, depending upon where the workers live. Impacts of uninsured workers are likely to be noted by providers, but it is unclear that this would reach a level that would negatively impact either clinical or public health services. The potential for increased utilization of the health care services to strain existing services is small unless a large number of workers are uninsured and they all utilize the same services. It is not expected that the extent of such a strain would lead to decreased availability and quality of clinical services. Likewise, insured workers will support local health services but the extent of such support may not be sufficient to lead to increased availability and quality of services. Local tax revenues from the Antero project will contribute to the overall county fund, but are not likely to be large enough to directly impact public health services in Battlement Mesa. Should health services be impacted in Battlement Mesa, the impacts would affect the entire community, and those that utilize health care services most frequently such as the elderly, young children and disabled may be more vulnerable to negative impacts such as decreased availability. Likewise, those groups would benefit from expanded health care services. Should health service impacts occur, they are likely to be noted in the first few years of Antero's project as the health infrastructure adjusts to new needs. Impacts to the health care infrastructure are not anticipated to last the entire duration of the project. The frequency of both positive and negative on impacts the health care system and therefore on the community are likely to be sporadic, given that the relatively small number of workers and families associated with the project. It is possible that large financial strain to local providers, particularly emergency care providers, could occur should expensive emergent care become necessary for an uninsured worker, but this is anticipated to be an infrequent event. Potential impact to vulnerable groups, the community at large and the multiple years of potential exposure create a relatively high ranking, however, it is unlikely that Battlement Mesa citizens will experience positive or negative health impacts as a result of changes to the health care infrastructure related to the project. Any impacts to health as a result of changes to the health care infrastructure are expected to be low. Using the numerical ranking scheme, impacts on the economy and employment produce a mixed rank of ± 10 on a scale of ±6-15.

ES4.8 Summary of Accidents and Malfunctions Assessment

The assessment of accidents and malfunctions relies on a review of past accidents and malfunctions in Garfield County, Colorado from the COGCC incident database and individual cases in other areas. The very nature of accidents and malfunctions makes it difficult to predict whether or how an incident may impact health. Review of several years of COGCC data however, indicates that reportable incidents occur in approximately 6% of wells permitted, state wide, in Garfield County and for Antero's previous operations, as well. Therefore, it is possible to predict that with 200 wells being drilled in Battlement Mesa, there may be approximately 12 incidents that could be considered an accident or malfunction.

When considering the possible health impacts due to an accident or malfunction, the impacts are likely to be negative. Depending upon the size and nature of the incident, health and safety impacts may be felt by those only in close proximity, or throughout the PUD. Again, depending upon the nature of the incident, certain populations may be more vulnerable to health impacts. For instance, elderly or frail and those living in the assisted living facility, may have difficulty evacuating an area quickly. Children in school may also be slower to evacuate. Those with underlying medical conditions such as pulmonary or cardiovascular disease may have negative health effects related to fires or air emissions at levels that are may not have significant impact to others. Accidents and malfunctions are likely to be short in duration and infrequent. Given the 6% rate of incidents in the industry and within Antero's other operations in Garfield County, incidents are likely to occur and it is possible that health impacts will occur. The health impacts will be low to high in magnitude, potentially ranging from minor irritation to more severe exacerbation of underlying health conditions to severe injury or death. Using the numerical ranking scheme, impacts to health due to accidents and malfunctions produce a negative rank of -10 on a scale of ±6-15.

ES5 Recommendations

At the end of each assessment we have provided several recommendations aimed at decreasing negative public health impacts, improving positive ones, and filling information gags. The summary recommendations that could be acted upon in the near future are listed below, and more long term summary recommendations are listed in the following section.

- **Promote Pollution Prevention:** Require Antero to use best available technology and rapidly adapt new technology, to reduce emissions of air, water and soil pollutants as well as noise reduction and control. Establish a system for short-term odor monitoring and reduction during gas well completion.

- **Protect Public Safety:** Review pipeline system for routes that avoid proximity to homes, schools or other areas used by residents. Require best available technology to avoid accidents and malfunctions and regular inspection of facilities and pipelines. Review emergency response plans and periodically test emergency response system.

- **Address Boomtown Effects**: Develop plans to address temporary and permanent population influx that may affect demand and capacity of social services, schools and other key community facilities and programs. Identify gaps in access to public health or social services and implement monitoring of community health needs.

