New Mexico Oil and Gas Greenhouse Gas Emissions Inventory for Year 2020

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Colorado State University, Center for the New Energy Economy

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Executive Summary

Oil and gas (O&G) exploration and production in New Mexico (NM) has increased dramatically in recent years as drilling technology has allowed development of unconventional oil and gas plays in areas where there was previously no activity, or where activity had subsided after depletion of the conventional reserves. This increased production has given rise to an increase in greenhouse gas (GHG) emissions, which in turn has prompted NM to take regulatory initiatives to reduce these emissions.

To obtain a better understanding of these emission increases and reductions, a comprehensive O&G Greenhouse Gas Inventory was developed for NM (NM O&G GHGI) for 2020 to include emission estimates of methane (CH_4) and carbon dioxide (CO_2). Emissions are included in the inventory for the following five categories:

- Oil and gas exploration and production,
- Gathering and boosting (G&B),
- Natural gas processing,
- Transmission and storage, and
- Inactive oil and gas wells

Emissions from natural gas distribution to end users (e.g. local utilities and industrial, commercial, and residential customers) are not included in the inventory. Details on the five emission categories listed above and the unique types of emission sources found in each category are provided in Section 2.

Emission estimates were developed using the best available information, which was obtained from several sources:

- NM Environmental Department (NMED) Minor Source Emissions Inventory,
- EPA's Greenhouse Gas Reporting Program (GHGRP),
- EPA's Greenhouse Gas Inventory (GHGI),
- EPA's National Emissions Inventory (NEI), and
- O&G air emissions studies

Emissions data reported directly to NMED and EPA as part of the Minor Source Emissions Inventory and the GHGRP was used as the basis of the NM O&G GHGI. Where this data was not available, emissions estimates were developed using data and methodologies from a variety of sources.

Details on the specific data sources and methodologies used to compile the NM O&G GHGI are provided in Sections 3, 4, and 5. Section 4 also includes details on the percentage of the emitting population represented by the emissions data reported directly to NMED and EPA. For every category except underground natural gas storage, the majority of emissions in the NM O&G GHGI were based on directly reported emissions and activity data. Section 6 provides a further breakdown of the NM O&G GHGI for each category, including emissions by basin and emission source.

Tables E-1 through E-3 below provide an overall summary of emissions.

Table E-1 presents a summary of CH_4, CO_2, and CO_2 equivalent (CO_2e) emissions for 2020 for each category. The production category has the highest emissions of both CH_4 and CO_2.

Table E-1. GHG Emissions by Category (Metric Tons)

Emission Category	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Production	387,824	6,836,720	17,307,968
Gathering and Boosting	126,013	6,158,405	9,560,756
Natural Gas Processing	19,210	4,552,987	5,071,657
Transmission and Storage	13,382	629,264	990,567
Inactive Oil and Gas Wells	784	23.5	21,192
Total	**547,212**	**18,177,400**	**32,952,130**

Table E-2 presents a summary of CH_4, CO_2, and CO_2e emissions for 2020 for each O&G basin in NM. The Permian and San Juan basins account for over 98% of O&G GHG emissions in NM, and also account for almost all of the O&G production in NM.

Table E-2. GHG Emissions by Basin (Metric Tons)

Basin	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	270,241	13,515,470	20,811,982
San Juan	261,414	4,282,920	11,341,106
Las Vegas-Raton	8,659	40,049	273,836
Sierra Grande Uplift	4,004	66,682	174,784
Pedregosa	451	104,932	117,099
Orogrande	1,020	68,086	95,614
Basin-And-Range Province	687	65,290	83,829
Estancia	619	33,968	50,683
Palo Duro	64	2	1,728
San Luis	54	2	1,470
Total	**547,212**	**18,177,400**	**32,952,130**

Table E-3 presents a summary of CH_4, CO_2, and CO_2e emissions for 2020 for the highest emitting emission sources as well as the cumulative emissions from the remainder of sources. The highest emitting CH_4 sources are equipment leaks, pneumatic controllers, and combustion (or combustion slip) which cumulatively account for 75% of CH_4 emissions. Combustion (e.g., from engines and turbines driving compressors) is the highest emitting CO_2 source, accounting for 72% of CO_2 emissions. Other significant CO_2 sources include acid gas removal units and miscellaneous flaring.

Table E-3. GHG Emissions by Emission Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Combustion	76,632	13,177,750	15,246,811
Equipment Leaks	196,139	5,699	5,301,442
Pneumatic Controllers	139,491	24,820	3,791,082
Acid Gas Removal Units	0	2,047,374	2,047,374
Miscellaneous Flaring	5,026	1,173,985	1,309,690
All Others	129,926	1,747,771	5,255,731
Total	**547,212**	**18,177,400**	**32,952,130**

Estimates of 2025 and 2030 emissions were developed to project the impact that future increases in industry activity (oil and gas production) and current NM regulatory initiatives are expected to have on future emission levels. Details on the projected inventories are provided in Section 7.

Table E-4 presents a summary of emissions in 2020, and projected emissions in 2025 and 2030. This data shows that despite projected increases in production, CH_4 emissions are expected to decrease by approximately 50% in 2025 and 2030 as a result of the regulatory initiatives undertaken by NM to reduce emissions.

Table E-4. GHG Emissions Inventory Projections (Metric Tons)

Year	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
2020	547,212	18,177,400	32,952,130
2025	283,013	20,255,314	27,896,654
2030	265,258	20,785,260	27,947,229

1 Introduction

Oil and gas (O&G) exploration and production in New Mexico (NM) has increased dramatically in recent years as drilling technology has allowed development of unconventional oil and gas plays in areas where there was previously no activity, or where activity had subsided after depletion of the conventional reserves. In NM, increased crude oil production has been particularly notable in the Permian Basin in the southeast part of the state. The US Energy Information Administration (EIA) estimates NM crude oil production increased from approximately 145 million barrels in 2016 to over 450 million barrels in 2021[1], while NM gas production increased from approximately 1.2 trillion cubic feet in 2016 to over 2.3 trillion cubic feet in in 2021.[2]

In 2019, Governor Michelle Lujan Grisham issued an Executive Order for the State of NM to join the United States Climate Alliance and set an economy-wide greenhouse gas (GHG) emissions target of 45% below 2005 levels by 2030 (EO 2019-003). In this Executive Order, Governor Lujan Grisham also established a Climate Change Task Force to evaluate policies and strategies to achieve the target, including developing a comprehensive, statewide, enforceable regulatory framework to reduce oil and gas sector methane (CH_4) emissions and prevent waste from new and existing sources.[3]

NM has implemented several regulatory initiatives to meet these objectives. The NM Energy, Minerals and Natural Resources Department (EMNRD) promulgated Title 19, Chapter 15, Part 27 "Venting and Flaring of Natural Gas"[4] and Part 28 "Natural Gas Gathering Systems"[5] in 2021 to reduce CH_4 emissions and prevent waste of natural gas. In addition, the NM Environment Department (NMED) promulgated Title 20, Chapter 2, Part 50 "Oil and Gas Sector – Ozone Precursor Pollutants" in 2022, which focused on reducing emissions of volatile organic compounds (VOCs) and Nitrogen Oxides (NOx).[6] While the NMED rule does not specifically address CH_4, there are expected to be co-benefits of this rule in reducing CH_4 emissions from sources such as storage tanks and pneumatic controllers.

Given NM's policy objectives and increase in oil and gas activity, the NMED sought assistance in conducting a detailed study of the oil and gas industry and in developing an updated GHG emissions inventory for the oil and gas industry for 2020 (NM O&G GHGI). Specifically, assistance was sought in identifying gaps in data currently reported to the US EPA and the State of NM; evaluating existing GHG emission factors, empirical formulas, and measurement methods; developing appropriate NM-specific GHG emission factors for oil and gas equipment and processes; estimating emissions from non-reporting sources; and preparing a comprehensive oil and gas emissions inventory report. The scope of the study includes oil and gas production, transmission and storage, and processing. This report presents the findings of this study and was prepared by Eastern Research Group, Inc. (ERG) under Task 4 of Purchase Order #733609 issued

[1] https://www.eia.gov/dnav/pet/pet_crd_crpdn_adc_mbbl_a.htm
[2] https://www.eia.gov/dnav/ng/ng_prod_sum_a_EPG0_FGW_mmcf_a.htm
[3] Governor Lujan Grisham, "Executive Order 2019-003: Executive Order Addressing Climate Change and Energy Waste Prevention."
[4] https://www.srca.nm.gov/parts/title19/19.015.0027.html
[5] https://www.srca.nm.gov/parts/title19/19.015.0028.html
[6] https://www.srca.nm.gov/parts/title20/20.002.0050.html

under Colorado State University's (CSU) Center for the New Energy Economy (CNEE) solicitation DQ-2021-051-EH "New Mexico Oil and Gas Sector GHG Emissions Inventory".

Section 2 of this report describes how the relevant emission sources for each industry segment included in the NM O&G GHGI were identified. Section 3 describes the emissions data considered in development of the NM O&G GHGI, including both federal and state datasets as well as various oil and gas emission studies and emission factor references. Section 4 describes the analysis of available datasets with respect to complete industry characterization in NM and how counts of sources such as wells and compressor stations were determined. Section 5 presents the NM O&G GHGI final steps and methodology for each industry segment. Section 6 presents a summary of the NM O&G GHGI emissions for each industry segment. Section 7 presents the findings of an analysis to estimate 2025 and 2030 emissions reflecting industry growth along with the impact of recent regulatory initiatives to reduce emissions. The report concludes in Section 8 with uncertainties in the NM O&G GHGI and recommendations for future inventories.

2 Emission Sources

2.1 Introduction

The NM O&G GHGI includes county-level emissions from five categories. The categories include four O&G industry segments plus inactive oil and gas wells:

1. Oil and gas exploration and production (onshore only),
2. Gathering and boosting (G&B),
3. Natural gas processing,
4. Transmission and storage (which includes transmission compressor stations, transmission pipelines, and underground natural gas storage stations), and
5. Inactive oil and gas wells.

Figure 1 illustrates the four industry segments, which follow the oil and gas production chain from drilling through to transmission. Note, the distribution segment is shown in Figure 1, but distribution segment emissions are not included in the NM O&G GHGI.

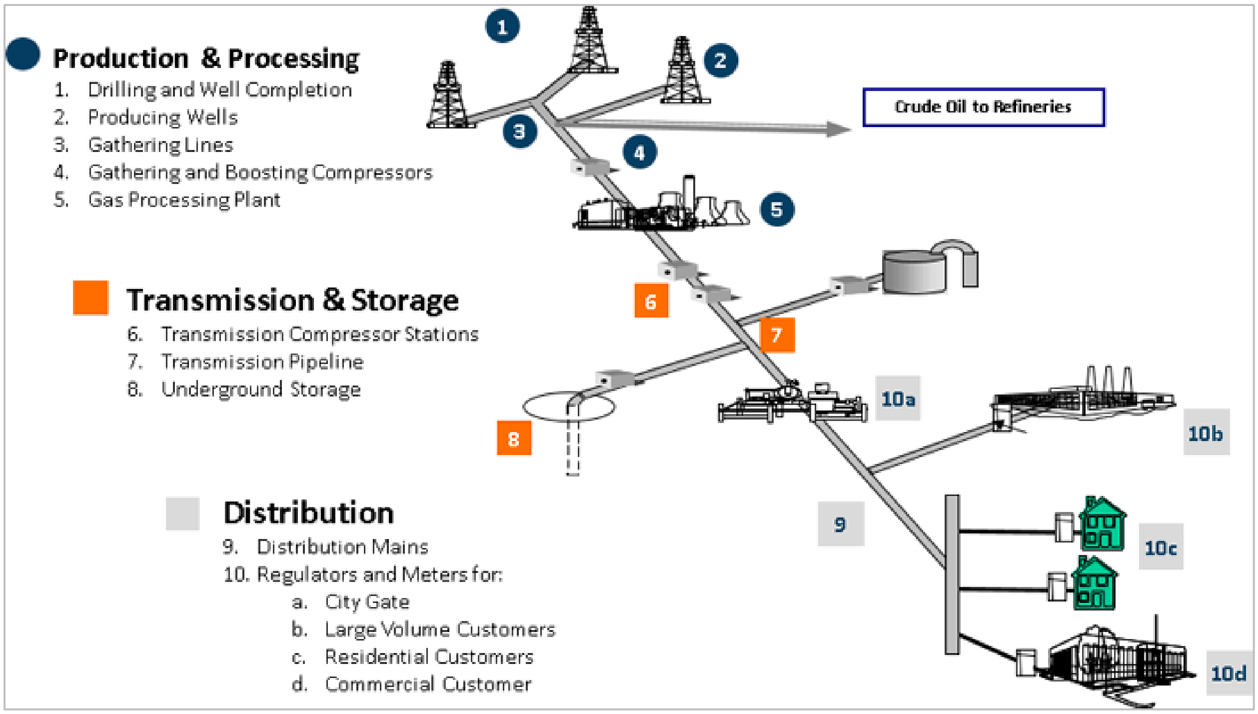

Figure 1. Oil and Gas Extraction, Production, Processing, and End Use

The following datasets were reviewed to identify relevant emission sources for each category:

1. U.S. EPA GHG Inventories for Natural Gas Systems, Petroleum Systems, and Abandoned Wells (EPA GHGI)[7]
2. U.S. EPA GHG Reporting Program (GHGRP) Subpart W (subpart W)[8]
3. U.S EPA National Emissions Inventory, Nonpoint Oil and Gas Emission Estimation Tool (NEI Tool)[9]

Section 2.2 identifies the specific emission sources included in the NM O&G GHGI for each category. Section 2.3 presents the approaches used to allocate emissions to the county-level.

