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MEMORANDUM

TO:	Board of Supervisors' Transportation and Planning Committee
FROM:	Chris Bazar, Director, Community Development Agency $\subset\!$
DATE:	September 4, 2014

SUBJECT: Presentation on Hydraulic Fracturing (Fracking) and Related Enhanced Oil Well Stimulation Techniques

Background:

The Transportation and Planning Committee, at its July meeting, requested from staff a presentation on Hydraulic Fracturing (Fracking). While the topic of enhanced well stimulation is fairly complex both physically and legally, the presentation accompanying this memo attempts to touch upon the key issues and bring together enough information for a basic understanding of the process and issues surrounding it.

Discussion:

This presentation includes the following topic areas related to Enhanced Well Stimulation Techniques:

- Description of hydraulic fracturing, acidization and cyclic steam stimulation
- Why hydraulic fracturing is used
- Water use in hydraulic fracturing
- Locations of major California petroleum deposits
- Potential environmental problems associated with fracking in California and other states air and water quality, seismic issues
- Efforts to restrict fracking in other states and California, and their effectiveness
- Alameda County oil wells and production
- Possible County Actions

A copy of the full presentation is attached to this letter. A draft ordinance that would restrict enhanced extraction techniques, suggested by the environmental community, is also attached; County Counsel is reviewing the details of this draft ordinance. There is potential concern, based on recent court cases, that efforts to restrict the method of petroleum extraction could be legally vulnerable to a challenge. Given that the draft ordinance does specify the method of petroleum extraction to be prohibited, staff recommends that this ordinance be reworked -should your Committee direct staff to move forward with an ordinance -- to reflect recent case law and avoid a possible legal challenge.

Based on the information contained in this memo and its attachments, Staff seeks further direction from the Transportation and Planning Committee.

Attachments

OVERVIEW OF HYDRAULIC FRACTURING

Alameda County Planning Department, September, 2014

How Hydraulic Fracturing Works

Hydraulic fracturing (also known as "fracking") is the high-pressure injection of a mix of fluids and substances called "proppants" into an oil or gas reservoir.

The mix fractures the reservoir rock. When the fluids are removed, the proppants keep open the cracks left by fracturing, allowing oil or natural gas to flow back to the well.

(<u>http://1.bp.blogspot.com/-Fr3V1qGcEhU/Tjboc_ot-</u> <u>UI/AAAAAAAAq4/Zf-</u> <u>hfin65Yc/s1600/drillingGRAPHIC_611301a.jpg</u>)

HOW HYDRAULIC FRACTURING WORKS



Wellhead and Casings

The wellhead and casings are designed to penetrate numerous layers of impermeable rock and aquifers to reach the oil and gas bearing shale deposits deep below the surface.

The design of the casings should protect the groundwater aquifers from contamination, and allow the fracking fluid to be injected at high pressure into the formation of interest.

http://www.laredoenergy.com/sites/default/files/images/re sources_largewatergraphic.jpg



Example of hydraulic fracturing for shale development

Fracking Fluid Composition

- * The injected fluid is composed of about 93-95% water, about 5-6% sand, and about 1% various chemicals used for various functions – lubrication, clay stabilization, rock dissolution, corrosion inhibition and so on.
- * The chemicals used depend on the kind of rock to be fractured, but can include a number of organic and inorganic compounds. In California, where acidization is a common form of fracturing, hydrofluoric acid or other strong acids may be mixture components.

(<u>http://fracfocus.ca/chemical-use/what-chemicals-are-used</u>, "What Chemicals are Used," Frac Focus Canada, 2014).

Brief History

- Hydraulic fracturing was first used in 1947 in a well in Kansas.
- Since then, hydraulic fracturing has been commonly used to tap previously unrecoverable reserves, or to stimulate increased production from existing oil or gas wells. Used in many states and around the world.
- In California, hydraulic fracturing has been used as a production stimulation method for more than 30 years.

