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All Fracked Up

Mixing oil and water rattles the Golden State

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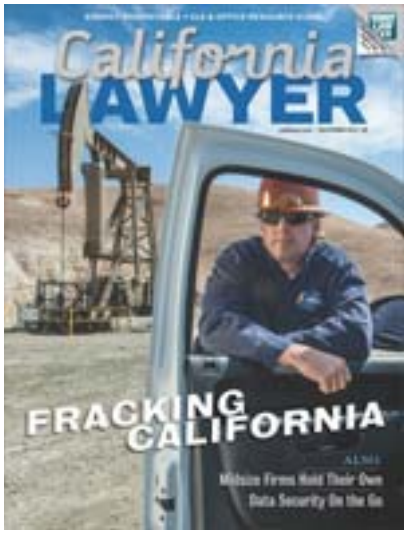

The oil pump looks like most of the grasshopper-style rigs you see churning away nearby in the fields west of Bakersfield, except that it's bigger. Much bigger. Travis Goddard regards it with pride as he disembarks from his pickup truck and ambles across the drilling pad to an array of pipes and gauges on the side of the rig.

Goddard, a field operator for Denver-based Venoco Inc., is a big guy, muscular in a lanky way. He's wearing wraparound shades, a long-sleeved denim shirt, and jeans stuffed into scuffed Wellington boots. Goddard supervised installation of this well on a site in the Sevier Oil Field known as the Cree Pad, carved from a hillside on the eastern slope of the Temblor Range. The range parallels the San Andreas Fault Zone - temblor is the Spanish word for earthquake.

Lower down the slope, Hereford cattle low plaintively in the unrelenting sun of late summer. A couple of miles beyond, near Taft, lies the Midway-Sunset Oil Field, the biggest in California. After more than a century of drilling, it's still producing 4,000 barrels a day of thick, heavy crude.

Oil from the Cree Pad is different. It's been forced from the earth after hydraulic fracturing, or fracking, deep in a complex geologic formation known as the Monterey Shale. Fracking is a well-stimulation technique that involves injecting a highly pressurized mixture of water, sand, and chemicals down oil or gas wells to create small fractures in hydrocarbon-bearing rock. When the pressure is withdrawn, the sand particles keep the cracks open - allowing oil and gas to migrate to the well bore, where it is siphoned upward.

Goddard bends down to monitor a gauge on the pipes of a unit that separates the oil from the natural gas rising from below.

"We're getting about 30 to 60 barrels a day here," he says. "Not great, not bad." Checking the oil-to-water ratio, he unscrews a Mason jar attached to a nib along the pipeline. At the bottom are a few inches of liquid: rich umber and thin, rather than black and tarry. He swirls the jar like a wine connoisseur evaluating the legs of a fine claret, then inhales the aroma.

"It really doesn't get any better than this," he says. "See how light it is? And smell it. It smells just like gasoline. You could almost run your car on this stuff, just as it is."

Goddard nods toward the helter-skelter swarm of smaller rigs pumping oil from the Midway-Sunset field. "We're not like those tar farmers down there," he laughs. "This is an entirely different product."

For the state's oil industry, gearing up for widespread fracking entails major capital investments - and promises great wealth. Most of the drilling rigs now operating in California are relatively shallow: 1,000 to 2,000 feet is typical on the Midway-Sunset. The well on the Cree Pad, however, extends its casings 9,197 feet underground into the oil-rich shale.

Venoco says it no longer fracks, though it continues to extract oil from the Cree Pad well. But its latest annual report assured investors, "we believe that our testing efforts and delineation drilling in the area will ultimately result in commercial levels of production."

Other oil companies aren't backing away. According to the industry's FracFocus website, Aera Energy (owned by Shell and Exxon) has fracked 779 wells in California since 2011, while Occidental Petroleum fracked 215 wells. Venoco reportedly fracked 20 wells since 2011.

If the Cree Pad and others like it are deemed a success, California's oil industry - and perhaps the entire state - will be transformed. Big money is involved, and big impacts can be anticipated. Some believe fracking will produce an economic bonanza. Others predict environmental disasters on a biblical scale. At this juncture, both scenarios seem possible.

"Monterey Shale" is something of a misnomer. Most of the formation lies under the dreary, monochromatic landscape of the Central Valley - not the picturesque tourist haunts of Monterey Bay. This vast deposit of oil-infused rock stretches from Chico to the Tehachapi Mountains, immured 6,000 to 12,000 feet beneath rich topsoil. The strata contain more than 15 billion barrels of oil - roughly two-thirds of the shale oil reserves in the entire nation.

