Frack or Fiction

Recommendations for Regulation of Hydraulic Fracturing in California
For the Department of Oil, Gas, and Geothermal Resources

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Executive Summary

California has often been a trailblazer among the 50 states in environmental policy. This has not yet been the case in the regulation of hydraulic fracturing for oil and gas production. This report offers recommendations for the Department of Oil, Gas, and Geothermal Resources (DOGGR) to take the Golden State from laggard to leader. Despite great interest in the oil trapped in California's Monterey shale formation, California's oil production has not surged so far. The state's oil production did increase in 2012 for the first time since 1997,[2] but new advances in hydraulic fracturing and other emerging techniques have yet to unlock the Monterey shale's oil in any meaningful quantity. There is still time to get this right.

The state has put in place world class policies on clean energy adoption and reducing greenhouse gas emissions, but oil will be a substantial part of the state's transportation energy mix for years to come. Increased oil production in California could yield economic benefits. It will not be easy to realize these benefits while also disproving the idea that environmental protection sacrifices economic growth. To accomplish this, a much stronger regulatory approach than DOGGR initially proposed will be required. The drive to harvest unconventional oil must be accompanied by industry modernization and safeguards for water, air, and land. Can fracking be a true boon to the state, not just an industry fiction? The answer will depend on the state's policymakers.

Figure ES-1: Monterey formation, about 64% of US Shale Oil

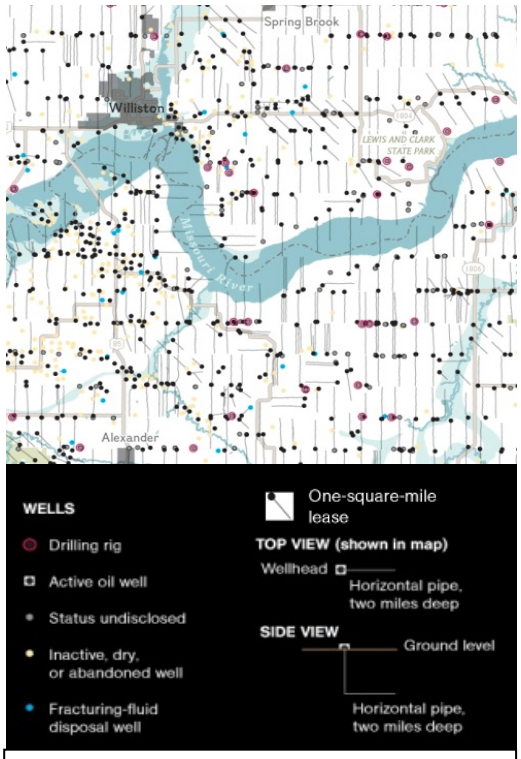
Source: New York Times.

[1] Thank you for input from Sonia Aggarwal, Hal Harvey, Hallie Kennan, Veery Maxwell, Cliff Rechtschaffen, Sarah Jo Szambelan, and Jeffrey Rissman. For more information about Energy Innovation please visit www.energyinnovation.org.
[2] David Baker. "California oil production rises slightly." San Francisco Chronicle. February 27, 2013.

Background. Hydraulic fracturing, also known as fracking, involves injecting a mixture of fluids ("fracking fluid") at high pressure deep underground to break up rock, releasing natural gas and oil trapped inside. Improvements in fracking technology, in combination with better horizontal drilling techniques, have changed the economics of energy in the United States, causing the supply of natural gas to grow and driving down gas prices by some 70 percent below their most recent peak in 2008.[3] Fracking is also used to extract oil found from shale formations. As a result, the International Energy Agency now predicts that the United States will be the largest oil producer in the world by 2020.[4] California's Monterey formation, mapped in Figure ES-1, is estimated to hold almost two-thirds (64 percent) of U.S. recoverable domestic shale oil resources.[5]

Benefits and risks. Localized economic development, lower natural gas prices and reduced dependence on imported energy are potential benefits of oil and gas extraction, but there are environmental risks to consider too. Compared to conventional production, fracking imposes a greater burden on the atmosphere, water, and land.

Figure ES-2. Fracking in North Dakota



This map shows the extent of fracking for oil in North Dakota, one of the places in the US where the technology has had the greatest impact. The impact on the landscape is dramatic, even though only the well heads are above ground. Source: National Geographic.

Methane leaks. Natural gas is mostly methane, a greenhouse gas roughly 25 times more potent than carbon dioxide. There is methane leakage throughout the natural gas system, from start to end use. More leakage ("fugitive methane") happens at the production stage when fracking is used, though new "green completion" approaches are reducing these emissions. Methane leaks are associated with oil production too, but they are a smaller fraction of overall methane emission. Uncertainty remains about the true leakage rate, but if the reality lies closer to the higher estimates, electricity generated from natural gas could be even worse than that from coal in global warming terms.

Water. Faulty well construction can lead to contaminated aquifers, important sources of drinking water. Fracking uses large volumes of water because it is the main component of fracking fluid. Much of the fracking fluid returns to the surface often mixed with brackish subsurface water. This makes surface water pollution another concern. Greater demands on water are another concern in California, where water stress is a perennial concern.

[3] U.S Energy Information Administration. Natural Gas Prices. 2013.
[4] International Energy Agency. *World Energy Outlook*. 2012.
[5] U.S Energy Information Administration. Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays. July 2011.

Land. Hydraulic fracturing and other emerging enhanced production techniques could open up large new areas of California to oil and gas production. Moreover, with fracking, the required quantity and velocity of drilling is often greater because well production tends to drop off faster. This means that more wells have to be drilled. More wells results in a larger impact on the land. An extreme outcome is shown in Figure ES-2, a map of well-heads and hydraulic fractures in an area of North Dakota, one of the places in the U.S. where the impact of fracking on the landscape has been greatest. One countervailing factor is directional drilling, which means that a single well pad can access a greater subterranean area.