(<u>http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx</u>, "Hydraulic Fracturing in California," California Department of Conservation, 2014)

(http://www.sourcewatch.org/index.php/California_and_fracking, "California and Fracking," SourceWatch, 2014)

Acidization (alternate to Hydraulic Fracturing)

Acidizing, another well stimulation process, involves the injection of hydrofluoric and/or hydrochloric acids to corrode the rock formation and allow for increase oilflow. This type of enhancement is commonly used in California deposits.

Hydrofluoric acid corrodes glass, steel, and rock. Drillers have been injecting it underground for years in dilute quantities (up to 9% HF) to extract the last bit of oil from depleted wells, and injecting in stronger concentrations to dissolve oil-bearing shale. What happens over the long term to the rock, and to the HF acid-laced water, is unknown.

Drillers must get a permit from the state Division of Oil, Gas, and Geothermal Regulations, but do not have to tell the state if they are fracking, using acid, or something else, although SB4, passed in September 2013, does place fracking and acidizing under state purview.

(<u>http://www.sourcewatch.org/index.php/California_and_fracking</u>, "California and Fracking," SourceWatch, 2014) (<u>http://www.cleanwateraction.org/fracking-california</u>, "Oil, Gas and Fracking in California," Clean Water Action, 2014).

Cyclic Steam Stimulation (Steam Injection)

- Cyclic Steam Stimulation (Steam Injection) is an increasingly common method of extracting heavy crude oil. It is considered an enhanced oil recovery (EOR). There are two main forms, these being Cyclic Steam Stimulation and Steam Flooding.
 - Cyclic Steam Stimulation (CSS) has been likened to a chemical-free version of fracking. Unlike the common well stimulation practice called steam flooding, cyclic steaming injects steam at high pressure specifically to break up relatively shallow, diatomaceous soil.
 - Steam injection is widely used in the San Joaquin Valley and other parts of California.

Water Use in Hydraulic Fracturing

Fracking is a water-intensive activity. Oil wells in the Eastern USA and Texas often use many millions of gallons of water per well. In California, while water use is still significant, these values tend to be lower.

(http://ecowatch.com/wp-content/uploads/2012/09/Screen-Shot-2012-09-25-at-10.20.06-AM.png, 2012)

Rank*	State	Fracks Reported	Average (in gallons)	Total Used	% of Total Water Use
1	Texas	11,922	2,573,701	30,683,667,301	47%
2	Colorado	4,205	1,242,158	5,223,274,238	8%
3	Pennsylvania	1,884	4,328,886	8,155,620,871	12%
4	North Dakota	1,353	2,010,931	2,720,789,835	4%
5	Arkansas	1,305	5,223,972	6,817,283,249	10%
6	Wyoming	1,131	761,048	860,745,353	1%
7	Oklahoma	1,113	3,756,270	4,180,728,158	6%
8	Louisiana	930	5,341,088	4,967,211,610	8%
9	New Mexico	789	663,868	523,791,968	0.8%
10	Utah	783	352,288	275,841,828	0.4%
11	California	314	167,507	52,597,101	0.1%
12	West Virginia	178	4,720,082	840,174,633	1.3%
N/A	All Other States	432	1,383,994	597,885,252	0.9%
*by # of fracks	TOTAL	26,339	2,501,984	65,899,611,396	100%

Annual Oil and Gas Production in Alameda County

Annual Oil and Gas production in Alameda County has never been large by scales experienced in other locations such as TX, OK, PA or Southern California, but modest amounts of fossil fuels have been extracted from wells in the East County for decades. Gas production has not been significant for 30 years, and current oil production is at it's lowest level in more then 40 years (only 1267 barrels in 2014), despite high prices (source – Drilling Edge, 2014 - <u>http://www.drillingedge.com/california/alameda-county</u>)



Existing Oil Well Locations

While many wells have been drilled in Alameda County over the decades, only about a dozen have been in operation the last ten years, and of these, only a few are in operation today. The wells in operation during the last 10 years are shown as solid black dots, other locations are closed and capped. (Source - ftp://ftp.consrv.ca.gov/pub/oil/maps/dist6/608/Map608.pdf -

DISCLAIMER from DoC: The well information and data represented on this site varies in accuracy, scale, origin and completeness and may be changed at any time without notice...)



