

Actual water use for gas well development may be different than the amounts analyzed here. If laws are adopted to minimize impacts at this projected level of water usage, then actual water use may be less than the estimates presented here.

Conclusions related to water supply

With wise management, adequate water supplies would likely be available to support shale gas extraction in the vicinity of the Triassic Basins in North Carolina. However, there is no clear, existing regulatory path or framework that gives any state agency the ability to ensure that groundwater or surface water withdrawals for natural gas development are appropriately managed to avoid stream impacts and conflicts with other water users.

Available information indicates that drilling and hydraulic fracturing of natural gas wells typically uses from three to five million gallons of water per well. According to a fact sheet by Chesapeake Energy entitled “Water Use in Deep Shale Gas Exploration,” dated May 2011, “the company uses a variety of water sources depending on availability.”⁵³ To quote the fact sheet, “This water is typically transported via temporary pipelines or trucked to drilling locations for storage prior to use in tanks or impoundments.”

If the necessary volumes of water can be accumulated over an extended period of time rather than only on the days when hydraulic fracturing actually occurs, then needs could be met by smaller withdrawals. That flexibility would make it possible to draw from a larger set of potential water sources. Overall withdrawal times could be reduced for sources capable of supporting larger withdrawals, because of stream size or seasonally higher flows. It is not possible to develop a more specific characterization of water needs and available sources prior to the initiation of shale gas development operations and the resulting determination of the site-specific needs in the Triassic Basins of North Carolina. However, most of the areas where natural gas exploration is expected to occur do appear to possess the capability to support additional surface water withdrawals and continue to support the needs of the local population.

Some public water systems in the vicinity of the Triassic Basins may have unused capacity that could supply water for shale gas exploration and production. These water sources have already been evaluated for their potential environmental impacts at their maximum withdrawal levels. Therefore, the time and expense of evaluating potential impacts of new withdrawals could be avoided. Increased water sales would be a boost to utility revenues and their ability to cover the costs of existing debt. The relatively short-term nature of gas well drilling and development would allow the option for time-limited commitments on the part of the utilities to take advantage of currently unused capacity, while at the same time keeping that capacity available in the future to provide water to a growing customer base. Details on the volume of water made available and duration of the commitment would be subject to negotiation between the parties.

⁵³ Chesapeake Energy. “Water Use in Deep Shale Gas Exploration.” 2011. Retrieved January 9, 2012 from <http://www.naturalgaswaterusage.com/Pages/information.aspx>.

Many local government and large community water systems across the state have seen their per capita demand for water decline because of their customers' experiences during recent droughts. For many systems, daily water use has not returned to the levels seen prior to drought response activities over the last decade. This phenomenon, combined with the downturn in economic expansion and the exodus of manufacturing facilities, has put some water utilities in the position of making payments on debts for unused system capacity. In addition, reduced per capita demand has resulted in reduced revenues to cover debt payments.

According to data in the 2010 local water supply plans, Sanford, Eden, Mayodan, Madison, Anson County and Montgomery County water systems do not currently use all the water available to them. Local plan data indicate that, based on water treatment plant capacities, the surface water systems in the Dan River hydrologic sub-basin could have about 17 million gallons per day available on an average day basis. In the Wadesboro geologic sub-basin, Montgomery County could have about three million gallons per day available on average, and in the Sanford geologic sub-basin the city of Sanford could have about six million gallons per day available on average for the next few years. Several of these systems do not indicate in their local water supply plans needing the total volume of their available supplies before 2060. Of course, the ability to make use of this water depends on the ability of the parties to come to a mutually acceptable agreement.

DENR suggests that the gas industry and public water utilities work together to meet water needs for gas exploration and encourages the investigation of options that take advantage of unused capacity at existing withdrawal facilities.

Based on the experience in other oil and gas producing states, DENR recommends that gas drillers be required to have an approved water management plan that identifies the location of water sources to be used, the volume of water to be withdrawn and the pace of withdrawal. New surface water withdrawals for gas wells be limited such that the cumulative instantaneous withdrawals in the vicinity of the intake do not exceed 20 percent of the 7Q10 flow calculated at the time of the withdrawal request. Instantaneous withdrawals greater than 20 percent of the 7Q10 should require site-specific evaluations of potential impacts. This threshold has been used for many years to differentiate activities having a minimum potential for environmental effects and has been shown to be protective of other existing water users and the environment. This approach has several inherent advantages: it would protect small watersheds with low 7Q10 flows and the existing water users; it would prevent excessive withdrawals during periods of peak usage, it would be consistent with existing state protocols; and it would prevent any surface water in North Carolina from drying up due to natural gas withdrawals. As a further precaution to protect water resources, gas well withdrawals should be prohibited during droughts and low-flow conditions.

Much of this analysis focused on surface water resources because of the historically low yields available from wells drilled in the Triassic Basins. Higher yields have been produced from some wells drilled in these areas, but the ability to estimate yields prior to investing in drilling a water supply well is limited by the highly variable nature of the fracture networks that may or may not be intersected by a wellbore. Table 3-18 provides yield information for the public water supply wells located in the Triassic Basins. Groundwater is available from a well because it can move

Section 4 – Potential environmental and health impacts

A. Constituents and contaminants associated with hydraulic fracturing

The use of chemicals in hydraulic fracturing

The hydraulic fracturing of a natural gas well involves injecting a mixture of proppant and fluids into the wellbore at high pressure, creating fractures in the rock. The proppant, which is often sand, holds the fractures open. These fractures become pathways for natural gas to flow towards the wellbore, increasing the rate at which natural gas can be extracted. Hydraulic fracturing creates permeability within the shale formation, allowing the well to produce a significant amount of natural gas.