ES6 Next Steps and Conclusions

This HIA used the compiled baseline health characteristics of Battlement Mesa, current ambient environmental conditions in Garfield County and Antero's proposed gas development and production plans to evaluate probable and possible health impacts of Antero's project to the residents of Battlement Mesa. Through this process we have attempted to address the concerns of the citizens outlined in the BCC petition.

At the end of each assessment we have provided recommendations aimed at decreasing potential negative health impacts, based upon existing information. However, we also identified numerous gaps in information that limited this evaluation and may limit future evaluations of health in Battlement Mesa. Recommendations intended to address some of these gaps are provided in the HIA. Some of these issues will be addressed in an environmental health monitoring study (EHMS) currently being developed by CSPH investigators. These "next steps" recommendations can be summarized as follows:

- **Establish Baselines:** Improve monitoring of environmental exposures and health effects. Past environmental monitoring (i.e., air, traffic) and public health tracking (e.g., substance abuse, mental health) are insufficient to establish current health impacts among Battlement Mesa/Garfield County residents during gas development and production.

- **Enhance Environmental Monitoring**: Establish monitoring and data systems to conduct ongoing measurement of environmental exposures. Such exposures include 1) pollution of air, water and soil impacts; 2) physical hazards such as traffic, noise, vibration and light, and 3) psychosocial and community changes. Where feasible, tie environmental monitoring to risk-based environmental standards.

- **Improve Health Effects Tracking Systems:** Develop a robust health tracking system for Battlement Mesa/Garfield County so that providers report health conditions potentially related to natural gas development and production to the county health department.

- **Ensure Transparency:** Make exposure and health monitoring data from all public and industry interventions and monitoring available to the Battlement Mesa/Garfield County residents public in a timely manner.

- **Enhance Current Regulations:** Utilize findings of the HIA and future studies to complement ongoing state and local efforts to protect public health.

Because natural gas development and production will continue to grow in Garfield County, other parts of the region and state, as well as other parts of the country, the results of this HIA and the

future EHMS will likely have application beyond the study area and will contribute to filling many knowledge gaps about natural gas development and production and health.

In addition, because the domestic natural gas resource is part of the national policy to increase domestic energy production and reduce greenhouse gas emissions, a high level discussion of the health implications of this policy needs to take place. While municipal, county and state governments have begun to respond to citizen concerns, a national discussion of the benefits and risks associated with this policy is due. As outlined in this HIA, in addition to potential local economic benefits of energy development, there are potential local negative impacts to the physical and social health of the community. It will be important to understand public health implications in the context of national priorities for domestic energy production.

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Newsroom

News Releases from Region 8

EPA Releases Draft Findings of Pavillion, Wyoming Ground Water Investigation for Public Comment and Independent Scientific Review

Release Date: 12/08/2011

Contact Information: EPA HQ: Larry Jackson, 202-564-0236, jackson.larry@epa.gov; EPA Region 8: Richard Mylott, 303-312-6654, mylott.richard@epa.gov

(Denver, Colo. –December 8, 2011) The U.S. Environmental Protection Agency (EPA) today released a draft analysis of data from its Pavillion, Wyoming ground water investigation. At the request of Pavillion residents, EPA began investigating water quality concerns in private drinking water wells three years ago. Since that time, in conjunction with the state of Wyoming, the local community, and the owner of the gas field, Encana, EPA has been working to assess ground water quality and identify potential sources of contamination.

EPA constructed two deep monitoring wells to sample water in the aquifer. The draft report indicates that ground water in the aquifer contains compounds likely associated with gas production practices, including hydraulic fracturing. EPA also re-tested private and public drinking water wells in the community. The samples were consistent with chemicals identified in earlier EPA results released in 2010 and are generally below established health and safety standards. To ensure a transparent and rigorous analysis, EPA is releasing these findings for public comment and will submit them to an independent scientific review panel. The draft findings announced today are specific to Pavillion, where the fracturing is taking place in and below the drinking water aquifer and in close proximity to drinking water wells – production conditions different from those in many other areas of the country.

Natural gas plays a key role in our nation's clean energy future and the Obama Administration is committed to ensuring that the development of this vital resource occurs safely and responsibly. At the direction of Congress, and separate from this ground water investigation, EPA has begun a national study on the potential impacts of hydraulic fracturing on drinking water resources.