Locations of California's Major Oil Deposits

California has one of the largest shale oil plays in the nation - the Monterey Shale. It, and other oil-bearing deposits, span much of the Central Valley, where most of California's fracking currently takes place, and Southern California. The Monterey Shale and related deposits may extend under portions of Alameda County. It contains oil that has historically been too difficult to extract.

(From http://www.cafrackfacts.org/wpcontent/uploads/2013/11/Monterey-shaleillustration.png)



The Monterey Shale Formation

- Believed to be among the largest reservoirs of frackable oil in the U.S., with original estimates up to 14 billion barrels of recoverable oil resource.
- However, this value was downgraded by 96% to only 600 million barrels recoverable in May, 2014, by the U.S. Energy Information Administration.
- This dashed the hopes of oil industry experts for easy access to the massive oil resource, although future technology could allow the estimated value of accessible oil to increase again.

(<u>http://www.mercurynews.com/california/ci_25810989/fracking-new-monterey-shale-oil-estimate-rocks-californias</u>, "Fracking: New Monterey Shale oil estimate rocks California's expectations," San Jose Mercury News, May 21, 2014)

Although Alameda County is potentially underlain by the Monterey Shale formation, to date, no proposals are known to conduct hydraulic fracturing or acidization on any of the existing wells in Alameda County, all of which are located in the East County near Greenville Road. These wells are, at present, very low production wells, although they have yielded higher quantities in the past.

(From: http://earthjustice.org/features/campaigns/fracking-across-the-united-states)



Shale basin and plays geographic data were retrieved from the U.S. ENERGY INFORMATION ADMINISTRATION and were current as of May 9, 2011.

Hydraulic Fracturing in California

- Most of California's remaining oil and gas reservoirs require some form of stimulation to flow.
- In California, hydraulic fracturing is used to ensure that conventional wells attain maximum production, often a preferable alternative to drilling additional wells. This practice complies with current State regulations to protect groundwater and public health and safety.
- Hydraulic fracturing methods differ from region to region nationwide. In other states, extraction requires lengthy fracking periods along lengthy stretches (up to hundreds of yards) of horizontally-drilled production wells. Millions of gallons of water are injected under constant pressure, a process that may take days or weeks to effectively open the reservoir rock.
- In California, much less water is used and the period of pressurizing the reservoir rock is much shorter. Fracturing projects tend to use less fluid to fracture within a narrow vertical band, generally starting at a point several thousand feet underground, with the fractures extending only tens to hundreds of feet away from the well. Most of California's oil and gas production to date has been from vertical wells into traditional oil and natural gas reservoirs.

(<u>http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx</u>, "Hydraulic Fracturing in California," California Department of Conservation, 2014)

Issues with Fracking in California

- In California, hydraulic fracturing has been used as a production stimulation method for more than 30 years with no formally reported damage to the environment.
- However, in 2009, a jury in Kern County found that 96 million barrels of wastewater from drilling had leached from holding ponds onto a farmer's property, resulting in contamination of the aquifer beneath his land. In 2010, contaminants from a wastewater injection well bubbled up in a west Los Angeles dog park. In both cases, the connection with fracking itself is indirect.
- In 2011, a Chevron manager died in a sinkhole at the Central Valley's Midway-Sunset oil field. The theory behind the sinkhole is that high-pressure steam from a Cyclic Steam Stimulation (CSS) operation "migrated" from a nearby injection project and escaped through Chevron's problem well.
- According to the Bakersfield Californian, CSS created ongoing problems at the oil fields: "Other oil fields in Kern County have repeatedly experienced seepage and even violent volcanoes in which oil, water, and rocks can shoot 50 to 60 yards through the air. In fact, about a month and a half after [Chevron manager] Taylor's death, one such eruption at the sinkhole site continued for three days. That event prompted [a shut down of] steam injection activity within 500 feet of Chevron's 'broken' well."