2.2 Emission Sources

A comprehensive list of emission sources for each category is provided in the following sub-sections. For each emission source, the dataset(s) that includes that emission source is also identified (i.e., EPA GHGI, subpart W, NEI Tool).

2.2.1 Exploration and Production

Table 1 identifies the emission sources included in the NM O&G GHGI for oil and gas exploration and Table 2 identifies the emission sources included in the NM O&G GHGI for oil and gas production.

[7] https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks
[8] https://www.epa.gov/ghgreporting/subpart-w-petroleum-and-natural-gas-systems
[9] 2017 Nonpoint Oil and Gas Emission Estimation Tool Version 1.2, October 23, 2019.

Table 1. Emission Sources Included in NM O&G GHGI for Exploration

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?
Hydraulically Fractured (HF) Well Completions	Yes	Yes	Yes
Non-HF Well Completions	Yes	Yes	Yes
Mud Degassing	No	No	Yes
Well Testing	Yes	Yes	No

Table 2. Emission Sources Included in NM O&G GHGI for Production

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?
Well Pad Equipment Leaks	Yes	Yes	Yes
Pneumatic Controllers (High, Low, and Intermittent)	Yes	Yes	Yes
Chemical Injection Pumps	Yes	Yes	Yes
Dehydrators	Yes	Yes	Yes
Hydrocarbon Liquid Storage Tanks	Yes	Yes	Yes
Hydrocarbon Liquid Storage Tank Unloading	Yes	No	Yes
Produced Water Tanks	Yes	No	Yes
Liquids Unloading	Yes	Yes	Yes
Associated Gas Venting and Flaring	Yes	Yes	Yes
Miscellaneous Production Flaring	Yes	Yes	No
Reciprocating Compressors	Yes	Yes	Yes
Centrifugal Compressors	Yes	Yes	Yes
HF Well Workovers	Yes	Yes	No
Non-HF Well Workovers	Yes	Yes	No
Combustion			
Engines (e.g., compressor engines, artificial lift engines, well drilling engines, fracking engines)	Yes	Yes	Yes
Turbines (e.g., compressor turbines)	Yes	Yes	Yes
External Combustion (e.g., Heaters)	No	Yes	Yes

2.2.2 Gathering and Boosting

Table 3 and Table 4 identify the emission sources included in the NM O&G GHGI for G&B stations and gathering pipelines.

Table 3. Emission Sources Included in NM O&G GHGI for G&B Stations

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Station Blowdowns	Yes	Yes	No
Dehydrator Vents	Yes	Yes	Yes[b]
Pneumatic Controllers (High, Low, and Intermittent)	Yes	Yes	No
Pneumatic Pumps	Yes	Yes	No
Flares	Yes	Yes	No
Compressors	Yes	Yes	Yes[c]
Hydrocarbon Liquid Storage Tanks	Yes	Yes	No
Acid Gas Removal Units	Yes	Yes	No
Station Leaks	Yes	Yes	No
Combustion			
Engines	Yes	Yes	No
Turbines	Yes	Yes	No
External Combustion	No	Yes	No

a. The NEI Tool only covers exploration and production and certain G&B emission sources.
b. G&B dehydrators are combined with production dehydrators.
c. G&B compressors are included as "line compressors."

Table 4. Emission Sources Included in NM O&G GHGI for Gathering Pipelines

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?
Pipeline Leaks	Yes	Yes	No
Pipeline Blowdowns	Yes	Yes	No

2.2.3 Natural Gas Processing

Table 5 identifies the emission sources included in the NM O&G GHGI for natural gas processing.

Table 5. Emission Sources Included in NM O&G GHGI for Natural Gas Processing

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Plant Leaks	Yes	Yes	No
Reciprocating Compressors	Yes	Yes	No
Centrifugal Compressors	Yes	Yes	No
Flares	Yes	Yes	No
Dehydrators	Yes	Yes	No
Blowdowns	Yes	Yes	No
Acid Gas Removal Units	Yes	Yes	No
Pneumatic Controllers	Yes	No	No

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Combustion			
Engines	Yes	Yes	No
Turbines	Yes	Yes	No

a. The NEI Tool only covers exploration and production and certain G&B emission sources.

2.2.4 Transmission and Storage

Table 6 and Table 7 identify the emission sources included in the NM O&G GHGI for transmission compressor stations and transmission pipelines. Table 8 identifies the emission sources included in the NM O&G GHGI for underground natural gas (NG) storage.

Table 6. Emission Sources Included in NM O&G GHGI for Transmission Compressor Stations

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Station Leaks	Yes	Yes	No
Reciprocating Compressors	Yes	Yes	No
Centrifugal Compressors	Yes	Yes	No
Dehydrators	Yes	No	No
Flares	Yes	Yes	No
Station Blowdowns	Yes	Yes	No
Pneumatic Controllers (High, Low, and Intermittent)	Yes	Yes	No
Combustion			
Engines	Yes	Yes	No
Turbines	Yes	Yes	No

a. The NEI Tool only covers exploration and production and certain G&B emission sources.

Table 7. Emission Sources Included in NM O&G GHGI for Transmission Pipelines

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Pipeline Leaks	Yes	No	No
Pipeline Blowdowns	Yes	Yes	No

a. The NEI Tool only covers exploration and production and certain G&B emission sources.

Table 8. Emission Sources Included in NM O&G GHGI for Underground NG Storage

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Station Leaks	Yes	Yes	No
Reciprocating Compressors	Yes	Yes	No
Dehydrators	Yes	No	No

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?[a]
Flares	Yes	Yes	No
Blowdowns	Yes	Yes	No
Pneumatic Controllers (High, Low, and Intermittent)	Yes	Yes	No
Storage Wells	Yes	Yes	No
Metering and Regulating Equipment	Yes	No	No
Combustion			
Engines	Yes	Yes	No
Turbines	Yes	Yes	No

a. The NEI Tool only covers exploration and production and certain G&B emission sources.

2.2.5 Inactive Wells

Table 9 identifies the emission sources included in the NM O&G GHGI for inactive wells. Inactive wells can also be referred to as abandoned wells and orphaned wells are a subset of inactive wells.

Table 9. Emission Sources Included in NM O&G GHGI for Inactive Wells

Emission Source	Included in EPA GHGI?	Included in Subpart W?	Included in NEI Tool?
Unplugged inactive wells	Yes	No	No[a]
Plugged inactive wells	Yes	No	No[a]

a. Inclusion of inactive well estimates planned for 2020 NEI.

2.3 County-Level Allocation

NM O&G GHGI estimates are provided at the county-level, using the following approaches for each industry segment.

For exploration and production, while emissions data are typically available at the basin-level (e.g., subpart W defines a production facility as all equipment within a basin), well counts and production data are available for each county from the NM Oil Conservation Division (NM OCD).[10] Well counts and production data from the NM OCD were used to disaggregate basin-level emissions to each county.

For the G&B segment, while emissions data are typically available at the basin-level (e.g., subpart W defines a G&B facility as all equipment within a basin), emissions were assigned to counties based on the location of individual G&B stations. G&B station locations are available from the NMED MSEI.

For the natural gas processing segment, emissions were assigned to counties based on the location of individual processing plants. Processing plant locations are available from the NMED MSEI.

[10] https://www.emnrd.nm.gov/ocd/ocd-data/statistics/

For the transmission and storage segment, compressor station emissions were assigned to counties based on the location of compressor stations, transmission pipeline emissions were assigned to counties based on the number of miles in each county, and underground NG storage emissions were assigned to counties based on the location of each storage field. Compressor station locations are available from the NMED MSEI. Natural gas transmission pipeline miles by county are available from the Pipeline and Hazardous Materials Safety Administration (PHMSA) National Pipeline Mapping System.[11] Underground NG storage field locations are available from PHMSA and the EIA.[12,13]

For inactive wells, emissions were assigned based on the location of wells in the NM OCD data. The NM OCD data includes location data for known inactive wells.

3 Emissions Data

3.1 Introduction

This section identifies the emissions data and emission factors that were used to estimate emissions for the five categories included in the NM O&G GHGI. Data from the U.S. EPA, Minor Source Emissions Inventory data submitted to the NMED, and measurement studies were evaluated to identify relevant emissions data and emission factors for each category. Each of these data sources are discussed in Sections 3.1.1 through 3.1.3.

3.1.1 U.S. EPA Data

The following five U.S. EPA datasets were evaluated in preparing the NM O&G GHGI:

1. GHGRP Subpart W (subpart W)
2. GHGRP Subpart C (subpart C)[14]
3. EPA GHGI
4. NEI Tool
5. U.S. EPA AP-42 (AP-42)[15]

The GHGRP collects annual emissions and related activity data from facilities that exceed the reporting threshold of 25,000 metric tons of CO_2 equivalent (CO_2e) per year. The most recent GHGRP data is for year 2020. GHGRP's subpart W collects data from petroleum and natural gas systems facilities, and subpart C collects stationary fuel combustion emissions from applicable facilities. Subpart W includes data for each of the four industry segments that are included in the NM O&G GHGI. A subpart W facility for transmission stations, underground NG storage stations, and NG processing plants is defined as each individual station and plant, consistent with other regulatory definitions of a facility.

[11] https://www.npms.phmsa.dot.gov/GeneralPublic.aspx
[12] https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids
[13] http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP7
[14] https://www.epa.gov/ghgreporting/subpart-c-general-stationary-fuel-combustion-sources
[15] https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors

For production and G&B facilities, subpart W defines facilities using a larger geographic region (i.e., basin) and not at the individual site-level. Subpart W production and G&B facilities include all equipment within a single basin, as detailed here:

- Petroleum and natural gas production refers to all petroleum or natural gas equipment on a single well-pad or associated with a single well-pad that are under common ownership or common control including leased, rented, or contracted activities by a petroleum and natural gas production owner or operator and that are located in a single hydrocarbon basin.
- Petroleum and natural gas gathering and boosting refers to all gathering pipelines and other equipment located along those pipelines that are under common ownership or common control by a gathering and boosting system owner or operator and that are located in a single hydrocarbon basin. If a person owns or operates more than one gathering and boosting system in a basin (for example, separate gathering lines that are not connected), then all gathering and boosting equipment that the person owns or operates in the basin would be considered one facility.

The GHGRP provides specific reporting forms for subpart W and subpart C, in spreadsheet format, that facilities may use to report their data. The reporting forms contain detailed information for each applicable emission source.

The EPA GHGI estimates national-level GHG emissions for the O&G industry (including the five categories that emissions are estimated for in the NM O&G GHGI). While the GHGRP accounts for only those facilities that exceed the reporting threshold, the EPA GHGI accounts for all O&G activities in the U.S. The EPA GHGI estimates emissions for all of the main emission sources in each industry segment. Each emission source has a unique calculation methodology, emission factors, and activity specific to that source. The EPA GHGI estimates annual emissions over time with the most recent EPA GHGI estimating emissions for 1990 through 2020.

The NEI Tool estimates county-level criteria pollutant emissions for the production industry segment with some overlap with G&B sources. Similar to the EPA GHGI, the NEI Tool estimates emissions for each emission source using a unique calculation methodology (i.e., emission factors and activity specific to each emission source). The most recent NEI Tool data is for year 2020.

The U.S. EPA's Compilation of Air Pollutant Emissions Factors (AP-42) contains emission factors for numerous emission sources. For the NM O&G GHGI, emission factors for combustion sources were reviewed, which include reciprocating engines that are commonly used in the O&G industry.

3.1.2 NMED Minor Source Emissions Inventory

For the 2020 reporting year, the NMED Air Quality Bureau solicited submittal of criteria pollutant (including NO_x, CO, SO_2, $PM_{2.5}$, PM_{10}, and lead), VOC, and GHG (i.e., CH_4 and CO_2) emissions data from minor sources for the first time. Prior to this request, only annual emission inventories from larger facilities were collected. These larger sources are not currently required to report their GHG emissions to NMED, although many are required to report their GHG emissions to EPA under the GHGRP. Approximately 5,000 minor sources across all industries were contacted to request this information, and responses related to oil and gas emissions were received from over

40 organizations. The organizations that submitted to NMED are very large and can have hundreds of facilities with multiple types of equipment under their jurisdiction. The Minor Source Emissions Inventory data was requested to be submitted to NMED between January 1, 2021 and April 1, 2021, and submittals were received thru the end of November 2021. The Minor Source Emissions Inventory is referred to as the NMED MSEI for this report.

As a result of this data collection effort, the NMED MSEI contains the most comprehensive dataset for criteria pollutants and GHG emissions and related activity data available for sources that have not previously been required to submit emission estimates. To estimate GHG emissions, companies were required to follow subpart W and subpart C methodologies and were asked to submit their subpart W and subpart C reporting forms. NMED requested GHG data from all facilities, including facilities that are below the GHGRP reporting threshold and would otherwise generally not report their data to EPA. NMED also asked companies to adjust their EPA reporting forms to provide data only for their NM operations, where appropriate. As noted above, subpart W defines a facility, for purposes of the production and G&B industry segments, as all equipment within a given basin, which can cross state boundaries. For example, the Permian Basin includes activity in both Texas (TX) and NM. Therefore, if a company operates in the Permian Basin, while they can use the subpart W reporting form submitted to the EPA as a starting point, only the data for their NM operations were to be submitted to the NMED MSEI (i.e., the TX emissions data were to be removed).

3.1.3 Measurement Studies

A number of studies have been conducted over the last ten years that measured CH_4 emissions from O&G emission sources. The results from these measurement studies are then published in peer-reviewed journal articles. While a number of these studies have been incorporated into EPA GHGI methodologies, others have not. Therefore, select measurement studies were considered for the NM O&G GHGI, these are specifically discussed in Sections 3.2.1, 3.5.1, 3.5.2, 3.6, and 3.7.