Public policy today. The federal government's role in regulating fracking is limited by the Energy Policy Act of 2005, which exempted fracking from aspects of the Safe Water Drinking Act, the Clean Water Act, and the Clean Air Act. Federal agencies control most mineral rights in the West, and have been leasing land at breakneck speed—although recently a federal judge halted drilling on 2,500 acres of land in Monterey County until an environmental impact review is conducted. This judicial intervention aside, there has been little federal action on fracking. Instead, states and local governments have been forced to take the lead.

California's approach to fracking regulation has only just begun to take shape. DOGGR released a discussion draft regulation in December of 2012. DOGGR is currently receiving public comments on the draft, and a proposed final regulation is expected in the last quarter of 2013. That will start the formal rulemaking process and another public comment period. DOGGR plans to put in place the finalized regulation by the middle of 2014. The DOGGR draft regulation largely targets ground and surface water concerns through requirements for permit approval, pre-fracking study and preparation, well construction and testing standards, and information disclosure.

Though the state of California has no specific rules to govern fracking practices, oil and gas production does operate under DOGGR's regulations for drilling, as well as mandates from water and air authorities. DOGGR's well construction requirements are designed to prevent unauthorized air emissions and to protect water quality. They also require the flaring of gas unless venting is necessary for safety reasons. The flaring of gas – burning it off instead of directly releasing it to the atmosphere – is environmentally preferable.

Generally, local air boards have exercised authority over air pollution that results directly from oil and gas production (in contrast to pollutants emitted when these are burned) because they have lead authority over stationary sources like oil and gas wells. The South Coast Air District recently adopted the state's first regulation specific to fracking, putting permit and disclosure requirements in place.

The California Air Resources Board (CARB) handles mobile pollution sources under the state's division of authority for the regulation of air pollution. However, CARB has lead authority across both stationary and mobile sources of greenhouse gas emissions, thanks to Assembly Bill 32 (AB 32), the statewide emissions cap. Under AB 32, CARB has developed approaches for estimating methane leaks. In 2014, CARB will launch a process to develop greenhouse gas performance standards for oil and gas production.

How to get it right. The DOGGR draft regulation ought to be strengthened. The Center for Sustainable Shale Development (CSSD) recently released a set of recommended performance standards for fracking.[6] CSSD is a coalition that includes petroleum giants like Shell and Chevron, along with the Environmental Defense Fund and the Clean Air Task Force. In many instances, DOGGR's draft regulation is less stringent than the minimum standards of good practice reflected in CSSD's consensus performance standards. For example, consider two requirements included in the CSSD's consensus standards but missing from the draft regulation: (1) surface and ground water testing before fracking begins and after fracking occurs, and (2) recycling for reuse of water on-site. If Shell and Chevron acknowledge that these steps are good practice, surely they should be required as part of California policy.

In the pages that follow, we recommend several specific changes in state regulations. Beyond this, we urge the establishment of a scientific advisory panel. The regulation should require tightening of standards on a regular basis to reflect new scientific insights and to incorporate new technologies. The scientific advisory panel will help to accomplish this.

Specific recommended changes to the DOGGR discussion draft regulation

California state agencies need to show a clear, coordinated regulatory strategy, covering land, drilling, water, conventional air pollution, and greenhouse gases. This will require better inter-agency communication and coordination, which should be achieved through a taskforce that meets on a regular basis. The state should also launch proceedings to consider regulation of other emerging enhanced production techniques, such as the injection of hydrogen sulfide.

A. Pre-fracking requirements. Permit application and site preparation.

- Require independent water quality testing before fracking takes place ("baseline testing"), and monthly testing for a period of at least one year following the completion of a well.
- Establish minimum set backs to separate well pads from both surface water sources and buildings.
- Require identification of anticipated water sources and development of a plan to recycle produced water not otherwise destined for productive reuse.
- Require affirmative approval from the State Water Resources Control Board on hydrological issues.
- Require the permit application to list all anticipated fracking fluid additives.

B. Notification and disclosure.

- Allow California residents to sign up for notices of nearby fracking applications and approvals, and the notice period should be increased to at least 30 days.
- Move quickly to build a disclosure website. Do not rely on FracFocus.org any longer than necessary.
- Add a process to adjudicate trade secret protection claims.

[6] For the list of CSSD's recommended performance standards, go to this hyperlink.

C. Hydraulic fracturing and production.

- As soon as is practical, require unique tracers in fracking fluid in order to better assign responsibility in case of water contamination.
- Formally state in the regulation that any accidents must be reported immediately.

D. Wastewater management.

- Wastewater should only be stored in tanks, i.e. a closed loop system, which offers the most reliable containment.
- If storage is allowed in pits, set performance standards for these design features:
    - liner type (double lined with impermeable material; specify type of materials allowed),
    - freeboard (the minimum distance between fluid in the pit and its rim),
    - leak detection technology, and;
    - setback requirements to separate pits from buildings and surface waters.
- If storage is allowed in pits, before any proposed pit is allowed, require producers to prove that the area is not subject to flooding.
- Prohibit the diversion of produced water to public treatment systems until EPA guidelines are developed.

