

Reckless Endangerment While Fracking the Eagle Ford

September 2013

**GOVERNMENT FAILS, PUBLIC HEALTH
SUFFERS AND INDUSTRY PROFITS
FROM THE SHALE OIL BOOM**



EARTHWORKS™

OIL & GAS ACCOUNTABILITY PROJECT

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FROM THE SHALE OIL BOOM

SEPTEMBER 2013

By

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For more information on this study go to: <http://eaglefordreport.earthworksaction.org>

Photos by Sharon Wilson, Earthworks, unless indicated.



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For 25 years, Earthworks has been working with communities and residents living in close proximity to oil and gas development to address potential links between health impacts and oil and gas development.

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For 25 years, Earthworks has been working with communities and residents living in close proximity to oil and gas development to address potential links between health impacts and oil and gas development.¹



Introduction

Oil and gas operations in shale formations release chemicals to air, water, and soil that are hazardous to human health. When operators act irresponsibly, these releases are exceptionally severe, and nearby communities are particularly at risk.

Government bears no small share of the blame for these releases because – **without exception – rules governing oil and gas development are inadequate to protect the public.** In addition to loopholes in bedrock federal environmental laws like the Safe Drinking Water Act and Clean Air Act, these inadequacies commonly include state failure to require measures to prevent or mitigate equipment failures, accidents or human errors that can lead to emissions of hazardous chemicals.²

These insufficient rules – again, without exception – are inadequately enforced.³ By failing to consistently apply rule and statute, and to penalize violators,⁴ regulators essentially condone reckless operator behavior, thereby placing the health of residents living near oil and gas development at risk.

Industry and state government insist that state regulation of oil and gas development best protects the public. But communities know differently, as this report details.

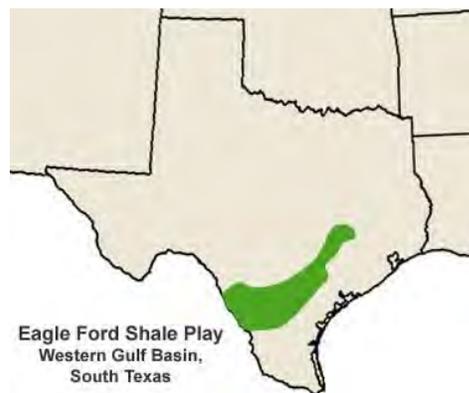
Without exception – rules governing oil and gas development are inadequate to protect the public. What rules there are, are inadequately enforced.

THE EAGLE FORD SHALE BOOM

The Eagle Ford Shale stretches from the Mexican border across South Texas and into East Texas. It is currently under intensive development because in addition to dry natural gas and natural gas liquids⁵ (also referred to as condensate), it also produces oil (which is more profitable than gas).⁶

The first Eagle Ford Shale well was drilled in 2008. By the end of April 2013, the Texas Railroad Commission (RRC) had issued 9,459 Eagle Ford drilling permits.⁷ RRC data show that oil production in the Eagle Ford Shale was approximately 130 thousand barrels per day (bpd) in 2011. As of March 2013, four times that amount was being produced from the Eagle Ford Shale (more than 500 bpd of oil).⁸ While dry natural gas and condensate liquid production are also on the rise, the increases in these products have been far less dramatic.⁹

One of the characteristics of oil and gas development in shale formations is that a high density of wells is required to sustain oil or gas production. Shale oil wells experience a dramatic, rapid decline in oil production compared to conventional oil wells. As a result, shale oil operators must intensively drill new wells to offset the loss of production from older wells.¹⁰ In the Eagle Ford Shale, some operators are beginning to drill one well per 65 or even 40 acres.¹¹



For citizens living amidst the development, forty-acre spacing means that there could be more than a dozen wells drilled within a one-mile radius of a family's home.¹² It also means: long periods of time during which wells are being drilled in close proximity to their homes; the addition of other facilities

such as oil processing and waste disposal sites nearby; and increased truck traffic to service the ever-growing number of wells.

As detailed in this report, shale oil development also brings a decrease in air quality. And as more wells and facilities come into an area, it becomes more and more likely that there will be accidental, scheduled and negligent releases of large quantities of toxic air pollutants.

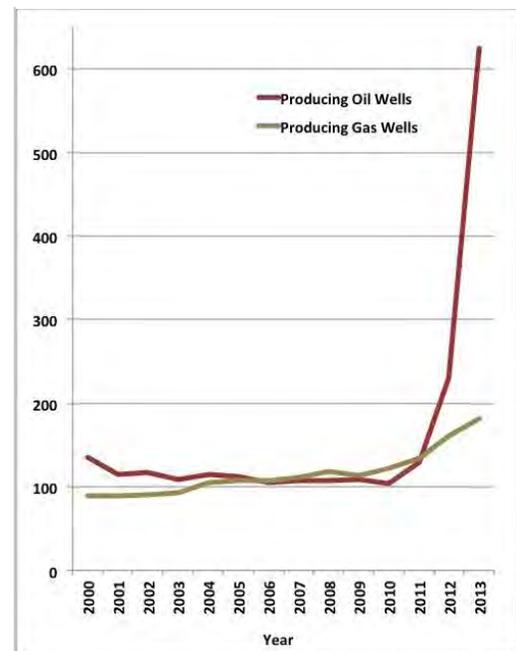
THE SHALE OIL BOOM IN KARNES COUNTY

Karnes County is within the core—the area with the most intensive oil development and potential for future growth— of the Eagle Ford Shale.¹³

There is a history of some oil and gas development in the county, but drilling has skyrocketed in the past couple of years. As seen in Table 1, oil development in Karnes County started to increase in 2011, but experienced a dramatic surge between 2012 and 2013. Development of gas wells has also increased in the past couple of years, but their growth has not been as strong as it has been for oil wells.

As of February 2013, there were 625 producing oil wells and 182 producing gas wells in Karnes County.¹⁴ Since November 2012, Karnes County has consistently been the top oil-producing county in the Texas.¹⁵

TABLE 1: Wells in Karnes County



OIL & GAS AIR POLLUTION AND ITS HEALTH IMPACTS

There are a variety of sources of air emissions common to oil and gas operations.¹⁶ Sources include:

- engines or turbines used to power pumps, drill rigs, compressors and vehicles;
- heaters and boilers
- process vents and flares from oil and gas treatment equipment (glycol dehydrators; separators; heater-treaters)
- losses during loading/unloading of oil/gas/produced water
- storage tanks for crude oil, condensate and produced water
- open-top fracturing liquid containers;
- pits/waste impoundments;
- pumps or other artificial lift equipment
- pneumatic devices

- leaks and fugitive emissions from pipelines and wellhead equipment (valves, connectors, flanges, pumps and others); separators, storage tanks);
- venting or flaring of gas during well completions and well testing.

The long-term cumulative health risks posed by the various sources of air emissions have not been studied in the Eagle Ford Shale. Early results from a long-term study in Pennsylvania suggest that air pollution from Marcellus Shale gas operations in that state may be contributing to a host of symptoms including breathing problems, headaches, dizziness and eye irritation.¹⁷

Studies from other oil and gas producing areas indicate that emissions during drilling and hydraulic fracturing operations can result in localized air quality levels that are detrimental to human health.

- In 2010, the Colorado School of Public Health published a study indicating higher risks for cancer and other health problems from poor air quality near gas wells that were hydraulically fractured. Within about a mile of these sites, researchers found elevated levels of benzene as well as chemicals that can irritate eyes and cause headaches, sore throats, or breathing difficulties.¹⁸ (To date, there have been 18 wells drilled and hydraulically fractured within a mile of the Cerny home, and 34 within 2 miles.)
- A 2012 peer-reviewed study published in *Science of the Total Environment* used air sampling data from Colorado and found that due to the toxicity of air emissions near natural gas sites, residents living within ½-mile of well sites had a greater risk of health-related impacts than those living further away.¹⁹ Additionally, the study found that the greatest health impact corresponded to the relatively short-term, but high emission, well completion period.²⁰ (There are currently three wells that are approximately ½-mile from the Cerny home.)
- A third peer-reviewed study to be published in the journal *Human and Ecological Risk Assessment*, sampled air before, during and after drilling and hydraulic fracturing of several natural gas wells on a single pad in Colorado. During the drilling and hydraulic fracturing phase, dozens of non-methane hydrocarbons were detected in the air near the well pad, including some chemicals known to harm the brain and nervous system. Of note, researchers detected PAHs at concentrations associated with developmental effects on children.²¹ (It is likely that due to the flaring of gas that contains propane, PAHs are being released from the Eagle Ford Shale.)

During the drilling and hydraulic fracturing phase, dozens of non-methane hydrocarbons were detected in the air near the well pad, including some chemicals known to harm the brain and nervous system. Of note, researchers detected PAHs at concentrations associated with developmental effects on children.

In addition to air emissions during the drilling and hydraulic fracturing phase of development, air pollution associated with gas flaring and venting during any stage of production (e.g., casinghead gas, processing facilities, fugitive emissions) “poses a significant health risk for local communities and for people who work in these oil fields.”²²

The balance of this report discusses air contaminants associated with oil and gas operations in Texas's Eagle Ford Shale, their impacts on the health of residents of Karnes County, and the failure of state regulators to protect its citizens from these impacts.

To illustrate some of the potential impacts related to the intensive development occurring in the Eagle Ford Shale, the report highlights and uses examples experienced by one family in particular.

THE CERNY FAMILY

The Cerny family lives in Karnes County, near Karnes City. Early in 2012, Myra Cerny contacted Earthworks because she, her husband Mike, and 15-year-old son Cameron were experiencing a variety of new health problems. Myra wondered if her family's deteriorating health was caused by the strong odors and fumes from shale oil and gas development surrounding her home.

In September 2012, Earthworks' visited the Cernys and found the situation alarming:

- Black smoke billowing off flares and haze hanging over the horizon;
- Dust boiling into the air from newly bladed pad sites and from trucks and heavy equipment traffic on newly created roads;
- The odor of rotten eggs, garlic, a sickly sweet smell and hydrocarbons.

On March 4 – 5, 2013, representatives of Earthworks and ShaleTest²³ traveled to Karnes City to conduct an investigation of the Cernys' complaints, take air quality samples and look for fugitive emissions of gas from Eagle Ford Shale facilities close to the Cerny family's home.

"It's not *if*, it's *when* you are going to get sick...We have a 15-year-old son and we cannot protect him [from the fumes]."

—Mother, Myra Cerny



Cameron Cerny

In 2010 and 2011, the TCEQ (Texas Commission on Environmental Quality) conducted a special inventory of air emissions from Barnett Shale operations. The TCEQ has not yet released a similar inventory of emissions from oil and gas sources in the Eagle Ford Shale. According to the Eagle Ford Shale Task Force, there is, however, an emissions inventory being developed by the Alamo Area Council of Governments with the assistance of the oil and gas industry in Eagle Ford Shale. That inventory is expected to be released by the end of 2013.

Notes from life in the heart of an oil boom

Excerpts from Myra Cerny's correspondence with Earthworks

July 23, 2012

We still suffer frequent headaches and have restless nights. Cameron still gets nosebleeds, depending on what is going on nearby. Mike had gotten a rash down both arms...The doctor said that he had seen rashes on other people since this oil industry came to town.

My son [Cameron] is 15. We only have a few more special childhood years with him remaining. He and I used to enjoy a long, almost 6 mile walk... We had set a goal of riding 4 miles up to the corner store, eating lunch, and then riding home. We had managed to come very close to achieving this goal, but the traffic has made it impossible to take part in either of these mother and son moments ever again... They have taken what would have been cherished memories and bonding moments away from us. That can't be expressed in words.



www.youtube.com/watch?v=rhuDUWLx9rE

August 30, 2012

Just a few weeks after FM 99 road was repaired, it is, once again, being ripped up and redone! We grow tired of having to avoid dangerous holes and the scattered debris.

New flares have arrived. Behind us, the fracking should give birth to the newest addition in that same family. By the horrible sound, labor is very intense. Wished I could ask for a separate room. Oh, but I did, and [operator name] denied that request.

The popular petroleum smell is gaining ground on its garlicky companion. I'm sure both will continue their assault on our lungs.

December 2012

We ended up at hospital on Turkey day. I've been sick since then. I can't put into words, because there are no words to express my anger of being placed into this hell with no escape. Each new flare or rig put up around my home leaves me standing there staring and crying.

In September 2012, an Earthworks' organizer visited the Cerny family. At that time the Cernys were afraid to speak out publicly because Mike works as a truck driver for the industry and they felt pressure from neighbors to keep quiet.

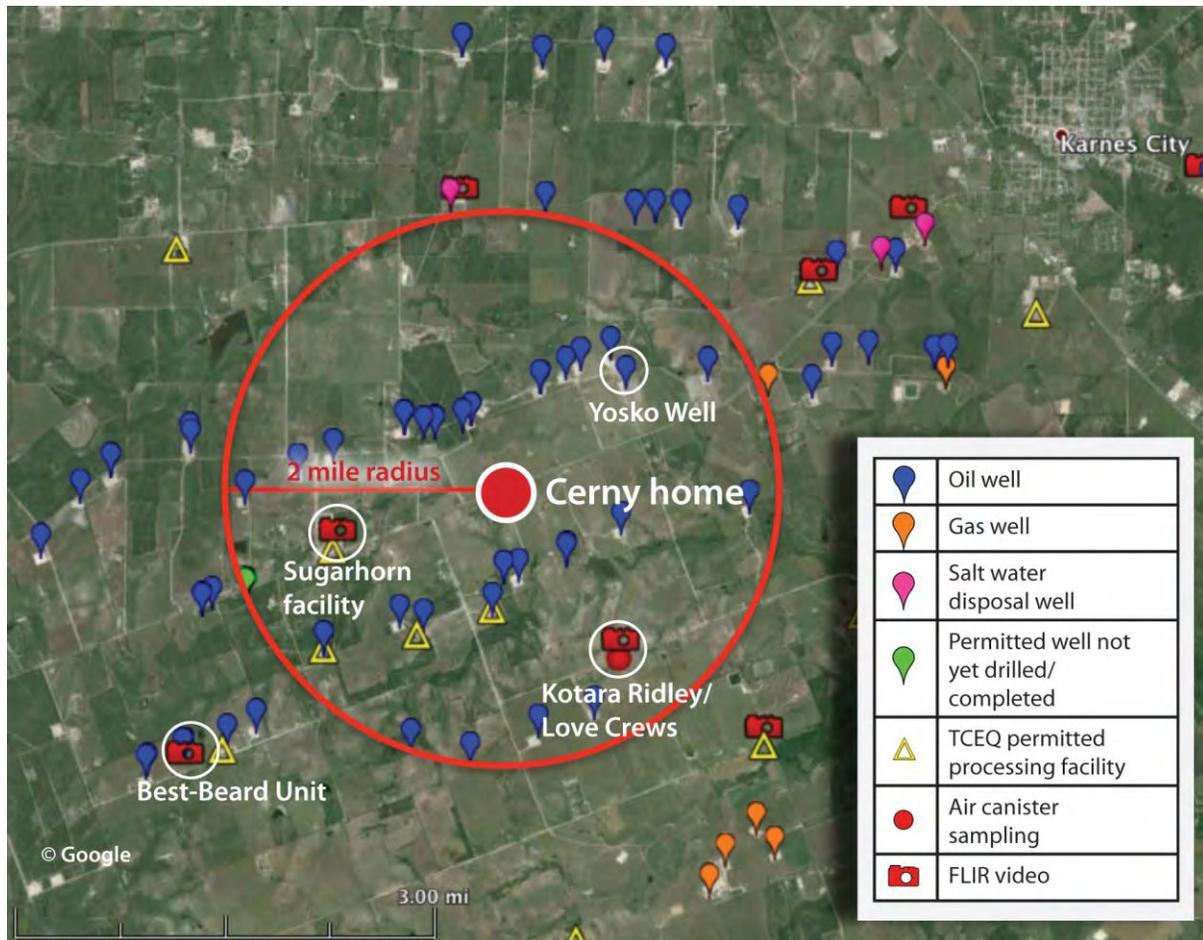
After the Thanksgiving health emergency, the Cernys decided that they could no longer stay silent.

In 2010 and 2011, the Texas Commission on Environmental Quality (TCEQ) conducted a special inventory of air emissions from Barnett Shale operations.²⁴ The TCEQ has not yet released a similar inventory of emissions from oil and gas sources in the Eagle Ford Shale. According to the Eagle Ford Shale Task Force²⁵, there is, however, an emissions inventory being developed by the Alamo Area Council of Governments with the assistance of the oil and gas industry in Eagle Ford Shale.²⁶ That inventory is expected to be released by the end of 2013.²⁷ Barnett Shale has special monitoring and is in wealthier neighborhoods. The Eagle Ford is more intensively developed than the Barnett Shale, with more wells per square mile, but has not had pollution inventories like the Barnett has.

Within approximately two miles of the Cerny home there are 37 existing oil wells. Since November 2010, 18 oil wells have been drilled and fractured within a mile.