3.1.4 General Approach

Due to the quantity of GHGRP data reported to the NMED MSEI and the U.S. EPA, and its specificity to NM operations, GHGRP emissions data was used for the majority of the emission sources. Where Subpart W is identified in the tables below in Sections 3.2 through 3.5, the reported emissions are used directly. However, in some instances, emission factors from the EPA GHGI, the NEI Tool, and measurement studies are used in conjunction with activity data from the NMED MSEI and EPA datasets.

A brief discussion below for each industry segment explains where emission factors other than Subpart W are used. In most cases, these emission factors allow for more recent measurement data not included in Subpart W methodologies to be used in the NM O&G GHGI as well as for emission sources not included in Subpart W.

Sections 3.2 through 3.5 present the source of the emissions data and emission factors used for each emission source in each industry segment. Section 3.6 presents the methodology used to estimate internal combustion engine CH_4 emissions for all industry segments. Section 3.7 presents the source of the emission factors used for inactive wells.

3.2 Exploration and Production

Table 10 and Table 11 present the source of the emissions data for exploration and production.

Table 10. Exploration Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
HF Well Completions	Subpart W	Subpart W
Non-HF Well Completions	Subpart W	Subpart W
Mud Degassing	NEI Tool	CO_2:CH_4 Ratio[16]
Well Blowouts	EPA GHGI	EPA GHGI
Well Testing	Subpart W	Subpart W

Table 11. Production Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Well Pad Equipment Leaks	Other (See Section 3.2.1)	CO_2:CH_4 Ratio
Pneumatic Controllers (High, Low, and Intermittent)	Subpart W	Subpart W
Chemical Injection Pumps	Subpart W	Subpart W
Dehydrators	Subpart W	Subpart W
Hydrocarbon Liquid Storage Tanks	Subpart W	Subpart W
Hydrocarbon Liquid Storage Tank Unloading	NEI Tool	CO_2:CH_4 Ratio
Produced Water Tanks	EPA GHGI	EPA GHGI
Liquids Unloading	Subpart W	Subpart W
Associated Gas Venting and Flaring	Subpart W	Subpart W
Miscellaneous Production Flaring	Subpart W	Subpart W
Reciprocating Compressors	Subpart W	Subpart W
Centrifugal Compressors	Subpart W	Subpart W
HF Well Workovers	Subpart W	Subpart W
Non-HF Well Workovers	Subpart W	Subpart W

Several emission sources in exploration and production are not required to be reported under subpart W, including: mud degassing, storage tank unloading, and produced water tanks. However, the EPA GHGI and the NEI Tool include emissions for these sources based on default emission factor data, which are used in the NM O&G GHGI.

The approach used to estimate equipment leak emissions from production well pads is discussed in Section 3.2.1.

[16] CO_2 emissions are estimated using CH_4 estimates and the ratio of CO_2 to CH_4 contents in natural gas. The CO_2 and CH_4 contents of natural gas may vary by industry segment and by basin.

3.2.1 Production Well Pad Equipment Leaks

Emission factor data for production well pad equipment leaks was reviewed from the following sources:

- Subpart W
- EPA GHGI
- Recently published peer-reviewed research studies
    - Pacsi et al. 2019 - Equipment leak detection and quantification at 67 oil and gas sites in the Western United States.[17]
    - Rutherford et al. 2021 - Closing the methane gap in US oil and natural gas production emissions inventories.[18]

The equipment leak emission factors used in the EPA GHGI and the GHGRP are based on a 1996 GRI/EPA study[19] for equipment components in natural gas service and from a 1995 API study[20] for crude oil. The component-level measurements used to develop the leak emission factors were obtained during the early 1990's.

The Pacsi et al. 2019 and Rutherford et al. 2021 studies used measurement data to develop component-level emission factors for production equipment leaks. A summary of each study is presented here.

The Pacsi et al. 2019 study (led by the American Petroleum Institute (API)) conducted component counts, leak detection (Method 21 and optical gas imaging (OGI)), and whole gas leak measurements (high-volume sampler) at 67 O&G production sites (including G&B) in the Permian, Anadarko, Gulf Coast, and San Juan basins. The study included 8 gas and 4 oil sites in the San Juan basin and 13 oil sites in the Permian basin. All field measurements were conducted in 2015.

The Rutherford et al. 2021 study compiled component data (counts and leak screening) and leak measurements from previously published studies. The compiled database contains approximately 3,700 measurements from seven different studies and component data from three studies. All the studies were related to onshore O&G production sites and were published between 1993 and 2019. The studies used one or both of Method 21 and OGI to detect leaks. The Rutherford study also accounts for super-emitters, which are large emission events that occur infrequently but may represent a significant contribution to total emissions. Component data and measurements from the Pacsi et al. 2019 study are also included in the database compiled by the Rutherford et al. 2021 study.

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[17] Adam P. Pacsi, Tom Ferrara, Kailin Schwan, Paul Tupper, Miriam Lev-On, Reid Smith, Karin Ritter; Equipment leak detection and quantification at 67 oil and gas sites in the Western United States. Elementa: Science of the Anthropocene 1 January 2019; 7 29. doi: https://doi.org/10.1525/elementa.368

[18] Rutherford, J.S., Sherwin, E.D., Ravikumar, A.P. et al. Closing the methane gap in US oil and natural gas production emissions inventories. Nat Commun 12, 4715 (2021). https://doi.org/10.1038/s41467-021-25017-4

[19] Methane Emissions from the Natural Gas Industry. Prepared by Harrison, M., T. Shires, J. Wessels, and R. Cowgill, eds., Radian International LLC for National Risk Management Research Laboratory, Air Pollution Prevention and Control Division, Research Triangle Park, NC. EPA-600/R-96-080a.

[20] Emission Factors for Oil and Gas Production Operations, API Publication 4615, 1995 Edition, January 1995.

Table 12 presents the CH_4 emission factors for production equipment leaks developed by the Pacsi et al. 2019 study and the Rutherford et al. 2021 study.

Table 12. Production Equipment leak Emission Factor Summary

Emission Source	CH_4 Emission Factor (kg/day/equipment)	
	Rutherford et al. 2021	**Pacsi et al. 2019**
Natural Gas		
Wellheads	3.35	0.70
Separators	3.72	0.81
Meters/Piping	2.66	0.74
Heaters	2.04	0.15
Dehydrators	3.13	1.02
Compressors	5.33	1.91
Crude Oil		
Wellheads	1.33	0.10
Separators	1.53	0.07
Heater/Treaters	1.01	0.08
Headers	3.86	0.10

The U.S. EPA's New Source Performance Standards (NSPS) OOOOa are applicable to crude oil and natural gas facilities constructed, modified, or reconstructed after September 18, 2015.[21] NSPS OOOOa requires leak detection and repair (LDAR) to be implemented on all applicable O&G wells.

Therefore, wells subject to NSPS OOOOa are expected to have lower equipment leak emissions than wells that are not subject to NSPS OOOOa. Emission factors from the Rutherford et al. 2021 study are used for all wells that are not subject to NSPS OOOOa (i.e., constructed on or before September 18, 2015) and emission factors from the Pacsi et al. 2019 study are used for all wells that are subject to NSPS OOOOa (i.e., constructed after September 18, 2015).

Well data are available from NM OCD, including the date of first production for a well (see OCD Wells Database discussion in Section 4.3.1). Since the emission factors are different for gas wells and oil wells, each well in the OCD Wells Database was classified based on the gas-to-oil ratio (GOR). The GOR is calculated as the volume of gas production for a well (thousand cubic feet, mcf) divided by the oil production for a well (barrels, bbl). Wells with a GOR greater than 100 were classified as gas wells and wells with a GOR less than 100 were classified as oil wells. Wells with a first production date prior to September 2015 were classified as not subject to NSPS OOOOa.

[21] NSPS OOOOa - https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-60/subpart-OOOOa

Table 13 presents the number of oil and gas wells by basin and the number subject to and not subject to NSPS OOOOa. The San Juan Basin has the highest number of gas wells not subject to NSPS OOOOa (which have the highest leak emission factors, see Table 12), and therefore will have the highest production equipment leak emissions using this approach.

Table 13. Summary of Oil and Gas Well Counts

Basin / Well Type	Wells Not Subject to NSPS OOOOa	Wells Subject to NSPS OOOOa
Permian	**24,095**	**3,526**
Gas	5,579	17
Oil	18,516	3,509
San Juan	**20,260**	**208**
Gas	18,218	64
Oil	2,042	144
Las Vegas-Raton	**828**	**0**
Gas	828	0
Sierra Grande Uplift	**674**	**7**
Gas	674	7

3.3 Gathering and Boosting

Table 14 and Table 15 present the source of the emissions data for G&B stations and gathering pipelines.

Table 14. G&B Station Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Station Blowdowns	Subpart W	Subpart W
Dehydrator Vents	Subpart W	Subpart W
Pneumatic Controllers (High, Low, and Intermittent)	Subpart W	Subpart W
Pneumatic Pumps	Subpart W	Subpart W
Flares	Subpart W	Subpart W
Compressors	EPA GHGI	EPA GHGI
Hydrocarbon Liquid Storage Tanks	EPA GHGI	Subpart W
Acid Gas Removal Units	Subpart W	Subpart W
Station Leaks	EPA GHGI	EPA GHGI

Table 15. Gathering Pipelines Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Pipeline Leaks	Subpart W	Subpart W
Pipeline Blowdowns	Subpart W	Subpart W

For certain G&B sources, EPA GHGI emission factors are used instead of using subpart W emissions; see Section 3.3.1 for details.

3.3.1 Gathering and Boosting Station Leaks, Compressor Venting, and Storage Tanks

CH_4 emission factor data for G&B station leaks, compressor venting, and storage tanks from the following sources were reviewed:

- Subpart W
- EPA GHGI

The subpart W G&B station leaks methodology relies on the same equipment component data as the production segment leaks, which is based on data from a 1996 GRI/EPA study (see Section 3.2.1). The subpart W G&B reciprocating compressor venting emission factor is the same as the production segment reciprocating compressor venting emission factor and only represents rod packing emissions. This emission factor is also based on the 1996 GRI/EPA study data. The subpart W G&B storage tank methodology generally relies on the use of process simulation software (e.g. ProMax) to estimate tank emissions.

The EPA GHGI updated its G&B station methodology in April 2020 to use emissions data from a comprehensive CH_4 emissions measurement program conducted for the G&B industry segment (Zimmerle et al. 2020).[22,23] The Zimmerle et al. study conducted measurements in 2017 at 180 G&B stations across the U.S., including stations in NM.

The EPA GHGI approach is used in the NM O&G GHGI to ensure that more recent measurements serve as the basis of the data, instead of the older 1996 GRI/EPA data. In addition, the Zimmerle et al. study captured emissions from large emission events (super-emitters), specifically from G&B storage tanks, which are important to reflect in inventories. Relying exclusively on process simulation software to estimate storage tank emissions, such as subpart W currently does, is appropriate to estimate typical emissions but does not capture large emission events such as those caused by malfunctioning equipment.

In addition to CH_4, CO_2 is also emitted from storage tanks where flares are used to control emissions. Subpart W CO_2 emissions data is used for storage tanks, to reflect those emissions that were controlled with flares.

3.4 Natural Gas Processing

Table 16 presents the source of the emissions data for natural gas processing.

[22] Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018: Updates to Natural Gas Gathering & Boosting Station Emissions. Available at: https://www.epa.gov/sites/default/files/2020-04/documents/2020_ghgi_update_-_gb_stations_final.pdf
[23] Zimmerle et al. Methane Emissions from Gathering Compressor Stations in the U.S. Environmental Science & Technology, 2020, 54, 12, 7552–7561. https://pubs.acs.org/doi/10.1021/acs.est.0c00516

Table 16. Natural Gas Processing Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Plant Leaks	Subpart W	Subpart W
Reciprocating Compressors	Subpart W	Subpart W
Centrifugal Compressors	Subpart W	Subpart W
Flares	Subpart W	Subpart W
Dehydrators	Subpart W	Subpart W
Blowdowns	Subpart W	Subpart W
Acid Gas Removal Units	Subpart W	Subpart W
Pneumatic Controllers	EPA GHGI	EPA GHGI

Pneumatic controllers powered by natural gas are not common at processing plants and are not subject to subpart W requirements. However, the EPA GHGI does include pneumatic controllers based on default data, which are used in the NM O&G GHGI.

3.5 Transmission and Storage

Table 17, Table 18, and Table 19 present the source of the emissions data for transmission compressor stations, transmission pipelines, and underground NG storage stations, respectively.

Table 17. Transmission Compressor Station Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Station Leaks	Subpart W	Subpart W
Reciprocating Compressors	Subpart W plus Other (see Section 3.5.1)	CO_2:CH_4 Ratio
Centrifugal Compressors	Subpart W plus Other (see Section 3.5.1)	CO_2:CH_4 Ratio
Dehydrators	EPA GHGI	EPA GHGI
Flares	Subpart W	Subpart W
Station Blowdowns	Subpart W	Subpart W
Pneumatic Controllers (High, Low, and Intermittent)	Subpart W	Subpart W

Table 18. Transmission Pipelines Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Pipeline Leaks	EPA GHGI	EPA GHGI
Pipeline Blowdowns	Subpart W	Subpart W

Table 19. Underground NG Storage Station Emissions Data Summary

Emission Source	CH_4 Emissions Data Source	CO_2 Emissions Data Source
Station Leaks	EPA GHGI	EPA GHGI
Reciprocating Compressors	EPA GHGI	EPA GHGI
Dehydrators	EPA GHGI	EPA GHGI
Flares	EPA GHGI	EPA GHGI
Station Blowdowns	EPA GHGI	EPA GHGI
Pneumatic Controllers (High, Low, and Intermittent)	EPA GHGI	EPA GHGI
Storage Wells	EPA GHGI	EPA GHGI
Metering and Regulating Equipment	EPA GHGI	EPA GHGI

A few emission sources in the transmission segment are not subject to subpart W reporting, including dehydrators and pipeline leaks. However, the EPA GHGI includes emissions for these sources, based on default emission factor data, which are used in the NM O&G GHGI.