End Executive Summary

1. Purpose and Structure

The purpose of this report is to provide an update on the regulation of hydraulic fracturing in California and offer recommendations for the improvement of the discussion draft regulation released in December 2012 by the Division of Oil, Gas, and Geothermal Resources (DOGGR).[7]

The structure of the remainder of this report is as follows:

Section 2: Background

- 2.1. Benefits
- 2.2. Environmental risks

Section 3: Where things stand

- 3.1. Draft Regulation from the Division of Oil, Gas, and Geothermal Resources
- 3.2 Regulation of air emissions
- 3.3. Regulation of water impacts

Section 4: Recommendations for getting it right

Section 5: Conclusion

2. Background

2.1. Benefits

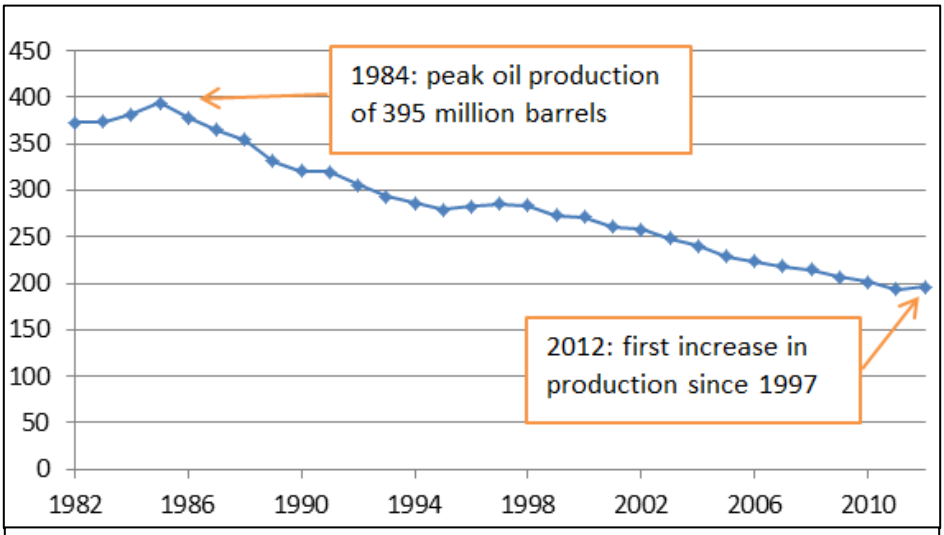
Hydraulic fracturing and horizontal drilling technology have upended assumptions about the size of recoverable oil and natural gas reserves in the U.S. These technologies have allowed for the profitable extraction of oil and gas trapped in shale rock and other sources. The results have already been dramatic. Because unconventional natural gas has boosted supply, gas prices in the U.S. today are 70 percent below their most recent peak in 2008. These trends are accelerating. The International Energy Agency has forecasted that the U.S. will be the world's largest oil producer by 2020.

Last year, the Department of Energy's Energy Information Administration estimated that California's Monterey formation contains 64 percent of the country's recoverable shale oil resources.[8] These reserves are likely to reinforce the dominance of oil within the state's oil and gas production portfolio. Today, more than 50,000 wells in the state produce oil, while less than 1,500 are dedicated gas rigs.[9] A large fraction of California's oil reserves also contain methane gas. In fact, most natural gas produced in California is "associated gas," gas mixed with oil that is captured as a byproduct of oil production.[10]

[7] The discussion draft regulation can be found at this hyperlink.
[8] Energy Information Administration. "Review of Emerging Resources: U.S. Shale Gas and Shale Oil Plays." July 8, 2011.
[9] Data on oil wells from the DOGGR 2012 Preliminary Report of Oil and Gas Production Statistics. 2012 estimate: 54,076 oil wells. Data on gas wells from the Energy Information Administration. 2011 figure: 1,308 (most current data as of May 16, 2013)
[10] DOGGR 2012 Preliminary Report of Oil and Gas Production Statistics. 2012.

In 2012, oil production in California grew for the first time since 1997. It has yet to greatly accelerate, though the possibility exists. So far, the Monterey formation has proven difficult to tap, due to faults and geologic folding. Sometimes it takes time to find the right extraction technique. Though a boom has yet to materialize, a University of Southern California study found that full exploitation of the recoverable oil in California's Monterey formation could boost the state's economic output by 14 percent.[11] Importantly, these estimates do not take into account carbon pricing, or other implications likely to result from the atmosphere becoming increasingly carbon constrained in future years.

Figure 1. California on-shore oil production inches up in 2012



Source: U.S. Energy Information Administration.

2.2. Environmental risks

If regulated poorly, fracking could produce an environmental nightmare in California. Imagine the most industrial parts of Kern County superimposed on Monterey County. Figure 3, below, shows a picture from Kern County's Midway Sunset Oil Field, the largest producing field, in historical terms.

To better understand the environmental risks of fracking, it helps to understand how the process works. Hydraulic fracturing involves injecting a mixture of fluids ("fracking fluids") at high pressure deep underground to break up rock and release natural gas and petroleum liquids inside. Fracturing refers to the effect—fracturing the rock. Hydraulic refers to the fact that fracking fluids are composed of approximately 90 percent water. The second largest component of fracking fluids is sand or other small particles, which keep the fracture cracks open to let the gas or oil flow out. About 0.5 percent of the mixture is made up of chemical additives.

Air. Per megawatt hour of electricity produced, natural gas power plants produce half as much carbon dioxide pollution as coal plants. However, this does not account for natural gas leaks. Natural gas is mostly composed of methane, a powerful greenhouse gas. It is 25 times more potent as a greenhouse gas than carbon dioxide over a 100-year time horizon.