The Cerny home is located a few miles west of Karnes City, in Karnes County, Texas. Since November 2010, 18 oil wells have been drilled and fractured within a mile of the Cernys. Within approximately 2 miles of the Cerny home there are 37 existing oil wells, several oil and gas processing facilities and a saltwater injection facility. Within 3 or 4 miles of the Cernys there are dozens of additional wells and facilities. (See Appendix 1 for list of facilities.)

FIGURE 1. Map of oil and gas facilities near the Cerny home



OIL AND GAS TOXIC POLLUTANTS SURROUNDING THE CERNY HOME

Pollutants from drilling, hydraulic fracturing and well completion

For the past couple of years, drilling and hydraulic fracturing of wells has been occurring on a fairly constant basis in close proximity to the Cernys. As seen in Table 2, drilling started in November 2010 with the Gilley Unit 1H well (0.91 miles away).²⁸ Since that time 36 more oil wells and one gas well have been drilled and fractured, and there has scarcely been a month when there has not been drilling and/or fracturing activity within about 2 miles of their home. In most months there have been several rigs operating.

TABLE 2. Wells drilled and fractured within 2 miles of the Cernys (2010-2013)

Well Name	Miles away	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug		
		2010				2011								2012								2013															
Gilley 1H	0.91	■	■	■	■	■	■	■	■																												
Yosko 1H	1.13		■	■	■	■	■	■	■																												
Jordan Unit 1H	1.75			■	■	■	■	■	■																												
Buehring 1H	1.18				■	■	■	■	■																												
Davenport 1H	1.75						■	■	■	■																											
Brysch-Jonas 1H	0.91								■	■	■	■	■																								
Yosko Borgfeld 1H	1.02									■	■	■	■	■																							
Chapman-Rogers 1H	1.77										■	■	■	■	■																						
Yosko-Kinkler 1H	1.2											■	■	■	■	■																					
Holland-Opielea 1H	0.89												■	■	■	■	■																				
Holland-Brown 1H	0.84													■	■	■	■	■																			
Vajdos-Foegelle 1H	1.26														■	■	■	■	■																		
Brysch-Jonas B 1H	0.75															■	■	■	■	■																	
Zaeske-Eckols 1H	1.66																■	■	■	■	■																
Brysch-Adams 1H	0.53																	■	■	■	■	■															
Kimble Gilley 1H	1.77																		■	■	■	■	■														
Hedtke-Henke 1H	1.87																			■	■	■	■	■													
Tipton-Jonas 1H	0.51																				■	■	■	■	■												
Adams-Tipton 1H	0.67																					■	■	■	■	■											
Brysch-Jonas C 1H	0.74																						■	■	■	■	■										
Brown-Dupnik A 1H	1.24																							■	■	■	■	■									
Culberson-Patteson 1H	0.89																								■	■	■	■	■								
Franke Unit	2.01																									■	■	■	■	■							
Tipton-Jonas 2H	0.52																										■	■	■	■	■						
Gilley 2H	1.79																											■	■	■	■	■					
Brysch-Adams 2H	0.69																												■	■	■	■	■				
Vajdos-Foegelle 2H	1.5																													■	■	■	■	■			
Vajdos-Foegelle 3H	1.5																														■	■	■	■	■		
Tipton-Jonas 4H	0.64																														■	■	■	■	■		
Brysch-Adams 3H	0.7																														■	■	■	■	■		
Tipton-Jonas 3H	0.63																															■	■	■	■	■	
Jordan 3H	2.00																															■	■	■	■	■	
Salge-Kinkler 2H	2.01																																■	■	■	■	■
Adams-Tipton 4H	0.7																																■	■	■	■	■
Buehring Unit 2H	1.99																																		■	■	■
Adams-Tipton 3H	0.67																																		■	■	■
Adams-Tipton 2H	0.67																																			■	■

Spudding and drilling (RRC data. See Appendix 1). As of Sept. 1, 2013, no data posted for most recent wells.
 Hydraulic fracturing start date (From FracFocus - only limited data available prior to February 2012. See Appendix 1)

After a well is drilled and fractured it must be 'completed' in order to begin producing. The completion process removes drilling mud and stimulation/fracturing fluids from the well. During the completion process natural gas is often vented to the atmosphere or flared.²⁹ Texas Railroad Commission rules allow gas to be flared or vented during drilling, and for up to 10 days following well completion.³⁰ According to a 2012 report by the Alamo Area Council of Governments (AACOG), flaring controls all well completion activity in the Eagle Ford Shale.³¹

Typically, raw natural gas that emerges from an oil well is a mixture of methane and other hydrocarbons (e.g., ethane, propane, butanes, and pentanes). Depending on the location, the gas may also contain water vapor, hydrogen sulfide (H₂S), carbon dioxide (CO₂), helium, nitrogen, and other compounds. Direct venting of this gas releases a significant amount of methane into the atmosphere along with H₂S and volatile organic compounds (VOC), which include cancer-causing pollutants and air toxics such as benzene.³²

When this gas is burned or flared, it primarily produces carbon dioxide (CO₂) and carbon monoxide (CO), with smaller volumes of a variety of air pollutants such as VOCs, nitrogen oxides (NO_x), sulfur dioxide (SO₂), toxic heavy metals, and black carbon soot.³³ Flaring of propane-rich gas produces soot emissions and many polycyclic aromatic hydrocarbons (PAH) attached to soot particles, including naphthalene, acenaphthalene, fluorene, phenanthrene, fluoranthene, and pyrene.³⁴ Some of the gas flared in the Eagle Ford Shale contains propane, and so is likely to produce at least some PAHs when flared.³⁵

In 2012, the U.S. Environmental Protection Agency (EPA) enacted a new rule that requires natural gas wells to capture gas during well completions instead of venting or flaring it (“green completions”). When the rule is fully in effect in 2015, EPA estimates that VOC emissions from natural gas well completions will be reduced by 95%.³⁶ EPA was unable to quantify the health benefits, but expects the rule will reduce health effects associated with exposure to hazardous air pollutants, ozone and particulate matter.³⁷

Unfortunately for residents living in shale oil territory, oil wells like those in the Eagle Ford Shale are not subject to these new EPA regulations requiring “green completions”.³⁸

FLARED/VENTED CASINGHEAD GAS

Many oil wells also produce natural gas. This gas is referred to as casinghead gas or associated gas. Options for managing casinghead gas include building pipelines to transport the gas, flaring or venting the gas at the wellhead, or using the gas on-lease.

According to the Eagle Shale Task Force, “Flaring of casinghead gas for extended periods of time may be necessary if the well is drilled in an area new to exploration where infrastructure is limited. In existing production areas, flaring also may be necessary because existing pipelines may have insufficient capacity or are otherwise unable to take the gas.”³⁹ A recent report by the Alamo Area Council of Governments suggests that at least some “oil wells in the Eagle Ford vent casinghead natural gas.”⁴⁰

The RRC issues 45-day permits for flaring or venting of casinghead gas, but extensions can be granted to allow releases for up to 180 days.⁴¹ RRC requires operators to report casinghead gas released on a lease-by-lease basis (a lease may have more than one well), but does not require operators to specify whether the gas was flared or vented.⁴² There is also no requirement for operators to provide RRC with an analysis of the hazardous components being released in the gas.

An upcoming rule will reduce VOC air pollution from natural gas wells by 95%. Unfortunately for Eagle Ford Shale residents, this rule will not apply to shale oil wells.



Flaring from one of the many wells near the Cerny home.

As with the venting and flaring of completion gas, venting of casinghead gas releases VOCs and other components of raw gas (e.g., methane, and H2S and other air toxics, if present) into the air, while flaring releases CO2, CO, VOCs, NOX, SO2, possibly PAHs and other partially combusted hydrocarbon compounds.

The following table shows that a large volume of casinghead gas has been released near the Cerny home. Data from the RRC reveal that from November 2011 to March 2013 between 4 and 21 thousand cubic feet (mcf) of casinghead gas was either vented or flared each month from wells located within 2 miles of the Cerny's home.⁴³

TABLE 3. Casinghead gas flared/vented from oil leases near the Cerny home

Lease	Miles from Cerny home	Total Gas vented / flared (mcf)	Nov 2011	Dec 2011	Jan 2012	Feb 2012	Mar 2012	Apr 2012	May 2012	Jun 2012	Jul 2012	Aug 2012	Sep 2012	Oct 2012	Nov 2012	Dec 2012	Jan 2013	Feb 2013	Mar 2013
Tipton-Jonas Unit	0.52 - 1.81	2,340								259	333	661	351	736					
Brysch-Adams Unit	0.53 - 0.7	4,627						65	1155	353	374	942	503	1235					
Adams-Tipton Unit	0.6 - 0.7	6,332						1880	886	206	396	1037	525	1349			53		
Brysch-Jonas Unit C	0.74	2,400							451	339	220	190	353	848					
Brysch-Jonas Unit B	0.75	2,244							678	240	88	265	365	608					
Holland-Brown Unit	0.84	4,302	488	430	257	71	319	403	248	99	209	487	248	1043					
Holland-Opiela Unit	0.84	3,798		208	299	246	403	549	353	89	205	511	201	734					
Culberson-Patteson Unit	0.89	1,383												1383					
Brysch-Jonas Unit	0.91	3,121	465	328	286	225	111	236	231	88	74	100	183	794					
Gilley Unit	0.91 - 1.81	4,072	120	96	76	76	63	155	36	0	28	59	685	2678					
Yosko Borgfeld Unit	1.02	3,703	566	428	488	10	127	374	254	57	57	74	183	1,085					
Yosko Unit	1.13	7,046	1,885	1,324	567	567	438	612	279	56	73	119	232	894					
Buerhing Unit	1.17	3,627	790	532	252	252	202	434	215	210	242	168	130	200					
Yosko-Kinkler Unit	1.2	2,390	220	173	165	197	245	182	182	21	34	56	178	737					
Brown-Dupnik Unit	1.24	3,309							218	278	442	883	437	1,051					
Vajdos-Foegelle Unit	1.26 - 1.5	4,381					551	237	598	208	383	1,316	519	569					
Zaeske-Eckols Unit	1.66	5,943																	
Davenport Unit	1.75	6,937						3,435	561	465	191	217	243	831					
Jordan Unit	1.75	18,694	2,604	1,082	453	453	383	398	243	232	235	91	73	690					
Chapman-Rogers Unit	1.77	4,926	7,530	3,756	1,691	1,691	1,192	1,131	59	55	51	222	166	825	325				
Kimble-Gilley Unit	1.77	13,785	808	567	464	213	206	324	430	70	70	95	317	1362					
Hedtke-Henke Unit	1.87	4,204						1675	3710	3591	3550	139	78	1042					
Franke-Unit	2.01	1,683									631	223	214	244	138	66	79	34	54
TOTAL (1,000 mcf)		115.2	15.5	8.9	5.0	4.0	4.2	13.6	11.6	7.1	8.2	8.1	6.5	21.4	0.463	0.066	0.132	0.034	0.054

MIDSTREAM SOURCES OF POLLUTANTS

Midstream sources are facilities that transport, handle, process, and distribute oil and gas products and wastes. Examples include: compressor stations, processing facilities, cryogenic plants, tank batteries, saltwater disposal sites, and pipelines, among others. Large emission sources at midstream facilities include heater/boilers, glycol dehydrators, compressor engines, storage tanks, flares/combustors, losses during loading of condensate and wastewater, scheduled releases (blowdowns) and accidental releases and leaks (i. e., fugitive emissions).⁴⁴

Within 3 miles of their home, Facilities are allowed to emit 374 tons of VOCs per year, and 225 tons of NOx, and 16 tons of HAPs.



Below are the midstream oil and gas facilities within 3 miles of the Cerny home in the TCEQ air permits database.⁴⁵ As seen in the table, these facilities are allowed to emit up to 374 tons of VOCs per year, as well as close to 225 tons of nitrogen oxides (NOx), 170 tons of carbon monoxide (CO), 14 tons of particulate matter (PM), 23 tons of sulfur dioxide (SO₂), 0.3 tons of hydrogen sulfide (H₂S), and at least 16 tons of hazardous air pollutants (HAPs).

TABLE 5. TCEQ-permitted emissions from midstream oil and gas facilities close to the Cerny home

Midstream Facilities	Miles from Cernys	VOC		NO _x		CO		PM ₁₀ OR 2.5		SO ₂		H ₂ S		HAP	
		lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy	lbs/hr	tpy
Gilley 1 Production Facility ⁴⁶	0.86	70.3	13.8	0.75	2.35	1.23	3.52	0.02	0.09	1.42	1.08	0.02	0.01	ND	ND
Buehring 1 Production Facility ⁴⁷	1.21	105.15	13.8	0.68	2.98	0.80	3.53	0.04	0.19	0.17	0.75	0.05	0.01	6.7	0.99
Sugarhorn Central Facility ⁴⁸	1.31	39.45	80.25	16.9	56.57	14.32	24.85	0.79	3.65	6.81	11.10	0.09	0.15	3.71	14.65
Jordan Davenport Prod. Facility ⁴⁹	1.73	107.0	15.2	1.45	4.17	2.29	5.69	0.04	0.14	0.48	1.29	0.03	ND	0.56	0.09
Kimble Gilley (emissions sources removed from site Oct. 2012) ⁵⁰	1.77	70.3	17.1	1.57	4.76	2.59	7.08	0.08	0.33	0.36	1.19	0.03	0.01	ND	ND
East Sugarloaf Central Facility ⁵¹	2.62	17.3	72.4	11.3	49.0	6.85	29.3	0.70	3.07	0.25	1.09	0.005	0.020	ND	ND
East Longhorn Central Facility ⁵²	2.67	14	59.5	6.58	28.6	4.26	18.3	0.44	1.93	0.66	2.85	0.01	0.04	ND	ND
Kotara Production Facility ⁵³	2.72	12.11	8.97	7.41	28.15	12.05	44.22	0.16	0.58	0.01	0.04	ND	ND	0.16*	0.68*
Pfeifer No 1. Production Facility ⁵⁴	2.84	5.74	19.9	1.16	4.65	1.76	6.94	0.08	0.30	0.04	0.14	<0.001	0.002	ND	ND
North Longhorn Central Facility ⁵⁵	2.95	31.72	82.62	12.84	44.65	11.74	23.32	0.64	2.79	0.84	3.65	0.012	0.05	ND	ND
TOTAL EMISSIONS (tons per year)		473	384	61	226	58	167	3	13	11	22	0.3	0.3	11	16

VOC = volatile organic compound NO_x = nitrogen oxides CO = carbon monoxide PM₁₀ or 2.5 = particulate matter of 10 or 2.5 microns SO₂ = sulfur dioxide H₂S = hydrogen sulfide HAP = hazardous air pollutants ND = no data * = the only HAP was formaldehyde

Fugitive emissions and unplanned emissions events

Fugitive emissions occur when raw gas is released to the atmosphere through equipment leaks, equipment failures, or human error, such as when tank hatches are left open. Depending on where in the process the leaks occur (i.e., before or after the gas is processed), these emissions will contain methane, and may contain VOCs, H₂S and other compounds found in natural gas.⁵⁶

Residents living near oil and gas facilities are also exposed to emissions that occur during planned “maintenance, startup and shutdown” (MSS) of equipment. MSS emissions may occur due to normal operations such as regular maintenance, or result from unplanned events such as blowdowns, pipeline pigging and tank de-gassing. There are also MSS events that arise when production units break down and gases have to be vented or routed to emergency flares.⁵⁷

According to the Environmental Integrity Project (EIP), between 2009 and 2011 unplanned “emission events” at natural gas operations in Texas (e.g., compressors, processing facilities, storage tanks) released more than 36,000 tons of sulfur dioxide and 38,000 tons of smog-forming volatile organic compounds (VOCs). EIP based its analysis on industry reports filed with TCEQ.⁵⁸

As will be seen later in this report, FLIR videos taken by ShaleTest and obtained through public information requests to TCEQ indicate that there are fugitive emissions and venting from many facilities in Karnes County. These emissions were not quantified during the Earthworks field visit.

