

A large oil pumpjack (jackal) is the central focus, set against a clear blue sky. The pumpjack is a complex of brown metal beams and counterweights. In the foreground, there are out-of-focus yellow wildflowers. The background shows a dry, hilly landscape with sparse vegetation.

ANALYSIS

Oil and Gas Methane Emissions in New Mexico

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EXECUTIVE SUMMARY

In 2014, scientists working on a NASA study discovered a 2,500-square-mile cloud of methane hovering over the Four Corners region of New Mexico – the largest concentration of methane anywhere in the nation.

Subsequent studies indicated that although the San Juan Basin includes other methane sources such as coal mines and geologic seepage, these sources are not large enough to explain the bulk of emissions, and that oil and gas development is the largest source of emissions contributing to this massive methane “hot spot.”

Methane is the main component of natural gas – the energy resource used to generate about 1/3 of our nation's electricity and an important industrial, commercial and residential energy source. But the lack of oversight of New Mexico's oil and gas industry has resulted in a substantial waste of an important domestic energy resource and needless pollution that threatens the climate and public health.

Scientific Breakthroughs

Recent scientific studies have enhanced our understanding of methane emissions from the oil and gas industry. Using measurements of component-, site-, and basin-level emissions, scientists can determine with more certainty how

much methane is leaking and identify the primary sources of these emissions.

Our analysis of recent peer-reviewed methane research and other data sources reveals that intentional emissions (venting), equipment leaks and other unintentional sources (fugitive emissions), and the combustion of gas (flaring) results in New Mexico's oil and gas operators emitting 570,000 tons of methane every year – equivalent to the climate impact of approximately 12 coal-fired power plants.

Financial Loss

To put this in terms of natural gas value, the system wide venting, leaking, and flaring of natural gas has resulted in New Mexico losing between \$182-244 million worth of natural gas every year. These wasteful practices cause the state's taxpayers to lose up to \$27.6 million in taxes and royalty revenues per year – an amount equal to the annual operating budget for the state's Environmental Protection Division, or enough funding to allow the state to increase Pre-K enrollment by 50 percent and enroll an additional 5,000 kids in vital early education programs.

New Mexico's oil and gas operators are emitting 570,000 tons of methane every year -- equivalent to the climate impact of approximately 12 coal-fired power plants.

Emission Sources

Scientists estimate that a phenomena sometimes known as “super emitters” – malfunctioning equipment at a variety of oil and gas sites that cause abnormally high emission rates – are responsible for a significant portion of industry’s methane pollution. A 2015 study using NASA airborne technology found that in New Mexico’s San Juan Basin, high emitting sites make up nearly half of the region’s total point source emissions (Frankenberg et al). Another 2015 study found high methane emissions in the Four Corners Region using an aircraft-balance method and concluded that oil and gas emissions were likely the largest source (Smith et al).

Opportunity for Reductions

There are proven, low-cost fixes that are already available that could eliminate up to half of the oil and gas industry’s pollution by simply plugging these leaks.

This report aims to clarify the scope of New Mexico’s methane problem in order to identify the greatest opportunities for achieving emission reductions statewide. Natural gas that isn’t wasted can be used or sold, to the benefit of New Mexico taxpayers. Requirements to reduce methane waste and pollution increase funding for important state needs like education, roads, and bridges, and allow companies to create New Mexico jobs of the future in clean, efficient energy production.



“These wasteful practices cause the state’s taxpayers to lose up to \$27.6 million in taxes and royalty revenues per year.”

Emissions by Source

Table 1 on the following page gives an overview of estimated emissions for 2015 in New Mexico, broken out by source category. Emission estimates are drawn from the EDF-compiled baseline inventory, created by Dr. David Lyon, an EDF Scientist, per the methodology outlined below. Note that the “Flares” category in this inventory just refers to estimated emissions from flaring (i.e., methane stemming from inefficient combustion); later in the analysis, a value for total gas sent to flare will be used to better represent total wasted gas. Note that local distribution emissions are not included in this inventory. The following general conclusions can be drawn from the table:

- Upstream emissions from production and gathering and boosting are substantially larger than downstream emissions from processing and transmission and storage.
- Within production, the largest emission sources are pneumatic controllers, abnormal conditions, and leaks. Abnormal conditions are malfunctions or other issues that cause unintentional, high emissions that are often excluded from emission inventories.