Different types of hydraulic fracturing fluids can be used, but the two most common are slickwater fracturing and nitrogen foam fracturing. Slickwater fracturing (named for its ability to reduce friction, thus reducing the pressure needed to pump the fluid into the wellbore), is the most commonly used method; slickwater fracturing fluids are primarily composed of water. Nitrogen foam fracturing uses nitrogen gas and less water than slickwater fracturing. Since slickwater fracturing is the more commonly used method, it is assumed for the purposes of this report that slickwater fracturing would be used in the development of shale gas in North Carolina.

Slickwater fracturing fluids typically consist of 98 to 99.5 percent water and sand. The New York State Department of Environmental Conservation (NYSDEC) studied the compositions by weight of a sample of fracturing fluid used in the Fayetteville Shale and a sample of fluid used in the Marcellus Shale. NYSDEC found that between approximately 84 – 90 percent of the fracturing fluid is water, and between 8 – 15 percent is sand.¹⁰⁵

In addition to water and sand (or other proppants), operators use a number of chemical additives to condition the water. Additives may be used to thicken or thin the fluid, prevent corrosion of the well casing, kill bacteria or for other purposes. The mixture of constituents used in hydraulic fracturing fluid for a particular drilling operation varies depending on the drilling company, specific characteristics of the geologic basin (such as depth, temperature, thermal maturity and structural characteristics), and the well operator's objectives.¹⁰⁶

Given the inherent variability in the composition of hydraulic fracturing fluids, we cannot know the exact composition of hydraulic fracturing fluids that could be used in North Carolina.

¹⁰⁵ New York State Department of Environmental Conservation (NYSDEC). *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program*, p. 5-51. Completed September 7, 2011. Retrieved September 7, 2011 from <http://www.dec.ny.gov/energy/75370.html>.

¹⁰⁶ NYSDEC, p. 5-39.

Any given hydraulic fracturing mixture typically contains between six and 12 chemical additives. Although a limited number of additives would be used at a particular drilling site, hundreds of different chemical additives may be in use across the country. In 2011, the Committee on Energy and Commerce of the United States House of Representatives completed a study on chemicals used in hydraulic fracturing operations. The Committee asked 14 leading oil and gas service companies to disclose the types and volumes of hydraulic fracturing products used in hydraulic fracturing fluids between 2005 and 2009.¹⁰⁷ The Committee found that during that time period, the 14 oil and gas service companies used more than 2,500 hydraulic fracturing products containing 750 chemicals and other components. This totaled 780 million gallons of additives, not including the water that is added to hydraulic fracturing fluids at the well site before injection.

NYSDEC collected information on additives proposed for use in fracturing in New York from 15 chemical suppliers and six service companies.¹⁰⁸ This information included material safety data sheets and “product composition disclosures consisting of chemical constituent names and their associated Chemical Abstract Service (CAS) Numbers, as well as chemical constituent percent by weight information.” NYSDEC obtained information for 235 products, which included 322 unique chemicals with CAS numbers and at least another 21 compounds that have no disclosed CAS number because they are mixtures. The list of chemical constituents and CAS numbers that NYSDEC extracted from the product composition disclosures and MSDSs submitted to NYSDEC begins on page 5-55 of NYSDEC’s *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program*.

The Groundwater Protection Council and the Interstate Oil and Gas Compact Commission maintain a registry for disclosure of chemicals used in hydraulic fracturing. The registry, FracFocus, notes that “there are a limited number [of chemicals] which are routinely used in hydraulic fracturing.” The FracFocus website lists 59 chemicals that are “used the most often.”

Classes of chemicals used

As noted above, an operator would only use a small number of additives (typically six to 12) on any single well. The chemical additives fall into certain categories and only one product from each category is used in any given hydraulic fracturing fluid. In addition, it would not be necessary to use a chemical from every category at every well site.¹⁰⁹ The following table shows the categories, purposes and examples of additives reported to NYSDEC as proposed for use in hydraulic fracturing wells in New York State. The categories listed are similar to additives shown on FracFocus (www.fracfocus.org). The exception would be of solvents, a category that does not appear on the FracFocus list. The categories listed in Table 4-1 are also similar to additives

¹⁰⁷ United States. Cong. House. Committee on Energy and Commerce. “Chemicals Used in Hydraulic Fracturing.” April 2011. Retrieved January 5, 2012 from <http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf>.

¹⁰⁸ NYSDEC, pp. 5-40 – 5-41.

¹⁰⁹ NYSDEC, pp. 5-49 – 5-51.

listed in the Department of Energy's *Modern Shale Gas Development in the United States: A Primer*.

Table 4-1. Categories and Purposes of Additives Proposed for Use in New York State¹¹⁰