(http://www.conservation.ca.gov/dog/general_information/Pages/HydraulicFracturing.aspx, "Hydraulic Fracturing in California," California Department of Conservation, 2014)

(http://www.sourcewatch.org/index.php/California_and_fracking, "California and Fracking," SourceWatch, 2014)

Issues in Other States

According to the National Resources Defense Council (NRDC):

"Communities across the country have experienced a wide range of negative impacts from natural gas production. Drinking water sources have been contaminated with explosive methane, as well as other dangerous substances, such as benzene and arsenic, that can cause cancer and other serious illnesses. Toxic chemicals, as well as erosion and runoff from drilling operations, have fouled treasured fishing streams and aquatic habitat. Leaks and spills of hazardous materials have polluted bodies of water, forests, farms, and backyards. Farmers and ranchers report serious health symptoms in livestock near natural gas operations. Exposure to open pits has killed countless birds and other wildlife. Emissions from drilling rigs, well-pad equipment, storage tanks, compressor stations, and truck traffic contribute to harmful ozone levels. The wells, roads, and pipelines that come with natural gas development can displace wildlife and fragment their habitats. And methane emissions from production sites and pipelines contribute to climate change pollution. There have even been incidences of serious human health threats that have led families to abandon their homes in order to preserve their children's health."

(<u>http://www.nrdc.org/energy/files/frackingrisks.pdf</u> , National Resources Defense Council, 2014)

Air Quality Issues

States with extensive hydrofracturing, such as Wyoming, Utah and Texas, suffer from serious air quality problems apparently related to hydrofracturing. In a community known as DISH, Texas (which overlies the extensive Barnett Shale formation that holds as much as 735 billion cubic meters of natural gas)—according to Scientific American :

"...a set of seven samples collected throughout the town analyzed for a variety of air pollutants last August found that benzene was present at levels as much as 55 times higher than allowed by the Texas Commission on Environmental Quality (TCEQ). Similarly, xylene and carbon disulfide (neurotoxicants), along with naphthalene (a blood poison) and pyridines (potential carcinogens) all exceeded legal limits, as much as 384 times levels deemed safe...DISH sits at the heart of a pipeline network now tuned to exploit a gas drilling boom in the Fort Worth region."

(<u>http://www.scientificamerican.com/article/shale-gas-and-hydraulic-fracturing/</u>, "What the Frack? Natural Gas from Subterranean Shale Promises U.S. Energy Independence--With Environmental Costs," Scientific American, March 30, 2010)

Air Quality Issues

Gas drilling aided by fracking in the Upper Green River Basin of Wyoming is booming, but the basin has experienced in recent years ozone levels higher than those normally found on bad days in Los Angeles. From a 2011 Huffington Post article:

"...Preliminary data show ozone levels last Wednesday got as high as 124 parts per billion. That's two-thirds higher than the Environmental Protection Agency's maximum healthy limit of 75 parts per billion and above the worst day in Los Angeles all last year, 114 parts per billion, according to EPA records... "

"The Wyoming Department of Environmental Quality urged the elderly, children and people with respiratory conditions to avoid strenuous or extended activity outdoors."

(http://www.huffingtonpost.com/2011/03/08/wyoming-ait-pollution-gas-drilling_n_833027.html)

Water Quality Issues

In a January 2014 USA Today article, the Associated Press (AP) reports significant and common potential water quality problems associated with **drilling made viable by fracking technology** across various states. Reporting and analysis varies considerably from state to state, and so Variations in results occur. Among the findings in the AP's review (<u>http://www.usatoday.com/story/Money/Business/2014/01/05/some-states-confirm-water-pollution-from-drilling/4328859/</u>, "4 states confirm water pollution from drilling," USA Today, January 5, 2014).

