TOXIC STEW

WHAT'S IN FRACKING WASTEWATER

ENVIRONMENTAL WORKING GROUP
MARCH 2015

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FRACKING WASTEWATER IN CALIFORNIA IS LACED WITH TOXIC CHEMICALS

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EXECUTIVE SUMMARY

Wastewater from hydraulic fracturing of oil and gas wells in California is heavily contaminated with a toxic stew of chemicals known to cause cancer or reproductive harm, an analysis by Environmental Working Group shows. Because California is the only state to require comprehensive chemical testing of drilling wastes and public disclosure of the results, the findings also provide a unique window into what chemicals likely contaminate fracking wastewater nationwide.

In 2014, the first year of California's groundbreaking fracking disclosure program, more than a dozen hazardous chemicals and metals as well as radiation were detected in the wastewater, some at average levels that are hundreds or thousands of times higher than the state's drinking water standards or public health goals **(Table 1)**.

These findings underscore the gravity of recent revelations that the state tolerated illegal injection of billions of gallons of drilling wastewater into thousands of disposal wells that pour into aquifers that potentially could be tapped for drinking water or irrigation. What's more, the mandated disclosure data on the state's website is still incomplete and confusing, so Californians cannot be confident that it provides a clear picture of the threat these hazardous substances pose to water supplies.

According to state officials, there is no evidence to date that California aquifers currently used for drinking water have been contaminated by fracking chemicals. But there is clear cause for alarm.

Petroleum chemicals, heavy metals and radioactive elements, plus high levels of dissolved solids, are among the pollutants found in fracking wastewater samples tested under the new disclosure program. **(Appendix 1)** They include benzene, chromium-6, lead and arsenic – all listed under California's Proposition 65 as causes of cancer or reproductive harm. Nearly every one of the 293 samples tested contained benzene at levels ranging from twice to more than 7,000 times the state drinking water standard. The wastewater also carried, on average, thousands of times more radioactive radium than the state's public health goals consider safe, as well as elevated levels of potentially harmful ions such as nitrate and chloride.

Fracking wastewater is the mix of chemicals, sand and water that is discharged back to the surface after an oil or gas well is "fracked." It contains chemicals added to the fracking fluid and possibly naturally occurring contaminants from groundwater in the fracked shale. In 2013, fracking and other oil and gas drilling operations in California produced more than 130 billion gallons of wastewater. Most of it was injected underground for disposal or enhanced oil recovery (USGS, 2014). There are about 50,000 disposal wells in the state. Wastewater that is not injected into a well or recycled typically ends up in a surface disposal pond, known as a sump (USGS, 2014).

In July 2014, the state ordered an emergency shutdown of 11 injection wells in Kern County after revelations that the Division of Oil, Gas and Geothermal Resources, in violation of state and federal law, had allowed drillers to inject almost 3 billion gallons of wastewater into disposal wells located in protected aquifers. These are aquifers that could one day be needed for drinking water or irrigation. More than 100 water wells for domestic use and agriculture were within a mile of the 11 wastewater injection wells that were shut down.

That turned out to be just the tip of the iceberg. In February 2015, after the U.S. Environmental Protection Agency demanded a response to criticisms dating back to 2011 of the state's Underground Injection Control program, the oil and gas division reported that it had permitted more than 2,000 injection wells in zones containing potential drinking water to accept oil and gas waste or other fluids in violation of the federal Safe Drinking Water Act. Of those wells, 490 were for disposal of oil and gas wastewater and 1,987 for wastewater or steam used for enhanced oil recovery.

The state subsequently tested eight water supply wells near the 11 injection wells that were ordered to shut down. High levels of several contaminants typical of the region were found, but none were specifically linked to drilling activity. The state has planned no additional testing of water supply wells near any of the newly identified injection wells with questionable permits.

On Feb. 17, 2015, state legislators dissatisfied with the agency's response so far introduced Assembly Bill 356 to prohibit approval of any new injection well unless a groundwater monitoring program is implemented with it. But only two weeks later there was more bad news, as the oil and gas division ordered the closing of 12 more disposal wells in protected aquifers, again in Kern County.

The state agency promised EPA that it would no longer allow waste injection into the most vulnerable protected aquifers after October 2015 but said it will take two more years to bring the program into full compliance with federal law.

EWG analyzed all available state records of wastewater samples from wells fracked (or treated with another form of well treatment known as acid stimulation) in 2014. California allows drillers to request permission to keep the exact recipe of their fracking fluid off the publicly accessible website, but they must disclose the full chemical composition to the oil and gas division and other agencies.

