Exhibit 1

Exhibit 1

The World – Coos Bay
http://theworldlink.com/news/local/govt-and-politics/jordan-cove-parent-company-looks-at-financing-ownership-options-expansion/article_5fe9f9ec-b521-11e3-9421-001a4bcf887a.html

MONEY STARTS FLOWING

Jordan Cove parent company looks at financing, ownership options, expansion

March 28, 2014 1:00 pm • By Chelsea Davis, The World

COOS BAY — Now that the Jordan Cove Energy Project has federal approval to export liquefied natural gas to non-Free Trade Agreement countries, parent company Veresen Inc. is making moves financially.

Don Althoff, Veresen's president and CEO, spoke with confidence during a conference call following the U.S. Department of Energy's Monday announcement.

"I don't think this is going to be a problem to finance," he said of the $7.7 billion project (approximately $1.1 billion of which is project financing, owner's cost and interest incurred during the four-year construction period).

Before Veresen can make a "final investment decision" in early 2015, it needs an Engineering, Procurement and Construction contract, all off-take contracts "signed with credit-worthy counterparties," and Federal Energy Regulatory Commission approval.

Veresen looks for potential owners, partners

Althoff wants Jordan Cove to be "completely sold out" by October or November. That means Veresen is analyzing "optimal ownership" and possibly bringing in partners.

"What we're going to decide over the next nine months is how much we want to own of the plant, and then how much more equity do I need to raise?" Althoff told The World this week.

Today, Veresen owns 100 percent of Jordan Cove, including the proposed marine facility, liquefaction plants, storage tanks, gas treating facilities and South Dunes Power Plant. The LNG facility will run capital costs of $5.3 billion, Veresen estimates.

The Pacific Connector Gas Pipeline, which would feed natural gas to Jordan Cove through a 232-mile, 36-inch pipeline from Malin, will incur capital costs of $1.5 billion. Veresen owns half of the pipeline; the other half is owned by Williams Companies, a U.S. natural gas processing and transportation company.

"I think owning 100 percent of it ... there probably aren't very many options where that makes the most sense for us," Althoff said.

Jordan Cove's potential customers have expressed interest in taking equity positions in the facility.

"Buyers of the natural gas like to invest in these, as well," he said. "If we do bring partners on, they would pay us for our percentage of the plant we'll sell them, then we'll use that equity to fund the rest of our equity, then go to the market and raise it if we still need more."

Time to pay the bills

Right now, Veresen just needs to pay its bills until Jordan Cove gets the go-ahead or the ax.

That's why Veresen announced Tuesday it had entered into an agreement with a syndicate of underwriters who agreed to purchase 15 million shares of Veresen at $16.50 CAD ($14.85 USD) a piece to raise $247.5 million CAD (more than $220 million USD).

The underwriters also get an overallotment option to purchase up to an additional 2.25 million shares. That would bring the total closer to $284.6 million CAD ($250 million USD.)

The offering will close around April 3. Veresen's common shares are listed on the Toronto Stock Exchange under the symbol VSN.

"We still have a lot of money to spend to get (Jordan Cove) sanctioned," Althoff said. "Part of what (the $284.6 million is) used for is to pay bills between now and this time next year when we come in and finance the project."

Once those bills are paid, Veresen can raise more equity to pay for the bulk of the project.

"While financing won't be without its challenges, we will have the benefit of falling on the path paved for us by other recent LNG export developments in the U.S. Gulf Coast," he said.

Non-FTA approval a big win for Veresen

In Veresen's 2013 fourth quarter and year-end results report issued earlier this month, officials confirmed they were really gunning for DOE's non-FTA export approval.

Most of Jordan Cove's potential customers do not have FTAs with the U.S., Althoff said. Singapore and Korea are the only two east Asian countries with FTAs, and their markets are small relative to the overall market, he said.

Last fall, Veresen announced it had snagged three non-binding long-term Heads of Agreement with companies in Indonesia, India and an "eastern Asian country."

Japan is the world's largest LNG consumer, according to Thomson Reuters, but China is right on its heels — "...it looks like China will be a top LNG importer by 2018-20."

Since October, Althoff said Veresen has entered into other HOAs with "large-scale prospective customers, including various emerging and traditional LNG buyers throughout the Asia-Pacific region."

Veresen plans to wrap up binding Liquefaction Tolling Service Agreements and Pipeline Service Agreements by this fall.

"This is a world-scale plant," he said. "To try to think about selling to just FTA countries limited us too much."

Already looking at expansion

Jordan Cove's proposed initial LNG capacity — 6 million metric tons per year — also has its limits, Althoff said.

The total amount of LNG capacity requested under Veresen's various HOAs exceeds that 6 million.

If and when Jordan Cove begins construction, Althoff said Veresen will immediately look into expanding the facility's capacity to 9 million metric tons per year.

"The marina, tankage, gas treating and power plant can all manage 9 tonnes per annum (metric tons per year)," he said. "What's needed to expand the plant is more pressure on the pipeline and more trains. It does have the ability to expand.

"I think as soon as I can get this thing through FID (final investment decision) we will start to look at expansion projects down there."

FERC timeline possibly pushed back

That's only if FERC green lights Jordan Cove.

Veresen and Jordan Cove both forecasted a FERC ruling by the end of the year, with construction starting in the first quarter of 2015.

But that could be delayed. During a routine conference call between federal agencies last week, officials said Jordan Cove is changing its proposed wetland mitigation sites, meaning all of the land use tables in FERC's draft Environmental Impact Statement will be affected.
In turn, that's going to delay FERC's schedule while they analyze the new edits.

Exhibit 2

UNITED STATES OF AMERICA
DEPARTMENTOF ENERGY

Jordan Cove Energy Project, L.P.	)	**FE Docket No. 12–32–LNG**
	)	
Application for Certificate	)	**Jordan Cove Energy Project, L.P.; Application for Long-Term Authorization to Export Liquefied Natural Gas Produced From Domestic and Canadian Natural Gas Resources to Non-Free Trade Agreement Countries for a 25-Year Period**
	)	
	)	
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CITIZENS AGAINST LNG, Inc;
CITIZENS AGAINST LNG
NOTICE OF INTERVENTION, PROTEST AND COMMENTS

On June 6, 2012, the Office of Fossil Energy at the Department of Energy posted in the Federal Register a Notice of receipt of an application (Application), filed on March 23, 2012, by Jordan Cove Energy Project, L.P. (Jordan Cove), requesting long-term, multi-contract authorization to export as liquefied natural gas (LNG) both natural gas produced domestically in the United States and natural gas produced in Canada and imported into the United States, in an amount up to the equivalent of 292 billion cubic feet (Bcf) of natural gas per year, 0.8 Bcf per day (Bcf/d), over a 25-year period, commencing on the earlier of the date of first export or seven years from the date the requested authorization is granted. The LNG would be exported from the proposed LNG terminal to be located on the North Spit of Coos Bay in Coos County, Oregon, to any country (1) with which the United States does not have a free trade agreement (FTA) requiring national treatment for trade in natural gas, (2) which has developed or in the future develops the capacity to import LNG via ocean-going carrier, and (3) with which trade is not prohibited by U.S. law or policy. Jordan Cove is requesting this authorization to export LNG both on its own behalf and as agent for other parties who hold title to the LNG at the point of export. The Application was filed under section 3 of the Natural Gas Act (NGA).

Citizens Against LNG is a grassroots organization of citizens that formed during the Federal Energy Regulatory Commission Prefiling phase of the Jordan Cove Energy Project, L.P. and the Pacific Connector Gas Pipeline, L.P., LNG Import project. We represent over 4,000 citizens in Southern Oregon who live, work, have businesses, recreate and socialize in areas that would be negatively impacted by the Jordan Cove LNG terminal, storage tanks, liquefaction facility and the Pacific Connector Gas Pipeline.

Citizens Against LNG, and the citizens who support our cause, declare that a liquefied natural gas (LNG) export terminal, storage tanks and liquefaction facility is not a well conceived or appropriate industry for the Southern Oregon Coast and that LNG represents an unacceptable risk to the people of the State of Oregon. For the safety, security, and well being of the citizens of our communities, the Citizens Against LNG ask the U. S. Department of Energy to immediately take action to stop the Jordan Cove LNG Export terminal, storage tanks and liquefaction facility proposed for the North Spit of Coos Bay and the 230 mile, 36 inch Pacific Connector natural gas pipeline to the California border. We ask the U. S. Department of

Energy to not approve the Jordan Cove Energy Project's application to Export LNG to non-free trade agreement nations as this would not be in the best interest of the public at large. Further details as to our reasons for this are spelled out in the attached comment letter and exhibits.

In order to protect the interest of citizens in Southern Oregon, Citizens Against LNG, Inc, also known as Citizens Against LNG, moves to intervene in this proceeding, pursuant to 10 C.F.R. § 590.303(b).

The Citizens Against LNG previously petitioned, intervened and was part of a coalition of groups that filed a Request for Rehearing to the Federal Energy Regulatory Commission (FERC) concerning their Environmental Impact Statement and their December 17, 2009, Order on the Jordan Cove LNG Terminal and Pacific Connector gas pipeline project. We also petitioned the FERC to protect Coos, Douglas, Jackson, and Klamath Counties and the State of Oregon by taking action to stop the Jordan Cove LNG Terminal and the Pacific Connector gas pipeline. Over 4,000 people have signed our petition opposing this project. A large portion of our petitions are on file in the FERC e-Library.[1] We ask the DOE to note the filed petitions linked below as a reference, along with these additional submitted petitions we have included in with this filing as supporting justification that our intervention in this proceeding should be granted.

In addition, Citizens Against LNG would like to go on record as being in full support of the Sierra club and the Landowners United motion to intervene, protest and comments that are also being filed in this proceeding.

Please send any correspondence to:

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Curt Clay
President
Citizens Against LNG
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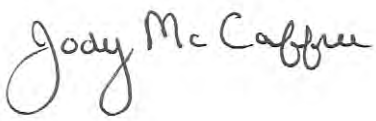
Sincerely,



Jody McCaffree

[1] Petition Filing 1) http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20070326-0003
Petition Filing 2) http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20070906-0013
Petition Filing 3) http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20091112-5040 - Exhibit P

Citizens Against LNG Inc
PO Box 1113
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August 6, 2012

By Email and by Electronic Filing on the Federal
eRulemaking Portal under FE Docket No. 12–32–LNG:
fergas@hq.doe.gov
http://www.regulations.gov

Ms. Larine A. Moore
Docket Room Manager
FE-34
U.S. Department of Energy
PO Box 44375
Washington, D.C. 20026-4375

Re: Application of Jordan Cove Energy Project, L.P. for Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, FE Docket No. 12-32-LNG

Dear Ms. Moore:

Please accept for filing the following protest of Citizens Against LNG Inc regarding the application of Jordan Cove for Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations. For the following reasons, we believe the Department of Energy should reject Jordan Cove's application because it would be detrimental to the public interest.

1. Jordan Cove's proposed export facility would hurt consumers in the United States by increasing the prices for domestic natural gas

It is not in dispute that Jordan Cove's proposed LNG export facility would increase the price for domestic natural gas in the United States. The only question is how much domestic natural gas prices in the United States would increase and how badly this would impact consumers. According to the latest assessment of the U.S. Department of Energy, allowing LNG export facilities, including Jordan Cove's proposed LNG export facility, would raise domestic natural gas prices substantially, by as much as 54% under certain scenarios:

> "Increased exports of natural gas lead to increased wellhead prices in all cases and scenarios. The basic pattern is evident in considering how prices would change under the Reference case (Figure 3):
>
> • The pattern of price increases reflects both the ultimate level of exports and the rate at which increased exports are phased in. In the low/slow scenario (which phases in 6 Bcf/d

of exports over six years), wellhead price impacts peak at about 14% ($0.70/Mcf) in 2022. However, the wellhead price differential falls below 10 percent by about 2026.

• In contrast, rapid increases in export levels lead to large initial price increases that would moderate somewhat in a few years. In the high/rapid scenario (which phases in 12 Bcf/d of exports over four years), wellhead prices are about 36 percent higher ($1.58/Mcf) in 2018 than in the no-additional-exports scenario. But the differential falls below 20 percent by about 2026. …..

• Slower increases in export levels lead to more gradual price increases but eventually produce higher average prices, especially during the decade between 2025 and 2035. The differential between wellhead prices in the high/slow scenario and the no-additional-exports scenario peaks in 2026 at about 28 percent ($1.53/Mcf), and prices remain higher than in the high/rapid scenario. ….

"In particular, with more pessimistic assumptions about the Nation's natural gas resource base (the Low Shale EUR case), wellhead prices in all export scenarios initially increase more in percentage terms over the baseline case (no additional exports) than occurs under Reference case conditions. For example, in the Low Shale EUR case the rapid introduction of 12 Bcf/d of exports results in a 54 percent ($3.23/Mcf) increase in the wellhead price in 2018; whereas under Reference case conditions with the same export scenario the price increases in 2018 by only 36 percent ($1.58/Mcf). But the percentage price increase falls in later years under the Low Shale EUR case, even below the price response under Reference case conditions. Under Low Shale EUR conditions, the addition of exports ultimately results in wellhead prices exceeding the $9 per Mcf threshold, with this occurring as early as 2018 in the high/rapid scenario."[1] (Emphasis added).

In a recent Congressional Report prepared by the staff of Representative Edward J. Markey, the Department of Energy's findings were summarized as follows:

"The United States faces a critical decision about whether to export natural gas following the rapid expansion of domestic production in recent years. The Department of Energy has already approved one export application and is currently considering eight others. If these applications are approved and the companies export at full capacity, the United States could soon be exporting more than 20 percent of current consumption. The Energy Information Administration has estimated that exporting even less natural gas than what is currently under consideration could raise domestic prices 24 to 54 percent, which would substantially increase energy bills for American consumers and could potentially have catastrophic impacts on U.S. manufacturing."[2]

[1] U.S. Department of Energy (January 2012) "Effect of Increased Natural Gas Exports on Domestic Energy Markets." http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/exhibits_11-128-LNG/15._EIA_Effects_of_increased_NG_exports_.pdf

[2] Representative Edward J. Markey (March 2012) "Drill Here, Sell There, Pay More: The Painful Price of Exporting Natural Gas." http://democrats.naturalresources.house.gov/sites/democrats.naturalresources.house.gov/files/2012-03-01__RPT_NGReport.pdf

Therefore, proposed LNG export facilities, including Jordan Cove's proposed facility which could 'substantially increase energy bills for American consumers and could potentially have catastrophic impacts on U.S. manufacturing' are simply not in the public interest.

2. Jordan Cove's proposed LNG export facility would likely cause a net loss in U.S. employment by causing job losses in manufacturing

Jordan Cove argues that its proposed LNG export facility would be in the public interest by creating jobs in Coos County. According to Jordan Cove's application:

> "The jobs impact of construction of the Jordan Cove Project will be consequential. On average, the Project will employ 1,768 workers a year, and it will create 1,530 indirect and 1,838 induced jobs a year. ….
>
> "The employment impacts of the Jordan Cove Project in the typical operating year will include 99 direct jobs at the Jordan Cove terminal and the PCGP pipeline, 51 indirect jobs paid by Jordan Cove (Sheriff's deputies, firefighters, tugboat crews and emergency planners), 404 other indirect jobs and 182 induced jobs for a total of 736 total jobs in Coos County."[3]

What Jordan Cove did not consider is how these possible jobs gained in Coos County would be more than offset by jobs lost in U.S. manufacturing generally. According to the Industrial Energy Consumers of America:

> "In regards to using natural gas for export as LNG, IECA supports free trade. At the same time, affordable, abundant natural gas is critical to U.S. manufacturing growth, which in turn is critical to the U.S. economy. The manufacturing sector uses one-third of all of the natural gas and one-third of all electricity (of which one-third is produced from natural gas) which fuels the employment of 12 million high-paid workers. As with any resource that is critical to America's economic growth, <u>any decision to approve the export of natural gas should include a rigorous analysis of the potential impact on the domestic economy and job creation, and place a high priority on the manufacturing sector</u>. ….
>
> "<u>Affordable and abundant natural gas is vital to the recent renaissance in the nation's manufacturing sector. This renaissance has already contributed to up to a half million new American jobs.</u> In fact, for every manufacturing job created, three to five additional jobs across the broader economy are also created. Natural gas is used as a fuel for the entire manufacturing sector, to make nitrogen fertilizer, and it is also used as a raw material for the production of chemicals that are converted into an immense array of products that are used every day. Manufacturing natural gas consumption creates far more jobs per unit of gas consumed than any other application. The chemical industry

[3] Application of Jordan Cove Energy Project, L.P. for Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, FE Docket No. 12-32-LNG, at pages 21-22.

alone has estimated that over $35 billion dollars of U.S. investments will be made by abundant, affordable supplies of natural gas."[4]

The Industrial Energy Consumers of America has concluded:

> "Jobs created by natural gas export facilities are small, relative to the opportunities to increase manufacturing jobs. Higher resulting natural gas prices will negatively impact U.S. manufacturing employment and ultimately additional jobs across the broader economy as well."[5]

Therefore, Jordan Cove's proposed LNG export facility, which could cause job losses in U.S. manufacturing that outweigh job gains locally, is not in the public interest.

3. Coos Bay would suffer the aftermath of unemployment that follows temporary employment in large-scale construction works

Unemployment impacts after the construction phase of the Jordan Cove / Pacific Connector project will not be in the public interest. The high unemployment in rural areas such as Coos Bay would be devastating to the local economy and clearly would not be in the public interest.

In 2003/2004 Coos County built a natural gas pipeline from Coos Bay to the Williams Northwest Grants Pass lateral pipeline that that runs along the I-5 hwy. The Coos County pipeline was a $51M gamble sold to the public with the promise of 2,900 jobs for the county. Despite all the promises made by industry speculators, those jobs never materialized and that pipeline currently is only operating at 5 to 7 percent of its capacity.

Jordan Cove estimates that 1,110 different jobs would need to be filled to build their project but the average job would only last 14 months. (FEIS 4.8-11)[6] After that there would be massive unemployment in the area and more people would be out of work than what we have now. The few jobs the facility would estimate to have as permanent jobs in no way justifies the public need for the facility. The Pacific Connector gas pipeline is estimated to end up with only 5 permanent employees after the construction phase of the pipeline is over. [7]

The Portland State University Population Research Center estimated that in July 2007, the population of Coos County was 63,050 people; which represented about a 4 percent increase since 2000. The two closest cities to the proposed Jordan Cove LNG terminal are North Bend, with a population estimated at 9,830 people, and Coos Bay, with a population of about 16,210 in

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[4] July 16, 2012 letter from the Industrial Energy Consumers of America to the Brookings Institute. Re: Hamilton Project: "A Strategy for U.S. Natural Gas Exports" by Michael Levi. http://www.ieca-us.com/wp-content/uploads/07.16.12_IECA-Response-to-Brookings.pdf

[5] Ibid.

[6] FERC Final Environmental Impact Statement (FEIS) for Jordan Cove LNG Import Facility; http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp Page 4.8-11

[7] FERC Jordan Cove Import Terminal Final EIS -http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp Page 4.8-22

July 2007 (Proehl 2008). (FEIS 4.8-11) The 56 to 99 jobs promised by Jordan Cove would not make a significant impact to what is truly needed in the area and when you count the jobs that will be lost due to the facilities impacts, the project most likely will end up being a job loser.

There is already high unemployment in the area which has been a continual example of plundering by industry speculators who come to town with big promises of jobs and prosperity and leave us with boondoggles and rotting infrastructure and eyesores. It has been so bad here that several books have been written about our area, the most recent being Wim de Vriend's book, "The Job Messiahs", which came out just this last December and is now in its second edition. Other books include, "Plundertown, USA: Coos Bay Enters the Global Economy" and David Cay Johnston's New York best selling book, "Free Lunch: How the Wealthiest Americans Enrich Themselves at Government Expense (and Stick You With the Bill)," where Johnston devoted two full chapters to Coos County.

4. Jordan Cove's economic analysis rests on the mistaken assumption that U.S. water supplies will be adequate to sustain increased production of natural gas by hydraulic fracturing

Jordan Cove argues that domestic natural gas prices in the United States would not increase that much because the burgeoning use of hydraulic fracturing will continue to create a vast oversupply of domestic natural gas. However, hydraulic fracturing consumes large quantities of water and the continued burgeoning use of hydraulic fracturing rests on assumptions that water supplies will, in the future, be adequate to sustain the continued increased use of this technology.

However, this assumption is likely to be wrong. According to the Pacific Institute:

> "There is some evidence that the water requirements for hydraulic fracturing are already creating conflicts with other uses and could constrain future natural gas production in some areas. For example, in Texas, a major drought in 2011 prompted water agencies in the region to impose mandatory reductions in water use. Water agencies, some of which sold water to natural gas companies, indicated they might have to reconsider these sales if the drought persisted. Natural gas companies also tried to purchase water from local farmers, offering $9,500 to nearly $17,000 per million gallons of water (Carroll 2011). Likewise, at an auction of unallocated water in Colorado during the spring 2012, natural gas companies successfully bid for water that had previously been largely claimed by farmers, raising concerns among some about the impacts on agriculture in the region and on ecosystems dependent on return flows (Finley 2012).
>
> "Concerns over water availability are not limited to drier climates. Pennsylvania is generally considered a relatively water-rich state. However, in August 2011, 13 previously approved water withdrawal permits in Pennsylvania's Susquehanna River Basin were temporarily suspended due to low stream levels; 11 of these permits were for natural gas projects (Susquehanna River Basin Commission 2011). While parts of the state were abnormally dry, the basin was not experiencing a drought at the time, suggesting that natural gas operations are already creating conflict with other uses under normal conditions. In many basins, the application of fracking is still in its infancy and

continued development could dramatically increase future water requirements and further intensify conflicts with other uses."[8]

The United States is experiencing one of the worst droughts in 60 years, and this is affecting energy production in the United States. According to a recent editorial in the New York Times:

> "We're now in the midst of the nation's most widespread drought in 60 years, stretching across 29 states and threatening farmers, their crops and livestock. But there is another risk as water becomes more scarce. Power plants may be forced to shut down, and oil and gas production may be threatened.
>
> "Our energy system depends on water. About half of the nation's water withdrawals every day are just for cooling power plants. In addition, the oil and gas industries use tens of millions of gallons a day, injecting water into aging oil fields to improve production, and to free natural gas in shale formations through hydraulic fracturing."[9]

If Jordan Cove's application is approved and an LNG export facility is built in Coos Bay, then this facility would be contractually bound to continue LNG exports to Asia regardless of whether future drought conditions would constrain the use of hydraulic fracturing to produce natural gas domestically. This would drive up U.S. natural gas prices and would hurt consumers and businesses in the United States by indirectly causing water shortages and exacerbating water scarcity. This would not be in the public interest.

5. If Jordan Cove is mistaken about Asian demand for imported LNG, then the proposed export facility would be mothballed, but after causing substantial impacts during its construction

Jordan Cove cites to Asian demand for imported LNG as the rationale for building its proposed export facility. In its application, Jordan Cove stated:

> "The Jordan Cove facility is the only LNG export terminal proposed for the U.S. West Coast. It is thus uniquely positioned among United States terminals, not only to source its natural gas from Canadian and U.S. Rockies supply basins and to serve Asian demand without the longer routes and Panama Canal transits necessary from the Gulf Coast, but also to provide specific advantages (in addition to the economic benefits already detailed) for gas markets in the United States, in the country's two non-contiguous states of Alaska and Hawaii and in Oregon along the route of the new PCGP pipeline.
>
> "Given North America's enormous shale gas resources and the Asian demand for its production, there is little doubt that Pacific Northwest LNG export facilities will be built."[10]

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[8] Pacific Institute (June 2012) "Hydraulic Fracturing and Water Resources: Separating the Frack from the Fiction." http://pacinst.org/reports/fracking/full_report.pdf

[9] Webber, E. (July 23rd, 2012) "Will Drought Cause the Next Blackout?" The New York Times.

[10] Application of Jordan Cove Energy Project, L.P. for Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, FE Docket No. 12-32-LNG, at page 27.

Jordan Cove has already demonstrated its inability to predict demand for natural gas imports and exports. Jordan Cove based the proposed Jordan Cove LNG import terminal in Coos Bay on predictions that an import facility would be needed to meet growing U.S. demand for natural gas imports from overseas. These predictions turned out to be wrong.

Jordan Cove's assumption about sustained Asian demand for LNG imports is likely to be wrong as well; the same factors that created an oversupply of domestic natural gas would likely also create an oversupply of natural gas in Asia, curtailing demand for LNG imports from the U.S. and rendering a West Coast-based LNG export facility economically unviable. According to a recent report of the International Energy Agency:

> "The size of unconventional gas resources in China is at an early stage of assessment, but it is undoubtedly large. At end-2011, China's remaining recoverable resources of unconventional gas totalled almost 50 tcm, comprised of 36 tcm of shale gas, 9 tcm of coalbed methane and 3 tcm of tight gas.5 This is around thirteen times China's remaining recoverable conventional gas resources. China's shale gas resources lie in several large basins spread across the country, with plays in the Sichuan and Tarim Basins believed to have the greatest potential.
>
> "The Chinese government has outlined ambitious plans for boosting unconventional gas exploration and production. These call for coalbed methane production of more than 30 bcm and for shale gas production of 6.5 bcm in 2015; the targets for shale gas output in 2020 are between 60 and 100 bcm. They are accompanied by the goal to add 1 tcm of coalbed methane and 600 bcm of shale gas to proven reserves of unconventional gas by 2015. In support of this effort, China plans to complete a nationwide assessment of shale gas resources and build nineteen exploration and development bases in the Sichuan Basin in the next four years. Efforts are also supported by the international partnerships that Chinese companies have formed in North America to develop shale gas acreage, which will provide valuable development experience. ….
>
> "China's huge unconventional gas potential and strong policy commitment suggest that these resources will provide an increasingly important share of gas in the longer term, though the pace of development through to 2020 – the key period of learning – remains uncertain. Because of China's highly centralised regulatory and policy-making framework and the high priority placed on industrial and economic development, unconventional gas projects may face fewer hurdles stemming from environmental concerns than those in Europe or the United States."[11]

Eastern Europe and Eurasia are also poised to vastly increase production of natural gas from unconventional gas resources. Unlike Jordan Cove, production of natural gas from these locations can supply Asia with natural gas by pipeline.[12]

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[11] International Energy Agency (2012) "Golden Rules for a Golden Age of Gas: World Energy Outlook Special Report on Unconventional Gas," at pages 115-120. .http://www.worldenergyoutlook.org/media/weowebsite/2012/goldenrules/WEO2012_GoldenRulesReport.pdf

[12] Ibid., at page 87.

The State of Oregon has found that Jordan Cove's proposed LNG import facility would have had adverse impacts on private landowners and the environment because of this facility's construction.[13] If Jordan Cove is mistaken (again) about future demand for LNG exports and imports, then the proposed facility would cause adverse impacts on private landowners and the environment by building a facility that would not be economically viable to operate. This would not be in the public interest. (See Exhibits A-G)

6. Liquefaction of natural gas for export/import is energy intensive and greatly diminishes the benefits of using natural gas

The liquefaction of natural gas requires a great amount of energy to compress methane into a liquid. This inherently wastes a substantial portion of the natural gas, which is burned in order to provide power to run compressors at liquefaction facilities. According to Jordan Cove's own study:

> "Approximately 6.2 percent of the gas delivered to the JCEP terminal would be either consumed as fuel to operate the liquefaction process or be removed from the feed gas stream (trace sulfur compounds, carbon dioxide, nitrogen and water) prior to or during the liquefaction step. Any hydrocarbons recovered that have a higher molecular weight than methane will fuel the power plant."[14] (Emphasis added).

Transoceanic transport and regasification of LNG are also energy intensive processes. According to a life-cycle assessment prepared by researchers with the Tepper School of Business, and Department of Engineering and Public Policy Carnegie Mellon University comparing coal and LNG:

> "The rated power of the LNG tankers ranges between 20 and 30 MW, and they operate under this capacity around 75% of the time during a trip (24, 25). The energy required to power this engine is 11.6MMBtu/MWh(26). As previously mentioned, some of this energy is provided by BOG and the rest is provided by fuel oil. A loaded tanker with a rated power of 20MW, and 0.12% daily boil-off rate would consume 3.88 million cubic feet of gas per day and 4.4 tons of fuel oil per day. The same tanker would consume 115 tons of fuel oil per day on they way back to the exporting country operating under ballast conditions. A loaded tanker with a rated power of 30 MW, and a 0.25% daily boil-off rate would get all its energy from the BOG, with some excess gas being combusted to reduce risks of explosion (22). Under ballast conditions, the same tanker would consume 172 tons of fuel oil per day.
>
> "For LNG imported in 2003 the average travel distance to the Everett, MA LNG terminal was 2700 nautical miles (13, 27). In the future LNG could travel as far as far as 11,700 nautical miles (the distance between Australia and the Lake Charles, LA LNG terminal (27)). This range of distances is representative of distances from LNG countries to U.S.

[13] State of Oregon's Motion to Reopen the Record and Request to Set Aside Order. December 2, 2011.
[14] ECONorthwest Construction Impact Study, at page 4.

terminals that could be located on either the East or West coasts. To estimate the number of days LNG would travel (at a tanker speed of 20 knots (22)), these distances were used. This trip length can then be multiplied by the fuel consumption of the tanker to estimate total trip fuel consumption and emissions, and these can then be divided by the average tanker capacity to obtain a range of emission factors for LNG tanker transport between 2 and 17 lb CO2 equiv/MMBtu.

"Regasification emissions were reported by Tamura et al. to be 0.85 lb CO2 equiv/MMBtu (21). Ruether et al. report an emission factor of 3.75 lb of CO2 equiv/MMBtu for this stage of the LNG life-cycle by assuming that 3% of the gas is used to run the regasification equipment (28). The emission reported by Tamura et al. differs because they assumed only 0.15% of the gas is used to run the regasification terminal, while electricity, which maybe generated with cleaner energy sources, provides the additional energy requirements. These values were used as lower and upper bounds of the range of emissions from regasification of LNG."[15]

These researchers with Carnegie Mellon University concluded.

"In addition to LNG, SNG has been proposed as an alternative source to add to the natural gas mix. The decision to follow the path of increased LNG imports or SNG production should be examined in light of more than just economic considerations. In this paper, we analyzed the effects of the additional air emissions from the LNG/SNG life-cycle on the overall emissions from electricity generation in the United States. We found that with current electricity generation technologies, natural gas life-cycle GHG emissions are generally lower than coal life-cycle emissions, even when increased LNG imports are included. However LNG imports decrease the difference between GHG emissions from coal and natural gas."[16]

The magnitude of the environmental benefits of natural gas fade away when natural gas is liquefied for export and importation. In general, natural gas supplies should be consumed on the continent they are produced, without liquefaction. For this additional reason, the proposed Jordan Cove export facility is contrary to the public interest.

7. Because Jordan Cove is owned and controlled by foreign investors, any profits from the project would only benefit non-U.S. investors.

The N-FTA Federal Register notice for Jordan Cove states the following:

"…Both Jordan Cove and its general partner are owned by the two limited partners in Jordan Cove. The first, Fort Chicago LNG II U.S.L.P., a Delaware limited partnership owns seventy-five percent. It is wholly owned and controlled, through a number of

[15] Jaramillo, P., et al (Sep 2007) "Comparative Life-Cycle Air Emissions of Coal, Domestic Natural Gas, LNG, and SNG for Electricity Generation Environ Sci Technol. 41(17):6290-6. http://www.fossil.energy.gov/programs/gasregulation/authorizations/2011_applications/exhibits_11-128-LNG/32._Jaramillo_ComparativeLCACoalNG.pdf

[16] Ibid., at page 6294.

> intermediate wholly owned and controlled companies, by Veresen, Inc., a Canadian corporation based in Calgary, Alberta, which, prior to its organization as a corporation, was Fort Chicago Energy Partners L.P., a Canadian limited partnership (**although the name of the parent changed, the name of the subsidiary owning Jordan Cove did not**)…'" (Emphasis added)

Fort Chicago Energy Partners L.P. is a Canadian limited partnership in which "only Canadians" are allowed to invest.

> "Fort Chicago is organized in accordance with the terms and conditions of a limited partnership agreement which provides that no Class A Units may be held by or transferred to, among other things, a person who is a "non- resident" of Canada, a person in which an interest would be a "tax shelter investment" or a partnership which is not a "Canadian partnership" for purposes of the Income Tax Act (Canada)."[17]

Profits projected to be made by Jordan Cove would then be funneled out of the country to only foreign investors. This would not be in the public interest. [18]

8. Obtaining natural gas from Hydro-Fracking techniques is not in the public interest

Jordan Cove Energy Project is currently proposing to export hydro-fracked gas from shale beds in Canada or the United States in the form of Liquefied Natural Gas (LNG). The LNG would be exported from their proposed LNG terminal to be located on the North Spit of Coos Bay in Coos County. Just because the industry has learned how to extract fossil fuel natural gas from shale bed formations does not mean this is a reliable, sustainable or environmentally friendly process. There are loads of factors that affect how much natural gas will actually be produced, and for how long.

The wave of fracking that is currently gong on across the country may soon find limitations due to the detrimental impacts of the fracking process itself. New research was recently published in the Proceedings of the National Academy of Sciences that concluded fluids from the Marcellus Shale are likely seeping into Pennsylvania's drinking water.[19] This means hydro-fracking contaminants will find their way into Pennsylvania's water supply also. This issue has create a storm of controversy and after months of research and discussion, Nationwide Insurance issued a memo stating they had determined that the exposures presented by hydraulic fracturing were too great to ignore and they would not be covering fracking damage.[20] Issues such as these

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[17] CNW Group, "*Canadian Newswire Fort Chicago announces monthly cash distribution for September 2009"* September 21, 2009 http://www.newswire.ca/en/releases/archive/September2009/21/c7157.html

[18] Bloomberg - "*Exports of LNG May Raise U.S. Prices as Much as 54%, Agency Says*" - By Katarzyna Klimasinska – Jan 19, 2012 http://www.bloomberg.com/news/2012-01-19/lng-exports-may-spur-higher-u-s-natural-gas-prices-report-says.html

[19] ProPublica – "*New Study: Fluids From Marcellus Shale Likely Seeping Into PA Drinking Water"* by Abrahm Lustgarten; July 9, 2012; http://www.propublica.org/article/new-study-fluids-from-marcellus-shale-likely-seeping-into-pa-drinking-water

[20] The Huffington Post – "*Nationwide Insurance: Fracking Damage Won't Be Covered*" AP | By MARY ESCH; 07/12/2012; http://www.huffingtonpost.com/2012/07/13/nationwide-insurance-fracking_n_1669775.html?utm_hp_ref=green

could spell a reduction or even a halting of fracking in some areas and as quickly as the shale bed fracking natural gas market has emerged; it could be gone, leaving fast amounts of land taken by the gas industry, possibly by eminent domain, and fossil fuel infrastructure to lay fallow.