Geologists have long studied the formation, and oil companies have wanted to develop it for decades. To a degree, they have: The petroleum fields of western Kern County are associated obliquely with the Monterey Shale. But until recently, nobody's had the means to plumb the deep reserves profitably.

In a basic form, fracking has been around since the middle of last century. But recent advances in horizontal drilling technology, injection fluids, and propping agents to hold rock fractures open have made the process much more productive. Most notably, fracking has brought an oil rush to the Bakken Shale area of North Dakota and a natural gas boom in Pennsylvania's Marcellus Shale country. Those operations are rejuvenating local economies and transforming landscapes in the High Plains and the rural Northeast.

The relative scale of the Monterey Shale portends an even bigger boom in California. According to a University of Southern California study, an all-out "frack" of the formation could boost the state's economy by more than 14 percent, generate more than $24 billion in state and local tax revenues, and add nearly three million new jobs.

The downside? Critics of fracking say it poses a number of hazards: depleting already overcommitted surface water, contaminating aquifers, spilling crude at coastline rigs, de-

grading air quality, and, conceivably, inducing earthquakes.

As one result, Californians - generally perceived as an environmentally conscious constituency - seem chary of widespread fracking. A recent statewide poll by the Public Policy Institute of California found that 51 percent of residents opposed the increased use of fracking and just 35 percent supported it. The ratio is roughly reversed in national sentiment: In a Pew Research Center survey in March, 38 percent opposed more fracking, and 48 percent favored it. (In both surveys, 14 percent said they were unsure.)

Tom Tanton, policy director at the Sacramento-based Coalition of Energy Users, acknowledges that fracking may carry environmental risks if oil companies act irresponsibly. "There's no doubt that the California landscape will change, both physically and economically," says Tanton, who also heads an energy services firm. "But there are major benefits to this kind of development - and it's not just the standard of living." He contends that increased oil production will provide the corporate tax revenue needed to repair California's aging infrastructure.

Environmental laws in California are generally among the most rigorous in the United States - certainly tougher than those in North Dakota. But weaker federal regulations also come into play, since much of the Monterey Shale lies under land administered by the U.S. Forest Service and the Bureau of Land Management (BLM).

In 2005 Congress enacted the Energy Policy Act (Pub. L. No. 109-158), which includes the so-called Halliburton loophole. A product of then-Vice President Dick Cheney's Energy Task force, the statute, among other changes, excludes from Safe Drinking Water Act regulations "the underground injection of fluids or propping agents (other than diesel fuels) pursuant to hydraulic fracturing operations related to oil, gas, or geothermal production activities." (42 U.S.C. § 300h(d)(1)(B)(ii).) This left hydraulic fracturing largely unregulated.

Last year the U.S. Environmental Protection Agency issued rules requiring oil companies to trap air-polluting emissions released during "flowback," but not until January 2015. The BLM also adopted rules, based on a model bill written by Exxon Mobil, for disclosure of injection fluid chemicals used to frack wells on federal lands - but only after the frack. The industry already provides much of that information voluntarily on its FracFocus website.

Still, says Tupper Hull, a spokesman for the Western States Petroleum Association, "Looking down the road, any energy production [in the Monterey Shale] will occur in a heavily regulated environment. It makes a boom along the lines of the Bakken [in North Dakota] hard to imagine."

Perhaps. But momentum for fracking here is gaining, and the legal skirmishes are already under way. In March the Center for Biological Diversity and the Sierra Club won a partial victory against the BLM in a federal suit alleging that four Central Valley oil and gas leases auctioned in 2011 violated the National Environmental Protection Act. In a summary judgment, the court determined that the leases violated NEPA by not adequately taking into account the impact of fracking when it's combined with technologies such as horizontal drilling. It marked the first time a court had ruled against a federal lease sale

on the basis of fracking considerations. (Ctr. for Biological Diversity v. Bureau of Land Mgmt., No. C-11-06174 (N.D. Cal. order filed Mar. 31, 2013).)