The approach used to estimate transmission station compressor emissions is discussed in Section 3.5.1. Background information on transmission station super-emitters are presented in Section 3.5.2.

For underground NG storage stations, EPA GHGI data were used to estimate emissions for all sources. While subpart W does collect data for most of the emission sources, data specific to storage stations in NM are not available (see section 4.3.4 for results of the coverage analyses). Therefore, average emissions from the EPA GHGI were used to estimate storage station emissions in NM.

3.5.1 Transmission Station Compressors

CH_4 emission factor data for transmission station reciprocating and centrifugal compressors were reviewed from the following sources:

- Subpart W
- PRCI White Paper: Methane Emission Factors for Compressors in Natural Gas Transmission and Underground Storage based on Subpart W Measurement Data[24]

Natural gas compressor activity causes leak emissions from specific components (i.e., blowdown valves, isolation valves, rod packing (for reciprocating compressors) and wet and dry seals (for centrifugal compressors)). The emissions from each component are dependent upon the compressor mode. Compressor modes include:

- operating mode

[24] PRCI White Paper: Methane Emission Factors for Compressors in Natural Gas Transmission and Underground Storage based on Subpart W Measurement Data (Oct. 17, 2019). PR-312-18209-E01.

- standby, pressurized mode
- not operating, depressurized mode

Subpart W collects transmission station reciprocating compressor emissions for the following components and compressor modes:

- blowdown valves during operating mode
- blowdown valves during standby, pressurized mode
- rod packing during operating mode
- rod packing during standby, pressurized mode
- isolation valves during not operating, depressurized mode

Subpart W collects transmission station centrifugal compressor emissions for the following components and compressor modes:

- blowdown valves during operating mode
- wet seals during operating mode
- isolation valves during not operating, depressurized mode

PRCI reviewed the subpart W compressor requirements and noted that emissions from certain components and compressor modes are not required to be reported. The components and compressor modes not required to be reported are:

- reciprocating compressor rod packing during standby, pressurized mode
- centrifugal compressor dry seals during operating mode
- centrifugal compressor dry seals during standby, pressurized mode

To provide a complete picture of compressor emissions at transmission stations, the PRCI white paper includes an emission factor for each component and compressor mode. Table 20 presents the emission factors from PRCI for the components and compressor modes that are not required to be reported under subpart W.

Table 20. PRCI Compressor CH_4 Emission Factors for Certain Components and Compressor Modes

Compressor Type	Component and Compressor Mode	CH_4 Emission Factor (mt CH_4/yr/compressor)
Reciprocating	Rod packing during standby, pressurized mode	10.9
Centrifugal	Dry seals during operating mode	24.6
Centrifugal	Dry seals during standby, pressurized mode	2.0

The NM O&G GHGI uses a combination of subpart W emissions and PRCI emission factors to estimate total emissions from transmission station reciprocating and centrifugal compressors. Subpart W emissions are used to reflect NM-specific operations, and then adjusted by applying the emission factors presented in Table 20 for each reported compressor, as applicable, to estimate total compressor emissions from reciprocating and centrifugal compressors.

3.5.2 Transmission Station Super-emitters

Data on transmission compressor station super-emitters was reviewed but are not included in the NM O&G GHGI, because their emissions are not attributable to a specific transmission compressor station emission source. A brief review of two studies that include super-emitters is presented here for informational purposes.

Two studies discuss super-emitters at transmission compressor stations:

- Subramanian et al. 2015 - Methane Emissions from Natural Gas Compressor Stations in the Transmission and Storage sector: Measurements and Comparisons with the EPA Greenhouse Gas Reporting Program Protocol[25]
- Zimmerle et al. 2015 - Methane Emissions from the Natural Gas Transmission and Storage System in the United States[26]

The Subramanian et al. 2015 study conducted emissions measurements at 45 transmission compressor stations across the U.S. The measurement campaign used two techniques, direct leak measurements of specific emission sources and downwind tracer flux measurements (which estimate station-wide emissions). During the measurement campaign, Subramanian et al. detected super-emitters at two stations via the tracer flux data. However, due to safety considerations, direct measurement data were not collected, and the super-emitter data were not assigned to a specific emission source.

The Zimmerle et al. 2015 study analyzed the measurement data collected for the Subramanian et al. 2015 study, including the super-emitter data. Zimmerle et al. 2015 estimated that at any one time approximately four percent of compressor stations are super-emitters. The study also estimated that national compressor station emissions would increase by about 3 times if super-emitters are considered.

3.6 Internal Combustion Engine Exhaust

CH_4 emission factor data for natural gas-fired internal combustion engine (ICE) exhaust (e.g., combustion slip or unburned CH_4) were reviewed from the following sources:

- Subpart C
- EPA GHGI
- AP-42

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[25] Subramanian, R.; Williams, L.L.; Vaughn, T.L.; Zimmerle, D.; Roscioli, J.R.; Herndon, S.C.; Yacovitch, T.I.; Floerchinger, C.; Tkacik, D.S.; Mitchell, A.L.; Sullivan, M.R.; Dallmann, T.R; Robinson, A.L. Methane Emissions from Natural Gas Compressor Stations in the Transmission and Storage sector: Measurements and Comparisons with the EPA Greenhouse Gas Reporting Program Protocol. Environmental Science and Technology, 49, 3252-3261. 2015

[26] Zimmerle, D.J.; Williams L.L.; Vaughn, T.L.; Quinn, C.; Subramanian, R.; Duggan, G.P.; Willson, B.; Opsomer, J.D.; Marchese, A.J.; Martinez D.M.; Robinson, A.L. Methane Emissions from the Natural Gas Transmission and Storage System in the United States. Environmental Science and Technology, 49, 9374-9383. 2015

- Vaughn et al. 2021 - Methane Exhaust Measurements at Gathering Compressor Stations in the United States.[27]

The GHGRP emission factor for natural gas fired ICE exhaust is taken from subpart C, which applies a single emission factor for all units that combust natural gas. The subpart C emission factor is fuel-based and does not recognize differences in the type of combustion units, so engines, turbines, and all other units that combust natural gas use the same emission factor. This emission factor is not representative of exhaust from natural gas-fired ICE's that dominate the oil and gas industry and is orders of magnitude lower than emission factors that are specific to natural gas-fired ICE exhaust.

The EPA GHGI uses a single emission factor for all engine types combusting natural gas, and it is based on the 1996 GRI/EPA study. The EPA GHGI emission factor does not account for engine technology type (i.e., rich burn and lean burn).

AP-42 contains CH_4 emission factors for natural gas-fired reciprocating engines. The AP-42 emission factors were developed using emissions testing data from 1990-2000 for stationary ICE. Compiled emissions test data includes historic source test data submitted by various state agencies, reports published by GRI, and emissions tests conducted by EPA in collaboration with industry and engine manufacturers. AP-42 provides CH_4 emission factors by type of engine (e.g., 4-stroke rich burn and 4-stroke lean burn). The EPA GHGI emission factor is very close to the AP-42 emission factor for lean burn engines (i.e., within 2%).

The Vaughn et al. 2021 study, which analyzed natural gas ICE exhaust test from a recent measurement campaign, was also considered. The field campaign measured emissions from 133 ICE operated at 67 G&B compressor stations in 11 states, including NM. CH_4 emission factors were developed for lean burn and rich burn engines.

Table 21 presents the CH_4 emission factors from AP-42 and the Vaughn et al. 2021 study. The emission factors are generally comparable between the two datasets.

Table 21. Natural Gas Engine Exhaust Emission Factor Summary

Emission Source	CH_4 Emission Factor (lbs/MMBtu fuel input)	
	AP-42 (U.S. EPA)	Vaughn et al. 2021
4-Stroke, Lean Burn	1.25	1.15
4-Stroke, Rich Burn	0.23	0.10

AP-42 emission factors were used to estimate exhaust emissions from natural gas engines for all oil and gas industry segments (production, G&B, natural gas processing, and transmission and storage). Table 22, below, presents AP-42 CH_4 emission factors and the fraction of rich and lean burn engines for NM. The fractions of rich burn and lean burn 4-stroke natural gas engines were developed using data from the NMED MSEI. NMED MSEI data included descriptions for internal

[27] Timothy L. Vaughn, Benjamin Luck, Laurie Williams, Anthony J. Marchese, and Daniel Zimmerle. Methane Exhaust Measurements at Gathering Compressor Stations in the United States. Environmental Science & Technology 2021 55 (2), 1190-1196. DOI: 10.1021/acs.est.0c05492.

combustion engines (e.g., 4STR Lean burn, 4STR Rich burn, 4SRB, and 4SLB). In some cases, engine make and model information were available to determine the engine technology type via internet search on the engine manufacturer's website. Additionally, information on the number of engines was also available from the NMED MSEI. Based on the compiled information (from NMED MSEI and internet searches), it was determined that the production segment in NM has 16 percent lean burn and 84 percent rich burn natural gas engines as shown in Table 22. Similarly, it was determined that the G&B, processing, and transmission segments in NM have 90 percent lean burn and 10 percent rich burn natural gas engines as shown in Table 23.

Using the CH_4 emission factors from AP-42 and the rich and lean burn engine fractions developed from the NMED MSEI data, composite emission factors were developed for production, G&B, processing, and the transmission segments. The CH_4 composite engine emission factor used for the production segment is shown in Table 22. The CH_4 composite engine emission factor for the G&B, processing, and transmission segments is shown in Table 23.

Table 22. Production Segment Natural Gas Engine Exhaust Composite CH_4 Emission Factor

Emission Source	AP-42 CH_4 Emission Factor (lbs/MMBtu fuel input)	% of Engine Type
4-Stroke, Lean Burn	1.25	16%
4-Stroke, Rich Burn	0.23	84%
All Engines (Composite EF)	**0.39**	

Table 23. G&B, Natural Gas Processing, and Transmission Natural Gas Engine Exhaust Composite CH_4 Emission Factor

Emission Source	AP-42 CH_4 Emission Factor (lbs/MMBtu fuel input)	% of Engine Type
4-Stroke, Lean Burn	1.25	90%
4-Stroke, Rich Burn	0.23	10%
All Engines (Composite EF)	**1.15**	

The engine combustion CO_2 emissions reported under subpart W are calculated using the default emission factor from subpart C (Table C-1) for natural gas fuel type. Using the CO_2 emission factor from subpart C and the composite CH_4 emission factor, CO_2 to CH_4 ratios (i.e., CO_2 emission factor divided by CH_4 emission factor) were developed for the production, G&B, processing, and transmission segments. These ratios, as shown in Table 24, were used to estimate CH_4 emissions from combustion of natural gas in engines. The reported CO_2 combustion emissions were divided by the CO_2:CH_4 ratios developed for each segment to estimate CH_4 emissions. For example, if a G&B facility reported 1,000 metric tons of combustion CO_2 for NM operations, the CH_4 emissions were estimated to be 9.8 metric tons (i.e., 1,000 metric tons of CO_2 divided by the G&B segment CO_2:CH_4 ratio of 102).

Table 24. Natural Gas Engine Exhaust CO2:CH4 Ratio

Industry Segment	Composite CH_4 Emission Factor (lbs/MMBtu fuel input)	Subpart C CO_2 Emission Factor (lbs/MMBtu fuel input)	CO_2:CH_4 Ratio
Production	0.39	116.98	300
G&B, Natural Gas Processing, and Transmission	1.15	116.98	102

3.7 Inactive Wells

CH_4 emission factor data for inactive oil and gas wells was reviewed from the following sources:

- EPA GHGI
- Townsend-Small et al. 2016: Emissions of coal bed and natural gas methane from abandoned oil and gas wells in the United States[28]
- Townsend-Small et al. 2021 - Direct measurements from shut-in and other abandoned wells in the Permian Basin of Texas indicate some wells are a major source of methane emissions and produced water[29]

The EPA GHGI estimates inactive oil and gas well emissions for plugged and unplugged inactive wells (termed abandoned wells in the EPA GHGI). The reviewed studies specifically observed that well status (i.e., plugged or unplugged) was a significant factor in emissions. The inactive well emissions studies also collected data from multiple producing regions, and while data are limited, preliminary indications are that inactive well emissions vary across the U.S. In particular, inactive well emissions in the Appalachian basin were higher than emissions from basins in the western U.S.

Two studies measured inactive well emissions in the western U.S. Townsend-Small et al. 2016 conducted measurements in Colorado, Utah, and Wyoming (this study was one of two studies used to develop the inactive well emission factors used in the EPA GHGI) and Townsend-Small et al. 2021 conducted measurements in the Permian Basin in TX. Table 25 summarizes emission factors from the two Townsend-Small studies and the EPA GHGI.

[28] Townsend-Small A, Ferrara T W, Lyon D R, Fries A E and Lamb B K. Emissions of coal bed and natural gas methane from abandoned oil and gas wells in the United States. Geophys. Res. Lett., 43, 2283–90. 2016. https://doi.org/10.1002/2015GL067623

[29] Amy Townsend-Small and Jacob Hoschouer. Direct measurements from shut-in and other abandoned wells in the Permian Basin of Texas indicate some wells are a major source of methane emissions and produced water. Environmental Research Letters, 16, 5, 2021. https://iopscience.iop.org/article/10.1088/1748-9326/abf06f

Table 25. Inactive Oil and Gas Well Emissions Data

Data Source	Region	Plugged / Unplugged	CH_4 Emission Factor (g/hr/well)	Used in NM O&G GHGI?
EPA GHGI	Eastern (PA) and Western U.S. (CO, UT, WY)	Plugged	0.002	No
EPA GHGI	Eastern (PA) and Western U.S. (CO, UT, WY)	Unplugged	10	No
Townsend-Small et al. 2016	Western U.S. (CO, UT, WY)	Plugged	0.002	Yes
Townsend-Small et al. 2016	Western U.S. (CO, UT, WY)	Unplugged	1.7	No
Townsend-Small et al. 2021	Permian Basin (TX)	Unplugged	6.1	Yes

The unplugged inactive well emission factor from Townsend-Small et al. 2021 was used in the NM O&G GHGI as this data is from the closest regional location. Since that study did not conduct measurements on plugged wells, the Townsend-Small et al. 2016 emission factor was used for plugged inactive wells.