9. Jordan Cove's proposed LNG export facility will negatively impact existing local and sustainable jobs and industries in the Coos Bay area

9.1 Tourism and Recreation

According to a 2011 study by Dean Runyan Associates for the Oregon Tourism Commission, during the period of 2007 to 2011, direct spending from tourism travel brought in more than a billion dollars into Coos County, Oregon alone.[21] Tourism travel dollars spent in the area have steadily increased every year going from 94.5 million in 1991 to 220.1 million in 2011. There are 3,090 employment jobs in Coos County related to this industry, a direct result of not developing our beaches, dunes and coastline.

Adjacent to the proposed Jordan Cove LNG export facility is a designated Dunes National Recreation Area that is used year round. In addition to this there is the Sunset Bay State Park and Campground which is also used year round along with multiple trails and beach areas in the area, some directly adjacent to the proposed Jordan Cove project. Other examples in the area include the Shore Acres State Park which has a Christmas light show every year that goes from Thanksgiving until New Years. The Park had an estimated 57,768 visitors for the 2011 light show. People came from 25 countries (other than the U.S.) and 42 states.[22] Winter months can see just as many recreational and tourist activates as summer months in our Coos Bay area.

The Final Environmental Impact Statement (FEIS) for Jordan Cove's Import Facility stated the following with regard to this issue: (Emphasis and photos are added)

FEIS Page 4.7-5: "*...The top five recreational activities along southern Oregon beaches include* ***walking (43 percent), relaxing in a stationary location (24 percent), walking dogs (10 percent), driving OHVs (8 percent), and beachcombing (3 percent)*** *(OPRD 2002).*"

FEIS Page 4.7-6: "*…Sunset Bay State Park includes a beach, picnic tables, hiking trails, 27 full recreational vehicle (RV) hookups, 66 tent spaces, and eight yurts. A public golf course is next to the park.* ***An OPRD study indicated that Sunset Bay State Park receives 800,000 visitors a year*** *(Hillmann 2006)*"

FEIS Page 4.7-6: "*...The Oregon Islands National Wildlife Refuge is administered by the FWS, and covers 1,850 rocks, reefs, islands, and two headlands, spanning a total of 320 miles along the Oregon coast. The* ***Oregon Islands National Wildlife Refuge provides sanctuary for seabirds and marine mammals****.*..."

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[21] Oregon Travel Impacts *1991-2011p* –May 2011; Dean Runyan Associates; *Prepared for the* Oregon Tourism Commission, Salem, Oregon; Page 83 - http://www.deanrunyan.com/impactsOR.html

[22] Shore Acres State Park Holliday Light Show Stats: http://www.shoreacres.net/images/pdf/stats-hol-lts-2011-wp.pdf

Birds swim just off of tidal sand areas at low tide and several species leave footprints in the wet tidal sands where the LNG slip dock is proposed to be built.

According to the World Newspaper; Monday, November 02, 2009:

> "Coos Bay got a bit of a tourism boost over the last several days, as 200 or so birders came to the bay to see a rare brown booby that is hanging out near Charleston. People came to scope out the tropical bird from places including Eugene, Portland, Bend, McMinnville, Coos Bay and Washington. The rare tropical bird showed up last week and

is the fourth verified sighting of this species of bird in Oregon. The last local sighting was in October 2008, when a dead female washed ashore at Lighthouse Beach."[23]

The Weyerhaeuser site where the Jordan Cove LNG Export facility is proposing to build is arguably one of the best birding destinations in Coos County and attracts a multitude of breeding, migrant and vagrant species year-round.[24] There are species like Wilsons Phalarope and Ring necked Duck. This is a crucial stop-over location for shorebirds during migration where they can rest and refuel, building fat reserves to last them on the next leg of their migration flight.

Oregon has lost much of its shorebird habitat through urban development and filling in wetlands and this site is one of the last significant "refueling stations" left on the Oregon Coast. Shorebirds by the thousands feed in late summer and fall here…

FEIS Page 4.7-7: *Figure 4.7-2 list* ***34 Recreational Areas that are within*** *the* ***LNG Zones of Concern*** *along the waterway for the proposed LNG Marine Traffic.*

FEIS Page 4.7-16: "…*The Siuslaw National Forest administers the* ***Oregon Dunes National Recreation Area (NRA)****. It extends 40 miles along the Oregon Coast between Florence and Coos Bay. The Oregon Dunes NRA contains the largest expanse of coastal sand dunes in North America, as well as a coastal forest and over 30 lakes and ponds.* ***Recreational opportunities at the NRA include OHV use, hiking, camping, horseback riding, angling, canoeing, sailing, water-skiing, and swimming.*** *Thousands of OHV owners take advantage of the three main off-highway riding areas within the Oregon Dunes NRA.* ***The day use and overnight camping facilities are used by over 400,000 visitors a year****…*"

For an Oregon Department of Fish and Wildlife listing of county expenditure estimates for Fishing, Hunting, Wildlife Viewing, and Shellfishing in Coos County and Oregon, see footnote below[25]

Coos County Local Recreation Expenditures, 2008

Category	Value	% of State Total*	% of All Travel**
Hunting	$904,977	2.90%	N/A
Fishing	$2,551,433	3.30%	N/A
Wildlife Viewing	$1,637,158	4.90%	N/A
Shellfishing	$1,080,963	20.60%	N/A
Total	$6,174,531	4.20%	N/A

[23] "*Flocking to see a rare bird*"; The World Newspaper; Monday, November 02, 2009 http://theworldlink.com/news/local/flocking-to-see-a-rare-bird/article_4c58af85-d571-52c5-b820-3301baf6f9d3.html

[24] "*Site Guide: Weyerhaeuser Settling Pond Site on the North Spit of Coos Bay",* Tim Rodenkirk: Oregon Birds 32(2): Pg 68 - 72, Summer 2006

[25] "*Fishing, Hunting, Wildlife Viewing, and Shellfishing in Oregon - 2008 State and County Expenditure Estimates*"; Prepared for the Oregon Department of Fish and Wildlife - Travel Oregon; DeanRunyan Associates; May 2009 http://www.dfw.state.or.us/agency/docs/Report_5_6_09--Final%20%282%29.pdf

Coos County Travel-Generated Expenditures, 2008

Category	Value	% of State Total*	% of All Travel**
Hunting	$2,534,940	2.40%	1.40%
Fishing	$12,253,254	4.60%	6.70%
Wildlife Viewing	$14,110,950	3.10%	7.70%
Shellfishing	$4,552,379	14.70%	2.50%
Total	$33,451,523	3.90%	18.30%

The Jordan Cove Project will clearly negatively impact this industry and all the permanent and sustainable jobs it supports as well as many others. Incredulously, the ECONorthwest study did not take into account the economic impacts of Jordan Cove's proposed LNG export facility on local tourism and recreation.

9.2 Commercial and Recreational Fishing

The ECONorthwest study did not include negative impacts to our commercial and recreational fishing fleet. This could include negative impacts from transiting LNG tankers, the negative impacts from additional Bay dredging, or negative impacts to salmon bearing streams crossed by the pipeline. **This is despite the fact Coos Bay is the third most important harbor in the state of Oregon in terms of total personal income generated from commercial fishing** (exceeded only by Astoria and Newport). Commercial landing data compiled by ODFW indicate that a total of $20.1 million worth of fish and shellfish were landed at Charleston in 2006.[26]

Landowners and non-profit groups who have done restoration projects to help restore fish runs in Southern Oregon will have their projects and efforts destroyed by the pipeline construction. This would not be in the public interest. (See Exhibits A, B)

FEIS Page 4.7-4: "*…According to a 2005 study by the Oregon State Marine Board (OSMB)* ***recreational boaters in Coos Bay took a total of 30,996 boat trips the previous year. Nearly 90 percent of the boat usedays involved fishing*** *(including angling, crabbing, and clamming), 9 percent was for pleasure cruising, and the remainder was for sailing and water skiing. Forty percent of the boating activities in Coos Bay originated from the Charleston Marina, and 20 percent at the Empire ramp…*"

FEIS Page 4.7-4: "*...****Recreational clamming and crabbing occurs year-round and brings tourism based revenue to the region. Crabbing occurs in the main channel areas from the Southern Oregon Regional Airport to the mouth of the bay around slack tides. Clamming occurs year-round in the mud flats of Coos Bay,*** *but is subject to closure as necessary by the ODA Food Safety Division for reasons of public health (Oregon Department of Agriculture Food Safety Division 2008)….*"

[26] FERC Final EIS for Jordan Cove LNG Import Facility; http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp - Page 4.8-8

Photo to Left:
People clamming at low tide in the Lower Coos Bay along Cape Arago Hwy.

Photo to Right:
Evidence of Clams in the tidal areas where the LNG slip dock is proposed to be built.

The ECONorthwest study did not account for the total time it would take homeland security to clear the bay before an LNG tanker would transit through the bay, nor did the study account for an accurate number of potential ship transits through the bay. When Freeport LNG import terminal began operating in April of 2008, Petty Officer Second Class Richard Ahlers said it would probably take up to three hours for the boat and its security perimeter to pass through in the first arrivals. Each time a LNG ship crawls into the harbor there, water-borne authorities like the Coast Guard plan on shutting down all boat traffic in a 1,000-meter radius of the transiting LNG vessel. Surfside Beach Mayor Jim Bedward said the village boat ramp, once it opened, would be closed as the ships pass. The City Hall in Freeport would get a 92-hour warning of the oncoming ships but would keep knowledge of the high-security vessels' arrival to themselves — for obvious reasons. [27]/[28]

Likewise the Jordan Cove LNG facility consultants have shown that ship transits would have security zones that are very similar to Freeport except that in some cases security zones for Jordan Cove would encompass the entire width of the Coos Bay and would take from 90 minutes to two hours. This would be an extreme hardship on the Commercial fishing fleet that also need high slack tides in order to transit the Coos Bay.

In Coos County the Pacific Connector is slated to directly negatively impact native Olympia oysters in Haynes Inlet and also Clausen Oyster Company's highly productive silver point Pacific oyster beds. Coos Bay is the largest commercial producer of shellfish in the state of Oregon. Pacific oysters are commercially raised in the mudflats of South Slough and Haynes Inlet and the upper bay east of McCullough Bridge. Clamming also occurs at Haynes Inlet. (FEIS page 4.7-17) In recent testimony provided by the Clausen Oyster Company, Lilli Clausen stated the following:

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[27] "*Coast Guard preparing for port shutdowns*", The Facts, by Hunter Sauls, April 14, 2008 http://thefacts.com/story.lasso?ewcd=f482d0ca682cb716

[28] Platts LNG Daily April 11, 2008 [subscription required] reports that the Sabine Pass LNG terminal expects to receive its commissioning cargo aboard the LNG carrier Celestine River today. In preparation for the arrival of the ship, the U.S. Coast Guard will impose a security zone at the Sabine Pass in Louisiana for approximately three hours between noon and 7 p.m…

"When the engineer and some other people representing LNG were in our office a few weeks ago my husband, Max, and I tried to explain that the proposed line was too destructive to our oyster business…" (See Exhibit E)

9.3 Timber Production

The Jordan Cove proposal will force a significant change and a significant cost increase in accepted tree farm and forest practices on agricultural and forest lands. Including but not limited to:

- Permanent loss of timber in pipeline right of way.
- Increased loss in timber production due to increased wind in the pipeline right of way. Coos County Commissioner, Fred Messerle, who is also a local private timber operator stated recently in public testimony,

> "Cutting and maintaining an extended "hard edge" in an existing and/or new stand of timber will dramatically increase the wind loss over the 40 year rotation and thus increase cost and decrease yield."

- Increase risk of foot traffic and spread of disease and root rot. Pacific Connector's plan will significantly change the accepted practices involved in raising a 40-year crop and/or in a worst case, eliminates the value of the land all together for timber production.
- Increased risk of noxious weed growth which negatively impacts timber production.
- An open vector (right of way) with dry grass and brush creates a path for fire to "run on." This means an increase in fire hazard exposure and risk in currently high timber production areas.
- Project significantly changes and or increases the costs of accepted practices overall. According to Commissioner Messerle,

> "Timber harvesting (logging) has always had a very "thin margin" of profit. Logging is not a "get rich quick" proposition. Any change to accepted logging practices will increase costs, decrease margins and significantly change the cost of accepted forest practices." (See Exhibit F)

Yankee Creek Forestry also issued similar statements with regard to the negative impacts this proposed LNG project and pipeline will have on timber production. (See Exhibit G)

Construction of the Pacific Connector pipeline would affect about 3,035 acres of forest and woodland, 623 acres of agricultural lands, 488 acres of grasslands-shrubland, and 131 acres of non- riparian vegetation. (FEIS page 5-9). Approximately 151 miles, or 66 percent, of the proposed pipeline route would cross private property, which could be taken by eminent domain. The remaining 79 miles (34 percent) of pipeline route would cross public lands administered by the BLM (18 percent), USFS (12 percent), BOR (0.14 percent), (FEIS page 4.8-25)

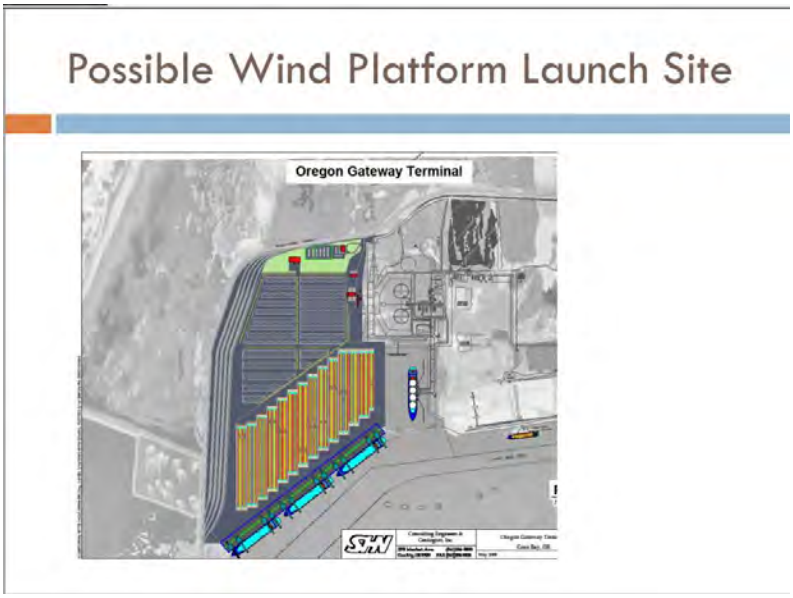
It is difficult enough for a small family owned operation to monitor and oversee its base operation. The Jordan Cove / Pacific Connector project will change family owned and operated practices and increase costs to timber production. Some businesses are likely to go out of business due to this increased cost.

In addition, Jordan Cove did not analyze timber jobs that will be impacted and lost from the flooding of the market with 144 miles of forestlands that will be clear-cut for pipeline construction. This will force timber prices to an all time low which will negatively impact the industry even more than it already has been. It could take years to recover.

9.4 Loss of other Proposed Port Developments

The negative impacts of the Jordan Cove Energy / Pacific Connector pipeline project to bay area businesses, including future potential businesses, industries and land owners was not considered in Jordan Cove's economic reports.

For example, on January 20, 2011 the Oregon International Port of Coos Bay presented the following diagram at their Port Commission meeting concerning a proposed Wind Project the Port is currently working on potentially developing.[29]



Unfortunately the proposed Jordan Cove Energy LNG Project Thermal Radiation Zones and Vapor Dispersion Zones would negatively impact the above proposed development as shown in the following diagrams below taken from the Final EIS of the Jordan Cove Import facility.[30]

[29] January 20, 2011, Oregon International Port of Coos Bay Wind Development presentation: http://www.portofcoosbay.com/minutes/wind.pdf

[30] FERC Final EIS for Jordan Cove / Pacific Connector - Diagrams of Jordan Cove's Thermal Radiation Zones and Vapor Dispersion Zones - Pages 4.12-19 and 4.12-21 : http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp

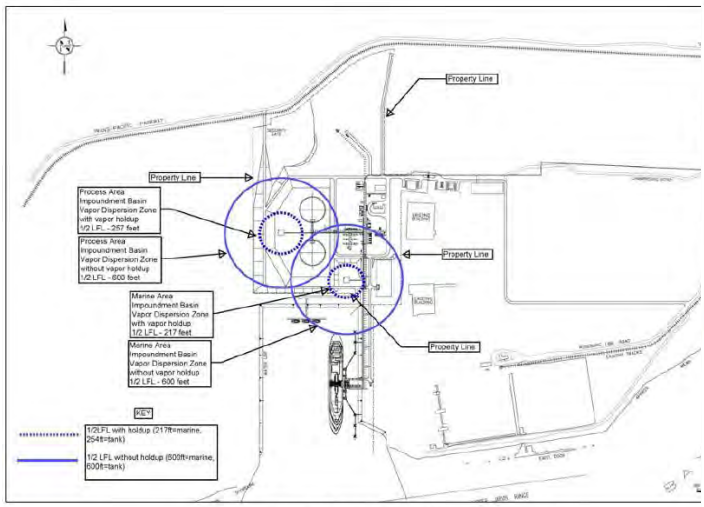


Figure 4.12-2. Vapor Dispersion Zones

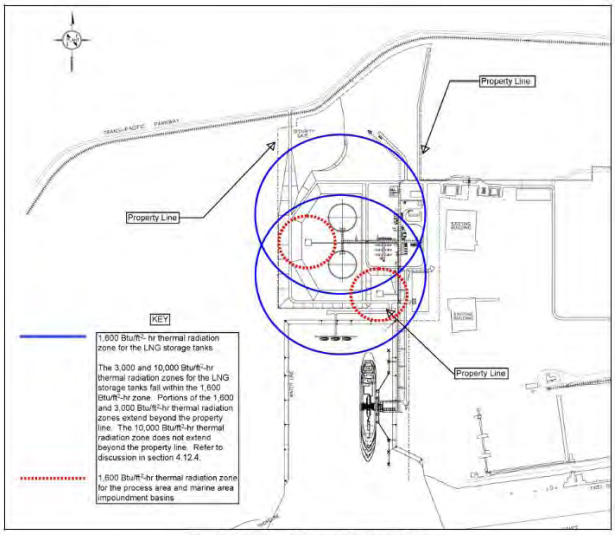


Figure 4.12-1. Thermal Radiation Zones

On October 8, 2010, FERC sent a letter to Jordan Cove requesting that Jordan Cove revise their Flammable Vapor-Gas Exclusion Zone requirements and modeling to be in compliance with PHMSA Recent Guidance contained in Title 49 CFR Part 193.2059.[31] It is highly likely that the Jordan Cove facility's hazard exclusion zones will end up being much larger than they currently are when they are calculated properly to be in compliance with PHMSA**.** This could have devastating impacts to other users of the harbor, adjacent landowners and industrial development including the Port's proposed Oregon Gateway cargo terminal, which would not be allowed to operate in these hazard zones. Jordan Cove has not to date filed with FERC their revised Flammable Vapor Gas Exclusion Zone requirements and modeling. Clearly Jordan Cove is aware of this problem and by now the Port should be.

In December 2011, a revised Land Option Agreement with the Jordan Cove Energy Project took back a large portion of Henderson Marsh to the west of the Jordan Cove facility to satisfy these thermal radiation and flammable vapor gas exclusion zone requirements. These thermal radiation and flammable vapor gas exclusion zones must be controlled by the Jordan Cove Energy Project at all times and must remain within the property boundaries of the facility. This will put any planned development to the west of the proposed Jordan Cove facility, including the above proposed wind turbine development, at risk.

The Oregon International Port of Coos Bay says its proposed Marine Terminal Slip is being designed for the Jordan Cove LNG docking facility and other potential marine uses on the west side berth. But the Marine Slip will not likely be usable for purposes other than those associated with and/or controlled by the Jordan Cove Energy Project. At a recent site tour held on March 27, 2012, that was sponsored by the Jordan Cove Energy Project, Bob Braddock from Jordan Cove stated that the current proposed Marine Terminal Slip was only designed to handle one vessel. Presumably this is due to Jordan Cove's thermal radiation and vapor dispersion exclusion

[31] October 8, 2010 letter requesting Jordan Cove Energy Project, L.P. provide the informing described in Enclosure 3 to assist the FERC in their review re the PHMSA Interpretations on the Part 193 Exclusion Zone Regulations under CP07-444. http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20101008-3036

zones referenced above and also the Coast Guard safety and security hazard zones proposed for the LNG facility and berth that will preclude the use of the berth for other purposes.

The safety and security hazard zones the Coast Guard has proposed to impose will encompass the LNG vessel both while the vessel is moored and even when the LNG vessel is not moored. When the LNG vessel is at the docking facility there will be a 150 yard security zone around the vessel to include the entire terminal slip and when there is no LNG vessel moored, the security zone shall cover the entire terminal slip and extend 25-yards in the waterway. (CG-WSA page 2)[32] In addition, the Coast Guard has also set a moving safety/security zone for the LNG tanker ship that extends 500-yards around the vessel but ends at the shoreline. No vessel may enter the safety /security zone without first obtaining permission from the Coast Guard Captain of the Port who resides in the Portland, OR office.[32]

As a result of the above safety zones, the Port's proposed Marine slip can realistically serve only LNG terminal purposes.

In addition, the ECONorthwest study assumes there will be only 80 - 90 shipments per year and not the more realistic number of between 186 - 232 LNG vessel harbor disruptions that would include LNG vessels both coming and leaving the lower Coos Bay during high slack tides. (See Exhibit J)

Detailed issues concerning Pollution, Noise, Visual Impacts, Security, LNG Hazards, Natural Hazards and Emergency Response were filed with the Federal Energy Regulatory Commission for the Jordan Cove LNG Import / Pacific Connector Docket numbers CP07-444-000 and CP07-441-000. Most of these issues were never fully addressed and would apply whether you were importing or exporting LNG.[33]

FERC's Order[34] that was recently pulled had 128 Conditions of Approval, many highly unlikely that Jordan Cove would ever be able to meet. The impacts of these issues and the true negative effects of the Jordan Cove LNG proposal on jobs in tourism, recreation, real estate, fishing, clamming, crabbing, oyster harvesting, timber, etc, were not addressed or considered fully in any economic study.

10. The proposed project will not provide tax revenue to local government

The Jordan Cove LNG facility will not increase the tax base of Coos County. The facility will sit in an Enterprise Zone and will be exempt from paying taxes for 3 or more years. The facility

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[32] Coast Guard - LOR / WSR / WSA for Port of Coos Bay / Jordan Cove Energy Project: http://homeport.uscg.mil/mycg/portal/ep/contentView.do?contentTypeId=2&contentId=63626&programId=12590&pageTypeId=16440&BV

[33] January 15, 2010, letter to FERC with detailed information on LNG Hazard information and studies; http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20100115-5057

[34] December 17, 2009, FERC Order on the Jordan Cove / Pacific Connector LNG Import Project - Dockets CP07-441-000; CP07-444-000 et al: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20091217-3076

also will sit in an Urban Renewal District for the North Spit, which is administered by the Oregon International Port of Coos Bay. Money received is to go to Urban Renewal for the North Spit. The Oregon International Port of Coos Bay has already announced at Port meetings how they plan on spending this money. It will not go into the County general fund for roads, schools, sheriffs, and other necessary county expenditures.

11. Jordan Cove proposed LNG export facility would create substantial risks to public safety

Building an LNG import-export terminal on dredging spoils located on a sand spit (an unstable sand dune area) directly across the bay from an airport runway, in the flight path of the runway, in an extreme tsunami inundation zone, in an earthquake subduction zone, in an area known for high winds and ship disasters, less than a mile from a highly populated city not only violates multiple safety codes and regulations but is not in the public interest.

The Jordan Cove LNG facility is not following gas industry recommended guidelines for the safe siting of LNG Ports and jetties, putting thousands of people in the Coos Bay area at risk.

11.1 Tsunami and Earthquake Hazards

The Jordan Cove Energy Project has never complied with FERC's request to show that that their facility which will be located on dredging spoils on a sand spit in a natural hazard zone has met engineering designs in order to withstand a Cascadia subduction 9.0 earthquake event and/or a tsunami.[35] Since it is not a matter of "if" but a matter of "when" a Cascadia subduction event will occur off of our Pacific West Coast, placing a hazardous LNG facility in these natural hazard zones would not be in the public interest.[36] (See Exhibit H)

It is estimated to take 90 minutes to 2 hours for an LNG tanker to transit from K Buoy to the marine slip dock. It is also estimated that it will take around 15-20 minutes from the time of a Cascadia subduction earthquake event until a tsunami would come ashore in the Coos Bay. A new study from Oregon State University says that the South Coast has a 40 percent chance of experiencing a major earthquake and resulting tsunami sometime in the next 50 years. The study further suggests that that tsunami could have a greater impact on the South Coast — around Coos

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[35] December 17, 2009, FERC Order - pages 79-84, Conditions 52-65,70,74: http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20091217-3076

[36] The World, Coos Bay – **"***Not a matter of 'if' It's a matter of when. What will the South Coast look like after a major disaster?*" Stories by Jessica Musicar, Nia Towne, Andy Rossback and Nate Traylor. Illustrations by Jeff Trionfante, Benjamin Brayfield and Andy Rossback The World | Posted: Saturday, August 7, 2010 http://theworldlink.com/news/local/not-a-matter-of-if/article_d4b8e520-a1f3-11df-89f5-001cc4c03286.html

● *"Oregon geology: 'The next 'Big One' is imminent'":* Story Published: Oct 16, 2009; *Courtesy OSU News & Communications*; http://www.kval.com/news/tech/64534977.html: *"...The release of pressure between two overlapping tectonic plates along the subduction zone regularly generates massive 9.0 magnitude earthquakes – including five over the last 1,400 years," Corcoran said. "The last 'Big One' was 309 years ago. We are in a geologic time when we can expect another 'Big One,'... ... "Prudence dictates that we overcome our human tendencies to ignore this inevitability," he added…".*

● Visit www.oregontsunami.org for more information on current tsunami maps and hazards in the vicinity of the Jordan Cove Energy LNG project.

Bay — than other areas of the west coast.[37] According to the study's authors, the clock is ticking fast. There is no consideration for this LNG ship transit hazard in the FERC FEIS or the Coast Guard Letter of Recommendation (LOR) or Water Suitability Assessment (WSA) or Jordan Cove's 3/31/09 Emergency Response Memorandum of Understanding (MOU). There is no Emergency Response plan that encompasses this and/or other safety issues in regard to transiting LNG tanker ships, floating objects, adrift vessels, barges, etc. Effects of tectonic subsidence (prolonged changes in tidal elevation inherent in the earthquake source scenarios used for tsunami generation) were also not considered in the FERC FEIS.

11.2 LNG Safety and Security Hazard Guidelines and Impacts

Industry SIGTTO Guidelines,[38] Sandia National Laboratory Guidelines,[39] GAO Report Guidelines[40] and the most recent U.S. Department of Energy report to Congress, "Liquefied Natural Gas Safety Research"[41] are not being considered or followed. The FERC Final EIS did not address the project's notable departures from **industry standards or comments to them on those departures.**[38] It is not in the public interest to proceed with this proposed project until these issues are fully addressed.

If the Jordan Cove LNG project should proceed, LNG tanker ships will be transiting our Coos Bay harbor carrying around 39 million gallons of LNG. If only about 3 million gallons of LNG was to spill onto the water from an LNG tanker ship, flammable vapors from the spill could travel up to three miles[42]. If a pool fire was to develop, people up to a mile away would be at risk of 2nd degree burns in 30 seconds.[39/40/41]

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[37] *Study: Coos Bay region in danger of megaquake*" By KATU.com Staff, Published: Aug 1, 2012 http://www.kpic.com/news/local/Study-Coos-Bay-region-in-danger-of-megaquake-164645456.html
● Oregon State University - "*13-Year Cascadia Study Complete – and Earthquake Risk Looms Large*" 8-1-12 - http://oregonstate.edu/ua/ncs/archives/2012/jul/13-year-cascadia-study-complete-%E2%80%93-and-earthquake-risk-looms-large

[38] "*Site Selection & Design for LNG Ports & Jetties – Information Paper No. 14*" - Published by Society of International Gas Tanker and Terminal Operators Ltd / 1997 http://www.dma.dk/themes/LNGinfrastructureproject/Documents/Risk%20analyses/sigtto-site%20selection%20and%20design%20lng%20ports%20jetties.pdf

[39] SANDIA REPORT "*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water"*; Mike Hightower, Louis Gritzo, Anay Luketa-Hanlin, John Covan, Sheldon Tieszen, Gerry Wellman, Mike Irwin, Mike Kaneshige, Brian Melof, Charles Morrow, Don Ragland; SAND2004-6258; Unlimited Release; Printed December 2004; http://www.fossil.energy.gov/programs/oilgas/storage/lng/sandia_lng_1204.pdf

[40] United States Government Accountability Office, Report to Congressional Requesters, Maritime Security; "*Public Safety Consequences of a Terrorist Attack on a Tanker Carrying Liquefied Natural Gas Need Clarification*", February 2007; GAO-07-316: http://www.gao.gov/new.items/d07316.pdf

[41] U.S. Department of Energy report to Congress, "*Liquefied Natural Gas Safety Research*" ; May 2012 : http://www.fossil.energy.gov/programs/oilgas/storage/publications/DOE_LNG_Safety_Research_Report_To_Congre.pdf [NOTE: Based on the data collected from the large-scale LNG pool fire tests conducted, thermal (fire) hazard distances to the public from a large LNG pool fire will decrease by at least 2 to 7 percent compared to results obtained from previous studies. In spite of this slight decrease, people up to a mile away are still at risk of receiving 2nd degree burns in 30 seconds should a LNG pool fire develop due to a medium to large scale LNG breach event.]

[42] "*LNG and Public Safety Issues – Summarizing Current Knowledge about Potential Worst Case Consequences of LNG spills onto water*". Jerry Havens, Coast Guard Journal Proceedings, Fall 2005

11.3 Airport Issues and Hazards

The proposed Jordan Cove LNG facility and South Dune Power Plant and liquefaction facility are directly across the Bay in close proximity to the Southwest Oregon Regional Airport in North Bend. Airport airspace and hazard issues were not addressed properly in the FERC FEIS. LNG Tank Heights clearly violate Title 14 Code of Federal Regulations (CFR) Part 77, Objects Affecting Navigable Airspace. Many issues concerning this and other airport hazards were raised in comments to FERC (Docket # CP07-444-000 and CP07-441-000)[43] The airport will clearly be impacted negatively in order for LNG vessels to safely transit our Coos Bay harbor. This would greatly affect many businesses in the area including the Bandon Dunes World Renowned Golf Course. Currently, there are no plans to prevent this impact and protect citizens in this area and that is not in the public interest. Issues involving LNG tanker passage and air space issues were also not addressed in the Coast Guard's LOR, WSA or considered in Jordan Cove's economic analysis.

11.4 Inadequate Emergency Response Resources

Emergency Response is inadequate with most Emergency Responders located in the Hazard Zones of Concern of the facility and LNG tanker transit. See Hazard Zone maps on FEIS pages 4.7-3,-7,-15.[44] The Coast Guard WSA is not in line with the Gas Industry SIGTTO guidelines and recommendations nor the Sandia National Laboratories guidelines and recommendations. The Coast Guard did not account for many LNG potential hazards in the waterway, air and shoreline and they failed to consider or mention hazard issues listed in the Coos County Natural Hazards Mitigation Plan. They underestimated the number of annual vessel calls and included no plans for handling tsunamis and earthquakes in their reports.

"*Once ignited, as is very likely when the spill is initiated by a chemical explosion, the floating LNG pool will burn vigorously…Like the attack on the World Trade Center in New York City,* ***there exists no relevant industrial experience with fires of this scale from which to project measures for securing public safety***." – Statement by Professor James Fay, Massachusetts Institute of Technology

Sandia Laboratory's Dec 2004 Report; "*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water",* states on page 83; "*... The distance from the fire to an object at which the radiant flux is 5 kW/m2 is 1.9 km"* (1.181 miles).

To clearly understand this one must understand that 5 kW/m2 is the heat flux level that can cause 2nd degree burns on exposed human skin in 30 seconds.

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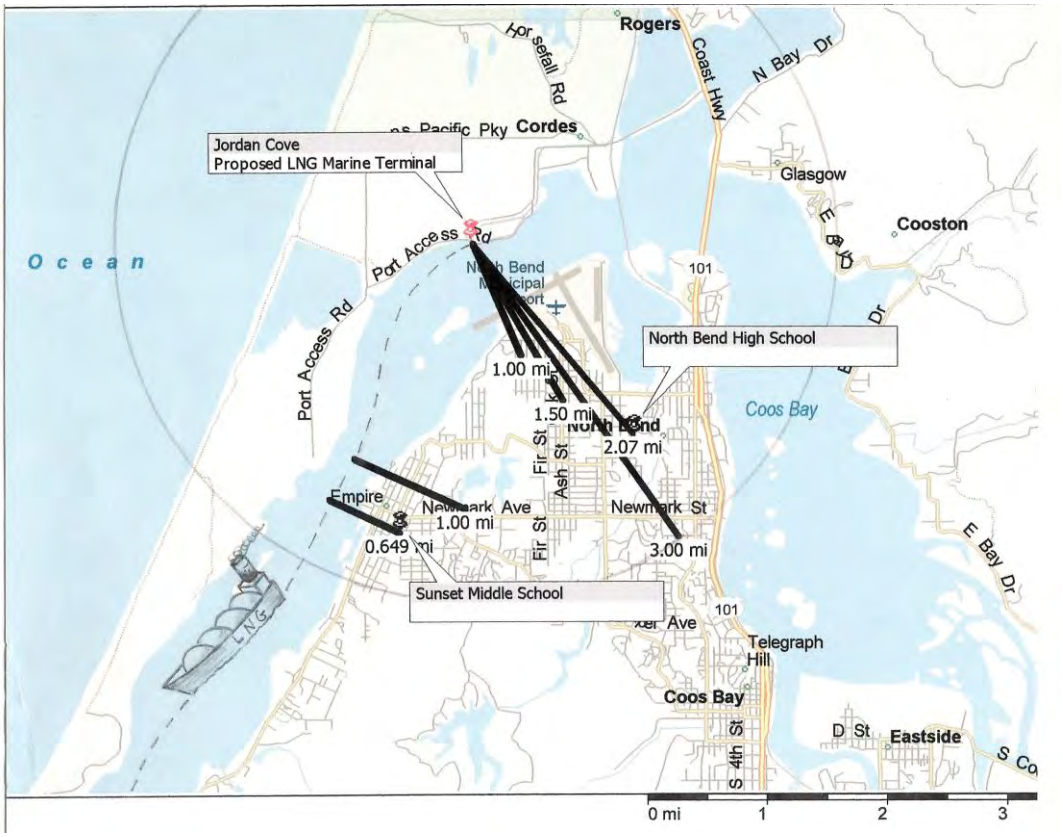
[43] March 31, 2009 comment letter to FERC addressing Safety and Security issues / Airport Hazards / Tsunami and Earthquake hazards:
http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20090331-5160 - &
http://elibrary.FERC.gov/idmws/file_list.asp?accession_num=20090401-5170

[44] FERC Final EIS for Jordan Cove / Pacific Connector http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp Pages 4.7-3,-7,-15



The FERC Jordan Cove Energy (Import) Project Final Environmental Impact Statement (FEIS) - Section 4-7, pages 4.7-3 and 4.7-15, has maps with diagrams of the structures that are within the LNG Ship Transit Route Hazard Zones of Concern.[45] (See Exhibit I) <u>According to the FERC Final Environmental Impact Statement for Jordan Cove (FEIS page 4.8-2), 16,922 people live in these hazard zones along the waterway and yet there is little concern given for their safety</u>. Trees and burnable scrub brush cover our area. Secondary fires will be paramount should an LNG accident occur. The FERC FEIS ignored comments on these dangers. The Coos Bay area has one hospital; it does not have a "Burn Unit." Neither the FEIS nor any public communication from Jordan Cove Energy Project, Inc. ("JCEP") has suggested how the medical response to even a minor LNG hazardous event could be handled in light of our area's obvious insufficiency of appropriate medical facilities and personnel.