Additive Type	Description of Purpose	Examples of Chemicals
Acids	Removes cement and drilling mud from casing perforations prior to injecting other fracturing fluids, providing an accessible path to the shale formation	Hydrochloric acid (HCl, 3% to 28%) or muriatic acid
Bactericide/Biocide/ Antibacterial Agent	Inhibits growth of organisms that could produce gases (particularly hydrogen sulfide) that could contaminate methane gas. Also prevents the growth of bacteria which can reduce the ability of the fluid to carry proppant into the fractures.	Gluteraldehyde; 2,2-dibromo-3-nitrilopropionamide
Breaker	Reduces the viscosity of the fluid in order to release proppant into fractures and enhance the recovery of the fracturing fluid	Peroxydisulfates
Buffer/pH Adjusting Agent	Adjusts and controls the pH of the fluid in order to maximize the effectiveness of other additives such as crosslinkers	Sodium or potassium carbonate; acetic acid
Clay stabilizers/Control/KCI	Prevents clays from swelling or shifting, which block pore spaces, reducing permeability	Salts such as potassium chloride (KCl) or tetramethyl ammonium chloride
Corrosion inhibitors (including Oxygen Scavengers)	Reduces rust formation on steel tubing, well casings, tools, and tanks (used only in fracturing fluids that contain acid).	Methanol; ammonium bisulfate for oxygen scavengers
Crosslinker	Increases fluid viscosity using phosphate esters combined with metals. The metals are referred to as crosslinking agents. The increased fracturing fluid viscosity allows the fluid to carry more proppant into the fractures.	Potassium hydroxide; borate salts
Friction reducers	Allows fracture fluids to be injected at optimum rates and pressures by minimizing friction.	Sodium acrylate-acrylamide copolymer; polyacrylamide (PAM); petroleum distillates
Gelling agents	Increases fracturing fluid viscosity, allowing the fluid to carry more proppant	Guar gum; petroleum distillates
Iron control	Prevents the precipitation of metal oxides which could plug off the formation.	Citric acid
Proppants	Hold open the fractures to allow gas to flow more freely to the well bore	Sand, sintered bauxite, zirconium oxide, ceramic beads
Scale inhibitors	Prevents the precipitation of carbonates and sulfates (calcium carbonate, calcium sulfate, barium sulfate) which could plug off the formation.	Ammonium chloride; ethylene glycol
Solvent	Additive which is soluble in oil, water and acid-based treatment fluids which is used to control the wettability of contact surfaces or to prevent or break emulsions.	Various aromatic hydrocarbons
Surfactants	Reduces fracturing fluid surface tension, which aids in fluid recovery	Methanol; isopropanol; ethoxylated alcohol

The Committee on Energy and Commerce of the U.S. House of Representatives found that the most widely used chemical in hydraulic fracturing was methanol, a hazardous air pollutant that is on EPA's list of contaminants that are currently not subject to any proposed or promulgated

¹¹⁰ This table is based on the table in NYSDEC, p. 5-50 and on a table on page 63 of the Department of Energy's *Modern Shale Gas Development in the United States: A Primer* (written by the Ground Water Protection Council and published in April 2009) and from a table at <http://fracfocus.org/chemical-use/what-chemicals-are-used>.

national primary drinking water regulations, that are known or anticipated to occur in public water systems, and which may require regulation under the Safe Drinking Water Act (SDWA). Methanol was used in 342 hydraulic fracturing products. Other chemicals that were the most widely used were isopropyl alcohol, ethylene glycol and crystalline silica.

Another commonly used chemical is 2-butoxyethanol (2-BE), which is used by hydraulic fracturing companies as a surfactant. The Committee writes, "According to EPA scientists, 2-BE is easily absorbed and rapidly distributed in humans following inhalation, ingestion, or dermal exposure. Studies have shown that exposure to 2-BE can cause hemolysis (destruction of red blood cells) and damage to the spleen, liver, and bone marrow."¹¹¹

Aquatic toxicity knowledge for certain chemicals used in hydraulic fracturing may be limited. Expected or predicted effects to the aquatic community, on a long-term or short-term basis, may be unknown.

Use of proprietary chemicals

Knowledge of the chemicals used in hydraulic fracturing remains imperfect. Many companies failed to provide the Committee on Energy and Commerce with a complete chemical makeup for their hydraulic fracturing fluids. The Committee found that "Between 2005 and 2009, the companies used 94 million gallons of 279 products that contained at least one chemical or component that the manufacturers deemed proprietary or a trade secret."¹¹² In some cases, oil and gas companies purchased these products off the shelf from chemical suppliers, and simply did not know what chemicals they were using. In the event of a spill, lack of knowledge about the chemical makeup could pose challenges for emergency responders. Without established groundwater and surface water standards, potential toxic effects to both human health and aquatic life may be unknown.

Health information related to hydraulic fracturing fluids

Fracturing fluids can pose both public health and environmental concerns; exposure to hydraulic fracturing additives should occur, however, only in the case of an accident, spill or other non-routine incident. Exposure could occur either while transporting additives to the well pad, during well pad operations or while transporting wastewater. After chemicals have been injected for hydraulic fracturing, a certain amount of the fluid returns to the surface as "flowback." This wastewater is stored in pits or tanks at the surface; absent sufficient safeguards, this wastewater can spill or overflow following heavy rainfall. If these chemicals are not properly disposed of or if an accident occurs in which fluids spill onto the ground or into surface waters, the fracturing fluid could pose threats to human health, the environment and to the health of livestock or wildlife. In the event of improper cementing of well casings, these chemicals could contaminate drinking water supplies. If a spill or other release occurred, more

¹¹¹ United States. Cong. House. Committee on Energy and Commerce. "Chemicals Used in Hydraulic Fracturing." April 2011. Retrieved January 5, 2012 from <http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf>, p. 7.

¹¹² *Ibid*, p. 2.

specific information about the chemicals involved would be required in order to assess the public health and environmental impacts.