- "— Pennsylvania [Environmental Department] has confirmed at least 106 water-well contamination cases since 2005, out of more than 5,000 new wells. There were five confirmed cases of water-well contamination in the first nine months of 2012, 18 in all of 2011 and 29 in 2010.
- Department of Natural Resources of Ohio had 37 complaints in 2010 and no confirmed contamination of water supplies; 54 complaints in 2011 and two confirmed cases of contamination; 59 complaints in 2012 and two confirmed contaminations; and 40 complaints for the first 11 months of 2013, with two confirmed contaminations and 14 still under investigation. None of the six confirmed cases of contamination was related to fracking.
- West Virginia has had about 122 complaints that drilling contaminated water wells over the past four years, and in four cases the evidence was strong enough that the driller agreed to take corrective action, officials said.
- A Texas spreadsheet contains more than 2,000 complaints, and 62 of those allege possible well-water contamination from oil and gas activity, said Ramona Nye, a spokeswoman for the Railroad Commission of Texas, which oversees drilling. Texas regulators haven't confirmed a single case of drilling-related water-well contamination in the past 10 years, she said."

Seismic Issues

- Although California has not yet experienced known significant impacts to seismic activity and safety as a result of drilling and fracking, other states have experienced seismicity that government experts have linked to fracking and related activities. This problem has shown up most notably in Oklahoma.
- The U.S. Geological Survey says the number of earthquakes in Oklahoma has gone up dramatically in recent months and that the surge in seismic activity has increased the danger of a damaging quake in the central part of the state.
- The USGS and Oklahoma Geological Survey issued a joint statement a few months ago citing a dramatic spike in magnitude-3.0 temblors, especially since October 2013.

U.S.G.S: "Record Number of Oklahoma Tremors Raises Possibility of Damaging Earthquakes"

Updated USGS-Oklahoma Geological Survey Joint Statement on Oklahoma Earthquakes Originally Released: 10/22/2013 1:07:59 PM; Updated May 2, 2014:

- The USGS statistically analyzed the recent earthquake rate changes and found that they do not seem to be due to typical, random fluctuations in natural seismicity rates. Significant changes in both the background rate of events and earthquake triggers needed to have occurred in order to explain the increases in seismicity, which is not typically observed when modeling natural earthquakes.
- The analysis suggests that a likely contributing factor to the increase in earthquakes is triggering by wastewater injected into deep geologic formations. This phenomenon is known as injection-induced seismicity, which has been documented for nearly half a century, with new cases identified recently in Arkansas, Ohio, Texas and Colorado. A recent publication by the USGS suggests that a magnitude 5.0 foreshock to the [magnitude 5.6] 2011 Prague, Okla., earthquake was human-induced by fluid injection; that earthquake may have then triggered the mainshock and its aftershocks. OGS studies also indicate that some of the earthquakes in Oklahoma are due to fluid injection. The OGS and USGS continue to study the Prague earthquake sequence in relation to nearby injection activities.

(http://earthquake.usgs.gov/regional/ceus/products/newsrelease 05022014.php)

Oklahoma Seismicity

The map below shows seismic events in Oklahoma since 1970. The blue dots cover the first 40 years of that period, through 2009; the red dots show earthquakes since 2010. The recent large upswing in seismic activity corresponds to the era of expanded enhanced extraction of gas and oil.

(http://www.npr.org/blogs/thetwo-way/2014/05/05/309888859/usgs-okla-fracking-has-increased-chance-of-damaging-quake)



The agencies said "183 earthquakes of magnitude 3.0 or greater occurred in Okla. from October 2013 through April 14, 2014. This compares with a long-term average from 1978 to 2008 of only two magnitude 3.0 or larger earthquakes per year. As a result of the increased number of small and moderate shocks, the likelihood of future, damaging earthquakes has increased for central and north-central Oklahoma."

"The statement says "a likely contributing factor to the increase in earthquakes is [oil and gas production] wastewater disposal by injection into deep geologic formations. The water injection can increase underground pressures, lubricate faults and cause earthquakes... The recent earthquake rate changes are not due to typical, random fluctuations in natural seismicity rates."