4 Industry Segment Coverage

4.1 Introduction

This section describes the methods used to identify the total population of facilities in NM for each O&G industry segment included in the NM O&G GHGI and presents the results of the coverage analyses for each segment.

To estimate total emissions for the NM O&G GHGI, two populations of facilities were evaluated for each industry segment. The first group (Group 1) is those facilities for which emissions data are available (i.e., via GHGRP subpart W data submitted to EPA and NMED MSEI). The second group (Group 2) is those facilities for which emissions data are not available. Emission estimates for the Group 2 facilities were developed using data from the Group 1 facilities.

This section examines each of these two groups of facilities and estimates the percent coverage for each industry segment. Generally, the percent coverage for each industry segment equals the population of facilities in Group 1 divided by the total population of facilities in NM (Group 1 plus Group 2). The coverage of a particular industry segment provides context for how much the Group 1 emissions need to be scaled and the representativeness of the Group 1 emissions for the NM O&G GHGI. Emissions are presented at the county-level for the NM O&G GHGI, and therefore the coverage is estimated at the county-level.

The total NM population is known and available in public datasets for exploration and production, transmission pipelines, and underground natural gas storage. Exploration and production population data rely on NM OCD datasets; these are further discussed in Section 4.3.1. The transmission pipeline and underground natural gas storage station populations are provided by PHMSA; these are further discussed in Section 4.3.4.

The total NM population is less known and is not directly available in public datasets for G&B, natural gas processing, and transmission compressor stations. The NMED MSEI data was reviewed to first estimate the total population of these types of facilities. Section 4.2 presents the steps for this analysis. Based on that analysis, coverage is then discussed for each industry segment in Section 4.3.

Inactive oil and gas wells are not applicable to this coverage analysis. The total population of inactive wells in NM is estimated using NM OCD data and the total well counts are used to estimate inactive well emissions for the NM O&G GHGI. Emissions data specific to inactive wells are not otherwise reported by individual organizations.

4.2 Identifying the Applicable Industry Segment for Facilities in the NMED Minor Source Emissions Inventory

The NMED MSEI for year 2020 is a comprehensive dataset of all O&G facilities in operation. Of note, the NMED MSEI includes data not just for facilities with Title V operating permits, but for all facilities regardless of the type of permit required. Therefore, the NMED MSEI is assumed to fully include all transmission compressor stations, G&B stations, and natural gas processing plants. However, in the reporting process, organizations did not explicitly identify the industry segment applicable to each facility. The NMED MSEI includes the organization name and identifier, individual facility names and identifiers, and equipment information (e.g., numbers and descriptions of tanks and internal combustion engines).

Facility names and equipment information was reviewed to assign NMED MSEI facilities to industry segments. Some records in the NMED MSEI listed zero or blank operating hours, indicating they did not operate in 2020. These same records also did not have emissions data. Records with zero and blank operating hours were excluded from the coverage analysis. Sections 4.2.1 through 4.2.3 provide details on the specific approach applied for each industry segment to use the NMED MSEI data.

4.2.1 Identification of Transmission Compressor Stations

Organizations that would have transmission compressor stations were identified as those that satisfied one of the following criteria:

1. The organization reported under the transmission compression industry segment of subpart W, as reported to the NMED MSEI and EPA.
2. The organization has transmission pipeline miles available in PHMSA. In other words, if the company has transmission pipelines, then it is expected there would also be compressor stations along the pipeline.

For each organization identified in the above steps, their specific transmission compressor stations included in the NMED MSEI were identified using the following steps:

1. Reviewed facility names for compressor station terms or acronyms, including “compressor station” or “CS”. Most transmission compressor stations were identified in this step.

2. Reviewed engine and turbine data to identify facilities with large engines and/or turbines based on size (e.g., engine > 1,300 hp) or gas fuel throughput.

All transmission compressor stations identified for organizations with subpart W data are Group 1 facilities. All transmission compressor stations identified for organizations that do not have subpart W data, but were identified using the PHMSA data, are Group 2 facilities.

Once these compressor stations were paired with organizations associated with transmission stations, the remaining compressor stations, regardless of size, were assumed to be associated with G&B stations.

4.2.2 Identification of G&B Stations

Several factors were considered when identifying G&B stations in the NMED MSEI. A challenge in identifying G&B stations is that it is common for an organization to have both production and G&B operations, and some facilities could apply to either industry segment depending on the definition used. For example, tank batteries can be considered part of an organization's production operations or part of their G&B operations. Because subpart W data are an important part of this NM O&G GHGI development process, the subpart W definitions were considered to the extent practical. The subpart W petroleum and natural gas production industry segment includes equipment "on a single well-pad or associated with a single well-pad." Therefore, equipment that is associated with multiple well-pads, such as a central tank battery that collects production from multiple wells, is part of the G&B industry segment. G&B sites are also likely to have larger compressor engines/turbines and more tanks than a production site. Therefore, the size of the engines/turbines and the number of tanks at a facility were reviewed to help distinguish between production and G&B.

G&B stations were identified in the NMED MSEI using the following steps:

1. Reviewed facility names for compressor station terms or acronyms, including:
    a. Compressor station or CS
    b. Booster
    c. Gather or Gathering
    d. Central Delivery Point or CDP
2. Reviewed engine and turbine data to identify facilities with large engines and/or turbines based on size (e.g., engine > 1,300 hp) or gas fuel throughput. This data would indicate, for example, if a facility is a larger G&B site versus a production site with smaller engines.
3. Reviewed storage tank counts to identify large central tank batteries that are part of the G&B segment. Comparing the storage tank counts from subpart W G&B data to the station counts in the NMED MSEI, based on applying only steps 1 and 2, showed a significant underestimate of storage tanks for certain organizations. G&B facilities were further identified using the following steps:
    a. Reviewed facility names for the following terms and where the facility tank count was greater than or equal to three storage tanks:
        i. Central tank battery or CTB
        ii. Tank battery
        iii. Battery

b. Facility name did not specifically have a storage tank term, but there were more than or equal to six storage tanks at a site.

The count of oil and condensate tanks, but not produced water tanks, were included in this analysis because the subpart W G&B data does not include produced water tanks.

Most G&B stations with compressors were identified in step 1 above, where specific terms or acronyms were identified in the facility name. Most G&B stations that do not necessarily have compressors but are central tank battery sites were identified in step 3 above. Step 2 in the hierarchy was only used in limited instances.

As with the compressor transmission stations, G&B stations identified for organizations that submitted subpart W data to the NMED MSEI or EPA for the G&B industry segment are Group 1 facilities. G&B stations identified for organizations that did not report subpart W data for the G&B industry segment are Group 2 facilities.

4.2.3 Identification of Natural Gas Processing Plants

Facility names in the NMED MSEI were reviewed to identify the population of natural gas processing plants and found that these plants are clearly indicated in the facility names.

4.3 O&G Industry Segment Coverage

4.3.1 Exploration and Production

For the exploration and production segment, coverage was calculated using well counts and production (e.g., not by facility counts). Exploration and production information are available from NM OCD datasets, one being a database of wells by operator (OCD Wells Database) and the second being annual reports with production by operator (OCD Annual Operator Reports).[30] The well counts used for each organization are those wells in the OCD Wells Database, which had non-zero production in year 2020. Each well has a unique record in the OCD Wells Database, and the wells were counted in each county for each organization.

Gas and oil production are available for each organization in the OCD Annual Operator Reports. However, the production data are only provided at an organization-level and production by county are not available. While the OCD Wells Database also includes production, the volumes are lower than reported in the OCD Annual Operator Reports. The Annual Operator Reports production volumes are similar to the production reported by the U.S. Energy Information Administration.[31] To estimate county-level oil and gas production, the OCD Annual Operator Reports production were apportioned for each organization based on the county-level OCD Wells Database production (i.e., if 40 percent of an organization's oil production occurs in Lea County according to the OCD Wells Database, then it was assumed that 40 percent of the OCD Annual Operator Reports production also occurs in Lea County for that organization).

Each organization in the OCD Wells Database and OCD Annual Operator Report dataset was classified as either a Group 1 or Group 2 facility. Each organization that reported subpart W data

[30] Both datasets are available at https://www.emnrd.nm.gov/ocd/ocd-data/statistics/

[31] https://www.eia.gov/petroleum/wells/

to the NMED MSEI or EPA under the production segment is classified as a Group 1 facility, and each organization that did not report subpart W data to the NMED MSEI or EPA under the production segment is classified as a Group 2 facility. In tables below, Group 2 data is not explicitly listed and is the difference between the totals and Group 1.

Table 26, Table 27, and Table 28 present the coverage results for wells, oil production, and gas production, respectively.

Table 26. Production Well Coverage[a]

Basin	County	# Wells for Group 1	Total # Wells	% Coverage
Permian	Lea	8,568	13,067	66%
Permian	Eddy	8,062	12,800	63%
Permian	Chaves	112	1,622	7%
Permian	Roosevelt	13	132	10%
Permian	**All**	**16,755**	**27,621**	**61%**
San Juan	San Juan	9,939	11,793	84%
San Juan	Rio Arriba	6,737	8,278	81%
San Juan	Sandoval	218	377	58%
San Juan	McKinley	0	20	0%
San Juan	**All**	**16,894**	**20,468**	**83%**
Las Vegas-Raton	Colfax	0	828	0%
Sierra Grande Uplift	Union	0	347	0%
Sierra Grande Uplift	Harding	0	334	0%
Total		**33,649**	**49,598**	**68%**

a. Well counts are from the OCD Wells Database.

Table 27. Oil Production Coverage (Million Barrels, MMbbl)[a]

Basin	County	Oil Production for Group 1 (MMbbl)	Total Oil Production (MMbbl)	% Coverage
Permian	Lea	165	213	78%
Permian	Eddy	127	147	87%
Permian	Chaves	0.24	1.2	20%
Permian	Roosevelt	0.03	0.42	6%
Permian	**All**	**292**	**361**	**81%**

Basin	County	Oil Production for Group 1 (MMbbl)	Total Oil Production (MMbbl)	% Coverage
San Juan	San Juan	4.7	4.8	98%
San Juan	Rio Arriba	0.8	0.98	77%
San Juan	Sandoval	2.2	2.2	97%
San Juan	McKinley	0	0	n/a
San Juan	**All**	**7.6**	**8.0**	**95%**
Las Vegas-Raton	Colfax	0	0	n/a
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Total		**300**	**369**	**81%**

a. Oil production is from the OCD Annual Operator Reports.

Table 28. Gas Production Coverage (Billion Standard Cubic Feet, Bcf)[a]

Basin	County	Gas Production for Group 1 (Bcf)	Total Gas Production (Bcf)	% Coverage
Permian	Lea	467	617	76%
Permian	Eddy	622	731	85%
Permian	Chaves	1.3	7.7	17%
Permian	Roosevelt	0.04	1.5	3%
Permian	**All**	**1,090**	**1,356**	**80%**
San Juan	San Juan	289	301	96%
San Juan	Rio Arriba	184	214	86%
San Juan	Sandoval	9.2	10	92%
San Juan	McKinley	0	0.07	0%
San Juan	**All**	**482**	**525**	**92%**
Las Vegas-Raton	Colfax	0	15	0%
Sierra Grande Uplift	Union	0	22	0%
Sierra Grande Uplift	Harding	0	22	0%
Total		**1,572**	**1,941**	**81%**

a. Gas production is from the OCD Annual Operator Reports.

4.3.2 Gathering and Boosting

G&B coverage was calculated based on the number of G&B stations and the number of compressors identified in the NMED MSEI, as discussed in Section 4.2.2. Section 4.2.2 also explains what G&B stations are included in Group 1 and Group 2. Table 29 and Table 30 present the coverage results for G&B stations and compressors, respectively. Sufficient data are not available on total gathering pipeline miles in NM.

Table 29. G&B Station Coverage[a]

Basin	County	G&B Station Count for Group 1	Total G&B Station Count	% Coverage
Permian	Lea	261	294	89%
Permian	Eddy	275	305	90%
Permian	Chaves	6	6	100%
Permian	Roosevelt	0	0	n/a
Permian	**All**	**542**	**605**	**90%**
San Juan	Rio Arriba	32	36	89%
San Juan	San Juan	72	74	97%
San Juan	Sandoval	0	1	0%
San Juan	McKinley	0	1	0%
San Juan	**All**	**104**	**112**	**93%**
Las Vegas-Raton	Colfax	0	1	0%
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Total		**646**	**718**	**90%**

a. G&B station counts are estimated from the NMED MSEI, see Section 4.2.2.

Table 30. G&B Compressor Coverage[a]

Basin	County	G&B Compressor Count for Group 1	Total G&B Compressor Count	% Coverage
Permian	Lea	622	685	91%
Permian	Eddy	970	1039	93%
Permian	Chaves	26	26	100%
Permian	Roosevelt	0	0	n/a
Permian	**All**	**1,618**	**1,750**	**92%**
San Juan	Rio Arriba	190	217	88%
San Juan	San Juan	259	273	95%
San Juan	Sandoval	0	0	n/a
San Juan	Mckinley	0	3	0%
San Juan	**All**	**449**	**493**	**91%**
Las Vegas-Raton	Colfax	0	3	0%
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Total		**2,067**	**2,246**	**92%**

a. G&B compressor counts are estimated from the NMED MSEI, see Section 4.2.2.