There is methane leakage throughout the natural gas system, from start to end use. More leakage ("fugitive methane") happens at the production stage when fracking is used, though new "green

[11] University of Southern California. Powering California: The Monterey Shale and California's Economic Future. 2012.

completion" approaches are reducing these emissions. There is considerable uncertainty around the rate of methane leakage. If the higher estimates turn out to be the reality, electricity generated from natural gas could be even worse than coal in global warming terms. Methane leaks are associated with oil production too, but they are a smaller fraction of U.S. methane emissions.[12]

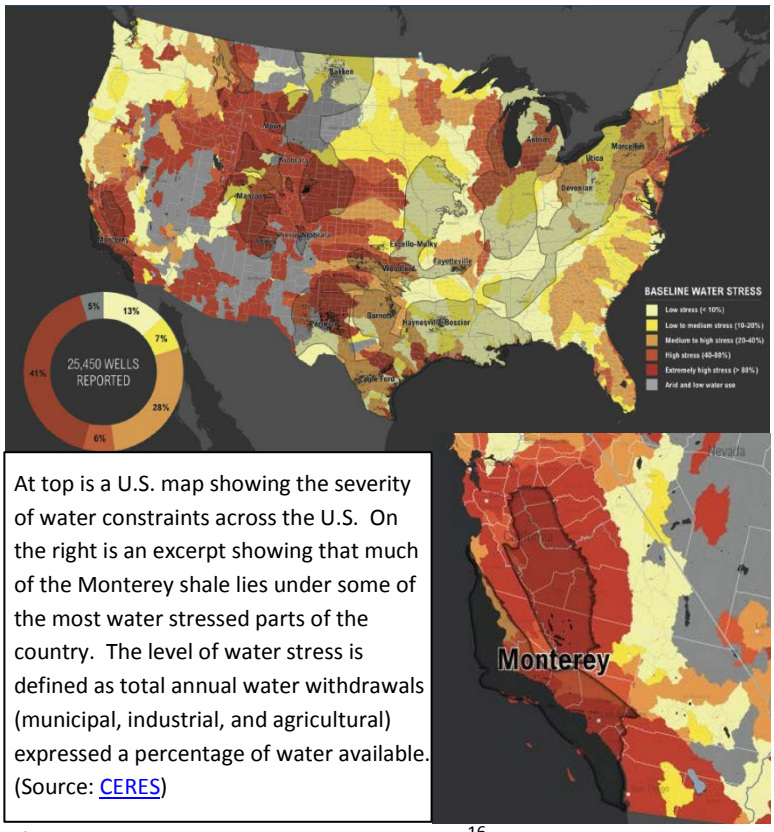
Water. Many have seen images of people's tap water catching fire after a nearby gas well was installed. Bad well casings can allow gas to leak into aquifers. With current practice, it can be difficult to tie any particular incidence of water contamination to a particular well. That's why we recommend a mandate for traceable elements. The accumulation of evidence does suggest a troubling amount of water contamination nationwide. Data from Pennsylvania has found "compromised structural integrity," indicating that cement has cracked, at six to nine percent of wells within one year of completion of all wells put in place over the last three years.[13] Further study of the California situation in this regard is needed. Additionally, it is important to consider how the cement is holding up in abandoned wells. Natural gas may no longer be extracted from these wells, but remaining gas or chemicals may still leak into groundwater if they do not remain properly sealed.

There are surface water pollution concerns as well. Fracking creates large volumes of wastewater by-products. These include both "flow back" (fracturing fluid that returns to the surface when drilling pressure is released) and "produced water" (all wastewater that emerges in the drilling process). Produced water can be contaminated by toxic, corrosive, or radioactive substances. Some of these pollutants come from the chemicals in the fracking fluids themselves, while others are naturally-occurring subterranean pollutants that are brought to the surface by the fracking fluid. California's conventional oil extraction has always resulted in a lot of produced water, as the state's oil reserves are typically mixed with 90 to 95 percent brackish water. The oil and gas industry pumps out roughly 120 billion gallons of produced water annually.[14]

In California, about 70 percent of produced water is used as an input for enhanced oil production. It is injected in fields where production has been declining to improve the extraction rate.[15] Therefore, produced water in California may not be viewed by operators as waste, but instead as a resource. Roughly 25 percent of California's produced water is disposed of underground in depleted oil fields that are no longer producing. These underground injection operations create another possible source of ground water contamination.

[12] U.S. EPA. "Inventory of US Greenhouse Gas Sources and Sinks:1990-2011." April 12, 2013.
[13] Ingraffea, Anthony. "Fluid migration mechanisms due to faulty well design and/or construction: An overview and recent experiences in the Pennsylvania Marcellus play" January 2013.
[14] DOGGR Preliminary Report of 2012 Oil and Gas Production Statistics. 2012.
[15] The quantitative data in this paragraph were stated by Oil and Gas Supervisor Tim Kustic, during the DOGGR Monterey public meeting held. April 30, 2011.

Figure 2. Water Stress and Hydraulic-Fracturing



At top is a U.S. map showing the severity of water constraints across the U.S. On the right is an excerpt showing that much of the Monterey shale lies under some of the most water stressed parts of the country. The level of water stress is defined as total annual water withdrawals (municipal, industrial, and agricultural) expressed a percentage of water available. (Source: CERES)

Water is a scarce resource in California, and there are concerns related to increased needs for California's water, which is already in high demand and the subject of heated debates. In other parts of the country, each fracking operation uses millions of gallons of water. However, most fracking in California has not yet used long horizontal drilling into shale. In California the majority has been in short, vertical shafts, and used to exploit reserves trapped in sandstone, not shale. This, plus the fact that California oil and gas is usually mixed with 90 to 95 percent brackish water, unlike dry shale gas plays in other parts of the country, shows why California fracking has generally used less water. To date, water use has been in the range of 200,000 to 300,000 gallons per well.[16]

Though water demands have been lower than in other parts of the country, California is highly water stressed, according to a new report from CERES.[17] As illustrated in Figure 2, the Monterey shale formation sits below some the most water-constrained land in the country, as determined by the relative size of supply as compared to demands on the water.