Data Sources

The EDF-compiled inventory is based upon a custom analysis combining several data sources including recent studies, the EPA GHG Reporting Program (GHGRP)¹, and the EPA's GHG Inventory (GHGI)² national estimates of Petroleum and Natural Gas Systems methane emissions. Individual source emissions were estimated using the

following data sources and methods:

- 1) Associated gas venting & flaring, 2) compressors, 3) dehydrators, 4) flares, 5) hydrocarbon tank flashing, 6) liquids unloading, 7) completions, workovers, and well testing
– *GHGRP onshore production emissions adjusted for non-reporters and scaled from basin to state level using well counts and production data*
- 8) Pneumatic controllers
– *Adjusted GHGRP activity data; Allen et al.³ emission factors for operational and malfunctioning low-bleed, high-bleed, and intermittent-bleed devices*
- 9) Pneumatic pumps
– *Adjusted GHGRP activity data; Allen et al.⁴ emission factors for pneumatic pumps*
- 10) Combustion Exhaust
– *Adjusted GHGRP CO₂ emissions; EPA AP-42⁵ emission factors*
- 11) Produced Water tank flashing
– *Drillinginfo water production; EPA O&G Tool⁶ emission factors*
- 12) Equipment Leaks
– *Production site counts and Allen et al.⁴ emission factors; based on approach of Zavala-Araiza et al.⁷*
- 13) Production abnormal conditions
– *Zavala-Araiza et al.⁷ found that site-level emissions of Barnett Shale well pads were 50% higher than component-based estimates. These emissions were attributed to abnormal process conditions that are the likely cause of sites with unintentionally high emissions. These emissions typically are excluded from inventories. For example, malfunctioning tank controls can cause a site to have much higher emissions than would be estimated if controls are assumed to be operating properly. We adjust our NM production emission estimates by 50% (excluding completions, workovers, well testing, and liquids unloading) to account for similar emissions missing from our component-based estimates. Although our estimate of abnormal condition emissions is based on data from the Barnett Shale, basin-level and source-level data from the San Juan Basin support that O&G emissions are substantially higher than inventory estimates.^{8,9}*
- 14) Gathering Stations
– *Marchese et al.¹⁰ estimate of 2012 NM gathering station emissions adjusted by the ratio of 2015:2012 NM gas production*
- 15) Gathering Pipelines
– *Based on GHGI EFs and NM gas producing well counts*
- 16) Gathering Blowdowns
– *Blowdowns are assumed to equal 10% of station operational emissions, which is based on the national fraction of blowdowns in Marchese et al.¹⁰*
- 17) Processing
– *GHGI national emissions prorated by gas production*
- 18) Transmissions & Storage
– *GHGI national emissions prorated by gas production EPA GHGI estimates T&S station emissions from Zimmerle et al.¹¹, but excludes their emissions from uncategorized/super-emitters. We increase the GHGI-based estimate by 34% to account for these emissions.*

SUPPLY CHAIN SEGMENT	SOURCE	2015 NM EMISSIONS (MT CH4)	% OF NM CH4 EMISSIONS BY SEGMENT
Onshore Production	Associated Gas Venting and Flaring	1,200	0%
	Equipment Leaks	54,000	15%
	Pneumatic Controllers	120,000	35%
	Pneumatic Pumps	3,500	1%
	Compressors	6,000	2%
	Combustion Exhaust	6,500	2%
	Dehydrators	580	0%
	Flares	1,500	0%
	Hydrocarbon Tank Flashing	7,700	2%
	Produced Water Tank Flashing	16,000	5%
	Liquids Unloading	22,000	6%
	Completions, Workovers & Well Testing	2,500	1%
	Abnormal Emissions	110,000	31%
	Total Production	360,000	100%
Gathering and Boosting	Gathering Stations	98,000	72%
	Blowdowns	10,000	7%
	Pipelines	28,000	21%
	Total Gathering and Boosting	140,000	100%
Processing	Leaks	16,000	49%
	Compressors	7,900	24%
	Pneumatic Controllers	49	0%
	Pneumatic Pumps	130	0%
	Other ¹²	8,400	26%
	Total Processing	32,000	100%
Transmission and Storage	Leaks	18,000	43%
	Compressors	3,600	9%
	High Bleed Pneumatics	700	2%
	Intermittent Bleed Pneumatics	540	1%
	Low Bleed Pneumatics	25	0%
	Pipeline Venting	2,800	7%
	Other ¹³	6,500	16%
	Uncategorized/Super emitters	9,700	23%
	Total Transmission and Storage	42,000	100%
Total Emissions		570,000	100%