Many of the guidelines for safety that are suggested in the gas industries "Society of International Gas Tanker & Terminal Operators" (SIGTTO)[46] Information Paper No. 14 have been completely ignored in this terminal siting, including the following:

1) **Approach Channels**. Harbor channels should be of uniform cross-sectional depth and have a minimum width, equal to five time the beam of the largest ship

[45] FERC Jordan Cove LNG Import FEIS pages 4.7-3 and 4.7-15: http://www.ferc.gov/industries/gas/enviro/eis/2009/05-01-09-eis.asp

[46] **Site Selection & Design for LNG Ports & Jetties – Information Paper No. 14 -** Published by *Society of International Gas Tanker and Terminal Operators Ltd* / 1997

2) **Turning Circles**. Turning circles should have a minimum diameter of twice the overall length of the largest ship, where current effect is minimal. Where turning circles are located in areas of current, diameters should be increased by the anticipated drift.
3) **Tug Power**. Available tug power, expressed in terms of effective bollard pull, should be sufficient to overcome the maximum wind force generated on the largest ship using the terminal, under the maximum wind speed permitted for harbor maneuvers and with the LNG carrier's engines out of action.
4) **Site selection process** should remove as many risk as possible by placing LNG terminals in sheltered locations remote from other port users. Suggest port designers construct jetties handling hazardous cargoes in remote areas where ships do not pose a (collision) risk and where any gas escaped cannot affect local populations. Site selection should limit the risk of ship strikings, limiting interactive effects from passing ships and reducing the risk of dynamic wave forces within mooring lines.
5) **Building the LNG terminal on the outside of a river bend** is considered unsuitable due to fact that a passing ship may strike the berthed carrier if the maneuver is not properly executed.
6) **SIGTTO Examples given for reducing risk factors** beyond normal operations of ship/shore interface include LNG terminal patrols of the perimeter of the offshore safety zones with guard boats and to declare the air-space over an LNG terminal as being a restricted zone where no aircraft is allowed to fly without written permission.
7) **Restriction of the speed of large ships passing** close to berthed LNG carriers.

Also ignored were some of the safety guideline preventative measures in the Sandi National Laboratories Report – "Guidance on Risk Analysis and Safety Implications of Large Liquefied Natural Gas (LNG) Spill Over Water" – Dec 04:[47]

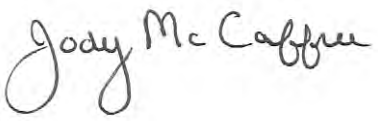
1) Appropriate off-shore LNG ship interdiction and inspections for explosives, hazardous materials, and proper operation of safety systems;
2) Appropriate monitoring and control of LNG ships when entering U.S. waters and **protection of harbor pilots and crews**;
3) Enhanced safety zones around LNG vessels (safety halo) that can be enforced;
4) **Appropriate control of airspace over LNG ships**; and
5) Appropriate inspection and protection of terminal areas, tug operations prior to delivery and unloading operations.

[47] Without an emergency response plan to review it is hard to know if some of these recommendations have been met. Page 4.8-9 of FEIS states, "The Coos County Airport District, which operates the airport, has stated that the airport would not have to stop operations while an LNG carrier was transiting in the waterway past the airport." "…and the Coos Bay Pilots Association foresees no delays for airplanes using the airport resulting from LNG marine traffic in the waterway." This clearly violates Sandia's safety guideline preventative measure recommendations.

Conclusion

It may be in the financial interest of some Canadian energy company to export domestic natural gas across the United States and across Oregon landowner's private property. But it is contrary to the public interest. Exporting Canadian and domestic natural gas from Jordan Cove will (1) put Coos Bay area residents at risk in the event of a Magnitude 9 earthquake and tsunami; (2) deprive many landowners of the full use of their private property; (3) negatively impact Oregon forests and waterways; (4) increase the costs for residential, commercial, and industrial natural gas users; and (5) negatively impact businesses and industries in Oregon and in other parts of the United States. The DOE should not grant such a permit for Jordan Cove to export LNG to non-free trade agreement nations when it is clearly not in "*the public interest*" both nationally and locally to do so.

Sincerely,



Jody McCaffree
Executive Director,
Citizens Against LNG Inc

Citizens Against LNG
Index for Exhibits

Exhibit A - Coos Watershed Association, May 13, 2010, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01.

Exhibit B - Declaration of Russell R Lyon on Pacific Connector Gas Pipeline Case No. CV-10-6279-HO

Exhibit C - Williams / Metcalf, May 13, 2012, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01.

Exhibit D – McCauley, May 11, 2012, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01.

Exhibit E - Clausen Oyster, May 13, 2010, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01.

Exhibit F - Messerle and Sons, June 10, 2010, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01.

Exhibit G - Yankee Creek Forestry/Jake Robinson, June 7, 2010, comment letter on Pacific Connector Gas Pipeline Coos County CUP #HBCU-10-01

Exhibit H - Current 2012 Tsunami Evacuation Map of Jordan Cove Project area

Exhibit I - Jordan Cove LNG Tanker Hazard Zones from FERC Final EIS page 4.7-3

Exhibit J - Calculation of the approximate number of LNG Ship Transits needed to liquefy .8 and 1 billion cubic feet of gas per day and transport using 148,000 cubic meter ships.

Exhibit A

Coos Watershed Association
P.O. Box 5860
Charleston, OR 97420
(541) 888-5922
E-mail: cooswa@cooswatershed.org
Web: www.cooswatershed.org

May 13, 2010

Ms. Patty Evernden, Planning Director
Coos County Planning Department
250 N. Baxter
Coquille, OR 97423

RE: Written Comments on Pacific Connector Pipeline #HBCU-10-01

Dear Ms. Evernden,

By a consensus vote without objection, the Board of Directors of the Coos Watershed Association at its regular meeting on May 10, 2010 authorized me to provide these written comments on the environmental effects of the Conditional Use Permit HBCU-10-01 to construct the Pacific Connector Liquefied Natural Gas (LNG) pipeline. The Association takes no position as to the merits of this project, but feels that certain aspects of the Hearings Board Conditional Use (HBCU) permit that affect watershed concerns need to be addressed. Based on the Proposed Route WC-1A from the FERC DEIS, which is the alignment being considered for the HBCU, we would like to provide information related to this route.

1. The alignment of Proposed Pacific Connector Pipeline (Route Alternative WC-1A) as identified in the Notice of Land Use Hearing does not follow a path of least environmental disturbance in the area covered by the Coos Bay Estuary Management Plan (CBEMP) of the Coos County Zoning and Land Development (CCZLDO). Alternative routes are available that would significantly reduce construction impacts and long term right-of-way maintenance impacts to streams and wetlands. Specifically, the Amended Blue Ridge Alternative Route includes a ridgeline alignment beginning at approximately MP 8 on the Proposed Route WC-1A in Section 20 (T.25S.;R.12W.) and joining with the Blue Ridge Route Variation in Section 33 (T.25S.;R.12W.). This route would avoid the impacts to lowland areas (particularly wetlands), while reducing the number of stream crossings. This "Amended Blue Ridge Alternative Route" largely follows the ridgeline between the Catching Slough and Daniels Creek watersheds, and is consistent with the design strategies identified in the Jordan Cover/Pacific Connector FERC DEIS to reduce environmental impacts.

2. This route crosses two significant streams (Kentuck Slough and Willanch Slough), both of which have high value for coho salmon. The area downstream from the proposed crossing at Willanch Slough is presently being considered for a Wetland Mitigation Bank, while the area upstream has had significant and successful riparian restoration projects. Information on the biological resources in these areas is available in our Coos Bay Lowlands Watershed Assessment (www.cooswatershed.org).

3. The route down Lilienthal Creek (T.25S.;R.12W., Sections 20 and 30) will cross the entirety of the Brunschmid Wetland Reserve Project (WRP) that has a perpetual easement held by the U.S.D.A. Farm Services Agency. This site has had significant restoration work during 2008 and was completed in the winter of 2009. Juvenile coho salmon (a Federally-listed Threatened species) were found during fish surveys in this wetland. We expect chronic sedimentation problems to occur in this wetland and Lilienthal Creek if the pipeline parallels the stream down this valley.

4. Across East Bay Drive—and hydrologically connected to the Brunschmid WRP—are high quality tidal fringe wetlands (low and high salt marsh) adjacent to the Cooston Channel that have also been identified as having potential for long-term protection and enhancement. These wetlands are in CBEMP zones 18RS, 18A-CA and 18B-CA. The area includes sites (U-12 and U-16(a)) identified as "high" priority for wetland mitigation as a Management Objective (§4.5.480), and this use would appear to be precluded by a 50' LNG pipeline right-of-way. Because juvenile coho salmon were found upstream in the Brunschmid WRP, they will also use this site.

5. Once it crosses the Coos River the proposed pipeline route will traverse lowlands adjacent to Catching Slough and its tributaries (approximately MP 8.25 to MP 18). These areas provide some of the most significant current lowland habitat for coho and Chinook salmon rearing, potential wetland restoration opportunities, and needed riparian restoration to reduce summer stream water temperatures. Of particular importance are Stock Slough (MP 10.1), the crossing in lower Catching Slough (MP 11), and Boone Creek (MP 15.75). All these streams and sloughs are used by coho salmon, and the adjacent riparian areas provide resources for these fish and other aquatic life. Additional information on these resources is found in the recently completed Catching Slough Assessment and Action Plan in the Publications section of our website (www.cooswatershed.org).

The Coos Watershed Association is interested in working with Coos County and Williams Pipeline consistent with our mission to "support environmental integrity and economic stability within the Coos watershed." In addition to our watershed assessments and restoration action plans, we have a deep knowledge of local conditions and landowner concerns in the project area in the Coos Bay Frontal watershed, as well as experience in designing and implementing water quality and habitat restoration and road upgrade projects. We would be happy to discuss such possibilities with the project proponents as plans progress.

Please don't hesitate to contact me if you have questions or need additional information.

Cordially,

Jon A. Souder, Ph.D.
Executive Director

Pursuant to the CCZLDO Section 5.7.300.4.B(4), I certify that Dr. Jon A. Souder is authorized to provide these comments on behalf of the Coos Watershed Association.

Date: 5/13/10

JR Herbst, President

Exhibit B

Susan Jane M. Brown (OSB #054607)
Western Environmental Law Center
4107 N.E. Couch Street
Portland, Oregon 97232
Tel: 503-914-1323
Fax: 541-485-2475
brown@westernlaw.org

Attorney for Applicants-in-Intervention/Defendants

UNITED STATES DISTRICT COURT
DISTRICT OF OREGON
EUGENE DIVISION

PACIFIC CONNECTOR GAS PIPELINE, LP, a Delaware limited partnership; Plaintiff, vs. LOUISE SOLLIDAY, in her official capacity as Director of the Oregon Department of State Lands; and RICHARD WHITMAN, in his official capacity as Director of the Oregon Department of Land Conservation and Development; Defendants, and BOB BARKER, JOHN CLARKE, BILL GOW, RUSS LYON, and MARY MARGARET MUENCHRATH, individuals; and OREGON WOMEN'S LAND TRUST, a nonprofit corporation; Applicants-in-Intervention/Defendants.	Case No. CV-10-6279-HO **DECLARATION OF RUSSELL R. LYON**

I, RUSSELL R. LYON, do hereby declare and state:

1. My name is Russell R. Lyon. I make this declaration based on my own belief and knowledge.

2. My property, which I own with my wife Sandra G. Lyon, is located at 3880 Days Creek Road, Days Creek, Oregon, 97429.

3. The Pacific Connector pipeline would cross through our property.

4. We have a 306-acre ranch consisting of farm and forest land.

5. There are two large creeks on our ranch. Days Creek runs east to west near the southern edge for almost the full length of our property before turning south, and Fate Creek runs north to south near the western edge. Nestled between these two creeks at the southwest corner, our house and barns are spread out on about five acres.

6. The proposed 36-inch diameter pipeline transporting unscented natural gas at 1400psi, buried as little as 2 to 3 feet under the surface, will cross the southwest corner of our ranch within less than 500 feet of our house.

7. I understand that the minimum safe blast zone around this type of high pressure gas line is 900 feet.

8. The pipeline would first enter our property on the western side, cutting southeast through a pasture before crossing Fate Creek (at pipeline milepost 88.48) within 500 feet of our house. It would then exit our property through another pasture before crossing Days Creek south of our property, but still within 500 feet of our house, and as it turns to head southeast.

9. The proposed pipeline would rip open 75 foot wide swaths across any stream or river, and create a 100 foot wide scar everywhere along its route.

10. I would like to tell you about the Fate Creek Project.

11. Fate Creek is a small stream in Douglas County, Oregon. It is a poster child, so to speak, of what citizens can do to improve our water quality and salmon habitat. Back in 1990, my wife and I searched all over the West for a spot to settle down and raise our family in a healthy

environment. When we moved to Days Creek, Oregon, it fulfilled all our dreams of a rural environment off the beaten track, away from many of man's detrimental impacts on the environment. Never in our wildest dreams did we imagine that a huge natural gas pipeline would be proposed right through our property. (The first map from Pacific Connector Corporation showed it going right through our very house!)

12. My wife and I purchased a historic cattle ranch which, through our hard labor, we turned into an organic farm.

13. We have spent 18 years improving our environment, and in particular, Fate Creek. We sought out and worked with the local Soil and Water Conservation District, our local Watershed Council, Oregon Department of Fish and Wildlife, and the Bureau of Land Management (BLM) to carry out numerous improvement projects to this small rural stream to restore its historic salmon runs.

14. As a tributary to Days Creek, which in turn is a tributary to the South Umpqua River, Fate Creek is part of one of the Pacific Northwest's prime salmon recovery areas. Before we started our restoration efforts, Fate Creek had no salmon spawning in it. The creek was not fenced so that the cattle were degrading banks and fouling the waters.

15. Fate Creek now has nearly 2 miles of fence that keep the livestock out of the creek. Two bridges have been installed to allow cattle to be moved across without going through the creek. An off-stream stock-water system has been installed to provide livestock the water they need without entering the riparian zone.

16. There was a 14 foot dam for irrigation diversion, a second smaller 8 foot dam, and a culvert crossing Days Creek Road, that all prohibited fish passage. That culvert has now been replaced, and also one on the BLM lands upstream from us. The smaller dam has been totally

removed, and the larger dam has been retrofitted with a huge gate valve which is left open during the fall, winter, and spring providing unimpaired fish passage.

17. In addition, a large riparian restoration project was done where blackberries were removed and replaced with native trees and shrubs to provide further shading in addition to the existing large trees. This September 2010, log/boulder structures are being placed in both Fate and Days Creeks to restore the natural instream habitat that would have historically existed.

18. Fate Creek and its restoration efforts will be a show place of riparian restoration possibilities for public tours to show other ranchers and landowners how restoration efforts can be beneficial to both land-managers and wildlife. Coho, a listed fish species, are now spawning and rearing once again in Fate Creek after years of absence.

19. The proposed pipeline crossing right through this restoration project area would destroy all of this effort.

20. In order to build the pipeline, a large swath of riparian trees will be removed and not be allowed to be replanted.

21. The history of past pipeline projects shows that they have major problems with erosion and continually contribute to water turbidity. This will reverse all of the positive things we've been able to do on Fate Creek.

22. As landowners along the pipeline route, my wife and I have been very frustrated by the pipeline representatives and how they deal with landowners, so we have not given Pacific Connector access to our property.

23. Their environmental and social arrogance has been amazing.

24. The idea of using eminent domain, with minimal compensation for our loss of well-being and decreased property values, is, of course, of large concern.

25. But, also the very long-lasting environmental damage that will occur over the 280-mile pipeline route and its 379 water body crossings – as well as on our land – are of equal or greater concern.

26. I have watched and heard from the beginning the pipeline representatives give whatever answer they thought would work to relieve landowner concerns.

27. For example, a meeting was held July 2009 at the proposed crossing site of Fate Creek that involved Pacific Connector Pipeline Company's lead project engineer, environmental scientist, lead router, and two land agents; Oregon Department of Fish and Wildlife district biologist; executive director and project planner from Partnership for the Umpqua Rivers; an Oregon Department of Forestry engineer; and our family.

28. The Oregon Department of Fish and Wildlife had flagged the Fate Creek crossing in their response to the DEIS because of the numerous restoration work and projects in the creek.

29. From our meeting, it was immediately clear to us that Pacific Connector representatives didn't have a clear concept of the impact the crossings would have. The disruption of the ecosystem, the erosion of soils, added turbidity in the watershed, the loss of shade from the removal of mature trees, and the introduction of invasive species from contaminated equipment needed to be addressed. Their answer to nearly all the very real concerns was that, if there were a problem, mitigation somewhere else would make up for the local destruction and damage.

30. This lack of understanding and caring about the impact of the pipeline on landowners was offensive.

31. Why is all of this important? As stated above, salmon are now spawning again in Fate Creek, and the water quality has greatly improved because of the work and money put into

improving our streams by those of us who cared. The proposed natural gas pipeline would cross right through Fate Creek.

32. Fate Creek is not the only such stream in the Umpqua watershed where large salmon recovery projects have been carried out. The local watershed council, alone, has spent over ten million dollars to improve fish habitat in the Umpqua watershed. The proposed pipeline will cross dozens of streams as well as going under our major rivers. Precious riparian areas will be mowed down and denuded causing loss of stream cover and spawning habitat.

33. My wife and I were told that there will be minimal disruption, but the past record of a pipeline between Roseburg and Coos Bay has proven otherwise. Drilling can cause underground blowouts and produce desecration of our waters for years to come.

34. We have worked for years now to protect and increase shade cover for our streams. The pipeline would rip open 75 foot swaths across our streams and rivers, and create 100 foot scars across our hillsides and mountains, which consist of greatly varied soil types and stabilities.

35. Oregonians appreciate our natural landscape and are proud of our forests and rivers. The terminal and its pipeline would degrade our environment and put our lives at risk, all for no benefit to Oregonians. Oregonians would receive a very small fraction of this gas, if any.

36. Besides this environmental damage, the social and economical disruption along the pipeline could be extensive. Our own property and lives will definitely be impacted. The pipeline will cross through our irrigated pastures, trees will be cut down, and our driveway and fields will be used for staging areas.

37. Does anyone really believe that we would have any chance of selling our home, at anywhere near its current value, while a 36 inch un-scented high pressure gas pipeline is buried

A portion of this document at this location is being withheld for redaction of Personally Identifiable Information.

A redacted version of this document will be posted when that process is complete.

Exhibit C

TO: Coos County Planning Department

FROM: Virgil and Carol Williams / Mary Metcalf
Fairview Residents

Subject: Coos County Permit Application (FILE # HBCU-10-01)

There are 5 main concerns we have with this Proposed Pipeline route.

(1.) We did NOT give pacific Connector pipeline permission to apply for a permit to come onto our private property.

(2.) The biggest concern is with our wells. The Aquifer in our area is very fragil and close to the surface. The productive wells here are hand dug and most are 25 to 35 ft. deep. Wells that have been drilled around 100 ft. to 200ft. produce only brackish or Salty water, as was the one drilled on Metcalf property. It had to be filled in. The hand dug well they now have supplies 3 homes. The pipline route would have to go under this supply pipe, which is 4 ft. underground. That would be a substantial depth for their large pipe. and when they break through the aquifer, what hapens to this well, along with 2 wells on the Williams property's. one of these also services a home on the other side of the road. Plus 3 other homes close by with shallow wells will

be in Jeperty. Thats 9 homes to survive without water. How will they compensate these homeowners? Mabe they could Contract out to have water delivered to a holding tank at each of them once a month.

(Well Guary Report from Water Master attached)

(3.) The pipeline route as planned, will cross the Williams property in the middle of a home site. When we purchased thise property, the intention was to build a house on it. It was already septic tank aproved, with an existing well. (one of the above mentioned wells) We obtained an address, and made plans. Due to unexpected Health problems, building a house had to be put on hold, but not abandoned. If the pipeline pushes through with this route, there will no longer be a home site. and you know they will only compensate for the land as they see it, not for what a person plans to do with it.

(4.) after laying the pipline accross the Williams home site, Crossing Metcalfs well line, advancing accross more of Williams property, (Removing a small Barn in it's way) it will border along the side of a natural pond (Registerd with The State) and cross the ponds drainage ditch that runs to the Coquille River. My Concern here is that during Salmon Season, young smolt have been known to come up this drainage ditch from the Coquille River, into the pond. But besides the fish, without this drainage ditch, the field will floods in the Rainy Season.

A portion of this document at this location is being withheld for redaction of Personally Identifiable Information.

A redacted version of this document will be posted when that process is complete.

Well Log Query Results

Township: 27 S, Range: 12 W, Sections: 24

	T-R-S	TAX LOT	STREET OF WELL	OWNER	COMPANY	SPECIAL SOIL	WELL TYPE	FIRST H2O	LOWER DEPTH	STATIC WATER LEVEL	COMPLETED DATE	ISSUED DATE	BONDED CONTRACTOR	STARTING CARD	WELL ID #	NEW	ABANDONED	DEEPENED	ALT. CONVERSION	DOMESTIC
	27.00S-12.00W-24 NE-SE			CHORMICLE, EUGENE 36604 MUNYAN NEWARK CA 94560			W	23.00	160.00	22.0	2.0	05/03/1991	05/30/1991	BARRINGTON, RON	22750	684	√				√
	27.00S-12.00W-24 SW-SW	1200	COQUILLE-FAIRVIEW CO RD	METCALF, JAMES HC 83 BOX 3365 COQUILLE OR 97423			W		200.00	0.0		11/19/1991	12/12/1991	SCHATTENKERK, DOUG	36522		√	√			√
	27.00S-12.00W-24 -SE	1500	RC83 2973, COQUILLE	HOLMES, JIM	HOLMES, CARLENA PO BOX 1218 COOS BAY OR 97420		W	148.00	180.00	115.0	2.0	08/18/1992	09/04/1992	MEYER, GLEN L	45014		√				√
	27.00S-12.00W-24 NE-SE	240		NEWMAN, MIKE	NEWMAN, LINDA HC 83 BOX 3426 COQUILLE OR 97423		W	42.00	205.00	36.0	3.0	10/22/1993	11/15/1993	BARRINGTON, RONALD L	50996		√				√
	27.00S-12.00W-24 NE-NW	500		BAUCUM, DANNY HC 83 BOX 3430 COQUILLE OR 97423			W	12.00	105.00	85.0	1.0	10/26/1993	11/15/1993	BARRINGTON, RONALD L	53674		√				√
	27.00S-12.00W-24 SW-NE	700		COOKE, GORDEN HC 83 BOX 3385 COQUILLE OR 97423			W	10.00	105.00	100.0	1.0	10/27/1993	11/15/1993	BARRINGTON, RONALD L	53678	63324	√				√
	27.00S-12.00W-24 SW-NW			SINCLAIR, BOYD			W	0.00	80.00	18.0	4.0	05/30/1986	06/16/1986	BARRINGTON, RON			√				√
	27.00S-12.00W-24 -			FULLER, ORVILLS A			W	10.00	0.00	0.0		10/02/1981	11/03/1981	BARRINGTON, DONALD				√			
	27.00S-12.00W-24 -			FOWLER, MADELINE J			W	0.00	0.00	0.0		05/12/1976	05/26/1976	BARRINGTON, DONALD			√	√			
	27.00S-12.00W-24 -			STEWART, J C			W	0.00	100.00	18.0	2.0	05/26/1969	06/23/1969	JONES, DELBERT S			√				√

1

Exhibit D

A portion of this document at this location is being withheld for redaction of Personally Identifiable Information.

A redacted version of this document will be posted when that process is complete.

STATE OF OREGON

COUNTY OF COOS

CERTIFICATE OF WATER RIGHT

This Is to Certify, *That* GRAYDON R. THOM, JR.

of Route 3, Box 220, Coos Bay *, State of* Oregon *, has made proof to the satisfaction of the STATE ENGINEER of Oregon, of a right to the use of the waters of* a spring

a tributary of unnamed stream *for the purpose of* domestic use of one family

under Permit No. 30562 *of the State Engineer, and that said right to the use of said waters has been perfected in accordance with the laws of Oregon; that the priority of the right hereby confirmed dates from* June 15, 1965

that the amount of water to which such right is entitled and hereby confirmed, for the purposes aforesaid, is limited to an amount actually beneficially used for said purposes, and shall not exceed 0.01 cubic foot per second

or its equivalent in case of rotation, measured at the point of diversion from the stream. The point of diversion is located in the NE¼ NW¼, Section 30, T. 26 S., R. 12 W., W. M. Spring located 230 feet South and 1660 feet East from NW Corner, Section 30.

The amount of water used for irrigation, together with the amount secured under any other right existing for the same lands, shall be limited to - - - - - - - - of one cubic foot per second per acre,

and shall conform to such reasonable rotation system as may be ordered by the proper state officer.

A description of the place of use under the right hereby confirmed, and to which such right is appurtenant, is as follows:

Lot 1 (NW¼ NW¼)
Section 30
T. 26 S., R. 12 W., W. M.

The right to the use of the water for the purposes aforesaid is restricted to the lands or place of use herein described.

WITNESS the signature of the State Engineer, affixed this date. June 17, 1969

CHRIS L. WHEELER
State Engineer

Recorded in State Record of Water Right Certificates, Volume 28 *, page* 36042

Exhibit E

SILVER POINT OYSTERS
PRODUCT OF CLAUSEN OYSTERS

CLAUSEN OYSTERS
66234 North Bay Road
North Bend, Oregon 97459
USA
(541) 756-3600
(541) 267-3704
Fax (541) 756-3200

I LOVE OYSTERS
COOS BAY, OREGON

Max & Lilli Clausen

May 13, 2010

Kimberly D Bose, Secretary
Federal Energy Regulatory Commission

We are very concerned about the route of the pipe line through Haynes Inlet and the bay on the West side of Highway 101! I realize that the diagonal path through Silverpoint I oyster bed was changed to run alongside the oyster bed.

However, according to the documentary we were shown some time ago, when a pipeline is constructed in the water, mud and sand are suspended in the water, especially on windy days, and would drift over our oyster beds which would kill our oysters.

Another problem is the fact when the line is build, the ground over the pipe and the right-of -way is altered to the point where it acts like quicksand. Our oyster crew could not cross there. They usually leave the boat at the edge of the oyster bed and walk to the predetermined site to fill the nets at low tide. The nets are later retrieved at high tide with the oyster barge hoist.

When the engineer and some other people representing LNG were in our office a few weeks ago my husband, Max, and I tried to explain that the proposed line was too destructive to our oyster business. Studying the maps it seems more logical and doable to swing away from our oyster plant from Haynes Inlet and continue straight West, North of Horsefall Beach Road, tunnel under Highway 101 through North Slough where nothing is planted due to poor water quality and ground conditions. There could even be a half mile saved in total distance to offset some of the additional cost.

Considering that the line is starting on the California border; crossing many roads and streets, this should be a possible solution without destroying our business. We do not like the idea of having a pipe line a few hundred feet from our oyster plant, but at least it would not impact our daily commute to and from the oyster beds. Most of the ground in the Northern part of Haynes Inlet is owned by the Division of State Lands while most of the ground in the North Slough is Coos County ground.

Please have your engineers take another look to alter the route to run North of Horsefall Beach Road, as sketched on the enclosed map. That change would eliminate any potential interference in our daily boating and harvesting activities, and hopefully also keep any harmful sediment away from our very productive oyster bed. In effect, you would not need our permission to survey this area, since your future installation would not take place on our land.

Thank you!

Lilli Clausen

WC-1A/ALT

WC-1A Land Push

WC-1A Land Push Option 1

WC-1A ALT 2 RXF

51 Oyster Beds

53 Oyster Bed

Wpt1

Wpt2

Wpt3

Wpt4

Wpt5

Wpt6

Wpt7

Wpt8

Wpt9

Wpt10

Wpt11

Wpt12

MP 1

MP2

Boat Ramp

OSPREY NEST

SLIDE

OYSTER BEDS

EEL GRASS

Shorewood

Glasgow

Cordes

Jordan Cove

Jordan Point

Russell Point

McCullough Bridge

Industrial Waste Ponds

Substation

Burner

Rogers 159

Russell 2

Radio Tower (KBBR)

Mabry

Well

MUD

SAND

DUNES

HAYES

CORPORATE BOUNDARY

McCULLOUGH STATE WAYSIDE DR.

NORTH BAY

Light

Exhibit F

MESSERLE
& SONS

94881 STOCK SLOUGH LANE
COOS BAY, OREGON 97420
(541) 267-2997
FAX (541) 269-1042

June 10, 2010

Coos County Planning Department
Attn: Patty Evernden
250 N. Baxter Street
Coquille, OR 97423

Re: HBCU 10-1

Dear Ms. Evernden:

Please forward the following discussion to Mr. Stamp for his consideration concerning the above referenced matter.

SIGNIFICANT CHANGES TO FORESTRY PRACTICES AND COSTS RELATIVE TO THE PROPOSED PIPELINE

The following is intended to provide the County with information requested relative to the proposed PCGP application. Specifically this information addresses the applicant's compliance with Section 4.8.400, 4.8.300 and 4.8.350.

Section 4.8.400 Review Criteria for Conditional Uses in Section 4.8.300 and Section 4.4.400

The use authorized by Section 4.8.300 and 4.8.350 may be allowed provided the following requirements are met.

A. The proposed use will not force a significant change in, or significantly increase the cost of, accepted farming or forest practices on agriculture or forest lands.

Note: The proposed use will force a significant change and a significant cost increase in accepted forest practices.

OVERVIEW
As a 150 year old Coos County farming and forest family owned business, we operate over 1800 acres of intensity managed timberland. Our operation is

based on owning and holding the timberlands for the full term (rotation) from growth to harvest and re-plantation of the timber crop. Therefore, the applicants proposed use does significantly change and significantly increase the cost of our accepted practices in the following ways.

1. The value of the timber.
   The price of timber over the last 40 years has gone up 8% per year. Timber value has increased from an average of $30.00 per 1000 board feet to today's value of $600.00 per 1000 board feet (a multiplier of 20x).

   Based on the increase in worldwide demand and the decrease in supply of softwood (Douglas Fir) timber from Federal land we anticipate the rate of valuation increase to remain the same over the next 40 years.

   Therefore, we expect 40 year old Douglas Fir which has been intensively managed to increase in value to $12,000.00 per 1000 board feet.

   Note: This will result in a gross value of $240,000.00 per acre for 40 year old timber in 2050.

   IN OTHER WORDS
   We can produce now 20,000 board feet per acre at the end of a 40 year rotation.

2. The wind loss exposure (and expense) in today's accepted forest practice is limited by the number of and/or the distance of the "hard edge" in each "stand" of timber.

   IN OTHER WORDS
   Cutting and maintaining an extended "hard edge" in an existing and/or new stand of timber will dramatically increase the wind loss over the 40 year rotation and thus increase cost and decrease yield.

3. The current accepted practice on our managed forest lands includes severely restricted access to anyone. This restricted access is enforced to:

   a. Reduce the potential for the spread of soil born pathogens.

Specifically we are trying to stop:

- Port Orford Cedar root rot.
- Douglas Fir root rot.

Note: These diseases produce a 100% mortality rate and once in the soil can never be gotten rid of.

FURTHER
These diseases are typically spread by vehicle and foot traffic thus the increased access, and stated requirement by the applicant, to "walk and maintain the right of way" will significantly change the accepted practices involved in raising a 40 year crop and or, in a worst case, eliminates the value of the land all together for timber production.

Special Note: Every timber company has "locked up" their land for these risks and or fire risks. The applicants proposed use completely changes the current practice of restricted access.

4. Noxious weeds

   An open right of way (vector) through an existing or new stand of timber creates an area for infestation of noxious weeds, once established (even as small populations) are very difficult to get rid of.

   FURTHER
   Douglas Fir creates a "canopy" of shade that reduces the viability of noxious weeds. This open vector along the proposed right of way will require a significant increase in our costs and time to eliminate noxious weeds on our timber lands.

5. An open vector (Right of Way) with dry grass and or brush creates a path for fire to "run on".

   There is no question that this vector (right of way) will increase our fire hazard exposure and or risk in the event of a fire.

6. Accepted logging practices.

   The applicant's proposed route is generally on ground that would allow mechanized equipment to perform the logging or thinning of the mature stand (i.e., feller buncher, cat, rubber tire skidder).

   Our land was specifically acquired and has been developed for this type of ground based operation. The proposed pipeline would change the "established harvest layout" and thus increase the cost to harvest.

   Specifically, we cannot "yard" and or drive our equipment (which would be dragging logs) across the right of way. Therefore, we have to go down or around or airlift to log.

   IN OTHER WORDS
   Each stand of timber has a specific way that we log it. Any breakup (by a right of way) significantly changes and or increases the costs of accepted practices.

   Note: Today's logging costs for us run about $400.00 per 1000 board feet. We expect this cost to increase to at least $500.00 to $600.00 per 1000 board feet due to the proposed right of ways impact on accepted forest harvesting practices.

   FURTHER
   We expect the cost of logging to run parallel to the value of the timber "on the stump" over the next 40 years (8% increase per year on average).

   FINALLY
   Timber harvesting (logging) has always had a very "thin margin" of profit. Logging is not a "get rich quick" proposition. Any change to accepted logging practices will increase costs, decrease margins and significantly change the cost of accepted forest practices.

7. Valuation of existing stands of timber with the proposed pipeline versus valuation without the proposed pipeline.

IN GENERAL
The valuation of the land will be reduced and appreciation of the land will be in some way restricted.

IN OTHER WORDS
There is no way that a tract of land for timber production is more valuable with the pipeline going through it than a similar tract without a pipeline. In fact, two parcels of similar timber, one with the pipeline and one without, will see a higher value to the parcel without the pipeline.

Actual value reduction:
We do not know but it will be significant. It depends on a variety of things such as:

i. FERC restrictions and or any increase in the size of the vector if and when they choose to do so.
ii. Accidents, risks and or other requirements that result from incidents throughout the world.
iii. The value of timber land without a pipeline running through it.

8. The <u>real width of the right of way relative to timber</u>.

A 40 year stand of Douglas Fir timber will require a distance from the base of one tree on one side of the right of way to the base of the tree on the other side of 80' to maintain a 50' <u>visible</u> right of way.

IN OTHER WORDS
Two trees 80' apart will create an open strip that is 50' wide.