Land. In many parts of the country, unconventional oil and gas production is imposing a heavy burden on the landscape. The larger volumes of water and wastewater needed to support unconventional extraction add up to a larger industrial infrastructure. In California, the oil and gas industry has always involved large flows of produced water and oil fields have been intensely developed. See Figure 3 below, a photo of the Midway Sunset Oil Field, the largest producing field in California history. Even though California has seen intense industrial oil and gas development before, there are still new land risks. Unconventional production, driven by higher oil prices and new technologies, is opening up broad new swaths of land to exploitation.

[16] The quantitative data in this paragraph were stated by Oil and Gas Supervisor Tim Kustic, during the DOGGR Monterey hearing, April 30, 2011.
[17] CERES. Hydraulic fracturing & Water Stress: Growing Competitive Pressures for Water. May 2013.

Figure 3. Midway Sunset Oil Field, Kern County, California

Source: New York Times.

The amount of oil or gas produced in each fracked well tends to drop off faster than with conventional production, which creates a need to keep drilling new wells quickly. The result is a heavier impact on the landscape.

A countervailing force is directional drilling, which does offer the potential to reduce land disturbances. A central drilling pad can be used to reach multiple directions.

Given these environmental risks, a comprehensive policy framework is needed to protect air, water, and land resources. The five keys to getting gas right are: [18]

1. Prevent methane leaks.
2. Enact sound well drilling and casing standards to protect ground water.
3. Prevent toxic produced water from contaminating surface water.
4. Protect the land by drilling only where it is sensible; protect sensitive ecosystems.
5. Use natural gas to help accelerate the deployment of renewable energy.

3. Where things stand

California has not yet updated its regulatory framework in response to the nationwide surge in fracking. There is not much clarity on how much fracking occurs in California or what the trends might be, due to a lack of mandatory reporting. But the growing use of fracking nationwide and the interest in tapping California's shale oil resources are not in dispute. Existing policy does cover some aspects of fracking, and a proposed regulation specifically regulating fracking has been released. The California legislature has also taken up the issue. As of March 14, 2013, eight bills on fracking have been introduced in the current legislative session. However, Governor Brown has voiced support for letting regulatory processes work, indicating little appetite for new legislation.[19] We focus on the regulatory landscape in our recommendations.

[18] For more on this five point plan, see: Hal Harvey, "Natural Gas: Cheap, Clean, and Risky," *Los Angeles Times*. January 3, 2012.
[19] "Between now and development lies a lot of questions that need to be answered, and I feel confident that the people are in place in my administration to handle the issues as they come up," Governor Brown, quoted in "California Fracking May Boost State Economy by 14%, USC says," Bloomberg News. March 14, 2013.

Federal policy on fracking has been hamstrung by explicit loopholes, including exceptions from the Clean Water Act and Safe Water Drinking Acts, as well as political gridlock. Starting in 2015, using existing administrative authority, the U.S. Environmental Protection Agency (U.S. EPA) will require "green completions," an approach to bringing wells into production that reduces the emission of both methane and local air pollutants. Rules for fracking on public lands managed by the Bureau of Land Management are also being developed. A federal judge recently halted progress on 2,500 acres of land leased for oil extraction in Monterey County on the grounds that no environmental impact review had been completed.

Figure 4. Unconventional Gas Wells, Pinedale, WY

Source: Ecoflight.org

The lack of greater federal action has forced states and some local governments to lead the regulation of fracking. Historically, California's leadership has been valuable on environmental issues: for example, the state's tailpipe regulation spread to 17 states and eventually spurred federal action. In the 1970s, the state's building and appliance energy performance standards were ahead of their time; today these are accepted the world over as best practice. Although California has been slow off the mark to develop the regulations needed to manage fracking, there is still time to get it right.

3.1. Regulation by the Division of Oil, Gas, and Geothermal Resources

DOGGR is the executive branch entity with lead responsibility for regulating oil and gas operations for public safety. Oil and gas drilling operations currently require a permit from DOGGR, but there is no need to apply for a permit to use fracking. DOGGR's well construction requirements are designed to prevent unauthorized air emissions and protect water quality, and require flaring of gas unless venting is necessary for safety reasons. Flaring of gas – burning it off instead of directly releasing it to the atmosphere – is environmentally preferable.

Figure 5. Belridge Oil Field, Kern County, CA

Though the state has no regulation that specifically covers fracking, existing regulations do cover oil and gas production, which have a history going back to the late 1800's in California. (Source: Howard Greenberg Gallery)

New rules applicable to fracking have started taking shape in the form of a discussion draft regulation released by DOGGR in December 2012. DOGGR plans to issue proposed final rules in the fourth quarter of 2013. That will start the formal rulemaking process, which then must be completed within one calendar year.

Some main provisions of the draft regulation include: advanced public notice, required permits for fracking, disclosure of fracking fluids, and requirement for operators to study nearby geology and hydrology and conduct tests to ensure that their well can withstand high pressure fluid injection. DOGGR is currently holding meetings around the state to collect public input on the proposal.

3.2. Air pollutant emissions

Beyond its focus on effective well-construction standards, which play a role in avoiding methane leaks, DOGGR does not directly concern itself with air emissions. The California Air Resources Board (CARB) has authority over all greenhouse gas (GHG) emissions in California under Assembly Bill 32 (AB 32), the state's seminal climate law. AB 32 also sets a statewide cap on GHG emissions, which includes methane emissions.

CARB requires all major GHG emitters to report their emissions using methods developed through the regulatory process. CARB has released draft protocols that are to be used for the assessment of fugitive methane. These are currently being refined. Current regulations prohibit venting, the intentional release of methane, so the only direct emissions should be unintended. CARB has sought to synchronize its methods with the U.S. EPA's accounting methods. In 2014, CARB will launch a proceeding to set GHG performance standards for oil and gas operations. Currently, some diesel equipment used in fracking is covered under the state's portable equipment regulation, but no other regulations related to fracking have been established.