TABLE 1 Methane Emissions by Source





PRODUCTION BY LAND TYPE

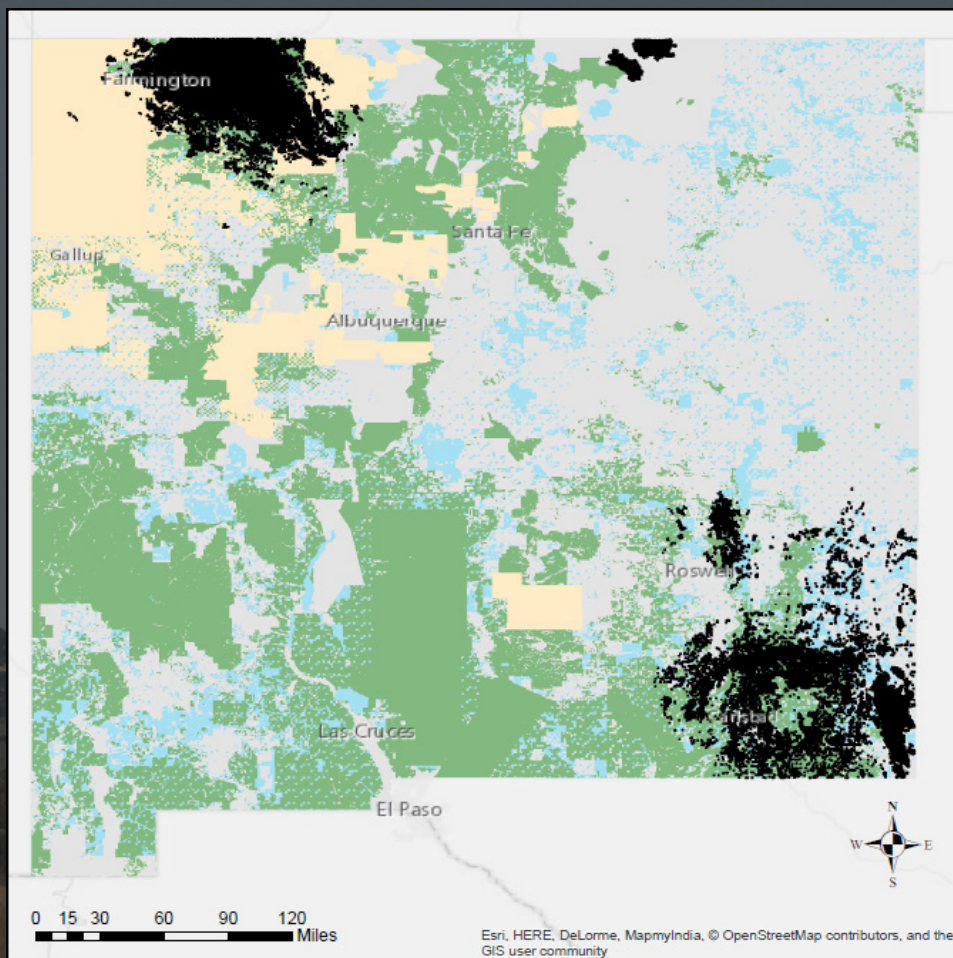
A look at drilling
on public, private
and tribal lands

Table 2 shows the percentage of oil and natural gas production in New Mexico by land type (federal, state, tribal, or private—based on land area data from the New Mexico office of the BLM¹⁴ and production data from DrillingInfo). Also shown is the percentage of production on state trust lands, based on data from the New Mexico State Land Office¹⁵. The state trust land area does not correspond exactly to the state land area from the BLM. The BLM state land area includes state parks and state game and fish

lands, which are not included in the state trust lands. However, state trust lands also include subsurface ownership (i.e., lands in which subsurface ownership belongs to the State Trust, but surface ownership belongs to federal, private, or tribal entities). Due to the inclusion of subsurface ownership, the state trust land area is larger than the BLM state land area. This report analyzes state trust lands as a separate category because some regulations may apply only to state trust lands.