<u>Note</u>: *We are being "told" that we can plant trees 30' apart across the proposed right of way. From the air in 20 years you will not be able to see the ground across that 30'.*

Therefore, we expect to lose 80 feet by whatever length the pipeline is (in timber production) when all the dust settles.

9. <u>Trespass and or vandalism</u>.

In forestry practices trespass and fire is a big concern. The ATV path that the right of way will create is an irresistible temptation to the ATV or walking trespassers. And, no short fence or gate at the road is going to stop them. Therefore, the right of way, in its visibly open vector form, significantly increases fire hazard and fire suppression costs.

10. The cost to cope with the applicants proposed construction and ongoing oversight.

    In general, our oversight and monitoring of the proposed construction and ongoing operation of the pipeline through our farm and forest land significantly changes our practices and increases our costs.

    We will spend more time and more money than we do now.

    Currently we have no third party construction going on in any of our lands and we have no power or pipeline routes through any of our forestry lands either.

    It is difficult enough for a small family owned operation to monitor and oversee its base operation. This proposed addition will change our practices and increase our costs.

CONCLUSION

The county must find that the proposed use relative to Section 4.8.300, Section 4.8.350 and 4.8.400 not be allowed because the requirement for the use and its compatibility with forest operations and agriculture has not been met.

Specifically, the proposed use will significantly change and increase the cost of accepted tree farming and forestry practices on agricultural and forest lands.

EXCEPTION SHORTEST ROUTE (Mr. Stamp's letter indicates that the applicant is taking the shortest route).

The proposed route is not the shortest route. The Amended Blue Ridge Route is approximately 2 ½ miles shorter and it dramatically reduces the miles of private timber right of way required.

Therefore, the effect and cost on accepted forest practices can be reduced by a shorter route such as the Amended Blue Ridge Route.

Specifically, we are correcting the statement made by Mr. Stamp in second paragraph of Mr. Stamp's 6/6/10 Pg. 8 letter to Patty Everden.

The applicant by not proposing the shortest route has not met the intention of the provision. The Amended Blue Ridge Route causes less impact to many specific properties because:

a. It reduces the private landowners affected from 37 to 18.
b. Shortens the pipeline by 2.5 miles.
c. Changes the percentage of private to public land affected from:
   Current Route - 10.65% Federal Land
   Blue Ridge - 76.32% Federal Land

We appreciate the opportunity to provide further comment on this matter.

Fred Messerle & Sons, Inc.

Fred R. Messerle
Secretary-Treasurer

Exhibit G

7 June 2010

Coos County Planning Dept.
Attn: Hearings Officer, Mr. Andrew Stamp
250 N. Baxter Street
Coquille, OR 97423

Re: *HBCU 10-01*

Mr Stamp;

I am writing you concerning the land use application submitted by Pacific Gas and Connector Pipeline for permission to construct a natural gas transmission pipe line across Coos Co. I may have stated some of my personal information during the verbal testimony portion of the hearing. Please forgive the repetition. I am a private consulting forester with 10 years experience and an operation base of the southwestern portion of Oregon. I have written forest management plans for over 2500 acres of private forest ground, and wrote the forest management plan for 5000 acres of forest at South Slough Reserve while employed for Oregon Dept of State Lands. I have also designed harvest lay out for commercial operations on both private and Federal forests. I have resided in Coos Co for the past 2 years at 94961 Stock Slough ln. This property would be crossed by the proposed pipeline route. I rent and am not the property owner.

The following comments are specific to **Coos Co Zoning Land Develop Ordinance (CCZLDO) 4.8.400** concerning forestry operations on lands zoned forestry. I believe that the proposed pipeline would significantly impact landowner's ability to practice timber stand maintenance and harvest on their lands. Most of these land owners rely heavily on periodic proceeds from timber harvest, for some it is a primary source of income. Logging is, in the best of times, a decent living. Under current conditions it is marginal at best. There are several issues which I will raise in regard to impacts. Any one of these impacts could be the difference between a profitable harvest and a break even project, combined they would make it very difficult to continue to economically harvest timber on land which is designated for that purpose.

- Increased costs associated with timber harvests; Most of the private timber ground along the pipeline route is under 35% slopes which makes it suitable for ground based harvesting. The applicants have proposed creating a limited number of 'hard crossings' across an otherwise 'no entry' easement. Having only a limited number of crossings will significantly increase logging costs because of changes to proposed harvest lay-out, increased length of skidding turns and haul routes, and reduced harvestable acreage within the stand. Ground based timber harvests require freedom of access, very little is done with long winch lines due to the inefficiency. Machinery is literally driven up to each and every tree. The cost increases would be different for different stands depending on amount if the stand the pipeline crossed, but it could easily range from 5-20%. Logging costs for a ground based operation would be $200-300 per thousand board feet(mbf). A 12% harvest cost increase at $200mbf for a 40 acre stand, with 20mbf per acre would work out to a loss of **$19,200**. This 40 acres is the typical annual harvest amount for local

private forest owners, and $20,000 is probably close to the expected income. The timber ground in this area is expected to produce roughly 20mbf per acre at 40 years, which in the established rotational age.

- The creation of a ± 100' working easement and a 50' permanent easement would fragment some forest stands to the point which made harvest financially restrictive. The increased cost to access an isolated portion of a stand would mean that the planned harvest would be changed to either harvest the patch early or late depending on the age of the adjacent stand. Depending on the restriction of access this would affect patches >5 acres, a small but significant value at $20mbf per acre.
- Most of the private forest ground along the proposed route is intensively managed on a 40 year rotation. These trees have been planted on a ±11' spacing resulting in 360 trees per acre. Within Coos Co, wind is the dominant disturbance type, both periodic gusts and episodic storm events. Since these stands have grown up under dense conditions, the structural integrity of the stand it based on the uniformity of the stand and individual trees are supported and buffered by their neighbors. The proposed route would create a 'hard edge' through the middle of the forest stands. This hard edge would inevitably create blowdown within the adjacent stands, especially those over 20 years old. The amount of wind damage would be tough to calculate, it would be based upon aspect, slope, age of the stand and, in some cases, pure chance.
- Opening up a corridor within these private forests will inevitably promote trespass, both vehicular and foot traffic. Either will have a negative effect on forestry operations. The applicant has discussed mitigation efforts such as gates, obstacles, and fencing. None of these will have a 100% success rate. You yourself mentioned piano wire as an effective deterrent. The Oregon Dept of Forestry lists humans as the dominant cause of forest fires within the state. I looked at a 5 year trend (2002-2006), **70-80%** of all fires were human caused. (http://www.oregon.gov/ODF/FIRE/fire.shtml) These corridors will also provide a vector for the spread and establishment for noxious weeds, both during and after the consrtuction. Even if access is successfully limited to just the contract crews who will be preforming the maintance, the spread of soil borne pathogens will be increased as easliy as mud on a boot. Port Orford Cedar Root Rot, *Phytophthora lateralis*, and Douglas Fir Laminated Root Rot, *Phellinus weirii*, are both local soil borne pathogens, which, once introduced to a stand, can effectively kill all host stems as they radiate out from the infection source. *P. lateralis* in particular has devastated a once very valuable timber species in Coos and Curry county. Once established, these organisms cannot be removed from the stand without removing all host species stems for a period of at least ten years. If you throw in vandalism, un-authorized hunting, mushroom picking, bough collection and dumping, it is easy to see why all industrial private timber lands in the state are attempting to severely reduce access to their crop.
- The proposed pipeline would have a ±100' construction right of way, followed by a 50' permanent right of way. This would mean that the applicant proposes to replant the 20-25' on either side to return it to productive timber. Once established these two 25'wide swaths of trees would constitute un-harvestable ground. They would be of a significantly different age class then the surrounding timber and would have absolutely no access do to restriction on equipment operation within the permanent right of way. Also the trees, especially within the interior of the corridor, would be of poor quality due to the amount of limbs growing on the inside edge. Generally speaking, a landowner could expect 5-15% of the timber harvested to be of poor

quality due to it's limbiness, mills want straight trees with few knots. The proposed 'mini-stands' would not only have very limited access, they would also have at least 50% of the trees deducted due to limbs. Currently Doug Fir saw logs graded 1-3p (good) are $600/mbf, while limby poorer quality logs (2-3s) are $450/mbf, **a 25% decrease**.
http://www.oregon.gov/ODF/STATE_FORESTS/TIMBER_SALES/logP110.shtml

- The proposed pipeline would significantly reduce the landowner or local response team's ability to fight forest fires, especially if they occur as result of trespass along the cleared right of way. One of the most effective methods for stopping the spread of forest fire is to run a 'cat line' above the leading edge of the fire with a bulldozer. Most if not all of the long time loggers in Coos Co have had to do this at one time or another. If access is restricted to hard-crossings then you have the combination of a forest fire which you cannot get to on top of a 3' gas pipeline. The idea of a 'cleared right of way' is somewhat misleading. Having utilized powerline right of ways to access timber land to survey, I can say that they generally have high surface fuel loads. Mulching of the entire pipeline is not possibly, so hand slashing and spraying will be utilized frequently, creating lots of small diameter fuels with direct exposure to the sun making them even drier. This ribbon of dried fuels could easily hasten the spread of a wildfire across the property.
- Though not as common or as profitable as intensively managed timber harvesting, setting forest land aside for conservation easements, watershed benefits and the sale of sequestered carbon is becoming more and more prevalent. Certified forestry (Forest Stewardship Council) and government funding provides the landowner with some funding for these projects. None of these activities would be possible with a permanent easement across the property. This is even more restrictive for wetland mitigation projects within the lower grazing grounds. The applicant will be utilizing wetland mitigation banks to offset the loss of wetlands during the proposed terminal construction. The proposed pipeline would significantly reduce landowners rights to develop potential non-traditional funding sources.

Coos Co Zoning Land Develop Ordinance 4.8.400 states "*The proposed use will not force a significant change in, or significantly increase the cost of, accepted farming or forest practices on agriculture or forest lands.*" Most of the impacted forest lands within Coos Co are private, non-industrial timber lands. These landowners do not have the land-base to absorb the increased costs of timber operations which I described above, yet they often rely on the timber proceeds for some if not all of their income. These properties are some of the most productive timber lands in the nation, that is why they were zoned as such. Even with the high level of productivity, making money of off trees is marginal at best. The market fluctuations require a successful timber land owner to have enough options to ride out the lows and save from the high times. The proposed pipeline project could effectively end a livelihood for impacted properties by increasing the costs of doing business while increasing the associated risks.

Please feel free to contact me with any questions

Thanks

Jake Robinson
Yankee Creek Forestry
94961 Stock Slough Rd
Coos Bay, OR 97420
541 941 1822

Exhibit H

Exhibit H

Current 2012 Tsunami Evacuation Map of Jordan Cove Project area

Orange – Distant Tsunami evacuation zone

Yellow – Local Cascadia Earthquake and Tsunami evacuation zone

Full Tsunami Evacuation Map for Coos Bay Area available at: http://www.oregongeology.org/pubs/tsubrochures/CoosBayEvac.pdf (4.03 MB)

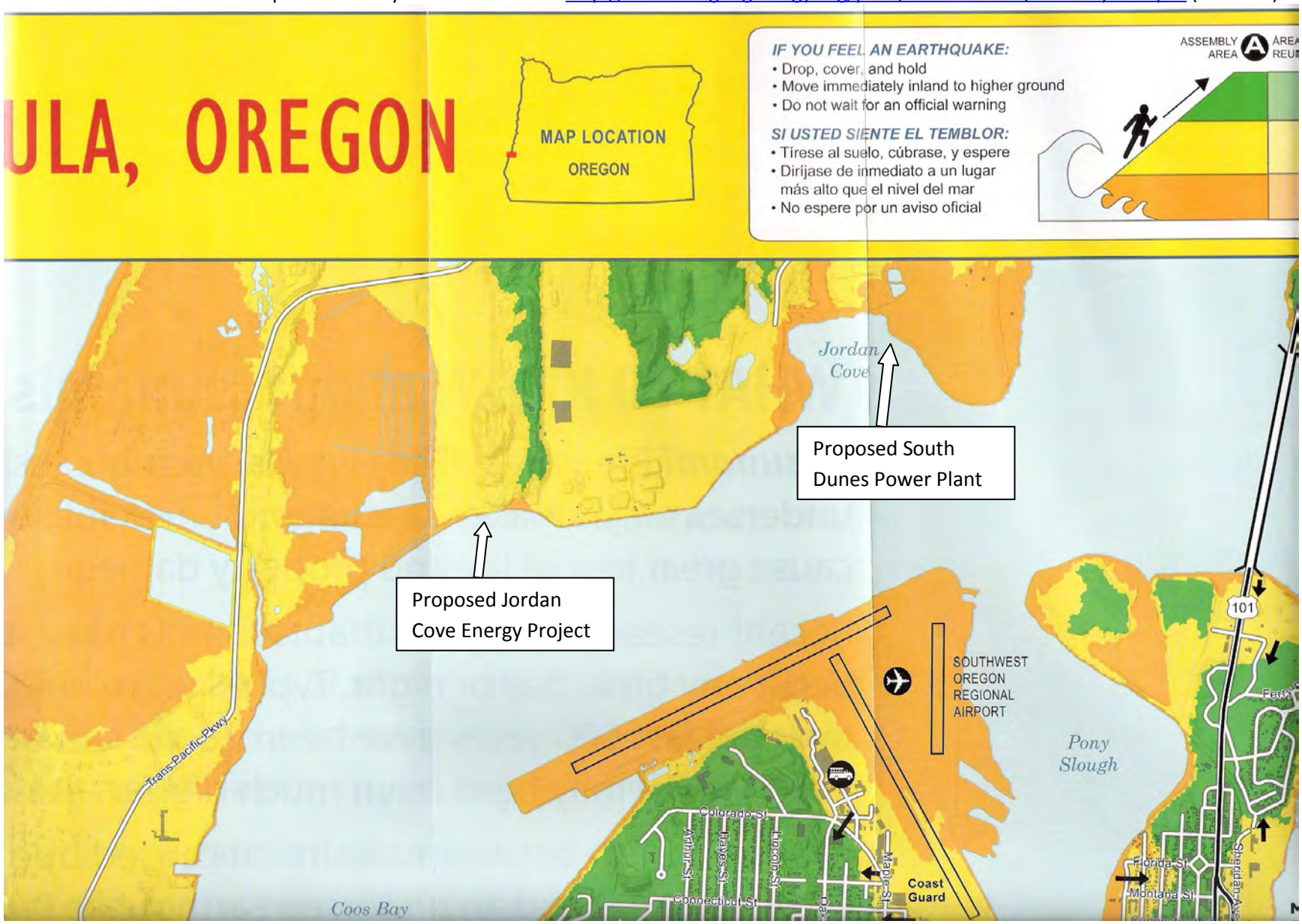


Exhibit I

Jordan Cove LNG Tanker Hazard Zones (FEIS Page 4.7-3)

No one is expected to survive in Zone 1 (yellow) - Structures will self ignite in this zone just from the heat. People in Zone 2 (green) will be at risk of receiving 2nd degree burns in 30 seconds on exposed skin. People in Zone 3 are still at risk of burns if they don't seek shelter but exposure time is longer than in Zone 2. Map does not include the hazard zones for the South Dunes Power Plant.

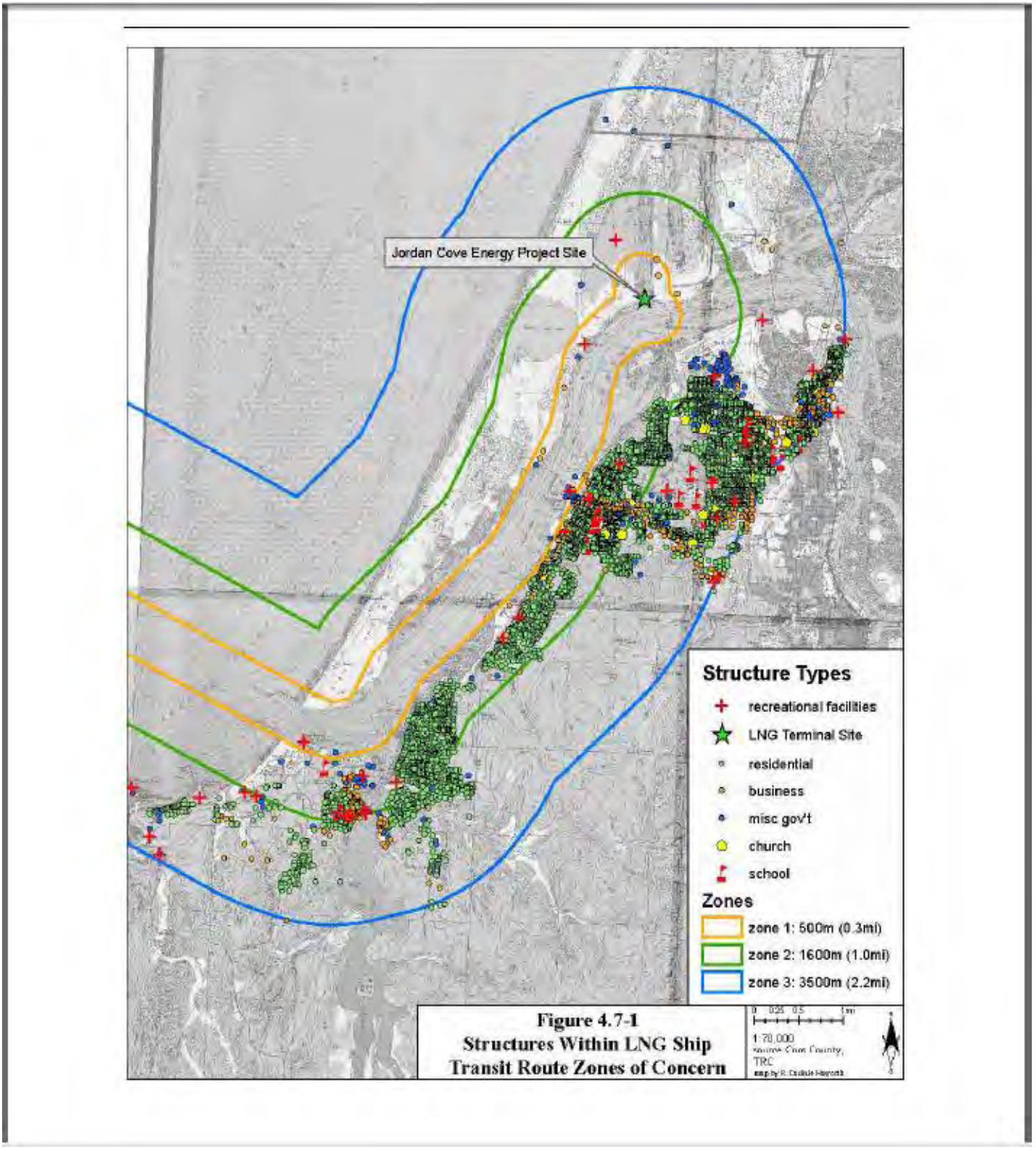


Exhibit J

EXHIBIT J

Calculating 148,000 cubic meter LNG ship at –
600 to 1 and 610 to 1 conversion from Natural Gas and how many shipments that would mean:

148,000 cubic meters LNG = 5,226,570.675 cubic feet LNG

5,226,570.675 X **600** = 3,135,942,405 cubic feet of natural gas

292,000,000,000 cubic feet of gas (yearly) :/: 3,135,942,405 cubic feet of gas per shipload = **93 shipments needed per year = 186 harbor disruptions at high slack tide.**

[**Note:** Jordan Cove non-FTA Application page one says JCEP will export 292 billion cubic feet (Bcf) per year (.8 Bcf/d); Page 13 states .9 Bcf/d beginning in 2017; ECONorthwest Construction Impact Study page 3 states; " The PCGP would have a nameplate capacity of 1.1 billion cubic feet of natural gas per day (Bcfd). At a 90 percent capacity factor, throughput would average 0.99 Bcfd." Page 5 states; "A single natural gas compressor station at Malin will allow the PCGP to transport 1.1 Bcfd to JCEP terminus in Coos County."]

****

148,000 cubic meters LNG = 5,226,570.675 cubic feet LNG

5,226,570.675 X **600** = 3,135,942,405 cubic feet of natural gas

365,000,000,000 cubic feet of gas (yearly) :/: 3,135,942,405 cubic feet of gas per shipload = **116 shipments needed per year = 232 harbor disruptions at high slack tide**

****

148,000 cubic meters LNG = 5,226,570.675 cubic feet of LNG

5,226,570.675 X **610** = 3,188,208,111.75 cubic feet of natural gas

365,000,000,000 cubic feet of gas (yearly) :/: 3,188,208,111.75 cubic feet of gas per shipload = **114 shipments needed per year = 228 harbor disruptions at high slack tide**

****

116 shipments: /: 12 (months) = Ten shipments per month (roughly) A shipment every 2 – 3 days. Some of the LNG is left in the ship to keep the containers cold and there is also LNG lost to boil off (about 15 % per shipment by some estimates) that has not been figured into these estimates.

Who's to say that the minute the DOE and FERC would approve this, Jordan Cove Energy Project would submit another application to increase their export capacity?

Another good question would be what is the pollution impact of having all these smaller ships? Right now most of the newer ships being built are much larger than 148,000 cubic meters - www.coltoncompany.com

Citizens Against LNG
Petition Exhibit

(Set 4 Beginning #501)

A portion of this document at this location is being withheld for redaction of Personally Identifiable Information.

A redacted version of this document will be posted when that process is complete.

Exhibit 3

Jody McCaffree
Individual / Executive Director
Citizens Against LNG
PO Box 1113
North Bend, OR 97459

September 12, 2012

By Email
fergas@hq.doe.gov
larine.moore@hq.doe.gov

Ms. Larine A. Moore
Docket Room Manager
FE-34
U.S. Department of Energy
PO Box 44375
Washington, D.C. 20026-4375

Re: Answer of Jordan Cove Energy Project, L.P. to Protests of Application for Long-Term Authorization to Export Liquefied Natural Gas to Non-Free Trade Agreement Nations, FE Docket No. 12-32-LNG

Dear Ms. Moore:

Please accept for filing the following response of Citizens Against LNG to the recent "Answer" filed by the Jordan Cove Energy Project (JCEP) dated August 29, 2012. We received this document by postal mail only a few days ago and even though the document has yet to appear in the U.S. Department of Energy Office of Fossil Energy e-library web portal for FE Docket No. 12–32–LNG, we feel a response is warranted in this case.

The Jordan Cove "Answer" included yet another ECONorthwest report that was dated May 14, 2012, and titled, "*The Impact of the Jordan Cove Energy Project on Coos County Housing and Schools.*" As previously explained in our August 6, 2012, protest comments, the U.S. Department of Energy Office of Fossil Energy should take a closer look into the ECONorthwest reports being submitted by the Jordan Cove Energy Project. The following supporting evidence is being provided to you in addition to our previously submitted documentation to help give you a better understanding as to why a thorough independent economic analysis is in order by the U.S. Department of Energy.

In October 2006 the South Coast Development Council (SCDC) in Coos Bay, Oregon, who fully supported the proposed Jordan Cove liquefied natural gas (LNG) import project, engaged the Portland-based ECONorthwest to forecast the net economic benefits of the proposed Jordan Cove LNG project. The report, "*Forecast of the Net Economic Benefits of a Proposed LNG*

Terminal in Coos County, Oregon," [1] was used as a justification for the Jordan Cove LNG import facility and was relied on by the Federal Energy Regulatory Commission (FERC) in the preparation of the Environmental Impact Statement (EIS) that led to the FERC Order approving the project in 2009. The ECONorthwest report was flawed for several reasons in that it did not include negative economic impacts that would have occurred as a result of the proposed Jordan Cove LNG import facility, nor did the report confirm the specifics as to the high number of jobs they were predicting would result due to Jordan Cove's operations. We now know the 2006 predictions and projections by ECONorthwest were incorrect. On Feb. 29, 2012, Jordan Cove notified FERC that due to current market conditions they no longer intended to implement their Dec. 17, 2009, FERC Order authorizing them to construct and operate a LNG import terminal. FERC vacated the Order for the Jordan Cove import project on April 16, 2012. Obviously the Jordan Cove Energy Project would not have produced the economic benefits and jobs that the 2006 ECONorthwest report had predicted would occur from the importation of LNG.

The U.S. Department of Energy should consider taking a thorough investigative review of the ECONorthwest reports similar to what the United States Department of Agricultural (USDA) Rural Development did in 2008. In December of 2008, the USDA Rural Development questioned the reliability and accuracy of an ECONorthwest report that was being used to justify a $6 million dollar proposed expansion of the Salmon Harbor resort in Winchester Bay, Oregon. The USDA did their own investigation and found the ECONorthwest projections used to justify the proposed expansion were not feasible, nor were the ECONorthwest conclusions warranted. As a result of the investigation, the USDA pulled their funding for that proposed project. (See Exhibit A) Likewise, the U.S. Department of Energy Office of Fossil Energy should not rely solely on the economic projections being provided by the Jordan Cove Energy Project. Before our property rights, businesses, people and the environment are potentially put at risk there should be an in-depth, complete and accurate economic analysis that includes the impacts on the public both now and in the future from exporting LNG. As we stated earlier in our August 6, 2012, protest comments on page 7:

> "Jordan Cove has already demonstrated its inability to predict demand for natural gas imports and exports. Jordan Cove based the proposed Jordan Cove LNG import terminal in Coos Bay on predictions that an import facility would be needed to meet growing U.S. demand for natural gas imports from overseas. These predictions turned out to be wrong.
>
> "Jordan Cove's assumption about sustained Asian demand for LNG imports is likely to be wrong as well; the same factors that created an oversupply of domestic natural gas would likely also create an oversupply of natural gas in Asia, curtailing demand for LNG imports from the U.S. and rendering a West Coast-based LNG export facility economically unviable…."

An example of the kind of economic analysis that should be done by the U.S. Department of Energy can be found in the 2006 Passamaquoddy Whole Bay Study (Part 1) that was completed

[1] "*Forecast of the Net Economic Benefits of a Proposed LNG Terminal in Coos County, Oregon*" An Economic Impact Analysis Prepared for the South Coast Development Council – October 16, 2006 ; ECONorthwest

by Yellow Wood Associates, Inc.[2] Citizens of three nations, the United States, Canada and the Passamaquoddy Tribe, commissioned the Whole Bay Study to determine what the potential costs and benefits of one or more LNG terminals in Passamaquoddy Bay would mean from the perspective of Bay communities. The focus of the Part 1 Whole Bay Study was on direct employment impacts on local residents and businesses, economic impacts on the real estate market, and fiscal impacts related to community infrastructure, transportation, housing, public safety and property values.

Unlike the ECONorthwest reports being presented to the U.S. Department of Energy Office of Fossil Energy by the Jordan Cove Energy Project, the Passamaquoddy Whole Bay Study looked at both economic benefit and loss. Part 1 of the Whole Bay Study concluded that there was no net gain that was realized overall by these LNG facilities and that the economic stimulus provided to a region by one or more LNG import terminals would be limited. The study also concluded the following:

> "…LNG is not a local resource. The beneficiaries of LNG development, including both investors and consumers, will be overwhelmingly from away. LNG is not a renewable resource. LNG is not an inexpensive form of energy. Even if LNG were made available through pipeline extensions and connections to local communities, it would not shield these communities from price hikes dictated by multinational corporations and the global economy. Nor would it increase the capacity of local communities to meet their own energy needs affordably today and in the future…
>
> "...**Economic Diversification**
> A diversified economic base in which the elements are compatible and synergistic is widely viewed as contributing to the health, resiliency, and vitality of rural communities. Diversity means that no single employer dominates the market, no single landowner dominates the tax rolls, and no single buyer determines the fate of the community.
>
> " Several of the LNG terminals proposed for Passamaquoddy Bay communities are offering millions of dollars in "support" to host communities in an attempt to make their development proposals more palatable. Although millions of dollars sounds like (and is) a lot of money in the context of a small rural community, in the context of LNG, it is very little. Each proposed terminal on Passamaquoddy Bay has the capacity to handle more than $1 billion worth of natural gas each year at present prices. Local communities need to be aware of the trade-offs made in accepting such "support." Once a single corporate entity comprises the majority of the tax base, communities rapidly lose the capacity and ability to make independent decisions regarding local services and investments..."[3]"

---

[2] "*Report on Potential Economic and Fiscal Impacts of LNG Terminals on the Whole Passamaquoddy Bay*". Prepared by Yellow Wood Associates, Inc – June 20th 2006
http://www.savepassamaquoddybay.org/documents/community_impact_studies/whole_bay_study/whole_bay_study/WholeBayStudy-Part_1.pdf
"*Study: Impacts of LNG costly, benefit limited*", Edward French; THE QUODDY TIDES Newspaper; Vol. 38, No. 14; June 23, 2006; http://quoddytides.com/lng6-23-06.html

[3] "*Report on Potential Economic and Fiscal Impacts of LNG Terminals on the Whole Passamaquoddy Bay*". Prepared by Yellow Wood Associates, Inc – June 20th 2006 – Page 121

The Yellow Wood Associates determined that a more thorough study would be required to determine the extent to which any economic gains that do result from LNG may be offset by damage to existing sections and that may create new obstacles of future economic diversification and sustainability.

Citizens in rural poor areas such as Coos Bay, Oregon, do not have the resources that the multinational corporations and the gas and oil industry have to conduct such a thorough independent analysis. We citizens depend on agencies such and the United States Department of Agricultural (USDA) Rural Development and the U.S. Department of Energy to do such an analysis for us and to make sure their decisions are in the public interest.

It would "not" be in the public interest of our fishing, timber, clamming, crabbing, oyster growing, farming, tourism, recreation and industries that use natural gas for the U.S. Department of Energy to make a decision on Jordan Cove exporting LNG to non-free trade agreement nations based solely on economic projections and reports provided by the Jordan Cove Energy Project. The decision as to whether Jordan Cove should be allowed to export LNG to nations that do not have a free trade agreements with the United States should be based on a rigorous independent economic and environmental impact analysis that includes "all" potential impacts (both negative and positive) of exporting natural gas from both natural gas produced domestically in the United States and natural gas produced in Canada. The analysis should encompass all proposed and potential LNG export proposals in North America.

Sincerely,

/s/ Jody McCaffree

Jody McCaffree

cc:
DOE/FE
john.anderson@hq.doe.gov
marc.talbert@hq.doe.gov
DOE/GC
edward.myers@hq.doe.gov

By postal mail to all persons listed in the Service list for FE Docket No. 12-32-LNG

The World – Coos Bay
http://theworldlink.com/news/local/feds-say-no-to-resort-funding/article_9b6904dc-b754-5a19-a23c-409471752788.html

Feds say no to resort funding

Monday, December 28, 2009 By Alex Powers, Reedsport Staff Writer

REEDSPORT — Federal officials have pulled funding for the Salmon Harbor Marina's proposed Phase III expansion to its resort.

In a letter dated Dec. 14 to the Port of Umpqua, Clem Singer, Roseburg area director for USDA Rural Development, told commissioners "there remains some serious doubt" if the expansion could pay for itself.

The nearly $6 million expansion calls for 46 new campsites, a bathroom and an about $1.8 million, 9,576-square-foot community building in Winchester Bay. According to an economic impact study prepared in 2008 by Portland-based ECONorthwest, that center could draw guests to the park during winter, a time of year that historically sees low usage from RVs. The study said in its first year, the expanded RV resort is expected to make $426,855 and more each year after that.

"It's not feasible. That building is not going to pay for itself. It's just not," Singer said.

Singer said USDA was not satisfied with ECO Northwest's projections.

"The conclusions that they drew weren't warranted, in our opinion," he said.

He said USDA also examined the occupancy earlier this year at Lakeside's Osprey Point RV Resort, Woahink Lake RV Resort and Sea Perch RV Resort in Yachats.

"All three of those, we were told, have high wintertime occupancy," Singer said.

USDA found they have few guests during winter.

Harbor Master Jeff Vander Kley said Salmon Harbor cannot become a special district and tax for revenue. It may look to Douglas County for assistance.

"This effort to expand the RV resort was to reduce the need for the county … contributions to the operations," Vander Kley said. "It's a big conundrum."

County Commissioner Susan Morgan asked the marina earlier this month to re-evaluate ECONorthwest's analysis.

Marina project manager Linda Noel said the marina probably will plug updated cashflow information from the resort into the original report, while Vander Kley said the agency may consider downsizing or phasing the project.

CERTIFICATE OF SERVICE

I hereby certify that in accordance with 10 C.F.R. § 509.107 (c), I have this 12th day of September 2012 caused a copy of the foregoing to be served by mail to the following individuals listed in the Service list for FE Docket 12-32 LNG:

Elliott L. Trepper, President
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Dickstein Shapiro LLP
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Washington DC 20006-5403

Clarence Adams
Landowners United
2039 Ireland Road
Winston, OR 97496

David Schryver, Executive Vice President
The American Public Gas Association
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Washington DC 20002

William T. Miller, Attorney
Miller, Balis & O'Neil, P.C.
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Washington DC 20005

Lesley Adams,Program Director
Rogue Riverkeeper
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Joseph Vaile, Program Director
Klamath-Siskiyou Wildlands Center
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Ashland, OR 97520

Nathan Matthews, Attorney
Sierra Club Environmental Law Program
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San Francisco, CA 94105

Kathleen Krust, Paralegal
Sierra Club Environmental Law Program
85 Second Street, 2nd Floor
San Francisco, CA 94105

Sincerely,

/s/ Jody McCaffree

Jody McCaffree

Exhibit 4

Exhibit 4

http://www.dailymail.co.uk/sciencetech/article-2208953/Shock-report-claims-100m-people-die-economic-growth-drop-3-2-2030-climate-change-ignored.html

Ignore climate change and 100m people will die by 2030, shocking new report claims

By DAILY MAIL REPORTER
PUBLISHED: 26 September 2012 |

More than 100 million people will die and global economic growth will be cut by 3.2 percent of gross domestic product (GDP) by 2030 if the world fails to tackle climate change, a report commissioned by 20 governments has claimed.

As global average temperatures rise due to greenhouse gas emissions, the effects on the planet, such as melting ice caps, extreme weather, drought and rising sea levels, will threaten populations and livelihoods, said the report conducted by humanitarian organisation DARA.

It calculated that five million deaths occur each year from air pollution, hunger and disease as a result of climate change and carbon-intensive economies, and that toll would likely rise to six million a year by 2030 if current patterns of fossil fuel use continue.

More than 90 percent of those deaths will occur in developing countries, said the report that calculated the human and economic impact of climate change on 184 countries in 2010 and 2030.

It was commissioned by the Climate Vulnerable Forum, a partnership of 20 developing countries threatened by climate change.

'A combined climate-carbon crisis is estimated to claim 100 million lives between now and the end of the next decade,' the report said.

It said the effects of climate change had lowered global output by 1.6 percent of world GDP, or by about $1.2 trillion a year, and losses could double to 3.2 percent of global GDP by 2030 if global temperatures are allowed to rise, surpassing 10 percent before 2100.

It estimated the cost of moving the world to a low-carbon economy at about 0.5 percent of GDP this decade.

British economist Nicholas Stern told Reuters earlier this year investment equivalent to 2 percent of global GDP was needed to limit, prevent and adapt to climate change.

