CALIFORNIA'S FRACKING FLUIDS: THE CHEMICAL RECIPE

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CALIFORNIA'S TOXIC FRACKING FLUIDS: THE CHEMICAL RECIPE

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EXECUTIVE SUMMARY

The fluids used in hydraulic fracturing of oil wells in California contain dozens of chemicals that are hazardous to human health, including substances linked to cancer, reproductive harm and hormone disruption, an EWG analysis of state data shows.

Under a 2013 California law (SB 4) requiring disclosure of all chemicals used to boost production from oil wells by fracking or similar methods, drilling companies reported using 197 unique chemicals in 691 oil wells from December 2013 through February 2015. The fracking fluids typically contained two dozen or more different chemicals. EWG's analysis[1] found that they included:

- 15 listed under California's Proposition 65 as known causes of cancer or reproductive harm
- 25 likely to contain impurities of Proposition 65-listed chemicals
- 5 that the European Union has associated with an increased risk of cancer
- 6 associated with reproductive harm
- 3 linked to clear evidence of hormone disruption
- 12 listed under the federal Clean Air Act as Hazardous Air Pollutants known to cause cancer or other harm
- 93 associated with harm to aquatic life.

California's fracking disclosure law is the most comprehensive in the nation. The data in the reports submitted to the state's oil and gas regulatory agency provide the most detailed accounting available of the chemical makeup of fracking fluids, at least for one state.

Fracking fluid is a mix of water, chemicals and sand that is pumped into underground shale rock formations under great pressure to free up trapped oil and gas. After a well is "treated" in this way, some of the fluid flows back to the surface, usually picking up additional chemicals that occur naturally in the shale. In California, most of the wastewater is disposed of in underground injection wells or in unlined pits, some of them dangerously close to potential sources of drinking or agricultural water. An earlier EWG analysis found that fracking wastewater contains numerous hazardous substances, some at levels much higher than state drinking water regulations allow (EWG 2015).

Nationwide, a recent U.S. Environmental Protection Agency report found nearly 700 fracking chemicals in use (EPA 2015a). But EPA relied on data from FracFocus.org, an industry-funded voluntary database that – unlike the California law – allows companies withhold information they consider trade secrets. FracFocus.org has repeatedly come under criticism for inaccuracies and lack of transparency (Hass et al 2012).

Comparing the state and EPA data shows that some of the most hazardous chemicals are used less often in California than nationwide, but the typical California job uses about twice as many distinct chemicals as the national average.[2] And because

1 The 197 chemicals were compared to an EWG database drawn from 15 sources, including government agencies, industry panels and academic institutions and Material Safety Data Sheets required by federal regulations. The tables in the Appendix provide the unique Chemical Abstracts Service Registry number for each chemical, which can be used to look up the safety data sheet.

2 It is unclear whether California fracking jobs actually use more unique chemicals or if the difference is because California's disclosure law is more comprehensive.

fracking in California tends to use less water than in other states, the concentrations of chemicals in fracking fluids are sometimes higher (CCST 2015).

The new EWG analysis looks at what goes into the fracking fluid *before* it's pumped into a well, revealing the likely origin of some contaminants in the wastewater and also the array of hazardous chemicals used, stored or transported at fracking sites. These chemicals have the potential to contaminate drinking water, air and soil, as well as to endanger the health of oilfield workers and people who live or work nearby. It is an industrial process that from beginning to end is a source of potential exposure to chemicals that are hazardous for people and the environment.

All citizens, and especially those living near fracking operations, have a right to understand the risks posed by fracking chemicals. In the absence of a moratorium or ban on fracking, California should make public safety its primary goal, not increasing the production of hydrocarbons. To accomplish this, state regulators should:

- assess whether less harmful alternatives can replace the toxic chemicals currently used;
- immediately halt the injection of wastewater into potential sources of drinking or agricultural water; and
- support recommendations for groundwater monitoring in oil and gas areas and properly enforce the model criteria developed under the disclosure law.

FULL REPORT

Hydraulic fracturing: a risk to drinking water and air quality

The nationwide fracking boom has sparked rising concern about and research into the health risks of the chemicals used (Colborn 2011, Bolden 2015, Webb et al 2014, EPA 2015b). Fracking chemicals include known carcinogens, reproductive toxins and endocrine disruptors, and drillers use many new chemicals whose health effects are largely unknown (Souther et al 2014, Schnoor 2014, Stringfellow 2014). Disclosure of these hazardous or little-known chemicals is essential to inform the public, trace contamination and study the long-term effects on health and the environment.

The oil and gas industry has long maintained that fracking chemicals are not a threat to drinking water, but evidence to the contrary is growing.

- A 2011 investigation by EWG and Earthjustice revealed that more than 25 years ago, an EPA study concluded that chemicals used to frack a 4,000-foot-deep natural gas well in West Virginia contaminated an underground drinking water source (EWG 2011).
- In May 2015, a Penn State University study found a commonly used fracking chemical, known as 2BE[3], in tap water from homes near fracked gas wells. The chemical is known to cause cancer in lab animals. Researchers said the contamination likely came either from a leak during drilling or a leaky wastewater pit (Llewellyn et al 2015).
- In June 2015, the EPA released a draft report that concluded, "there are above and below ground mechanisms by which hydraulic fracturing activities have the potential to impact drinking water resources." The federal agency said it found no "widespread, systemic impacts" but did find "instances where one or more mechanisms led to impacts on drinking water resources, including contamination of drinking water wells." EPA said that in 2013, about 6,800 sources of drinking water nationwide, serving more than 8.6 million people, were within one mile of a fracked well (EPA 2015b).
- A recent 2015 study of water supply wells in the Barnett Shale region of Texas found contamination from BTEX chemicals (benzene, toluene, ethylbenzene, xylene), chlorinated compounds and alcohols. Although the study, published in the journal Environmental Science & Technology, could not definitely link the contamination to hydraulic fracturing, chemicals used in the process were identified in hundreds of wells in the region (Hildenbrand et al 2015).

Researchers have also documented health hazards from air pollution for people living near fracking sites:

- A recent study by the Yale University School of Medicine found significantly more respiratory and skin symptoms among Pennsylvanians living within a kilometer of a fracking site than among those farther away (Rabinowitz et al 2014).
- Air samples near oil and gas production sites in six states found benzene, formaldehyde and other known carcinogens at levels far above federal health standards (Macey et al 2014, Coming Clean 2014).

3 2-Butoxyethanol

- If inhaled, the crystalline silica sand used in fracking fluid can cause cancer or silicosis, an incurable scarring of the lungs (OSHA 2002).

Fracking has been used to increase production from California wells since at least 1953, but until recently the state's oil and gas division did not keep records on fracking or even know where it was occurring (EWG 2012). Currently, fracking is used to produce about one-fifth of all oil in the state (CCST 2015). In 2013, mounting public concern about fracking's health and environmental hazards pushed the state to adopt the most stringent regulations in the nation, including required notification of planned fracking jobs, disclosure of all chemicals added to fracking fluid[4] and testing and reporting of chemicals in fracking wastewater.

However, recent revelations that the state illegally allowed disposal of oil and gas wastewater into potential sources of drinking water show that disclosure is not enough. EWG's analysis reveals that because fracking is heavily dependent on the use of chemicals known to harm human health and the environment, it is by its very nature a toxic threat. California must go beyond ensuring the public's right to know and take stronger steps to protect public health.

CALIFORNIA'S FRACKING DISCLOSURE LAW

Fracking has been used to stimulate production of oil and gas wells in California for more than 60 years amid an appalling lack of oversight and few rules. In 2012, the Division of Oil, Gas & Geothermal Resources, or DOGGR, admitted that it did not keep any records on fracking or even know where it was occurring (EWG 2012). Public concern about the health and environmental effects of fracking mounted, and in 2013 the California Legislature passed Senate Bill 4, the most comprehensive fracking law in the nation. Governor Jerry Brown signed it into law on January 1, 2014.