Figure 6. South Coast Air District regulations target fracking

On April 9th, the South Coast Air District passed the state's first regulation to address fracking. Rule 1148.2 includes two main elements: (1) pre-notification; and (2) emissions and chemical use reporting. Not just fracking but all well stimulation activities are covered. The South Coast Air District views this as step one of a two-step process. The photo shows oil rigs in Culver City, within the Los Angeles city limits. Image source: David McNew/Getty Images.

Local air quality issues related to fracking are primarily the responsibility of regional air boards as they are the lead on stationary sources under state law. Figure 6 describes recent South Coast Air District regulation, the state's first regulation to cover fracking.

3.3. Water impacts

As with air quality, DOGGR views its mandate as limited and mainly related to well construction standards. DOGGR relies upon the State Water Resources Control Board (SWRCB) and regional water boards to ensure water quality. The SWRCB currently reviews water protection measures in drilling plans and has the authority to require changes before a permit is issued. The same will be true once fracking permit applications are required to be filed under the DOGGR discussion draft regulation: the SWRCB will review and approve plans.

While much public attention has centered upon concerns about well casing integrity, an expert survey by Resources for the Future points to handling of wastewater as the greater threat to water quality.[20] DOGGR's discussion draft regulation does not address handling of wastewater, but there is an existing body of regulation that does. These regulations already exist because even conventional oil and gas drilling produces significant wastewater in California. The state's oil is typically mixed with brackish water. Therefore, California already has experience regulating large volumes of wastewater from oil and gas operations.

Most wastewater is disposed of via the Underground Injection program, which DOGGR manages. Usually, this involves injecting wastewater into spent oil wells. A smaller fraction of wastewater is used for enhanced oil production. It is injected into working wells in order to stimulate additional production. The smallest portion of wastewater is treated and disposed of at the surface level, under permits issued by the SWRCB. About 70 of these permits were issued in 2012. Both the injection of fracking fluids and handling of fracking waste water are exempted from treatment under the state's toxics rules. The injection of fracking fluids is exempted as it is considered a productive activity. Wastewater from oil and gas is exempted under the rules that establish the Underground Injection program.

Figure 7. The Kern River

Source: CW Whitman Photography.

In 2011, an analysis commissioned by the U.S. EPA found some shortcomings in the state's Underground Injection Program. At the EPA's request, in November 2012, DOGGR produced an action plan to fix

[20] For more about the results, see Resources for the Future's Shale Gas Experts Survey Report.

these deficiencies.[21] In Texas, there has been at least one instance of underground injection leading to contamination of an aquifer, and regulators there are in the process of strengthening rules for this type of disposal.[22]

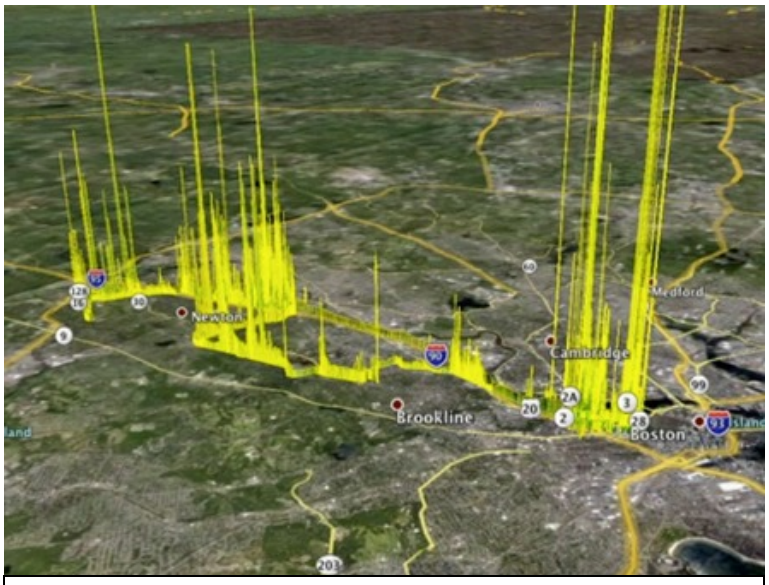
Water testing is the last line of defense in protection of water quality. If problems are not prevented, at least they can be quickly brought to light and remediated. The state has one program that tests public drinking systems and another for private wells. The California Department of Public Health tests public drinking sources quarterly. The SWRCB tests private well water under its Groundwater Ambient Monitoring and Assessment Program. The ground water program was founded in 2002 and has since sampled 2,220 wells that supply public systems in addition to 1,100 private wells (according to an October 2012 accounting[23]).

4. Recommendations for getting it right

The state needs a more active approach to protecting public health and the environment from the potential damage caused by fracking. We focus our recommendations on the DOGGR discussion draft regulation ("the draft regulation"). We also recommend establishment of a scientific advisory body to help ensure the regulation regularly incorporates the best science.

Note that these recommendations do not directly address methane leakage. It will be important to incorporate new technologies for better leak detection and measurement (see Figure 8). We look forward to working for this as well as engaging in the process that CARB will launch on greenhouse gas performance standards for oil and gas production.

Figure 8. New Technology Better Maps Methane Leaks



Picarro has developed a new methane leak detection technology that looks to be a game changer. This is a map showing leaks in the Boston area distribution network. Leaks can be located and their magnitude reliably estimated "at the fence line," i.e. without having to leave public property, a kilometer or more away from the leak. Credit: Picarro Inc.