His report on the economics of climate change in 2006 said an average global temperature rise of 2-3 degrees Celsius in the next 50 years could reduce global consumption per head by up to 20 percent.

Temperatures have already risen by about 0.8 degrees Celsius above pre-industrial times.

Almost 200 nations agreed in 2010 to limit the global average temperature rise to below 2C (3.6 Fahrenheit) to avoid dangerous impacts from climate change.

But climate scientists have warned that the chance of limiting the rise to below 2C is getting smaller as global greenhouse gas emissions rise due to burning fossil fuels.

The world's poorest nations are the most vulnerable as they face increased risk of drought, water shortages, crop failure, poverty and disease.

On average, they could see an 11 percent loss in GDP by 2030 due to climate change, DARA said.

'One degree Celsius rise in temperature is associated with 10 percent productivity loss in farming.

'For us, it means losing about 4 million metric tonnes of food grain, amounting to about $2.5 billion.

'That is about 2 percent of our GDP,' Bangladesh's Prime Minister Sheikh Hasina said in response to the report.

'Adding up the damages to property and other losses, we are faced with a total loss of about 3-4 percent of GDP.'

Even the biggest and most rapidly developing economies will not escape unscathed.

The United States and China could see a 2.1 percent reduction in their respective GDPs by 2030, while India could experience a more than 5 percent loss.

The full report is available here:
http://daraint.org/climate-vulnerability-monitor/climate-vulnerability-monitor-2012/report/

Executive Summary here:
http://www.daraint.org/wp-content/uploads/2012/09/EXECUTIVE-AND-TECHNICAL-SUMMARY.pdf

Exhibit 5

REPORT: CLIMATE CRISIS ALREADY CAUSING UNPRECEDENTED DAMAGE TO WORLD ECONOMY; HUMAN IMPACT ON LARGE-SCALE

- New and comprehensive assessment of the costs of climate change
- Inaction on climate change already causing over one trillion dollars in losses
- Costs to escalate rapidly: global GDP stunted by over 3 percent by 2030 – crisis to increasingly hold back growth if urgent action is not taken
- Climate change and carbon economy linked to 5 million deaths each year
- High-level political, scientific and economic leaders call for international action to halt surge in losses to human life and the world economy hitting all nations

NEW YORK, Wednesday 26 September 2012 – DARA and Climate Vulnerable Forum report: Most comprehensive ever assessment of the current global impact of climate change released today.

20 governments commissioned the independent report, the first of its kind to show that tackling the global climate crisis would already reap significant economic benefits for world, major economies and poor nations alike.

"*Climate Vulnerability Monitor*" study's findings point to unprecedented harm to human society and current economic development that will increasingly hold back growth, on the basis of an important updating and revision of previous estimates of losses linked to climate change.

KEY FINDINGS INCLUDE THE FOLLOWING ESTIMATES:

- Climate change and a carbon-intensive economy considered a leading global cause of death today, responsible for 5 million deaths each year – 400,000 due to hunger and communicable diseases aggravated by climate change and 4.5 million carbon economy deaths due mainly to air pollution
- Failure to act on climate change *already costs* the world economy 1.6% of global GDP amounting to 1.2 trillion dollars in forgone prosperity a year
- Rapidly escalating temperatures and carbon-related pollution will double costs to 3.2% of world GDP by 2030
- Losses for lower-income countries are already extreme: 11% of GDP on average for Least Developed Countries already by 2030
- Major economies are heavily hit: in less than 20 years China will incur the greatest share of all losses at over 1.2 trillion dollars; the US economy will be held back by more 2% of GDP; India, over 5% of its GDP

- Economic losses dwarf the modest costs tackling climate change: emission reductions at just 0.5% of GDP for the next decade; and support to the vulnerable: a minimum of 150 billion dollars per year for developing countries

Climate Vulnerable Forum Chair, Bangladesh – one of the largest newly-emerging economies in Asia – represented by **Prime Minister Sheikh Hasina** officially launched the report at a major diplomatic event to coincide with the 67th session of United Nations General Assembly. Commenting on the report she said:

> *"One degree Celsius rise in temperature is associated with 10% productivity loss in farming. For us, it means losing about four million metric tonnes of food grain, amounting to about US$ 2.5 billion. That is about 2% of our GDP. Adding up the damages to property and other losses, we are faced with a total loss of about 3-4% of GDP. Without these losses, we could have easily secured much higher growth."*
>
> *"After seventeen years of international negotiations, we are still without any meaningful agreement or action to reduce global warming. As a climate vulnerable country, every day we see and feel the ramifications of that inaction as outlined in the Climate Vulnerable Monitor. But experts have struggled to tie all the pieces together to design a clear picture of climate vulnerability. This report examines impacts linked to climate change in some new ways and attempts to draw new conclusions. We did not have access to this information until now. Of course, experts may call into question this or that aspect of the Monitor's findings, but we are certain subsequent research will continue to reaffirm the broad conclusions of the report. Its publication is a milestone for the climate negotiations. It is our hope it will help redirect efforts to effectively address the harms being done to today's economy. We continue to work with all governments and other stakeholders to bring about a fair and just outcome to the negotiations."*

The report is the second to be issued by an ongoing international research program on climate-related vulnerability mandated to the independent humanitarian and development research organization, DARA. Its expanded assessment of the costs of inaction on climate change presents a new and original assimilation of the latest scientific evidence, research and data in a survey of thirty-four indicators of climate-related concern. The study estimates human and economic impacts for 184 countries in 2010 and 2030 across a wide range of separate effects. Indicators of impact range from issues such as hunger and skin cancer, to permafrost thawing and sea-level rise, indoor and outdoor air pollution, and fisheries, biodiversity and forest deterioration. Constraints on labor productivity, imposed by rising heat, are the largest single impact due to climate change and a new component of the analysis.

High-level and technical panels of over 50 leading scientists, economists, and policy experts, including former heads of government, reviewed the report

whose development also involved field-based research in Africa and Asia.

Report Panel member, **DARA Trustee and Former President of Costa Rica José María Figueres** said today:

> *"1.3 billion people are still fighting their way out of the most extreme forms of poverty while major economies are today fighting their way out of crippling financial and economic crises. We simply cannot afford to part with more growth. The prospect of economic losses that rise with every decade could destabilize the world economy far before the worst impacts of climate change set in. Governments and international policy makers must act decisively to combat the spiraling costs to national and global GDP resulting from inaction on climate change. The Monitor shows how failure to do so has already caused unprecedented damage to the world economy and threatens human life across the globe. With the investment required to solve climate change already far below the estimated costs of inaction, no doubt remains as to the path worth taking."*

The new Monitor report, entitled "A Guide to the Cold Calculus of A Hot Planet," juxtaposes on the one hand the large-scale anticipated increases in fossil fuel consumption over the coming decades with the enormous human and developmental consequences of this. However, it also points out that decisions taken on cold monetary terms alone would actually favour strong action on climate change globally and regionally.

The report outlines how the first edition of the Monitor is already used as a tool by development, humanitarian and aid agencies concerned with addressing the growing impact of climate change around the world, as well as investment and security analysts among others.

Ends

FOR ADDITIONAL COMMENT, INFORMATION OR TO REQUEST AN INTERVIEW WITH A DARA/FORUM SPOKESPERSON, PLEASE CONTACT:

Daniel Rolle, MHP Communications

daniel.rolle@mhpc.com / +44 (0)203 128 8199 / +44 (0)7946 656 212

Tom Gillingham, MHP Communications

tom.gillingham@mhpc.com / +44 (0)20 3128 8151 / +44 (0) 7585 301 464

About the Monitor

The *Climate Vulnerability Monitor* measures the global impact of climate change and the carbon economy at a national level. It calculates and compares the vulnerability for 184 countries in four areas of impact (environmental disasters, habitat change, health impact and industry stress) using 34 climate and carbon related indicators. The monitor uses five levels of vulnerability, from acute to low, to compare and contrast nations.

The first Monitor was launched in 2010 to assess the effects of global climate change on nations up to 2030. It uses current peer-reviewed scientific research, in-country field research and critical input from two separate external advisory bodies.

About DARA

Founded in 2003, DARA is an international organization headquartered in Madrid, Spain, committed to improving the effectiveness of aid for vulnerable populations suffering from conflict, disasters and climate change.

It is an impartial, non-partisan, non-profit entity independently governed by a foundation Board of Trustees and actively engaged in field research and evaluation work of aid programs and operations in developing countries across five continents. It also produces and issues specialized publications and data in particular on aid accountability and effectiveness issues, as well as emerging strategic concerns for the development, humanitarian and disaster reduction domains.

DARA's Climate Vulnerability Initiative is mandated to develop the Monitor as an independent and politically impartial report and convenes the external advisory bodies that provide third-party guidance and review inputs to this process.

www.daraint.org

About the Climate Vulnerable Forum

Founded in 2009, the Climate Vulnerable Forum is a semi-formal government cooperation group of developing countries facing high degrees of insecurity due to climate change and active in seeking a resolution to the climate crisis.

The Forum has called for ambitious outcomes in international climate change policy, such as setting the temperature increase goal at 1.5° Celsius (2.7° Fahrenheit) which was subsequently also adopted by other groups of countries and played an important boundary definition role in the UN climate negotiations at Copenhagen in 2009. The Forum has advocated for and insisted on accountability to decisions taken in international arena regarding climate change and sustainable development and its members have committed to pursue domestic low-carbon and even carbon neutral development pathways.

The Forum currently has 20 members and meets periodically at head of government, ministerial and delegate levels. The Monitor is an analytical input and communication tool for Forum members, and the two country studies included in this report were undertaken in member countries, Ghana and Vietnam.

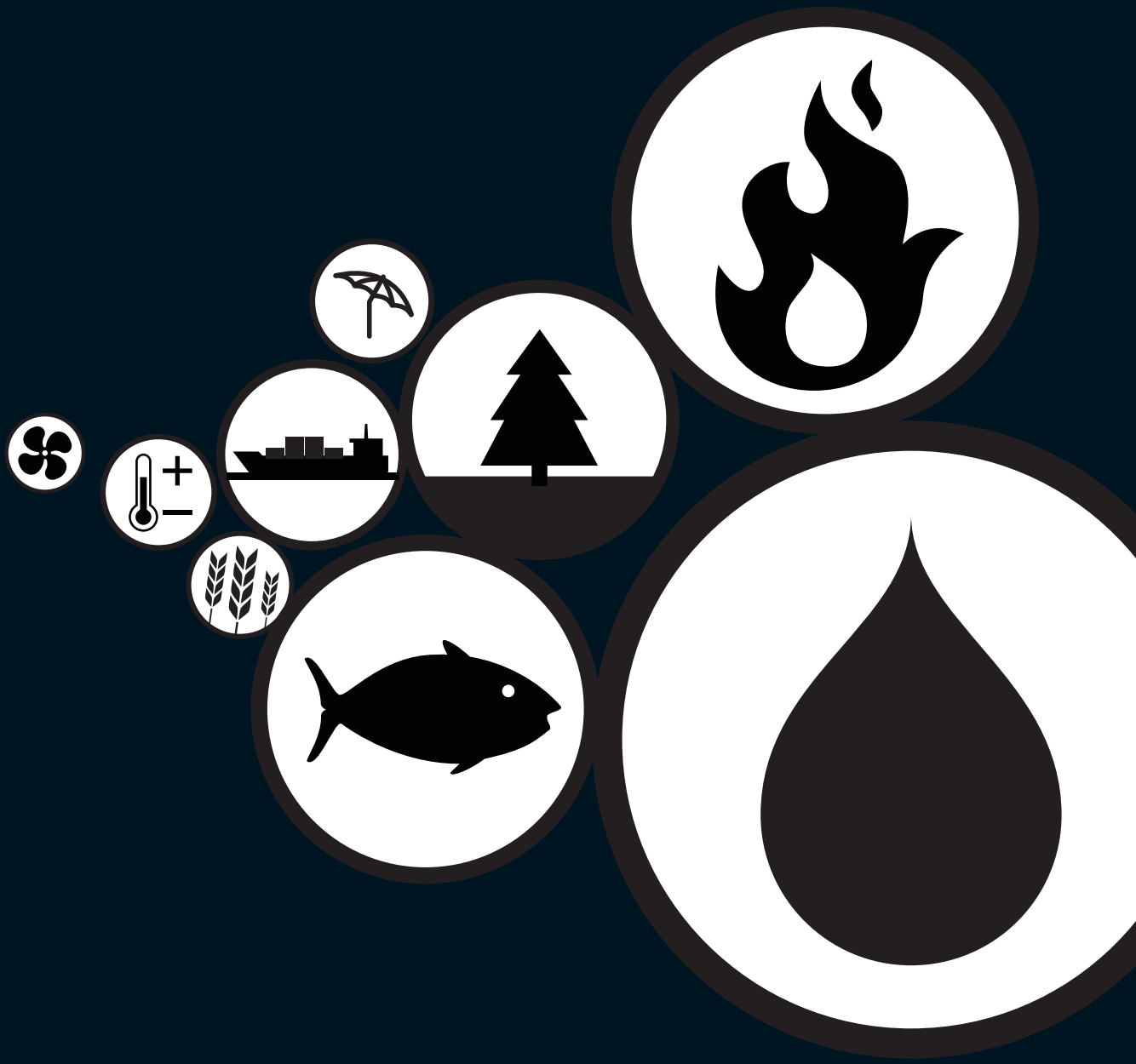
Exhibit 6

2ND EDITION CLIMATE VULNERABILITY MONITOR

A GUIDE TO THE COLD CALCULUS OF A HOT PLANET

Climate Vulnerable Forum

DARA

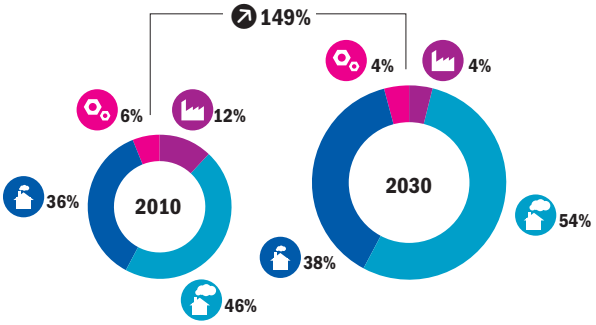


EXECUTIVE SUMMARY

This report provides a reassessment of the human and economic costs of the climate crisis. The reassessment is based on a wealth of the latest research and scientific work on climate change and the carbon economy, research that is assimilated as a part of this report.

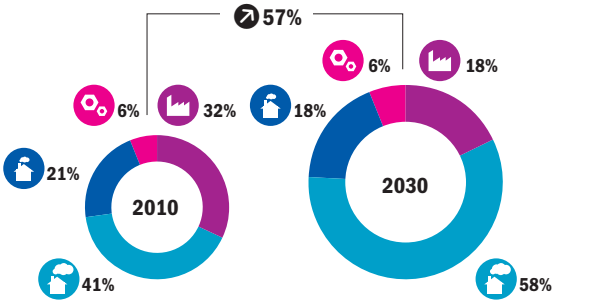
THE MAIN FINDING OF THIS REPORT IS THAT CLIMATE CHANGE HAS ALREADY HELD BACK GLOBAL DEVELOPMENT: IT IS ALREADY A SIGNIFICANT COST TO THE WORLD ECONOMY, WHILE INACTION ON CLIMATE CHANGE CAN BE CONSIDERED A LEADING GLOBAL CAUSE OF DEATH.

CLIMATE – TOTAL COSTS



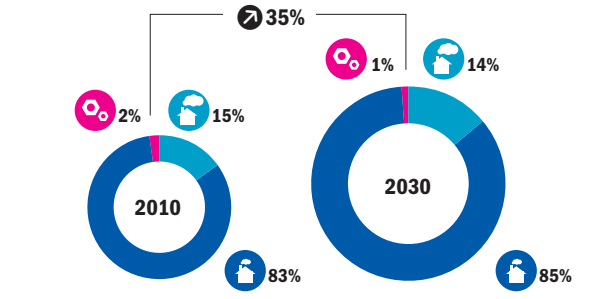
Developed
Developing Country High Emitters
Developing Country Low Emitters
Other Industrialized

CARBON – TOTAL COSTS



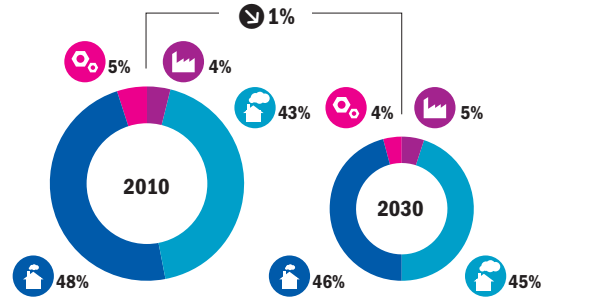
Developed
Developing Country High Emitters
Developing Country Low Emitters
Other Industrialized

CLIMATE – TOTAL DEATHS



Developing Country High Emitters
Developing Country Low Emitters
Other Industrialized

CARBON – TOTAL DEATHS



Developed
Developing Country High Emitters
Developing Country Low Emitters
Other Industrialized

This report estimates that climate change causes 400,000 deaths on average each year today, mainly due to hunger and communicable diseases that affect above all children in developing countries. Our present carbon-intensive energy system and related activities cause an estimated 4.5 million deaths each year linked to air pollution, hazardous occupations and cancer.

OVERALL COSTS

	Losses 2010, Bln PPP corrected USD	Losses 2010, % of GDP	Net Losses, % of GDP 2010	Net Losses, % of GDP 2030
Climate	696	0.9%	0.8%	2.1%
Carbon	542	0.7%	0.7%	1.2%
World	**1,238**	**1.7%**	**1.6%**	**3.2%**

Climate change caused economic losses estimated close to 1% of global GDP for the year 2010, or 700 billion dollars (2010 PPP). The carbon-intensive economy cost the world another 0.7% of GDP in that year, independent of any climate change losses. Together, carbon economy- and climate change-related losses amounted to over 1.2 trillion dollars in 2010.

The world is already committed to a substantial increase in global temperatures – at least another 0.5° C (1° F) due to a combination of the inertia of the world's oceans, the slow response of the carbon cycle to reduced CO_2 emission and limitations on how fast emissions can actually be reduced.[1] The world economy therefore faces an increase in pressures that are estimated to lead to more than a doubling in the costs of climate change by 2030 to an estimated 2.5% of global GDP. Carbon economy costs also increase over this same period so that global GDP in 2030 is estimated to be well over 3% lower than it would have been in the absence of climate change and harmful carbon-intensive energy practices.

Continuing today's patterns of carbon-intensive energy use is estimated, together with climate change, to cause 6 million deaths per year by 2030, close to 700,000 of which would be due to climate change. This implies that a combined climate-carbon crisis is estimated to claim 100 million lives between now and the end of the next decade. A significant

NUMBER OF DEATHS

		2010	2030
Climate	Diarrheal Infections	85,000	150,000
	Heat & Cold Illnesses	35,000	35,000
	Hunger	225,000	380,000
	Malaria & Vector Borne Diseases	20,000	20,000
	Meningitis	30,000	40,000
	Environmental Disasters	5,000	7,000
Carbon	Air Pollution	1,400,000	2,100,000
	Indoor Smoke	3,100,000	3,100,000
	Occupational Hazards	55,000	80,000
	Skin Cancer	20,000	45,000
World		**4,975,000**	**5,957,000**

TECHNICAL SUMMARY

The Monitor presents a new and original analysis, synthesizing the latest research and scientific information on the global impact – including benefits and losses – of climate change and the carbon economy in economic, environmental and health terms. Climate change already causes 400,000 deaths each year on average. The present carbon-intensive economy moreover is linked to 4.5 million deaths worldwide each year. Climate change to date and the present carbon economy are estimated to have already lowered global output by 1.6% of world GDP or by around 1.2 trillion dollars (2010 PPP). Losses are expected to increase rapidly, reaching 6 million deaths and 3.2% of GDP in net average global losses by 2030. If emissions continue to increase unabated in a business-as-usual fashion (similar to the new IPCC RCP8.5 scenario), yearly average global losses to world output could exceed 10% of global GDP before the end of the century, with damages accelerating throughout the century. The costs of climate change and the carbon economy are already significantly higher than the estimated costs of shifting the world economy to a low-carbon footing – around 0.5% of GDP for the current decade, although increasing for subsequent decades.[1]

This report and scientific literature imply adaptation costs

share of the global population would be directly affected by inaction on climate change.

Global figures mask enormous costs that will, in particular, hit developing countries and above all the world's poorest groups. Least Developed Countries (LDCs) faced *on average* in excess of 7% of forgone GDP in 2010 due to climate change and the carbon economy, as all faced inequitable access to energy and sustainable development.

Over 90% of mortality assessed in this report occurs in developing countries only – more than 98% in the case of climate change.

Of all these losses, it is the world's poorest communities within lower and middle-income countries that are most exposed. Losses of income among these groups is already extreme. The world's principal objectives for poverty reduction, the Millennium Development Goals (MDGs), are therefore under comprehensive pressures, in particular as a result of climate change.

The impact for rural and coastal communities in the lowest-income settings implies serious threats for food security and extreme poverty (goal 1 of 8), child health and the ability of children to attend school (goals 2 and 4), maternal health and women's development (goals 3 and 5), the prevalence of infectious diseases (goal 6) and, through water, fisheries and biodiversity impacts, environmental sustainability (goal 7). Furthermore, in a difficult fiscal environment, the advent of climate change has pressured governments to divert Official Development Assistance (ODA) funds from other development commitments and activities in an attempt to provide support for climate change concerns, including to a marginal degree, for helping vulnerable communities adapt to climate change. The Green Climate Fund, agreed upon in incrementally greater detail at the successive international climate talks at Copenhagen, Cancún and Durban, faces an economic environment of declining ODA tied to acute fiscal crises across a host of the world's wealthiest economies (see: climate finance). These developments have ultimately compromised the global partnership for development (goal 8). Lag areas towards MDG achievement also align very closely with the most pronounced vulnerabilities resulting from climate change: sub-Saharan Africa, small island developing states, and South Asia in particular.

Poverty reduction efforts are in peril as the potential temperature increase the world is already committed to has only begun to be realized, and the world's major economies are in no way spared. The United States, China and India in particular are expected to incur enormous losses that in 2030 for these three countries alone will collectively total 2.5 trillion dollars in economic costs and over 3 million deaths per year, or half of all mortality – the majority in India and China.

The whole world is affected by these comprehensive concerns: 250 million people face the pressures of sea-level rise; 30 million people are affected by more extreme weather, especially flooding; 25 million people are affected by permafrost thawing; and 5 million people are pressured by desertification. The pressures that these combined stresses put on affected communities are immense and force or stimulate the movement of populations. As is highlighted in the Ghana country study in this report, they can also fuel violence and an erosion of the social and economic fabric of communities.

The impact of climate change on Labour Productivity is assessed here as the most substantial economic loss facing the world as a result of climate change. A large proportion of the global workforce is exposed to the incessant increase in heat, with the number of very hot days and nights increasing in many places by 10 days a decade.[2] Developing countries, and especially the lowest-income communities, are highly vulnerable to these effects because of geographical location – northern countries like Scandinavia, it is assumed, *benefit* from improved labour productivity due to warmer weather – but also because their labour forces have the highest proportion of non-climate controlled occupational environments.[3] Global productivity in labour is surging due to technological advances and a shift of emphasis from agricultural activities to an industrial and service sector focus for most developing countries, among other key developments.[4] Climate change, however, holds back the full extent of productivity gains the world would otherwise enjoy.[5] In this way, the

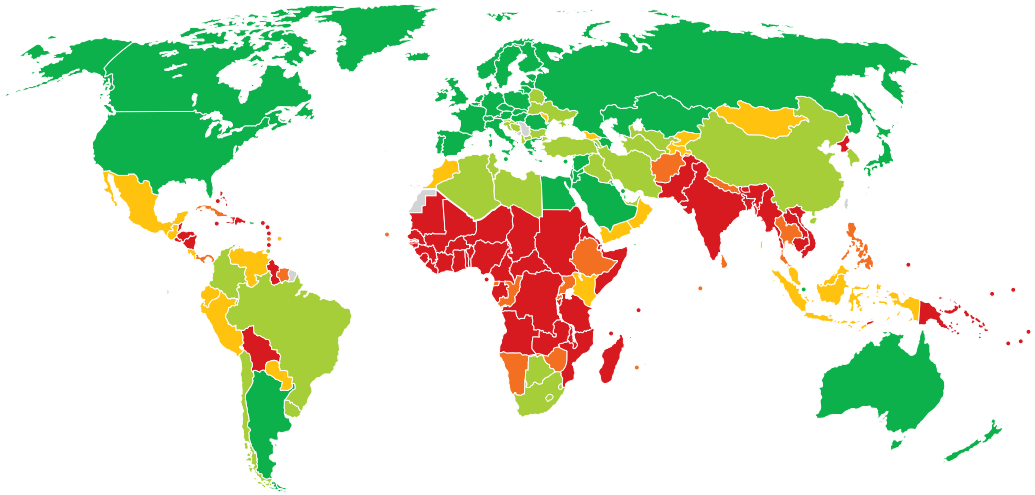
to be at least 150 billion dollars per year today for developing countries, rising to a minimum of more than 1 trillion dollars per year by 2030. These costs are, however, considerably lower than costs of damages to developing countries estimated here, so adapting to climate change is very likely a cost-effective investment in almost all cases and should be central to any climate change policy. Beyond adaptation, this report also emphasizes the urgency of mitigating key risks: tackling food security, indoor fires/ smoke, air pollution and other health issues such as diarrheal illnesses, malaria and meningitis that are all urgent priorities for lessening the extent of the human toll of this crisis.

With costs due both to unabated climate change and the carbon economy expected to rise rapidly over the course of this century, tackling climate change by reducing emissions yields net benefits to the world economy in monetary terms – amounting to around a 1% higher GDP for the entirety of the 21st century (net present value at a 3% discount rate). World net benefits from action on climate change are insensitive to discount rates from 0.1% to 20% (the highest tested). Even the most ambitious reductions in emissions aimed at holding warming below 2°C (e.g. 400ppm CO_2e/IPCC AR5 RCP2.6 scenario) generates economic benefits for the

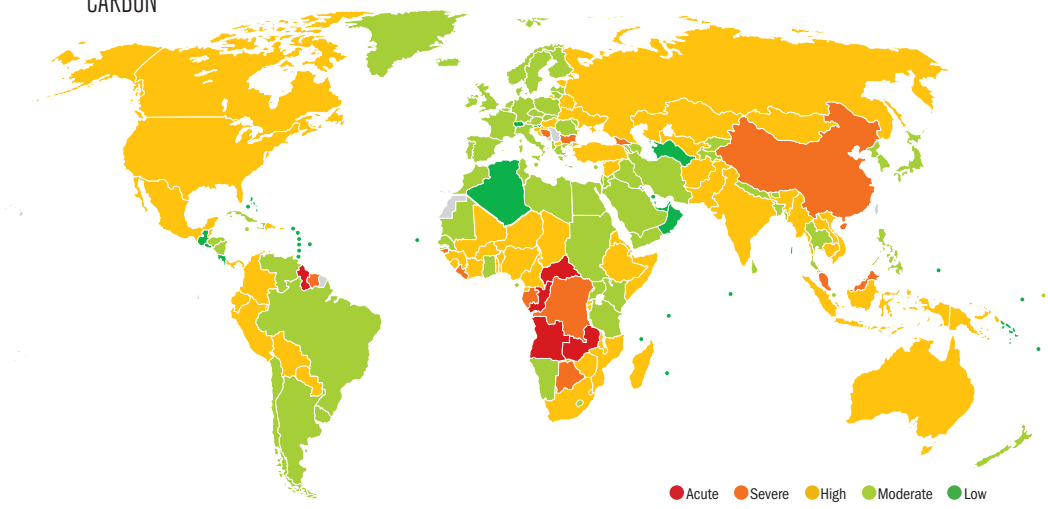
costs of climate change are hidden, which helps to explain in part how their full extent may have been missed. Even so, not all have benefitted from fast expanding labour productivity: labour productivity is a core indicator for MDG 1 (on extreme poverty and hunger), for instance, where little progress has been registered in many developing regions of the world, in particular for sub-Saharan Africa and the Pacific.[6] Not one country is *invulnerable* to the combined effects of climate change and the carbon economy. Inaction on climate change penalizes every country in the world, just as all are set to gain from action

MULTI-DIMENSIONAL VULNERABILITY

CLIMATE



CARBON



world economy after accounting for the costs of reducing emissions (mitigation costs). Limiting warming to this level would limit human, territorial and ecological damage as well as other concerns, such as climate-induced forced movement of human populations.

Over 98% of all climate change mortality and over 90% of all carbon economy related mortality is in developing countries: between 80% and 90% of all economic costs are projected to fall on developing countries. The most extreme effects of climate change are estimated to be felt by the Least Developed Countries, with average GDP losses of 8% in 2030. With respect to carbon economy effects, inequitable access to sustainable development sees Least Developed Countries again incurring the highest relative losses at over 3% of GDP, while between two thirds and three quarters of all carbon economy costs are borne by developing countries.

When the costs of climate change and the carbon economy estimated here are combined, not one country in the world is left unharmed. In terms of regional incentives to tackle climate change, every region is estimated to experience net economic benefits from action on climate change even for the highest levels of action.

The Monitor only analyses incremental impacts as a result of climate change, or changes in the frequency of well-known stochastic events, such as floods and landslides. Not assessed here in any way are potential catastrophic impacts that could occur due to more rapid climate change fuelled

on climate change. Moreover, the vulnerability of the world is shifting with every passing decade. Countries once resilient to marginal weather effects increasingly realize susceptibilities to a changed climate as the increase in heat and associated effects continue to reach new extremes.

Some quite serious damage is now unavoidable, but certain losses can still be reduced in the short term. In particular, human costs can be transferred to economic costs. This can be achieved through programmes aimed at reducing rural poverty – at the origin of hunger deaths and many communicable diseases afflicting the world's poorest groups, with risks that worsen with climate change. Or it can be achieved by ensuring clean air regulations, safer working conditions and modern energy options for people at risk due to carbon-intensive forms of energy. All these measures will save lives but cost money.

Economic losses themselves can also be lessened. A major recent review of humanitarian assistance work noted that Mozambique had requested 3 million dollars from the international community for flood preparations. That sum went unsecured, and 100 million dollars was subsequently spent on emergency flood response.[7] Investment in agriculture might also be cost-effective if the costs of supporting upgraded farming were to generate more benefits (in productivity, output) than the initial outlay.[8]

There are, however, limits to the ability of populations to adapt. The oceans can hardly be refrigerated against marine stresses.[9] Desert encroachment can be prevented but rarely reversed, and if so, generally at great expense.[10] It might be possible to protect a beach, but concrete polders could well be to the detriment of an area's authentic charm and so to the value of properties.

A low-carbon, renewable economy – of hydro, wind, solar, geothermal, tidal and other innovative sources of energy – now competes with the most carbon-intensive forms of power generation in the open market, where they constitute around 10% of the global energy mix today.[11] Shifting the balance in favour of low-carbon energy has been estimated to cost approximately 0.5% or less of GDP for the current decade.[12]

The carbon economy is largely responsible for the incredible growth in overall wealth society has amassed over the last 200 years, although, according to the World Bank, 1.3 billion people continue to remain trapped in dire poverty.[13] Regardless, an economic system developed to support a global population of 1 or 2 billion people in the 19th century is ill suited to a global population in excess of 7 billion and growing.[14]

The climate challenge runs in parallel to other key global developments: a growing world population, a major propensity to urbanization, and structural

by feedbacks such as a release of Arctic methane deposits, more rapid sea-level rise that could result from the disintegration of the West Antarctic Ice Sheet or large-scale climatic disruptions such as the collapse of ocean circulation mechanisms, all of which are understood to pose significantly larger human, economic and ecological risks than anything portrayed here. The possibilities of these events are by no means ruled out, with risks increasing substantially with warming.[2] Other economists have therefore factored such risks into their economic analysis to a degree.[3]

Only with the deep and sustained emissions reductions spelled out in the lowest of the new IPCC RCP 2.6 scenario is there a reasonable chance (comfortably over 50%) of not exceeding the internationally accepted "safety" temperature threshold of 2°C global mean warming above preindustrial.[4] Given the clear human, ecological and,

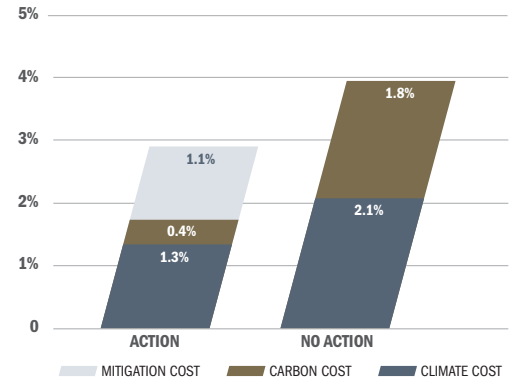
REGIONAL COST BENEFIT ANALYSIS, 2010-2100** PERCENTAGE OF GLOBAL GDP (NOMINAL), NET PRESENT VALUE AT 3% DISCOUNT RATE

	Climate + Carbon Costs				Highest Action		High Action		Moderate Action		Net Benefit		
Region	**No Action**	**Highest action (400 ppm)**	**High action (450 ppm)**	**Moderate action (550 ppm)**	**Avoided costs***	**Mitigation costs**	**Avoided costs***	**Mitigation costs**	**Avoided costs***	**Mitigation costs**	**Highest action**	**High Action**	**Moderate action**
USA	3.0%	1.0%	1.0%	1.5%	2.0%	1.5%	2.0%	1.0%	1.5%	0.5%	0.5%	1.0%	1.0%
Japan	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.5%	0.0%	0.0%	0.0%
Russia	4.5%	1.5%	1.5%	2.0%	3.0%	2.0%	3.0%	2.0%	2.5%	2.5%	1.0%	1.0%	0.0%
China	4.5%	2.0%	2.0%	2.5%	2.5%	2.0%	2.5%	1.5%	2.0%	1.0%	0.5%	1.0%	1.0%
India	11.0%	5.0%	5.5%	6.5%	6.0%	3.0%	5.5%	2.0%	4.5%	0.5%	3.0%	3.5%	4.0%
EU27	1.0%	0.5%	0.5%	0.5%	0.5%	1.0%	0.5%	0.5%	0.5%	0.5%	0.0%	0.0%	0.0%
ROW	8.5%	3.5%	3.5%	4.5%	5.5%	2.0%	5.0%	1.0%	4.5%	0.5%	3.5%	4.0%	3.5%
World***	4.0%	1.5%	1.5%	2.0%	2.5%	1.5%	2.0%	1.0%	2.0%	0.5%	1.0%	1.0%	1.0%

*Avoided costs: No action (A1B +8.5) minus reduced ppm scenario (400 ppm C02e: RCP2.6; 450 ppm: RCP2.9; 550 ppm: SRES B1)
** Discounted (3%) sum of costs and GDP – mitigation costs from Edenhofer et al., 2010 (regional: Remind + Poles)
*** Median value of all 5 scenarios (Edenhofer et al., 2010)

ACTION VERSUS INACTION OVER THE 21ST CENTURY

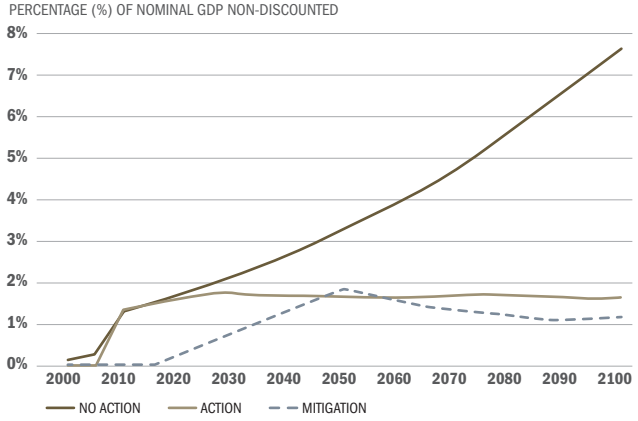
NPV OF GLOBAL CLIMATE/CARBON COSTS AND MITIGATION COSTS RELATIVE TO GDP (NOMINAL 2010-2100, 3% DISCOUNT RATE)



Action equals 450 ppm (RCP 2.9) No action equals mid-point of 2 non-stabilization scenarios (RCP 8.5 and SRES A1B)

21ST CENTURY COSTS OF CLIMATE CHANGE ACTION, INACTION AND MITIGATION

PERCENTAGE (%) OF NOMINAL GDP NON-DISCOUNTED



shifts occurring in economies around the world. All of these tendencies – most pronounced in developing countries, in particular the process of industrialization now spreading more and more widely[15] – can worsen or attenuate vulnerabilities to climate change or the carbon economy.