The law requires drillers to apply for permits for any well activity used to stimulate greater production from a well, whether by fracking or acid. The application must include the location and time of the proposed well treatment, a list of all chemicals to be used, the source of the water used and a plan to monitor groundwater in the area for possible contamination. Notices of the proposed activities are publicly disclosed on the oil and gas division's website (DOGGR 2015). Property owners near the site must also be notified within 30 days of the activity.

Within 60 days of completing a fracking operation, drillers must disclose the source and amount of water used and the chemicals in the fracking fluid. They must also disclose how much water was recovered, test the wastewater and report all chemicals detected. This information is publicly available in the Well Stimulation Public Disclosure Report, which is posted and regularly updated on the website (DOOGR 2015).

Thirteen states now have laws requiring the disclosure of chemicals used in fracking operations, but most allow the withholding of "trade secrets." An additional 15 states have chemical disclosure rules that require reporting to FracFocus.org (FracFocus.org 2015), a website that is partly funded by the oil and gas industry. The reporting to that site is known to contain errors or have missing data (Konschink 2013). Trade secrets are allowed on FracFocus, preventing full transparency, and searching for data on the website is cumbersome.

California's public disclosure program is not without flaws, but it is more useful than FracFocus. Unlike FracFocus, the California website makes it possible to easily search for multiple records and download all records for analysis. Even if drillers refuse to publicly disclose their fracking fluid formulas as "trade secrets," they must disclose all chemicals used to the state agency, and that list must be made public (SB 4 2013). EWG's analysis of the disclosures on the Division's database from December 2013 to February 2015 also shows:

4 California lets companies apply to the oil and gas division for permission to withhold the exact formula of some "trade secret" additives from the website accessible to the public, but those details must still be reported to the state and the chemical constituents of those additives must be publicly disclosed.

- Hydraulic fracturing is by far the most common type of well stimulation in California, but some wells are treated by "acid fracturing" or "matrix acidizing," which involve injecting acids instead of a mix of water and chemicals. About 95 percent of the well treatments involved hydraulic fracturing, 4 percent were matrix acidizing and 1 percent acid fracturing.
- Nearly all of the more than 1,500 pre-fracking notices reported were for Kern County, although several were for operations in Fresno, Kings and Ventura counties. (Fracking is concentrated in those areas, but it is possible that chemicals could have impacts beyond those regions.)
- California operators used an average of 62,600 gallons of water for each fracking job. Added chemicals typically made up less than 2 percent of the fluid. Typically only 1-to-5 percent of the fluid was recovered for disposal or recycling.

In its first full year of operation, lax oversight of the disclosure program resulted in missing records and confusing inconsistencies in the information reported to the state (EWG 2015, White 2015). In early 2015, both EWG and the California legislature questioned the oil and gas division about the problems. The head of the division said it was working with drilling operators to help them understand the regulations and that the final regulations would be more specific. Changes in the final regulations included requiring operators to list specific chemicals to be tested in the recovered wastewater and to specify where they disposed of the wastewater. The final regulations for the disclosure program took effect on July 1, 2015.

THE HEALTH HAZARDS OF FRACKING CHEMICALS

Since January 2014, oil and gas companies in California have been required to report all chemicals used in fracking or other well stimulation methods to the Division of Oil, Gas and Geothermal Resources, which publishes these Well Stimulation Public Disclosure reports on its website. (The website includes reports on some wells treated in December 2013.) From these reports, EWG reviewed the chemicals listed under the Well Stimulation Fluid Information tab (DOGGR 2015).

Through February 2015, a total of 691 fracking jobs were reported, all for oil wells and nearly all in Kern County. These fracking jobs used 197 distinct chemicals – typically 25 to 30 chemicals for each operation. (See Appendices 1 and 2 for the complete list of 197 chemicals, how often they were used and a summary of their health effects.) They include:

Fracking sand

After water, the second most commonly used ingredient in fracking fluid was sand – but not just any sand. Every fracking job in the state database used crystalline silica and calcined diatomaceous earth, which is largely composed of crystalline silica. If inhaled, airborne crystalline silica is a Proposition 65 carcinogen. Mining, transport, storage and use of these sands can result in hazardous air quality for miners, workers at fracking sites and people nearby (EWG 2015, NPR 2013).

Petroleum distillates

About 90 percent of the fracking jobs reported using chemicals refined from crude oil known as petroleum distillates. Diesel fuel – the only chemical prohibited in fracking under the federal Safe Drinking Water Act – is a petroleum distillate. The U.S. EPA does not consider the two types of distillates reported in the state database to be diesel. However, one is listed by the European Union as carcinogenic, and the other is an acute inhalation hazard, has nervous system effects and is toxic to aquatic life. Petroleum distillates can contain traces of BTEX chemicals – benzene and ethylbenzene, both Proposition 65 carcinogens; toluene, a Proposition 65 reproductive toxin; and xylene, a hazardous air pollutant.

Aromatic hydrocarbons

The fracking disclosure report lists 11 chemicals classified as aromatic hydrocarbons, including

xylene, toluene, trimethylbenzene and naphthalene. Most have been linked to cancer, reproductive harm or hormone disruption. A recent study found that exposure to the BTEX chemicals, which are all aromatic hydrocarbons, may disrupt hormones even at exposure levels the EPA currently considers safe (Bolden et al, 2015). Although these chemicals were used less often – in about 2-to-5 percent of the fracking jobs reported – the levels of BTEX chemicals in EWG's previous analysis of fracking wastewater were quite high (EWG 2015), suggesting that the wastewater may contain naturally occurring hydrocarbons from the petroleum deposits or shale formations.

Biocides

Eight different biocides – chemicals that kill bacteria – are listed in the disclosures, with additives known as MIT[5] and CMIT[6] the most common. They are used to prevent the growth of bacteria that could clog or corrode the wells. They are poisonous by design, so it is not surprising that MIT and CMIT biocides are extremely toxic to aquatic life. In the environment, sunlight may break down biocides, but little is known about what happens to biocides after they are pumped down a well (Kahrilas et al 2014).

Glycol ethers and alcohols

The disclosure reports list 24 unique chemicals classified as glycol ethers or ethoxylated alcohols. Although many of them are ingredients in household cleaning products, they have been linked to health and environmental harms. Most of the alcohols are toxic to aquatic life and often contain as impurities ethylene oxide and 1,4 dioxane, both Proposition 65 carcinogens. Glycol ethers have been also linked to suspected endocrine disruption and reproductive harm in people.

Chemicals by category

Table 1 lists the categories of all reported fracking chemicals by use, how often each was used and examples of specific chemicals in that category.

5 Methylisothiazolinone.

6 Chloromethylisothiazolinon.

TABLE 1.

Types and examples of chemicals reported by California fracking jobs from December 2014 to February 2015, with percentage of jobs using each type.