EWG also assessed the website itself and found a number of deficiencies that limit its ability to provide full, accurate and accessible information as required by the new regulations:

- The chemicals in the tested wastewater varied significantly from one drilling company to the next. The records EWG analyzed were submitted under interim regulations; the agency says it will require more complete data beginning in July 2015.
- As of January 2015, chemical analyses of wastewater from more than 100 fracking jobs completed in early 2014 were incomplete, listed as pending as much as a full year after the wells were fracked.
- The instructions to drillers for sampling and reporting information need clarification and standardization. Operators are not reporting the correct "source" of recovered fluid from many fracking jobs. The recovered fluid should be specified as both "produced fluid and flowback" in the instructions.
- Drillers do not have to specify the exact injection well or sump pond where wastewater produced from a job was discarded. If a water supply is contaminated, this information would be key to identifying the company responsible.

Allowing injection of toxic wastewater into federally protected drinking water sources for even a limited period is an unacceptable risk to California's water supply, especially in a time of severe drought. Gov. Jerry Brown should order an immediate halt to the practice even if that means temporarily shutting down oil and gas drilling or fracking in those areas. If drinking water supplies were to be contaminated by wastewater containing the alarmingly high levels of pollutants the testing found, it would be extremely costly or impossible ever to clean them up.

It is also unacceptable that the Division plans no further testing of drinking water sources beyond the eight water wells tested in the summer of 2014. The agency should call on the expertise of the California Environmental Protection Agency and State Water Resources Board to test every water source where waste injection has been allowed.

In 1983, the federal EPA turned over to the state responsibility for regulating injection wells in California. It is now evident that this was a mistake. For 30 years the state's Underground Injection Control program allowed practices that endangered drinking water under the aegis of a parent agency that had ignored fracking for decades. The federal EPA has threatened to take back control of the state's program if California doesn't do a better job (Baker, 2015). It is long past time for the Division to place public health before oil and gas industry profits.

FULL REPORT

California responds to a national problem

In hydraulic fracturing, or “fracking,” large volumes of water are mixed with relatively smaller amounts of chemicals and sand, producing a thick slurry known as *frack fluid.* In other states, hundreds of thousands gallons (up to 20 million in some cases) are used in each well, but the oil and gas industry says wells drilled in California’s unique geology typically require no more than 130,000-210,000 gallons apiece (CCST, 2015). The fluid, pumped deep underground under high pressure, fractures shale rock formations to free up trapped oil and gas. A closely related process, *acid stimulation*, involves pumping water laced with chlorine and/or fluorine acids, sometimes in concentrations strong enough to actually dissolve oil-bearing shale, under relatively lower pressures. Collectively the two techniques are called *well stimulation.*

After a well is fracked, much of the fluid returns to the surface – anywhere from 15-to-80 percent, according to the U.S. Environmental Protection Agency (EPA, 2010). This wastewater includes *flowback* from the chemical-laced fluid that was pumped in and *formation water* that occurs naturally in the shale and is brought back to the surface with the oil or gas. The industry’s term for both types of waste is *produced water.*

Drilling a well produces much more wastewater than oil. Nationally, a typical well yields an average of 7.6 barrels of water for each barrel of oil. California is second only to Texas in the amount of produced water generated from total oil and gas activity (ANL, 2009). In 2013, the state’s oil and gas industry produced more than 130 billion gallons of wastewater (USGS, 2014).

All that wastewater has to go somewhere. Some is stored in surface reservoirs, where it either evaporates or percolates into the ground (CWA, 2014). Some can be immediately re-injected into the ground to help force more oil to the surface, a process known as water flooding. A smaller portion is heated to make steam and injected to soften heavy oil deposits. However, the wastewater cannot be recycled this way if the water quality is low, and because of the high cost and technological challenge of removing the toxic chemicals, most of it is injected underground into aquifers whose water is deemed by the U.S. EPA to be unfit for drinking or agricultural use. California has more than 50,000 injection wells for disposal of oil and gas wastewater (Bohlen and Bishop, 2015). Nationwide, there are more than such 170,000 wells (GAO, 2014).

Injection for disposal is legal only in poor-quality aquifers, but contamination may occur when injected fluids migrate into an area with high quality water. This can happen as a result of weak regulation of injection procedures, faulty well construction or poorly executed well abandonment.