LAND TYPE	% OF 2015 OVERALL PRODUCTION	% OF 2015 GAS PRODUCTION
Federal ¹⁴	51.7%	55.1%
State ¹⁴	23.8%	18.5%
Private ¹⁴	21.9%	22.2%
Tribal ¹⁴	2.7%	4.1%
State Trust Lands ¹⁵	28.5%	21.8%

TABLE 2 The majority of production in New Mexico occurs on federal lands, followed by state, private and tribal lands. Note that this production data is from 2015. A map on the following page shows well locations overlaid on a map of different land types in New Mexico.



New Mexico Oil and Gas Production by Land Type

- Oil/Gas Wells
- Federal Land
- Tribal Land
- State Land
- Private Land

SOURCE: New Mexico BLM; DrillingInfo



COST ANALYSIS

The value of
New Mexico's
wasted gas

Value of Wasted Gas: Statewide

The following sections break out wasted natural gas in New Mexico by state trust, federal, private, and tribal land ownership.

According to the EPA's Subpart W inventory, production emissions vary between basins. However, the EDF-compiled inventory does not break out emissions by basin; therefore, the percentage of emissions by land type is assumed to correspond with the percentage of production by land type (as shown in Table 2). Production emissions are scaled by the percent of overall production, and Gathering and Boosting, Processing, and Transmission and Storage emissions are scaled by the percentage of gas production.

	WASTED GAS (Mcf NG)	VALUE WASTED GAS (\$2.98/Mcf)	VALUE WASTED GAS (\$4/Mcf)
Production: Emissions ¹⁷	22.9 million	\$68.2 million	\$91.6 million
Production: Vented and flared gas ¹⁶	24.9 million	\$74.1 million	\$99.4 million
Total Production	47.8 million	\$142.3 million	\$191 million
Gathering and Boosting Emissions	9 million	\$26.7 million	\$35.8 million
Processing Emissions	1.9 million	\$5.6 million	\$7.5 million
Transmission and Storage Emissions	2.4 million	\$7.1 million	\$9.5 million
Total	61 million	\$182 million	\$244 million

TABLE 3 Table 3 displays total wasted natural gas in New Mexico, along with the value of that wasted gas, calculated using the current \$2.98/Mcf price and a reference \$4/Mcf. Emissions are taken from the EDF-compiled inventory as presented in Table 1; however, vented and flared production emissions from that analysis are set to zero to avoid double-counting. Combustion emissions are also set to zero as these emissions are often seen as necessary. Methane emissions are converted to volumes of natural gas using volumetric methane content values of 78.8% for production and gathering and boosting emissions, and 90.3% for processing and transmission and storage emissions. Total vented and flared gas is taken from the EIA website.¹⁶

Because the state trust lands include subsurface ownership, the summation of the following tables will not equal the totals from Table 3.

	WASTED GAS (Mcf NG)	VALUE WASTED GAS (\$2.98/Mcf)	VALUE WASTED GAS (\$4/Mcf)
Production: Emissions	6.6 million	\$19.4 million	\$26.1 million
Production: Vented and flared gas	7.1 million	\$21.1 million	\$28.3 million
Total Production	13.5 million	\$40.5 million	\$54.5 million
Gathering and Boosting Emissions	2 million	\$5.8 million	\$7.8 million
Processing Emissions	0.4 million	\$1.2 million	\$1.6 million
Transmission and Storage Emissions	0.5 million	\$1.6 million	\$1.2 million
Total	16.5 million	\$49.1 million	\$65.9 million

TABLE 4 Displays wasted natural gas in New Mexico on state trust lands, using the delineation of state trust lands from the New Mexico State Land Office.