In order to understand the fuller implications of this study and to make its findings comparable with previous works that take on longer-term perspectives, the costs of climate change and the carbon economy were also estimated for the period up until 2100. On this basis, business-as-usual development could see the costs of inaction exceeding 10% of global GDP in losses prior to 2100.

Reducing emissions results in net benefits for society in every case because the costs of a low-carbon transition are more than outweighed by averted losses due to climate change and the carbon economy.

In the global context, the highest level of emission reductions results in similar global benefits to lower levels of action. However, the highest action sees fewer negative impacts on society –from human health to biodiversity and for the world's oceans – but requires slightly greater investments in low-emission forms of energy. Less ambitious action means accepting larger scales of human and ecological impacts.

The regional analysis of costs and benefits differs little in fundamental terms from the global analysis: all regions benefit from climate action in economic terms. Most regions find optimal climate action in the high-action scenario. The highest action to reduce emissions also limits the risks of crossing tipping points leading to large-scale climate disruptions.[16] Less ambitious action on climate change does not: moderate action on climate change has a high chance of exceeding the accepted international temperature goal of holding warming below 2° C (3.6° F) above pre-industrial levels.[17] The most vulnerable countries have called for warming to be limited below 1.5° C above pre-industrial levels as they believe 2° C is far too damaging and a risk to their survival.

Neither should the risks of catastrophic impacts be discarded as heresy: new research has highlighted great risks associated with *heat*, as opposed to ocean-related immersion of countries, with heat risks concerning far greater shares of the world economy and its population. In particular, at certain levels of high-end warming, large areas of the planet would progressively begin to exceed the thermal maximum at which human beings are able to survive outdoors.[18] The possibilities of very rapid climate change are not implausible or ruled out by climate change models, especially as the planet warms beyond the 2 degrees Celsius temperature threshold

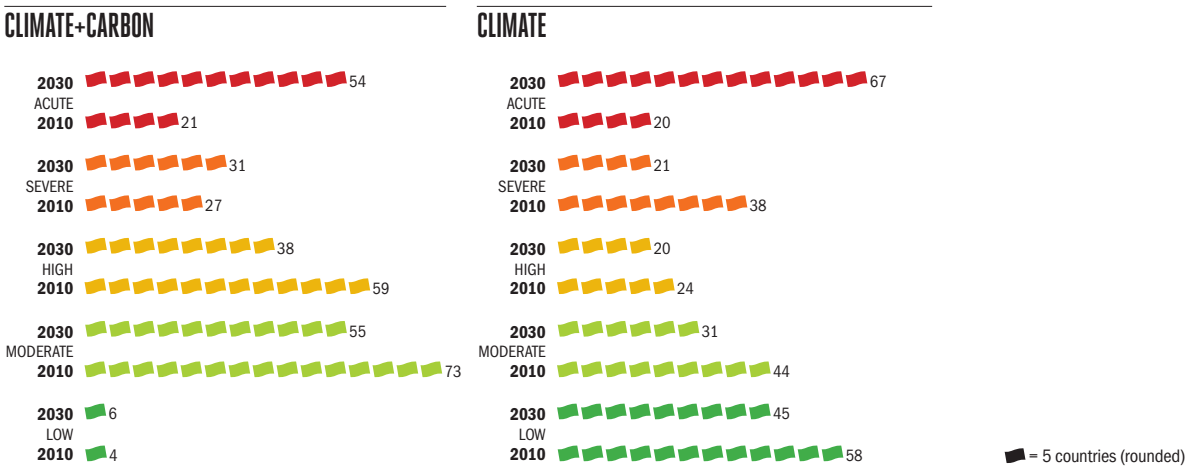
ultimately, economic advantages of aiming for a highest-action scenario, this report's findings imply that the highest action targets would reap the most benefits for the world. Therefore, the highest-action scenario is recommended to policy makers as the preferred target for enhancing and safeguarding global prosperity. Mainstream economic modelling shows that this transition is technologically and economically feasible but that action is needed now to get onto this pathway.[5] *International cooperation will clearly be central to ensuring that the costs of the transition are maintained at the lowest most efficient level and that the transition yields the highest co-benefits.*[6]

[1] See: Edenhofer et al., 2010; IPCC, 2012a
[2] Weitzman, 2007; Hare in Mastny, 2009
[3] For example: Hope, 2006; Stern, 2006
[4] Pope et al., 2010
[5] For an overview of some leading mitigation scenarios, see: Edenhofer et al., 2010; UNEP, 2011; IPCC, 2012a
[6] For example the economic benefits of cross-border emission reduction cooperation: De Cian and Tavoni, 2010

the international community has set for itself.[19] Of particular long-term concern are 1500 gigatonnes of CO_2 ($GtCO_2$) of methane stored in frozen sediments in the East-Siberian Sea at depths of less than 40 to 50 metres.[20] This represents three times the amount of CO_2 that could be released over much of this century if the 2 degrees target is to be kept.[21] As the Arctic sea warms due to climate change, these sediments are thawing and methane is already being visibly released at rates that currently exceed the total amount of methane emitted through natural processes over the entirety of the world's oceans.[22] While all policy pathways for reducing emissions have similar net benefits in economic terms, the highest-action route would clearly reap the greatest human, societal, economic and environmental benefits, since it would ensure the greatest chances of avoiding climate-triggered catastrophe and would minimize the human, social and environmental impacts of a hotter planet. Therefore, the cold calculus of a hot planet implies the most ambitious action on climate change is the savviest choice both in monetary, humanitarian and environmental terms. The highest-action approach is the pathway that the analysis in this report most supports.

The world risks carbon lock-in due to high-intensity carbon infrastructure plans still moving forward in the near term, so the shift in focus to a low-carbon transition should likely occur prior to 2017 and continue aggressively thereafter.[23] Several major economies will need to adjust and enact important domestic policy and legislative initiatives in order to make this a reality. Whatever the case, action on climate change that seeks out international partnership is most likely to further lessen the costs of a low-carbon transition and expand the benefits of this transition for all concerned. This report documents in part the potential benefits of avoided impacts of climate change in addition to the potential co-benefits of emission reductions that are targeted at key economic, health and environmental concerns.[24]

[1] Hansen et al., 2005
[2] Kjellstrom et al., 2009a; McSweeney et al., 2012
[3] ILO LABORSTA, 2012
[4] Storm and Naastepad, 2009; Wacker et al., 2006; Restuccia, et al., 2004; Storm and Naastepad, 2009; McMillan and Rodrik, 2012
[5] Kjellstrom et al., 2009a-b
[6] UN, 2012
[7] Ashdown et al., 2011
[8] Parry et al., 2009; EACC, 2010
[9] Cheung et al., 2010
[10] Puigdefaabregas, 1998
[11] US EIA, 2011
[12] Edenhofer et al., 2010; IPCC, 2012b
[13] Chen and Ravallion, 2012
[14] World Population Prospects/UN DESA, 2011
[15] OECD, 2012; IMF WEO, 2012; World Population Prospects/UN DESA, 2011
[16] Pope et al., 2010
[17] UNFCCC, 2009
[18] Sherwood and Huber, 2010
[19] Wietzman, 2007
[20] Shakhova et al., 2008
[21] Meinshausen et al., 2009
[22] Shakhova et al., 2008 and 2010
[23] IAE, 2011; UNEP, 2011
[24] De Cian and Tavoni, 2010



SUMMARY OF ECONOMIC IMPACT

		NET 2030	NET 2010	LOSSES 2010	GAINS 2010	2010				2030			
CLIMATE	DROUGHT	18	4	4	*	*	2	1	*	4	11	3	1
	FLOODS & LANDSLIDES	94	10	10	*	2	6	1	*	21	66	5	3
	STORMS	100	15	15	*	2	3	7	*	16	64	20	*
	WILDFIRES	*	*	*	*	*	*	*	*	*	*	*	*
	TOTAL	**213**	**29**	**29**	*	**5**	**14**	**10**	**1**	**40**	**142**	**28**	**4**
	BIODIVERSITY	389	78	78	*	8	26	36	9	56	299	80	54
	DESERTIFICATION	20	4	5	*	*	*	2	1	5	4	6	6
	HEATING & COOLING	-77	-33	5	-38	1	2	24	-8	30	7	-65	-49
	LABOUR PRODUCTIVITY	2,400	311	314	-3	135	162	16	-1	1,035	1,364	49	-12
	PERMAFROST	153	31	31	*	1	10	3	17	5	68	5	75
	SEA-LEVEL RISE	526	86	86	*	23	42	15	5	166	310	29	22
	WATER	13	14	44	-30	3	-3	13	7	-21	45	39	39
	TOTAL	**3,461**	**491**	**563**	**-71**	**166**	**235**	**60**	**30**	**1,276**	**1,908**	**144**	**135**
	TOTAL	**106**	**23**	**23**	*	**17**	**5**	*	**0.5**	**84**	**21**	*	**1**
	AGRICULTURE	367	50	51	*	27	17	3	2	208	144	8	10
	FISHERIES	168	13	16	-3	7	7	1	-1	97	80	-3	-6
	FORESTRY	44	6	7	-1	*	4	*	*	9	34	1	1
	HYDRO ENERGY	-24	-4	*	-4	*	-3	*	*	3	-20	-1	*
	TOURISM	*	*	5	-5	2	*	-1	*	19	-16	-2	-1
	TRANSPORT	7	1	1	*	*	*	1	*	*	1	6	*
	TOTAL	**565**	**66**	**80**	**-13**	**37**	**25**	**2**	**2**	**329**	**223**	**8**	**5**
TOTAL GLOBAL RESULTS		**4,345**	**609**	**695**	**-84**	**225**	**279**	**72**	**33**	**1,730**	**2,294**	**179**	**144**
CARBON	OIL SANDS	24	7	7	*	*	*	7	*	2	1	20	0.5
	OIL SPILLS	38	13	13	*	1	6	6	0.5	3	24	9	2
	TOTAL	**61**	**20**	**20**	*	**1**	**6**	**13**	**0.5**	**5**	**25**	**29**	**3**
	BIODIVERSITY	1,734	291	291	*	32	128	114	17	236	1,034	349	115
	CORROSION	5	1.5	1.5	*	*	0.5	0.5	*	1	4	0.5	0.5
	WATER	10	4	4	*	*	*	3	1	*	2	4	4
	TOTAL	**1,749**	**296**	**296**	*	**32**	**129**	**117**	**18**	**238**	**1,038**	**353**	**120**
	TOTAL	**630**	**172**	**172**	*	**74**	**67**	**21**	**10**	**226**	**341**	**37**	**26**
	AGRICULTURE	-171	15	17	-2	1	2	9	4	-58	-121	4	4
	FISHERIES	77	9	9	*	1	7	0.5	*	5	70	2	0.5
	FORESTRY	83	28	28	*	3	9	14	1	13	48	18	4
	TOTAL	**-11**	**52**	**54**	**-2**	**4**	**18**	**24**	**5**	**-40**	**-3**	**24**	**8**
TOTAL GLOBAL RESULTS		**2,429**	**540**	**542**	*	**112**	**220**	**174**	**34**	**429**	**1,401**	**444**	**156**

* Less than one billion dollars

Billions of dollars (2010 PPP) non-discounted. Totals do not correspond exactly due to rounding.

Environmental disasters · Habitat change · Health impact · Industry stress

Developing Country Low Emitters · Developing Country High Emitters · Developed · Other Industrialized

Exhibit 7

Fracking by the Numbers

Key Impacts of Dirty Drilling at the State and National Level

ENVIRONMENT AMERICA
RESEARCH & POLICY CENTER

Fracking by the Numbers

Key Impacts of Dirty Drilling at the State and National Level

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Environment America Research & Policy Center

October 2013

Acknowledgments

Environment America Research & Policy Center sincerely thanks John Amos of SkyTruth, Anthony Ingraffea, Ph.D., P.E., and Kari Matsko, Director of People's Oil & Gas Collaborative-Ohio for their review of drafts of this document, as well as their insights and suggestions. Tareq Alani, Spencer Alt, Elise Sullivan and Anna Vanderspek provided valuable research assistance. Thanks also to Travis Madsen of Frontier Group for technical assistance, and Tony Dutzik and Benjamin Davis of Frontier Group for editorial help.

We also are grateful to the many state agency staff who answered our numerous questions and requests for data. Many of them are listed by name in the methodology.

Environment America Research & Policy Center thanks the V. Kann Rasmussen Foundation and the Park Foundation for making this report possible.

The authors bear responsibility for any factual errors. The recommendations are those of Environment America Research & Policy Center. The views expressed in this report are those of the authors and do not necessarily reflect the views of our funders or those who provided review.

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Layout: To the Point Publications, www.tothepointpublications.com

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Executive Summary

Over the past decade, the oil and gas industry has fused two technologies—hydraulic fracturing and horizontal drilling—in a highly polluting effort to unlock oil and gas in underground rock formations across the United States.

As fracking expands rapidly across the country, there are a growing number of documented cases of drinking water contamination and illness among nearby residents. Yet it has often been difficult for the public to grasp the scale and scope of these and other fracking threats. Fracking is already underway in 17 states, with more than 80,000 wells drilled or permitted since 2005. Moreover, the oil and gas industry is aggressively seeking to expand fracking to new states—from New York to California to North Carolina—and to areas that provide drinking water to millions of Americans.

This report seeks to quantify some of the key impacts of fracking to date—including the production of toxic wastewater, water use, chemicals use, air pollution, land damage and global warming emissions.

To protect our states and our children, states should halt fracking.

Toxic wastewater: Fracking produces enormous volumes of toxic wastewater—often containing cancer-causing and even radioactive material. Once brought to the surface, this toxic waste poses hazards for drinking water, air quality and public safety:

- Fracking wells nationwide produced an estimated 280 billion gallons of wastewater in 2012.
- This toxic wastewater often contains cancer-causing and even radioactive materials, and has contaminated drinking water sources from Pennsylvania to New Mexico.
- Scientists have linked underground injection of wastewater to earthquakes.
- In New Mexico alone, waste pits from all oil and gas drilling have contaminated groundwater on more than 400 occasions.

Table ES-1. National Environmental and Public Health Impacts of Fracking

Fracking Wells since 2005	82,000
Toxic Wastewater Produced in 2012 (billion gallons)	280
Water Used since 2005 (billion gallons)	250
Chemicals Used since 2005 (billion gallons)	2
Air Pollution in One Year (tons)	450,000
Global Warming Pollution since 2005 (million metric tons CO_2-equivalent)	100
Land Directly Damaged since 2005 (acres)	360,000

Water use: Fracking requires huge volumes of water for each well.

- Fracking operations have used at least 250 billion gallons of water since 2005. (See Table ES-2.)
- While most industrial uses of water return it to the water cycle for further use, fracking converts clean water into toxic wastewater, much of which must then be permanently disposed of, taking billions of gallons out of the water supply annually.
- Farmers are particularly impacted by fracking water use as they compete with the deep-pocketed oil and gas industry for water, especially in drought-stricken regions of the country.

Chemical use: Fracking uses a wide range of chemicals, many of them toxic.

- Operators have hauled more than 2 billion gallons of chemicals to thousands of fracking sites around the country.
- In addition to other health threats, many of these chemicals have the potential to cause cancer.
- These toxics can enter drinking water supplies from leaks and spills, through well blowouts, and through the failure of disposal wells receiving fracking wastewater.

Table ES-2. Water Used for Fracking, Selected States

State	Total Water Used since 2005 (billion gallons)
Arkansas	26
Colorado	26
New Mexico	1.3
North Dakota	12
Ohio	1.4
Pennsylvania	30
Texas	110
West Virginia	17

Air pollution: Fracking-related activities release thousands of tons of health-threatening air pollution.

- Nationally, fracking released 450,000 tons of pollutants into the air that can have immediate health impacts.
- Air pollution from fracking contributes to the formation of ozone "smog," which reduces lung function among healthy people, triggers asthma attacks, and has been linked to increases in school absences, hospital visits and premature death. Other air pollutants from fracking and the fossil-fuel-fired machinery used in fracking have been linked to cancer and other serious health effects.

Global warming pollution: Fracking produces significant volumes of global warming pollution.

- Methane, which is a global warming pollutant 25 times more powerful than carbon dioxide, is released at multiple steps during fracking, including during hydraulic fracturing and well completion, and in the processing and transport of gas to end users.
- Global warming emissions from completion of fracking wells since 2005 total an estimated 100 million metric tons of carbon dioxide equivalent.

Damage to our natural heritage: Well pads, new access roads, pipelines and other infrastructure turn forests and rural landscapes into industrial zones.

- Infrastructure to support fracking has damaged 360,000 acres of land for drilling sites, roads and pipelines since 2005.
- Forests and farmland have been replaced by well pads, roads, pipelines and other gas infrastructure, resulting in the loss of wildlife habitat and fragmentation of remaining wild areas.

- In Colorado, fracking has already damaged 57,000 acres of land, equal to one-third of the acreage in the state's park system.
- The oil and gas industry is seeking to bring fracking into our national forests, around several of our national parks, and in watersheds that supply drinking water to millions of Americans.

Fracking has additional impacts not quantified here—including contamination of residential water wells by fracking fluids and methane leaks; vehicle and workplace accidents, earthquakes and other public safety risks; and economic and social damage including ruined roads and damage to nearby farms.

Defining "Fracking"

In this report, when we refer to the impacts of "fracking," we include impacts resulting from all of the activities needed to bring a shale gas or oil well into production using high-volume hydraulic fracturing (fracturing operations that use at least 100,000 gallons of water), to operate that well, and to deliver the gas or oil produced from that well to market. The oil and gas industry often uses a more restrictive definition of "fracking" that includes only the actual moment in the extraction process when rock is fractured—a definition that obscures the broad changes to environmental, health and community conditions that result from the use of fracking in oil and gas extraction.

To address the environmental and public health threats from fracking across the nation:

- States should prohibit fracking. Given the scale and severity of fracking's myriad impacts, constructing a regulatory regime sufficient to protect the environment and public health from dirty drilling—much less enforcing such safeguards at more than 80,000 wells, plus processing and waste disposal sites across the country—seems implausible. In states where fracking is already underway, an immediate moratorium is in order. In all other states, banning fracking is the prudent and necessary course to protect the environment and public health.
- Given the drilling damage that state officials have allowed fracking to incur thus far, at a minimum, federal policymakers must step in and close the loopholes exempting fracking from key provisions of our nation's environmental laws.
- Federal officials should also protect America's natural heritage by keeping fracking away from our national parks, national forests, and sources of drinking water for millions of Americans.
- To ensure that the oil and gas industry—rather than taxpayers, communities or families—pays the costs of fracking damage, policymakers should require robust financial assurance from fracking operators at every well site.
- More complete data on fracking should be collected and made available to the public, enabling us to understand the full extent of the harm that fracking causes to our environment and health.

Introduction

Many Americans have an image of the damage caused by fracking. Documentaries and YouTube videos have shown us tap water catching on fire and families experiencing headaches, dizziness, nausea and other illnesses while living near fracking operations. Plane trips over Texas or Colorado reveal the grids of wells across the landscape.

These snapshots illustrate the damage that fracking does to the environment and our health. But, until now, it has been difficult to comprehend the cumulative extent of that damage. Individual fracking wells, we know, can pollute the air and water of a neighborhood or town. But what does it mean now that the nation has not dozens or hundreds but tens of thousands of fracking wells in at least 17 states? What, for example, is the magnitude of the risk those wells present to drinking water? How many iconic landscapes are being damaged?

In this report, we have quantified several of the key impacts of fracking on water, air and land, at the state and national level, using the best available sources of information on the extent of fracking and the impacts of fracking on our environment and health.

Our analysis shows that damage from fracking is widespread and occurs on a scale unimagined just a few years ago. Moreover, three factors suggest that the total damage from fracking is far worse than we have tabulated here. Severe limitations in available data constrain our ability to see the full extent of the damage. Second, there are broad categories of fracking damage—such as the number of water wells contaminated—that would be difficult to ascertain under any circumstances. Finally, there remain major gaps in the scientific community's understanding of issues such as the long-term consequences of pumping toxic fluids into the ground.

Even the limited data that are currently available, however, paint an increasingly clear picture of the damage that fracking has done to our environment and health. It will take decisive action to protect the American people and our environment from the damage caused by dirty drilling.

Our analysis shows that damage from fracking is widespread and occurs on a scale unimagined just a few years ago.

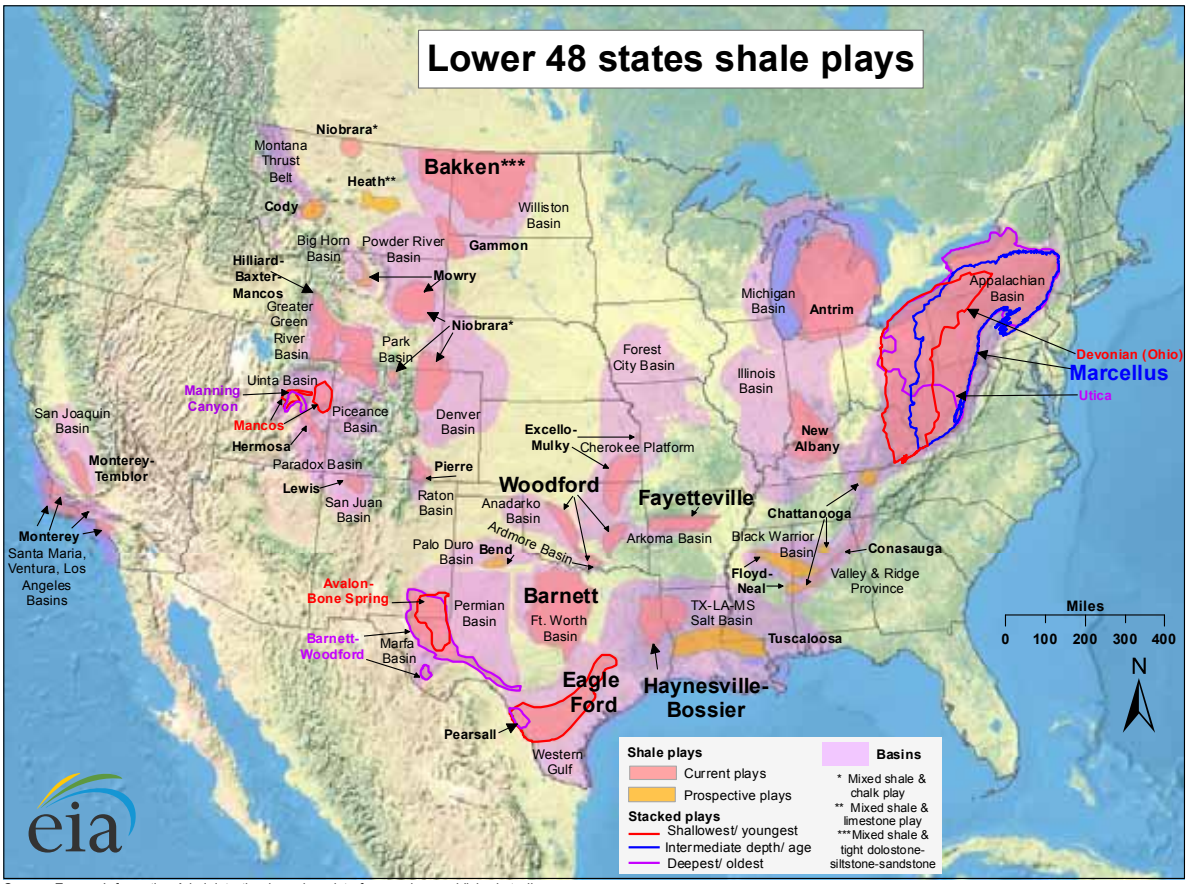
Fracking Poses Grave Threats to the Environment and Public Health

Over the past decade, the oil and gas industry has used hydraulic fracturing to extract oil and gas from previously inaccessible rock formations deep underground. The use of high-volume hydraulic fracturing—colloquially known as "fracking"—has expanded dramatically from its origins in the Barnett Shale region of Texas a decade ago to tens of thousands of wells nationwide today.

Roughly half of U.S. states, stretching from New York to California, sit atop shale or other rock formations with the potential to produce oil or gas using fracking. (See Figure 1.)

Fracking has unleashed a frenzy of oil and gas drilling in several of these shale formations—posing severe threats to the environment and public health.

Figure 1. Shale Gas and Oil Plays[1]



Source: Energy Information Administration based on data from various published studies.
Updated: May 9, 2011

Contaminating Drinking Water

Fracking has polluted both groundwater and surface waterways such as rivers, lakes and streams. Fracking pollution can enter our waters at several points in the process—including leaks and spills of fracking fluid, well blowouts, the escape of methane and other contaminants from the well bore into groundwater, and the long-term migration of contaminants underground. Handling of toxic fracking waste that returns to the surface once a well has been fracked presents more opportunities for contamination of drinking water. State data confirm more than 1,000 cases of water contaminated by dirty drilling operations. For example:

- In Colorado, approximately 340 of the leaks or spills reported by drilling operators engaged in all types of oil and gas drilling over a five-year period polluted groundwater;[2]
- In Pennsylvania, state regulators identified 161 instances in which drinking water wells were impacted by drilling operations between 2008 and the fall of 2012;[3] and
- In New Mexico, state records show 743 instances of all types of oil and gas operations polluting groundwater—the source of drinking water for 90 percent of the state's residents.[4]

Spills and Leaks of Fracking Fluids

Toxic substances in fracking chemicals and wastewater have been linked to a variety of negative health effects on humans and fish. Chemical components of fracking fluids, for example, have been linked to cancer, endocrine disruption and neurological and immune system problems.[5] Wastewater brought to the surface by drilling can contain substances such as volatile organic compounds with potential impacts on human health.[6]

There are many pathways by which fracking fluids can contaminate drinking water supplies. Spills from trucks, leaks from other surface equipment, and well blowouts can release polluted water to groundwater and surface water. For example, in September 2009 Cabot Oil and Gas caused three spills in Dimock Township, Pennsylvania, in less than a week, dumping 8,000 gallons of fracturing fluid components into Stevens Creek and a nearby wetland.[7]

Leaks of Methane and Other Contaminants from the Well Bore

A study by researchers at Duke University found that the proximity of drinking water wells to fracking wells increases the risk of contamination of residential wells with methane in Pennsylvania. The researchers pointed to faulty well casing as a likely source.[8] Data from fracking wells in Pennsylvania from 2010 to 2012 show a 6 to 7 percent well failure rate due to compromised structural integrity.[9]

Migration of Contaminants

A recent study of contamination in drinking water wells in the Barnett Shale area of North Texas found arsenic, selenium and strontium at elevated levels in drinking water wells close to fracking sites.[10] The researchers surmise that fracking has increased pollution in drinking water supplies by freeing naturally available chemicals to move into groundwater at higher concentrations or through leaks from faulty well construction.

Toxic Fracking Waste

The wastewater produced from fracking wells contains pollutants both from fracking fluids and from natural sources underground. It returns to the surface in huge volumes—both as "flowback" immediately after fracking and "produced water" over a longer period while a well is producing oil or gas. Yet fracking operators have no safe, sustainable way of dealing with this toxic waste. The approaches that drilling companies have devised for dealing with wastewater can pollute waterways through several avenues.

- Waste pits can fail. In New Mexico, substances from oil and gas pits have contaminated groundwater at least 421 times.[11] Moreover, waste pits also present hazards for nearby wildlife and livestock. For example, in May 2010, when a Pennsylvania fracturing wastewater pit owned by East Resources leaked into a farm field, the state Department of Agriculture was forced to quarantine 28 cattle exposed to the fluid to prevent any contaminated meat from reaching the market.[12]

- Discharge of fracking wastewater into rivers can pollute drinking water supplies. For example, after water treatment plants discharged fracking wastewater into the Monongahela River, local authorities issued a drinking water advisory to 350,000 people in the area.[13] In addition, fracking wastewater discharged at treatment plants can cause a different problem for drinking water: when bromide in the wastewater mixes with chlorine (often used at drinking water treatment plants), it produces trihalomethanes, chemicals that cause cancer and increase the risk of reproductive or developmental health problems.[14]

- Drilling companies deliberately spread wastewater on roads and fields. Pollutants from the water can then contaminate local waterways. Drilling operators sometimes spray wastewater on dirt and gravel roads to control dust, or on paved roads to melt ice. In some Western states, fracking waste is spread on farmland or used to water cattle.[15]

- Deep disposal wells are a common destination for fracking waste, but these wells can fail over time, allowing the wastewater and its pollutants to mix with groundwater or surface water.[16] For example,

Photo: The Downstream Project via SkyTruth/LightHawk.

Fracking wastewater is often stored in open waste pits such as these, near Summit, Pennsylvania. Leaks from pits can contaminate drinking water supplies.

wastewater injected into a disposal well contaminated the Cenozoic Pecos Alluvium Aquifer with 6.2 billion gallons of water near Midland, Texas.[17] In Pennsylvania, a disposal well in Bell Township, Clearfield County, lost mechanical integrity in April 2011, but the operator, EXCO Resources, continued to inject fracking wastewater into the well for another five months.[18] The U.S. Environmental Protection Agency (EPA) fined the company nearly $160,000 for failing to protect drinking water supplies. Nationally, routine testing of injection wells in 2010 revealed that 2,300 failed to meet mechanical integrity requirements established by the EPA.[19]

- Pressure from injection wells may cause underground rock layers to crack, accelerating the migration of wastewater into drinking water aquifers. For example, at two injection wells in Ohio, toxic chemicals pumped underground in the 1980s, supposedly secure for at least 10,000 years, migrated into a well within 80 feet of the surface over the course of two decades.[20] Investigators believe that excessive pressure within the injection well caused the rock to fracture, allowing chemicals to escape.

Despite the risk presented to drinking water supplies by fracking, the oil and gas industry is seeking to drill near sources of drinking water for millions of people, including George Washington National Forest in Virginia, White River National Forest in Colorado, Otero Mesa in New Mexico, Wayne National Forest in Ohio, and the Delaware River Basin.

Consuming Scarce Water Resources

Each well that is fracked requires hundreds of thousands of gallons of water depending on the shale formation and the depth and length of the horizontal portion of the well. Unlike most industrial uses of water which return water to the water cycle for further use, fracking converts clean water into toxic wastewater, much of which must then be permanently disposed of, taking billions of gallons out of the water supply annually. Moreover, farmers are particularly impacted by fracking water use, as they must now compete with the deep-pocketed oil and gas industry for water, especially in the drought-stricken regions of the country.

In some areas, fracking makes up a significant share of overall water demand. In 2010, for example, fracking in the Barnett Shale region of Texas consumed an amount of water equivalent to 9 percent of the city of Dallas' annual water use.[21] An official at the Texas Water Development Board estimated that one county in the Eagle Ford Shale region will see the share of water consumption devoted to fracking and similar activities increase from zero a few years ago to *40 percent* by 2020.[22] Unlike other uses, water used in fracking is permanently lost to the water cycle, as it either remains in the well, is "recycled" (used in the fracking of new wells), or is disposed of in deep injection wells, where it is unavailable to recharge aquifers.

Already, demand for water by oil and gas companies has harmed farmers and local communities:

- In Texas, water withdrawals by drilling companies caused drinking water wells in the town of Barnhart to dry up. Companies drilling in the Permian Basin have drilled wells and purchased well water drawn from the Edwards-Trinity-Plateau Aquifer, drying up water supplies for residential and agricultural use.[23]

- Wells that provided water to farms near Carlsbad, New Mexico, have gone dry due to demand for water for drilling and years of low rainfall.[24]

Competition for limited water resources from fracking can increase water prices for farmers and communities—especially in arid western states. A 2012 auction of unallocated water conducted by the

Northern Water Conservation District in Colorado saw gas industry firms submit high bids, with the average price of water sold in the auction increasing from $22 per acre-foot in 2010 to $28 per acre-foot in the first part of 2012.[25] For the 25,000 acre-feet of water auctioned, this would amount to an added cost of $700,000.

Moreover, water pumped from rivers for fracking reduces the quality of the water remaining in the river because pollution becomes more concentrated. A 2011 U.S. Army Corps of Engineers study of the Monongahela River basin of Pennsylvania and West Virginia, where oil and gas companies withdraw water from the river for fracking, concluded that, "The quantity of water withdrawn from streams is largely unregulated and is beginning to show negative consequences."[26] The Corps report noted that water is increasingly being diverted from the relatively clean streams that flow into Corps-maintained reservoirs, limiting the ability of the Corps to release clean water to help dilute pollution during low-flow periods.[27] It described the water supply in the Monongahela basin as "fully tapped."[28]

Excessive water withdrawals undermine the ability of rivers and streams to support wildlife. In Pennsylvania, water has been illegally withdrawn for fracking numerous times, to the extent of streams being sucked dry. Two streams in southwestern Pennsylvania—Sugarcamp Run and Cross Creek—were reportedly drained for water withdrawals for fracking, triggering fish kills.[29]

Nationally, nearly half of all fracking wells are located in regions with very limited water supplies. A study by Ceres, a coalition of business and environmental interests, found that nearly 47 percent of wells fracked from January 2011 through September 2012 were located in areas with "high or extremely high water stress."[30]

Endangering Public Health with Air Pollution

Air pollution from fracking threatens the health of people living and working close to the wellhead, as well as those far away. Children, the elderly and those with respiratory diseases are especially at risk.

Fracking produces air pollution from the well bore as the well is drilled and gas is vented or flared. Emissions from trucks carrying water and materials to well sites, as well as from compressor stations and other fossil fuel-fired machinery, also contribute to air pollution. Well operations, storage of gas liquids, and other activities related to fracking add to the pollution toll.