"EPA's highest priority remains ensuring that Pavillion residents have access to safe drinking water," said Jim Martin, EPA's regional administrator in Denver. "We will continue to work cooperatively with the State, Tribes, Encana and the community to secure long-term drinking water solutions. We look forward to having these findings in the draft report informed by a transparent and public review process. In consultation with the Tribes, EPA will also work with the State on additional investigation of the Pavillion field."

Findings in the Two Deep Water Monitoring Wells:
EPA's analysis of samples taken from the Agency's deep monitoring wells in the aquifer indicates detection of synthetic chemicals, like glycols and alcohols consistent with gas production and hydraulic fracturing fluids, benzene concentrations well above Safe Drinking Water Act standards and high methane levels. Given the area's complex geology and the proximity of drinking water wells to ground water contamination, EPA is concerned about the movement of contaminants within the aquifer and the safety of drinking water wells over time.

Findings in the Private and Public Drinking Water Wells:
EPA also updated its sampling of Pavillion area drinking water wells. Chemicals detected in the most recent samples are consistent with those identified in earlier EPA samples and include methane, other petroleum hydrocarbons and other chemical compounds. The presence of these compounds is consistent with migration from areas of gas production. Detections in drinking water wells are generally below established health and safety standards. In the fall of 2010, the U.S. Department of Health and Human Services' Agency for Toxic Substances and Disease Registry reviewed EPA's data and recommended that affected well owners take several precautionary steps, including using alternate sources of water for drinking and cooking, and ventilation when showering. Those recommendations remain in place and Encana has been funding the provision of alternate water supplies.

Before issuing the draft report, EPA shared preliminary data with, and obtained feedback from, Wyoming state officials, Encana, Tribes and Pavillion residents. The draft report is available for a 45 day public comment period and a 30 day peer-review process led by a panel of independent scientists.

For more information on EPA's Pavillion groundwater investigation, visit:
http://www.epa.gov/region8/superfund/wy/pavillion/index.html

Last updated on Tuesday, January 27, 2015

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Recent additions

12/11/2014 EPA adds former Colorado Smelter site in Pueblo, Colo. to Superfund list
12/08/2014 EPA finalizes Libby Amphibole Asbestos health assessment (Mont.)
10/27/2014 Frontier Refining agrees to resolve alleged risk management planning and chemical reporting violations at Cheyenne refinery
10/01/2014 EPA Awards $120,000 Environmental Justice Grant to address illegal dumping in San Luis Valley (Colo.)
09/29/2014 Commerce City (Colo.) refinery agrees to resolve alleged risk management planning and chemical reporting violations

Fracking
Gas Drilling's Environmental Threat

EPA Finds Compound Used in Fracking in Wyoming Aquifer

by Abrahm Lustgarten
ProPublica, Nov. 10, 2011, 12:10 p.m.

Pavilion, Wyo. (Abrahm Lustgarten/ProPublica)

As the country awaits results from a nationwide safety study on the natural gas drilling process of fracking, a separate government investigation into contamination in a place where residents have long complained that drilling fouled their water has turned up alarming levels of underground pollution.

A pair of environmental monitoring wells drilled deep into an aquifer in Pavillion, Wyo., contain high levels of cancer-causing compounds and at least one chemical commonly used in hydraulic fracturing, according to new water test results released yesterday by the Environmental Protection Agency.

The findings are consistent with water samples the EPA has collected from at least 42 homes in the area since 2008, when ProPublica began reporting on foul water and health concerns in Pavillion and the agency started investigating reports of contamination there.

Last year -- after warning residents not to drink or cook with the water and to ventilate their homes when they showered -- the EPA drilled the monitoring wells to get a more precise picture of the extent of the contamination.

The Pavillion area has been drilled extensively for natural gas over the last two decades and is home to hundreds of gas wells. Residents have alleged for nearly a decade that the drilling -- and hydraulic fracturing in particular -- has caused their water to turn black and smell like gasoline. Some residents say they suffer neurological impairment, loss of smell, and nerve pain they associate with exposure to pollutants.

The gas industry -- led by the Canadian company EnCana, which owns the wells in Pavillion -- has denied that its activities are responsible for the contamination. EnCana has, however, supplied drinking water to residents.

The information released yesterday by the EPA was limited to raw sampling data: The agency did not interpret the findings or make any attempt to identify the source of the pollution. From the start of its investigation, the EPA has been careful to consider all possible causes of the contamination and to distance its inquiry from the controversy around hydraulic fracturing.