The danger that chemicals in fracking fluid and produced wastewater could contaminate drinking and irrigation water supplies has caused widespread concern across the country among citizens and regulators, who have pressured the industry to disclose the chemicals it uses.

In the absence of a national disclosure law, a number of states now require drillers to report to the website FracFocus.org (FracFocus.org, 2015), and some drillers voluntarily do so. But FracFocus is partly funded by the oil and gas industry, and the reporting may be less than transparent (Hass et al, 2012). Moreover, FracFocus makes public the information submitted by drillers without checking for accuracy or completeness. Drillers can withhold details about the chemicals they use by claiming that their formulas are trade secrets. FracFocus does not provide for or require drillers to test wastewater and report the results.

California’s new disclosure requirements closes many of the loopholes in FracFocus. In 2013, legislators passed and Gov. Jerry Brown signed Senate Bill 4, the state’s first law regulating fracking (Senate Bill 4, 2013). Some of its provisions will not be fully implemented until June 2015, but disclosure under interim regulations went into effect on Jan. 1,

TABLE 1
CALIFORNIA WELL TREATMENT NOTICES AND WASTEWATER TESTING REPORTS, 2014

Operator	Treatment notices by county				Wastewater testing reports
	Kern	Ventura	Fresno	Kings	
Aera Energy LLC	1,071	3			460
Occidental of Elk Hills Inc.	133				53
Breitburn Operating LP	50				25
Vintage Production California LLC	36				12
Chevron USA	10				7
Seneca Resources Corp.	2		2		1
Central Resources Inc.	3				1
KMD Operating Co. LLC				2	
Crimson Resource Management Corp.	1				
DCOR LLC		1			
Totals	1306	4	2	2	559

Source: Environmental Working Group, from data reported to DOGGR up to January 5, 2015

2014, and some records on the state website are for wells fracked as far back as December 2013.

The law's disclosure requirements are far-reaching and in some cases unique to California. Before a well is fracked or undergoes acid stimulation, drillers must submit a notice that includes the names and concentrations of all chemicals and other substances to be used. The Division of Oil, Gas and Geothermal Resources maintains an online searchable database of this information (DOGGR, 2015). Property owners near the site must get a copy of the notice at least 30 days before fracking begins, and landowners may request water sampling and testing, paid for by the driller, of any drinking water or irrigation well on their property.

Through early January 2015, a total of 1,314 notices had been posted – 1,249 for fracking and 65 for acid stimulation (**Table 1**). Although fracking has been used in at least nine California counties (CCST, 2015), almost all of the activity reported for 2014 (1,306 notices) was in Kern County. More than 80 percent of the notices came from a single company, Aera Energy LLC of Bakersfield, which is jointly owned by Shell and ExxonMobil.

Within 60 days of fracking the well, the driller must also disclose the source, volume and complete chemical composition of all fluid used. The information must also include the amount of wastewater recovered and how the driller disposed of it. The results are compiled in large and unwieldy spreadsheets, the Well Stimulations Disclosure Report, posted on the Division's website (DOGGR, 2015). According to the report, the well treatments recorded for 2014 used from about 12,000 to 226,000 gallons of water as base fluid.

Drilling companies must also sample the recovered wastewater, test it using state-specified methods and disclose the chemicals detected and their amounts. They must also measure other characteristics such as radioactivity. Detailed reports of each chemical test must be reported.

CHEMICALS IN WASTE INCLUDED CARCINOGENS AND NEUROTOXINS

Since December 2013, drilling companies in California have reported using more than 200 distinct chemicals in hydraulic fracturing fluids (DOGGR, 2015). They range from relatively benign gelling agents such as guar gum to neurotoxins and known carcinogens identified on California's Proposition 65 list (OEHHA, 2015), including toluene and formaldehyde.

In California, chemicals typically make up 2 percent of the total volume of the fracking fluid – twice the concentration common in other states (CCST Webinar, 2015). A portion of the chemical-laced fluid returns to the surface as *flowback,* bringing with it naturally occurring *formation water* that can also contain chemicals released from the shale. The industry's term for this wastewater (flowback plus formation water) is *produced water.* In this report *wastewater* is used to describe all produced water unless it is specifically known to be flowback or formation water.

From the Division's records for 2014, EWG calculated that California operators used an average of 62,600 gallons of water in fracking jobs, and that on average only about 4 percent of the volume of the fluid was recovered. The amount of flowback varies greatly depending on the pressure in the field (Bohlen, 2015).