Making Local Residents Sick

People who live close to fracking sites are exposed to a variety of air pollutants including volatile organic compounds (VOCs) such as benzene, xylene and toluene. These chemicals can cause a wide range of health problems—from eye irritation and headaches to asthma and cancer.[31]

Existing data demonstrate that fracking operations are releasing these pollutants into the air at levels that threaten our health. In Texas, monitoring by the Texas Department of Environmental Quality detected levels of benzene—a known cancer-causing chemical—in the air that were high enough to cause immediate human health concern at two sites in the Barnett Shale region, and at levels that pose long-term health concern at an additional 19 sites. Several chemicals were also found at levels that can cause foul odors.[32] Air monitoring in Arkansas has also found elevated levels of volatile organic compounds (VOCs)—some of which are also hazardous air pollutants—at the perimeter of hydraulic fracturing sites.[33] Local air pollution problems have also cropped up in Pennsylvania. Testing conducted by the Pennsylvania Department of Environmental Protection detected components of gas in the air near Marcellus Shale drilling operations.[34]

Residents living near fracking sites have long suffered from a range of acute and chronic health problems, including headaches, eye irritation, respiratory problems and nausea.[35] An investigation by the journalism website ProPublica uncovered numerous reports of illness in western states from air pollution from fracking.[36] In Pennsylvania, a homeowner in the town of Carmichaels described how she and her children began to suffer from a variety of symptoms after a compressor station was built 780 feet from her house.[37] Pam Judy explained to the nearby Murrysville Council that "Shortly after operations began, we started to experience extreme headaches, runny noses, sore/scratchy throats, muscle aches and a constant feeling of fatigue. Both of our children are experiencing nose bleeds and I've had dizziness, vomiting and vertigo to the point that I couldn't stand and was taken to an emergency room." Eventually, she convinced state officials to test air quality near her home. That testing revealed benzene, styrene, toluene, xylene, hexane, heptane, acetone, acrolein, carbon tetrachloride and chloromethane in the air.[38]

All indications are that these known stories just scratch the surface of health damage from fracking. In cases where families made sick from fracking have sought to hold drilling companies accountable in court, the companies have regularly insisted on gag orders as conditions of legal settlements—in a recent case even the children were barred from talking about fracking, for life.[39]

Workers at drilling sites also suffer from health impacts. A recent investigation by the National Institute for Occupational Safety and Health (NIOSH) found that workers at some fracking sites may be at risk of lung disease as a result of inhaling silica dust from sand injected into wells. The NIOSH investigation reviewed 116 air samples at 11 fracking sites in Arkansas, Colorado, North Dakota, Pennsylvania and Texas. Nearly half (47 percent) of the samples had levels of silica that exceeded the Occupational Safety and Health Administration's (OSHA) legal limit for workplace exposure, while 78 percent exceeded OSHA's recommended limits. Nearly one out of 10 (9%) of the samples exceeded the legal limit for silica by a factor of 10, exceeding the threshold at which half-face respirators can effectively protect workers.[40]

Over the past few years, health clinics in fracking areas of Pennsylvania have reported seeing a number of patients experiencing illnesses associated with exposure to toxic substances from fracking, all of whom have used false names and paid in cash. David Brown, a toxicologist with the Southwest Pennsylvania Environmental Health Project believes that these are mostly fracking workers, who are afraid that any record of their work making them sick will cost them their jobs.[41]

Regional Air Pollution Threats

Fracking also produces a variety of pollutants that contribute to regional air pollution problems. VOCs and nitrogen oxides (NO_x) in gas formations contribute to the formation of ozone "smog," which reduces lung function among healthy people, triggers asthma attacks, and has been linked to increases in school absences, hospital visits and premature death.[42]

Fracking is a significant source of air pollution in areas experiencing large amounts of drilling. A 2009 study in five Dallas-Fort Worth-area counties experiencing heavy Barnett Shale drilling activity found that oil and gas production was a larger source of smog-forming emissions than cars and trucks.[43] In Arkansas, gas production in the Fayetteville Shale region was estimated to be responsible for 5,000 tons of NO_x.[44] In Wyoming, pollution from fracking contributed to such poor air quality that, for the first time, the state failed to meet federal air quality standards.[45] An analysis conducted for New York State's revised draft environmental impact statement on Marcellus Shale drilling posited that, in a worst case scenario of widespread drilling and lax emission controls, shale gas production could add 3.7 percent to state NO_x emissions and 1.3 percent to statewide VOC emissions compared with 2002 emissions levels.[46]

Exacerbating Global Warming

Global warming is a profound threat to virtually every aspect of nature and human civilization—disrupting the functioning of ecosystems, increasing the frequency and violence of extreme weather, and ultimately jeopardizing health, food production, and water resources for Americans and people across the planet. Gas extraction produces enormous volumes of global warming pollution.

Fracking's primary impact on the climate is through the release of methane, which is a far more potent contributor to global warming than carbon dioxide. Over a 100-year timeframe, a pound of methane has 25 times the heat-trapping effect of a pound of carbon dioxide.[47] Methane is even more potent relative to carbon dioxide at shorter timescales, at least 72 times more over a 20-year period.

Intentional venting and leaks during the extraction, transmission and distribution of gas release substantial amounts of methane to the atmosphere. The U.S. Environmental Protection Agency revised downward its estimate of fugitive methane emissions from fracking in April 2013, citing improved practices by the industry.[48] A study conducted with industry cooperation and released in September 2013 found very low fugitive emissions of methane at the wells included in the study, though the findings may not be representative of standard industry practice.[49]

However, recent air monitoring by researchers at the National Oceanic and Atmospheric Administration and the University of Colorado, Boulder, near a gas and oil field in Colorado revealed fugitive methane emissions equal to 2.3 to 7.7 percent of the gas extracted in the basin, not counting the further losses that occur in transportation.[50] Recent aerial sampling of emissions over an oil and gas field in Uintah County, Utah, revealed methane emissions equal to 6.2 to 11.7 percent of gas production.[51]

The global warming impact of fracked natural gas is so great that electricity produced from natural gas may have a greater global warming impact than electricity from coal, especially when evaluated on a short timeline. An analysis by Professor Robert Howarth at Cornell and others found that, on a 20-year timescale, electricity from natural gas is more polluting than electricity from coal.[52]

Regardless of the fugitive emissions level from fracked gas, increased production of and reliance on gas is not a sound approach to reducing our global warming emissions. Investments in gas production and distribution infrastructure divert financing and efforts away from truly clean energy sources such as energy efficiency and wind and solar power. Gas is not a "bridge fuel" that prepares us for a clean energy future; rather, increasing our use of gas shifts our reliance from one polluting fuel to another.

Additionally, to the extent that fracking produces oil instead of gas, fracking does nothing to reduce global warming pollution: in fact, refining oil into useable products like gasoline and diesel, and then burning those products, is a huge source of global warming pollution.

Damaging America's Natural Heritage

Fracking transforms rural and natural areas into industrial zones. This development threatens national parks and national forests, damages the integrity of landscapes and habitats, and contributes to water pollution problems that threaten aquatic ecosystems.

Before drilling can begin, land must be cleared of vegetation and leveled to accommodate drilling equipment, gas collection and processing equipment, and vehicles. Additional land must be cleared for roads to the well site, as well as for any pipelines and compressor stations needed to deliver gas to market. A study by the Nature Conservancy of fracking infrastructure in Pennsylvania found that well pads average 3.1 acres and related infrastructure

damages an additional 5.7 acres.[53] Often, this development occurs on remote and previously undisturbed wild lands.

As oil and gas companies expand fracking activities, national parks, national forests and other iconic landscapes are increasingly at risk. Places the industry is seeking to open for fracking include:

- **White River National Forest** – Located in Colorado, this forest draws 9.2 million visitors per year for hiking, camping and other recreation, making it the most visited national forest in the country.[54] The forest also hosts 4,000 miles of streams that provide water to several local communities and feed into the Colorado River.
- **Delaware River Basin** – This basin, which spans New Jersey, New York, Pennsylvania and Delaware, is home to three national parks and provides drinking water to 15 million people.[55]
- **Wayne National Forest** – Part of Ohio's beautiful Hocking Hills region, most of the acres in the forest are to be leased for drilling near the sole drinking water source for 70,000 people.[56]

Photo: Peter Aengst via SkyTruth/EcoFlight.

Wells and roads built to support fracking in Wyoming's Jonah gas field have caused extensive habitat fragmentation.

- **George Washington National Forest** – This area hosts streams in Virginia and West Virginia that feed the James and Potomac Rivers, which provide the drinking water for millions of people in the Washington, D.C., metro area.
- **Otero Mesa** – A vital part of New Mexico's natural heritage, Otero Mesa is home to pronghorn antelope and a freshwater aquifer that could be a major source of drinking water in this parched southwestern state.[57]

The disruption and fragmentation of natural habitat can put wildlife at risk. In Wyoming, for example, extensive gas development in the Pinedale Mesa region has coincided with a significant reduction in the region's population of mule deer. A 2006 study found that the construction of well pads drove away female mule deer.[58] The mule deer population in the area dropped by 50 percent between 2001 and 2011, as fracking in the area continued and accelerated.[59]

Concerns have also been raised about the impact of gas development on pronghorn antelope. A study by the Wildlife Conservation Society documented an 82 percent reduction in high-quality pronghorn habitat in Wyoming's gas fields, which have historically been key wintering grounds.[60]

Birds may also be vulnerable, especially those that depend on grassland habitat. Species such as the northern harrier, short-eared owl, bobolink, upland sandpiper, loggerhead shrike, snowy owl, rough-legged hawk and American kestrel rely on grassland habitat for breeding or wintering habitat.[61] These birds typically require 30 to 100 acres of undisturbed grassland for habitat.[62] Roads, pipelines and well pads for fracking may fragment grassland into segments too small to provide adequate habitat.

The clearing of land for well pads, roads and pipelines may threaten aquatic ecosystems by increasing sedimentation of nearby waterways and decreasing shade. A study by the Academy of Natural Sciences of Drexel University found an association between increased density of gas drilling activity and degradation of ecologically important headwater streams.[63]

Water contamination related to fracking has caused several fish kills in Pennsylvania. In 2009, a pipe containing freshwater and flowback water ruptured in Washington County, Pennsylvania, triggering a fish kill in a tributary of Brush Run, which is part of a high-quality watershed.[64] That same year, in the same county, another pipe ruptured at a well drilled in a public park, killing fish and other aquatic life along a three-quarter-mile length of a local stream.[65]

Imposing Costs on Communities

As with prior extractive booms, the fracking oil and gas rush disrupts local communities and imposes a wide range of immediate and long term costs on them.

Ruining Roads, Straining Services

As a result of its heavy use of publicly available infrastructure and services, fracking imposes both immediate and long-term costs on taxpayers.

The trucks required to deliver water to a single fracking well cause as much damage to roads as 3.5 million car journeys, putting massive stress on roadways and bridges not constructed to handle such volumes of heavy traffic. Pennsylvania estimates that repairing roads affected by Marcellus Shale drilling would cost $265 million.[66]

Fracking also strains public services. Increased heavy vehicle traffic has contributed to an increase in traffic accidents in drilling regions. At the same time, the influx of temporary workers that typically accompanies fracking puts pressure on housing supplies, thereby causing social dislocation. Governments respond by increasing their spending on social services and subsidized housing, squeezing tax-funded budgets.

Governments may even be forced to spend tax money to clean up orphaned wells—wells that were never

properly closed and whose owners, in many cases, no longer exist as functioning business entities. Though oil and gas companies face a legal responsibility to plug wells and reclaim drilling sites, they have a track record of leaving the public holding the bag.[67]

Risks to Local Businesses, Homeowners and Taxpayers

Fracking imposes damage on the environment, public health and public infrastructure, with significant economic costs, especially in the long run after the initial rush of drilling activity has ended. A 2008 study by the firm Headwaters Economics found that Western counties that have relied on fossil-fuel extraction for growth are doing worse economically than their peers, with less-diversified economies, a less-educated workforce, and greater disparities in income.[68]

Other negative impacts on local economies include downward pressure on home values and harm to farms. Pollution, stigma and uncertainty about the future implications of fracking can depress the prices of nearby properties. One Texas study found that homes valued at more than $250,000 and located within 1,000 feet of a well site lost 3 to 14 percent of their value.[69] Fracking also has the potential to affect agriculture, both directly through damage to livestock from exposure to fracking fluids, and indirectly through economic changes that undermine local agricultural economies.

Fracking can increase the need for public investment in infrastructure and environmental cleanup. Fracking-related water demand may also lead to calls for increased public spending on water infrastructure. Texas, for example, adopted a State Water Plan in 2012 that calls for $53 billion in investments in the state water system, including $400 million to address unmet needs in the mining sector (which includes hydraulic fracturing) by 2060.[70] Fracking is projected to account for 42 percent of water use in the Texas mining sector by 2020.[71]

The cost of cleaning up environmental damage from the current oil and gas boom may fall to taxpayers, as has happened with past booms. For example, as of 2006, more than 59,000 orphan oil and gas wells were on state waiting lists for plugging and remediation across the United States, with at least an additional 90,000 wells whose status was unknown or undocumented.[72] Texas alone has more than 7,800 orphaned oil and gas wells.[73] These wells pose a continual threat of groundwater pollution and have cost the state of Texas more than $247 million to plug.[74] The current fracking boom ultimately may add to this catalog of orphaned wells.

Threatening Public Safety

Fracking harms public safety by increasing traffic in rural areas where roads are not designed for such high volumes, by creating an explosion risk from methane, and by increasing earthquake activity.

Increasing traffic—especially heavy truck traffic—has contributed to an increase in traffic accidents and fatalities in some areas in which fracking has unleashed a drilling boom, as well as an increase in demands for emergency response. In the Bakken Shale oil region of North Dakota for example, the number of highway crashes increased by 68 percent between 2006 and 2010, with the share of crashes involving heavy trucks also increasing over that period.[75] A 2011 survey by StateImpact Pennsylvania in eight counties found that 911 calls had increased in seven of them, with the number of calls increasing in one county by 49 percent over three years, largely due to an increase in incidents involving heavy trucks.[76]

Methane contamination of well water poses a risk of explosion if the gas builds up inside homes. In both Ohio and Pennsylvania, homes have exploded after high concentrations of methane inside the buildings were ignited by a spark.[77]

Another public safety hazard stems from earthquakes triggered by injection wells. For example, on New Year's Eve in 2011—shortly after Ohio began accepting increasing amounts of wastewater from Pennsylvania—a 4.0 earthquake shook Youngstown, Ohio. Seismic experts at Columbia University determined that pumping fracking wastewater into a nearby injection well caused the earthquake.[78] Earthquakes triggered by injection well wastewater disposal have happened in Oklahoma, Arkansas, Texas, Ohio and Colorado. The largest quake—a magnitude 5.7 temblor in Oklahoma that happened in 2011—injured two people, destroyed 14 homes and buckled highways. People felt the quake as far as 800 miles away.[79]

As fracking wastewater volumes have increased dramatically since 2007, the number of earthquakes in the central United States, where injection well disposal is common, has increased by more than 1,100 percent compared to earlier decades.[80] Scientists at the U.S. Geological Survey have concluded that humans are likely the cause.[81] After reviewing data on the Oklahoma quake, Dr. Geoffrey Abers, a seismologist at the Lamont-Doherty Earth Observatory, concluded that, "the risk of humans inducing large earthquakes from even small injection activities is probably higher" than previously thought.[82]

Quantifying the State and National Impacts of Fracking

Fracking imposes numerous costly impacts on our environment and public health. This report seeks to estimate several key impacts of fracking for oil and gas, with a primary focus on high-volume fracking.

There have been few, if any, efforts to quantify the cumulative impacts of fracking at a state or national scale. The task is made difficult, in part, by differing definitions and data collection practices for unconventional drilling used in the states. These variations in data make it difficult to isolate high-volume fracking from other practices. To address this challenge, we collected data on unconventional drilling targets (shale gas, shale oil, and tight-gas sands) and practices (horizontal and directional drilling) to ensure the comprehensiveness of the data. Where possible, we then narrowed the data to include only those wells using high-volume hydraulic fracturing involving more than 100,000 gallons of water.

Photo: The Downstream Project via SkyTruth/LightHawk.

More than 6,000 shale gas/liquids wells, such as this well site in Tioga County, have been drilled in Pennsylvania since 2005.

The data presented in the following sections come from multiple sources, including state databases, estimates from knowledgeable state employees, and information provided by oil and gas companies to a national website. As a result, the quality of the data varies and figures may not be directly comparable from state to state. Nonetheless, the numbers paint an initial picture of the extensive environmental and public health damage from fracking.

Table 1. Estimate of Fracking Wells[83]

State	Fracking Wells since 2005	Fracking Wells Drilled in 2012
Arkansas	4,910	719
Colorado	18,168	1,896
Kansas	407	236
Louisiana	2,327	139
Mississippi	9	Unavailable
Montana	264	174
New Mexico	1,353	482
North Dakota	5,166	1,713
Ohio	334	234
Oklahoma	2,694	Unavailable
Pennsylvania	6,651	1,349
Tennessee	30	Unavailable
Texas	33,753	13,540
Utah	1,336	765
Virginia	95	1
West Virginia*	3,275	610
Wyoming	1,126	468
TOTAL	**81,898**	**22,326**

"Unavailable" means information was not available to determine when wells were drilled. See methodology for complete details.

** Data for West Virginia is for permitted fracking wells, not wells that have been drilled. Data were not available on drilled wells.*

Wells Fracked by State

The most basic measure of fracking's scope is a tally of how many fracking wells have been drilled. In addition, having an accurate count of wells by state offers a basis for estimating specific impacts to water, air and land.

Fracking has occurred in at least 17 states (see Table 1), affecting approximately 82,000 wells. In the eastern U.S., Pennsylvania reports the most fracking wells since 2005, with 6,651 wells tapping into the Marcellus and Utica shales. More than 5,000 fracking wells have been drilled in North Dakota to produce oil from the Bakken formation. Western states with the most fracking include Colorado, New Mexico and Utah.

Absent policies to rein in fracking, fracking is likely to expand in these and other states. Tennessee currently has a handful of wells but more will soon be fracked in the Cumberland Forest.[84] One test well was fracked in Georgia in the past year.[85] Illinois recently adopted new regulations governing fracking, paving the way for the practice there.[86] Oil and gas companies are seeking to expand to states such as California, New York, Maryland and North Carolina where there has been no such activity to date. In New York, as many as 60,000 wells could be drilled.[87]

Wastewater Produced

One of the more serious threats fracking poses to drinking water is the millions of gallons of toxic wastewater it generates.

While there are many ways in which fracking can contaminate drinking water—including but not limited to spills of fracking fluid, well blowouts, leaks of methane and other contaminants from the well bore into groundwater, and the possible eventual migration of fluids from shale to the water table—one of the most serious threats comes from the millions of gallons of toxic wastewater fracking generates.

Table 2 shows how much wastewater has been produced from fracking wells in selected states. In some states, such as New Mexico, North Dakota, Ohio, Pennsylvania and Utah, well operators submit regular reports on the volume of wastewater, oil and gas produced from their wells. In some states where operators do not report wastewater volumes, we estimated wastewater volumes using state-specific data as described in the methodology. These estimates are for wastewater only, and do not include other toxic wastes from fracking, such as drilling muds and drill cuttings.

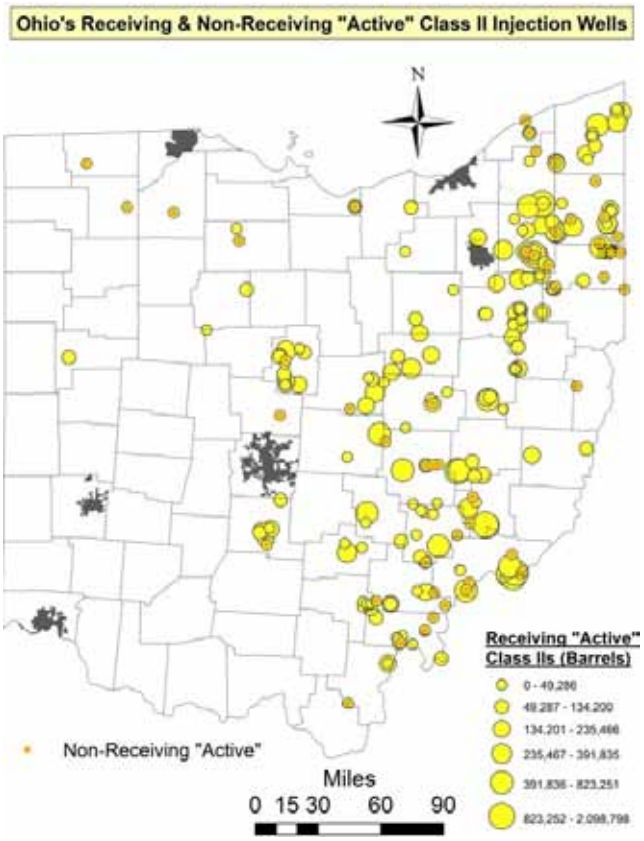
The rapid growth of fracking has caused wastewater volumes to increase rapidly. In the Marcellus Shale underlying Pennsylvania, West Virginia and Ohio, for example, wastewater production increased six-fold from 2004 to 2011.[89]

Table 2. Wastewater from Fracking in 2012[88]

State	Wastewater Produced (million gallons)
Arkansas	800
Colorado	2,200
Kansas	No estimate
Louisiana	No estimate
Mississippi*	10
Montana	360
New Mexico	3,000
North Dakota**	12,000
Ohio	30
Oklahoma	No estimate
Pennsylvania	1,200
Tennessee	No estimate
Texas	260,000
Utah	800
Virginia	No estimate
West Virginia	No estimate
Wyoming	No estimate
TOTAL	**280,000**

** Data for Mississippi are for 2012-2013.*

*** Data for North Dakota are cumulative to early 2013.*



Fracking wastewater is disposed into Class II injection wells in Ohio. "Receiving" wells currently accept fracking wastewater. "Non-receiving" wells are those wells that could receive fracking wastewater but haven't to date. Data mapped by the FracTracker Alliance on FracTracker.org. Original data source: *Bulk Transporter Magazine*, accessed at www.fractracker.org/2013/06/oh-waste-network, 23 July 2013.

In 2012 alone, fracking in Pennsylvania produced 1.2 billion gallons of wastewater, almost as much as was produced in a three-year period from 2009 to 2011.[90]

This huge volume of polluted wastewater creates many opportunities for contaminating drinking water. More wells and more wastewater increase the odds that the failure of a well casing or gasket, a wastewater pit or a disposal well will occur and that drinking water supplies will be contaminated. Moreover, as the sheer volume of wastewater generated exceeds local disposal capacity, drilling operators are increasingly looking to neighboring states as convenient dumping grounds. For example, in 2011, more than 100 million gallons of Pennsylvania's fracking waste were trucked to Ohio for disposal into underground injection wells.[91] (See map of Ohio disposal wells.)

As the volume of this toxic waste grows, so too will the likelihood of illegal dumping. For example, in 2013 Ohio authorities discovered that one drilling waste operator had dumped thousands of gallons of fracking wastewater into the Mahoning River.[92] And in Pennsylvania, prosecutors recently charged a different company with dumping fracking waste.[93]

For other industries, the threats posed by toxic waste have been at least reduced due to the adoption of the federal Resource Conservation Recovery Act (RCRA), which provides a national framework for regulating hazardous waste. Illegal dumping is reduced by cradle-to-grave tracking and criminal penalties. Health-threatening practices such as open waste pits, disposal in ordinary landfills, and road spreading are prohibited. However, waste from oil and gas fracking is exempt from the hazardous waste provisions of RCRA—exacerbating the toxic threats posed by fracking wastewater.

Chemicals Used

Fracking fluid consists of water mixed with chemicals that is pumped underground to frack wells. Though in percentage terms, chemicals are a small component of fracking fluid, the total volume of chemicals used is immense.

The oil and gas industry estimates that 99.2 percent of fracking fluid is water (by volume) and the other 0.8 percent is a mix of chemicals.[94] Assuming that this percentage is correct and has held true since 2005, that means oil and gas companies have used 2 billion gallons of chemicals.

These chemicals routinely include toxic substances. According to a 2011 congressional report, the toxic chemicals used in fracking include methanol, glutaraldehyde, ethylene glycol, diesel, naphthalene, xylene, hydrochloric acid, toluene and ethylbenzene.[95] More recently, an independent analysis of data submitted by fracking operators to FracFocus revealed that *one-third* of all frack jobs reported there use at least one cancer-causing chemical.[96] These toxic substances can enter drinking water supplies from the well, well pad or in the wastewater disposal process.

Water Used

Since 2005, fracking has used at least 250 billion gallons of water across the nation. Extrapolating from industry-reported figures on water use at more than 36,000 wells since 2011, we estimated total water use for all wells that were fracked from 2005 through mid-2013. (See Table 3.)

The greatest total water consumption occurred in Texas, at the same time the state was struggling with extreme drought. Other states with high water use include Pennsylvania, Arkansas and Colorado. The amount of water used for fracking in Colorado was enough to meet the water needs of nearly 200,000 Denver households for a year.[97]

Table 3. Water Used for Fracking[98]

State	Total Water Used since 2005 (million gallons)
Arkansas	26,000
Colorado	26,000
Kansas	670
Louisiana	12,000
Mississippi	64
Montana	450
New Mexico	1,300
North Dakota	12,000
Ohio	1,400
Oklahoma	10,000
Pennsylvania	30,000
Tennessee	130
Texas	110,000
Utah	590
Virginia	15
West Virginia	17,000
Wyoming	1,200
TOTAL	**250,000**

Air Pollution Created

Fracking created hundreds of thousands of tons of air pollution in 2012. As shown in Table 4, well-site operations during drilling and well completion generated approximately 450,000 tons of health-threatening air pollution. And that does not even include the significant emissions from ongoing operations, compressors, waste pits and truck traffic to and from drilling sites carrying supplies and personnel.

This air pollution estimate for all wells is based on emissions figures from wells in the Marcellus Shale. Different drilling targets and practices may lead to different results.[99] Additional research and improved data availability will help clarify the amount of pollution occurring in different regions.

The 2012 NO_x emissions from the early stages of fracking in Colorado were equal to 27 percent of the NO_x produced by power plants in the state, assuming fracking well emissions rates were similar to those in the Marcellus.[100] In Pennsylvania, fracking produced NO_x equal to 7 percent of that emitted in 2011 by electricity generation, a major source of smog-forming emissions.

Table 4. Estimated Air Pollution Produced from Early Stages of Fracking (Drilling and Well Completion) in 2012 (tons)

State	Particulate Matter	NO_x	Carbon Monoxide	VOCs	Sulphur Dioxide
Arkansas	400	5,300	8,100	700	20
Colorado	1,100	14,000	21,000	2,000	50
Kansas	100	1,700	2,700	200	6
Louisiana	80	1,000	1,600	100	3
Mississippi	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Montana	100	1,300	2,000	200	4
New Mexico	300	3,600	5,400	500	10
North Dakota	1,000	13,000	19,000	2,000	40
Ohio	100	1,700	2,600	200	6
Oklahoma	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Pennsylvania	800	10,000	15,000	1,000	30
Tennessee	Unavailable	Unavailable	Unavailable	Unavailable	Unavailable
Texas	7,800	100,000	153,000	14,000	300
Utah	400	5,700	9,000	1,000	20
Virginia	1	7	11	1	0
West Virginia	400	4,500	6,900	600	20
Wyoming	270	3,500	5,300	500	12
TOTAL	**13,000**	**170,000**	**250,000**	**23,000**	**600**

Global Warming Pollution Released

Completion of fracking wells produced global warming pollution of 100 million metric tons of carbon dioxide equivalent from 2005 to 2012, equal to emissions from 28 coal-fired power plants in a year.[101]

Using the data on the number of fracking wells, we estimated emissions from well completion using an emissions rate from a recent study by researchers at MIT. The researchers calculated that the average fracked shale gas well completed in 2010 released 110,000 pounds of methane during the first nine days of operation.[102] The researchers assumed that 70 percent of wells were operated with equipment to limit emissions, that 15 percent of wells flared gas, and that 15 percent of wells vented gas. Their calculations did not include methane emissions after the first nine days, such as during processing, transmission and distribution, nor did they include carbon dioxide emissions from trucks and drilling equipment. We used data on the number of wells fracked since 2005 (as presented in Table 1 in "Estimate of Fracking Wells ") to estimate methane emissions. Table 5 presents estimated emissions from completion of fracking wells from 2005 to 2012.

In Texas, emissions from completion of fracking wells since 2005 are equal to those produced by 12 coal-fired power plants in a year.[103] Completion of wells in Pennsylvania produced emissions equal to the pollution from 1.7 million passenger vehicles in a year.[104]

This estimate of emissions from well completion is both incomplete and includes several points of uncertainty. First and foremost, it does not include emissions from ongoing operation of wells. Second, in states where regulators do not have a firm estimate of the number of fracking wells, such as in Colorado and Texas, our conservative estimate of the number of fracking wells results in an underestimate of emissions. Introducing uncertainty, this estimate treats all wells as if they were the same and have the same emissions. In reality, some wells produce gas, some produce oil, and some wells produce gas that requires additional processing.[105] Finally, even those states that track the number of fracking wells typically don't track well type.

We believe this estimate of emissions from well completions understates total emissions from fracking wells. To compare this estimate of emissions from well completion to an estimate from ongoing emissions and to avoid the problem of uncertainty regarding emissions by well type, we estimated emissions based on gas production for a few states.

Table 5. Global Warming Pollution from Completion of Fracking Wells

State	Based on Well Completion from 2005 to 2012 (metric tons of carbon dioxide-equivalent)
Arkansas	6,200,000
Colorado	23,000,000
Kansas	500,000
Louisiana	2,900,000
Mississippi	11,000
Montana	300,000
New Mexico	1,700,000
North Dakota	6,500,000
Ohio	420,000
Oklahoma	3,400,000
Pennsylvania	8,300,000
Tennessee	No estimate
Texas	40,000,000
Utah	1,700,000
Virginia	120,000
West Virginia	4,100,000
Wyoming	1,400,000
TOTAL	**100,000,000**

Researchers at Cornell have studied emissions from fracking in five unconventional gas formations.[106] The researchers estimated the methane emissions released from multiple steps in the fracking process—drilling, fracking and processing—and calculated emissions as a percentage of produced gas.[107] Using estimates of gas production by state, where available, we calculated statewide global warming pollution from fracking. For the two states where we have complete production data—Pennsylvania and North Dakota—the production-based emissions estimate is higher than the estimate based on the number of completed wells.

Using our production-based method, Pennsylvania, North Dakota and Colorado had the highest emissions. Pennsylvania produced the most global warming pollution from fracking for gas. In 2012, the state created 24 million metric tons of carbon dioxide-equivalent, as much pollution as produced by seven coal-fired power plants or 5 million passenger vehicles.[108]

Photo: Gerry Dincher/Flickr.

Storage tanks can be a significant source of fugitive methane emissions.

Acres of Land Damaged

Nationally, land directly damaged for fracking totals 360,000 acres. (See Table 6.) This estimate includes the amount of land that has been cleared for roads, well sites, pipelines and related infrastructure in each state. However, the total amount of habitat and landscape affected by fracking is much greater. In treasured open spaces, a single well-pad can mar a vista seen from miles around. A study of fracking development in Pennsylvania estimated that forest fragmentation affected more than twice as much land as was directly impacted by development.[109]

Fracking activity in Colorado damaged 57,000 acres, equal to one-third of the acreage in the state's park system.[110] In Pennsylvania, the amount of land directly affected by fracking-related development since 2005 is equal to all the farmland protected since 1999 through the state's Growing Greener land preservation program.[111]

Table 6. Land Damaged for Fracking[112]

State	Acres Damaged since 2005
Arkansas	24,000
Colorado	57,000
Kansas	No estimate
Louisiana	No estimate
Mississippi	No estimate
Montana	230
New Mexico	8,900
North Dakota	50,000
Ohio	1,600
Oklahoma	22,000
Pennsylvania	33,000
Tennessee	No estimate
Texas	130,000
Utah	9,000
Virginia	460
West Virginia	16,000
Wyoming	5,000
TOTAL	**360,000**

Photo: ©Dennis Dimick/Flickr.

A grid of drilling sites and roads, similar to those used in fracking, lies across the landscape near Odessa, Texas.

In the years to come, fracking may affect a much bigger share of the landscape. According to a recent analysis by the Natural Resources Defense Council, 70 of the nation's largest oil and gas companies have leases to 141 million acres of land, bigger than the combined areas of California and Florida.[113] Moreover, as noted earlier in this report, the oil and gas industry is seeking access to even more acres of land for fracking—including areas on the doorsteps of our national parks, and inside our national forests—some of which contain sources of drinking water for millions of Americans.

Policy Recommendations

As evidenced by the data in this report, fracking is causing extensive damage to the environment and public health in states across the country. States as disparate as Colorado, North Dakota, Pennsylvania and Texas suffer from air pollution, water pollution, habitat disruption and water depletion caused by widespread fracking. Wherever fracking has occurred, it has left its mark on the environment and our well-being.

Fracking has additional impacts not documented in this report. Environmental damage includes water pollution from spills of fracking fluids and methane leaks into groundwater, as well as air pollution from toxic emissions that causes both acute and chronic health problems for people living near wells. Economic and social damage includes ruined roads and damage to farm economies.

The scale of this threat is growing almost daily, with thousands of new wells being added across the nation each year. Given the scale and severity of fracking's myriad impacts, constructing a regulatory regime sufficient to protect the environment and public health from dirty drilling—much less enforcing such safeguards at more than 80,000 wells, plus processing and waste disposal sites across the country—seems implausible at best.

In states where fracking is already underway, an immediate moratorium is in order. In all other states, **banning fracking is the prudent and necessary course to protect the environment and public health.**

- At a minimum, state officials should allow cities, towns and counties to protect their own citizens through local bans and restrictions on fracking.
- Moreover, states bordering on the fracking boom should also bar the processing of fracking waste so that they will not become dumping grounds for fracking operations next door. Vermont has already banned fracking and its waste, and similar proposals are under consideration in other states.

Where fracking is already happening, the least we should expect from our government is to **reduce the environmental and health impacts of dirty drilling as much as possible**, including:

- The federal government should close the loopholes that exempt fracking from key provisions of our federal environmental laws. For example, fracking wastewater, which often contains cancer-causing and even radioactive material, is exempt from our nation's hazardous waste laws.
- Federal and state governments should protect treasured open spaces and vital drinking water supplies from the risks of fracking. In 2011, the Obama administration's science advisory panel on fracking recommended the "[p]reservation of unique and/or sensitive areas as off limits to drilling and support infrastructure."[114] In keeping with this modest directive, dirty fracking should not be allowed near our national parks, national forests or in watersheds that supply drinking water.

- Policymakers should end worst practices. Fracking operators should no longer be allowed to use open waste pits for holding wastewater. The use of toxic chemicals should not be allowed in fracking fluids. Operators should be required to meet aggressive water use reduction goals and to recycle wastewater.