Chemical	Purpose	Percent of fracking jobs that reported using it	Examples of specific chemicals
Proppant	Keeps fractures in the rock open for oil and gas to flow	100%	crystalline silica (frac sand) diatomaceous earth
Breaker	Reduces thickness of the fluid to release proppant into fractures. Allows fluid to flow after proppant has been added	100%	ammonium persulfate sodium chloride hemicellulase enzyme
Gelling Agent	Increases fluid thickness to suspend the proppant	97%	guar gum petroleum distillates ethylene glycol
Clay control/ stabilizer	Locks clays in the rock to keep pore spaces open	97%	magnesium chloride magnesium nitrate oxyaklylated amine quat
Biocide/ Bactericide	Inhibits growth of bacteria that reduce the amount of proppant carried	94%	methylisothiazolinone chloromethylisothiazolinone
Crosslinker	Maintains fluid viscosity	94%	sodium tetraborate vinylidene chloride/methyl acrylate copolymer
Scale inhibitor	Prevents mineral scale in pipes and in the rock	77%	ethylene glycol nitrilo methylene phosphonic acid phosphonic acid ammonium chloride
Iron Control	Prevents build-up of metal oxides	15%	citric acid
Buffer/pH Control	Adjusts and controls the pH of the fluid	15%	sodium hydroxide
Solvent	Separates oil and water mixtures	15%	isoproponal
Surfactant	Reduces fluid surface tension and improves fluid recovery	13%	isotridecanol ethoxylate butoxy propanol methanol
Corrosion inhibitor	Protects well and tubing from corrosion	5%	methanol isopropanol
Acid	Dissolves minerals and forms cracks in rock	2%	hydrochloric acid
Friction reducer	Reduces friction of fluid in pipes to optimize rate and pressure	> 1%	ethylene glycol methanol glycerol

Source: EWG, from DOGGR Well Stimulation Public Disclosure Report.
Adapted from USGS 2014, CCST 2015 and Colborn et al 2011

COMPARISON WITH EPA'S NATIONAL DATA

In March 2015, the U.S. EPA released a report that analyzed data from the national FracFocus Chemical Disclosure Registry. The report was a preliminary step in the major EPA study that recently concluded that fracking had indeed contaminated some sources of drinking water across the country. It analyzed disclosures from 20 states for fracking jobs from early 2011 to February 2013 and identified a total of 692 distinct chemicals that had been used in oil and gas fracking operations (EPA 2015).

The EPA report shows that there are significant differences between the fracking chemicals used most often nationwide and those used most often in California. (See Table 2 for a complete comparison.) Among them:

- **Methanol** was the top chemical used nationally, reported in nearly three-fourths of oil fracking jobs but in only about 20 percent of California jobs. Methanol is listed as a Hazardous Air Pollutant under the federal Clean Air Act.
- **Petroleum distillates** (hydrotreated light) were the second most commonly reported chemical nationally and the sixth most reported in California.
- **Crystalline silica** was reported in only half of the national disclosures but in all of the California reports.
- **Hydrochloric acid** was reported in nearly 58 percent of national disclosures but in only 5 percent of California reports. Hydrochloric acid is also a federally listed Hazardous Air Pollutant.
- **Heavy aromatic naphtha**, a neurotoxin known to cause cancer in lab animals, was reported in nearly 22 percent of national reports but in less than 1 percent of California disclosures.
- **Naphthalene,** a known carcinogen, was reported in almost 18 percent of disclosures nationally, compared to about 2 percent of those in California.
- **Glutaraldehyde** was the most common biocide nationally, reported in about a third of fracking jobs. It was not reported at all in California, where CMIT and MIT were the most commonly reported biocides.
- **2-BE,** a glycol ether surfactant found in tap water in Pennsylvania, was reported in about one-fifth of the national disclosures but fewer than 5 percent of the California reports.
- On average, fewer chemical additives were reported per fracking job nationally than in California. The median[7] number of added chemicals per fracking job was 19 in California and 14 nationwide for both oil and gas jobs. EWG's analysis of the California disclosure data showed that the most common number of chemicals per fracking job was 28.

CONTAMINATION OF DRINKING WATER: MECHANISMS ARE CLEAR, BUT DATA ARE LACKING

There are several ways that fracking fluids can potentially contaminate drinking water, and a number of cases of actual contamination have been reported (Hildenbrand et al 2015, Llewellyn et al 2015, EPA 2015b). However, the impact of hydraulic fracturing on water resources nationally is impossible to quantify because of the lack of data. Few studies exist, and the recent EPA report said it could not conclude "the frequency of impacts with any certainty" because it lacked access to water quality data or the needed data did not exist. What little data are available point to the following sources of possible contamination:

7 The value that half the records were above and half below.

TABLE 2.
The top 40 fracking chemicals used in California, Dec. 2013-Feb. 2015, compared to national data from U.S. EPA's March 2015 report, "Analysis of Hydraulic Fracturing Fluid Data from the FracFocus Chemical Disclosure Registry 1.0."

Rank	Chemical Abstract Service Number (CAS #)	Chemical Reported	Percent of California frack jobs reporting chemical	Percent of frack jobs reporting chemical in EPA national analysis (all oil wells)
1	14808-60-7	crystalline silica, quartz	100%	49.4%
2	91053-39-3	diatomaceous earth, calcined	100%	15.3%
3	9000-30-0	guar gum	97.0%	52.4%
4	7727-54-0	ammonium persulfate (per-oxydisulfuric acid, diammonium salt)	94.9%	59.6%
5	64742-55-8	petroleum distillate, hydrotreated light paraffinic (blend 2)	89.6%	7.9%
6	64742-47-8	petroleum distillates, hydrotreated light (blend 1)	89.6%	60.8%
7	14464-46-1	crystalline silica, cristobalite	88.0%	5.0%
8	2682-20-4	2-methyl-4-isothiazolin-3-one	87.8%	5.7%
9	7786-30-3	magnesium chloride	87.8%	5.7%
10	10377-60-3	magnesium nitrate	87.8%	5.8%
11	7647-14-5	sodium chloride	87.0%	21.2%
12	26172-55-4	5-chloro-2-methyl-4-isothiazolin-3-one	86.8%	5.7%
13	15821-83-7	2-butoxy-1-propanol	86.3%	NR
14	9043-30-5	isotridecanol, ethoxylated	86.3%	6.1%
15	107-21-1	ethylene glycol	86.0%	59.3%
16	1310-73-2	sodium hydroxide	85.5%	49.5%
17	1303-96-4	sodium tetraborate decahydrate	81.2%	10.7%
18	9025-56-3	hemicellulase enzyme concentrate	77.9%	6.5%
19	6419-19-8	nitrilotris (methylene phosphonic acid)	68.6%	3.6%
20	13598-36-2	phosphonic acid	68.6%	10.7%
21	5131-66-8	propylene glycol butyl ether (1-butoxy-2-propanol)	64.3%	4.0%

Rank	Chemical Abstract Service Number (CAS #)	Chemical Reported	Percent of California frack jobs reporting chemical	Percent of frack jobs reporting chemical in EPA national analysis (all oil wells)
22	138879-94-4	oxyalkylated amine quat (1,2-eth-anediaminium, n, n'-bis[2-[bis(2-hydroxyethyl)methylammonio] ethyl]-n,n'bis(2-hydroxyethyl)-n,n'-dimethyl-,tetrachloride)	63.5%	3.2%
23	67-56-1	methanol	21.3%	71.8%
24	56-81-5	glycerol	18.4%	5.8%
25	55636-09-4	2-hydroxytrimethylene,bis(trimeth ylammonium) dichloride	18.1%	NR
26	77-92-9	citric acid	15.1%	19.0%
27	14807-96-6	magnesium silicate hydrate (talc)	11.9%	3.3%
28	9002-84-0	poly(tetrafluoroethylene)	11.9%	NR
29	25038-72-6	vinylidene chloride/methylacrylate copolymer	11.9%	2.8%
30	67-63-0	isopropanol	11.4%	46.2%
31	9003-35-4	phenol formaldehyde polymer (phenolic resin)	11.3%	17.9%
32	63-42-3	lactose	10.4%	NR
33	73049-73-7	tryptone	10.3%	NR
34	8013-01-2	yeast extract	10.3%	NR
35	7631-86-9	silica, amorphous - fumed	9.7%	NR
36	69-53-4	ampicillin	9.4%	NR
37	37288-54-3	enzyme	9.4%	NR
38	64-19-7	acetic acid	9.1%	26.6%
39	31726-34-8	polyethylene glycol monohexyl ether	9.0%	3.2%
40	104-76-7	2-ethyl hexanol (2-ethylhexan-1-ol)	8.8%	4.6%

Source: Environmental Working Group, from DOGGR 2015 and EPA 2015.
NR = Not Reported.