Still, the chemical compounds the EPA detected are consistent with those produced from drilling processes, including one -- a solvent called 2-Butoxyethanol (2-BE) -- widely used in the process of hydraulic fracturing. The agency said it had not found contaminants such as nitrates and fertilizers that would have signaled that agricultural activities were to blame.

The wells also contained benzene at 50 times the level that is considered safe for people, as well as phenols -- another dangerous human carcinogen -- acetone, toluene, naphthalene and traces of diesel fuel.

The EPA said the water samples were saturated with methane gas that matched the deep layers of natural gas being drilled for energy. The gas did not match the shallower methane that the gas industry says is naturally occurring in water, a signal that the contamination was related to drilling and was less likely to have come from drilling waste spilled above ground.

EnCana has recently agreed to sell its wells in the Pavillion area to Texas-based oil and gas company Legacy Reserves for a reported $45 million, but has pledged to continue to cooperate with the EPA's investigation. EnCana bought many of the wells in 2004, after the first problems with groundwater contamination had been reported.

The EPA's research in Wyoming is separate from the agency's ongoing national study of hydraulic fracturing's effect on water supplies, and is being funded through the Superfund cleanup program.

The EPA says it will release a lengthy draft of the Pavillion findings, including a detailed interpretation of them, later this month.

Menu

United States Environmental Protection Agency

Region 8

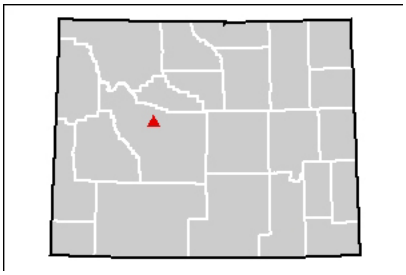
Pavillion

DRAFT REPORT

EPA has released a draft report outlining findings from the Pavillion, Wyoming groundwater investigation for public comment and independent scientific peer review. The draft report will be available for public comment through September 2013. A subsequent peer-review process will be led by a panel of independent scientists.

- Draft Report, December 8, 2011
- Press Release
- Tables and Charts
- Appendix C Figures
- Appendix D Figures
- Appendix E Figures
- Supplemental Information and Data

Groundwater Investigation



Site Type: Non-NPL
City: Pavillion
County: Fremont
ZIP Code: 82523
EPA ID: WYN000802735
SSID: 08QV
Congressional District: At Large

On this page:

- **Links to State Agencies**
- **Photo/Video Gallery**

On other pages:

- **Site Documents:** more than 800 documents related to quality assurance, monitoring well drilling information, raw laboratory data, well sampling information, lab standard operating procedures, and lab-produced reports

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What's New?

March 25, 2014
Consistent with the June 20, 2013 announcement, EPA is continuing to provide input to the state of Wyoming in their ongoing investigation of Pavillion groundwater issues. As part of that input, EPA provided a summary/evaluation of information on gas wellbore integrity and pits for consideration by the state of Wyoming. Documents (all in PDF format) are provided below:

- Pavillion Gas Well Integrity Evaluation (EPA Region 8, July 2013) (28 pp, 1 MB, About PDF)
- Pavillion Oil & Gas Field Pits Evaluation (EPA Region 8, July 2013) (31 pp, 700 K, About PDF)
- Oil & Gas Field Pits Evaluation: Appendices A-B (23 pp, 249 K, About PDF)
- Oil & Gas Field Pits Evaluation: Appendix C (252 pp, 9.9 MB, About PDF)
- Oil & Gas Field Pits Evaluation: Appendix D (848 pp, 16.8 MB, About PDF)
- Oil & Gas Field Pits Evaluation: Appendices E-F (106 pp, 5.2 MB, About PDF)

September 11, 2013
Consistent with a June 20 announcement, EPA is announcing the discontinuation of the public comment period for the external review of the draft research report, "Investigation of Ground Water Contamination near Pavillion, Wyoming (PDF)" (1 p, 176 K, About PDF). EPA does not plan to finalize or seek peer review of the draft report and will continue to support the State of Wyoming as it investigates water quality in the area.