The New York State Department of Environmental Conservation (NYSDEC) requested assistance from the New York State Department of Health (NYSDOH) in identifying potential exposure pathways and constituents of concern associated with hydraulic fracturing. NYSDOH assessed the health concerns by examining chemicals grouped into categories according to their chemical structure (or function in the case of microbiocides). Based on this assessment, NYSDEC concludes,

“Chemicals in products proposed for use in high-volume hydraulic fracturing include some that, based mainly on occupational studies or high-level exposures in laboratory animals, have been shown to cause effects such as carcinogenicity, mutagenicity, reproductive toxicity, neurotoxicity or organ damage. This information only indicates the types of toxic effects these chemicals can cause under certain circumstances but does not mean that use of these chemicals would cause exposure in every case or that exposure would cause those effects in every case. Whether or not people actually experience a toxic effect from a chemical depends on whether or not they experience any exposure to the chemical along with many other factors including, among others, the amount, timing, duration and route of exposure and individual characteristics that can contribute to differences in susceptibility.”¹¹³

Some of the chemicals used in hydraulic fracturing fluids are relatively harmless, such as salt and citric acid. Others are known or possible human carcinogens. The oil and gas service companies that reported to the Committee on Energy and Commerce used 652 different products containing 29 chemicals that are “(1) known or possible human carcinogens, (2) regulated under the Safe Drinking Water Act for their risks to human health, or (3) listed as hazardous air pollutants under the Clean Air Act.”¹¹⁴

Many of the chemicals used in hydraulic fracturing fluids are also regulated under the Clean Water Act for their toxic effects to human health, fish and wildlife. More information on these toxic substances can be found below.

Carcinogens

The Committee found that between 2005 and 2009, hydraulic fracturing operators used 95 products containing 13 different known, probable, or possible carcinogens.¹¹⁵ These included naphthalene, benzene, and acrylamide. In the Committee’s study, companies injected 10.2 million gallons of fracturing additives containing at least one carcinogen. Many of these chemicals also have adverse non-cancer human health effects, such as impacts to the kidney, liver and lungs.

¹¹³ NYSDEC, p. 5-79.

¹¹⁴ U.S. House of Representatives Committee on Energy and Commerce, p. 8.

¹¹⁵ *Ibid*, p. 9.

Safe Drinking Water Act considerations

In most cases, underground injection of chemicals requires a permit under the Underground Injection Control (UIC) provisions of the Safe Drinking Water Act (SDWA). Congress modified the law in 2005, however, to exclude “the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities” from regulation under the Act. Unless diesel fuel is used in the hydraulic fracturing process, EPA does not regulate the permanent underground injection of chemicals used for hydraulic fracturing.¹¹⁶

Diesel fuel has been used as an additive in hydraulic fracturing fluids and according to some sources, companies continue to use diesel fuel. The use of diesel is a concern because it contains toxic constituents, including the BTEX compounds benzene, toluene, ethylbenzene and xylenes. Benzene is a human carcinogen, while chronic exposure to toluene, ethylbenzene or xylenes can damage the central nervous system, liver and kidneys.¹¹⁷

In 2003, the EPA entered into a memorandum of agreement with the three largest providers of hydraulic fracturing fluids “to eliminate the use of diesel fuel in hydraulic fracturing fluids injected into coalbed methane production wells in underground sources of drinking water.”¹¹⁸

Congress excluded use of diesel fuel in hydraulic fracturing from the general exemption of hydraulic fracturing from regulation under the UIC provisions of the Safe Drinking Water Act “because of concern about the risks to drinking water from diesel fuel.”¹¹⁹ This means that any operator who uses diesel as a hydraulic fracturing additive should receive approval under the UIC program to do so.

Many assumed that the combination of EPA’s memorandum of agreement with hydraulic fracturing fluid providers and continued regulation of hydraulic fracturing with diesel fuel under the UIC program would cause the industry to abandon use of diesel as a hydraulic fracturing additive. In fact, EPA staff told the U.S. House of Representatives Committee on Energy and Commerce that “the agency assumed that the MOA had eliminated most diesel use.”¹²⁰ In February 2010, the Committee began an investigation into hydraulic fracturing, collecting information from 14 oil and gas service companies. The companies voluntarily provided data,

¹¹⁶ Ibid.

¹¹⁷ United States. Cong. House. Committee on Energy and Commerce. “Waxman, Markey, and DeGette Investigation Finds Continued Use of Diesel in Hydraulic Fracturing Fluids.” January 31, 2011. Retrieved January 5, 2012 from <http://democrats.energycommerce.house.gov/index.php?q=news/waxman-markey-and-degette-investigation-finds-continued-use-of-diesel-in-hydraulic-fracturing-f>.

¹¹⁸ United States Environmental Protection Agency. “A Memorandum of Agreement between the United States Environmental Protection Agency and BJ Services Company, Halliburton Energy Services, Inc., and Schlumberger Technology Corporation.” Retrieved February 26, 2012 from http://s3.amazonaws.com/propublica/assets/natural_gas/diesel_agreement_031212.pdf.

¹¹⁹ United States Environmental Protection Agency. “Natural Gas Extraction: Hydraulic Fracturing.” Retrieved January 23, 2012 from <http://www.epa.gov/hydraulicfracture/#diesel>.