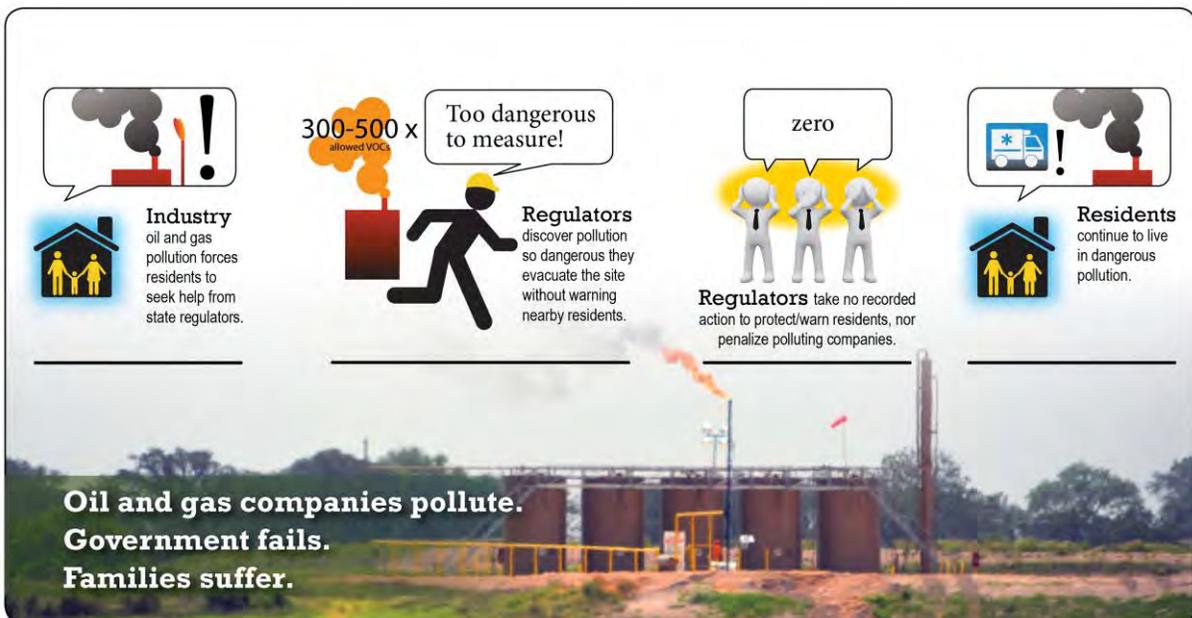


State regulators fail to protect the public

AIR QUALITY COMPLAINTS IN KARNES COUNTY

The Cernys are not alone in noticing and expressing concern about how air quality has been affected by the arrival of drilling rigs and shale oil facilities. Between 2006 and July 2013 more than 30 air complaints related to oil and gas operations in Karnes County were filed with TCEQ. (See Appendix 2.)

Citizens complained of odors, which they described as bad, terrible, sulfur-like, H₂S, rotten egg, crude, petroleum, chemical, dust, and more. In addition to odors, citizens sometimes complained that while smelling the odors they could not go outside. The complainants associated the odor events with symptoms such as headaches, nausea, rashes, vomiting, burning eyes/nose/throat, nosebleeds and other effects.



The Cernys have registered complaints with both the RRC and TCEQ on numerous occasions, and at least one of these complaints resulted in an investigation by TCEQ, and the discovery of air emissions violations.

AIR QUALITY INVESTIGATIONS NEAR THE CERNY HOME

Sugarhorn Facility—Marathon Oil EF, LLC

1. VOC readings are so high, it is unsafe for inspectors, and presumably for nearby residents

According to documents obtained by Earthworks through an Open Records request filed with TCEQ, in 2012 there were four visits by TCEQ inspectors and two additional compliance investigations at the Sugarhorn Central Facility operated by Marathon Oil EF LLC in Karnes County. The Sugarhorn facility is approximately 1.3 miles south-west of the Cerny home. (See Figure 1).

The first four site visits took place on February 3, March 1, June 15 and 30 2012. On February 3, a flare at the facility was observed to be emitting black smoke over a period of more than 15 minutes.⁵⁹ During two other visits, elevated concentrations of VOCs were measured using a Toxic Vapor Analyzer (TVA): March 1, TVA detected a maximum of 24 ppm; June 15, TVA detected 132 ppm.⁶⁰ Inspectors did not test for VOCs during the other two inspections.⁶¹

VOC levels were so high that the inspectors left the site. But they did not take further action to reduce pollution, cite the operator, nor warn residents.

According to a TCEQ investigation summary, “upwind and downwind Summa canister samples would be taken only when the TVA monitor reads 5 parts per million (ppm) or greater above background and a receptor was within a quarter of a mile.”⁶²

No canister samples were taken during these investigations, even though on two occasions VOC levels were well above 5 ppm, and there appeared to be receptors within ¼ mile. The June 15, 2012 investigation notes stated:

*“TVA measured 132 ppm VOCs downwind of the facility. Canister samples were not taken as the **VOC measurement was too high to safely obtain the samples** [emphasis added].”⁶³*

Although an exact distance to the nearest receptor was not obtained, the inspector’s notes estimated the nearest receptor was “yards” away.⁶⁴

It is not uncommon for TCEQ inspectors to leave oil wells and processing sites for safety reasons (see Yosko investigation below). This is an important precaution, as it is essential to protect TCEQ-employee safety, but it is extremely troubling that there is apparently no step taken to either warn nearby residents of the chemicals in the air, or to take canister samples at nearby receptors in order to try to determine residents’ potential exposure to the chemicals emanating from the facility.⁶⁵

2. In addition to measuring high VOCs, inspectors documented emissions at the Sugarhorn facility using a Gas Find Infrared Camera (IR camera) and observations:

- June 15, 2012: IR camera “indicates hydrocarbon emissions from the enardo valves on oil tanks, as well as condensate tanks and water tank. Generator near flare emitting smoke.”⁶⁶
- June 30, 2012: IR camera “indicated extensive hydrocarbon emissions from the two vent lines on the black production tanks that were going offsite.”⁶⁷



Sugarhorn facility, June 15, 2012 Infrared camera indicates extensive hydrocarbon emission. <http://eaglefordreport.earthworksaction.org>

Video recorded by TCEQ inspectors.

3. Inspectors find violations

On August 15 and September 5, 2012, TCEQ performed compliance investigations at the Sugarhorn facility in response to a complaint received from Myra Cerny on August 14, 2012, of sulfur and petroleum like odors from nearby oil and gas facilities. As stated in the investigation report “Complainant sees flares smoking. Family member is getting nose bleeds and complainant is suffering from rashes and eye irritants.”⁶⁸

On August 15, 2012, TCEQ inspectors used an IR camera and identified emissions coming from vents located on top of petroleum storage tanks at the facility. The investigators, however, could not get downwind of the facility to detect odors.⁶⁹

On September 5, 2012, TCEQ inspectors documented that the enclosed barrel flare at the facility was not burning. TCEQ informed Marathon of the inoperative flare that same day.⁷⁰ Because of the wind direction, investigators could not get downwind of the facility to detect odors or record emissions using handheld monitoring devices.⁷¹

Marathon operators report emission violations 3 months later, instead of the required 24 hours.

4. Excessive air pollution from Sugarhorn releases

Marathon was supposed to report the emission events within 24 hours of their occurrence, but failed to do so for more than three months.⁷² On December 20, 2012, Marathon reported to TCEQ that the August 15, 2012, emissions event at the Sugarhorn facility involved venting from petroleum storage tanks, and lasted 12 hours. As seen in Table 6, the event caused the release of various carcinogenic chemicals such as benzene, toluene, ethylbenzene and xylenes (collectively known as BTEX), more than 500 times the “maximum allowable emissions rate” of VOCs and more than 100 times the allowable emission of H₂S in Marathon’s permit.⁷³

Marathon’s report indicated hydrogen sulfide emissions 112 times the allowable rate, and VOCs at 514 times the allowable rate.

TABLE 6. Air emissions from two events at the Sugarhorn Central Facility (Aug. 15 and Sept. 5, 2012)

	Emissions (lbs)	Emissions (lbs/hr)	Allowable emissions in permit (lbs/hr)	Exceedence
August 15	12-hour period			
Benzene	42	3.5		
Toluene	58	4.8		
Ethylbenzene	4	0.4		
Xylenes	33	2.7		
Hydrogen sulfide	1.35	0.1	0.001	112.5 times permitted emissions rate
Propane	8,535	711.3		
Other VOCs	> 10,000	> 833	1.62	514 times a permitted emissions rate
September 5	11.5-hour period			
Benzene	27.63	2.4		
Toluene	38.34	3.3		
Ethylbenzene	2.76	0.24		
Xylenes	21.54	1.87		
Hydrogen sulfide	0.88	0.077	0.001	77 times permitted emissions rate
Propane	5,607	711		
Other VOCs	> 6,600	> 574	1.62	354 times permitted emissions rate

According to Marathon, on September 5, 2012, the enclosed barrel flare failed to operate over a time period of 11 hours and 30 minutes. Marathon again reported releasing BTEX, hydrogen sulfide, and over 6,600 of other volatile organic compounds. This is more than 350 times the maximum allowable emissions rate for VOCs in Marathon’s permit, and more than 75 times the allowable emissions rate for H₂S.⁷⁴

5. No penalty for violations

On January 24, 2013 Marathon was issued Notices of Violation for: 1) failing to operate the facility with all air pollution emissions capture and abatement equipment working; and 2) late reporting of emissions events; exceeding emissions represented in an air permit.⁷⁵

On February 19, 2013 Marathon sent a letter to TCEQ indicating that the company had provided various awareness trainings to its employees to make sure that they knew how to operate flares properly and could recognize emissions events. According to TCEQ, these trainings resolved the violations.⁷⁶

No further enforcement action, such as issuing a fine or penalty, appears to have been taken.⁷⁷

The investigation and enforcement record at the Sugarhorn central facility raises many concerns:

- Because no canister samples were taken during any of the inspections and investigations it is not clear how these various emissions may have affected the health of the Cernys and other nearby residents.
- The August and September emissions incidents were caught by TCEQ inspectors because they were investigating the Cerny's complaint and happened to be on site to capture the emissions on IR camera. This raises the question of whether there were other periods when toxic contaminants were being vented from this site but were not caught because TCEQ was not there.
- It's clear that in addition to the August and September 2012 violations found by TCEQ there was a history of problems at this site. TCEQ documented emissions from vents, valves and storage tanks using an IR camera, and had detected high VOC readings at the site in March and June 2012. Also, the venting storage tanks from the August 15 event were found to be venting again on December 18, 2012.⁷⁸ Marathon's failure to report the emissions from the August and September events within the required 24-hour reporting period shows a disregard for the law and for public safety. Even after TCEQ met with Marathon about the emissions events, it took the company two months to file the required reports.⁷⁹ These behaviors suggest an ongoing pattern of inattention by Marathon regarding emissions from this facility. Yet TCEQ chose to not penalize the company for its non-compliance.

Kimble-Gilley Facility—Marathon Oil EF, LLC

In response to the Cerny's complaint made August 14, 2012, TCEQ investigators visited Marathon Oil EF LLC's Kimble Gilley facility on September 5, 2012. The site is located approximately 1.8 miles from the Cerny home. During the visit, TCEQ investigators noted "very light sour crude type odors" intermittently, at the facility gate. The investigators wrote that, "with southerly winds this facility could contribute or be a possible source of odors detected by the complainant."⁸⁰

1. Violations noted

Investigators observed emissions coming from a barrel flare and from different vents located on top of the petroleum storage tanks. The investigators concluded that "The enclosed barrel flare located at the Kimble Gilley Production Facility was not burning and was releasing unburned hydrocarbons," in violation of the 30 Texas Administrative Code 116.110(a).⁸¹

2. No penalty for violation

Marathon did not receive any fines/penalties for this violation. TCEQ concluded that, "this violation is resolved since the equipment at the Kimble Gilley Production Facility has been removed."⁸²

- 3. To repeat:** the company was allowed to violate TCEQ rules and pollute the air, but was not penalized because the company removed the offending equipment. Yet nearby neighbors were not only inconvenienced, but were likely exposed to unhealthy levels of air contaminants. Also, it does not appear that Marathon ever reported this emissions event, so there is no information on the duration of the event, or the amount of toxic pollution released into the air.

Yosko Number 1 Production Facility—Marathon Oil EF, LLC

On January 30, 2012, a complaint of a “rotten egg” odor and mist that burned the eyes and nasal area was registered with TCEQ. The source of the odors/mist was not known. Investigators from TCEQ visited a number of facilities on February 3, but did not detect any odors.

On March 1, 2012 investigators visited several sites including the Yosko Number 1 Production Facility, which had not been visited on February 3. The No. 1 site is approximately 1.13 miles northeast of the Cerny home. (See Figure 1.) The complaint was filed by a landowner living 0.73 miles southwest of the well.⁸³

1. VOC levels unsafe for inspectors and presumably for nearby residents

At this site, the Toxic Vapor Analyzer detected 1,100 ppm near a piece of equipment called a separator. The leak was also visible with the IR camera. According the investigation report:

“The Recon team evacuated the area quickly to prevent exposure...This facility is located less than a mile from the Complainant’s residence.”⁸⁴

It is unclear whether nearby residents were in danger because TCEQ inspectors did not record VOC levels at nearby residences. The complainants residence was 0.73 miles away. The closest residence was approximately 400 feet.



Winds from the northeast would have transported the chemicals directly to the closest home. It is unclear how long the Yosko site had been leaking VOCs. The initial complaint was filed on Jan. 30, 2012, but TCEQ did not find the leak at the Yosko site until March 1st.

3. No violation issued

Despite the fact that a leaky valve created VOC concentrations that forced TCEQ employees to evacuate the site, no violation was issued for this pollution event. TCEQ sent an email to Marathon on March 2 stating that, "Repair, replacement, or shut down of this unit should occur as soon as possible, as the alternative shall be recommendation of a nuisance violation." On March 5, Marathon responded stating that the leak had been repaired on March 1.

The investigation report concluded by stating that, "No nuisance was verified by the investigator during this investigation at this time... although no nuisance violation was verified, it is possible that the leak around the valve near the pneumatic controller at the Yosko Number 1 Production Facility...may have created a nuisance odor situation."⁸⁵

Despite the fact that a leaky valve created VOC concentrations that forced TCEQ employees to evacuate the site, no violation was issued for this pollution event.

Earthworks and Shale Test Investigation

METHODS

In order to identify the presence of pollutants that might be linked to both shale oil development and health symptoms being experienced by the Cerny family, air tests and monitoring were conducted using:

Summa Canisters – air samples were taken using stainless steel Summa canisters. The canister samples were collected March 4, 2013, and analyzed by Columbia Analytical Services on March 14, 2013. The laboratory used U.S. Environmental Protection Agency-approved methods, which analyzed for methane (method TO-3) and a wide range of Volatile Organic Compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene (BTEX chemicals) and others (method TO-15). See Appendix 3 for limitations of canister testing.

FLIR GasFindIR Camera – this camera enables detection of methane and other volatile organic compounds. When gases are detected through the infrared imaging, they appear as ‘smoke’. The camera does not provide information on the volume of gas escaping, or the chemical make-up of the gas.⁸⁶

SUMMA CANISTER RESULTS

SAMPLE 1: Kotara-Ridley/Love Crews Facility

A small sign identified the site as Kotara-Ridley/Love Crews, operated by Plains Exploration and Production. According to the RRC map of wells, there is no oil or gas well on this location. Also, the site does not appear to have an air permit. When the TCEQ permit database was searched, a permitted facility named “Kotara Production Facility” was found in Karnes County, but its permit described more equipment than what was observed at this location, and the facility is located a couple of miles from this canister sampling location.



Sample 1 canister location: Katara-Ridley/Love Crews facility.

Photo by Wilma Subra

Earthworks and ShaleTest staff observed various types of equipment on site, including what looked like a separator, dehydrator and storage tanks. This site smelled overpoweringly of hydrogen sulfide (rotten eggs) and hydrocarbons when they installed the canisters at this site. All participants except one who was wearing protective breathing gear experienced health symptoms that included: headache, sore throat, and burning eyes and nasal passages.

The canister was placed outside of the gate, north of the facility, at approximately 8:00 p.m. on March 4, 2013. A grab sample was obtained at this location.

SAMPLE 2: Cerny Home

The second canister sample was set up in the Cerny's back yard, at approximately 8:45 p.m. on March 4, 2013. At the time of canister set-up, there were no odors. Over the 12-hour sampling period, the wind was coming primarily from the south and southeast,⁸⁹ so it is possible that chemicals emitted from the Kotara-Ridley/Love Crews site, located approximately 1.5 miles southeast of Cernys, may have been carried to the Cerny home.

As seen in Table 7, the first Summa canister near the Kotara-Ridley/Love Crews facility captured a total of 14 VOCs, as well as methane. The second canister, located outside of the Cerny home, detected methane and six of the same VOCs that were found near the Kotara-Ridley/Love Crews site.

TABLE 7. VOCs in ambient air canister samples

Volatile Organic Compound (VOC)	Units	Sample 1: Kotara-Ridley/ Love Crews	Sample 2: Cerny Home	TCEQ AMCV- Short Term	TCEQ AMCV- Long Term
Benzene	ppbV	28	0.7	180	1.4
Toluene	ppbV	38	0.3	4,000	1,100
Ethylbenzene	ppbV	1.0		20,000	450
m&p-Xylenes	ppbV	13		1,700	140
o-Xylene	ppbV	2.2		1,700	140
Dichlorodifluoromethane	ppbV	0.47	0.49	10,000	1,000
Trichlorofluoromethane	ppbV	0.22	0.19	5,000	500
1,3,5-Trimethylbenzene	ppbV	0.47		250	25
1,2,4-Trimethylbenzene	ppbV	0.51		250	25
n-Heptane	ppbV	8.4	0.38	850	85
n-Hexane	ppbV	37	2.6	1,800	190
Cyclohexane	ppbV	7.4		1,000	100
n-Octane	ppbV	1.7		750	7.5
n-Nonane	ppbV	0.38		2,000	200
Methane	ppmV	13	4.1		

TCEQ AMCV – Texas Commission on Environmental Quality, Air Monitoring Comparison Values.⁹⁰

While none of the chemical concentrations exceeded TCEQ's short-term Air Monitoring Comparison Values (AMCV), benzene at the Kotara Ridley site was 20 times the acceptable long-term AMCV limit set by TCEQ.