EFFORTS to Ban or Place Moratoria on Fracking

Many communities nationwide and in California have passed or are considering bans on fracking.

In 2014, in New York and Pennsylvania, two city / community bans that challenged state law in court have been upheld by the courts in those states. In both cases, and especially in the Pennsylvania case, state laws that guaranteed the right to extract oil by fracking as preempting local zoning laws were successfully challenged.

Pennsylvania - <u>Robinson Township v Pennsylvania</u>.

In regard to Pennsylvania, the challenge centered around a state law known as Act 13, which has already been struck down by the State Supreme Court.

- "Act 13, put into effect in 2012, allowed wells, pipelines, impoundments, and seismictesting explosives to take place "of right" in every zoning district, even residential ones. One section of the law asserted the oil and gas laws "occupy the entire field of regulation, to the exclusion of all local ordinances."
- Six townships and a borough sued.
- Four court justices concurred in striking down Act 13, as against three dissenters... The 3justice lead opinion invoked the "public trust" doctrine in the Pennsylvania constitution, which requires all branches of government — including counties and townships — to consider in advance the environmental effect of any proposed action.
- The one remaining concurring justice's view was that Act 13's preemption violated constitutional substantive due process.
- The bottom line of all four justices is the same: Townships and boroughs in Pennsylvania are now free to ban fracking.

(<u>http://banmichiganfracking.org/#sthash.J3PrsBhI.dpuf</u>)



Several municipal fracking bans in other states, notably Colorado, have been overturned by courts in successful challenges by industry groups and possibly Colorado's own Oil and Gas Conservation Commission.

Like many states, Colorado has a 1951 law that prioritizes state regulation of oil and natural gas above all else.

The most recent ban to be discarded by the court was the 5year moratorium passed by voters in Fort Collins. The decision came in early August, 2014.

(http://thehill.com/policy/energy-environment/214678-judge-overturns-colorado-citys-frackingban#ixzz39oytOPsI)

Anti-Fracking Efforts in California

- In California, as in other states, natural resources law pre-empts local regulation of oil drilling generally (e.g. methods of drilling, etc), although it does not normally prevent local jurisdictions from regulating land uses (e.g. barring oil extraction in certain zones, etc).
- To date, several California municipalities have considered bans and moratoria on oil extraction and/or fracking, many choosing to place these decisions on the ballot as voter initiatives in November 2014. As examples, Santa Cruz County, based on health and safety risks, adopted a general plan amendment banning oil and gas exploration. The City of Beverly Hills banned fracking and similar extraction techniques.
- The Cities of Compton and Carson have both placed moratoria on fracking activities in 2014, Compton's being of indefinite length. Other bans and moratoria are expected to be considered in coming months in many other locations.
- To date, there has been one legal challenge in California -- the Western States Petroleum Association 's challenge of Compton's actions on constitutional and police power grounds. The ordinance, which was adopted April 22, prohibits the use of hydraulic fracturing or any other well stimulation treatment to extract or produce oil, gas or other hydrocarbons from any surface location within the city, or outside the city limits where the subsurface bottom hole is located beneath the city.
- Western States Petroleum Association argues that Compton's ordinance impermissibly regulates drilling methods and is therefore pre-empted under state law, based in part on last year's SB 4 (Pavley). Thus, ordinances/policies defining and banning "fracking" may face challenges from industry as being pre-empted by state law.

(http://www.bna.com/petroleum-trade-group-n17179892818/, Bloomberg BNA, July 22, 2014)

Options for Alameda County

Alameda County has six major options it may consider.

- Do nothing, and allow oil operators to use enhanced well stimulation if they wish.
- 2. Pass an ordinance requiring administrative or discretionary review of enhanced well stimulation proposals.
- 3. Adopt a moratorium on enhanced stimulation.
- 4. Adopt a ban on enhanced stimulation.
- 5. Adopt a moratorium or ban on all new oil and gas activities.
- 6. Track the outcome on the City of Compton legal challenge, and then choose a strategy.