[21] DOGGR. Action Plan and Response to June 2011 US EPA Review of California's Underground Injection Control (November 2012).
[22] Jennifer Whitney and Kate Galbrith. "As Fracking Proliferates, So Do Wastewater Wells," New York Times. March 28, 2013.
[23] State Water Resources Control Board. Groundwater Ambient Monitoring and Assessment Program.

4.1. Recommendations for the DOGGR draft regulation

The draft regulation needs strengthening. DOGGR has sought a narrow focus on well construction and disclosure, but the Department of Conservation's mandate to protect California's environment, natural resources, and public health requires a broader focus.

Our recommendations have been informed by multiple sources, including the state-by-state policy assessment related to fracking undertaken by Resources for the Future and an environmental coalition letter with recommended changes to the draft regulation.[24] Some of our suggested additions are influenced by the performance standards recommended by the Center for Sustainable Shale Development (CSSD), a coalition of environmental groups and industry, including Chevron and Shell.[25] These voluntary performance standards ("CCSD standards") are a statement of good practice for hydraulic fracturing. Though crafted for use in the Appalachian basin, the standards have broad applicability. Surely California can meet the standards for good practice that have been endorsed by the major oil and gas companies like Chevron and Shell.

The recommendations below are ordered to follow the steps in the fracking process.

A. Pre-fracking requirements. Permit application and site preparation.

- ***Require independent water quality testing before fracking takes place ("baseline testing"), and monthly testing for a period of at least one year following the completion of a well.*** This water testing requirement is included in the CSSD standards. American Petroleum Institute's best practices call for baseline testing of water quality before both drilling and fracking. To avoid conflicts of interest, testing should be done by third-parties or government officials.

- ***Establish minimum set-backs to separate well pads from both surface water sources and buildings.*** A majority of the states that Resource for the Future surveyed have such requirements, which are intended to provide some shielding from noise and visual spillover effects on neighbors as well as added environmental protection.

- ***Require identification of anticipated water sources and development of a plan to recycle produced water*** on-site for further use in drilling and fracking if the produced water is not destined for enhanced production. In a semi-arid state like California, new demands on freshwater are always of interest. This step will provide additional information about potential impacts on other water users and will force operators to explore options for recycling water. The CCSD standards require a 90 percent recycling rate within two years.

[24] Resources for the Future, "State-by-state review of shale gas regulations," accessed June 1, 2013. DOGGR is not publishing public comments received. We will provide the environmental coalition letter upon request.
[25] Their website lists 15 initial performance standards (hyperlink here).

- ***Require affirmative approval from the State Water Resources Control Board on plans for handling produced water and to certify that the fracture radius analysis – done to verify that no fracturing fluids or hydrocarbons will migrate into a strata or zone that contains protected water – has been done correctly.***

- ***Require the permit application to list all anticipated fracking fluid additives.*** Currently, the fracking permit does not collect this important information.

B. Notification and disclosure.

- ***California residents should have the ability to sign up for notices of nearby fracking applications and approvals***, and they should have the option of email or U.S. mail notification. Making information available by posting it to a web site 10 days in advance of fracking is not adequate. A longer time period of at least 30 days is appropriate.

- ***The state should move quickly to build its own reporting system.*** DOGGR proposes to use the existing website FracFocus in the short run because it is an off-the-shelf solution. While this is a good stopgap solution, the state should build its own database for disclosure.

- ***There should be an additional process to adjudicate trade secret protection claims.*** There are legitimate concerns that the use of the "trade secret" exemption has become a giant loophole that effectively renders disclosure meaningless. Trade secrets in this instance refer to fracking fluid formulas, which are not generally known or reasonably ascertainable, by which well operations can obtain an economic advantage over competitors. The trade secret exemption has been claimed 19,000 times in Texas in order to prevent compelled disclosure of fracking fluid formulas. We must find ways to balance legitimate proprietary technology concerns with the public's right to know what drillers are injecting into the environment. These include more descriptive but still protective categorical disclosures and exceptions to trade secret protection where public health would be at risk. DOGGR has commented that it is favorably open to medical and emergency exemptions to trade protections.

C. Hydraulic fracturing and production

- ***As soon as is practical, require unique tracers in fracking fluid in order to better assign responsibility in case of water contamination.***

- ***Formally state in the regulation that accident reporting needs to happen immediately.***

D. Wastewater management

- ***Wastewater should only be stored in tanks, i.e. a closed loop system. This offers the most reliable containment.***

- ***If pit storage is allowed, the regulation should set performance standards for the following design features:***
  - ***liner (double lined with impermeable material; specify material),***
  - ***freeboard (the minimum distance between fluid in the pit and its rim),***
  - ***leak detection technology, and;***
  - ***setback requirements to separate pits from buildings and surface waters.***

- ***If pit storage is allowed, producers should be required to prove that the area of a proposed pit is not subject to flooding.***

Floods happen in California. And swaths of California oil fields are located in land that is vulnerable to flooding, including areas that were historically underwater for part of the year before the arrival of European colonists.

It will be important to take into account that climate change is increasing the chances of extreme rainfall events and flooding in California. U.S. Geological Survey researchers have found that with climate change there is an increased risk of California being hit by a set of repeated storms "much larger than anything in living memory. Eight feet of rain could fall over three weeks."[26] This would be similar to the 1861-62 flooding that temporarily moved the state capital from Sacramento to San Francisco. The flooding inundated the entire Sacramento and San Joaquin valleys, an area roughly 300 miles long and 20 miles wide.

There is about a two in three chance that a catastrophic flood will occur in the Sacramento-San Joaquin Delta sometime in the next 50 years.[27] Hurricane Katrina taught us many lessons, and the costly toxic aftermath that can follow flooding is the relevant one here. A history of flooding and an increased chance for epic rains means that open-pit storage should not be allowed. And if they are allowed, they should be located in carefully screened areas.