It is important to remember that these canister samples provide information on air quality for one short period of time. It is likely that during periods of calmer winds, or winds from different directions, that the chemical concentrations at the sampling locations could be much lower or much higher. (See Appendix 3 – Limitations of Canister Testing)

While none of the chemical concentrations exceeded TCEQ's short-term Air Monitoring Comparison Values (AMCV), benzene at the Kotara Ridley site was 20 times the acceptable long-term AMCV limit set by TCEQ.

Recently, when ShaleTest measured benzene levels in the Barnett Shale that exceeded TCEQ long-term AMCVs, TCEQ stated that it is not appropriate to compare short-term tests against long-term thresholds. TCEQ assured the public that it was monitoring air in the Barnett shale using a network of monitors that constantly test for dozens of chemicals, so that the agency would be able to determine if chemicals were exceeding their long-term air quality thresholds.⁹¹

No similar network of monitors has been established in the Eagle Ford Shale. So TCEQ does not know whether sites like Kotara Ridley, or the other locations where they have found high VOC readings (e.g., Yosko No. 1 Production Facility, Sugarhorn Central Facility, etc.) are creating concentrations of chemicals in Karnes County air that exceed TCEQ's long-term AMCV values.

FLIR CAMERA RESULTS

On March 4 and 5, 2013, ShaleTest documented fugitive emissions from numerous facilities in Karnes County using a FLIR GasFind IR camera.

The first example, below, shows emissions from the Sugarhorn Central Facility taken by TCEQ during its September 5, 2012 investigation of the site when large volumes of VOCs were being emitted due to an inoperative flare.⁹² This is compared to a FLIR video taken by ShaleTest at the Sugarhorn facility on March 4, 2013. On that date, there were major emissions from the same sources as those recorded by TCEQ during the September 2012 emissions event (photos taken from a different perspective). It appears that during the ShaleTest visit, this facility may have had an inoperative flare, which is a violation of the company's permit.

FLIR VIDEOS	
<p>TCEQ FLIR VIDEO Sugarhorn Central Facility</p> <p>August 15 and September 5, 2012 http://eaglefordreport.earthworksaction.org</p>	
<p>SHALETTEST FLIR VIDEO Sugarhorn Central Facility</p> <p>Operator: Marathon Oil EF LLC Location: Lat 28.83075, Long -97.95397 Date: March 4, 2013 Distance from Cernys: 1.3 mi http://eaglefordreport.earthworksaction.org</p>	

In addition to venting at the Sugarhorn facility, ShaleTest recorded FLIR images showing gaseous emissions from other oil and gas facilities located in fairly close proximity to the Cernys. (ShaleTest also took FLIR videos of numerous other facilities in Karnes County that had significant gaseous emissions, but they are not included in this report, as they were located farther away from the Cerny residence.)

As mentioned previously, FLIR videos do not provide information on the exact chemical make-up of the gaseous emissions. The gases venting or leaking from oil and gas facilities, however, would contain methane, as well as various VOCs.

FLIR VIDEOS

SHALETTEST FLIR VIDEO Best-Beard Unit

Operator: Marathon Oil EF LLC
Location: Lat 28.83075, Long -97.95397
Date: March 4, 2013
Distance from Cernys: 1.3 mi
<http://eaglefordreport.earthworksaction.org>



Notes:

- hydraulic fracturing occurring on two wells
- cattle grazing nearby

SHALETTEST FLIR VIDEO High Roller Karnes Salt Water Disposal Well

Operator: High Roller LLC.
Location: Lat 28.87346, Long -97.91729
Date: March 4, 2013
Distance from Cernys: 3.5 mi
<http://eaglefordreport.earthworksaction.org>



Notes:

- vents on tanks emitting gas

SHALETTEST FLIR VIDEO OF Kotara-Ridley/Love Crews Facility

Operator: Plains Exploration and Production
Location: Lat 28.83075, Long -97.95397
Date: March 5, 2013
Distance from Cernys: 1.46 mi
<http://eaglefordreport.earthworksaction.org>



Notes:

- site of Canister Sample 1
- strong, bad odors

SYMPTOM AND AIR TESTING CORRELATIONS

The air canister tests were conducted at a time when there was no drilling or fracturing occurring in the immediate area, so they do not represent the range of chemicals that may have already been inhaled by the Cerny family during the year of intense drilling activity close to their home.

Nonetheless, many of the chemicals detected in the canister samples are known to be associated with both oil and gas operations and with the health symptoms being experienced by the Cerny family members.

In June 2013, the Cerny family filled out a health survey provided by Earthworks. They reported that since development of the Eagle Ford Shale started occurring in their area they have developed a myriad of new health problems. The symptoms are parallel to what Earthworks found in its survey of more than 100 residents living near Marcellus shale gas operations in Pennsylvania.⁹³

The following table includes some of the health symptoms experienced by all three Cerny family members, and compares them to the top ranked symptoms among Pennsylvania survey participants. For example, the five health symptoms most frequently reported in the Marcellus shale health surveys were increased fatigue, nasal irritation, throat irritation, sinus problems and eye burning. All three Cerny family members experienced these same symptoms.

Health problems experienced by the Cerny family are in close agreement to health effects from chemicals known to be released from nearby oil and gas operations, and correlate to the same effects as people living in the Marcellus shale formation.

TABLE 8. Comparison of Cerny symptoms to those experienced by Marcellus shale residents

Symptom experienced by all three Cernys	Ranking of the same symptom in the Pennsylvania surveys
Increased fatigue	1
Nasal irritation	2
Throat irritation	3
Sinus problems	4
Eye burning	5
Joint pain	7
Severe headaches	9
Difficulty breathing	14
Skin rashes	20
Depression	20

In addition to the symptoms listed in the table, all three of the Cernys also experienced tension, agitation, dry eyes, persistent cough, and ringing in ears.

There are symptoms experienced by the Cerny's 15-year-old son that one would not expect to see in a young adult, such as joint pain and severe headaches. These symptoms were also experienced by

some of the young adults in the Marcellus health survey study. The young Cerny also had frequent nosebleeds, again, a common symptom among the children and young adults who filled out surveys in Pennsylvania.

As mentioned previously, the shale oil and gas facilities surrounding the Cernys are allowed to release hundreds of tons of air pollutants on an annual basis, including VOCs, hazardous air pollutants, NOx, particulate matter, carbon monoxide, sulfur dioxide and hydrogen sulfide.

Facilities are permitted by the RRC to vent or flare casinghead gas. RRC does not require companies to report the names or quantities of toxic pollutants or methane released from casinghead gas emissions. Nor are the emissions from drilling and hydraulic fracturing reported.

RRC does not require companies to report the names or quantities of toxic pollutants or methane released from casinghead gas emissions, nor from drilling and hydraulic fracturing.

Some data are available on the chemicals released from processing facilities. For example, when Marathon failed to properly flare gas at its Sugarhorn facility, a variety of chemicals were vented directly to the atmosphere (benzene, C9+ compounds, ethane, ethyl benzene, heptanes, hexanes, hydrogen sulfide, i-butane, i-pentane, methane, n-butane, n-pentane, octanes, propane, toluene and xylenes). During a 12-hour period, the site emitted thousands of pounds of these volatile chemicals.

As shown in Table 9, health problems experienced by the Cerny family are in close agreement to health effects from chemicals known to be released from nearby oil and gas operations. Several of these chemicals were detected in the air samples collected by Earthworks.

TABLE 9. Health effects of chemicals detected in Karnes County air samples (after Colborn et al.⁹⁴)

Chemical name	Sensory	Respiratory System	Gastro-intestinal	Brain / Nervous	Immune System	Kidney	Cardio/Blood	Cancer/Tumor	Geno-toxic	Endo-crine	Liver/Met	Other
Benzene												
Toluene												
m-Xylene												
p-Xylene												
1,2,4-Trimethylbenzene												
n-Heptane												
n-Hexane												
Cyclohexane												
n-Octane												
n-Nonane												
Methane												
Overlap with Cerny symptoms	✓	✓	✓	✓			✓				✓	✓

Sensory = skin/eye/sensory organ; Brain/Nerv = brain/nervous system; Immune = immune system; Kidney = kidney; Card/Blood = cardiovascular/blood; Cancer/Tumor = cancer/tumorigen; Geno-toxic = genotoxic; Endocrine = endocrine system; Liver/Met = liver/metabolic;



Additionally, it is important to specifically mention hydrogen sulfide, which is known to be associated with shale oil and gas development in the Eagle Ford area. Information from RRC shows that hydrogen sulfide is present in all three of the major Eagle Ford Shale fields, including the Eagleville (or Eagle Ford 2) field being developed around the Cernys.⁹⁵

The Eagleville (Eagle Ford 2) field has an average concentration of 431 parts per million (ppm) H₂S and a maximum concentration of 10,000 ppm.⁹⁶ One well within a mile of the Cerny home reported an H₂S concentration in gas of 900 ppm. As discussed in Table 10, a release of gas with more than 500 ppm H₂S will lead to unconsciousness and possibly death. (See Appendix 1 for concentrations of H₂S in shale oil and gas operations reported from wells and facilities near the Cernys.)

The Earthworks health survey asked whether symptoms occurred in conjunction with odor events. The Cernys associated the following symptoms with either petroleum or hydrogen sulfide odor, and indicated that typically most symptoms would last for a few hours after exposure:

- Nausea:** H₂S, petroleum
- Dizziness:** petroleum
- Headache:** H₂S, petroleum.
- Eye/vision problems:** H₂S, petroleum
- Difficulty breathing:** H₂S, petroleum
- Nose/throat irritation:** H₂S, petroleum
- Confusion, anxiety:** petroleum
- Rapid heart beat:** petroleum

Many of the Cerny's symptoms correspond to the health effects known to be related to H₂S exposure. As seen in the table below, at low to moderate concentrations, H₂S produces symptoms such as eye and throat irritation and difficulty breathing, which are symptoms experienced by the Cernys when they smell H₂S. All three Cernys have experienced increased fatigue since shale oil development began. And Mr. Cerny, who works in the oilfields, has experienced a loss of sense of smell, which may be due to H₂S exposure.⁹⁷



Scenes from the Eagle Ford Shale.

TABLE 10. Physiological Responses to H2S exposure.⁹⁸

Symptom experienced by all three Cernys	Ranking of the same symptom in the Pennsylvania surveys
10 ppm	Beginning eye irritation
50-100 ppm	Slight conjunctivitis and respiratory tract irritation after 1 hour exposure
100 ppm	Coughing, eye irritation, loss of sense of smell after 2-15 minutes. Altered respiration, pain in the eyes and drowsiness after 15-30 minutes followed by throat irritation after 1 hour. Several hours exposure results in gradual increase in severity of these symptoms and death may occur within the next 48 hours.
200-300 ppm	Marked conjunctivitis and respiratory tract irritation after 1 hour of exposure
500-700 ppm	Loss of consciousness and possibly death in 30 minutes to 1 hour
700-1000 ppm	Rapid unconsciousness, cessation of respiration and death.
1000-2000 ppm	Unconsciousness at once, with early cessation of respiration and death in a few minutes. Death may occur even if individual is removed to fresh air at once.

Increasingly, more attention is being paid to the potential health effects of exposure to low concentrations of H2S in the air. According to a 2007 review of low-level exposure to H2S, “much of the data, as well as the recommendations from [the U.S. Environmental Protection Agency, the U.S. Agency for Toxic Substances and Disease Registry and the World Health Organization], suggest toxicity from long-term exposure is likely to exist below the odor threshold. This suggests that an individual should not be exposed long term to any level of hydrogen sulfide that one can smell.”¹⁰⁰

Recommendations by the EPA and other agencies suggest that individuals should NOT be “exposed long term to any level of hydrogen sulfide that one can smell.”



Note the home on the left directly downwind of the flaring. The windsock (circled center) is used by the well operators to indicate wind direction so they can stay clear of the fumes of VOCs and hydrogen sulfide emissions. Of course homes and families cannot move themselves to a safer location. Another home is on the right, circled.

Conclusions

Evidence from TCEQ and Earthworks/ShaleTest investigations indicate that air pollution from oil and gas development in the Eagle Ford Shale definitely threatens, and likely harms, the health of Karnes County Texas residents, including the Cerny family. Despite these findings, no action has been taken by regulators to rein in irresponsible operations, or otherwise protect area residents. Specifically:

HEALTH THREATS

- 1. TCEQ discovered air pollution from oil and gas development operations in Karnes County, close to the Cernys and other residents, so dangerous that TCEQ evacuated its onsite investigators.**
- 2. Canister samples detected chemicals of concern close to an Eagle Ford Shale facility and the Cerny home.**
 - Canister samples are important tools for determining short-term exposure to chemicals. For example, when there are known emissions events, canisters and handheld monitors can and should be deployed by TCEQ to determine concentrations at nearby homes.
 - Because canister samples determine chemical concentrations at a particular moment or period of time, they do not adequately gauge the concentrations of chemicals that people are exposed to on a continuous and long-term basis. Permanent, stationary monitoring equipment should be established by TCEQ to determine longer-term exposures of residents living in the Eagle Ford Shale region.
- 3. FLIR camera videos revealed that numerous facilities in Karnes County, including facilities close to the Cerny home, have gaseous emissions.**
 - Although emissions have often been detected, they have not always been quantified. TCEQ should be monitoring fugitive emissions more closely, and when emissions are found, find out how these emissions are affecting air quality at homes of the nearest residents.
- 4. There are many sources of permitted and unpermitted pollution from oil and gas facilities close to the Cerny family.**

TCEQ is thoroughly aware of dangerous emission levels, and has not taken steps to measure or mitigate.

While the TCEQ has carried out a few investigations, the agency has failed to address how this pollution is affecting the health of the Cernys and others like them. Often, samples are not taken because chemicals are at a concentration that threatens TCEQ employee safety. Due to a lack of data, there are many questions that will remain unanswered:

- What was the baseline air quality before the drilling boom hit?
- What were the concentrations of air toxics, including H₂S, at the Cerny or other nearby homes when Sugarhorn was releasing thousands of pounds of contaminants into the air? Or when the leak at the Yosko well forced TCEQ investigators to evacuate that site?

- What were the concentrations or air contaminants at the Cerny home when, for months on end, drilling and hydraulic fracturing rigs were running diesel engines, and flaring or venting gas during well completions?
- What were the concentrations at the Cerny home when the wells were venting/flaring casinghead gas for months on end?

5. Hydrogen sulfide is present in the Eagle Ford Shale at concentrations that may pose a threat to public health.

- Although there have been numerous complaints from the Cerny family and other residents in the Eagle Ford Shale related to hydrogen sulfide, it appears that very few attempts have been made by TCEQ to measure H₂S concentrations in Karnes County air. Long-term monitoring of H₂S in ambient air in the Eagle Ford Shale, as well as site-specific monitoring at oil and gas well and processing sites with H₂S in gas,¹⁰¹ should be conducted to ensure that concentrations are at levels that do not pose a risk to citizens in that area.

REGULATORY FAILURES

1. Despite finding oil and gas air pollution too dangerous for its own investigators, TCEQ did not act to protect the public.

- TCEQ took no meaningful action to protect the public after discovering hazardous air pollution, such as warning area residents or evacuating them, immediately stopping the violating operation (e.g., by shutting in wells), or stopping the hazardous activity at the violating operation.

2. TCEQ did not take any meaningful steps to penalize the operator or prevent future violations.

- Operations causing the hazardous pollution were not stopped.
- Operators responsible for the pollution were not penalized.
- One operation was observed in violation later the same year for the same issue.
- Although TCEQ has publicly announced that it would install air monitoring facilities similar to what is now in place in the Barnett Shale (see sidebar), as of July 2013, there is no information on the TCEQ web site to indicate that any continuous air quality monitors have been installed in the Eagle Ford Shale.¹⁰² Communication with TCEQ suggests that one monitoring station will be installed in Wilson County during the summer of 2013.¹⁰³ It's unclear whether this monitor is close to active Eagle Ford Shale development and/or affected citizens.

These conclusions highlight a lack of attention and concern for the citizens by government regulators to even try to understand and prevent the impacts of Eagle Ford Shale development on public health.

By failing to measure and monitor toxic emissions from shale oil facilities in the Eagle Ford Shale, the TCEQ, RRC and industry are treating the Cernys as guinea pigs, and are endangering the health of many residents living amidst this shale oil boom.