June 20, 2013
EPA has announced that it will be supporting the State of Wyoming in its further investigation of drinking water quality in the rural area east of Pavillion, Wyoming. While EPA stands behind its work and data, the agency recognizes the State of Wyoming's commitment to further investigation and efforts to provide clean water and does not plan to finalize or seek peer review of its draft Pavillion groundwater report released in December 2011.

The sampling data obtained throughout EPA's groundwater investigation will be considered in Wyoming's further investigation, and EPA will have the opportunity to provide input to the State of Wyoming and recommend third-party experts for the State's consideration. The State intends to conclude its investigation and release a final report by September 30, 2014.

- View the press release
- View the state investigation document (PDF) (6 pp, 369 K, About PDF)

January 11, 2013
EPA is extending the public comment period for the draft research report to September 30, 2013. During this time, EPA will continue its public outreach activities including meeting with key stakeholders and posting additional technical information on this website. This extension will allow the public additional opportunity to comment on EPA's draft report and the latest round of sampling conducted by EPA and USGS. The Agency will take into account new data, further stakeholder input, and public comment as it continues to review the status of the Pavillion investigation and considers options for moving forward. View the Federal Register notice announcing the extension of the public comment period (PDF) (2 pp, 203 K, About PDF).

November 6, 2012
EPA has updated and corrected the well completion schematics for Monitoring Wells 01 and 02 based on a detailed review of the drillers logs and field notes. View the updated schematics here:

- Monitoring Well 01 Completion Schematic (PDF)(1 pg, 202 K, About PDF)
- Monitoring Well 02 Completion Schematic (PDF)(1 pg, 193 K, About PDF)

October 16, 2012
EPA has extended the public comment period on the Draft Report until January 15, 2013. View the Federal Register Notice announcing the extension of the public comment period.

October 10, 2012
EPA released the methodology and results for samples collected during April 2012. Click here for more information.

September 26, 2012
The U.S. Geological Survey has released data from samples taken from a Pavillion area monitoring well earlier this year. USGS conducted this sampling at the request of the State of Wyoming and in coordination with EPA. This data will be made available to the independent peer review panel that will review EPA's draft Pavillion groundwater report beginning later this year.

- Groundwater-Quality and Quality-Control Data for Two Monitoring Wells near Pavillion, Wyoming, April and May 2012
- Sampling and Analysis Plan for the Characterization of Groundwater Quality in Two Monitoring Wells near Pavillion, Wyoming

June 2012: Update on sampling activity
EPA, in cooperation with the U.S. Geological Survey, the Tribes, and the State of Wyoming, is re-sampling two monitoring wells the Agency installed in the Pavillion area in the summer of 2010. EPA is also collecting samples from four private and one public water supply well. Sample results, which are expected later this summer, will be posted on this web page. These data will be made available for public comment and included in the peer review process.

March 8, 2012: EPA extending public comment period and delaying peer review to consider additional sampling
EPA and the State of Wyoming recognize the value of further sampling of the deep monitoring wells drilled for the Agency's ground water study in Pavillion, Wyoming. EPA will partner with the U.S. Geological Survey (USGS), the State, and the Tribes to complete this sampling as soon as possible.

To ensure that the results of this next phase of testing are available for the peer review process, EPA has delayed convening the peer review panel on the Pavillion Draft Report until a report containing the USGS data are publicly available. In addition, EPA is extending the public comment period on the Draft Report through October 2012 to provide additional time for the public to review and comment on the new data. View Federal Register Notice announcing public comment period (PDF)(5 pp, 75 K, About PDF)

View the full joint statement from EPA Administrator Lisa Jackson, Governor Matt Mead and the Northern Arapaho and Eastern Shoshone Tribes.

February 8, 2012: The public comment period on the Draft Peer Review Charge opened on February 8; the comment period has closed. View public comments on the Draft Peer Review Charge that were received during the public comment period:

- Comment from Lloyd Hetrick
- Comment from John Corra
- Comment from David Stewart
- Comment from Nancy Tujague

January 31, 2012: 622 files have been added to the Site Documents page. The files include additional analytical data and QA documentation.

January 23, 2012:

- Op-ed from EPA Regional Administrator Jim Martin in the Casper Star-Tribune (1/22)
- Letter from EPA Administrator Lisa Jackson to Governor Matt Mead (1/19)

January 18, 2012: EPA is inviting the public to nominate scientific experts to be considered as peer reviewers of a draft report on the Pavillion ground water investigation. Nominations will be accepted through February 17. Details can be found in the Federal Register notice (PDF).(2 pp, 156 K, About PDF)

View more information on the peer review process

December 14, 2011: EPA has released a draft report outlining findings from the Pavillion, Wyoming groundwater investigation for public comment and independent scientific peer-review. See the box at the top right of this page for more information.