- **Surface spills**. Again, data are lacking. Existing estimates of the number of spills of hydraulic fracturing fluids nationally range from 100-to-3,700 a year (EPA 2015b). The EPA found that most chemical spills resulted from equipment failures or leaks from storage containers (EPA 2015b). An extensive groundwater study in the Barnett Shale region in Texas found a pattern suggesting that some of the identified contaminants likely came from surface spills (Hildenbrand et al 2015).
- **Well casing failures**. There are estimates that well casings fail in up to 12 percent of new wells within the first year of operation (Ingraffea et al 2014). These failures may result in underground contamination of aquifers well outside of the immediate production zone.
- **Migration of fluids**. A report by the U.S. Geologic Service last year concluded that "new pathways can be created when injection pressures are applied during well stimulation," allowing fracking fluids to migrate underground over significant distances (USGS 2014).
- **Improper handling of wastes**. In California, an ongoing investigation of thousands of improperly approved injection wells for oil and gas wastewater is producing troubling findings. On May 15, 2015, the oil and gas division submitted new information to the EPA identifying 53 injection wells that could potentially contaminate drinking and irrigation water, and an additional 207 wells that might affect potential drinking water sources (Bishop and Bohlen 2015). In May 2015, the Sierra Club and the Center for Biological Diversity sued the oil and gas division to stop the illegal wastewater injections.

CONCLUSIONS

As a result of lack of regulation and official negligence, the oil and gas industry has been able to claim that fracking fluid and recovered wastewater do not threaten and have never polluted drinking water, but that claim is no longer credible. We now know incontrovertibly that chemicals from fracking fluid and wastewater have contaminated drinking water in locations across the country.

To date, however, state and federal officials have been incapable or unwilling under existing regulations to place protection of public health ahead of the wishes of the oil and gas industry. Although California now probably has the nation's most stringent regulations for fracking and the most comprehensive disclosure requirements of the chemicals used, those measures have not been enough to ensure that sources of drinking and agricultural water are safe from contamination. Stronger actions are needed.

EWG recommends:

- California should take steps to further regulate the dangerous chemicals used in fracking. An assessment of whether less harmful alternatives can replace the chemicals now in use is urgently needed.
- All citizens, and especially those living near fracking operations, have a right to understand the risks. Chemical safety data sheets should be submitted and posted along with the chemical disclosures on the website of the Division of Oil, Gas and Geothermal Resources and made available to residents adjacent to fracking operations. Nationally, chemicals used in fracking should be disclosed in a transparent program similar to California's SB 4 program.
- There is a severe lack of data on the effects of hydraulic fracturing on drinking water resources in California and nationally. The state should support the recommendations for groundwater monitoring in areas of oil and gas well stimulation and properly enforce the model criteria for the regional groundwater-monitoring program developed under SB 4. This program should serve as a model for a national program to collect groundwater-monitoring data.
- The state must immediately stop the illegal

injection of wastewater into potential sources of drinking or agricultural water.

- Integration of renewable energy sources is sorely needed. California must make clean energy a priority for the long term instead of relying on fossil fuels and dangerous practices using harmful chemicals.

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APPENDIX 1.

The 197 unique fracking chemicals publicly disclosed from 691 wells in California from 2014 to February 2015, ranked by the number of times they were reported.

Rank	Chemical Abstract Service umber	Chemical Constituent	No. of CA disclosures	Percent of CA disclosures
1	14808-60-7	crystalline silica (quartz)	691	100%
2	91053-39-3	diatomaceous earth, calcined	691	100%
3	9000-30-0	guar gum	670	97.0%
4	7727-54-0	ammonium persulfate (peroxydisulfuric acid, diammonium salt)	656	94.9%
5	64742-55-8	petroleum distillate, hydrotreated light paraf-finic (blend 2)	619	89.6%
6	64742-47-8	petroleum distillates, hydrotreated light (blend 1)	619	89.6%
7	14464-46-1	crystalline silica (cristobalite)	608	88.0%
8	2682-20-4	2-methyl-4-isothiazolin-3-one	607	87.8%
9	7786-30-3	magnesium chloride	607	87.8%
10	10377-60-3	magnesium nitrate	607	87.8%
11	7647-14-5	sodium chloride	601	87.0%
12	26172-55-4	5-chloro-2-methyl-4-isothiazolin- 3-one	600	86.8%
13	15821-83-7	2-butoxy-1-propanol	596	86.3%
14	9043-30-5	isotridecanol, ethoxylated	596	86.3%
15	107-21-1	ethylene glycol	594	86.0%
16	1310-73-2	sodium hydroxide	591	85.5%
17	1303-96-4	sodium tetraborate decahydrate	561	81.2%
18	9025-56-3	hemicellulase enzyme concentrate	538	77.9%
19	6419-19-8	nitrilotris (methylene phosphonic acid)	474	68.6%
20	13598-36-2	phosphonic acid	474	68.6%
21	5131-66-8	propylene glycol butyl ether (1-butoxy-2-pro-panol)	444	64.3%
22	138879-94-4	oxyalkylated amine quat (1,2-ethanediaminium, n, n'-bis[2-[bis(2-hydroxyethyl)methylammonio] ethyl]-n,n'bis(2-hydroxyethyl)-n,n'-dimethyl-,tetrachloride) (clay master)	439	63.5%
23	67-56-1	methanol	147	21.3%
24	56-81-5	glycerol	127	18.4%
25	55636-09-4	2-hydroxytrimethylene,bis(trimethylammoni um) dichloride	125	18.1%
26	77-92-9	citric acid	104	15.1%
27	14807-96-6	magnesium silicate hydrate (talc)	82	11.9%
28	9002-84-0	poly(tetrafluoroethylene)	82	11.9%
29	25038-72-6	vinylidene chloride/methylacrylate copolymer	82	11.9%
30	67-63-0	isopropanol	79	11.4%
31	9003-35-4	phenol formaldehyde polymer (phenolic resin)	78	11.3%
32	63-42-3	lactose	72	10.4%
33	73049-73-7	tryptone	71	10.3%
34	8013-01-2	yeast extract	71	10.3%

35	7631-86-9	silica, (amorphous – fumed)	67	9.7%
36	69-53-4	ampicillin	65	9.4%
37	37288-54-3	enzyme	65	9.4%
38	64-19-7	acetic acid	63	9.1%
39	31726-34-8	polyethylene glycol monohexyl ether	62	9.0%
40	104-76-7	2-ethyl hexanol (2-ethylhexan-1-ol)	61	8.8%
41	298-14-6	potassium bicarbonate	60	8.7%
42	10043-35-3	boric acid	59	8.5%
43	121-43-7	methyl borate	59	8.5%
44	584-08-7	potassium carbonate	59	8.5%
45	57-55-6	propylene glycol	59	8.5%
46	1310-58-3	potassium hydroxide	56	8.1%
47	102-71-6	triethanolamine (2,2`,2”-nitrilotriethanol)	52	7.5%
48	129898-01-7	2-propenoic acid, polymer with sodium phosphinate	44	6.4%
49	111-46-6	diethylene glycol	44	6.4%
50	127-08-2	acetic acid, potassium salt (potassium acetate)	44	6.4%
51	78330-21-9	alcohol, c11-14, ethoxylated	44	6.4%
52	10043-52-4	calcium chloride	44	6.4%
53	61789-77-3	dicoco dimethyl quaternary ammonium chloride	44	6.4%
54	9003-11-6	methyl oxirane polymer with oxirane	44	6.4%
55	1332-77-0	potassium borate	44	6.4%
56	143-18-0	potassium oleate	44	6.4%
57	55566-30-8	tetrakis(hydroxymethyl)phosphonium sulfate	44	6.4%
58	66455-15-0	alkyl (c10-c14) alcohols, ethoxylated	43	6.2%
59	68123-18-2	crosslinked po/eo-block polymer	43	6.2%
60	577-11-7	dioctyl sulfosuccinate sodium salt	43	6.2%
61	112-80-1	oleic acid	43	6.2%
62	78330-19-5	alcohol, c7-9-iso, c8, ethoxylated	42	6.1%
63	77-89-4	acetyl triethyl citrate	41	5.9%
64	1330-20-7	xylene	37	5.4%
65	7699-43-6	zirconium dichloride oxide	36	5.2%
66	7647-01-0	hydrochloric acid	34	4.9%
67	27103-90-8	poly(dimethylaminoethylmethylacrylate) dimethyl sulphate quat.	34	4.9%
68	107-19-7	propargyl alcohol	34	4.9%
69	68527-49-1	thiourea polymer	32	4.6%
70	12125-02-9	ammonium chloride	27	3.9%
71	141-43-5	ethanolamine	27	3.9%
72	7664-93-9	sulfuric acid	27	3.9%
73	111-76-2	2-butoxyethanol	25	3.6%
74	9016-45-9	oxyalkylated alkylphenol (nonyl phenol ethoxylate)	25	3.6%
75	108-88-3	toluene	25	3.6%
76	84012-43-1	walnut shells	25	3.6%
77	25321-41-9	xylenesulfonic acid	25	3.6%
78	68439-45-2	polyoxyalkylenes	24	3.5%
79	8042-47-5	petroleum distillate (blend 3, white mineral oil)	23	3.3%