¹²⁰ United States. Cong. House. Committee on Energy and Commerce. “Waxman, Markey, and DeGette Investigation Finds Continued Use of Diesel in Hydraulic Fracturing Fluids.” January 31, 2011. Retrieved January 5, 2012 from <http://democrats.energycommerce.house.gov/index.php?q=news/waxman-markey-and-degette-investigation-finds-continued-use-of-diesel-in-hydraulic-fracturing-f>.

including material safety data sheets, on the volume of diesel fuel and other additives used from 2005 to 2009. The Committee found that 12 of the 14 hydraulic fracturing companies injected more than 30 million gallons of diesel fuel or hydraulic fracturing fluids containing diesel fuel in wells in 19 states. In addition, the Committee found that 60 hydraulic fracturing products in use between 2005 and 2009 contained the BTEX compounds (benzene, toluene, ethyl benzene, xylene). Those products were used in 11.4 million gallons of hydraulic fracturing fluids.¹²¹

To assess whether these companies obtained the required UIC permit to use diesel fuel as a hydraulic fracturing component under the SDWA, the Committee contacted state agencies and EPA regional offices in the 19 states where diesel fuel was used as a component of hydraulic fracturing fluids. No state or EPA office contacted had ever issued a UIC permit for use of diesel fuel in fracturing or received an application for a UIC permit to authorize its use. Some of the state regulators who were contacted expressed doubt that diesel fuel had been used in hydraulic fracturing.¹²² EPA is currently developing permitting guidance for hydraulic fracturing using diesel fuels under SDWA Underground Injection Control Class II regulations.

The UIC exemption described only applies to injection for purposes of fracturing; underground injection of drilling wastes continues to require a Class II injection well permit from EPA or a state that has authority to implement the program. At present, North Carolina has an EPA-approved program for permitting of all classes of injection wells, but N.C. General Statute 143-214.2(b) prohibits the use of wells for waste disposal.

Surface water contamination

The Clean Water Act applies to any discharge of fluids used or produced in the hydraulic fracturing process to surface waters. Drilling wastewater may be temporarily stored in tanks or pits at the well site, where spills are possible. Operators who do not dispose of wastewater by injection into underground injection wells as described above, may transport it to wastewater treatment facilities regulated under the Clean Water Act, or dispose of it through land application methods regulated by states.

There are concerns about the ability of wastewater treatment plants to adequately treat this type of wastewater. In 2011, Gov. Tom Corbett and the Pennsylvania Department of Environmental Protection asked natural gas drillers to stop sending wastewater from drilling operations to the 15 publicly owned water treatment plants that were accepting it at the time because of concern over the elevated levels of bromide being discharged to rivers in the wastewater effluent. Although bromide is non-toxic, when bromide mixed with chlorine for

¹²¹ United States. Cong. House. Committee on Energy and Commerce. "Chemicals Used in Hydraulic Fracturing." April 2011. Retrieved January 5, 2012 from <http://democrats.energycommerce.house.gov/sites/default/files/documents/Hydraulic%20Fracturing%20Report%204.18.11.pdf> p. 10.

disinfection at a water treatment facilities becomes “a combination of potentially unsafe compounds called Total Trihalomethanes.”¹²³

Some of the chemicals used in the hydraulic fracturing process have North Carolina Surface Water and Groundwater Quality Standards; however, many do not. If these chemicals are released to North Carolina waters, defensible and enforceable state water quality standards are needed to address potential adverse effects to public health and the environment.

Hazardous Air Pollutants

The Clean Air Act requires EPA to control the emissions of 187 hazardous air pollutants. Hazardous air pollutants are pollutants that are known or are suspected to cause cancer or other serious health effects, such as reproductive problems, birth defects or developmental, respiratory and other health problems. Hazardous air pollutants can also cause adverse environmental effects. In addition to exposure through breathing, hazardous air pollutants can be deposited onto soils or surface waters and taken up by plants or ingested by animals. Humans can then be exposed to these toxic pollutants by eating exposed plants or animals. Animals may also experience health problems if exposed to sufficient quantities of air toxics over time.¹²⁴

EPA regulates emissions of hazardous air pollutants through Maximum Achievable Control Technology (MACT) standards. The state of North Carolina issues federal Clean Air Act permits that include MACT standards for any federally regulated source of hazardous air emissions in the state. North Carolina also has a state health-based program to regulate emissions of toxic air pollutants. The state program, which has been in effect since May 1, 1990, regulates 105 toxic air pollutants (TAPs). Most of the TAPs are also considered HAPs by the EPA. The state program reaches some sources of toxic air emissions that are not regulated under the federal program.

According to the survey of chemicals used in hydraulic fracturing operations by the U.S. House Energy and Commerce Committee, oil and gas companies used 595 products containing 24 chemicals capable of producing hazardous air emissions between 2005 and 2009.¹²⁵ Examples of these chemicals included hydrogen fluoride, lead and methanol. Hydrogen fluoride can cause severe and sometimes delayed health effects due to deep tissue penetration. Lead is particularly harmful to children’s neurological development but can also cause health problems in adults. The EPA reports that exposure to small amounts of methanol can cause headaches, incoordination, sleep disorders, gastrointestinal problems and optic nerve damage.¹²⁶

¹²³ Gresh, Katy. “DEP Calls on Natural Gas Drillers to Stop Giving Treatment Facilities Wastewater.” Pennsylvania Department of Environmental Protection. April 19, 2011. Retrieved February 26, 2012 from <http://www.portal.state.pa.us/portal/server.pt/community/newsroom/14287?id=17071&typeid=1>.

¹²⁴ EPA. <http://www.epa.gov/oar/toxicair/newtoxics.html>. Retrieved January 18, 2012.

¹²⁵ U.S. House of Representatives Committee on Energy and Commerce, 2011.

¹²⁶ United States Environmental Protection Agency. “Chemicals in the Environment: Methanol (CAS No. 67-56-1).” August 1994. Retrieved February 26, 2012 from http://www.epa.gov/chemfact/f_methan.txt.