November 9, 2011: EPA released the latest data from Pavillion-area domestic and monitoring wells at a public meeting on November 9, 2011. We are sharing this data with the community, Encana, the state, tribes and federal partners as part of an ongoing process to develop sound science about contamination in the aquifer used by Pavillion residents for drinking water.

EPA will release a draft research report summarizing investigation findings. This report will be available for public comment as part of an independent peer-review process coordinated by our Office of Research and Development.

Public Documents and Presentations

- Methods, Graphics, and Data Tables Handout, November 8, 2011

- 2010-2011 Sampling Summary of Results and Next Steps Presentation, November 9, 2011
- Workgroup Meeting Presentation, November 30, 2011

Site Description

Pavillion, Wyoming is located in Fremont County, about 20 miles northwest of Riverton. In 2003, the estimated population was 166 residents. The concern at the site is potential groundwater contamination, based on resident complaints about smells, tastes and adverse changes in water quality of their domestic wells. Community members contacted EPA in spring 2008.

The Pavillion area has approximately 80 domestic wells. The town of Pavillion provides municipal water to residents through eight groundwater wells. Private water wells just outside the town of Pavillion are used for drinking water, irrigation, and stock watering, and are completed at depths from 50 feet to 750 feet or more. Pavillion is within the Wind River Indian Reservation as described by the Northern Arapaho and Eastern Shoshone Tribes in a pending application for treatment in a similar manner as a state under the Clean Air Act. The site is located west of Boysen State Park.

January 2010 sampling

In March 2009 EPA sampled 39 individual wells (37 residential wells and two municipal wells). The purpose of this sampling was to collect data to assess groundwater conditions and evaluate potential threats to human health and the environment. EPA conducted additional sampling in Pavillion in January 2010. This effort included sampling 21 domestic wells within the area of concern, two municipal wells, and sediment and water from a nearby creek. EPA has also sampled groundwater and soil from pit remediation sites, produced water, and condensate from five production wells operated by the primary natural gas operator in the area. EPA installed two monitoring wells in the Pavillion area in 2010. Data collected from these wells will build upon prior sampling events and help us further assess groundwater hydrology and contamination in the aquifer. EPA released the latest data from domestic and monitoring wells at a public meeting on November 9, 2011.

The Pavillion groundwater investigation is being conducted by EPA's regional office in Denver in collaboration with scientists from our Office of Research and Development.

Site Reports and Public Presentations

You will need Adobe Reader to view some of the files on this page. See EPA's About PDF page to learn more.

Best way to open a **very large file**: right-click and **save it to a folder**

Documents related to August 31, 2010 public meeting:

- Public Meeting Presentation of Phase 2 Sampling Results
- Press Release: EPA releases results of Pavillion, Wyo. water well testing
- Agency for Toxic Substances and Disease Registry Health Consultation Document (PDF)(46 pp, 2.2 MB)
- Fact Sheet: January 2010 Sampling Results and Site Update
- Final Analytical Results Report for the Pavillion Area Groundwater Investigation Site
    - Results Report Appendices: Lab Data, Photos, Figures, Chemicals Used
    - Figure 1: Site Location Map
    - Figure 2: Sampling Location Map of the January 2010 Event
    - Figure 3: Area of Influence and Well Locations
    - Figure 4: Conceptual Site Model of the Pavillion Area Groundwater Plume
    - Pavillion Area Groundwater Investigation: ALL tables

Phase 2 Field Sampling Plan, January 2010

Public Meeting Presentation of Phase 1 Sampling Results, August 11, 2009

Groundwater Investigation Analytical Results Report and Phase I Maps, August 2009

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Links to State Agencies

The following links exit the site Exit

Wyoming Oil and Gas Conservation Commission – Pavillion Working Group

Wyoming Department of Environmental Quality – Investigation of Water Quality Concerns Near Pavillion, WY

Photo/Video Gallery

Click on a thumbnail below to view the full size image.

Pavillion, Wyoming landscape

January 2010 sampling

January 2010 sampling

Collecting January 2010 samples

Preparing January 2010 samples

Last updated on August 12, 2014