80	629-73-2	1-hexadecene	20	2.9%
81	112-88-9	1-octadecene	20	2.9%
82	68951-67-7	alcohols, c14-c15, ethoxylated	20	2.9%
83	68155-09-9	cocamidopropylamide oxide	19	2.7%
84	61788-89-4	mixture of dimer and trimer fatty acids of indefinite compostion derived from tall oil	19	2.7%
85	1120-36-1	1-tetradecene	18	2.6%
86	12125-01-8	ammonium flouride	18	2.6%
87	75-21-8	ethylene oxide	18	2.6%
88	3452-07-1	1-eicosene	17	2.5%
89	73772-46-0	caprylamidopropyl betaine	17	2.5%
90	61789-40-0	cocamidopropyl betaine	17	2.5%
91	50-00-0	formaldehyde	17	2.5%
92	61790-59-8	amines, hydrogenated tallow alkyl, acetates	16	2.3%
93	94266-47-4	citrus terpenes	16	2.3%
94	7447-39-4	copper dichloride	16	2.3%
95	68131-39-5	ethoxylated alcohol c12-15	16	2.3%
96	61791-12-6	ethoxylated castor oil	16	2.3%
97	100-97-0	hexamethylenetetramine	16	2.3%
98	5470-11-1	hydroxylamine hydrochloride	16	2.3%
99	70559-25-0	nonionic alkoxylate	16	2.3%
100	112-27-6	organic polyol	16	2.3%
101	68815-65-6	polyethers (n'-(2-aminoethyl)-n-[2-(2-aminoethylamino)ethyl]ethane-1,2-diamine; 2-methyloxirane; oxirane)	16	2.3%
102	7758-87-4	tricalcium phosphate	16	2.3%
103	95-63-6	1,2,4-trimethylbenzene	15	2.2%
104	61790-12-3	fatty acids, tall-oil	15	2.2%
105	91-20-3	naphthalene	15	2.2%
106	63428-92-2	oxyalkylated alkylphenolic resin	14	2.0%
107	7447-40-7	potassium chloride	13	1.9%
108	526-73-8	1,2,3-trimethylbenzene	12	1.7%
109	108-67-8	1,3,5-trimethylbenzene	12	1.7%
110	68584-27-0	alkylaryl sulfonate	12	1.7%
111	98-82-8	cumene	12	1.7%
112	64742-95-6	light aromatic naphtha	12	1.7%
113	64743-02-8	olefin	12	1.7%
114	9003-04-7	sodium polyacrylate	12	1.7%
115	89-65-6	erythorbic acid	11	1.6%
116	26062-79-3	polydimethyl diallyl ammonium chloride	11	1.6%
117	67-48-1	choline chloride	10	1.4%
118	13197-76-7	lauryl hydroxysultaine	10	1.4%
119	7775-27-1	sodium persulfate	10	1.4%
120	7757-82-6	sodium sulfate	10	1.4%
121	58160-99-9	3-aminopropyl (sileanetriol)	9	1.3%
122	68584-25-8	alkylbenzene sulfonate with 2-propanamine	9	1.3%
123	68584-24-7	alkylbenzene sulfonate with triethanolamine	9	1.3%
124	111-42-2	diethanolamine	9	1.3%
125	64-17-5	ethanol	9	1.3%

126	68400-07-7	silanetrio (3-aminopropyl, homopolymer)	9	1.3%
127	112926-00-8	silica gel	9	1.3%
128	121888-68-4	bentonite, benzyl(hydrogenated tallow alkyl) dimethylammonium stearate complex	8	1.2%
129	7631-90-5	sodium bisulfite	8	1.2%
130	9012-54-8	hemicellulase enzyme	7	1.0%
131	26038-87-9	monoethanolamine borate	7	1.0%
132	25322-69-4	polypropylene glycol	6	0.9%
133	1344-28-1	aluminum oxide	5	0.7%
134	1309-37-1	iron oxide	5	0.7%
135	13463-67-7	titanium oxide	5	0.7%
136	1113-55-9	2-monobromo-3-nitrilopropionamide	4	0.6%
137	10222-01-2	2,2 dibromo-3-nitrilopropionamide	4	0.6%
138	68551-12-2	alcohols, c12-16, ethoxylated	4	0.6%
139	1341-49-7	ammonium hydrogen difluoride	4	0.6%
140	27176-87-0	dodecylbenzene sulfonic acid	4	0.6%
141	64-18-6	formic acid	4	0.6%
142	15827-60-8	organic phosphonate	4	0.6%
143	1319-33-1	ulexite	4	0.6%
144	11138-66-2	xanthan gum	4	0.6%
145	9046-01-9	acid phosphate ester	3	0.4%
146	78330-20-8	alcohol, c9-11-iso, c10, ethoxylated	3	0.4%
147	68439-46-3	alcohol, c9-c11, ethoxylated	3	0.4%
148	631-61-8	ammonium acetate	3	0.4%
149	122-18-9	benzyldimethylammonium chloride	3	0.4%
150	139-07-1	benzyllauryldimethylammonium chloride	3	0.4%
151	7758-19-2	chlorous acid, sodium salt	3	0.4%
152	139-08-2	dimethylbenzylmyristylammonium chloride	3	0.4%
153	139-33-3	disodium ethylene diamine tetra acetate	3	0.4%
154	12008-41-2	disodium octaborate tetrahydrate	3	0.4%
155	34398-01-1	ethoxylated c11 alcohol	3	0.4%
156	30846-35-6	ethoxylated propoxylated 4-nonylphenol-form-aldehyde resin	3	0.4%
157	64742-94-5	heavy aromatic naphtha	3	0.4%
158	25322-68-3	poly(oxy-1,2-ethanediyl),a-hydro-hydroxy- ethane-1,2-diol, ethoxylated	3	0.4%
159	61789-71-7	quaternary ammonium chloride	3	0.4%
160	68989-00-4	quaternary ammonium chlorides derivatives	3	0.4%
161	6381-77-7	sodium erythorbate	3	0.4%
162	2836-32-0	sodium glycolate	3	0.4%
163	64-02-8	tetrasodium ethylenediaminetetraacetate	3	0.4%
164	150-38-9	trisodium ethylenediaminetetraacetate	3	0.4%
165	5064-31-3	trisodium nitrilotriacetate	3	0.4%
166	107-89-1	aldol	2	0.3%
167	54300-24-2	amine salts	2	0.3%
168	86706-87-8	cationic polymethacrylamide	2	0.3%