4.3.3 Natural Gas Processing

Natural gas processing coverage was calculated based on the number of processing plants included in the Group 1 data sources (i.e., those processing plants that reported subpart W data to the NMED MSEI or EPA) compared to the total number of processing plants based on the NMED MSEI. Table 31 presents the coverage results for natural gas processing.

Table 31. Natural Gas Processing Coverage[a]

Basin	County	Processing Plant Count for Group 1	Total Processing Plant Count	% Coverage
Permian	Lea	13	13	100%
Permian	Eddy	10	13	77%
Permian	Chaves	0	1	0%
Permian	Roosevelt	0	0	n/a
San Juan	San Juan	6	6	100%
San Juan	Rio Arriba	0	0	n/a
San Juan	Sandoval	0	0	n/a
San Juan	McKinley	0	0	n/a
Las Vegas-Raton	Colfax	0	0	n/a
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Total		**29**	**33**	**88%**

a. Natural gas processing plant counts are estimated from the NMED MSEI, see Section 4.2.3.

4.3.4 Transmission and Storage

Transmission and storage coverage was calculated based on the number of transmission compressor stations and compressors, transmission pipeline miles, and the number of underground natural gas storage stations. Transmission compressor stations and compressor data are based on using the NMED MSEI to identify transmission stations discussed in Section 4.2.1. Section 4.2.1 also explains what compressor stations are included in Group 1 and Group 2. Table 32 and Table 33 present the coverage of the available emissions data for transmission compressor stations and compressors.

Transmission pipeline miles are available from PHMSA.[32] However, the miles are not available for each county, only as a total for NM. The two emission sources for transmission pipelines are pipeline leaks and pipeline blowdowns. For the NM O&G GHGI, a pipeline leak emission factor was applied to all pipeline miles, and thus the PHMSA data provide 100 percent coverage for leak emissions. Pipeline blowdowns are intermittent and unique to an individual organization's operations in a particular year (e.g., maintenance activities in a given year). Pipeline blowdown data are reported under subpart W, including the number of blowdowns, blowdown emissions, and a reporter's total pipeline miles. These data are available through the subpart W submittals to the NMED MSEI and EPA. Transmission pipeline coverage was calculated at the state-level, based

[32] https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids

on the number of miles for the organizations that reported pipeline blowdown data to the NMED MSEI or EPA (Group 1 facilities); see Table 34 for the coverage results.

Underground natural gas storage station data are also available from PHMSA. Table 35 presents the coverage of the available emissions data for underground natural gas storage stations.

Table 32. Transmission Compressor Station Coverage[a]

Basin	County	Compressor Station Count for Group 1	Total Compressor Station Count	% Coverage
Permian	Lea	3	6	50%
Permian	Eddy	1	5	20%
Permian	Chaves	2	2	100%
Permian	Roosevelt	0	1	0%
San Juan	San Juan	2	4	50%
San Juan	Rio Arriba	0	0	n/a
San Juan	Sandoval	0	2	0%
San Juan	McKinley	2	4	50%
San Juan	Valencia	1	1	100%
Las Vegas-Raton	Colfax	0	0	n/a
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Basin-And-Range Province	Luna	1	2	50%
Estancia	Torrance	1	1	100%
Orogrande	Dona Ana	1	1	100%
Orogrande	Lincoln	2	2	100%
Pedregosa	Hidalgo	1	1	100%
Total		**17**	**32**	**53%**

a. Transmission compressor station counts are estimated from the NMED MSEI, see Section 4.2.1.

Table 33. Transmission Compressor Station Compressor Coverage[a]

Basin	County	Compressor Count for Group 1	Total Compressor Count	% Coverage
Permian	Lea	14	26	54%
Permian	Eddy	3	17	18%
Permian	Chaves	7	7	100%
Permian	Roosevelt	0	2	0%
San Juan	San Juan	19	25	76%
San Juan	Rio Arriba	0	0	n/a
San Juan	Sandoval	0	9	0%

Basin	County	Compressor Count for Group 1	Total Compressor Count	% Coverage
San Juan	McKinley	6	13	46%
San Juan	Valencia	3	3	100%
Las Vegas-Raton	Colfax	0	0	n/a
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Basin-And-Range Province	Luna	6	7	86%
Estancia	Torrance	3	3	100%
Orogrande	Dona Ana	3	3	100%
Orogrande	Lincoln	10	10	100%
Pedregosa	Hidalgo	5	5	100%
Total		**79**	**130**	**61%**

a. Transmission compressor counts are estimated from the NMED MSEI, see Section 4.2.1.

Table 34. Transmission Pipelines Coverage[a]

Basin	County	Pipeline Miles for Group 1	Total Pipeline Miles	% Coverage
All	All	4,322	6,393	68

a. Transmission pipeline miles are from PHMSA.

Table 35. Underground Natural Gas Storage Station Coverage[a]

Basin	County	Underground Natural Gas Station Count for Group 1	Total Underground Natural Gas Station Count	% Coverage
Permian	Lea	0	1	0%
Permian	Eddy	0	1	0%
Permian	Chaves	0	0	n/a
Permian	Roosevelt	0	0	n/a
San Juan	San Juan	0	0	n/a
San Juan	Rio Arriba	0	0	n/a
San Juan	Sandoval	0	0	n/a
San Juan	McKinley	0	0	n/a
Las Vegas-Raton	Colfax	0	0	n/a
Sierra Grande Uplift	Union	0	0	n/a
Sierra Grande Uplift	Harding	0	0	n/a
Total		**0**	**2**	**0%**

a. Underground natural gas storage station counts are from PHMSA.

5 Inventory Development for each Industry Segment

The NM O&G GHGI development approach was generally similar for each industry segment. The basis of the NM O&G GHGI is GHGRP subpart W and subpart C emissions and activity data submitted to the NMED MSEI (see Section 3.1.2) and EPA; facilities that submitted these data are classified as Group 1 facilities (see related discussion in Section 4). The unique data submitted by each Group 1 facility was used to estimate its emissions; data from other facilities were not used for Group 1 facilities. Emission factors for Group 2 facilities (those facilities that did not submit subpart W and subpart C data to the NMED MSEI or EPA) were estimated based on the Group 1 data. For each industry segment, average emissions for each emission source were calculated from the entire Group 1 dataset and the average emissions were then applied to estimate emissions for each Group 2 facility. Specific details on the approach for each industry segment are discussed in Sections 5.1 through 5.5.

5.1 Exploration and Production

The methodology to develop the exploration and production NM O&G GHGI relies mainly on subpart W data submitted to the NMED MSEI and EPA from facilities with operations in NM (Group 1 facilities). Production facilities that submitted subpart W data directly to the NMED MSEI only included emissions and activity data for their NM operations. The subpart W production data reported to EPA are at the basin-level and thus may include emissions from states bordering NM. In either case, to estimate the emissions for each Group 1 facility their reported data was scaled from the state-level (if using data submitted to the NMED MSEI) or basin-level (if using data submitted to EPA) to the county-level based either on well counts or production volumes. For example, if a facility reported to EPA for the Permian basin and had 500 wells in the basin but had 200 wells in Eddy County and 200 wells in Lea County, then 40 percent of the emissions were apportioned to both Eddy and Lea Counties and the remaining 20 percent of the emissions were assumed to come from TX operations and not included in the NM O&G GHGI.

The Group 1 data were then consolidated to develop emission factors for each emission source to apply to Group 2 facilities. Emission factors were developed on a "per well" or "per production" basis, using the same reference as for scaling emissions.

The emission sources that were scaled using well counts are discussed in Section 5.1.1 and the sources that were scaled using production volumes are discussed in Section 5.1.2.

There were also production facilities that reported to EPA where most of their operations were in another state (e.g., a facility that operates mostly in the TX side of the Permian Basin, with minimal NM operations). Their reported data were not used in the analysis because it was not specific to NM operations. These facilities were treated as Group 2 facilities.

5.1.1 Sources Scaled Using Well Counts

Emissions from subpart W data reported by facilities with operations in NM were scaled for eight sources using well counts. These sources were:

1. Pneumatic Controllers (High, Low, and Intermittent)
2. Chemical Injection Pumps
3. Liquids Unloading

4. Well Completions and Workovers
5. Well Testing
6. Centrifugal Compressors
7. Reciprocating Compressors
8. Well Pad Equipment Leaks

The OCD Wells Database described in Section 4.3.1 was used to determine the count of active wells in each county with non-zero production in 2020 (see Table 26). Wells that began production after September 2015, which are subject to the provisions of NSPS OOOOa, were also identified for use in the well pad equipment leaks analysis.

For all sources except well pad equipment leaks, separate per-well emissions factors were calculated for the Permian and the San Juan Basin to apply to Group 2 facilities. The emission factors equal the sum of Group 1 emissions for an emission source in a basin divided by the total number of wells reported for that basin. Table 36 presents the calculated average emission factors for each emission source, by basin. The San Juan emission factors were applied to sources in the Las Vegas Raton and Sierra Grande Uplift basins. For Group 2 facilities, the emission factor was then multiplied by the number of wells in the county to estimate emissions for each emission source.

Table 36. Emission Factors for Sources Scaled Using Well Counts

Emission Source	Permian Basin		San Juan Basin	
	Average CH_4 Emissions (mt/well)	Average CO_2 Emissions (mt/well)	Average CH_4 Emissions (mt/well)	Average CO_2 Emissions (mt/well)
Low Bleed Pneumatic Controllers	0.12	0.005	0.44	0.42
Intermittent Bleed Pneumatic Controllers	1.08	0.19	3.94	2.60
High Bleed Pneumatic Controllers	0.003	0.0001	0.09	0.01
Reciprocating Compressors	0.023	0.0034	0.024	0.0037
Centrifugal Compressors	0	0	0	0
Pneumatic Pumps	0.050	0.0027	0.023	0.0027
Liquids Unloading	0.007	0.00015	0.97	0.045
Well Testing	0	0	0	0
HF Completions	0.17	20.94	0.0004	0.12
HF Workovers	0	0	0	0
Non-HF Workovers	0.004	0.0003	0.0012	0.0002

For well pad equipment leaks, a unique methodology was applied that relied on equipment counts. For Group 1 facilities, the equipment counts reported at an individual facility were used. From the Group 1 data, an equipment per well activity factor was calculated for each equipment type separately for gas wells and oil wells. Different activity factors were calculated for gas wells and oil wells due to the unique equipment present at each (see Table 37). The activity factors equal the sum of Group 1 equipment (e.g., number of separators at gas wells) in a basin divided by the total number of gas or oil wells reported for that basin. All equipment and well counts for this analysis are from the subpart W reporting form Table R.4. Table 37 presents the calculated activity factors for each equipment type. For Group 2 facilities, the basin-specific activity factors were applied to the county-level well counts (available as the number of wells subject to NSPS OOOOa and wells not subject to NSPS OOOOa) to estimate the number of equipment in each county.

For Group 1 and Group 2 facilities, two calculations were made for each equipment type to estimate well pad equipment leak emissions. One calculation is for wells in the county not subject to NSPS OOOOa, using the CH_4 emission factors from the Rutherford et al. 2021 study (described in 3.2.1 above), and a second for wells in the county subject to NSPS OOOOa using the CH_4 emission factors from the Pacsi et al. 2019 study (also described in 3.2.1). These two calculations were then summed to obtain the county CH_4 emissions total for each equipment type.

The well pad equipment leak CO_2 emissions were estimated using a CO_2:CH_4 ratio at the basin-level (0.0213 for Permian and 0.0342 for San Juan). These CO_2:CH_4 ratios were developed using subpart W reported average CH_4 and CO_2 mole fractions by production facilities operating in NM.

Table 37. Well Pad Equipment Leaks Activity Factors

Emission Source	Well Type (Gas or Oil)	Component / Well	
		Permian Basin	San Juan Basin
Wellheads	Gas	1.0	1.0
Separators	Gas	1.1	1.0
Meters and Piping	Gas	2.6	1.1
Compressors	Gas	0.9	0.2
In-line Heaters	Gas	0.1	0.003
Dehydrators	Gas	0.01	0.005
Wellheads	Oil	1.0	1.0
Separators	Oil	0.6	1.0
Heater-Treater	Oil	0.3	0.002
Header	Oil	0.2	0.2

5.1.2 Sources Scaled Using Production

CH_4 emissions from subpart W data reported by facilities with operations in NM were scaled for six sources using total gas or oil production volumes. These sources were:

1. Dehydrators
2. Tanks
3. Associated Gas Venting and Flaring
4. Miscellaneous Flaring
5. Combustion
6. Tank Unloading

The OCD Annual Operator Report for 2020 (which includes total oil, gas, and produced water production volumes for each operator at the state-level) was combined with the OCD Wells Database to apportion an operator's production to each county based on the proportion of wells owned by that operator in a given county. For combustion and dehydrators, scaling to the county and the emission factor calculations were performed using gas production. For tanks, associated gas venting and flaring, and miscellaneous flaring, scaling to the county and the emission factor calculations were performed using oil production. For tank unloading, the EPA GHGI emission factor was used.

Produced water emissions were estimated using produced water volumes available in the OCD Annual Operator Report. Produced water was apportioned to each county based on the proportion of wells owned by that operator in a given county; this is the same approach as used for oil and gas production apportioning.

For all sources, separate per-production emissions factors were calculated for the Permian and the San Juan Basin to apply to Group 2 facilities. The emission factors equal the sum of Group 1 emissions for an emission source in a basin divided by the total production reported for that basin. Table 38 presents the calculated average emission factors for each emission source, by basin. The San Juan emission factors were applied to sources in the Las Vegas Raton and Sierra Grande Uplift basins. For Group 2 facilities, the emission factor was then multiplied by the gas or oil production in the county to estimate emissions for each emission source.