Recommendations

As exemplified in this report, state agencies -- repeatedly and across the United States -- have failed in their charge to protect the public from irresponsible oil and gas development.

Furthermore, although existing data strongly indicate that the public needs to be concerned about the public health impacts from exposure to air pollution from oil and gas development, regulators are not taking this public health threat seriously – as expressed in their lack of oversight, and in their inaction when problems are brought to their attention.

Such inaction helps explain why communities across the nation are considering bans to fracking-enabled oil and gas development.

To put communities first, Earthworks recommends the state of Texas take the following actions:

PROTECT AFFECTED COMMUNITIES

Recommendation 1:

Regulators must be required to act quickly to protect the public.

- TCEQ should implement a 12-hour response time for odor complaints, especially those that involve health concerns, in the Eagle Ford Shale.
- TCEQ employees should have personal protective equipment (such as gas masks) that enable them to safely remain on site long enough to carry out air canister sampling when handheld devices indicate elevated concentrations of VOCs or H₂S.
- If a site is deemed too dangerous for regulatory staff to inspect or sample, regulators must act immediately to force the operator to fix the problem, or shut down the entire operation; and nearby residents must be immediately informed of the potential health and safety risks.
- Extreme violations, or threat of imminent public harm under which regulators would be forced to act, should be defined in rule or statute.

Recommendation 2:

- TCEQ should immediately set up a network of long-term air quality monitoring sites in the Eagle Ford Shale. This is important for determining the potential for residents to be exposed to hazardous air pollutants. This should include:
- Continuous, long-term air monitoring should be conducted both at oil and gas facilities and at people's homes. Sites should be installed prior to drilling/hydraulic fracturing of new wells, and near processing and storage facilities.
- Sampling should include VOCs, as well as PAHs, formaldehyde and other combustion products, and the highly toxic hydrogen sulfide.
- When emissions are observed by TCEQ via FLIR imaging or detected via handheld VOC and H₂S monitors, canister samples and handheld monitor readings should be taken by TCEQ at nearby homes.

- All information, such as canister samples, infrared videos (FLIR), and continuous air monitoring results should be made freely and publicly available, in the same manner as the Barnett Shale data, which have been posted online.¹⁰⁴

Recommendation 3:

The state of Texas, working with appropriate federal agencies (e.g, the Agency for Toxic Substances and Disease Control or Center for Disease Control and Prevention) or others, must rigorously investigate¹⁰⁵ the current and future health impacts of oil and gas development in the Eagle Ford Shale. That investigation should include:

- Baseline health data collection in Eagle Ford Shale counties, and
- A comparative health analysis with a similar population not impacted by oil and gas development.
- A prospective analysis of the impacts of expanded operations in the area.

FIX REGULATORY FAILURES

Recommendation 4:

Regulation and enforcement of oil and gas development must be overhauled so as to deter potential violators and prevent repeat violations, including¹⁰⁶:

- Establishing binding criteria for taking enforcement actions and levying penalties;
- Increase the use of enforcement actions to deter would-be violators;
- Increase the use of severances and seals to encourage compliance with field rule violations.
- Increase penalties to exceed the economic value that oil and gas operators gain from noncompliance with rules or statutes;
- Publish online in an easily searchable and downloadable format, comprehensive oil and gas enforcement data (complaints, inspections, violations, enforcement actions taken, penalties levied/collected, etc).

RECOGNIZE OIL & GAS DEVELOPMENT IS NOT SACROSANCT

Recommendation 5:

Until the state can demonstrate that it can adequately oversee oil and gas development and protect public health, the state must not permit new development. Currently, Texas regulators are putting industry economic interests before public health.

APPENDIX 1

List of oil and gas facilities within approximately 2 miles of the Cerny home. Data as of Sept. 1, 2013.

Miles from Cernys	Facility name: Oil/gas lease or processing facility	Well No	API Number / Air permit	Operator	Type of Facility	Spud Date	Date Drilling Completed	Hydraulic Fracture Date	H2S Field	H-9 avail. on-line?	H2S in gas (parts per million)
0.52	TIPTON-JONAS UNIT	2H	25532554	MARATHON OIL EF LLC	Oil well	7/12/12	9/2/12	11/19/12	YES	NO	
0.53	BRYSCH-ADAMS UNIT	1H	25532249	MARATHON OIL EF LLC	Oil well	2/13/12	2/29/12	3/10/12	YES	NO	
0.53	TIPTON-JONAS UNIT	1H	25532250	MARATHON OIL EF LLC	Oil well	3/11/12	4/25/12	5/19/12	YES	NO	
0.63	TIPTON-JONAS UNIT	3H	25532557	MARATHON OIL EF LLC	Oil well	9/6/12	9/27/12	12/7/12	YES	NO	
0.64	TIPTON-JONAS UNIT	4H	25532558	MARATHON OIL EF LLC	Oil well	9/28/12	10/15/12	10/18/12	YES		
0.67	ADAMS-TIPTON UNIT	1H	25532350	MARATHON OIL EF LLC	Oil well	3/4/12	3/21/12	4/7/12	YES	NO	
0.67	ADAMS-TIPTON UNIT	3H	25532810	MARATHON OIL EF LLC	Oil well	No data	No data	8/5/13	YES	NO	
0.68	ADAMS-TIPTON UNIT	2H	25532809	MARATHON OIL EF LLC	Oil well	No data	No data	8/5/13	YES	NO	
0.69	BRYSCH-ADAMS UNIT	2H	25532550	MARATHON OIL EF LLC	Oil well	8/28/12	9/19/12	11/3/12	YES	NO	
0.70	ADAMS-TIPTON UNIT	4H	25532984	MARATHON OIL EF LLC	Oil well	2/14/13	3/3/13	3/19/13	YES	NO	
0.70	BRYSCH-ADAMS UNIT	3H	25532553	MARATHON OIL EF LLC	Oil well	9/20/12	10/15/12	11/11/12	YES	NO	
0.74	BRYSCH-JONAS UNIT C	1H	25532271	MARATHON OIL EF LLC	Oil well	3/16/12	4/14/12	5/2/12	YES	YES	900
0.75	BRYSCH-JONAS UNIT B	1H	25532260	MARATHON OIL EF LLC	Oil well	1/14/12	3/13/12	5/14/12	YES	NO	
0.84	HOLLAND-BROWN UNIT	1H	25531924	MARATHON OIL EF LLC	Oil well	9/8/11	9/29/11	Pre-FF	YES	NO	
0.84	HOLLAND-OPIELA UNIT	1H	25531925	MARATHON OIL EF LLC	Oil well	8/18/11	9/7/11	10/7/11	YES	NO	
0.86	GILLEY 1 PROD. UNIT		101405	MARATHON OIL EF LLC	Processing						up to 500
0.89	CULBERSON-PATTESON UNIT	1H	25532580	MARATHON OIL EF LLC	Oil well	6/23/12	7/11/12	7/21/12	YES	NO	
0.91	BRYSCH- JONAS UNIT	1H	25532001	HILCORP ENERGY CO	Oil well	6/27/11	8/3/11	Pre-FF	YES	YES	50
0.91	GILLEY UNIT	1H	25531757	MARATHON OIL EF LLC	Oil well	11/20/10	5/4/11	Pre-FF		NO	
1.02	YOSKO BORGFELD UNIT	1H	25532022	MARATHON OIL EF LLC	Oil well	7/11/11	8/11/11	Pre-FF	YES	YES	60
1.13	YOSKO UNIT	1H	25531792	MARATHON OIL EF LLC	Oil well	12/22/10	4/8/11	Pre-FF	YES	NO	85
1.18	BUEHRING UNIT	1H	25531833	HILCORP ENERGY CO	Oil well	2/7/11	4/5/11	Pre-FF	YES	NO	
1.2	YOSKO-KINKLER UNIT	1H	25532049	HILCORP ENERGY CO	Oil well	8/19/11	9/4/11	Pre-FF	YES	NO	
1.21	BUEHRING PROD. UNIT		11040	MARATHON OIL EF LLC	Processing						up to 66
1.24	BROWN-DUPNIK A UNIT	1H	25532347	MARATHON OIL EF LLC	Oil well	3/22/12	4/15/12	5/9/12	YES	NO	
1.26	VAJDOS-FOEGELLE UNIT	1H	25532246	MARATHON OIL EF LLC	Oil well	12/29/11	1/26/12	2/13/12	YES	YES	15
1.31	SUGARHORN CENTRAL FAC.		99763	MARATHON OIL EF LLC	Processing						up to 100
1.46	KOTARA-RIDLEY		Not found	PLAINS EXPL. & PROD.	Processing						
1.50	VAJDOS-FOEGELLE UNIT	2H	25532684	MARATHON OIL EF LLC	Oil well	8/8/12	8/26/12	9/30/12	YES	NO	
1.50	VAJDOS-FOEGELLE UNIT	3H	25532691	MARATHON OIL EF LLC	Oil well	8/27/12	9/11/12	9/30/12	YES	NO	
1.66	ZAESKE-ECKOLS UNIT	1H	25532222	MARATHON OIL EF LLC	Oil well	1/17/12	2/5/12	2/17/12	YES	NO	
1.73	JORDAN DAVENPORT PROD.		99028	MARATHON OIL EF LLC	Processing						up to 500
1.75	DAVENPORT UNIT	1H	25531876	HILCORP ENERGY CO	Oil well	4/4/11	6/11/11	Pre-FF	YES	YES	65
1.75	JORDAN UNIT	1H	25531817	HILCORP ENERGY CO	Oil well	1/28/11	5/24/11	Pre-FF	YES	NO	
1.77	CHAPMAN-ROGERS UNIT	1H	25531960	MARATHON OIL EF LLC	Oil well	7/30/11	9/12/11	Pre-FF	YES	NO	
1.77	KIMBLE GILLEY UNIT	1H	25532296	MARATHON OIL EF LLC	Oil well	2/17/12	4/3/12	3/21/12	YES	NO	
1.79	GILLEY UNIT	2H	25532365	MARATHON OIL EF LLC	Oil well	7/13/12	7/28/12	8/6/12	YES	NO	
1.87	HEDTKE-HENKE UNIT	1H	25532323	MARATHON OIL EF LLC	Oil well	2/20/12	3/12/12	4/10/12	YES	NO	
1.99	BUEHRING UNIT	2H	25532989	MARATHON OIL EF LLC	Oil well	No data	No data	7/9/13	YES	NO	
2.00	JORDAN UNIT	3H	25532740	HILCORP ENERGY CO	Oil well	10/3/12	10/20/12	11/2/12	YES	NO	
2.01	FRANKE UNIT	3H	25532462	PLAINS EXPL. & PROD.	Oil well	5/11/12	7/4/12	6/21/13	YES	YES	60
2.01	SALGE-KINKLER	2H	25532858	MARATHON OIL EF LLC	Oil well	11/30/12	12/17/12	1/1/13	YES	NO	
2.06	KALEB BREWER SWD		25531958	EAGLE FORD DISP. LLC	Injection	4/27/12	5/12/12	5/12/12			



Miles from Cernys	Facility name: Oil/gas lease or processing facility	Well No	API Number / Air permit	Operator	Type of Facility	Spud Date	Date Drilling Completed	Hydraulic Fracture Date	H2S Field	H-9 avail. on-line?	H2S in gas (parts per million)
Wells sites permitted but not yet drilled as of Sept. 1, 2013											
2.02	WHITLEY MEJOR UNIT	3H	25533252	MARATHON OIL EF LLC						YES	
2.02	WHITLEY MEJOR UNIT	4H	25533230	MARATHON OIL EF LLC						YES	
2.03	WHITLEY MEJOR UNIT	1H	25533228	MARATHON OIL EF LLC						YES	
2.03	WHITLEY MEJOR UNIT	2H	25533229	MARATHON OIL EF LLC						YES	

Data Notes:

Miles from Cernys: Determined by entering latitude and longitude for all facility locations into a mapping program called BatchGeo.¹⁰⁷ BatchGeo calculates the distance from a site to a particular location – in this case, the Cerny residence. Latitude and longitude data for wells from RRC data.¹⁰⁸

Facility Name: Obtained from RRC (for wells) and TCEQ (for processing facilities).

Well Number: There are often several wells associated with one lease, so this number was included for clarity.

API/Air permit: An API number is a unique, permanent, numeric identifier assigned to each oil and gas well drilled in the U.S. The number was obtained from the W-1 forms for each well. The TCEQ air permit number was obtained from the technical review documents for the well permits (by searching for the facilities in Karnes County via the TCEQ air permit search site¹⁰⁹).

Operator: Obtained from W-1 forms for each well.

Type of Facility: Either an oil/gas well or a site where oil/gas is processed (e.g., oil, gas and water are separated; gas is dehydrated and compressed; waste gas is flared; and hydrocarbon products and wastewater are held onsite until removed by truck or pipeline).

Spud Date: this is the date when drilling commences. Data are from the W-1 reports for each well. These are obtained by searching the RRC "Drilling Permit (Form W-1) Application Query."¹¹⁰ As seen in the Table, FracFocus contains data for some wells fractured in July and August of 2013, but RRC had not yet posted data on spud date (or drilling completion date).

Drilling completion date: the date when drilling is completed. Obtained through the W-1 search (see Spud Date).

Fracture date: the date when hydraulic fracturing begins. Obtained from the FracFocus web site¹¹¹ (Searched by API number). Pre-FF (preFracFocus) means that wells were fractured prior to February 2012, the date when Texas operators had to begin reporting fracturing information to FracFocus.

H2S – information on whether or not a well is located in an H2S field can be obtained from the on-line W-1 reports. Under the Section entitled "Field Restrictions," wells in H2S fields are identified by Code 02, which states: "This is a hydrogen sulfide field. Hydrogen Sulfide Fields with perforations must be isolated and tested per State Wide Rule 36 and a Form H-9 filed with the district office."

H-9 available: H-9s, also known as a "Certificate of Compliance Statewide Rule 36," are filed with district offices. Some H-9s were found online in the documents that accompany an RRC "Oil and Gas Completions" Query for a particular well.¹¹² But not all H-9s are available electronically, so data on H2S concentrations is not included for all well sites. H-9 forms certify that operators will comply with Statewide Rule 3.36 "Oil, Gas, or Geothermal Resource Operation in Hydrogen Sulfide Areas."¹¹³ The H-9 forms provide information on the concentration of H2S that may be released at the site, and the expected "radius of exposure" around the well for 100 and 500 parts per million (ppm) H2S. It also indicates if the 500-ppm radius of exposure includes part of a public road.¹¹⁴

H2S in gas: for oil/gas wells, this is the concentration of H2S at each site as reported in H-9 reports (except for Yosko Unit. That information came from a TCEQ air permit.¹¹⁵). For processing facilities, this is the concentration of H2S expected in the oil/gas to be processed at the facility. That information is contained in TCEQ air permit review documents for the facility.