Not all the reported laboratory analyses of recovered fluids included data on all appropriate chemicals. Of the five companies that filed reports on chemical sampling, only one, Aera Energy LLC, provided complete and detailed data. Aera submitted more than 80 percent of the records in the database for 2014, and EWG used its reports for its analysis. Of the 460 records submitted by Aera through early January 2015, more than 167 reported that no sample had been taken or included no laboratory report at all. That left 293 records for EWG's analysis, covering fracking operations conducted from January to November 2014.

Despite these limitations, this dataset holds more information about chemicals in fracking wastewater than ever before available. The laboratory analyses showed extremely high concentrations of contaminants, many of them listed under Proposition 65 (**Table 2**). Many of the chemicals, heavy metals and radiation levels exceeded the state's standards for drinking water, known as Maximum Contaminant Levels (MCLs) (SWRCB, 2015). Others exceeded the state Public Health Goals (PHGs) set by the Office of Environmental Health Hazard Assessment as health-protective levels that public water systems should strive to achieve if feasible (OEHHA, 2015).

This wastewater would likely be diluted in an injected aquifer, but the reported concentrations are startling. Even low levels of many of these chemicals can cause problems in drinking water. "A single teaspoon of benzene, for example, is enough to contaminate more than 260,000 gallons of water to a level that exceeds the EPA's drinking water standard..." (EWG, 2012).

Here is a summary of what EWG's analysis of the reports found:

BTEX petroleum chemicals (benzene, toluene, ethylbenzene and xylene)

- Benzene was found in 99 percent of the samples. All detections exceeded the California drinking water standard, and 80 percent exceeded it by factors of 100 to 1,000. Benzene is listed as a known carcinogen under Proposition 65.
- Toluene, a neurotoxin that is also listed as a potent reproductive toxin under Proposition 65, was detected in 83 percent of the samples at levels above the drinking water standard.
- Ethylbenzene, a Proposition 65 carcinogen, was reported in excess of drinking water standards in 19 percent of the samples.
- Xylene, a reproductive and developmental toxin, was found in 12 percent of the samples in amounts above the drinking water standard.

TABLE 2.

TOXIC CHEMICALS AND OTHER CONTAMINANTS MEASURED IN FRACKING WASTEWATER AT LEVELS EXCEEDING CALIFORNIA MAXIMUM CONTAMINANT LEVELS OR PUBLIC HEALTH GOALS, 2014

Chemicals	Parts per billion (ppb)				Prop. 65	Exceeded MCL or PHG (293 samples)
	AVG	MAX	MCL	PHG		
Antimony	996	8,200	6	20		24% > MCL
Arsenic	1,094	15,000	10	0.0004	✓	45% > MCL
Barium	5,120	160,000	1,000[1]	2,000		78% > MCL
Benzene	703	7,700	1	0.15	✓	99% > MCL
Benzo(a)pyrene	7	35	0.2	0.0007	✓	17 samples > MCL
Berylium	47	290	4	1		20 samples > PHG
Cadmium	38	600	5	0.04	✓	18 samples > MCL
Chromium (total)	15	160	50			4 samples > MCL
Chromium-6	8	54	10	0.02	✓	37% > PHG
Copper	138	1,900	1,000*	300		7% > PHG
Ethylbenzene	193	1,200	300	300	✓	19% > MCL
Lead	520	5,800	15	0.2	✓	43% > MCL
Nickel	35	280	100	12	✓	34% > PHG
Selenium	1,892	16,000	50	30		35% > MCL
Silver	310	2,000	100*			18 samples > MCL
Thalium	3,081	10,000	2	0.1		10 samples > MCL up to 5,000X
Toluene	1,113	11,000	150	150	✓	83% > MCL
Xylenes (total)	926	7,600	1,750	1,800		12% > MCL
Zinc	526	9,400	5,000*			7 samples > MCL
Ions and TDS	Parts per million (ppm)					
	AVG	MAX	MCL	PHG		
Chloride (Cl^-)	46,972	380,000	500*			90% > MCL
Fluoride (F^-)	8	100	2	1		12% > MCL
Nitrate (NO_3^-)	23	270	45	45		8 samples > MCL
Sulfate (SO_4^{-2})	149	2,200	500*			12 samples > MCL
Total dissolved solids (TDS)	120,050	1,400,000	1,000*			97% > MCL, 73% >10X
Radionuclides	Picocuries per liter (piC/L)					
	AVG	MAX	MCL	PHG		
Gross alpha emitters	283	3,040	15		✓	26% > MCL
Radium 226	73	1,152		0.05	✓	94% > PHG
Radium 228	56	959		0.019	✓	89% of samples > PHG
Uranium	3	95	20	0.43	✓	6 samples > MCL

MCL (Maximum Contaminant Level): Legal limit allowed in drinking water by state law.