Table 38. Emission Factors for Sources Scaled Using Production Volumes

Emission Source	Units	Permian Basin		San Juan Basin	
		CH_4	CO_2	CH_4	CO_2
Dehydrators	mt/Bcf	0.29	75	0.9	0.6
Tanks	mt/MMbbl	4.5	462	402	4,720
Associated Gas Venting and Flaring	mt/MMbbl	9.8	1,980	47	126.2
Miscellaneous Flaring	mt/MMbbl	8.4	1,960	0.1	28
Combustion	mt/Bcf	4.3	1,890	4.5	1,490
Tank Unloading	mt/MMbbl	0.67	0.01	0.67	0.01

5.2 Gathering & Boosting

The methodology to develop the G&B NM O&G GHGI relies mainly on subpart W data reported by facilities with operations in NM (Group 1 facilities). For reporting year 2020, twenty-nine facilities operating in NM reported subpart W emissions. Eighteen of these facilities reported their subpart W data directly to the NMED MSEI and included emissions and activity data only for relevant NM operations. For the remaining 11 facilities, subpart W reported data were obtained from EPA. Subpart W data reported to EPA are at the basin-level; therefore, basin-level emissions were apportioned to state-level by using the ratio of tanks reported by each facility at the basin-level and at the state-level (e.g., if a G&B facility has a total of 100 tanks operating in the Permian Basin and only 30 tanks are in NM, then 30 percent of their total basin-level G&B emissions were apportioned to NM).

The following changes were applied to the state-level emissions data for the 29 G&B facilities (see Section 3.3 for background):

- Dehydrators – Subpart W CH_4 emissions were replaced with estimates developed using the EPA GHGI CH_4 emission factor (0.05 metric tons/dehydrator). Subpart W CO_2 emissions for dehydrators were used as reported.
- Tanks – Subpart W CH_4 emissions were replaced with estimates developed using the EPA GHGI CH_4 emission factor (5.6 metric tons/tank). Subpart W CO_2 emissions for tanks were used as reported.
- Centrifugal and Reciprocating Compressors – Subpart W CH_4 emissions were replaced with estimates developed using the EPA GHGI CH_4 emission factor (16 metric tons/compressor). Subpart W CO_2 emissions were replaced with estimates developed using a CO_2:CH_4 ratio at the basin-level (0.0213 for Permian and 0.0342 for San Juan). These CO_2:CH_4 ratios were developed using subpart W reported average CH_4 and CO_2 mole fractions by production facilities operating in NM.
- Equipment Leaks – Subpart W CH_4 emissions were replaced with estimates developed using EPA GHGI CH_4 emission factors (12.6 metric tons/station and 0.09 metric tons/separator). Subpart W CO_2 emissions were replaced with estimates developed using a CO_2:CH_4 ratio at the basin-level (0.0213 for Permian and 0.0342 for San Juan).
- Combustion – Subpart W CH_4 emissions were replaced with estimates developed using reported CO_2 emissions and a CO_2:CH_4 ratio developed for combustion emissions (102), see Section 3.6 for more information. All combustion emissions were assumed to be from engines and turbines.

After the changes listed above were made to the G&B emissions data, average station emissions for the Permian and San Juan basins were developed. G&B emissions for the facilities operating in each basin were aggregated and divided by the total number of stations operating in each basin. The number of stations operating in each basin were obtained from NMED MSEI data (see Section 4.2.2). Table 39 presents the average G&B station emissions for the Permian and San Juan basins.

Table 39. Average Emissions Per G&B Station

Emission Source	Permian Basin		San Juan basin	
	Average CH_4 Emissions (mt/station)	Average CO_2 Emissions (mt/station)	Average CH_4 Emissions (mt/station)	Average CO_2 Emissions (mt/station)
High-Bleed Pneumatics	1.0	0.05	12	2.8
Intermittent-Bleed Pneumatics	8.0	1.2	24	4.7
Low-Bleed Pneumatics	0.5	0.03	0.9	0.1
Pneumatic Pumps	1.7	0.3	1.5	0.4
Dehydrator Vents	0.007	53.5	0.02	10
Station Blowdowns	3.5	0.4	12	3.2

Emission Source	Permian Basin		San Juan basin	
	Average CH_4 Emissions (mt/station)	Average CO_2 Emissions (mt/station)	Average CH_4 Emissions (mt/station)	Average CO_2 Emissions (mt/station)
Pipeline Blowdowns	0.2	0.007	-	-
Tanks	25	72	16	8.4
Miscellaneous Flaring	1.0	330	0.04	14
Centrifugal Compressors	0.001	0.00002	3.3	0.1
Reciprocating Compressors	28	0.6	34	1.2
Equipment Leaks	13	0.3	13	0.4
Pipeline Leaks	13	9.1	9.7	2.2
Combustion	67	6,867	121	14,324

The average station emissions were then assigned to the non-reporting G&B facilities (i.e., facilities that did not or are not required to report to subpart W or Group 2 facilities). Based on NMED MSEI data, it was determined that 26 G&B facilities (or organizations) did not report to subpart W in 2020 and operated a combined total of 70 G&B stations in NM. Of these 70 stations, 63 were reported to be in the Permian basin, 6 were reported to be in the San Juan basin, and a single station was reported for the Raton basin. The Raton basin station was assigned average station emissions for San Juan basin.

Once facility-level emissions were compiled for all of the 59 G&B facilities (or organizations) operating in NM, emissions were allocated to NM counties. The NMED MSEI contained information on the number of stations at the county level for each G&B facility (or organization) for reporting year 2020. Using this information, facility-level emissions were allocated to NM counties. For example, if one facility (or organization) operated 60 stations in Eddy County and 20 stations in San Juan County, then 75 percent (i.e., 60/80) of total facility emissions were allocated to Eddy County and 25 percent (i.e., 20/80) to San Juan County.

5.3 Natural Gas Processing

Subpart W data that was submitted to the NMED MSEI and EPA for 29 processing plants were used as-is (Group 1 facilities) in the NM GHGI. The data submitted for these plants were also used to develop average emissions per plant for each emission source, to apply to the four processing plants that did not have reported subpart W data (Group 2 facilities). The average emissions equal the sum of emissions for a given emission source from Group 1 facilities divided by the total count of Group 1 facilities. Table 31 above summarizes the Group 1 and Group 2 plant counts. Table 40 presents the average emissions per plant, calculated from the Group 1 facilities.

Subpart C data were available for 26 of the 29 Group 1 facilities, and their reported combustion CO_2 emissions were used as-is for these facilities. These emissions were also used to develop average combustion CO_2 emissions per plant. The average emissions equal the sum of subpart C CO_2 emissions from Group 1 facilities divided by the total count of Group 1 facilities. For the three Group 1 processing plants that did not report subpart C data, the NMED MSEI indicated that two plants did have compressors (and the average combustion emissions per plant were applied) and one plant did not have compressors (and combustion emissions were not estimated). For the four Group 2 plants, only one of the plants had compressors in the NMED MSEI, and the average combustion CO_2 emissions were applied to that plant.

Combustion CH_4 emissions were adjusted (i.e., increased) for compressor engines (see Section 3.6 for related emission factor discussion), based on the NMED MSEI compressor engine and turbine fuel volumes. Natural gas processing combustion CH_4 emissions were adjusted based on (1) the percentage of the fuel used for engines versus turbines at a specific plant (e.g., if 30 percent of the compressor fuel was for engines and 70 percent for compressor turbines in the NMED MSEI, then only 30 percent of the emissions were considered for adjustment) and (2) the percentage of combustion emissions due to compressors. Of note, most processing plants only operated engines or turbines. The subpart C combustion emissions include combustion emissions from non-compressor sources, such as heaters and boilers. Based on a review of the NMED MSEI for all processing plant combustion related data, it was estimated that 75 percent of the combustion emissions are from compressors. Continuing the previous example, combustion CH_4 emissions would increase for about 23 percent of the combustion emissions (i.e., 30 percent * 75 percent = 23 percent). This example processing plant's CH_4 emissions would be calculated as the combustion CO_2 emissions times the combustion CO_2:CH_4 ratio of 102 (see Table 24) times 23 percent. Table 40 presents the average combustion emissions per plant, calculated from the Group 1 facilities.

Table 40. Natural Gas Processing Average Emissions Per Plant

Emission Source	Average CH_4 Emissions (mt/plant)	Average CO_2 Emissions (mt/plant)
Plant Leaks	16	4
Reciprocating Compressors	89	5
Centrifugal Compressors	37	1
Flares	39	7,958
Dehydrators	1	538
Blowdowns	137	6
Acid Gas Removal Units	0	62,895
Pneumatic Controllers	3.2	0.4
Combustion	318	80,667

5.4 Transmission and Underground NG Storage

Subpart W data that was submitted to the NMED MSEI and EPA was available for 17 transmission compressor stations (Group 1 facilities). Their emissions data were used as-is in the NM GHGI, with the exception of compressor emissions. For reciprocating and centrifugal compressors, the reported subpart W emissions were augmented with additional emissions from a PRCI White Paper (see discussion in Section 3.5.1 and Table 20), based on the number of reciprocating compressors and centrifugal compressors with dry seals reported for each Group 1 facility. The Group 1 data were then used to develop average emissions per compressor for certain emission sources, to apply to the 15 facilities that did not have reported subpart W data (Group 2 facilities). The average emissions equal the sum of emissions for a given emission source from Group 1 facilities divided by the sum of compressors (reciprocating plus centrifugal compressors) at Group 1 facilities. Table 41 presents the average emissions per compressor, calculated from the Group 1 facilities.

Table 41. Transmission Compressor Station Average Emissions Per Compressor

Emission Source	Average CH4 Emissions (mt / compressor)	Average CO2 Emissions (mt / compressor)
Pneumatic Controllers	1.04	0.03
Centrifugal Compressors	17.9	0.39
Reciprocating Compressors	12.1	0.24
Flare Stacks	0.01	2.97
Blowdown Vent Stacks	12.4	0.35
Equipment Leaks	1.9	0.06
Transmission Storage Tanks	1.4	0.04

Subpart C data were available for 27 transmission compressor stations, and their reported combustion CO_2 emissions were used as-is for these stations. These emissions were also used to develop average combustion CO_2 emissions per compressor fuel throughput (see Table 42). The average emissions equal the sum of subpart C CO_2 emissions from Group 1 facilities divided by the total compressor fuel throughput (engine plus turbine fuel throughput) at Group 1 facilities. The compressor fuel throughput was available from the NMED MSEI for all transmission compressor stations.

Subpart C combustion CH_4 emissions were adjusted (i.e., increased) for compressor engines (see Section 3.6 for related emission factor discussion), based on the NMED MSEI compressor engine and turbine fuel throughput volumes. Subpart C combustion CH_4 emissions were not adjusted for turbines. Combustion CH_4 emissions were adjusted based on the percentage of the fuel used for engines versus turbines at a specific compressor station (e.g., if 30 percent of the compressor fuel was for engines and 70 percent for compressor turbines in the NMED MSEI, then only 30 percent of the emissions were considered for adjustment). It was assumed that all combustion emissions were due to compressors for transmission compressor stations. Of note, most compressor stations only operated engines or turbines. If a compressor station only had engines, then the combustion CH_4 emissions were estimated as the combustion CO_2 emissions times the combustion CO_2:CH_4 ratio of 102 (see Table 24). After adjusting the CH_4 emissions for each of the 27 compressor stations with combustion data, average combustion CH_4 emissions per compressor fuel throughput were developed. Table 42 presents the average combustion emissions per compressor fuel throughput, calculated from the 27 compressor stations.

For the five transmission compressor stations that did not report subpart C data, the average combustion emissions in Table 42 were applied to the engine and turbine fuel throughput volumes from the NMED MSEI to estimate combustion emissions.

Table 42. Transmission Compressor Station Average Combustion Emissions Per Compressor Fuel Throughput

Emission Source	Average CH4 Emissions (mt / MMscf Fuel)	Average CO2 Emissions (mt / MMscf Fuel)
Engines	0.6	47.5
Turbines	0.01	47.5

Transmission pipeline blowdown emissions relied on the subpart W data reported to the NMED MSEI and EPA. Blowdown emissions were reported for 4,322 miles of transmission pipeline (see Table 34). The sum of reported blowdown CH_4 and CO_2 emissions were divided by 4,322 miles to develop average emissions per mile, see Table 43. The average blowdown emissions per mile were then applied to the 2,071 miles without reported blowdown data available to estimate total blowdown emissions in NM.

Transmission pipeline leak emissions were estimated by applying the average emissions from Table 43 to all transmission pipelines.

Transmission pipelines cross multiple counties, however, pipeline miles are not directly available for each county. A map of transmission pipelines is available from PHMSA through the National Pipeline Mapping System, and the public viewer was used to approximate county mileage.[33] Each county was viewed at this website and the "measure distance" feature was used to measure the gas transmission pipelines. Table 44 presents the results of this analysis along with the estimated miles for each county. The county-level mileage was used to apportion transmission pipeline blowdown and leak emissions to each county.