Appendix 2

TCEQ: Eagle Ford Shale air-related complaints in Karnes County.¹¹⁶

Complaint Date	Complaint Summary (Operator and location included when mentioned in complaint). ¹¹⁷	Enforcement action? (ND = no data)
6/12/2013	Complainant is getting odors from nearby oil and gas facilities. Company is drilling and may be fracking to the south. Complainant and family are being impacted by odors . Complainant's son is suffering from nose bleeds and has to use an inhaler. . . June 8, 2013 it was bad. ¹¹⁸	ND
5/21/2013	The complainant states that he has been getting a chemical taste in the air due to heavy flaring with thick black smoke from the RE. States that the flaring happens a lot at night. Also . . . getting a lot of dust from all the truck traffic from the facility. ¹¹⁹	ND
03/21/2013	Complainant indicated they are experiencing bad H2S and crude odors at their house. Stated the odors gave him a headache today. They cannot open windows or stay outside long when winds are out of south. ¹²⁰	ND
3/11/2013	SUGARHORN CENTRAL FACILITY. Complainant is getting heavy hydrogen sulfide odors at their house and they note the flare at the Sugarhorn is burning black. Complainant was air sampled using sumacanister. ¹²¹	No NOV/NOE has been issued. ¹²²
02/19/2013	MARATHON OIL EF LLC. EAST LONGHORN CENTRAL FACILITY. Complainant alleged that a flare at an oil and gas production facility was smoking . ¹²³	ND
2/14/2013	ENAUQUA OPERATING LLC. CAT KENEDY SWD FACILITY. Complainant states that saltwater disposal facility and cement plant are creating bad odor and dust nuisance. ¹²⁴	<u>NOV issued 07/08/13.</u> ¹²⁵
10/03/2012	FREEMPORT-MCMORAN OIL & GAS LLC. PATTON TRUST SOUTH PRODUCTION FACILITY. Continuing noise/smells . . . Date is approximate to beginning drilling from PXP wells. Pumping station was installed late Spring, 2012. Issues are documented from June, 2012. ¹²⁶	<u>NOV issued 1/22/13.</u> <u>Resolved 3/26/13.</u> ¹²⁷
09/18/2012	EOG RESOURCES INC. LAZY OAK UNIT 5H OIL WELL. "...they are drilling very near their house and the smell is so bad they can not be outside for long periods of time. . . what can be done to eliminate the fumes/odors coming from the drilling platform and the accompany sludge pit that was excavated near the drilling site and is located near the family's home." ¹²⁸	No NOV/NOE has been issued. ¹²⁹
09/11/2012	HIGH ROLLER WELLS LLC. Caller is getting bad dust from construction next door where a disposal well is about to be drilled. . . dust is keeping family inside and is covering a field where goats are eating. The house and cars are covered in dust. ¹³⁰	No NOV/NOE has been issued. ¹³¹
9/10/2012	Complainant is getting a lot of dust from two sources: a 10-acre piece of land leased by Catarina, and County Road 165. . . Catarina has supposedly drilled a well in the back and brought in tanks in preparation for a saltwater disposal well. . . About six weeks ago they subleased property to concrete company who is mixing concrete there and hauling it off, causing more truck traffic and dust. ¹³²	No NOV/NOE has been issued. ¹³³
08/14/2012	MARATHON OIL EF LLC. KIMBLE GILLEY PRODUCTION FACILITY. Complainant is getting odors from the oil and gas facilities all around her (rigs, waste disposal sites, flares, etc.). It smells like sulfur and petroleum . She sees flares continuing to smoke . Her son is getting nose bleeds and she gets rashes and eye irritation. . . dust from a road on her neighbor's property who lets the trucks drive on it to get to a rig. ¹³⁴	<u>NOV issued 2/15/13.</u> <u>Resolved 2/08/13.</u> ¹³⁵
06/19/2012	Complainant states that Marathon is building a drilling pad across the road from their home. The dust is unbearable and the south wind blows it directly onto their property. They are having respiratory issues. The large trucks speed down the road creating huge dust clouds off Farm To Market 99 Road west of Karnes City. ¹³⁶	Investigation data not avail. until approved by management ¹³⁷
05/14/2012	Complainant states that from Thursday night through Saturday night, a drilling facility next to the residence was fracking and emitting chemical fumes . The complainant said it smelled like a mixture of skunk and hair perm. The complainant and one member of the family had to leave the residence due to respiratory and other health issues. . .No odors could be confirmed at the time of the investigation. ¹³⁸	No NOV/NOE has been issued. ¹³⁹



Complaint Date	Complaint Summary (Operator and location included when mentioned in complaint). ¹¹⁷	Enforcement action? (ND = no data)
03/26/2012	The complainant is alleging odors and dust from oil and gas facilities. The problems was described as this: "At times there is a chemical odor similar to the smell in the insecticide department at Walmart. It makes your nose burn. Frequently, there is also dust ." ¹⁴⁰	No NOV/NOE has been issued. ¹⁴¹
02/22/2012	MARATHON OIL EF LLC. NORTH LONGHORN CENTRAL TANK BATTERY. Complainant states that tank battery across road from house is stinking bad smells like sour gas . Flares are burning and emitting black smoke . She has rash all over her face, arms, legs (areas of body where exposed) has been to four different doctors. Cannot stay outside due to odors, cannot garden or enjoy outdoors. On February 27, 2012, April 5, 2012, May 24, 2012, June 25, 2012, August 29, 2012, September 6, 2012, and October 22, 2012, Ms. Salazar conducted odor complaint investigations. Air canister samples were taken during this investigation. ¹⁴²	<u>NOV issued 12/20/12.</u> Resolved 1/30/13. ¹⁴⁵
1/30/2012	MARATHON OIL EF LLC. YOSKO 1 PRODUCTION FACILITY. "At our property 3.6 miles out on Farm Road 99 I often smell a terrible odor accompanied by a wet mist that burns my eyes and my nasal area and tightens my chest. This has happened four times in the past month at around 2 a.m. when I wasn't able to sleep. I have also noticed strange symptoms on my drive home from my evening job just as I near the Paul Jauer's Home on Farm Road 99. My eyes begin to water, nose begins to run and throat burns and becomes hoarse. My windshield appears to have a fine mist of some sort on it as well. . . happened to me nightly Tuesday, January the 24 through Friday the 27th of this past week." ¹⁴⁴	No NOV/NOE has been issued. ¹⁴⁵
12/22/2011	BURLINGTON RESOURCES. ARMSTRONG UNIT 1A. Black smoke billowing from flare, we have flares all around us and it smells TERRIBLE . ¹⁴⁶	No NOV/NOE has been issued. ¹⁴⁷
06/14/2011	Pad for compressor site being built across FM1144 from complainant. Dust is created by truck traffic and equipment at pad site which is southeast of complainant. ¹⁴⁸	No NOV/NOE has been issued. ¹⁴⁹
12/14/2010	Oil Drilling Company traffic is creating dust to come on to their property. Her father is being impacted at his home and the dust is bothering the cattle and cattle will not eat the dust covered grass. . . drilling company traffic travels above the speed limit of 35 mph. ¹⁵⁰	No NOV/NOE has been issued. ¹⁵¹
10/10/2010	PLAINS EXPL. & PRODUCTION. NIESCHWIETZ UNIT 1H WELL. Bad odor coming from oil production equipment for three days . . . Odor is strong and very unpleasant . It has oily characteristic that may also be harmful to health. ¹⁵²	No NOV/NOE has been issued. ¹⁵³
08/30/2010	Complainant states that trucks from unknown drilling company creating terrible dust clouds on County Road 220 which is dirt. His home and business (next to one another) are covered in dust; all surrounding vegetation is also covered in dust. These trucks travel down this road (the long way) to reach drilling site on Cemetery Road (which is paved). ¹⁵⁴	No NOV/NOE has been issued. ¹⁵⁵
8/17/2010	The complainant is concerned about an easement that runs parallel to his property that is being used by Pioneer Oil Drilling to set up a drill rig. He states that dust is being kicked up constantly and he's afraid they will be putting herbicide along his fence line. ¹⁵⁶	No NOV/NOE has been issued. ¹⁵⁷
01/03/2010	The first complainant stated that trucks from Pioneer Drilling Company creating terrible dust clouds on County Road 220 which is dirt. . . The second complainant stated that trucks from Pioneer Drilling Company creating terrible dust . . . His home is covered in dust; all surrounding vegetation is also covered in dust and may be affecting the cattle. ¹⁵⁸	No NOV/NOE has been issued. ¹⁵⁹
12/07/2008	REGENCY FS LP. KUNKLE COMPRESSOR STATION. Complainant alleges that he has been getting hydrogen sulfide odors since October 2007 when he moved into his house. In the past, the odor was so bad it woke him up during the night and he began vomiting and had to leave his home. It also sometimes burns his nose. He needs a southeast wind to be downwind of the alleged source. ¹⁶⁰	No NOV/NOE has been issued. ¹⁶¹
01/04/2008	REGENCY FS LP. KUNKLE COMPRESSOR STATION. The compressor gas station located off Cty Rd. 211 is emitting sulphur like odors in the late evening around 6-8:00 pm. Odor goes away in the mornings. ¹⁶²	No NOV/NOE has been issued. ¹⁶³



Complaint Date	Complaint Summary (Operator and location included when mentioned in complaint). ¹¹⁷	Enforcement action? (ND = no data)
01/29/2007	REGENCY FS LP. KUNKLE COMPRESSOR STATION. The complainant alleged that the smell was bad the evening before (May 14). She claimed the odor was coming from the compressor station located south of her. . . She added that there was a lot of flaring going on Sunday (May13) and this morning. Contact was made that same day with Will Yenke, EHS Coordinator for Regency Gas . . . He later reported that a third engine was being installed at the site and that blowdowns were done on the other two engines, which resulted in more flaring. ¹⁶⁴	Investigation Data not Available Until Approved by Management. ¹⁶⁵
01/29/2007	REGENCY FS LP. KUNKLE COMPRESSOR STATION. Complaint No. 1: at 7:00 this morning it stunk outside like rotten eggs . Complainant No. 2: This complainant said the stink was unbearable this morning just before 7:00. . . She said she is worried about her children. She believes the odor was coming from the nearby gas plant. She said she has seen a very large flame on the flare periodically (before Christmas). ¹⁶⁶	No NOV/NOE has been issued. ¹⁶⁷
11/21/2006	H2S odor from recently drilled wells near the residence . . . has been going on for about three weeks, but this morning it was especially bad. The complainant has called the field operator, but the odor continues. A new well has been drilled about 1.5 miles north of the residence. ¹⁶⁸	No NOV/NOE has been issued. ¹⁶⁹
11/05/2006	REGENCY FS LP. KUNKLE COMPRESSOR STATION. RN105001671. Complaint No. 1: reported getting a bad odor from the gas plant on CR 211 and that the plant was making a horrible noise. Complaint No. 2: reported that the odor from the compressor station is so bad . ¹⁷⁰	No NOV/NOE has been issued. ¹⁷¹
10/03/2006	REGENCY FS LP. KUNKLE COMPRESSOR STATION. RN105001671. She notices the smell from the gas plant. It is worse at night around midnight when she gets home from work. Smells like rotten egg . She did notice any odors before. She also complained about the noise. ¹⁷²	No NOV/NOE has been issued. ¹⁷³
9/11/2006	REGENCY FS LP. KUNKLE COMPRESSOR STATION. RN105001671. Compressor Site started up south of Falls City and odor was bad and may have been poisonous. One evening . . .could not sit outside because of odor. . . also objecting to the loud metallic noises.. ¹⁷⁴	No NOV/NOE has been issued. ¹⁷⁵

Appendix 3

LIMITATIONS OF CANISTER TESTING

For this investigation, the wind conditions were not ideal for collecting canister samples. On the date when the canister samples were taken (evening of March 4 to morning of March 5, 2013), the wind was blowing between 10 and 20 miles per hour (mph) for most of the sampling period.¹⁷⁶ Research by Colborn and others found that the detection of hydrocarbons near natural gas drilling sites was highest during times when winds were calm (less than 1 mile per hour).¹⁷⁷

Also, it is important to note that the concentrations found in our study represent a snapshot in time. The sample at the Cerny home was taken at a time when the closest drilling/hydraulic fracturing activity was approximately 3 miles away.¹⁷⁸ Ideally, the sample would have been taken at a time when odors were present, to gauge whether or not odors were associated with higher concentrations of certain air contaminants. Unfortunately, Earthworks representatives were only in the region for a limited time, and while they were there the Cernys were not experiencing the odors that sometimes make them feel ill.

Finally, the chemicals sampled in our project were limited to a selection of VOCs. The analytical methods used did not test for some chemicals known to be associated with oil and gas facilities such as:

- PAHs, created during combustion of hydrocarbons.¹⁷⁹
- Formaldehyde, commonly emitted from natural gas compressors, such as those located on some of the production facilities near the Cernys. Exposure to formaldehyde may cause eye, nose, and throat irritation, skin rashes and other symptoms.¹⁸⁰
- Hydrogen sulfide, a known toxic compound associated with many of the health effects documented in this project, is associated with oil and gas development in Karnes County. Testing for PAHs, formaldehyde and H₂S would have required different types of air sampling methods than applied here.¹⁸¹

ENDNOTES

¹ In 2009, Earthworks Oil and Gas Accountability Project (OGAP) worked with residents in DISH, Texas to perform air quality monitoring (1); in 2010, OGAP conducted health surveys with local residents in Pavillion, Wyoming, and analyzed results in relation to contaminants identified through water quality investigations (2); in 2011 OGAP developed case studies of residents who reported health problems while living in close proximity to Barnett Shale gas facilities in several counties in Texas (3); and in 2012, Earthworks conducted health surveys and air and water monitoring in several counties affected by Marcellus Shale drilling in Pennsylvania (4). (Sources: (1) Earthworks OGAP, 2009. *Community Health Survey of Current and Former Residents of DISH, Texas*. <http://earthworksaction.org/publications.cfm?pubID=438>;(2) Earthworks OGAP. 2010. *Community Health Survey Results of Pavillion, Wyoming*. http://earthworksaction.org/PR_PavillionHealthSurvey.cfm; (3) Earthworks' OGAP, 2011. *Natural Gas Flowback: How the Texas gas boom affects community health and safety*. http://www.earthworksaction.org/library/detail/natural_gas_flowback; and 4) Earthworks OGAP, 2012. *Gas Patch Roulette: How Shale Gas Development Risks Public Health in Pennsylvania*. http://www.earthworksaction.org/library/detail/gas_patch_roulette_full_report#.UeW3OIOGE1

² Earthworks. 2011. *Loopholes for Polluters*. http://www.earthworksaction.org/library/detail/loopholes_for_polluters#.UiUD_7yw7jE

³ Earthworks. 2012. *Breaking All the Rules – The Crisis in Oil and Gas Regulatory Enforcement*. <http://www.earthworksaction.org/files/publications/FINAL-US-enforcement-sm.pdf>

⁴ In a 2012 report, Earthworks research showed that the Texas Railroad Commission (RRC), which oversees oil and gas development in the state, is failing to enforce oil and gas regulations at many existing oil and gas facilities. For example, in 2011, an estimated 296,000 active Texas oil and gas wells went uninspected. (Earthworks. 2012. *Enforcement Report - RRC: Public should not have confidence that oil and gas development is occurring responsibly in Texas*. http://www.earthworksaction.org/issues/detail/texas_oil_gas_enforcement#.UeW1AIOGE1)

⁵ EIA: http://www.eia.gov/dnav/ng/TblDefs/ng_prod_ngpl_tbldef2.asp

⁶ Texas Railroad Commission (hereafter referred to as RRC) web site: *Eagle Ford Information*, <http://www.rrc.state.tx.us/eagleford/>

⁷ RRC web site: *Texas Eagle Ford Shale Drilling Permits Issued*, <http://www.rrc.state.tx.us/eagleford/EagleFordDrillingPermitsIssued.pdf> Accessed May 28, 2013.

⁸ RRC web site: *Eagle Ford Shale oil production statistics*. <http://www.rrc.state.tx.us/eagleford/EagleFordOilProduction.pdf> Accessed May 28, 2013.

⁹ Between 2011 and March 2013, production of natural gas increased from 1,200 to 1,945 bpd and condensate increased from 77,350 to 96,952 bpd. (RRC web site. *Eagle Ford Shale natural gas production statistics*. (RRC. "Texas Eagle Ford Shale Total Natural Gas Production. 2008 through April 2013." <http://www.rrc.state.tx.us/eagleford/EagleFordGWGProduction.pdf> and "Texas Eagle Ford Shale condensate Production. 2008 through April 2013" <http://www.rrc.state.tx.us/eagleford/EagleFordCondensateProduction.pdf>. Accessed May 28, 2013)

¹⁰ Hughes, J. David. 2013. *Drill, Baby, Drill: Can Unconventional Fuels Usher in a New Era of Energy Abundance?* <http://www.postcarbon.org/reports/DBD-report-FINAL.pdf>

¹¹ Maugeri, L. 2013. *The Shale Oil Boom: A U.S. Phenomenon*. Discussion Paper 2013-05, Belfer Center for Science and International Affairs, Harvard Kennedy School. pp. 4, 7. <http://belfercenter.ksg.harvard.edu/publication/23191>

¹² One well per 40 acres equates to 16 vertical wells per square mile. With horizontal drilling, the number of wells drilled per 40 acres depends on the length of the horizontal leg of the well bore. (NTC Consultants. 2011. *Impacts on Community Character of Horizontal Drilling and High Volume Hydraulic Fracturing in Marcellus Shale and Other Low-Permeability Gas Reservoirs*. Prepared for the New York State Energy Research and Development Authority. p. 7. <http://www.nysrerda.ny.gov/Publications/Research-and-Development-Technical-Reports/Other-Technical-Reports/-/media/Files/Publications/PPSER/NYSERDA/ng/ntc.ashx>)

¹³ Other sections of the core area include: sections of the core area in Dewitt, Gonzales, Atascosa, and Live Oak counties. (Alamo Area Council of Governments. August 1, 2012. *Oil and Gas Emission Inventory Improvement Plan*, Eagle Ford. Draft Technical Proposal. p. 1-4. <http://www.aacog.com/DocumentCenter/View/8286>)

¹⁴ RRC web site: "Well Distribution by County." <http://www.rrc.state.tx.us/data/wells/wellcount/index.php>

¹⁵ RRC web site: See the "Texas Monthly Oil and Gas Statistics" available as Railroad Commission of Texas Press Releases. <http://www.rrc.state.tx.us/pressreleases/>

¹⁶ For example, a fact sheet on the Barnett Shale Area Special Inventory provides links to documents that list various sources of air emissions. Not all of these emissions were included in the Barnett shale emissions inventory. (TCEQ. "Barnett Shale Area Special Inventory." Fact Sheet. <http://www.tceq.texas.gov/assets/public/implementation/air/ie/pseiforms/Barnett%20Shale%20Area%20Special%20Inventory.pdf> Accessed July 18, 2013.)