169	50-70-4	d-glucitol	2	0.3%
170	123-01-3	dodecylbenzene	2	0.3%
171	107-22-2	glyoxal	2	0.3%
172	68130-99-4	oxyalkylated polyamine	2	0.3%
173	127036-24-2	poly(oxy-1,2-ethanediyl), alpha-undecyl-omega-hydroxy-, branched and linear	2	0.3%
174	7681-11-0	potassium iodide	2	0.3%
175	915-67-3	2,7-naphthalenedisulfonic acid, 3-hydroxy-4-[(4-sulfor-1-naphthalenyl) azo] -, trisodium salt	1	0.1%
176	6625-46-3	2,7-naphthalenedisulfonic acid, 5-(acetylamino) -4-hydroxy-3-[(2-methoxyphenyl) azo] -, disodium salt	1	0.1%
177	9003-06-9	acrylamide acrylate copolymer	1	0.1%
178	107-31-1	acrylonitrile	1	0.1%
179	7784-13-6	aluminum chloride, hexahydrate	1	0.1%
180	7429-90-5	aluminum (powder)	1	0.1%
181	1302-76-7	aluminum silicate	1	0.1%
182	61788-62-3	amines, dicoco alkylmethyl	1	0.1%
183	65-85-0	benzoic acid	1	0.1%
184	66402-68-4	ceramic materials and wares, chemicals	1	0.1%
185	68412-53-3	ethoxylated nonylphenol	1	0.1%
186	3734-67-6	food red 10	1	0.1%
187	65997-17-3	glassy calcium magnesium phosphate	1	0.1%
188	7664-39-3	hydrofluoric acid	1	0.1%
189	1302-93-8	mullite	1	0.1%
190	139-13-9	nitrilotriacetic acid	1	0.1%
191	7727-37-9	nitrogen	1	0.1%
192	9051-89-2	polylactide resin	1	0.1%
193	71-23-8	propanol	1	0.1%
194	7789-38-0	sodium bromate	1	0.1%
195	497-19-8	sodium carbonate	1	0.1%
196	7757-83-7	sodium sulfite	1	0.1%
197	10133-44-7	triethanolamine zirconate	1	0.1%

Source: EWG, from DOGGR Well Stimulation Public Disclosure Report.

Appendix 2

The environmental and human health effects of fracking chemicals used in California (2014 to February 2015).

Frequency rank	Chemical	Chemical Abstract Number	Regulations			Human Health Effects										Environmental		Notes:
			Calif. Prop 65 List	Known to contain impurities listed on Prop 65	Federal hazardous air pollutant	Cancer	Reproductive harm	Hormone disruption	Damage to DNA	Central nervous system danage	Liver damage	Kidney damage	Respiratory irritatant	Asthmagen	Harmful or toxic if inhaled	Acute aquatic toxicity	Chronic aquatic toxicity	
1	crystalline silica: quartz (sio2)	14808-60-7	X			X							X			X		Prop 65 for airborne particles; cancer (EU)
2	diatomaceous earth, calcined**	91053-39-3	X			X							X					Prop 65: contains crystalline silica
3	guar gum	9000-30-0																
4	ammonium persulphate	7727-54-0											X	X			X	
5	petroleum distillate (mineral oil, blend 2)	64742-55-8				X												Cancer (EU GHS)
6	petroleum distillate (kerosene, blend 1)	64742-47-8								X					X	X		
7	crystalline silica: cristobalite	14464-46-1	X			X							X					Prop 65: for airborne particles
8	2-methyl-4-isothiazolin-3-one (methylisothiazolinone)	2682-20-4											X			X		Very high acute aquatic toxicity

9	magnesium chloride	7786-30-3																
10	magnesium nitrate	10377-60-3																
11	sodium chloride	7647-14-5														X	X	
12	5-chloro-2-methyl-4-isothiazolin-3-one (methylchloroisothiazolinone)	26172-55-4												X		X	X	Very high acute aquatic toxicity
13	2-butoxy-1 propanol**	15821-83-7																
14	isotridecanol, ethoxylated (polyethyleneglycol isotridecyl ether)	9043-30-5		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide as impurity
15	ethylene glycol	107-21-1			X					X			X			X		
16	sodium hydroxide	1310-73-2											X			X		
17	sodium tetraborate decahydrate (sodium borate)	1303-96-4					X	X					X					
18	hemicellulase enzyme concentrate	9025-56-3																
19	nitrilotris (methylene phosphonic acid)	6419-19-8														X	X	
20	phosphonic acid	13598-36-2																
21	1-butoxy-2-propanol	5131-66-8														X		
22	oxyalkylated amine quat (1,2-ethanediaminium, n,n'-bis[2-[bis(2-hydroxyethyl) methylammonio] ethyl]-n,n'-bis(2-hydroxyethyl)-n,n'-dimethyl-, tetrachloride)**	138879-94-4														X		
23	methanol	67-56-1	X		X	X	X			X	X	X	X		X	X		
24	glycerol	56-81-5														X		

25	2-hydroxytrimethylene,bis(trimethylammonium) dichloride**	3327-22-8		X		X										X		Prop 65: known to contain di-chloromethane, epichlorohydrin, 1,3-dichloro-2-propanol as impurities
26	citric acid	77-92-9														X		
27	hydrated magnesium silicate (talc)	14807-96-6	X			X							X					
28	poly(tetrafluoroethylene)	9002-84-0																
29	vinylidene chloride-methylacrylate polymer**	25038-72-6																
30	isopropanol	67-63-0														X		
31	phenol formaldehyde polymer (resin)	9003-35-4		X		X					X	X	X		X	X		Prop 65: known to contain formaldehyde as impurity
32	lactose	63-42-3																
33	tryptone	73049-73-7																
34	yeast extract	8013-01-2																
35	amorphous silica	7631-86-9																
36	ampicillin	69-53-4											X	X				
37	enzyme	37288-54-3												X		X		
38	acetic acid	64-19-7														X		
39	polyethylene glycol monohexyl ether**	31726-34-8														X		
40	2-ethyl hexanol	104-76-7														X		
41	potassium bicarbonate	298-14-6																
42	boric acid	10043-35-3					X	X	X									
43	methyl borate	121-43-7					X			X								
44	potassium carbonate	584-08-7														X		

45	propylene glycol	57-55-6														X		
46	potassium hydroxide	1310-58-3											X			X		
47	triethanolamine (2,2`,2"-nitrilotriethanol)	102-71-6												X		X	X	
48	2-propenoic acid, polymer with sodium phosphinate**	129898-01-7																
49	diethylene glycol (2,2'-oxydiethanol)	111-46-6		X		X	X		X	X	X		X	X		X		Prop 65: known to contain ethylene oxide as impurity
50	acetic acid, potassium salt	127-08-2																
51	alcohol, c11-14, ethoxylated	78330-21-9		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities
52	calcium chloride	10043-52-4														X	X	
53	dicoco dimethyl quaternary ammonium chloride	61789-77-3												X		X		Very high acute aquatic toxicity
54	methyl oxirane polymer with oxirane	9003-11-6		X		X	X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities
55	potassium borate	1332-77-0					X											
56	potassium oleate	143-18-0														X		
57	tetrakis(hydroxymethyl)phosphonium sulfate	55566-30-8								X		X						