Although the plaintiffs had requested that the sales be nullified, the court instead recommended subsequent steps for both sides. In September the parties settled: The BLM agreed to undertake a full Environmental Impact Statement for 284,000 acres under jurisdiction of the agency's Hollister Field Office - 90 percent of the BLM acreage in the eight-county district north of San Luis Obispo. The agency also commissioned the California Council on Science and Technology to independently analyze potential effects of fracking on California's geology and environment; findings will be used to draft the EIS. Meanwhile, the BLM will continue to process permits for existing federal leases there.

Gabe Garcia is the field manager for the BLM's Bakersfield district to the south and east, overseeing 650,000 surface acres and 1 million acres of "mineral estate" lands, including the oil fields around Taft. Garcia anticipates tougher fracking regulations for all federal lands, noting that the agency recently extended the public comment period on fracking regulations proposed for federal and tribal trust lands. "This is actually our second go-round," he says. "After our first draft, we had more than 170,000 public comments - so many [that] we felt we had to go back and redraft the rules."

The revised draft would require drillers to disclose the chemicals they use in fracking fluids; to verify the integrity of well bores intended to prevent the by-products from seeping into aquifers; and to prepare plans for managing the flowback returned to the surface.

The Center for Biological Diversity has brought two other lawsuits in state court against California's Division of Oil, Gas and Geothermal Resources (DOGGR). In the first, the center and coplaintiffs including the Sierra Club argue that all of the standard procedures required by the California Environmental Quality Act (CEQA) apply to oil and gas well permits that involve fracking. (Ctr. for Biological Diversity v. Dep't of Conservation, No. RG-12652054 (Alameda Cnty. Super. Ct. filed Oct. 16, 2012).) No trial date has been set.

The CEQA suit challenges a practice that critics say has become standard at DOGGR: issuing categorical exemptions to full environmental review for fracking operations as "minor alterations to land." The DOGGR "maintains that these projects are routine and not worth a full review," says Sierra Club associate attorney Nathan Matthews, who is based in San Francisco. "We think that any time you start injecting large quantities of chemicals underground, complete environmental impact reports are required."

The second suit alleges that DOGGR has failed to monitor and supervise all forms of injection wells, including those associated with fracking, which the plaintiffs contend is required by the Underground Injection Control Program (UICP) California adopted in the 1980s. (Cal. Code Regs., tit. 14, §§ 1724-1724.10.) The way the agency has interpreted the regulatory code, that part doesn't apply to fracking. (See Ctr. for Biological Diversity v. Dep't of Conservation, No. RG-13664534 (Alameda Cnty. Super Ct. filed Jan. 24, 2013).)

Under the UICP, says Hollin Kretzmann, a staff attorney for the center, "DOGGR exercises authority over underground disposal of

treated wastewater. ... But somehow DOGGR thinks fracking - which involves tremendous quantities of chemically treated water - doesn't require application of the UICP."

When queried about the lawsuits, DOGGR passed along questions to the California Department of Conservation, which manages the division but declined, through a spokesman, to comment on the pending litigation. On the general issue of hydraulic fracturing, however, associate director of communications Ed Wilson responded by email that the procedure has been used in California for decades, with no state-documented evidence of direct environmental harm. He wrote that DOGGR's standards are rigorous, but acknowledged that expanded fracking could lead to greater environmental issues. "With that in mind," Wilson stated, "[DOGGR] is in the process of developing regulations specifically directed at the use of hydraulic fracturing, to enhance environmental protection and public health and safety."

Kretzmann maintains that DOGGR's oversight is anything but rigorous, and that fracking regulations the division proposed last December would amount to mere window-dressing. "DOGGR refuses to even track fracking, let alone regulate it," he claims. "They only agreed to draft new regulations after putting up a lot of resistance. ... They've demonstrated time and again that they're simply unwilling to oversee fracking in any meaningful way."

Even if the petroleum industry eventually gets a pass on CEQA, NEPA, UICP, and other pertinent environmental statutes, it will still need copious amounts of water to fully frack the Monterey Shale. But California is semi-arid, and demand for the state's water has long exceeded supply.

Because saline groundwater can be used for fracking where available, per-well estimates of how much surface water will be required range from a few hundred thousand gallons, on the low end, to several million gallons. Not surprisingly, oil industry representatives tend to cite the low estimates, while environmentalists lean toward the higher numbers.

"We haven't seen a lot of fracking in California yet because of two things - complicated geology, and water," says Matthews of the Sierra Club. "Really, water acquisition hasn't been addressed."