*Secondary MCL: Advisory-only guideline based on taste/smell/color for chemicals with no negative health effects.

PHG (Public Health Goal): Level the state says poses “no significant health risk if consumed for a lifetime.”

Prop. 65: State registry of chemicals known to cause cancer or birth defects.

piC/L: Intensity of radioactivity in a sample of material.
1 The California MCL for barium was set in 1977 at 1,000 ppb. In 1991 U.S. EPA recalculated its MCL at 2,000 ppb, and California adopted that same level as a PHG, but has not updated the state MCL.

Source: Environmental Working Group, from California DOGGR

Polynuclear Aromatic Hydrocarbons

- Benzo(a)pyrene, listed as a carcinogen under Proposition 65, was detected in 17 samples at levels above the drinking water standard.

Metals

- Arsenic, listed as a carcinogen under Proposition 65, was reported in excess of the drinking water standard in 45 percent of the samples.
- Lead, a developmental toxin under Proposition 65 for which there is no safe level (CDC, 2012), was detected in 43 percent of the samples in amounts above the drinking water standard.
- Chromium-6, also known as hexavalent chromium, a Proposition 65 carcinogen, turned up in 37 percent of the samples at above the drinking water standard.
- Nickel, a Proposition 65 carcinogen, was found in 34 percent of samples at above the state's Public Health Goal.
- Cadmium, a Proposition 65-listed developmental and reproductive toxin also linked to lung, prostate and kidney cancer, was detected in 18 samples at levels above the drinking water standard (OEHHA, 2015).
- Barium was measured at up to 160 times the drinking water standard in 78 percent of the samples. Ingesting high levels of barium over an extended period may increase blood pressure (EPA, 2015). Lower exposures for even a short time can result in vomiting, cramps, diarrhea and breathing difficulties (OEHHA, 2003).

Total Dissolved Solids

- Total dissolved solids (TDS) were measured at above the drinking water standard in 97 percent of the samples. They are an indicator of dissolved salts in the water; high levels render water unfit for drinking.

Radionuclides

- Radiation from uranium was measured at levels exceeding the drinking water standard in six samples. Radiation from radium-226 and radium-228 in excess of the Public Health Goal was found in 94 percent and 89 percent of samples, respectively. Exposure to radiation may increase the risk of cancer (OEHHA, 2003).

STATE WEBSITE HAS SERIOUS FLAWS

Interpreting data on the website of the Division of Oil, Gas and Geothermal Resources is difficult because the presentation is somewhat cumbersome. More importantly, there are many discrepancies and gaps. Although the website offers the most detailed look at chemicals in wastewater ever available, serious flaws remain in terms of making it a useful and fully transparent tool:

- **Discrepancies in sampling**
  The new disclosure law requires reporting the composition and disposition of all wastewater after a well is fracked, but there are significant discrepancies among reports from different drillers. It is unclear just what fluid must be sampled and analyzed after the well "treatment" has ended. Drillers report sampling

fluids from different sources, including flowback water, formation water and produced water. Moreover, there is no clear definition of when a well treatment is considered to have ended (UC Davis, 2014).

- **Discrepancies in chemical analysis**
  The validity and efficacy of the reported chemical analyses also varied from company to company. Aera Energy LLC reported the most comprehensive analyses, including all the required categories. Other companies reported much less comprehensive data. One, Breitburn Operating LP of Los Angeles, submitted 25 identical records for fracking jobs from June to August 2014, and the chemical analyses in those reports were dated in April. Some records did not identify sampling dates or include required information from the lab that did the analysis.
- **Missing records**
  As of January 2015, there were 31 fracking jobs in 2014 that had been reported to FracFocus.org but were not reflected on the state website. Chemical analysis reports were still pending for 116 jobs that took place from January to March 2014. No samples were collected for 51 reported fracking jobs.

In December 2014, EWG contacted the Division requesting an explanation of the discrepancies and missing records. The agency responded two months later. Officials acknowledged that the reporting directions given to drilling companies under the interim regulations were vague, that categories on the reporting forms were confusing and that companies were inconsistent in their reporting. They said, however, that by the summer of 2015 the requirements would be more specific and would be enforced.