58	alkyl (c10-c14) alcohols, ethoxylated	66455-15-0		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities
59	crosslinked po/eo-block polymer*	68123-18-2																
60	dioctyl sulfosuccinate sodium salt	577-11-7														X		
61	oleic acid	112-80-1														X		
62	alcohol, c7-9-iso, c8, ethoxylated**	78330-19-5														X		
63	acetyl triethyl citrate	77-89-4																
64	xylene	1330-20-7			X										X	X	X	
65	zirconium dichloride oxide	7699-43-6																
66	hydrochloric acid	7647-01-0			X								X	X	X			
67	poly(dimethylaminoethylmethylacrylate) dimethyl sulphate quat.	27103-90-8																
68	propargyl alcohol	107-19-7										X			X	X	X	Very high acute aquatic toxicity
69	thiourea, polymer with formaldehyde and 1-phenylethanone**	68527-49-1											X				X	
70	ammonium chloride	12125-02-9																
71	monoethanolamine	141-43-5								X	X	X	X	X	X	X	X	
72	sulfuric acid	7664-93-9	X			X							X	X	X			Prop 65: for mist
73	2-butoxyethanol (ethylene glycol monobutyl ether)	111-76-2		X		X	X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide as impurity

74	oxyalkyl-ated alkylphenol (ethoxylated nonylphenol)	9016-45-9		X		X	X	X	X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide as impurity; Very high acute aquatic toxicity
75	toluene	108-88-3	X		X		X			X						X		
76	walnut shells	84012-43-1																
77	xylenesulfonic acid	25321-41-9													X			
78	ethoxylated hexanol	68439-45-2		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide as impurity
79	petroleum distil-late blend (3)	8042-47-5																
80	1-hexadecene	629-73-2																
81	1-octadecene (c18)**	112-88-9																
82	alcohols, c14-15, ethoxylated (7eo)	68951-67-7		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities; Very high acute aquatic toxicity
83	cocamidopropyl-amide oxide	68155-09-9												X				
84	mixture of dimer and trimer fatty acids of indefi-nite compostion derived from tall oil**	61788-89-4											X					
85	1-tetradecene	1120-36-1																

86	ammonium fluoride	12125-01-8													X			
87	ethylene oxide	75-21-8	X		X	X	X		X	X			X	X	X	X	X	
88	1-eicosene**	3452-07-1																
89	caprylamidopro-pyl betaine	73772-46-0							X							X	X	
90	cocamidopropyl betaine	61789-40-0														X	X	
91	formaldehyde	50-00-0	X		X	X							X	X	X	X		
92	amines, hydro-genated tallow alkyl, acetates	61790-59-8																
93	citrus terpenes	94266-47-4											X	X	X	X	X	
94	copper dichloride	7447-39-4														X	X	
95	ethoxylated alcohol c12-15	68131-39-5		X		X			X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide and acetalde-hyde as impuri-ties; Very high acute aquatic toxicity
96	ethoxylated castor oil	61791-12-6		X												X		Prop 65: known to contain ethylene oxide, acetaldehyde, 1,4 dioxane as impurities
97	hexamethylene-tetramine	100-97-0		X		X							X	X	X	X		Prop 65: known to release formaldehye impurities
98	hydroxylamine hydrochloride	5470-11-1				X										X	X	Cancer (EU GHS)

99	nonionic alkoxylate**	70559-25-0		X		X							X					Prop 65: known to contain ethylene oxide, acetaldehyde, 1,4 dioxane as impurities
100	organic polyol	112-27-6														X		
101	polyethers**	68815-65-6											X					
102	tricalcium phosphate	7758-87-4										X						
103	1,2,4-trimethyl-benzene	95-63-6											X		X	X	X	Very high acute aquatic toxicity
104	fatty acids, tall-oil	61790-12-3														X		
105	naphthalene	91-20-3	X		X	X										X	X	Very high acute aquatic toxicity
106	formaldehyde polymer with methyl oxirane, 4-nonylphenol and oxirane**	63428-92-2					X				X	X	X			X	X	
107	potassium chloride	7447-40-7																
108	1,2,3-trimethyl-benzene	526-73-8											X					
109	1,3,5-trimethyl-benzene	108-67-8											X				X	
110	alkylaryl sulfonate*	68584-27-0																
111	cumene	98-82-8	X		X	X				X						X		Very high acute aquatic toxicity
112	light aromatic naphtha	64742-95-6				X			X								X	Cancer (EU GHS)
113	olefin**	64743-02-8											X					
114	sodium polyacrylate	9003-04-7														X	X	
115	erythorbic acid	89-65-6																

116	polydimethyl diallyl ammonium chloride	26062-79-3																
117	choline chloride	67-48-1																
118	lauryl hydroxysultaine	13197-76-7																
119	sodium persulfate	7775-27-1																
120	sodium sulfate	7757-82-6														X	X	
121	3-aminopropyl (silanetriol)**	58160-99-9											X					
122	alkylbenzene sulfonate compd. with triethanolamine	68584-25-8												X		X	X	
123	alkylbenzene sulfonate compd. with 2-propanamine**	68584-24-7											X					
124	diethanolamine	111-42-2	X		X	X						X	X	X		X	X	
125	ethanol	64-17-5														X		
126	silanetriol (3-aminopropyl, homopolymer**	68400-07-7																
127	silica gel	112926-00-8																
128	bentonite, benzyl(hydrogenated tallow alkyl) dimethylammonium stearate complex**	121888-68-4		X		X							X					Prop 65: contains crystalline silica as impurity
129	sodium bisulfite	7631-90-5											X					
130	hemicellulase enzyme	9012-54-8																
131	monoethanolamine borate**	26038-87-9											X					
132	polypropylene glycol	25322-69-4																
133	aluminum oxide	1344-28-1											X	X				
134	iron oxide	1309-37-1																
135	titanium oxide	13463-67-7											X					
136	2-monobromo-3-nitrilopropionamide**	1113-55-9											X			X		
137	2,2 dibromo-3-nitrilopropionamide	10222-01-2											X			X		

138	alcohols, c12-16, ethoxylated	68551-12-2		X		X	X		X	X	X		X	X	X	X	X	Prop 65: known to contain ethylene oxide as impurity
139	ammonium bifluoride	1341-49-7																
140	dodecylbenzene sulfonic acid	27176-87-0											X			X	X	
141	formic acid	64-18-6											X					
142	organic* phosphonate	70714-66-8																
143	ulexite**	1319-33-1																
144	xanthan gum	11138-66-2														X		
145	acid phosphate ester	9046-01-9		X		X	X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities
146	alcohol, c9-11-iso, c10, ethoxylated**	78330-20-8		X		X							X				X	Prop 65: known to contain ethylene oxide, acetaldehyde, 1,4 dioxane as impurities
147	alcohol, c9-c11, ethoxylated	68439-46-3		X		X	X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide as impurity
148	ammonium acetate	631-61-8																
149	benzyldimeth-ylammonium chloride	122-18-9												X		X		
150	benzyllauryldi-methylammo-nium chloride	139-07-1												X		X	X	

151	chlorous acid, sodium salt	7758-19-2													X	X	X	Fatal if inhaled or skin contact.
152	dimethylbenzyl-myristylammo-nium chloride	139-08-2												X				
153	disodium eth-ylene diamine tetra acetate	139-33-3														X	X	
154	disodium octaborate tetra-hydrate	12008-41-2											X					
155	alcohol, c11 lin-ear, ethoxylated	34398-01-1		X			X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide as impurity
156	ethoxylated propoxylated 4-nonylphenol-formaldehyde resin	30846-35-6																
157	heavy aromatic naphtha	64742-94-5				X											X	
158	poly(oxy-1,2-ethanediyl),a-hydro-hydroxy-ethane-1,2-diol, ethoxylated	25322-68-3		X		X			X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide and 1,4 dioxane as impurities
159	quaternary am-monium chloride	61789-71-7												X		X	X	
160	quaternary ammonium com-pounds chlorides derivatives	68989-00-4												X		X		
161	sodium erythorbate	6381-77-7																
162	sodium glycolate	2836-32-0																
163	tetrasodium ethylenediami-netetraacetate	64-02-8														X	X	
164	trisodium ethyl-enediaminetet-raacetate	150-38-9																
165	trisodium nitrilo-triacetate	5064-31-3				X												Cancer (EU GHS)