Endocrine disruptors

Endocrine disruptors are chemicals that “produce adverse developmental, reproductive, neurological, and immune effects in both humans and wildlife [and they] may pose the greatest risk during prenatal and early postnatal development when organ and neural systems are forming.”¹²⁷ The Endocrine Disruption Exchange (TEDX) has conducted analysis of the potential health effects of the products and chemicals used in natural gas operations. TEDX is a nonprofit organization “dedicated to compiling and disseminating the scientific evidence on the health and environmental problems caused by low-dose exposure to chemicals that interfere with development and function, called endocrine disruptors.”¹²⁸ Endocrine disruptors can have effects at low doses, even lower than doses used for traditional toxicological studies.¹²⁹ TEDX has collected information about hydraulic fracturing products and chemicals from a variety of sources, including environmental impact statements, rule-making documents, accident and spill reports, federal and state agencies, the natural gas industry and other sources. TEDX collected material safety data sheets (MSDSs) for additives commonly used in hydraulic fracturing, which contain some information on the composition of products. Most MSDSs do not disclose all of the chemicals in a product, and may list ingredient types, such as surfactants or biocides, rather than the specific ingredient name. TEDX used MSDSs and other sources to identify Chemical Abstract Service numbers, a more specific way to identify chemicals because CAS numbers provide a unique identifier.

TEDX identified 980 products, containing a total of 649 chemicals. Based on analysis performed by TEDX, 47 percent of the 980 products examined contained chemicals considered to be endocrine disruptors. These products “have the potential to affect the endocrine system, including human and wildlife development and reproduction.” The endocrine system is “susceptible to very low levels of exposure.”¹³⁰

Chemicals used aboveground

In addition to the chemicals that are pumped into well bores to enhance hydraulic fracturing, drilling for natural gas involves the use of a number of chemicals aboveground. These chemicals could potentially pose a threat to public health or the environment if they are spilled either at the drilling site or in transit. Drilling rigs require power to drill and case wellbores. Typically, in the Marcellus Shale, this power would be provided by transportable diesel engines.¹³¹ During hydraulic fracturing, “To inject the required water volume and achieve the necessary pressure, up to 20 diesel-pumper trucks operating simultaneously are necessary” for a period of two to

¹²⁷ National Institute of Environmental Health Sciences. “Endocrine Disruptors.” Retrieved April 14, 2012 from <http://www.niehs.nih.gov/health/topics/agents/endocrine/index.cfm>.

¹²⁸ “The Endocrine Disruption Exchange.” Retrieved April 14, 2012 from <http://www.endocrinedisruption.org/home.php>.

¹²⁹ Vandenberg, Laura N. et al. “Hormones and Endocrine-Disrupting Chemicals: Low-Dose Effects and Nonmonotonic Dose Responses.” *Endocrine Reviews*, June 2012. Retrieved April 14, 2012 from <http://edrv.endojournals.org/content/early/2012/03/14/er.2011-1050.full.pdf+html>.

¹³⁰ The Endocrine Disruption Exchange. “Health Effects Spreadsheet and Summary.” Retrieved April 14, 2012 from <http://www.endocrinedisruption.org/files/Multistatesummary1-27-11Final.pdf>.

¹³¹ NYSDEC, p. 6-196.

five days per well.¹³² Diesel is stored on the well pad for this purpose and “The diesel tank fueling storage may be larger than 10,000 gallons in capacity and may be in one location on a multi-well pad for the length of time required to drill all of the wells on the pad.”¹³³

In addition to use in hydraulic fracturing operations, hazardous air pollutants also originate from mobile sources, such as the trucks that are used by gas drilling companies. The potential impacts from air emissions are discussed in Section 4.F of this report.

Regulation of hydraulic fracturing chemical disclosure

Some states require the disclosure of the chemical additives used in hydraulic fracturing fluids. The level of disclosure required varies by state. So far, Colorado is the only state to require the names and concentrations of all individual chemicals used.¹³⁴ Some states merely require the compilation of material safety data sheets (MSDSs) for additives. The Occupational Safety and Health Administration (OSHA) requires chemical manufacturers to create an MSDS for every product they sell to communicate potential health and safety hazards to employees and employers. The MSDS must list all hazardous ingredients that comprise at least 1 percent of the product; for carcinogens, the reporting threshold is 0.1 percent.¹³⁵ Chemical manufacturers do not have to disclose trade secret information on MSDSs, which allows many additives used in hydraulic fracturing to be withheld. Some states require that operators also disclose CAS registry numbers, the unique numerical identifiers for chemicals.

Many states allow reporting of chemical information to be made to FracFocus (www.fracfocus.org), a website managed by the Ground Water Protection Council and the Interstate Oil and Gas Compact Commission that serves as a type of clearinghouse for this information. The site was created “to provide the public access to reported chemicals for hydraulic fracturing,” but also includes “objective information on hydraulic fracturing, the chemicals used, the purposes they serve and the means by which groundwater is protected.” Although FracFocus provides a convenient location for chemical disclosure information from several states, it does have some limitations. Most notably, information is provided via .pdf documents for each well and is not in a database or spreadsheet format that could be used to analyze data across counties, states or other geographies. GWPC plans to release a new version of FracFocus in late 2012 that will include the capability to provide data to states, though not the general public, in spreadsheet format.¹³⁶

Arkansas requires companies to disclose all fracturing fluids, additives, chemical constituents and CAS numbers to the Arkansas Oil and Gas Commission, with the exception of chemicals that

¹³² NYSDEC, p. 6-296.

¹³³ NYSDEC, p. 7-33.

¹³⁴ Groeger, Lena. “Federal Rules to Disclose Fracking Chemicals Could Come with Exceptions.” ProPublica. February 16, 2012. Retrieved February 27, 2012 from <http://www.propublica.org/article/federal-rules-to-disclose-fracking-chemicals-could-come-with-exceptions>.