	WASTED GAS (Mcf NG)	VALUE WASTED GAS (\$2.98/Mcf)	VALUE WASTED GAS (\$4/Mcf)
Production: Emissions	11.8 million	\$35.3 million	\$47.3 million
Production: Vented and flared gas	12.8 million	\$38.3 million	\$51.4 million
Total Production	24.7 million	\$73.5 million	\$98.7 million
Gathering and Boosting Emissions	4.9 million	\$14.7 million	\$19.8 million
Processing Emissions	1 million	\$3.1 million	\$41. million
Transmission and Storage Emissions	1.3 million	\$3.9 million	\$5.3 million
Total	32 million	\$95.2 million	\$128 million

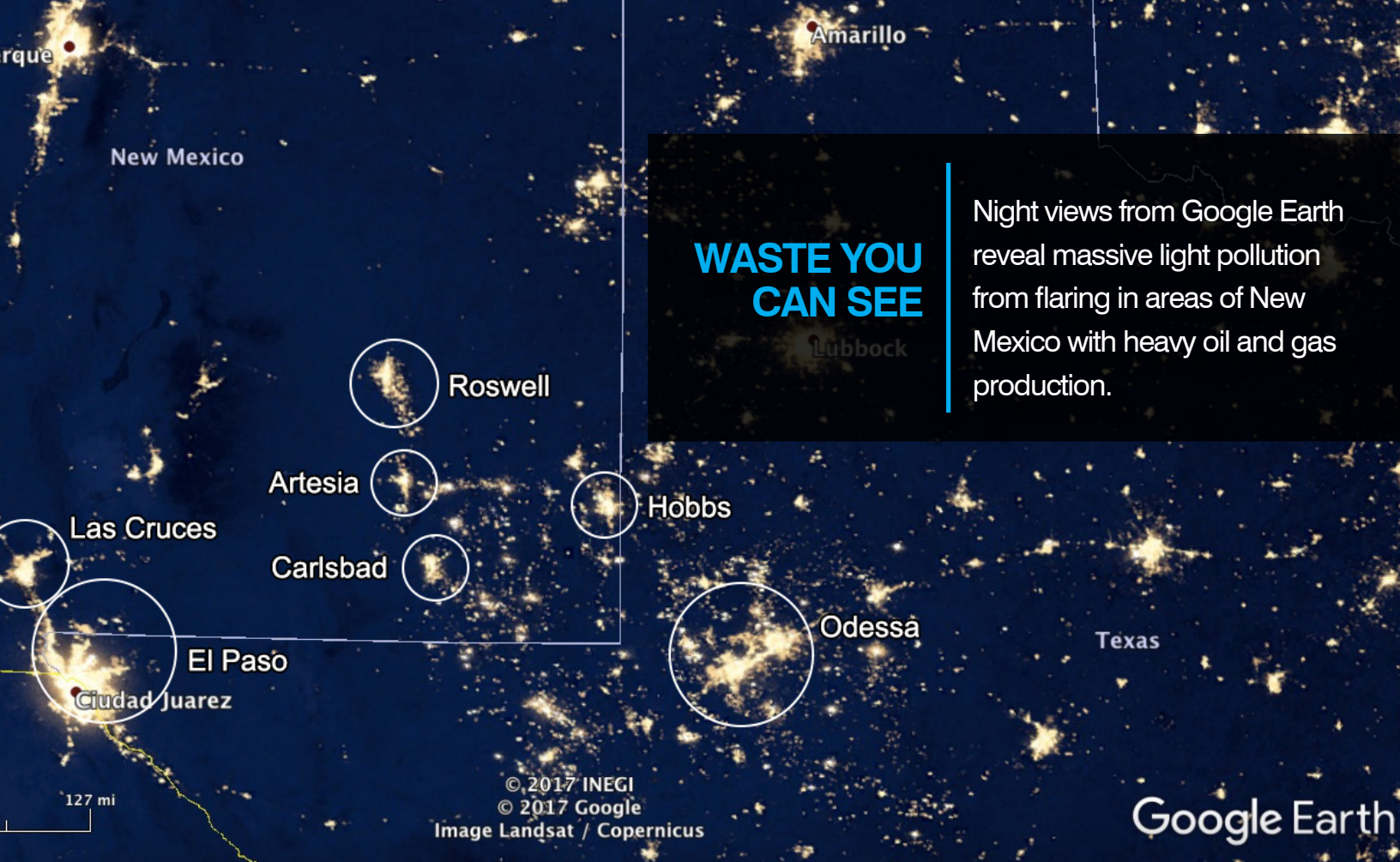
TABLE 5 Displays wasted natural gas in New Mexico on just federal lands, using the delineation from the New Mexico office of the BLM.