¹⁷ Begos, K. August 25, 2013. "Fracking health projet puts numbers to debate," *Associated Press*. <http://bigstory.ap.org/article/fracking-health-project-puts-numbers-debate>

¹⁸ Witter R, McKenzie, L., Towle, M., Stinson, K. Scott, K., Newman, L. and Adgate, J. September 2010. *Health Impact Assessment for Battlement Mesa, Garfield County Colorado*. Colorado School of Public Health, University of Colorado Denver. Available: <http://tinyurl.com/6hccwrpz> Accessed June 26, 2013.

¹⁹ McKenzie, L.M., Witter, R.Z., Newman L.S., Adgate J.L. May 2012. "Human Health Risk Assessment of Air Emissions from Development of Unconventional Natural Gas Resources." *Science of the Total Environment*. 1;424:79-87. Available at: <http://cogcc.state.co.us/library/setbackstakeholdergroup/Presentations/Health%20Risk%20Assessment%20of%20Air%20Emissions%20From%20Unconventional%20Natural%20Gas%20-%20HMcKenzie2012.pdf> Accessed June 26, 2013



- ²⁰ Interview with the study author. (Kelly, D. March 19, 2012. "Study shows air emission near fracking sits may pose health risks," University of Colorado Newsroom. <http://www.ucdenver.edu/about/newsroom/newsreleases/Pages/health-impacts-of-fracking-emissions.aspx>)
- ²¹ In an air quality study conducted in 2010, and accepted for publication by *Human and Ecological Risk Assessment: An International Journal*, Theo Colborn and her colleagues sampled air quality in rural western Colorado before, during and after drilling and hydraulic fracturing of a new natural gas well pad. (Source: Colborn, T., Schultz, K., Herrick, L. and Kwiatkowski, C. (In Press) "An exploratory study of air quality near natural gas operations," *Human and Ecological Risk Assessment: An International Journal*. Available at: <http://www.endocrinedisruption.com/chemicals.air.php> Accessed July 17, 2013.)
- ²² Buzcu-Guven, B., Hariss, R. and Hertzmark, D. 2010. *Gas Flaring and Venting: Extent, Impacts and Remedies*. Energy Forum of the James Baker III Institute for Public Policy. p. 11. <http://www.bakerinstitute.org/publications/CARBONFlaring%20paper%20Birnur%20FINALwith%20cover%20secured.pdf>
- ²³ Shaletest.org ShaleTest is a non-profit organization that collects environmental data and provides testing to lower income families and communities that are negatively impacted by shale oil and gas extraction.
- ²⁴ Texas Commission on Environmental Quality. (Hereafter, TCEQ). "Barnett Shale Special Inventory." Fact Sheet. <http://www.tceq.texas.gov/assets/public/implementation/air/ie/pseiforms/Barnett%20Shale%20Area%20Special%20Inventory.pdf>
- ²⁵ The Eagle Ford Task Force was created under the directive of Texas Railroad Commissioner David Porter in 2011 to promote economic activity and establish best practices across the play. <http://eaglefordshale.com/eagle-ford-task-force/>
- ²⁶ Eagle Ford Shale Task Force. March 2013. *Eagle Ford Shale Task Force Report*. p. 84. http://www.rrc.state.tx.us/commissioners/porter/reports/Eagle_Ford_Task_Force_Report-0313.pdf
- ²⁷ Pers. Comm. With Peter Bella, AACOG. July 18, 2013. For more information about the inventory, see: Alamo Area Council of Governments. August 1, 2012. *Oil and Gas Emission Inventory Improvement Plan, Eagle Ford. Draft Technical Proposal*. pp. iii and iv. <http://www.aacog.com/DocumentCenter/View/8286>
- ²⁸ Data Sources for Table 2: Well drilling spud date and drilling completion dates are from the Texas Railroad Commission. Information on each well is available by entering the well permit (API) number into the "Drilling Permit Application Query." Available at: <http://webapps.rrc.state.tx.us/DP/initializePublicQueryAction.do>. (See Appendix 1 for API numbers for these wells). Information on well fracturing start-date obtained by entering well API into the FracFocus search engine (<http://www.fracfocusdata.org/DisclosureSearch/MapSearch.aspx>). Texas operators are required to report fracturing information for wells drilled as of February 1, 2012, but some operators have reported information on wells drilled prior to that date. FracFocus doesn't provide information on the length of time required to complete fracturing.
- ²⁹ Armendariz, A. Jan. 26, 2009. *Emissions from Natural Gas Production in the Barnett Shale Area and Opportunities for Cost-Effective Improvements*. Prepared for Environmental Defense Fund. Austin, Texas. p. 18. Available at: http://www.edf.org/sites/default/files/9235_Barnett_Shale_Report.pdf
- ³⁰ RRC web site: "Flaring Regulation – Frequently Asked Questions." <http://www.rrc.state.tx.us/about/faqs/flaringfaq.php#4>
- ³¹ Alamo Area Council of Governments. August 1, 2012. *Oil and Gas Emission Inventory Improvement Plan, Eagle Ford. Draft Technical Proposal*. p. 5-20. <http://www.aacog.com/DocumentCenter/View/8286>
- ³² Buzcu-Guven, B., Hariss, R. and Hertzmark, D. 2010. *Gas Flaring and Venting: Extent, Impacts and Remedies*. Energy Forum of the James Baker III Institute for Public Policy. p. 10. <http://www.bakerinstitute.org/publications/CARBONFlaring%20paper%20Birnur%20FINALwith%20cover%20secured.pdf>
- ³³ Ibid.
- ³⁴ Kostiuk, L.W., Johnson, M.R. and Thomas, G.P. 2004. *University of Alberta Flare Research Project Final Report November 1996 – September 2004*. University of Alberta, Department of Mechanical Engineering. pp. 180, 234. <http://www.mece.ualberta.ca/groups/combustion/flare/papers/Final%20Report2004.pdf>
- ³⁵ For example, large volumes of propane were released from the Sugarhorn processing facility when gas was being vented instead of flared. (See section on Air quality investigations near the Cerny home).
- ³⁶ U.S. EPA. "Summary of Requirements for Processes and Equipment at Natural Gas Well Sites. Fact Sheet. <http://www.epa.gov/airquality/oilandgas/pdfs/20120417summarywellsites.pdf>
- ³⁷ U.S. EPA. April 2012. *Regulatory Impact Analysis. Final New Source Performance Standards and Amendments to the National Emissions Standards for Hazardous Air Pollutants for the Oil and Natural Gas Industry*. p. 1-3. http://www.epa.gov/ttn/ecas/regdata/RIAs/oil_natural_gas_final_neshap_nsps_ria.pdf
- ³⁸ Eagle Ford Shale Task Force. March 2013. *Eagle Ford Shale Task Force Report*. p. 82. http://www.rrc.state.tx.us/commissioners/porter/reports/Eagle_Ford_Task_Force_Report-0313.pdf
- ³⁹ Ibid. p. 76.
- ⁴⁰ Alamo Area Council of Governments. August 1, 2012. *Oil and Gas Emission Inventory Improvement Plan, Eagle Ford. Draft Technical Proposal*. p. 5-21. <http://www.aacog.com/DocumentCenter/View/8286>
- ⁴¹ RRC web site: "Flaring Regulation – Frequently Asked Questions." <http://www.rrc.state.tx.us/about/faqs/flaringfaq.php#4>
- ⁴² RRC's Production Report system indicates why the gas was flared/vented, but does not specify whether the gas was flared or vented. (RRC Online System. Production Reports. PR Queries Home. Production by Lease. <http://webapps.rrc.state.tx.us/PR/publicQueriesMainAction.do>)
- Selected oil lease, use lease number. Data are the same as the Production Data Query, but include information on why gas was flared/vented (Disposition Code 04). The most common reason is "Compressor Maint Dow".
- ⁴³ RRC Online System. Production Data Query. Specific Lease Query. <http://webapps2.rrc.state.tx.us/EWA/specificLeaseQueryAction.do>

Selected oil leases, because all of the wells close to the Cernys are oil wells. Entered lease number, District 02, date range Jan. 2010 to May 2013. The table labeled "Disposition Details" provides a monthly account of the volume of casinghead gas used on-site, delivered to pipeline or processing plant, injected, or used for other purposes. Volumes are reported in thousands of cubic feet (MCF) per month. Gas vented/flared the disposition code 4.

⁴⁴ Alamo Area Council of Governments. August 1, 2012. *Oil and Gas Emission Inventory Improvement Plan*, Eagle Ford. Draft Technical Proposal. p. 7-1. <http://www.aacog.com/DocumentCenter/View/8286>.

⁴⁵ TCEQ Air Permits Remote Document Server. Available at: <https://webmail.tceq.state.tx.us/gw/webpub>

⁴⁶ "...the H2S content of the produced gas has been adjusted to 500 ppmv (0.050 mol %) as measured by the stained tube method." (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 101405. Gilley 1 Production Facility. Reviewed by John Gott, TCEQ, May 16, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: Gilley TRV 101405 Marathon)

⁴⁷ "Natural gas at the site contains up to 66 parts per million volume (ppmv) hydrogen sulfide..." (Technical Review: Air Permit by Rule (PBR). PBR Registration No. 11040. Buehring 1 Production Facility. Reviewed by John Gott, TCEQ, June 21, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: Buehring PBR 101440 Marathon)

⁴⁸ HAPs are benzene only. (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 99763. Sugarhorn Central Facility. Reviewed by Margaret Schell, TCEQ, March 1, 2013. Available at: <https://webmail.tceq.state.tx.us/gw/webpub/3169a952744940bfe8a53c5fa0429a5860c51070/GWDOC/DREF/tnrdm3.dms3apo.ansrp01/462186/Official/webacc/GWContentRoot/TRV%2099763%20Marathon%20%28620%29?action=Document.ViewNative&User.context=3169a952744940bfe8a53c5fa0429a5860c51070>) The most recent TRV did not include H2S concentration. Previous TRV dated said company conservatively estimated a maximum of 100 ppmv H2S in the gas being processed at the facility. (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 99763. Sugarhorn Central Facility. Reviewed by John Gott, TCEQ, July 25, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub/e07e8a1768a4aa3442a5a5c15a7f1b190d81e8c/GWDOC/DREF/tnrdm3.dms3apo.ansrp01/442789/Official/webacc/GWContentRoot/TRV%2d%2d99763%2d%2dMARATHON%20OIL%20EF%20LLC%2d%2d6002?action=Document.ViewNative&User.context=e07e8a1768a4aa3442a5a5c15a7f1b190d81e8c>)

⁴⁹ "The H2S concentration has been adjusted to 500 ppmv to be conservative." (Technical Review: Air Quality Standard Permit for Oil and Gas Handling and Production Facilities. Permit No. 99028. Jordan Davenport Production Facility. Reviewed by John Gott, TCEQ, June 19, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: TRV 99028 Marathon)

⁵⁰ Certified emissions associated with the Kimble Gilley Production Facility Permit By Rule Registration (Registration No. 103753) Oct. 30, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: Kimble Gilley PBR 103753 Marathon) Accessed July 16, 2013. But in TCEQ investigation it was reported the tanks were removed from the facility on Dec. 18, 2012 (TCEQ Investigation Report 1030412. August 15, 2012 Marathon Oil EF LLC's Kimble Gilley Production Facility. p. 5. Obtained by Earthworks through an Open Records request)

⁵¹ "This facility is expected to process a maximum of 50 MMSCF of sour natural gas (200 ppmv H2S)." (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 100493. East Sugarloaf Central Facility. Reviewed by John Gott, TCEQ, April 25, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: East Sugarloaf TRV 100493 Marathon)

⁵² "Gas is sour and co. used a max 100 ppmv H2S to estimate sulfur emissions." (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 99759. East Longhorn Central Facility. Reviewed by John Gott, TCEQ, August 3, 2013. Available at: <https://webmail.tceq.state.tx.us/gw/webpub/3169a952744940bfe8a53c5fa0429a5860c51070/GWDOC/DREF/tnrdm3.dms3apo.ansrp01/443550/Official/webacc/GWContentRoot/TRV%2d%2d99759%2d%2dMARATHON%20OIL%20EF%20LLC%2dM002%20Revision?action=Document.ViewNative&User.context=3169a952744940bfe8a53c5fa0429a5860c51070>)

⁵³ "H2S content of inlet gas: 50." Technical Review: Air Permit by Rule. Permit Registration No. 102437. Plains Exploration and Production Co. Kotara Production Facility. Reviewed by Guillermo Reyes, TCEQ, Aug. 23, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: Kotara TRV Plains

⁵⁴ "Slightly sour gas (40 ppmv) will be produced at the site." (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 99876. Pfeifer No. 1 Production Facility. Reviewed by John Gott, TCEQ, Jan. 13, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: Pfeifer TRV Marathon)

⁵⁵ "...handles natural gas that may contain more than 24 ppmv H2S (company is now claiming 400 ppmv H2S)." (Technical Review: Air Quality Standard Permit for Installation and/or Modification of Oil and Gas Facilities. Permit No. 99778. North Longhorn Central Facility. Reviewed by John Gott, TCEQ, June 3 2013. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search North Longhorn TRV 99778 Revision Marathon)

⁵⁶ At gas processing facilities different pieces of equipment remove some of the hazardous compounds. For example, amine or sweetening units remove hydrogen sulfide from the gas stream, so if the leak occurs after the sweetening unit there should not be H2S emitted. If, however, the leak is from a tank containing oil, condensate or produced water, the H2S has not yet been removed and so would be released to the atmosphere.

⁵⁷ TCEQ. 2012. "Oil and Gas Site Planned Maintenance, Startup, and Shutdown." <http://www.tceq.texas.gov/assets/public/permitting/air/Guidance/NewSourceReview/og-plan-mss.pdf>

⁵⁸ Environmental Integrity Project. July 2012. Accident Prone: Malfunctions and "Abnormal" Emissions Events at Refineries, Chemical Plants and Natural Gas Facilities in Texas, p. 1. 2009. http://www.environmentalintegrity.org/news_reports/documents/20120718AccidentProneFinal.pdf

⁵⁹ TCEQ Investigation Report 987182. Feb. 3, to March 1, 2012. Yosko 1 Production Facility. p. 2. (Obtained by Earthworks through an Open Records request).



⁶⁰ Sources: TCEQ Investigation Report 987182. Feb. 3, to March 1, 2012. Yosko 1 Production Facility. p. 3; and TCEQ Investigation Report 1022281 June 15, 2012. Eagle Ford Recon Karnes City. (Documents obtained by Earthworks through an Open Records request).

⁶¹ No odors were detected on Feb. 3, just smoke. (TCEQ Investigation Report 987182. Feb. 3, to March 1, 2012. Yosko 1 Production Facility. p. 3). On June 30, 2012 investigators could not get a TVA reading due to wind direction and fence lines (TCEQ Investigation Report 1023402. June 30, 2012. Eagle Ford Recon Karnes City. p. 2.) (Documents obtained by Earthworks through an Open Records request).

⁶² TCEQ Investigation Report 1022281. June 15, 2012. Eagle Ford Recon Karnes City. p. 2. (Obtained by Earthworks through an Open Records request).

⁶³ TCEQ Investigation Report 1022281. June 15, 2012. Eagle Ford Recon Karnes City. p. 4. (Obtained by Earthworks through an Open Records request).

⁶⁴ Inspector's field notes said: ". . .receptor very near to holding pond but readings too high to obtain distance from receptor to facility.. . Nearest Receptors: yards." (From: "Field Notes. Site Assessment Recon (RECON) Investigation No. 1022281. Investigator: Felischa Cullins. Date of Investigation: June 15, 2012. Site ID: K-EFS-307. p. 3 of 4. (Documents obtained by Earthworks through an Open Records request).

⁶⁵ There was no documentation that the inspectors went to the nearest receptor to warn them to stay indoors, or to take canister samples.

⁶⁶ From: "Field Notes. Site Assessment Recon (RECON) Investigation No. 1022281. Investigator: Felischa Cullins. Date of Investigation: June 15, 2012. Site ID: K-EFS-307. p. 3 of 4. (Documents obtained by Earthworks through an Open Records request).

⁶⁷ TCEQ Investigation Report 1023402. June 30, 2012. Eagle Ford Recon Karnes City. p. 2. (Obtained by Earthworks through an Open Records request)

⁶⁸ TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 2. (Obtained by Earthworks through an Open Records request)

⁶⁹ TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 2. (Obtained by Earthworks through an Open Records request)

⁷⁰ TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 3. (Obtained by Earthworks through an Open Records request)

⁷¹ In the Kimble-Gilley investigation report, there is a description of the Sugarhorn investigation, which states that "EIs drove north on County Road 209 to the Sugarhorn Central Production Facility. . . Because of the wind direction we could not get down-wind of the facility to detect odors or record emissions using the MiniRae or the QRae." (TCEQ Investigation Report 1030412. August 15, 2012 Marathon Oil EF LLC's Kimble Gilley Production Facility. p. 2. Obtained by Earthworks through an Open Records request)

⁷² "Emissions events that occurred on August 15, 2012 and September 5, 2012 were not reported until December 20, 2012." (TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 4. Obtained by Earthworks through an Open Records request)

⁷³ VOCs: 10,000 pounds divided by 12 hours = 833 pounds per hour. The allowable emissions rate was 1.62 pounds per hour. 833 lbs/hr divided by 1.62 lbs/hr = 514.