At the Wheeler Institute for Water Law and Policy at UC Berkeley School of Law, associate director Michael Kiparsky says experience with experimental fracking wells gives a good indication of what's to come: The oil industry provides voluntary disclosures of water use in its California fracking operations. In 2011 the statewide total amounted to about 200 acre-feet - a tiny fraction of California's industrial consumption. Kiparsky says there would have to be a huge increase in fracking before it registers as a significant part of the state's overall water use. "That said, all water is local," he adds. "The impacts on local water sources could be an issue. We just don't know at this point."

Hull, of the Western States Petroleum Association, believes much of the water needed for fracking could come from by-products of oil wells themselves. "Oil production in California produces, on average, about ten barrels of water for every barrel of oil," he says. "Ultimately, that water could be reclaimed for hydraulic fracturing."

But environmentalists contend that would only begin to meet the need: Recycled oil-well water, says Matthews, can meet no more than 20 percent of the requirements for a typical frack. "In many areas, [the lack of] water is going to be a real physical barrier."

Food and Water Watch - a Washington, D.C.-based nonprofit that opposes fracking - is also skeptical of the oil industry's numbers. "The best estimates we have indicate each frack takes from 500,000 to 4 million gallons (up to twelve acre-feet)," says Adam Scow, director of California operations. "Full-blown exploitation of the Monterey Shale could result in as many as 30,000 new wells. You're talking about a lot of water."

Up to 360,000 acre-feet in total consumption, by a back-of-the-envelope calculation. A lot of water, indeed. Still, the State Water Project and Central Valley Project canals transport up to 5 million acre-feet of water from the Sacramento- San Joaquin River Delta annually. The huge corporate farms of the western San Joaquin Valley alone contract to receive about 2.1 million acre-feet of that.

In recent years, Central Valley growers have expanded their operations from agriculture to water marketing, selling off some of their water allotment to municipal water districts in the Southland. Although many have expressed concern about how fracking in the area would affect their livelihood, others may wind up selling water rights to the oil industry if it becomes more profitable than farming.

Even if the scarcity of water doesn't sink fracking in California, concerns about its threat to groundwater still could. "In the short term, groundwater is by far the most urgent question," Kiparsky says. The risk is that aquifers become contaminated by seepage from fracking fluid admixtures - the proprietary blends of water and chemicals that oil producers are loathe to disclose in detail.

Earlier this year, the federal EPA backed away from the issue in Wyoming. After the agency found tainted water near Encana Corp. gas wells in 2011 and 2012, a U.S. Geological Survey study reported different results. In June the EPA handed off the investigation to the state, which plans to rely on research funded by Encana's U.S. oil and gas subsidiary.

Last month, Duke University researchers announced that samples collected from 2010 to 2012 near a fracking wastewater treatment facility in Pennsylvania contained elevated levels of radium, salts, and heavy metals.

The oil companies have reflexively discredited any study linking groundwater pollution to fracking, maintaining that the shales they target are too deep to pose any threat to reserves of potable groundwater, usually found closer to the earth's surface.

But UC's Kiparsky emphasizes that the risk of groundwater contamination in the Central Valley is real. A recent article he coauthored with Berkeley Law colleague Jayni Foley Hein states: "Fracturing 'flowback' ... and 'produced water' (all waste-water that emerges from the well after production begins) contain potentially harmful chemicals, some of which are known carcinogens. Produced water is also highly saline and potentially harmful to humans, aquatic life, and ecosystems."

The potential ecological risks could be heightened if oil companies pursue "acidizing," a process by which potent hydrofluoric

acid is used in subter-ranean deposits to dissolve the rock rather than to fracture it. Because acidizing requires significantly less water than hydraulic fracturing, it may prove to be the preferred extraction technique for the Monterey Shale. With both processes, however, the basic concern is the same: How can oil producers be sure that toxins injected into the wells won't reach aquifers?

"We haven't studied the issue sufficiently to determine the precise risks, but it's clear there are mechanisms where contamination can occur," Kiparsky says in an interview. "The Monterey Shale is like a layer cake. The freshwater aquifers are in the top layers. There's saline water below that, and lower still is the Corcoran Clay, a thick layer of generally impermeable clay."

Below the clay is the payload - layers of convoluted rock charged with petroleum. In theory, Kiparsky says, the oil could be accessed without threatening the freshwater aquifers above the formation: The Corcoran Clay would block the injected fracking fluid from seeping upward. And the wells that penetrate the strata are cased in steel pipe and cemented to prevent fluid migration.