166	aldol (acetaldol)	107-89-1											X					Fatal in contact with skin.
167	amine salts*	54300-24-2																
168	cationic polymethacryl-amide*	86706-87-8																
169	d-glucitol	50-70-4																
170	dodecylbenzene	123-01-3																
171	glyoxal	107-22-2							X						X			
172	oxyalkylated polyamine	68130-99-4																
173	poly(oxy-1,2-ethanediyl), alpha-undecyl-omega-hydroxy-, branched and linear	127036-24-2		X		X	X		X	X	X		X	X	X	X		Prop 65: known to contain ethylene oxide as impurity
174	potassium iodide	7681-11-0																
175	2,7-naphthalene-disulfonic acid, 3-hydroxy-4-[(4-sulfor-1-naph-thalenyl) azo] -, trisodium salt	915-67-3																
176	2,7-naphthalene-disulfonic acid, 5-(acetylamino) -4-hydroxy-3-[(2-methoxyphenyl) azo] -, disodium salt	6625-46-3																
177	acrylamide acry-late copolymer	9003-06-9																
178	acrylonitrile	107-13-1	X		X					X			X		X	X	X	
179	aluminum chlo-ride, hexahy-drate	7784-13-6														X	X	
180	aluminum	7429-90-5											X	X				
181	alluminum sillicate	1302-76-7		X		X							X					Prop 65: contains crystalline silica as impurity, Cancer (EU GHS)
182	amines, dicoco alkylmethyl	61788-62-3																
183	benzoic acid	65-85-0													X	X		

184	ceramic materials and wares, chemicals	66402-68-4																
185	ethoxylated nonylphenol**	68412-53-3		X												X	X	Prop 65: known to contain ethylene oxide, acetaldehyde, 1,4 dioxane as impurities
186	food red 10	3734-67-6																
187	glassy calcium magnesium phosphate	65997-17-3																
188	hydrofluoric acid	7664-39-3			X								X		X			Fatal if inhaled
189	mullite**	1302-93-8	X			X							X					Prop 65: contains crystalline silica
190	nitrilotriacetic acid	139-13-9	X			X												
191	nitrogen	7727-37-9																
192	polylactide resin	9051-89-2																
193	propanol	71-23-8								X						X		
194	sodium bromate	7789-38-0											X					
195	sodium carbonate	497-19-8																
196	sodium sulfite	7757-83-7																
197	triethanolamine zirconate**	101033-44-7											X					

Notes:

* No MSDS sheet identified

** Only MSDS information available. Data may be limited. Further study may determine additional risks or inclusion on toxicity lists.

APPENDIX 2

REFERENCES

CA Proposition 65 List: Hazardous Air Pollutants:

OEHHA (Office of Environmental Health Hazard Assessment) 2015. http://oehha.ca.gov/prop65/prop65_list/files/P65single051115.pdf

EPA, Office of Air Quality, Planning & Standards. Section 112 Hazardous Air Pollutants List. http://www.epa.gov/ttn/atw/188polls.html

Cancer:

CA Proposition 65 list. OEHHA 2015. http://oehha.ca.gov/prop65/prop65_list/files/P65single051115.pdf

American Conference of Governmental Industrial Hygienists (ACGIH): Threshold Limit Value (TLV) Basis. https://www.acgih.org

International Agency for Research on Cancer: IARC 103. http://monographs.iarc.fr/ENG/Classification/

National Toxicology Program (NTP): NTP 12th RoC. http://ntp.niehs.nih.gov/pubhealth/roc/roc13/index.html

Environmental Protection Agency (EPA): EPA Integrated Risk Information System (IRIS). http://www.epa.gov/iris/search_human.htm

EU GHS Hazard Labeling Codes: GHS Hazard Codes. http://ec.europa.eu/environment/archives/dansub/home_en.htm

Reproductive:

CA Proposition 65 list. OEHHA 2015. http://oehha.ca.gov/prop65/prop65_list/files/P65single051115.pdf

EU GHS Hazard Labeling Codes: GHS Hazard Codes

EU ECHA Substances of Very High Concern, toxic for Reproduction. http://echa.europa.eu/candidate-list-table

Endocrine Disruption:

EU Endocrine Disruptor. Clear evidence of endocrine disruption in at least one animal study. http://ec.europa.eu/environment/chemicals/endocrine/strategy/substances_en.htm

Genetic Effects-Damage to DNA:

EU GHS Hazard Labeling Codes: GHS Hazard Codes

The peer-reviewed study reports methylchloroisothiazolinone is mutagenic [T. H. Connor, P. G. Tee, M. Afshar & K. M. Connor. 1996. Mutagenicity of cosmetic products containing Kathon. Environmental and molecular mutagenesis 28(2), 127-32

Central Nervous System effects:

Central Nervous System impairment. American Conference of Governmental Industrial Hygienists (ACGIH): Threshold Limit Value (TLV) Basis

Central nervous system depression [Centers for Disease Control and Prevention (CDC): NIOSH Pocket Guide to Chemical Hazards

EU GHS Hazard Labeling Codes: GHS Hazard Codes

Liver Damage:

Liver Damage. American Conference of Governmental Industrial Hygienists (ACGIH): Threshold Limit Value (TLV) Basis

A U.S. Environmental Protection Agency review finds inhalation of 2-butoxyethanol causes liver damage in lab animals. [U.S. Environmental Protection Agency. 2010. Toxicological Review of Ethylene Glycol Monobutyl Ether (EGBE)

Kidney Damage:

Kidney damage [American Conference of Governmental Industrial Hygienists (ACGIH): Threshold Limit Value (TLV) Basis

A review article reports phosphates are associated with increased risk for kidney disease in people. [Geoffrey A. Block, Keith Hruska, Harald Jüppner, Myles Wolf, Marcello Tonelli, Ravi I. Thadhani, Kevin J. Martin, Markus Ketteler, Joachim H. Ix & David C. Wheeler. 2013. Phosphate Homeostasis in CKD: Report of a Scientific Symposium Sponsored by the National Kidney Foundation. American journal of kidney diseases : the official journal of the National Kidney Foundation. (Tricalcium phosphate, CAS 7758-87-4)

Respiratory Irritation:

Causes respiratory irritation [Centers for Disease Control and Prevention (CDC): NIOSH Pocket Guide to Chemical Hazards

Lower respiratory tract irritation. American Conference of Governmental Industrial Hygienists (ACGIH): Threshold Limit Value (TLV) Basis

May cause respiratory irritation. EU GHS Hazard Labeling Codes: GHS Hazard Codes.

Asthmagen:

Asthmagen [AOEC: AOEC Asthmagen list. http://www.aoecdata.org

Harmful or toxic if inhaled:

Toxic or Harmful if inhaled. EU GHS Hazard Labeling Codes:

GHS Hazard Codes.

Acute Toxicity:

Environmental Protection Agency (EPA): EPA Fathead Minnow Acute Toxicity Database. http://www.epa.gov/med/Prods_Pubs/fathead_minnow.htm

EU ecolabel: Detergents Ingredients Database. http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

U.S. Environmental Protection Agency (EPA). 1998. Reregistration Eligibility Decision (RED) Methylisothiazolinone. EPA738-R-98-012

U.S. Environmental Protection Agency (EPA). 2012. DfE Alternatives Assessment for Nonylphenol Ethoxylates.

EU GHS Hazard Labeling Codes: GHS Hazard Codes

Chronic Toxicity:

EU ecolabel: Detergents Ingredients Database. http://ec.europa.eu/environment/ecolabel/products-groups-and-criteria.html

U.S. Environmental Protection Agency (EPA). 2012. DfE Alternatives Assessment for Nonylphenol Ethoxylates.

Toxic to aquatic life with long lasting effects [EU GHS Hazard Labeling Codes: GHS Hazard Codes]