Sample Ordinance (provided by environmental community representatives) to Ban the Use of Land for Fracking and Other High-Intensity Petroleum in Unicorporated Areas of Alameda County

Whereas, the purpose of this Ordinance is to protect the public health and safety, and general welfare of the residents of Alameda County and to safeguard the local air, water, and soil our County depends on; and

whereas high-intensity petroleum operations including but not limited to: hydraulic fracturing, acid well stimulation, acid matrix, enhanced recovery wells, and combinations of these and other extreme methods; require the use of chemicals known to be hazardous to humans and the environment; and utilize vast quantities of water; and

whereas high-intensity petroleum operations threaten contamination of ground and surface water; contribute hazardous chemicals to air pollution; contaminate soil and, in the processes of extraction, transport and refining, emit large quantities of greenhouse gases; and

whereas High-Intensity Petroleum Operations as well as the disposal of waste fluid resulting from these operations have now been shown to cause increased strength and frequency of earthquakes; and

whereas all of Alameda County is considered highly seismically active with numerous identified earthquake faults, including the Hayward and Calaveras Faults;

whereas the unincorporated areas of Alameda county include and are adjacent to some of the most densely populated areas in California; and

whereas these same unincorporated areas of Alameda county serve as underground water storage for much of Alameda County as well as underground water storage for San Francisco County; and

whereas water scarcity is a frequently recurring problem in Alameda County and predicted to become worse as the effects of climate change accelerates; and

whereas Alameda County already experiences serious air pollution problems; and

whereas the significant greenhouse gas emissions that would result from high-intensity petroleum operations would undermine Alameda County's Climate Action Plan's goal of reducing greenhouse gas emissions 80% by 2050; the Board of Supervisors of the County of Alameda find that the use of land for the development, construction, installation, or operation of any facility, appurtenance, or above-ground equipment in support of high-intensity petroleum operations as defined below is incompatible within the unincorporated portions of Alameda County and is prohibited in all unincorporated areas of Alameda County.

Traditional oil and gas extraction operations already permitted within the county may continue, but those operational wells are prohibited from being subject to any of the high-intensity petroleum operations prohibited in the unincorporated areas of Alameda County.

Definitions (Taken from San Benito's *Protect Our Water and Health: Ban Fracking Initiative.*)

"High-Intensity Petroleum Operations" mean (1) Well Stimulation Treatments and/or (2) the operation of Enhanced Recovery Wells. "Well Stimulation Treatment" means any treatment of a well designed to enhance oil and gas production or recovery by increasing the permeability of the formation. Well Stimulation Treatments include, but are not limited to, Hydraulic Fracturing Treatments and Acid Well Stimulation Treatments.

"Hydraulic Fracturing Treatment" means a Well Stimulation Treatment that, in whole or in part, includes the pressurized injection of hydraulic fracturing fluid or fluids into an underground geologic formation in order to fracture or with the intent to fracture the formation, thereby causing or enhancing the production of oil or gas from a well.

"Acid Well Stimulation Treatment" means a Well Stimulation Treatment that uses, in whole or in part, the application of one or more acids to the well or underground geologic formation. The Acid Well Stimulation Treatment may be at any applied pressure and may be used in combination with Hydraulic Fracturing Treatments or other Well Stimulation Treatments. Acid Well Stimulation Treatments include acid matrix stimulation treatments and acid fracturing treatments. Acid matrix stimulation treatments are acid treatments conducted at pressures lower than the applied pressure necessary to fracture the underground geologic formation.

"Enhanced Recovery Wells" means wells that are injected with brine, water, steam, polymers, carbon dioxide, or other fluids into oil-bearing formations to recover residual oil and in some limited applications natural gas. The injected fluid thins (decreases the viscosity) or displaces oil and gas, which is then available for recovery. Examples include waterflood injection, steamflood injection, and cyclic steam injection.