"But the casings are made by human beings," Kiparsky says, "and that means they're subject to failures and mistakes." He adds, "Any material, including well casings and cement, will degrade over time. And in California, there is always a risk of seismic movement. In any of those cases, fracking fluids or oil could migrate up a pipe and contaminate an aquifer within days or even hours. And the more wells you have, the greater chance of a failure. That's just a basic tenet of risk analysis."

Not all of fracking's water hazards involve freshwater streams and aquifers. Environmentalists have been outraged by recent reports that fracking has occurred at oil platforms off the southern California coast at least twelve times since the 1990s. According to documents released by the federal Bureau of Safety and Environmental Enforcement (BSEE), Venoco completed six different fracks in 2010 at wells in the Santa Barbara Channel. The California Coastal Commission, claiming it wasn't aware of the practice, has launched an investigation.

Both the BSEE and the EPA make inspections during offshore fracking procedures, but it's left largely to the industry to report oil spills and leaks. (Shortly after details of the offshore fracking operations were revealed, the EPA said in a statement that the procedures had not imperiled the environment or human health.)

The Center for Biological Diversity's Kretzmann says the offshore fracking incidents - all conducted without environmental impact reports - prove that BSEE oversight is lax. "BSEE appears to have looked the other way and failed to study or address the dangers of fracking," he comments by email. "A federal agency must perform an Environmental Impact Report before allowing fracking. The law is clear on that."

Air pollution - including emissions of methane, volatile organic compounds, and other hazardous substances - is another major concern. "We know that more air pollution is associated with fracking than with standard drilling operations - and that's hardly pollution free," says Matthews. "Much of this activity is going to occur in the southern San Joaquin Valley, which already ... has some of the dirtiest air in the nation."

Other consequences of fracking could be earth-shaking - literally. In July, a paper in the peer-reviewed Science journal concluded that fluid injections from fracking and geothermal operations could induce earthquakes measuring between 4 and 5 on the Richter scale. In a subsequent press release, lead author Nicholas van der Elst of Columbia University warned that fluid injection "was driving faults to their tipping point."

In a companion article in the same issue of Science, U.S. Geological Survey seismologist William L. Ellsworth stated that numerous Midwest earthquakes in 2011 and 2012 may have been triggered by the underground injection of fracking wastewater into nearby disposal wells, including a 5.6 temblor in central Oklahoma that injured two people and wrecked 14 homes.

A final hurdle to development of the Monterey Shale involves popular culture more than science. Opposition to hydraulic fracturing has become a cause célèbre in Hollywood. Promised Land, starring Matt Damon, and Gasland, an Oscar-nominated documentary, have heightened the public's concerns. And a growing number of celebrities - Robert Redford, Ethan Hawke, Lady Gaga, and Chez Panisse chef Alice Waters among them - have inveighed against the technology.

Still, California lawmakers have shown little zeal for antagonizing the oil industry. Though a number of bills to regulate fracking were introduced this year, only SB 4 survived. Signed by Gov. Jerry Brown in September, the legislation requires oil companies to obtain separate permits for all fracking and acidizing operations, disclose the chemicals injected into wells within 60 days of fracking, and notify adjoining landowners before operations begin. Last-minute amendments make it unclear whether existing wells are subject to CEQA review, or whether CEQA will apply to individual fracking permits. Many fracking opponents had pushed for an outright moratorium on use of the technology while the state conducts its full environmental review.

Nevertheless, environmentalists and oil industry representatives both anticipate more stringent oversight of the practice. "I'm cautiously optimistic we'll see a better framework sooner rather than later," Matthews says. "Pennsylvania had a huge gas boom, and then they tried to regulate. The results haven't been that great."

Garcia of the BLM also foresees a regulatory shift. "My sense is that the oil companies know tighter regulation is coming," he says. "Of course, they don't want to see new rules cripple the industry. But they're involved in the process, and I think they're willing to accommodate change."

Still, in California's oil fields, the tone of talk about fracking is one of implacable determination rather than willingness to compromise. The country still guzzles oil by the supertanker load, day after day. And everybody knows that way down there, locked between layers of rock, is a trove of shale oil - billions of barrels of it.

For Travis Goddard at the Cree Pad, there's no question: The oil industry is going to drill down and get it. Gazing at the huge rig that's slowly sucking up high-grade petroleum from the Monterey Shale nearly two miles below, he says with a lazy smile, "The way I figure it, it's steady as she goes."