"We are meeting regularly with operators in an attempt to get them to understand more completely the requirements and how to comply," Oil & Gas Supervisor Dr. Steven Bohlen told EWG (personal communication, Bohlen, 2015). At an oversight hearing on Senate Bill 4, Bohlen acknowledged, "We do have a serious data management problem. Our problems are on the table, and I am not hiding them" (White, 2015).

INJECTION CONTROL PROGRAM MAY NOT PROTECT GROUNDWATER

The disposal of recovered fluids from fracking varies, but most are reported as having gone into Class II injection wells **(Table 3)**. (The U.S. EPA defines several types of injection wells; Class II wells are those used for enhanced oil recovery or disposal of oil and gas waste fluids). Even in the absence of hydraulic fracturing, the oil and gas industry produces significant quantities of wastewater that must be disposed of. The Senate Bill 4 regulations do not address the problems associated with wastewater injection in general or the federal aquifer exemption process, which allows injection of oil and gas wastewater directly into aquifers that will not be used for drinking water.

California's Underground Injection Control Program is regulated under the federal Safe Drinking Water Act to protect groundwater from contamination. Since 1983, however, U.S. EPA has given the state responsibility for implementing the program, a responsibility shared by the oil and gas division and the Water Resources Control Board. U.S. EPA has turned over UIC Class II programs to a total of 39 states (GAO, 2014).

Concerns have been raised over the program at both the federal and state level, none more seriously than in California.

In 2011, EPA conducted an audit of the California program, which for the first time revealed that wastewater was being injected into aquifers that could potentially be used for drinking water in the future. The agency called on the oil and gas division to fix the problem. The Division developed an action plan but did little to implement it. EPA set a final deadline of February 2015 for the state to address the deficiencies, specifically calling for review of injection into 11 aquifers that had mistakenly been treated as

TABLE 3.

REPORTED DISPOSITION OF RECOVERED WELL STIMULATION TREATMENT (WST) FLUIDS IN STATE PUBLIC DISCLOSURE REPORT.

Operator	Disposition reported for recovered WST fluids
Aera Energy LLC	Class II injection
Breitburn Operating L.P.	Class II injection
Chevron U.S.A. Inc.	Recycled
Occidental of Elk Hills, Inc.	Injection
Vintage Production California LLC	Went to Santa Clara WWTP

Source: Environmental Working Group, from data reported to DOGGR up to January 5, 2015

exempt from protection because they were unfit for drinking or irrigation. The Division's initial response to the audit didn't come until July 2014, when it ordered the emergency shutdown of those 11 wells, all in Kern County.

In February 2015, the Division responded more fully, revealing that a staggering number of injection wells – a total of 2,553 – may have illegally been permitted to inject wastewater into protected aquifers (Bohlen and Bishop, 2015). The following month, the Division ordered the shutdown of 12 more Kern County injection wells.

The Division told EPA that "approximately 140 of the active wells have been tabbed for immediate review by the State Water Board" because the aquifers are believed to contain potable water. The agency promised that those injection wells will be shut down by October 2015 and it would complete "the phased elimination of new and existing injection into aquifers that have not been approved as exempt by the US EPA by February 15, 2017." It also promised that it would create a searchable database of injection walls and take other steps to provide "vastly improved data management systems." The Division concluded:

> The severe drought emergency, new regulations for well stimulation with ground water monitoring and other requirements, as well as long overdue revision to the [Underground Injection Control] program, have fundamentally changed how the Division and the State Water Board work together to protect public health and ensure the security of the State's groundwater resources. We are committed . . . (to) achieve full compliance with the [Safe Drinking Water Act], and we are committed to revising the [Underwater Injection Control] program efficiently, and with public safety as a first priority.

However, the state's actions still fall short. Waste injection into many of these wells could continue for two full years, and testing drinking water supply wells is not part of the plan. Although the Division now appears to be moving in the right direction, it is inexcusable that years have gone by with no action, during which the situation has reached a state of emergency. It is clear that since the Underground Injection Control program was turned over to the state, the Division has allowed questionable practices that endanger drinking water to continue. The program has been run with little transparency and has ignored its responsibility to protect drinking water and public health.

Similar crises may be looming in other states. In 2014, the U.S. Government Accountability Office concluded that the EPA had not adequately reviewed emerging risks from injection wells, and that the program may lack "the information necessary to fully protect underground drinking water" (GAO, 2014).