	WASTED GAS (Mcf NG)	VALUE WASTED GAS (\$2.98/Mcf)	VALUE WASTED GAS (\$4/Mcf)
Production: Emissions	5 million	\$14.9 million	\$20 million
Production: Vented and flared gas	5.4 million	\$16.2 million	\$21.7 million
Total Production	10.4 million	\$31.1 million	\$41.7 million
Gathering and Boosting Emissions	2 million	\$5.9 million	\$8 million
Processing Emissions	0.4 million	\$1.2 million	\$1.7 million
Transmission and Storage Emissions	0.5 million	\$1.6 million	\$2.1 million
Total	13.4 million	\$39.8 million	\$53.5 million

TABLE 6 Displays wasted natural gas in New Mexico on private lands

	WASTED GAS (Mcf NG)	VALUE WASTED GAS (\$2.98/Mcf)	VALUE WASTED GAS (\$4/Mcf)
Production: Emissions	0.6 million	\$1.8 million	\$2.5 million
Production: Vented and flared gas	0.7 million	\$2 million	\$2.7 million
Total Production	1.3 million	\$3.8 million	\$5.1 million
Gathering and Boosting Emissions	0.4 million	\$1.1 million	\$1.5 million
Processing Emissions	0.1 million	\$0.2 million	\$0.3 million
Transmission and Storage Emissions	0.1 million	\$0.3 million	\$0.4 million
Total	1.8 million	\$5.5 million	\$7.3 million

TABLE 7 Displays wasted natural gas in New Mexico on tribal lands



Lost State Revenue

Waste values are estimated based on the following assumptions:

- The royalty rate for production on federal lands is 12.5%, of which 49% is returned to the state.¹⁸
- The royalty rate for production on state trust lands varies by lease. The director of the Royalty Management Division at the New Mexico State Land Office estimated (via a private phone call) that on average, the royalty rate is 17% for oil and 15% for gas.
- The following taxes are assessed on production on all land types:¹⁸
 - 4% emergency school tax on natural gas, 3.15% on crude oil
 - 3.75% severance tax
 - 0.19% conservation tax on crude oil, 0.24% on natural gas
 - Assumed 1% ad valorem tax

LAND TYPE	VOLUME OF WASTED NATURAL GAS (Mcf)	VALUE OF WASTED NATURAL GAS (\$)	LOST STATE REVENUE (\$)
Federal	29.6 million	\$88.2 million	\$12.7 million
State Trust	15.6 million	\$46.4 million	\$11.1 million
Private	12.4 million	\$37 million	\$3.3 million
Tribal	1.7 million	\$4.9 million	\$ 0.4 million
Total	59.3 million	\$176.6 million	\$27.6 million

TABLE 8 Displays state revenue lost as a result of these emissions

- Any allowable deductions (of which there are many) are ignored in this analysis, and the lost revenue values should be viewed as estimates.
- Lost revenue is calculated only from production emissions, production vented and flared gas, and gathering and boosting emissions.
- Revenue is calculated based on a \$2.98/Mcf natural gas price.
- The totals represent a slight over-estimation, because state trust estimates are based on the delineation from the New Mexico State Land Office and include subsurface ownership, and all other categories are based on the delineation from the BLM which is based on surface ownership.
- Federal royalties (of which 49% are returned to the state) are already assessed on flared gas from federal lands in the Permian basin. This value was subtracted from the Federal Lost State Revenue estimate in Table 8.

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BLM	Bureau of Land Management
CH ₄	Methane
EDF	Environmental Defense Fund
EF	Emission Factor
EIA	Energy Information Administration
EPA	Environmental Protection Agency
G&B	Gathering and Boosting
GHG	Greenhouse Gas
GHGI	Greenhouse Gas Inventory
GHGRP	Greenhouse Gas Reporting Program
LDAR	Leak Detection and Repair
LNG	Liquefied Natural Gas
Mcf	Thousand Cubic Feet
MT	Metric Ton
NM	New Mexico
NG	Natural Gas
O&G	Oil and Gas
T&S	Transmission and Storage