H2S: 1.35 pounds divided by 12 hours = 0.117 pounds per hour. 0.1125 lbs/hr divided by 0.001 lbs/hr = 112.5 times the allowable emission rate.

Data from the TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 11. (Obtained by Earthworks through an Open Records request). See also July 2012 permit which was valid at time. Allowable VOC and H2S emissions from Marathon's permit. See FLARE-O1 in the Maximum Allowable Emission Rates Table (MAERT). (Technical Review: Air Quality Standard Permit for Oil and Gas Handling and Production Facilities. Permit No. 99763. Sugarhorn Central Facility. Reviewed by John Gott, TCEQ, July 25, 2012. Available at: <https://webmail.tceq.state.tx.us/gw/webpub/c7e01193737a7d638db4c92dc1946e6749971a3a/GWDOC/DREF/tnrdom3.dms3apo.ansrp01/442789/Official/webacc/GWContentRoot/TRV%2d%2d99763%2d%2dMARATHON%20OIL%20EF%20LLC%2d%2d6002?action=Document.ViewNative&User.context=c7e01193737a7d638db4c92dc1946e6749971a3a>)

⁷⁴ VOCs: 6,660 pounds divided by 11.5 hours = 574 pounds per hour. The allowable emissions rate was 1.62 pounds per hour. 574 lbs/hr divided by 1.62 lbs/hr = 354.

H2S: 0.88 pounds divided by 11.5 hours = 0.77 pounds per hour. 0.77 lbs/hr divided by 0.001 lbs/hr = 77 times the allowable emission rate.

Data from the TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC's Sugarhorn Central Facility. p. 7. (Obtained by Earthworks through an Open Records request).

⁷⁵ Violations included: Violation of General Condition 8 of Permit 99764 and listed in 30 Texas Administrative Code Section 116.615(9) which states the facility may not be operated unless all air pollution emissions captures and abatement and equipment maintained in good working order and working properly during normal facility operations. (TCEQ Investigation Report 1060291. March 28, 2013. Marathon Oil EF LLC's Sugarhorn Central Facility. p. 4. (Obtained by Earthworks through an Open Records request)

⁷⁶ TCEQ Investigation Report 1060291. March 28, 2013. Marathon Oil EF LLC's Sugarhorn Central Facility. p. 4. (Obtained by Earthworks through an Open Records request)

⁷⁷ Reviewed "All administrative orders issued since September 1, 1998," "Court orders issued since September 1, 1998," and "All pending enforcement cases" on TCEQ's web site. (<http://www.tceq.texas.gov/enforcement/penenfac/index.html>) There was no mention of a penalty being issued to Marathon Oil in Karnes County. Also, TCEQ's complaint investigation tracking web site show that "No NOV/NOE has been issued" for the Sugarhorn Central Facility Investigation done on February 5, March 21, April 3, 2013 and May 8, 2013. (<http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=766289452013114>)



⁷⁸ “On December 18, 2012, the EI returned to the area of the complaint. . . A video taken at the Sugarhorn Central Facility was sent to Marathon. The flare was working, but emissions could be seen coming from vents on top of the storage tanks.” (TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC’s Sugarhorn Central Facility. p. 3. Obtained by Earthworks through an Open Records request)

⁷⁹ The company was informed by TCEQ of the emissions events on Sept. 5. By law, they should have reported the events within 24 hours, but did not. Marathon met with TCEQ on Oct. 24, 2012, where the company “acknowledged the events,” yet still did not report the events until December 20, 2012, more than 3 months after the events occurred. (TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC’s Sugarhorn Central Facility. pp. 3,4. Obtained by Earthworks through an Open Records request)

⁸⁰ TCEQ Investigation Report 1030412. August 15, 2012 Marathon Oil EF LLC’s Kimble Gilley Production Facility. p. 3. (Obtained by Earthworks through an Open Records request)

⁸¹ TCEQ Investigation Report 1030412. August 15, 2012 Marathon Oil EF LLC’s Kimble Gilley Production Facility. p. 4. (Obtained by Earthworks through an Open Records request)

⁸² In October 2012 Marathon informed TCEQ that the Kimble Gilley facility would be removing storage tanks and flares from the site, and be rerouting products to the East Sugarloaf Production Facility. By December the tanks were no longer in use. So TCEQ considered the violation resolved. (TCEQ Investigation Report 1030412. August 15, 2012 Marathon Oil EF LLC’s Kimble Gilley Production Facility. pp. 3,5. Obtained by Earthworks through an Open Records request)

⁸³ Email from Carol McGrath (TCEQ) to Vijay Kurki (Marathon Oil). May 4, 2012. The email pertains to the Yosko No. 1 Production Facility. Handwritten note on email reads: 0.73 miles to Complainant, 3843.61 feet to complainant.” Email obtained as part of documentation for Air Complaint Investigation 98182 obtained by Earthworks through an Open Records request (Attachment 1, p. 18 of 25). Also, documentation of the investigation indicates that the Yosko facility was “0.73 miles NE of complainant’s home.” (Attachment 1, p. 10 of 25) (TCEQ Investigation Report 987182. Feb. 2 to March 3, 2012 Marathon Oil EF LLC’s Yosko 1 Production Facility. “Attachment 1 – Documentation for Air Complaint Investigation 987182 of Marathon Oil Company Yosko 1 Production Facility, Karnes City, Karnes County, Texas.” Obtained by Earthworks through an Open Records request)

⁸⁴ TCEQ Investigation Report 987182. Feb. 2 to March 3, 2012 Marathon Oil EF LLC’s Yosko 1 Production Facility. pp. 3, 4. Obtained by Earthworks through an Open Records request)

⁸⁵ TCEQ Investigation Report 987182. Feb. 2 to March 3, 2012 Marathon Oil EF LLC’s Yosko 1 Production Facility. p. 5. Obtained by Earthworks through an Open Records request)

⁸⁶ FLIR web site: “Thermal imaging cameras for optical gas imaging.” <http://www.flir.com/cs/apac/en/view?id=41663>

⁸⁹ Weather History for Beeville, Texas (the closed weather station to Karnes City). Monday March 4, 2013. <http://www.wunderground.com/auto/kvii/history/airport/KBEA/2013/3/4/DailyHistory.html>

⁹⁰ TCEQ web site: “Air Monitoring Comparison Values.” http://www.tceq.state.tx.us/cgi-bin/compliance/monops/agc_ amcv.spl

⁹¹ Fuquay, J. Jan.2 23, 2013. “Benzene levels at Fort Work, Dish gas compressor stations questioned.” *Star-Telegram*. <http://www.star-telegram.com/2013/01/23/4570536/benzene-levels-at-fort-worth-dish.html>

⁹² According to a TCEQ investigation report, “While conducting a comalint investigation on September 5, 2012, it was discovered wit the use of the GasFind IR Camera that the enclosed barrel flare, EPN FLARE-01 was not working.” This resulted in the venting of large volumes of benzene (27 lbs.), propane (5,606 lbs) and other VOCs (6,600 lbs). As discussed previously, the emissions at that time were found to be in violation of Marathon Oil EF’s air permit. (TCEQ Investigation Report 1027204. August 15, 2012 Marathon Oil EF LLC’s Sugarhorn Central Facility. pp.3, 4. Obtained by Earthworks through an Open Records request)

⁹³ Steinzor, N., Subra, W. and Sumi, L. 2013. “Investigating Links between Shale Gas Development and Health Impacts Through a Community Survey Project in Pennsylvania.” *New Solutions*. 23:1:55-83. Available at: <http://www.newsolutionsjournal.com/index.php/newsolutionsjournal/issue/view/19>

⁹⁴ The table is excerpted from a peer-reviewed article soon to be published in *Human and Ecological Risk Assessment: An International Journal*. In an air quality study conducted in 2010, and accepted for publication by *Human and Ecological Risk Assessment: An International Journal*, Theo Colborn and her colleagues sampled air quality in rural western Colorado before, during and after drilling and hydraulic fracturing of a new natural gas well pad. As part of the study, Colborn and her colleagues performed an in-depth literature search of potential health effects related to chemicals found in an air sampling study near a natural gas pad in rural western Colorado (Colborn, T., Schultz, K., Herrick, L. and Kwiatkowski, C. (In Press) “An exploratory study of air quality near natural gas operations,” *Human and Ecological Risk Assessment: An International Journal*. Table 4. Available at The Endocrine Disruption Exchange web site: <http://www.endocrinedisruption.com/chemicals.air.php>. References for health effects can be found in supplemental material posted at: <http://www.endocrinedisruption.com/files/HERA12-137Table4References.pdf>

⁹⁵ RRC web site: “Active Eagle Ford fields.” Shows that the Eagleville (Eagle Ford 1 and Eagle Ford 2) and Brisco Ranch (Eagleford) fields all contain H2S. http://www.rrc.state.tx.us/eagleford/EagleFord_Fields_and_Counties_201306.xls Accessed July 17, 2013.

W-1 data for wells close to the Cernys shows that most if not all are in the Eagleville (Eagle Ford 2) field. Searched RRC “Drilling Permit Application Query.” <http://webapps.rrc.state.tx.us/DP/initializePublicQueryAction.do> Searched by API for wells in Appendix 1 of this report.

⁹⁶ RRC web site: “Hydrogen Sulfide (H2S) Fields and Concentration Listing.” District 2. June 2013. <http://www.rrc.state.tx.us/data/fielddata/h2s/dist2.php> Accessed July 17, 2013.

⁹⁷ The odor of hydrogen sulfide is often described as “rotten egg,” but at higher concentrations it can have a sweet odor, and above 100 ppm it can paralyze the olfactory nerves, causing the loss of the sense of smell. (Simonton, S. and Spears, M. Oct. 3, 2007. “Human health effects from exposure to low-level concentrations of hydrogen sulfide,” *Occupational Health and Safety*. <http://ohsonline.com/Articles/2007/10/Human-Health-Effects-from-Exposure-to-LowLevel-Concentrations-of-Hydrogen-Sulfide.aspx?Page=1>)



⁹⁸ The table was prepared by the Michigan Department of Environmental Quality, based on information excerpted from the American National Standards Institute standard: Z37.2-1972 Acceptable Concentrations of Hydrogen Sulfide. Available at: http://www.michigan.gov/deq/0,1607,7-135-3311_4111_4231-9162--00.html#2. What are the effects?

¹⁰⁰ Simonton, S. and Spears, M. Oct. 3, 2007. "Human health effects from exposure to low-level concentrations of hydrogen sulfide," *Occupational Health and Safety*. <http://ohsonline.com/Articles/2007/10/Human-Health-Effects-from-Exposure-to-LowLevel-Concentrations-of-Hydrogen-Sulfide.aspx?Page=1>

¹⁰¹ The RRC H-9 reports include information on the concentration of H₂S in gas.

¹⁰² TCEQ's web page "Automated gas chromatograph (AutoGC)" lists sites where air quality monitoring stations have been installed. It includes a section on the Barnett Shale Monitoring Network, but there is no mention of the Eagle Ford Shale. See: <http://www.tceq.texas.gov/airquality/monops/agg> Accessed June 16, 2013.

¹⁰³ Pers. Comm. Keith Sheedy, TCEQ. July 2, 2013.

¹⁰⁴ TCEQ web site: "Barnett Shale Geological Area." <http://www.tceq.texas.gov/airquality/barnettshale> NOTE: This is being done in the Barnett Shale, with the exception of video from the infrared monitoring cameras (FLIR) that reveal emissions invisible to the naked eye are not freely publicly available. FLIR video should also be freely publicly available.

¹⁰⁵ Center for Disease Control and Prevention web site: "The different types of health assessments." http://www.cdc.gov/healthyplaces/types_health_assessments.htm

¹⁰⁶ For a comprehensive assessment of Texas oil and gas oversight: http://www.earthworksaction.org/issues/detail/texas_oil_gas_enforcement

¹⁰⁷ Batchgeo web site: <https://batchgeo.com/>

¹⁰⁸ Note: Lat/long can be found in plats filed by the company with RRC (via a W-1 search). For some locations, lat/longitude data had to be obtained by using the RRC public map viewer, entering the well's API, and scrolling over the surface (not downhole) location for the well. (RRC Public GIS Map Viewer for Oil, Gas, and Pipeline Data: <http://gis2.rrc.state.tx.us/public/startit.htm>)

¹⁰⁹ TCEQ. <https://webmail.tceq.state.tx.us/gw/webpub>

¹¹⁰ RRC web site: "Drilling Permit Application Query." <http://webapps.rrc.state.tx.us/DP/initializePublicQueryAction.do>

¹¹¹ FracFocus web site: "Find a well." <http://www.fracfocusdata.org/DisclosureSearch/MapSearch.aspx>

¹¹² RRC web site: "Completions Query." <http://webapps.rrc.state.tx.us/CMPL/publicSearchAction.do?formData.methodHndlr.inputValue=init&formData.headerTabSelected=home&formData.pageForwardHndlr.inputValue=home>

¹¹³ View statewide rule 3.36 at: [http://info.sos.state.tx.us/pls/pub/readtac\\$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=16&pt=1&ch=3&rl=36](http://info.sos.state.tx.us/pls/pub/readtac$ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=16&pt=1&ch=3&rl=36)

¹¹⁴ For example, see the H-9 filed for the Brysch-Jonas Unit C, 1H well. <http://webapps.rrc.state.tx.us/dpimages/r/1775844>

¹¹⁵ Technical Review: Air Permit by Rule. Permit No. 97998. Hilcorp Energy Company. Yosko 1 Production Facility. Reviewed by Jeffrey Voorhis, TCEQ, Aug. 29, 2011. Available at: <https://webmail.tceq.state.tx.us/gw/webpub> Search: TRV 97998

¹¹⁶ TCEQ web site: "Search for the status of a complaint." Searched Karnes County. Checked to make sure that complaint "effect" stated Eagle Ford Shale. <http://www2.tceq.texas.gov/oce/waci/index.cfm>

¹¹⁷ Operator found by looking up the regulated entity (RN) number associated with the complaint. <http://www12.tceq.state.tx.us/crpub/index.cfm?fuseaction=regent.RNSearch>

¹¹⁸ Complaint 184004. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=184044>

¹¹⁹ Complaint 183114. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=183114>

¹²⁰ Complaint 180822. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=180822>

¹²¹ Complaint 184955. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=184955>

¹²² Complaint investigation details for 184955. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=766289452013114>

¹²³ Complaint 181475. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=181475>

¹²⁴ Complaint 179379. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=179379>

¹²⁵ Complaint investigation details for 179379. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=555408012013087>

¹²⁶ Complaint investigation details for 174327. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=174327>

¹²⁷ Complaint 174327. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=340397912012292>

¹²⁸ Complaint 173742. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=173742>

¹²⁹ Complaint investigation details for 173742. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=151523202012277>

¹³⁰ Complaint 173359, <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=173359>

¹³¹ Complaint investigation details for 173359, <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.investigation&invid=460580732012275>

¹³² Complaint 173312. <http://www2.tceq.texas.gov/oce/waci/index.cfm?fuseaction=home.complaint&incid=173312>



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- ¹⁷⁶ Weather History for Beeville, Texas (the closed weather station to Karnes City). March 4, 2013, and March 5, 2013. <http://www.wunderground.com/auto/kvii/history/airport/KBEA/2013/3/4/DailyHistory.html>
- ¹⁷⁷ Colborn, T., Schultz, K., Herrick, L. and Kwiatkowski, C. (In Press) "An exploratory study of air quality near natural gas operations," *Human and Ecological Risk Assessment: An International Journal*. p. 9. Available at: <http://www.endocrinedisruption.com/chemicals.air.php>
- ¹⁷⁸ Earthworks representatives observed and took FLIR footage at the Best-Beard Unit site, where two wells were being hydraulically fractured. According to FracFocus, fracking started on the site on February 21, 2013 (Searched FracFocus, API #: 42-255-32694 and 42-255-32660 <http://www.fracfocusdata.org/DisclosureSearch/MapSearch.aspx>). The Best-Beard Unit is approximately 3 miles from the Cerny home. As seen from Appendix 1, only one well within a 2-mile radius of Cernys was undergoing hydraulically fracturing in March 2013. The Adams-Tipton 4H well was fracturing on March 15, 2013 (as noted on the FracFocus web site. Searched API #42-255-32984.) This was after the canister samples were taken.
- ¹⁷⁹ US Geological Survey web site: "Polynuclear Aromatic Hydrocarbons (PAHs)." Toxic Substances Hydrology Program. <http://toxics.usgs.gov/definitions/pah.html>
- ¹⁸⁰ U.S. EPA web site: "Formaldehyde." <http://www.epa.gov/iaq/formaldehyde.html>
- ¹⁸¹ ALS-Columbia Analytical web site: "Air Sampling Instructions." <http://www.caslab.com/Air-Sampling-Instructions/>



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