In the United States, groundwater is the source of drinking water used by more than 130 million people. A report last year by the U.S. Geological Survey on more than 6,000 samples from both public supply and domestic wells showed that more than 20 percent contained at least one contaminant at a level that could be a health risk (DeSimone et al, 2014). High quality groundwater is a precious resource that must be protected as the demand for water grows.

CONCLUSION AND RECOMMENDATIONS

Continuing to allow more than 2,000 wells to inject fracking wastewater into federally protected drinking water sources for even a limited period is an unacceptable risk to California's water supply, especially in a time of severe drought. The state Division of Oil, Gas and Geothermal Resources must put an immediate halt to the practice, even if that means temporarily shutting down oil and gas drilling at those locations. Once a drinking water supply is contaminated with wastewater containing alarmingly high levels of chemicals, it will be extremely costly or perhaps impossible to clean it up.

It is also unacceptable that the Division plans no further testing of potentially affected drinking water sources beyond the eight water wells tested in the summer of 2014. The Division should call on the expertise of the California Environmental Protection Agency and State Water Resources Board to test each and every water source where wastewater injection was allowed.

In addition, the Division must take steps to correct the significant flaws of its website. Senate Bill 4 was intended to provide California citizens with complete and transparent information about the chemicals in fracking fluid and fracking wastewater, as well as on how wastes are disposed of. The data as reported during the first year of the program fall short of this goal. The agency should:

- Develop clear, unambiguous instructions for drilling operators on how to fill out the disclosure forms.
- Specify that the volume of recovered fluid must include both flowback and formation water.
- Standardize and clearly specify what chemicals must be tested for in the wastewater.
- Specify when drillers must sample fracking wastewater by clearly defining what constitutes the end of the well treatment.
- Require that all reports provide full sampling data, including verified sampling dates and laboratory cover sheets.
- Clearly identify each injection well used for disposal of wastewater from a specific fracking job.

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APPENDIX 1

CHEMICAL ANALYSIS COMPILED FROM LABORATORY REPORTS SUBMITTED FOR RECOVERED WELL STIMULATION FLUIDS IN DOGGR'S WELL STIMULATION PUBLIC DISCLOSURE REPORT.

Chemical	Units	AVG	MAX	MIN	MCL	PHG	Prop 65	Exceeded MCL or PHG (293 records)
Benzene	ug/l	703	7700	2	1	0.15	✔	99% > MCL & PHG. 80%, 100 to 1000x > MCL.
Ethylbenzene	ug/l	193	1200	1.9	300	300	✔	19% of records > MCL & PHG
Toluene	ug/l	1113	11000	2.4	150	150	✔	83% of records > MCL & PHG
Total Xylenes	ug/l	926	7600	11	1750	1800		12% of records > MCL & PHG
p- & m-Xylenes	ug/l	593	5500	6.6				
o-Xylene	ug/l	336	2100	2.8				
Acenaphthene	ug/l	111	24000	0.07				
Acenaphthylene	ug/l	46	7400	0.059				
Anthracene	ug/l	8	29	1.3				
Benzo[a]anthracene	ug/l	3	17	0.099			✔	
Benzo[b]fluoranthene	ug/l	1	3.3	0.3			✔	
Benzo[k]fluoranthene	ug/l	3	4.9	1.2			✔	
Benzo[a]pyrene	ug/l	7	35	0.14	0.2	0.007	✔	17 records (6%) > MCL & PHG
Benzo[g,h,i]perylene	ug/l	1	1.4	0.21				
Chrysene	ug/l	53	4500	0.16			✔	
Dibenzo[a,h] anthracene	ug/l	23	23	23				
Fluoranthene	ug/l	48	2500	0.19				
Fluorene	ug/l	283	66000	0.27				
Indeno[1,2,3-cd]pyrene	ug/l	8	22	0.4				
Naphthalene	ug/l	461	99000	0.3			✔	
Phenanthrene	ug/l	299	76000	0.15				
Pyrene	ug/l	43	3800	0.041				
TPH - Crude Oil	ug/l	4108522	990000000	8800				
Methane	mg/L	1	15	0.0012				
Electrical Conductivity @ 25 C (Field)	umhos/cm	25140	110000	240				
pH (Field Test)	pH	7	9.43	3.59				
Temperature (Field Test)	F	95	133	64				
Total Calcium	mg/L	16484	170000	10				
Total Magnesium	mg/L	888	8800	0.88				
Total Sodium	mg/L	4937	130000	84				
Total Potassium	mg/L	1604	66000	1.3				