- ***Prohibit the diversion of produced water to a public treatment system until anticipated guidelines from the U.S. EPA are developed.***

[26] Dale Cox et al. "Overview of the ARKStorm scenario." U.S Geological Service. 2011. (accessed April 18, 2013)
[27] Alex Prud'homme. "California's Next Nightmare." New York Times. July 1, 2011.

E. Areas deserving further consideration

- DOGGR should launch proceedings on other enhanced production techniques with an expectation that these will require regulations specifically designed to take into account their characteristics. It may not be hydraulic fracturing that unlocks the oil in the Monterey shale. Instead, it could be emerging techniques that involve injecting hydrogen sulfide, for example.

- What is the optimal number of wells per inspector? At one legislative hearing, Tim Kustic, State Oil and Gas Supervisor, estimated DOGGR to have roughly 50 well inspectors—or approximately one per 1000 wells, which would put California among the least staffed in the country according to a state-by-state review by Resources for the Future.[28] On the other hand, California does have a high density of oil wells compared to other parts of the country.

- On the topic of responsibilities associated with well abandonment, California is much more lenient than other states. California allows wells to remain idle, not currently producing oil or gas, for the longest time of any state. Twenty-six states regulate the amount of time that a well is allowed to sit idle before it must receive official temporary abandonment status; to be either permanently plugged and abandoned, or brought back into production. The national average is 24 months versus 300 months in California.[29]

- California does not have temporary abandonment regulations, though most oil and gas producing states (24 of them) do have such regulations.[30] Usually, these require producers to apply for a permit to temporarily abandon a well and place a time limit on abandonment.

4.2. Develop an independent science advisory panel

We urge the establishment of a science advisory panel to better link policy to the best available science. It's not clear what the scientific basis is for many of the policy design choices in the DOGGR regulation. Why is the pre-fracking study area twice the anticipated fracture length? Why is 500 pounds per square inch the right increment above the anticipated fracking pressure for well integrity testing? Naturally, DOGGR's expert judgment will be the best guide initially in some instances. However, the regulation should be actively improved over time as better information becomes available. DOGGR could task the advisory body with questions that need further consideration. California's world class universities and research institutions are an important resource, and this panel would be a way to institutionalize their involvement.

[28] Access the state policy review at the Resources for the Future website then go to "wells and inspections," and then next to "number of inspectors." (Accessed June 1, 2013)
[29] According to a state-by-state policy survey by Resources for the Future. (Accessed June 1, 2013)
[30] Ibid.

Here are some key issues to be addressed and questions to be answered by such an advisory board, broken down into air, water, land, and other categories.

Air

- Interact with CARB to update fugitive emission estimation protocols with particular attention to ensuring new leak detection technologies are fully exploited.
- If open pit wastewater storage is to be allowed, study air emissions from these.

Water

- Consider whether micro seismic analysis should be required to analyze geology and hydrology prior to approval of fracturing instead of fracture radius analysis.
- Pressure gauges are used to monitor well integrity. As long as pressure is maintained, in the absence of large pressure drops, the expectation is that the cement has not been compromised. Currently, analog gauges are checked periodically. It seems likely that the technology exists for more sophisticated continuous monitoring with data sent in real time to a publicly accessible website. What technological solutions might exist to accomplish this?
- In addition to well-specific testing, should California develop a more comprehensive water quality testing program? The extent of water quality testing is dwarfed by the number of active oil and gas wells.
- Is 500 pounds per square inch the right increment above the anticipated fracking pressure for well integrity testing?
- Should there be a list of approved impermeable materials for use in pit liners, if these are to be allowed? If so, what materials should be included?

Land

- Conduct a rapid assessment of areas to determine if there are ecologically sensitive areas of the state where not currently protected (as a state park, for example) and where it might make sense to impose a temporary moratorium on fracking until the state establishes adequate safeguards.
- Develop a statewide assessment of how new oil and gas development is likely to impact sensitive ecosystems. Are there any sensitive ecological areas not already protected that should be off limits?

Cross-cutting

- The draft regulation uses twice the anticipated fracture length to define the area for geologic and hydrologic study before approval is granted. Is that the right size for the study area? At the Monterey public meeting, it was acknowledged that there is no scientific basis for this design parameter. The number was chosen by DOGGR staff using their best expert judgment. While the use of expert opinion is often necessary in policy design, every effort should be made to analyze these choices.
- Are there additives other than diesel that should be prohibited?

- Seismic concerns are crying out for more scientific study. Resources for the Future report that: "Arkansas, Colorado, Ohio, Oklahoma, and Texas have recently experienced an increase in seismic activity near deep underground injection sites. As a result, many deep injection wells have been closed while further research is conducted."[31]

5. Conclusion

Fracking proponents argue that the practice has a long history in California and that incidents of environmental contamination or other accidents have been few and infrequent. Of course, history is not always an accurate guide to the future. The housing sector crisis that caused the most recent economic downturn occurred in part because of experts who reassured people and markets with pronouncements that housing prices had never declined in the post-WW II era. History has shown us that a decent track record in the past is not a reason to be lax. New fracking techniques and other emerging enhanced oil production technologies present new risks. In light of these, plus an expanding population, greater mingling of human settlements with oil and gas zones, more water stresses, and increasing risks due to climate change, a fresh look and a stronger approach to public health and environmental protection is warranted in California's oil and gas production industry. The state's regulatory regime and its industry are due for modernization. In the long run, a safe, clean industry is the only type that will be accepted by the people of California, so it is in the industry's interest to partner with government and watchdog groups alike to help to craft stronger performance requirements.

[31] See the underground injection page of the state-by-state policy survey by Resources for the Future. (Accessed June 1, 2013)