¹³⁵ U.S. House of Representatives Committee on Energy and Commerce, 2011.

¹³⁶ Mike Nickolaus, GWPC. Personal communication, March 12, 2012.

are considered trade secrets.¹³⁷ Information on concentrations used is not required, but operators report the percent by volume of each product used. The information is disclosed to the state and must be provided to health care professionals who require it. The chemical family is disclosed to the public using the state website. The information is due before hydraulic fracturing begins and updates must be submitted after hydraulic fracturing.¹³⁸ The rule became effective on Jan. 15, 2011.¹³⁹

Colorado requires drillers to disclose all the chemicals used in hydraulic fracturing, as well as the concentrations of each chemical and the CAS numbers. Certain chemical names can be withheld as trade secrets. Operators are also required to disclose these chemicals to the public using the FracFocus website and directly to the Colorado Oil & Gas Conservation Commission. Chemicals, including those considered trade secrets, must also be disclosed to health professionals in an emergency when disclosure is necessary. The requirements will be effective April 1, 2012.¹⁴⁰ The trade secret provisions of Colorado's rule are slightly different than in other states. Whereas in other states, companies can determine which chemicals are trade secrets or state regulators or the governor sign off on trade secret requests, "In Colorado, companies will be required to sign a legally-binding form to declare a chemical proprietary. Drillers who lie could be charged with perjury."¹⁴¹ The information must be posted to FracFocus within 60 days following the conclusion of the hydraulic fracturing treatment.¹⁴²

Louisiana requires operators to disclose additives in products subject to Occupational Safety and Health Administration (OSHA) Hazard Communication requirements (29 CFR 1910.1200), which requires MSDSs for chemicals considered hazardous to worker safety. For these additives, Louisiana requires the disclosure of the chemical names and concentrations of the chemicals. Operators can either report disclosure information to the Office of Conservation or post it to the FracFocus website within 20 days of well completion.¹⁴³ According to the Department of Natural Resources, "The Louisiana regulation has no effect on rules or laws mandating disclosure of trade secret information to health care providers." The rules are effective as of Oct. 20, 2011.¹⁴⁴

Michigan requires that material safety data sheets be filed for hazardous chemicals and matched with the products into which they go. Operators disclose a range of concentrations, not the exact concentration. Proprietary information is not disclosed to regulators or the public.

¹³⁷ Louisiana Department of Natural Resources. "Comparison of State Hydraulic Fracturing Chemical Disclosure Regulations." December 30, 2011. Retrieved February 27, 2012 from <http://dnr.louisiana.gov/index.cfm?md=pagebuilder&tmp=home&pid=888>.

¹³⁸ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012. Retrieved February 27, 2012 from <http://www.propublica.org/special/fracking-chemical-disclosure-rules>.

¹³⁹ Louisiana Department of Natural Resources, 2011.

¹⁴⁰ Ibid.

¹⁴¹ Detrow, Scott. "Colorado Approves Fracking Disclosure Regulations." StateImpact. December 14, 2011. Retrieved February 27, 2012 from <http://stateimpact.npr.org/pennsylvania/2011/12/14/colorado-approves-fracking-disclosure-regulations/>.

¹⁴² ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁴³ Ibid.

¹⁴⁴ Louisiana Department of Natural Resources, 2011.

MSDSs are posted on the state website and must be provided within 60 days of drilling completion.¹⁴⁵

Montana requires operators to disclose the names and CAS numbers of chemicals that are not deemed trade secrets to the Montana Oil and Gas Board or to the FracFocus website. Operators provide the chemical family and the maximum concentration of chemicals, not the actual concentration. Proprietary chemicals, as determined by the well operator, can be withheld but must be disclosed to health care professionals in an emergency. MSDSs are required before hydraulic fracturing begins and after it is complete. Disclosure must be made before hydraulic fracturing begins and after it is completed.¹⁴⁶ The requirements are effective for all hydraulic fracturing performed after Aug. 27, 2011.¹⁴⁷

Ohio requires material safety data sheets, which list the products' chemical components and CAS numbers. Concentrations of chemicals are not disclosed. Proprietary information is not disclosed to regulators or the public. No specific requirements are in place for medical disclosure, but "a regulator from the Ohio Dept. of Natural Resources said he's confident the information would be provided to health care professionals in an emergency."¹⁴⁸ The information is required 60 days after drilling is complete and is posted on the state website.¹⁴⁹

New Mexico recently adopted regulations that require operators to disclose all additives used in hydraulic fracturing fluids and the names and concentrations of chemicals that are subject to OSHA Hazard Communication requirements. Operators do not have to disclose trade secret information. Disclosure can be made by reporting to the Oil Conservation Division. The rule is effective as of Feb. 15, 2012.¹⁵⁰

North Dakota has passed new rules related to hydraulic fracturing that became effective on April 1, 2012. The revised regulation requires the owner, operator or service company to post to FracFocus "all elements made viewable by the FracFocus website,"¹⁵¹ which includes the total volume of water used at the well, the trade names of chemicals used, the supplier of each chemical, the purpose of each chemical, the ingredients, the chemical abstract service number, the maximum ingredient concentration in the additive, and the maximum ingredient concentration in the hydraulic fracturing fluid.¹⁵²

Pennsylvania has a regulation requiring operators to disclose to the Pennsylvania Office of Oil and Gas Management the names of products and chemicals, without matching them with the products into which they go. Operators must also disclose the names and concentrations of

¹⁴⁵ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁴⁶ Ibid.

¹⁴⁷ Louisiana Department of Natural Resources, 2011.

¹⁴⁸ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁴⁹ Ibid.

¹⁵⁰ Title 19, *New Mexico Administrative Code*, Chapter 15, Part 16.

¹⁵¹ North Dakota Industrial Commission. "Order of the Commission." Case no. 15869, Order no. 18123. January 23, 2012. Retrieved February 27, 2012 from <https://www.dmr.nd.gov/oilgas/or18123.pdf>.

¹⁵² This list of elements viewable on the FracFocus website was taken from the "Hydraulic Fracturing Fluid Product Component Information Disclosure" for the Dave 2H well in Bradford County, Pennsylvania, retrieved February 27, 2012 from <http://www.hydraulicfracturingdisclosure.org/fracfocustfind/>.

chemicals subject to OSHA Hazard Communication requirements.¹⁵³ All chemical constituents must be provided by the operator if the department makes a request in writing.¹⁵⁴ The information is required within 30 days of well completion. It is not posted online but is available by request from the Department of Environmental Protection.¹⁵⁵ Trade secret information is protected. The requirements are effective as of Feb. 5, 2012.¹⁵⁶

Texas recently revised its chemical disclosure rules. The revised rules require that service companies disclose to operators the names of products, chemicals that are not deemed trade secrets, and their CAS numbers. Only hazardous chemicals are matched with the products of which they are a component. The concentrations of chemical constituents are only required for chemicals subject to OSHA Hazard Communication requirements.¹⁵⁷ A listing of chemical ingredients used to hydraulically fracture a well that has been permitted by the Texas Railroad Commission on or after Feb. 1, 2012, must be uploaded to the FracFocus website. A supplier, service company or operator is not required to disclose trade secret information unless the Attorney General or court determines the information is not entitled to trade secret protection.¹⁵⁸

Wyoming has a regulation requiring operators or service companies to disclose the names of products, chemicals and their CAS numbers. Operators must disclose product concentrations but not the concentrations of individual chemical components to the supervisor of the Wyoming Oil and Gas Conservation Commission. The information is not made public.¹⁵⁹ Trade secret information is kept confidential according to the Wyoming Public Records Act. The requirements have been in effect since Aug. 17, 2010.¹⁶⁰

The United States Bureau of Land Management (BLM) has developed draft regulations applicable to wells that are hydraulically fractured on federal land. The proposed rules would require the disclosure of the names of products, chemicals and CAS numbers. Concentrations of chemicals would be disclosed for some products. At this time the rules are still a draft, and it is unclear whether the information collected by BLM would be posted publicly.¹⁶¹ BLM's proposed rules would also "compel companies to report the total volume of fracking fluid used, as well as how they intend to recover and dispose of it."¹⁶²

¹⁵³ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁵⁴ Louisiana Department of Natural Resources, 2011.

¹⁵⁵ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁵⁶ Ibid.

¹⁵⁷ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁵⁸ Nye, Ramona. "Railroad Commissioners Adopt One of Nation's Most Comprehensive Hydraulic Fracturing Chemical Disclosure Requirements." Railroad Commission of Texas. December 13, 2011. Retrieved February 27, 2012 from <http://www.rrc.state.tx.us/pressreleases/2011/121311.php>.

¹⁵⁹ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012.

¹⁶⁰ Louisiana Department of Natural Resources, 2011.

¹⁶¹ ProPublica. "Fracking Chemical Disclosure Rules." February 16, 2012. Retrieved February 27, 2012 from <http://www.propublica.org/special/fracking-chemical-disclosure-rules>.

¹⁶² Groeger, 2012.

Existing regulation of trade secrets in North Carolina

North Carolina does not currently have a statute or rule that would require disclosure of hydraulic fracturing fluids. Existing provisions in the state's Public Records Act may protect proprietary information submitted to state regulators as part of a permit application or in response to a request. Under G.S. 132-1.2, a public agency may not disclose information that meets the following criteria:

- The information would be a "trade secret" as defined in G.S. 66-152.3;
- The information is owned by a private person (which may include a corporation);
- The information has been provided for purposes of complying with local, state or federal statutes, rules or ordinances; and
- The information was marked as "confidential" or "trade secret" information when it was submitted to the public agency.

Under G.S. 66-152.3, "trade secret" means "business or technical information, including but not limited to a formula, pattern, program, device, compilation of information, method, technique, or process that:

- a. Derives independent actual or potential commercial value from not being generally known or readily ascertainable through independent development or reverse engineering by persons who can obtain economic value from its disclosure or use; and
- b. Is the subject of efforts that are reasonable under the circumstances to maintain its secrecy.

Other provisions of state law may provide additional insights into what types of information may or may not be protected as a trade secret. For example, G.S. 143-215.3C(b) provides that information related to emissions of air pollutants cannot be protected as a trade secret.

Conclusions related to hydraulic fracturing additives

We recommend that the General Assembly require full disclosure of hydraulic fracturing chemicals and constituents to the state regulatory agency and to local government emergency response officials. We also recommend that the General Assembly should encourage the industry to disclose all hydraulic fracturing chemicals and constituents to the public through the FracFocus website or a state agency website. The General Assembly may need to clarify how current protections for trade secrets under state law apply to the identification of chemicals used in hydraulic fracturing.

The use of diesel fuel in fracturing fluid should be completely prohibited because it contains toxic constituents, including the BTEX compounds benzene, toluene, ethylbenzene and xylenes. Benzene is a human carcinogen, while chronic exposure to toluene, ethylbenzene or xylenes can damage the central nervous system, liver and kidneys.