Chemical	Units	AVG	MAX	MIN	MCL	PHG	Prop 65	Exceeded MCL or PHG (293 records)
Bicarbonate Alkalinity as CaCO3	mg/L	656	3100	17				
Carbonate Alkalinity as CaCO3	mg/L	132	470	7.6				
Hydroxide Alkalinity as CaCO3	mg/L	0	0	0				
Total Alkalinity as CaCO3	mg/L	660	3100	17				
Bromide	mg/L	55	310	0.44				
Chloride	mg/L	46972	380,000	110	500*			90% of records > MCL
Fluoride	mg/L	8	100	0.07	2	1		47 records > PHG (16%). 12% > MCL
Nitrate as NO3	mg/L	23	270	0.29	45	45		8 records > MCL & PHG
Sulfate	mg/L	149	2200	8.2	500*			12 records > MCL
pH	pH	7	9.26	4.25				
Electrical Conductivity @ 25 C	umhos/cm	26592	97700	667	1600*			95% of records > MCL
Total Dissolved Solids @ 180 C	mg/L	120050	1,400,000	360	1000*			97% of records > MCL. 73% > 10x MCL
Fixed Dissolved Solids	mg/L	65035	960000	270				
Volatile Dissolved Solids	mg/L	76049	640000	90				
Hexavalent Chromium	ug/L	8	54	0.71	10	0.02	✔	37% of records > PHG
Total Antimony	ug/L	996	8200	19	6	20		24% of records > MCL
Total Arsenic	ug/L	1094	15000	9	10	0.004	✔	45% of records > MCL
Total Barium**	ug/L	5120	160000	33	1000	2000		78% of records > MCL
Total Beryllium	ug/L	47	290	0.51	4	1		20 records (7%) > PHG
Total Boron	mg/L	38	110	0.26				
Total Cadmium	ug/L	38	600	2.2	5	0.04	✔	25 records (9%) > PHG and 18 records > MCL
Total Chromium	ug/L	15	160	1.3	50			4 records > MCL
Total Cobalt	ug/L	139	1200	1.7				
Total Copper	ug/L	138	1900	2.9	1000*	300		21 records (7%) > PHG
Total Lead	ug/L	520	5800	6.5	15	0.2	✔	43% of records > MCL
Total Lithium	mg/L	51	520	0.0095				
Total Mercury	ug/L	0	0.85	0.025	2		✔	
Total Molybdenum	ug/L	696	11000	1.7				
Total Nickel	ug/L	35	280	4.4	100	12	✔	34% of records > PHG
Total Selenium	ug/L	1892	16000	29	50	30		35% of records > MCL
Total Silver	ug/L	310	2000	4.1	100*			18 records over (6%) MCL
Total Strontium	mg/L	306	3200	0.25				

Chemical	Units	AVG	MAX	MIN	MCL	PHG	Prop 65	Exceeded MCL or PHG (293 records)
Total Thallium	ug/L	3081	10000	63	2	0.1		10 samples > MCL, up to 5000x
Total Vanadium	ug/L	29	730	2.2				
Total Zinc	ug/L	526	9400	12	5000*			7 records > MCL
Total Carbohydrates	ug/L	369679	5000000	0				
Gross Alpha	pCi/L	283	3040	0	15		✔	26% of records > MCL
Radium 226	pCi/L	73	1152	0		0.05	✔	94% of records > MCL
Radium 228	pCi/L	56	959	0		0.019	✔	89% of records > MCL
Total Recoverable Uranium	pCi/L	3	95	0.17	20	0.43	✔	62% > PHG, 6 records > MCL

Data were compiled from 293 total records submitted by Aera Energy for 2014. The 167 records with miss data or no sample taken were not considered in the total.
MCL (Maximum Contaminant Level): Legal limit allowed in drinking water by state law.
*Secondary MCL: Advisory-only guideline based on taste/smell/color for chemicals with no negative health effects.
PHG (Public Health Goal): Level the state says poses "no significant health risk if consumed for a lifetime."
Prop. 65: CA State registry of chemicals known to cause cancer or birth defects.
piC/L: Intensity of radioactivity in a sample of material.
** The California MCL for barium was set in 1977 at 1,000 ppb. In 1991 U.S. EPA recalculated its MCL at 2,000 ppb, and California adopted that same level as a PHG, but has not updated the state MCL.
Source: Environmental Working Group, from California DOGGR Well Stimulation Public Disclosure Report accessed January 5, 2015