To ensure that the oil and gas industry—rather than taxpayers, communities or families—pays the costs of fracking damage, states and the Bureau of Land Management should **require robust financial assurance from operators at every well site**.

While we conclude that existing data alone is sufficient to make the case against fracking, additional data will provide a more complete picture and is critical for local communities and residents to assess ongoing damage and liability where fracking is already occurring. As this report revealed, data available on fracking are inconsistent, incomplete and difficult to analyze. To remedy this, oil and gas companies should be required to report all fracking wells drilled, all chemicals used, amount of water used, and volume of wastewater produced and toxic substances therein. Reporting should occur into an accessible, national database, with chemical use data provided 90 days before drilling begins.

Methodology

This report seeks to estimate the cumulative impacts of fracking for oil and gas in the United States. We attempted to limit the scope of the data included in the report to wells using high-volume hydraulic fracturing with horizontal drilling, because that new technology has the greatest environmental impacts and its use is increasing rapidly. However, the definition of and data collection practices for unconventional drilling vary significantly from state to state, making it difficult—and in some cases impossible—to limit our study only to those wells that have been developed using high-volume fracking.

To ensure that our estimates included the most comprehensive data possible, we began by collecting—largely from state oil and gas regulators, as described below—data on all unconventional drilling targets and practices (excluding acidization). Where possible, we then narrowed the data to include only those wells using high-volume hydraulic fracturing involving more than 100,000 gallons of water and/or horizontal drilling. In many states, the information needed to identify these wells was lacking. In those states, we included all wells using unconventional drilling practices in the data. In the section "Number of Wells, Wastewater and Produced Gas," we explain what types of drilling are included in the data for each state.

For data on water use and for teasing apart state data on conventional and unconventional wells, we relied heavily on the work done by SkyTruth to make data reported by the fracking industry more accessible. Oil and gas drilling companies report some of their fracking activities to the FracFocus website, providing information on individual wells in separate PDF files. SkyTruth compiles these individual PDFs and extracts the data "as is," placing the data into a standard machine-readable database that can be downloaded and analyzed. We downloaded SkyTruth's *Fracking Chemical Database* from frack.skytruth.org/fracking-chemical-database/frack-chemical-data-download on 12 June 2013. References below to SkyTruth data or API numbers from SkyTruth refer to this database.

The data we were able to collect undercounts the scope of fracking and its damage, for several reasons. First, when the data were unclear, we made conservative assumptions and chose conservative methodologies. Second, the FracFocus data we drew upon for some of our calculations are incomplete (see text box "Problems with FracFocus Data").

Our analysis does not include data from several states where fracking is a subject of policy debates, including Michigan and California. In those states, the data show that little to no fracking has occurred using high volumes of water because oil and gas companies have not yet begun to combine horizontal drilling with fracking. In these states, hydraulic fracturing has taken place in vertical wells, which require far less water.

Problems with FracFocus Data

Data collected on the FracFocus website have several limitations: FracFocus does not include all fracking wells in the nation, the data that are provided can be of poor quality, and loopholes in reporting requirements enable companies to hide some information.

The FracFocus website does not include data on all fracking wells. The website came into operation in 2011, after thousands of wells had already been fracked and in most cases operators have not retroactively entered information on older wells. Furthermore, in many states, reporting to FracFocus is voluntary and therefore the website does not cover all wells fracked since 2011. Only Colorado, Louisiana, Montana, New Mexico, North Dakota, Oklahoma, Pennsylvania, Texas and Utah require reporting to FracFocus.[115] In most of those states, however, the reporting requirement was adopted in 2012 or later and therefore not all earlier fracking activity is included on FracFocus.

Table 7. FracFocus Contains an Incomplete Count of Fracking Wells (Using More than 100,000 Gallons of Water)

	Count from FracFocus		Count Based on State Data	
State	**Fracking Wells since 2005**	**Fracking Wells in 2012**	**Fracking Wells since 2005**	**Fracking Wells in 2012**
Arkansas	1,461	611	4,910	719
Colorado	4,996	2,308	18,168	1,896
Kansas	150	108	407	236
Louisiana	1,078	346	2,327	139
Mississippi	5	3	9	Unavailable
Montana	264	174	264	174
New Mexico	916	515	1,353	482
North Dakota	2,654	1,653	5,166	1,713
Ohio	156	121	334	234
Oklahoma	2,097	1,270	2,694	Unavailable
Pennsylvania	2,668	1,295	6,651	1,349
Tennessee	2	0	30	Unavailable
Texas	16,916	9,893	33,753	13,540
Utah	1,336	765	1,336	765
Virginia	5	3	95	1
West Virginia	280	170	3,275	610
Wyoming	1,126	468	1,126	468
TOTAL	**36,457**	**19,923**	**81,898**	**22,326**

We compared the data we collected from states with the data included in FracFocus. SkyTruth's database of FracFocus data contains records for approximately 36,000 unique wells that used more than 100,000 gallons of water. Based on data we collected directly from states, we tallied more than 80,000 wells from the beginning of 2005 through mid-2013. Table 7 shows the state-by-state differences between our figures and those derived from FracFocus.

Further evidence of how much data are missing from FracFocus comes from a comparison of water use in all Texas wells reported to FracFocus by individual oil and gas companies versus water use calculated for the Texas Oil & Gas Association. This comparison shows that the figures in FracFocus in 2011 might be 50 percent too low. According to Jean-Philippe Nicot, et al., for the Texas Oil & Gas Association, *Oil & Gas Water Use in Texas: Update to the 2011 Mining Water Use Report*, September 2012, fracking used 81,500 acre-feet of water in Texas in 2011 and consumed 68,400 acre-feet. In contrast, the data from SkyTruth's compilation of FracFocus data suggest total use was 46,500 acre-feet in 2011. Reporting by Texas operators was voluntary at this point, and in 2011 only half of Texas wells were reported to FracFocus, according to Leslie Savage, Chief Geologist, Oil and Gas Division of the Texas Railroad Commission, personal communication, 20 June 2013.

Second, the quality and scope of the data are inconsistent. Typographical errors and incorrect chemical identifying numbers mean some of the data are unusable.

Finally, companies are not required to report all the chemicals they use in the fracking process. Through a trade-secrets exemption, drilling companies can mask the identities of chemicals. In some states, up to 32 percent of the chemicals used are not disclosed because companies claim they are trade secrets, per SkyTruth, *SkyTruth Releases Fracking Chemical Database*, 14 November 2012.

Number of Wells, Wastewater and Produced Gas

We obtained most of our data on a state by state basis for the number of wells, the amount of wastewater produced, and the amount of gas produced.

Arkansas

Data on well completions in Arkansas came from Arkansas Oil and Gas Commission, *Fayetteville Well Completion Report*, downloaded from www.aogc2.state.ar.us/FayettevilleShaleInfo/regularly%20updated%20docs/B-43%20Field%20-%20Well%20Completions.pdf, 4 June 2013. Essentially all these wells are fracked, per James Vinson, Webmaster, Little Rock Office, Arkansas Oil & Gas Commission, personal communication, 4 June 2013. We included wells with no date listed for "Date of 1st Prod" when they had other remarks indicating they were drilled in the past few years.

Our calculation of the volume of flowback and produced water in Arkansas is based on a finding in J.A. Veil, Environmental Science Division, Argonne National Laboratory, for the U.S. Department of Energy, Office of Fossil Energy, National Energy Technology Laboratory, *Water Management Practices Used by Fayetteville Shale Gas Producers*, June 2011. Veil reports that one producer in the Fayetteville Shale estimates that "the combined return volume of flowback water and subsequent produced water for the Fayetteville shale is … about 25%." We multiplied this by data on water consumed to frack Fayetteville shale wells in 2012.

Colorado

Colorado does not track fracking wells separately from other oil and gas wells. To estimate the number of fracking wells in the state, we counted the number of wells in Weld, Boulder, Garfield and Mesa counties with spud dates of 2005 or later. Data on well completions came from Colorado Oil and Gas Conservation

Commission, *2013 Production Summary*, accessed at cogcc.state.co.us/, 3 September 2013, and guidance on which counties to include came from Diana Burn, Eastern Colorado Engineering Supervisor, Colorado Oil and Gas Commission, personal communication, 4 September 2013. Many wells in Weld and Boulder counties use fracking to tap the Niobrara and Codell formations, while wells in Garfield and Mesa counties target the Piceance Basin. We excluded wells from all other counties because those wells use lower volumes of water due to shallower wells, foam fracking, or recompletion of existing wells.

Our estimate of gas production and produced water volumes came from Colorado Oil and Gas Conservation Commission, *2012 Annual Production Summary* (Access database), downloaded 25 June 2013. We selected for gas and water production data from all wells drilled in Weld, Garfield, Boulder and Mesa counties since 2005 as described above.

Kansas

We obtained data on all horizontal wells from Kansas Geological Survey, *Oil and Gas Well Database*, accessed at chasm.kgs.ku.edu, 30 May 2013. We counted only those wells with a listed spud date. We were unable to obtain an estimate of wastewater produced.

Louisiana

We obtained data on shale wells drilled in the Haynesville formation from Louisiana Department of Natural Resources, *Haynesville Shale Wells* (spreadsheet), updated 13 June 2013. We counted only those wells with a spud date. The majority of fracking in Louisiana is occurring in the Haynesville shale, per Michael Peikert, Manager, Environmental Section of Engineering Division at the Department of Natural Resource's Office of Conservation, personal communication, early June 2013.

Data on produced water are not available in Louisiana.

Mississippi

Mississippi began requiring permits for fracking wells only in March 2013. Therefore, we used data provided to FracFocus by oil and gas companies involved in fracking. We used the "Find a Well" function on the FracFocus website to search for wells in Mississippi as of 18 June 2013. Reporting to the FracFocus website is voluntary for companies in Mississippi, so the website likely undercounts fracking wells in the state.

Monthly data on produced water are available well by well from the Mississippi Oil and Gas Board's website (http://gis.ogb.state.ms.us/MSOGBOnline/) using individual API numbers. We looked up three wells, one of which has been abandoned, and used the volume of produced water to calculate a state average.

Montana

Our count of fracking wells came from the FracFocus database. We screened for wells that reported using more than 100,000 gallons of water, and counted 264 wells.

This estimate is conservative. A tally of new horizontal and recompleted horizontal wells in Montana Board of Oil and Gas Conservation, *Horizontal Well Completion Count*, accessed at www.bogc.dnrc.mt.gov, 29 May 2013 turned up 1,052 wells, which may include some coalbed methane wells.

To obtain an estimate of produced water, we downloaded the list of API numbers in Montana reported to FracFocus and compiled by SkyTruth. We provided that list of API numbers, which started in 2011, to Jim Halvorson, Petroleum Geologist, Montana Board of Oil and Gas, who queried the state's database for all produced water reports associated with those API numbers in a spreadsheet on 27 June 2013. We summed the produced water figures for the 12-month period ending 31 May 2013.

New Mexico

We calculated the total number of fracking wells in New Mexico in two different ways and chose to use the lower estimate to be conservative.

We counted 1,353 fracking wells by downloading a list of all permitted wells in the state from New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division, *OCD Data and Statistics*, 12 June 2013. We selected all wells with an "H" (for hydraulically fractured) at the end of the well name, per a conversation with Phillip Goetze, New Mexico Oil Conservation Division, 25 June 2013. We further screened the wells to include just those with a status of "Active," "Plugged" or "Zone Plugged." We included wells that were identified as "New (Not drilled or compl)" if those records otherwise contained information suggesting the well has been completed (by listing days in production in 2011, 2012, or 2013). This count included a few wells started before 2005.

We counted 1,803 fracking wells by reviewing the list of hydraulic fracturing fluid disclosure forms submitted by drillers for approval before fracking a well. We obtained the list from New Mexico Oil Conservation Division, *Action Status Permitting Database*, 13 June 2013. The requirement to submit these forms began in 2012, so this count doesn't include wells from 2011 and earlier. This approach was based on a conversation with Laurie Hewig, Administrative Bureau Chief, New Mexico Oil Conservation Division, 13 June 2013.

To estimate produced water, we used water production data reported in New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division, *OCD Data and Statistics*, 12 June 2013, and filtered as described above. We obtained gas production figures in the same manner.

North Dakota

We obtained data on fracking wells in North Dakota from North Dakota Oil and Gas Division, *Bakken Horizontal Wells by Producing Zone*, accessed at www.dmr.nd.gov, 29 May 2013. We assumed that all horizontal wells are fracked and that all fracking in the state happens in the Bakken Shale. We obtained data on produced water from this same data source. However, reported production data are cumulative by well and we could not calculate production by all fracking wells over a one-year period. Therefore, our tally of water includes multiple years of production.

Data on gas production from fracking wells comes from North Dakota Industrial Commission, Department of Mineral Resources, *North Dakota Monthly Gas Production and Sales*, accessed at www.dmr.nd.gov/oilgas/stats/Gas1990ToPresent.pdf, 9 August 2013. We tallied production in 2012 only.

Ohio

For Ohio, we included data for wells drilled in both the Marcellus and Utica shales from the Ohio Department of Natural Resources, Division of Oil & Gas Resources. The state separates shale well permit activity into Marcellus and Utica categories, and presents it in spreadsheets entitled *Cumulative Permitting Activity*, available at oilandgas.ohiodnr.gov/shale#SHALE, with well sites permitted through 2 May 2013.

Produced water and gas information for the Utica came from Ohio Department of Natural Resources, Division of Oil & Gas Resources, *2012 Utica Shale Production Report*, 16 May 2013. Data on production from the 11 drilled Marcellus wells came from Ohio Department of Natural Resources, Division of Oil & Gas Resources, *Ohio Oil & Gas Well Database*, accessed at http://oilandgas.ohiodnr.gov/well-information/oil-gas-well-database, 24 June 2013. We used the API numbers from Ohio Department of Natural Resources, Division of Oil & Gas Resources, *Marcellus Shale Horizontal Wells*, 6 July 2013.

Oklahoma

Our count of fracking wells in Oklahoma came from a database downloaded from FracTracker, *Oklahoma Shale Wells (3-18-2013)*, accessed at www.fractracker.org/downloads/, 28 June 2013. The database does not contain any date information.

Pennsylvania

We included data for all unconventional wells with spud dates of January 1, 2005 and later from Pennsylvania Department of Environmental Protection, *Oil and Gas Reports: SPUD Data Report*, www.portal.state.pa.us, 29 May 2013.

Data on gas and water produced in 2012 from Pennsylvania's fracking wells came from the Pennsylvania Department of Environmental Protection, *PA DEP Oil & Gas Reporting Website—Statewide Data Downloads by Reporting Period*, accessed at www.paoilandgasreporting.state.pa.us/publicreports/Modules/DataExports/DataExports.aspx, 24 June 2013. Our produced water tally included "Drilling Fluid Waste," "Fracing Fluid Waste" and "Produced Fluid."

Tennessee

Our estimate of the number of fracking wells came from Ron Clendening, Geologist, Oil & Gas Contacts, Division of Geology, Tennessee Department of the Environment and Conservation, personal communication, 8 July 2013. We were unable to obtain an estimate of wastewater or gas production.

Texas

Texas began keeping track of fracking wells in February 2012. To compile an estimate of fracking wells since 2005, we used several data sources.

- 2005-2009: We assume that from 2005 through 2009, the bulk of fracking activity in Texas occurred in the Barnett Shale and was barely beginning elsewhere. A total of 8,746 new horizontal wells were drilled in the Barnett Shale from 2005 through 2009, per *Powell Barnett Shale Newsletter*, 18 April 2010, as cited in Zhongmin Wang and Alan Krupnick, *A Retrospective Review of Shale Gas Development in the United States*, Resources for the Future, 2013. The Eagle Ford Shale was first drilled in 2008 and by 2009 there were 107 producing oil and gas wells, per Texas Railroad Commission, *Eagle Ford Information*, accessed at www.rrc.state.tx.us/eagleford/, 3 September 2013.
- 2010: Nearly 40 percent of wells drilled in 2010 were fracked using more than 100,000 gallons of water, per Table 7 of Jean-Philippe Nicot, et al., Bureau of Economic Geology, Jackson School of Geosciences, University of Texas at Austin, for the Texas Water Development Board, *Current and Projected Water Use in the Texas Mining and Oil and Gas Industry*, June 2011. We multiplied 39.7 percent times the 8,133 "new drill dry/completions" in 2010, per Railroad Commission of Texas, *Summary of Drilling, Completion and Plugging Reports,* accessed at www.rrc.state.tx.us/data/drilling/drillingsummary/index.php, 19 July 2013.
- January 2011 through January 2012: We calculated the number of fracking wells in this period by multiplying the number of wells drilled by an estimate of the percentage of those wells that were fracked. The number of "new drill dry/completions" came from Railroad Commission of Texas, *Summary of Drilling, Completion and Plugging Reports,* accessed at www.rrc.state.tx.us/data/drilling/drillingsummary/index.php, 3 September 2013. We interpolated between 2010 and February 2012 using the percentage of wells that were fracked using the 2010 estimate of 39.7 percent, described above, and the percent fracked from February 2012 to April 2013, described below.
- February 2012 through April 2013: Beginning in February 2012, drilling companies in Texas have been required to report their drilling activities

to FracFocus. Per SkyTruth, 19,678 wells were fracked in Texas in that period that used more than 100,000 gallons of water. This number of wells equals 82.5 percent of all "new drill dry/completions" in the same period in Railroad Commission of Texas, *Summary of Drilling, Completion and Plugging Reports,* accessed at www.rrc.state.tx.us/data/drilling/drillingsummary/index.php, 3 September 2013.

Texas does not require reporting of produced water volumes. However, the state does track the volume of water that is injected into disposal wells or for enhanced recovery in other wells. Our estimate of wastewater is based on the assumption that 99 percent of all produced water is reinjected, and therefore reinjected water volumes indicate wastewater production, per Leslie Savage, P.G., Chief Geologist, Oil & Gas Division, Railroad Commission of Texas, personal communication, 18 July 2013. Ms. Savage queried the Railroad Commission's *H10 Filing System* to return results on injected saltwater volumes in 2012, which we used as the basis of our estimate. This includes both flowback and produced water.

Utah

Our count of fracking wells came from the FracFocus database. We screened for wells that reported using more than 100,000 gallons of water, and counted 1,336 wells.

We calculated gas and produced water volumes from fracking wells in Utah from Utah Department of Natural Resources, Division of Oil, Gas and Mining, *Production Data*, accessed at http://oilgas.ogm.utah.gov/Data_Center/DataCenter.cfm#download, 12 July 2013. To limit our tally to production from fracking wells, we used API numbers for all Utah wells included in SkyTruth's database from FracFocus data. Of the 1,607 wells with APIs in SkyTruth's database, we found 2012 production reports for 1,364 wells in Utah's data.

Virginia

We counted all horizontal wells included in Virginia Department of Mines, Minerals, and Energy Division of Gas and Oil Information System, *Drilling Report*, accessed at www.dmme.virginia.gov, 29 May 2013.

We were unable to obtain data on produced water. An estimated 15 to 30 percent of water and chemicals used to frack a well returns to the surface, per Virginia Department of Mines, Minerals, and Energy, Division of Gas and Oil, *Hydraulic Fracturing in Virginia and the Marcellus Shale Formation*, accessed at www.dmme.virginia.gov/DGO/HydraulicFracturing.shtml, 12 July 2013. However, we were unable to obtain data on how much formation water also is produced.

West Virginia

Our data for West Virginia includes all permitted wells targeting the Marcellus Shale. We were unable to narrow our count to drilled wells. We also chose to include wells without a listed permit date, on the assumption that any Marcellus drilling in West Virginia has occurred recently. Data is from West Virginia Department of Environmental Protection, *Resource Extraction Data Viewer*, http://tagis.dep.wv.gov/fogm/, 20 June 2013.

We tallied gas production from 2011 (the most recent year reported). We obtained 2011 production data from West Virginia Department of Environmental Protection, *Oil and Gas Production Data*, accessed from www.dep.wv.gov/oil-and-gas/databaseinfo/Pages/default.aspx, 12 July 2013. We looked up production from fracking wells by using the API numbers reported to FracFocus and compiled in SkyTruth's database. Our calculation of production is an underestimate because only 52 wells from FracFocus corresponded to wells in West Virginia's production database.

West Virginia does not collect water production data.

Wyoming

We used data on fracking wells reported to the FracFocus database to ensure we did not accidentally include coalbed methane wells. There are 1,126 wells in the FracFocus database that report using more than 100,000 gallons of water.

This figure from FracFocus is close to data we obtained through another approach. We tallied 1,273 horizontal wells since 2005 in Wyoming from FracTracker, *WY_horiz_06032013*, accessed at www.fractracker.org/data/, 28 June 2013. FracTracker obtained this list via a request to the Wyoming Oil and Gas Conservation Commission. This estimate excludes any wells that list a spud date before 2005, and includes wells with no date or that were flagged as coalbed.

Water Used

We multiplied the number of fracking wells per state since 2005 by average water use per well per state since 2011.

Average water use per well that reported using more than 100,000 gallons came from Skytruth, *Fracking Chemical Database*, accessed at http://frack.skytruth.org/fracking-chemical-database/frack-chemical-data-download, 12 June 2013. SkyTruth compiled data posted in PDFs on the FracFocus website into a database that includes water use, which can encompass freshwater, produced water and/or recycled water. The inclusion of recycled water may lead to some double-counting of water used. We included data beginning in 2011 through the most recent entries for 2013. In calculating average water consumption per well, we excluded wells that listed "None" for water use. We excluded what appeared to be duplicate entries, based on API numbers, frack date and reported water use. We also excluded two wells from Texas that reported using more than 1 billion gallons of water each, which we assumed was a data entry error by the reporting operator.

To estimate water use since 2005, we multiplied average water use per reporting well in each state by the number of fracking wells (using more than 100,000 gallons of water) in each state since 2005. The source of our well count is described in the previous section.

Air Pollution

We used data from New York State's assessment of air pollution from each well site to estimate the volume of particulate matter, smog precursors and other hazardous compounds from fracking. Though the U.S. Environmental Protection Agency recently studied air pollution from gas drilling, the data were compiled primarily from vertically rather than horizontally fracked wells and were limited to fewer types of pollutants (see EC/R, Inc., for U.S. Environmental Protection Agency, *Oil and Natural Gas Sector: Standards of Performance for Crude Oil and Natural Gas Production, Transmission, and Distribution. Background Technical Support Document for Proposed Standards*, July 2011. New York State's pollution assessment was more complete and more relevant to high-volume fracking wells.

We assume that four wells per drilling site are drilled, fracked and completed each year, per New York State Department of Environmental Conservation, *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling And High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, 7 September 2011, 6-105. We assumed that wells produce dry gas, not wet gas, and that operators flare flowback gas instead of simply venting it. This first assumptions means our air pollution estimate may understate the problem, since wet gas wells have higher emissions, while our second assumption changes the mix of pollutants released. We multiplied the tons-per-year emissions estimates from Table 6.7 of the *Revised Draft Supplemental Generic Environmental Impact Statement* by a recent year's well completion figure for each state.

This emissions estimate does not include the significant emissions from ongoing operations, compressors, and truck traffic to and from drilling sites carrying supplies and personnel.

Methane Emissions

We calculated methane emissions using two different approaches because neither approach alone provided a complete picture. The lack of data on wells drilled, gas produced and emissions per well makes it very hard to assess the extent of global warming damage from fracking. Our first approach multiplied emissions per well during completion by the number of fracking wells. Our second method multiplied emissions as a percentage of gas produced by the amount of gas produced from fracking wells.

In states with more comprehensive production data, the energy-based calculation may be more accurate because it is based on state-specific conditions. In addition, the energy-based method includes emissions from a wider range of activities involved in producing gas from fracking wells—from drilling to fracking to processing—and therefore better reflects the impact of fracking.

In states where we could obtain no or limited emissions data, the estimate based on per-well emissions during completion offers a rough emissions estimate. The per-well emission factor is conservative because it is based on a narrower definition of fracking activity (it excludes production and processing). However, it may overestimate emissions from wells that were drilled but produced little to no gas.

Emissions Based on Well Completion

We estimated methane emissions by multiplying an estimate of emissions per completion of a fracking gas well by the number of fracking wells in 2012 in each state. We estimated average emissions of 50,000 kilograms of methane per well, per Francis O'Sullivan and Sergey Paltsev, "Shale Gas Production: Potential Versus Actual Greenhouse Gas Emissions," *Environmental Research Letters*, 7:1-6, 26 November 2012, doi: 10.1088/1748-9326/7/4/044030. This estimate is a national average based on nearly 4,000 wells completed in 2010 and assumes 70 percent of wells undergo "green" completions in which fugitive emissions are captured. This likely overstates the green completions rate before 2010.

Our estimate has two limitations of note. First, it does not include methane emissions from pipelines, compressor stations, and condensate tanks, or carbon dioxide emissions from equipment used to produce gas. Second, it may not accurately reflect emissions from fracked shale wells that produce oil rather than gas. The data we obtained on well completions do not distinguish between wells fracked for oil versus gas production and therefore we have chosen to apply this estimate for shale gas wells to all wells. We spoke with two experts in the field who believe that, given the lack of better data on emissions from oil wells, is it reasonable to assume that fracked oil wells have substantial methane emissions.

We converted methane emissions to carbon dioxide equivalents using a 100-year global warming potential of 25 times that of carbon dioxide, per Federal Register, *Environmental Protection Agency, 40 CFR Part 98, 2013 Revisions to the Greenhouse Gas Reporting Rule and Proposed Confidentiality Determinations for New or Substantially Revised Data Elements; Proposed Rule*, 78(63): 19802-19877, 2 April 2013.

Emissions Based on Gas Production

We calculated methane emissions as a percentage of gas production. See the previous section for a description of how we estimated gas production in each state.

We converted cubic feet of gas production to megajoules of methane using the assumption that 78.8 percent of gas produced from unconventional wells is methane, per Robert Howarth, et al., "Meth-

ane and the Greenhouse Gas Footprint of Natural Gas from Shale Formations," *Climatic Change* 106: 679-690, 2011. (Note that other researchers have estimated the methane content of Marcellus Shale gas as high as 97.2 percent. See ICF International, Technical Assistance for New York State Department of Environmental Conservation, *Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program*, as cited in Mohan Jiang, et al., "Life Cycle Greenhouse Gas Emissions of Marcellus Shale Gas," *Environmental Research Letters,* 6, 034014, July-September 2011, doi:10.1088/1748-9326/6/3/034014, supplemental materials.)

We assume that 3.3 percent of the methane produced over the life of a well is lost as fugitive emissions, per Robert Howarth, et al., "Methane and the Greenhouse Gas Footprint of Natural Gas from Shale Formations," *Climatic Change* 106: 679-690, 2011, as presented in Robert Howarth, et al., *Methane Emissions from Natural Gas Systems; Background Paper Prepared for National Climate Assessment,* 25 February 2012. This estimate includes well-site and processing emissions from shale and tight-gas sands wells that produce gas. The estimate assumes significant venting of methane in the initial days after a well is fracked.

The 3.3 percent pollution rate from Howarth, et al., is higher than reported in EPA, *Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990 to 2011*, 12 April 2013. However, it is in the range of one recent study that measured fugitive emissions over a gas and oil field in Colorado, finding fugitive methane emissions of 2.3 to 7.7 percent of gas produced (Gabrielle Pétron, et al., "Hydrocarbon Emissions Characterization in the Colorado Front Range: A Pilot Study," *Journal of Geophysical Research*, 117, D04304, 2012, doi:10.1029/2011JD016360, and Jeff Tollefson, "Air Sampling Reveals High Emissions from Gas Field," *Nature*, 483(7384): 139-140, 9 February 2012, doi: 10.1038/482139a). A second recent study in the same area measured methane emissions equal to 6.2 to 11.7 percent of production (Anna Karion, et al., "Methane Emissions Estimate from Airborne Measurements over a Western United States Natural Gas Field," *Geophysical Research Letters*, 27 August 2013, doi: 10.1002/grl.50811).

We used a slightly different method to calculate emissions for North Dakota, where a large portion of gas is flared rather than sold. We calculated emissions for the flared gas and emissions for the remaining gas separately. Because of lack of infrastructure to get gas to market, 29 percent of all gas produced in North Dakota is flared, per Lynn Helms, North Dakota Industrial Commission, Department of Mineral Resources, *Director's Cut*, 15 July 2013. We estimated emissions from this gas based on New York State Department of Environmental Conservation, *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling And High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, 7 September 2011, 6-194. We calculated emissions from the remaining wells using Robert Howarth, et al., "Methane and the Greenhouse Gas Footprint of Natural Gas from Shale Formations," *Climatic Change* 106: 679-690, 2011, as presented in Robert Howarth, et al., *Methane Emissions from Natural Gas Systems; Background Paper Prepared for National Climate Assessment*, 25 February 2012.

Landscape Impacts

We calculated landscape impacts based on the number of wells in each state. We divided the number of wells drilled (or permitted, if only that figure was available) since the beginning of 2005 by the average number of wells per pad to obtain the number of well pads. We then multiplied the number of well pads by the size of each well pad and the roads and pipelines servicing it. Where possible, we used state-specific estimates about the number of wells per pad and the acreage damaged by pads and supporting infrastructure.

For states where most drilling is into the Marcellus Shale (**Pennsylvania** and **West Virginia**), we assumed that land disruption patterns are comparable to those in Pennsylvania, where existing drilling practices place an average of 1.8 wells per well pad. Well pads average 3.1 acres and associated infrastructure disturbs 5.7 acres. Pennsylvania data were presented in New York State Department of Environmental Conservation, *Revised Draft Supplemental Generic Environmental Impact Statement on the Oil, Gas and Solution Mining Regulatory Program: Well Permit Issuance for Horizontal Drilling And High-Volume Hydraulic Fracturing to Develop the Marcellus Shale and Other Low-Permeability Gas Reservoirs*, 7 September 2011, 6-76. We assumed **Ohio** and **Virginia** follow the same land disturbance patterns.

In **Oklahoma**, we assumed 1.1 wells per pad, and the same wellpad size and road and pipeline impacts as in Ohio and Pennsylvania.

For **Texas**, we assumed two wells per pad because the sources we consulted suggest that there are some multi-well pads but that the number of wells per pad remains small. In the Barnett, well pads hold anywhere from one to eight wells, per George King, GEK Engineering, *Multi-Well Pad Operations for Shale Gas Development, Draft Document*, 5 May 2010. In the Eagle Ford Shale, Chesapeake Energy, as of early 2013, was drilling only half of its wells on multi-well pads, per Jennifer Hiller, "Chesapeake Thinks It Has 342 Million Barrels in Eagle Ford," *Eagle Ford Fix* (blog operated by *San Antonio Express-News*), 6 May 2013. We assumed pad size is the same as in Pennsylvania (which has an average of 1.8 wells per pad). We assume road and pipeline infrastructure occupies 4.75 acres, the same as on public land in western Colorado.

For **New Mexico**, we estimated the number of wells per pad after mapping the location of fracking wells reported to FracFocus in 2012. We used the API number of those wells to obtain the latitude and longitude for each well from New Mexico Energy, Minerals and Natural Resources Department, Oil Conservation Division, *OCD Data and Statistics*, 12 June 2013. A small number of 2012 wells appear to be on multi-well pads. Given that in neighboring Texas, few wells before 2012 were drilled on multi-well pads, we assumed that New Mexico wells average 1.1 wells per pad. We assumed pad size for a single-well pad is 2.47 acres, based on the average pad size and wells per pad in Weld County, Colorado (see below). We assumed road and pipeline infrastructure occupies 4.75 acres, the same as on public land in western Colorado.

We made the same assumption for **Utah**, based on mapping the location of fracking wells and finding few multi-well pads.

For **Colorado**, we obtained estimates for acres damaged by wells in Weld County and on public land in western Colorado. By looking at the Form 2A documentation for 20 fracking wells across Weld County, we found that an average of 2.25 wells are drilled per pad and that well pads disturb an average of 5.56 acres. We could not obtain an estimate of land disturbed for roads and pipelines. We obtained this data from Colorado Oil and Gas Conservation Commission, *GISOnline*, accessed at http://dnrwebmapgdev.state.co.us/mg2012app/, 11 July 2013. Leases on federal land in western Colorado average eight wells per pad, with 7.25 acres of land disturbed per pad and an additional 4.75 acres for roads and other infrastructure, per U.S. Department of the Interior, Bureau of Land Management, Colorado State Office, Northwest Colorado Office, White River Field Office, *Draft Resource Management Plan Amendment and Environmental Impact Statement for Oil and Gas Development*, August 2012. For our calculation, we used the Weld County data for Weld and Boulder wells, and the western Colorado estimates for Garfield and Mesa wells. We used the western Colorado estimate of acreage for supporting infrastructure.

For **Wyoming**, we assumed an average of two wells per pad. Drilling in the Jonah Field is estimated to

occur with single well pads and in the Pinedale Anticline with multiple wells per pad, per U.S. Department of the Interior, Bureau of Land Management, Pinedale Field Office, *Proposed Resource Management Plan and Final Environmental Impact Statement for Public Lands Administered by the Bureau of Land Management, Pinedale Field Office*, August 2008. From that same source, we used an estimate of four acres per two-well pad, and 4.9 acres for roads and pipelines per pad.

In **Montana**, we calculated land impacts based on data from current land impacts of wells in the HiLine Planning Area in north central Montana. Existing wells in the Bowdoin Dome and the rest of the HiLine Planning Area (which may not be high-volume wells) disturb an average of 0.21 acres per well pad and 0.67 acres for roads and flow lines, based on a weighted average of data presented in Table 22 of Dean Stillwell and J. David Chase, U.S. Department of the Interior, Bureau of Land Management, *Reasonable Foreseeable Development Scenario for Oil and Gas Activities on BLM-Managed Lands in the HiLine Planning Area, Montana, Final Report*, 30 October 2012. We assumed one well per pad.

In **North Dakota**, we assumed one well per pad, though that estimate may be less valid for wells drilled in the past year, per Mike Ellerd, "Evolution Continues: Densities Could Reach 24 Wells Per Pad; 6,000 Wells Over Next 3 Years," *Petroleum News Bakken*, 21 April 2013. We assumed the average well occupies five acres of land, per Alison Ritter, Public Information Specialist, North Dakota Industrial Commission Department of Mineral Resources (Oil & Gas Division), personal communication, 8 July 2013. We were unable to obtain a North Dakota-specific estimate of acres disturbed for roads, pipelines and infrastructure and made the assumption that 4.75 acres are damaged, the same as in western Colorado.

In **Arkansas**, we assumed that most of the wells drilled to date in Arkansas were drilled one to a pad, per Jeannie Stell, "Angling in the Fayetteville," *Unconventional Oil & Gas Center*, 15 October 2011. In the Fayetteville Shale, we assumed well pads are 2.1 acres and that associated roads and infrastructure add 2.7 acres, per Dan Arthur and Dave Cornue, ALL Consulting, "Technologies Reduce Pad Size, Waste," *The American Oil & Gas Reporter*, August 2010.

Notes

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4. New Mexico Oil Conservation Division, Environmental Bureau, *Generalized Record of Ground Water Impact Sites*, accessed at www.emnrd.state.nm.us/OCD/documents/rptGeneralizedGWImpact.pdf, 20 September 2013.

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