Table 43. Average Emissions Per Transmission Pipeline Mile

Emission Source	Average CH4 Emissions (mt / mile)	Average CO2 Emissions (mt / mile)
Pipeline Blowdowns	0.57	0.02
Pipeline Leaks	0.01	0.0003

Table 44. Transmission Pipeline Miles by County

County	Miles Measured[a]	% of Pipeline Miles Per County[b]	Calculated PHMSA Miles Per County[c]
Bernalillo	89	2%	138
Catron	0	0%	0
Chaves	284	7%	441
Cibola	113	3%	176
Colfax	63	2%	98
Curry	52	1%	81
De Baca	0	0%	0
Dona Ana	136	3%	212

[33] Accessed at https://pvnpms.phmsa.dot.gov/PublicViewer/

County	Miles Measured[a]	% of Pipeline Miles Per County[b]	Calculated PHMSA Miles Per County[c]
Eddy	472	11%	732
Grant	93	2%	144
Guadalupe	0	0%	0
Harding	0	0%	0
Hidalgo	147	4%	228
Lea	619	15%	960
Lincoln	192	5%	298
Los Alamos	12	0%	18
Luna	183	4%	284
McKinley	295	7%	458
Mora	40	1%	62
Otero	50	1%	77
Quay	1	0%	2
Rio Arriba	78	2%	121
Roosevelt	109	3%	169
San Juan	455	11%	706
San Miguel	16	0%	25
Sandoval	186	5%	288
Santa Fe	68	2%	106
Sierra	0	0%	0
Socorro	72	2%	111
Taos	60	1%	94
Torrance	102	2%	159
Union	12	0%	19
Valencia	121	3%	188
Total	**4,120**		**6,393**

a. Miles measured for each county using the National Pipeline Mapping System Public Viewer (see footnote 33).
b. Equals the miles measured for an individual county divided by the total measured (4,120 miles).
c. Equals the % of Pipeline Miles Per County times the state total from PHMSA (6,393 miles).

For the two underground natural gas storage stations, no emissions data are available. As a result, the average emissions per station were applied, based on EPA GHGI data. The average emissions equal total emissions in the EPA GHGI for each emission source divided by the total number of storage stations (344) in the EPA GHGI, see Table 45.

Table 45. Underground Natural Gas Storage Station Average Emissions Per Station

Emission Source	Average CH4 Emissions (mt/station)	Average CO2 Emissions (mt/station)
Station Leaks	71	2.1
Reciprocating Compressors	299	8.8

Emission Source	Average CH4 Emissions (mt/station)	Average CO2 Emissions (mt/station)
Dehydrators	13	0.4
Flares	3.3	348
Station Blowdowns	84	2.5
Pneumatic Controllers (High, Low, and Intermittent)	50	1.7
Storage Wells	33	1.0
Metering and Regulating Equipment	219	6.4
Engine Combustion	66	19,800

5.5 Inactive Oil and Gas Wells

Inactive oil and gas well GHG emissions were estimated uniquely. The OCD Wells Database described in Section 4.3.1 was used to determine the count of inactive wells in each county. Each of the 112,000 wells in the OCD Wells Database that produced during years 2019, 2020, or 2021 were assumed not to be inactive.

The completion status of the remaining 60,000 wells was then reviewed to determine those wells that should be identified as inactive. Each status type was then assigned as either plugged or unplugged. Table 46 presents the unique completion status, the number of wells with that completion status, and the assigned inactive well plugging status (unplugged, plugged, or n/a).

Certain completion status were easily assigned (i.e., plugged, temporarily abandoned, zone plugged, zones aban/not plugged). Wells with a Completion Status of "Active" and "Unknown" required further evaluation. It appears the Active status may not be fully representative, as the majority of these wells had not produced in years or decades. Therefore, it was assumed that all Active wells (that did not produce in years 2019 – 2021) were unplugged inactive wells. Little information is available for the "Unknown" Completion Status; few have any type of date information, and location and operator information are the only other information that is available. Therefore, "Unknown" wells were treated similarly as Active wells and were classified as unplugged inactive wells.

Table 46. Summary of Well Completion Status and Assigned Plugging Status

Completion Status	Count of Wells	Assigned Plugging Status
Active	6,584	Unplugged
Dry Hole	7	Unplugged
Never Drilled	8	n/a
New (Not drilled or compl)	1,930	n/a
Plugged	43,277	Plugged
Temporarily Abandoned	482	Unplugged
Unknown	7,704	Unplugged

Completion Status	Count of Wells	Assigned Plugging Status
Zone Plugged	16	Plugged
Zones Aban/not plugged	2	Unplugged
Total	60,010	

Using the inactive well plugging status assignments in Table 46, approximately 58,000 wells were considered to be inactive for the NM O&G GHGI. Of this number, 75 percent of the inactive wells were plugged, and 25 percent were unplugged. To estimate inactive well CH_4 emissions, the number of plugged and unplugged wells were multiplied by the applicable emission factor (0.002 g/hr/well for plugged wells and 6.1 g/hr/well for unplugged wells, from Table 25) and 8,720 hours.

6 GHG Emissions Summary

Attachment A "NM_Oil+Gas_GHGInventory_2020_Emissions.xlsx" contains the complete set of results for the NM O&G GHGI, including a breakdown of emissions by county, segment, and emissions source and by owner/operator, segment, and basin. Table 47 through Table 59 present select results from the NM O&G GHGI.

Table 47 presents a summary of CH_4, CO_2, and CO_2e emissions for the NM O&G GHGI for each category. CO_2e emissions are estimated for CH_4 using a global warming potential (GWP) of 27. Figure 2 presents the percent contribution to total CO_2e emissions by pollutant for production, G&B, processing, and transmission. Underground NG storage and inactive wells contribute only 0.3% to total CO_2e.

Table 47. GHG Emissions by Category (Metric Tons)

Emission Category	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Production	387,824	6,836,720	17,307,968
Gathering and Boosting	126,013	6,158,405	9,560,756
Natural Gas Processing	19,210	4,552,987	5,071,657
Transmission and Storage	13,382	629,264	990,567
Inactive Oil and Gas Wells	784	23.5	21,192
Total	**547,212**	**18,177,400**	**32,952,140**

Figure 2 presents the percent contribution to total CO_2e emissions by pollutant for production, G&B, processing, and transmission. Underground NG storage and abandoned wells contribute only 0.3% to total CO_2e.

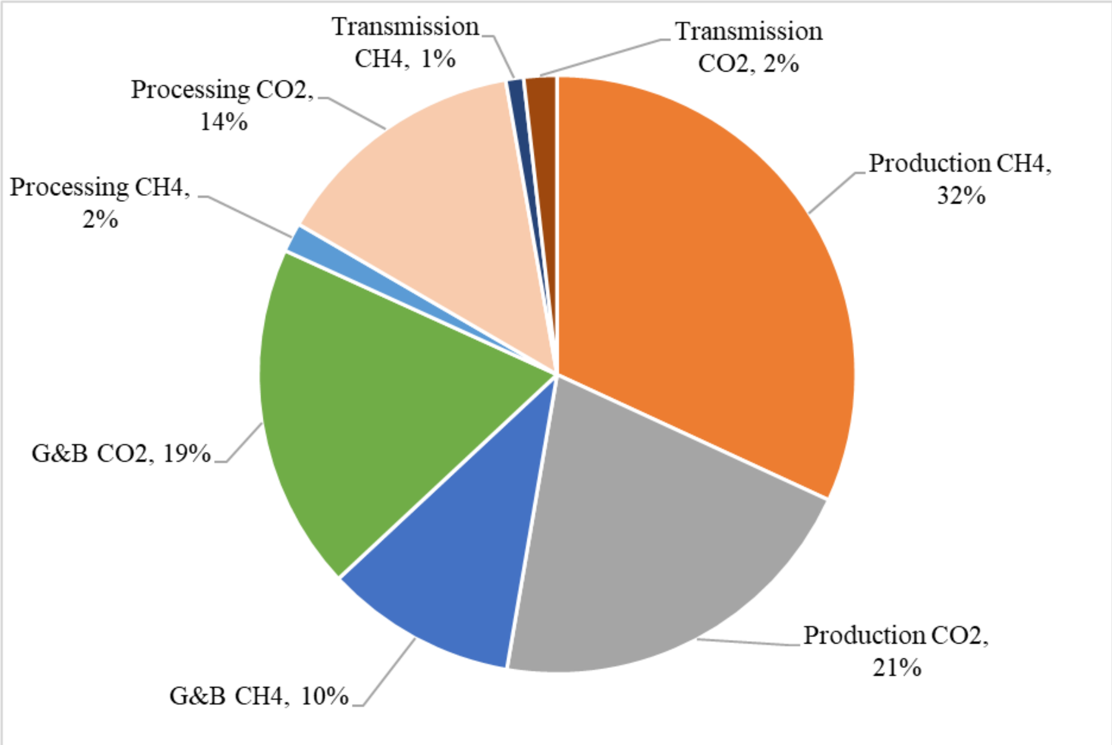

Figure 2. Percent Contribution to Total CO2e Emissions by Industry Segment and Pollutant

Table 48 presents a summary of CH_4, CO_2, and CO_2e emissions for 2020 for each O&G basin in NM. The Permian and San Juan basins account for over 98% of O&G GHG emissions.

Table 48. GHG Emissions by Basin (Metric Tons)

Basin	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	270,241	13,515,470	20,811,982
San Juan	261,414	4,282,920	11,341,106
Las Vegas-Raton	8,659	40,049	273,836
Sierra Grande Uplift	4,004	66,682	174,784
Pedregosa	451	104,932	117,099
Orogrande	1,020	68,086	95,614
Basin-And-Range Province	687	65,290	83,829
Estancia	619	33,968	50,683
Palo Duro	64	2	1,728
San Luis	54	2	1,470
Total	**547,212**	**18,177,400**	**32,952,130**

Table 49 presents a summary of CH_4, CO_2, and CO_2e emissions for 2020 for each emission source. Table 49 is ordered from highest to lowest CO_2e emissions. The highest emitting CH_4 sources are equipment leaks, pneumatic controllers, and combustion (or combustion slip) which cumulatively account for 75% of CH_4 emissions. Combustion (e.g., from engines and turbines driving compressors) is the highest emitting CO_2 source, accounting for 72% of CO_2 emissions. Other significant CO_2 sources include acid gas removal units and sources with flaring (i.e., miscellaneous flaring, associated gas, hydraulically fractured (HF) completions, tanks, dehydrators) which cumulatively account for 27% of CO_2 emissions.

Table 49. GHG Emissions by Emission Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Combustion	76,632	13,177,750	15,246,811
Equipment Leaks	196,139	5,699	5,301,442
Pneumatic Controllers	139,491	24,820	3,791,082
Acid Gas Removal Units	0	2,047,374	2,047,374
Miscellaneous Flaring	5,026	1,173,985	1,309,690
Tanks	23,177	243,099	868,877
Associated Gas	3,651	695,755	794,333
HF Completions	5,047	626,332	762,595
Reciprocating Compressors	26,885	929	726,819
Liquids Unloading	22,574	3,203	612,689
Equipment Blowdowns	9,461	814	256,252
Pipeline Leaks	9,010	5,787	249,045
Produced Water	8,400	173	226,960
Mud Degassing	8,244	588	223,186
Dehydrators	922	170,434	195,339
Centrifugal Compressors	3,843	100	103,870
Pipeline Blowdowns	3,760	109	101,618
Pneumatic Pumps	3,188	383	86,458
Inactive Wells	784	24	21,193
Metering and Regulating Equipment	438	13	11,839
Tank Unloading	247	5	6,669
Transmission Storage Tanks	185	5	4,995
Storage Wells	66	2	1,784
Non-HF Workovers	44	16	1,210
Total	**547,212**	**18,177,400**	**32,952,130**

Figure 3 through Figure 6 depict CH_4 and CO_2 emissions for high emitting emission sources by industry segment.

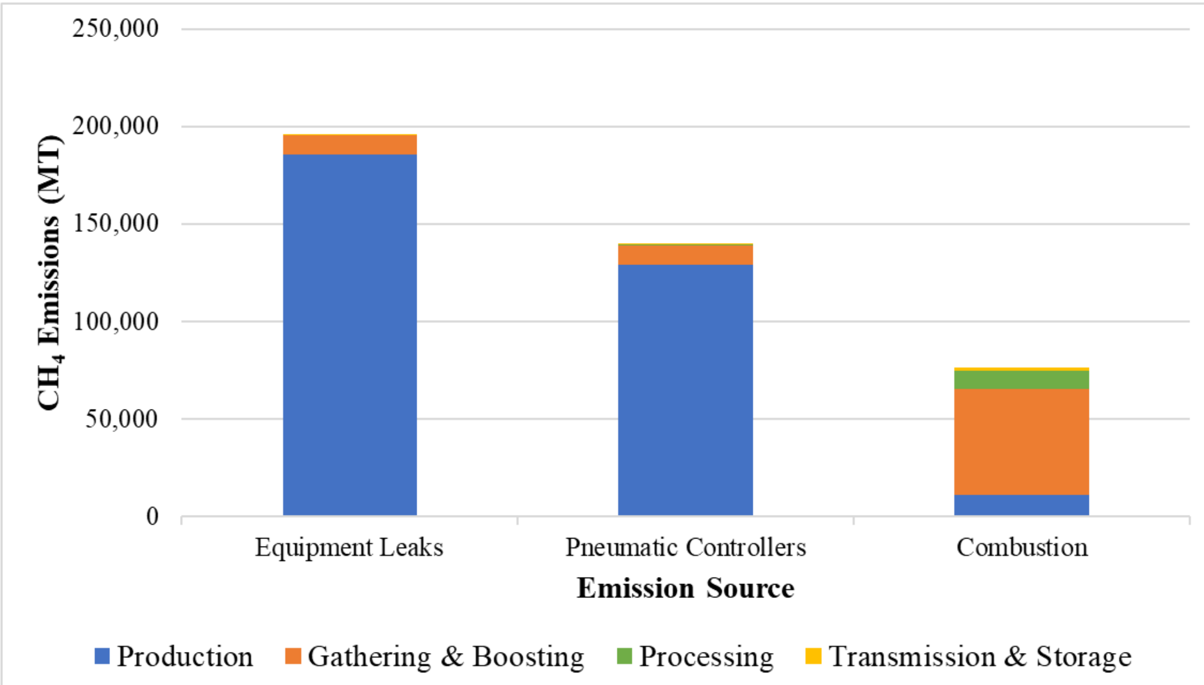

Figure 3. CH_4 Emissions for Highest Emitting Sources by Segment (Metric Tons)

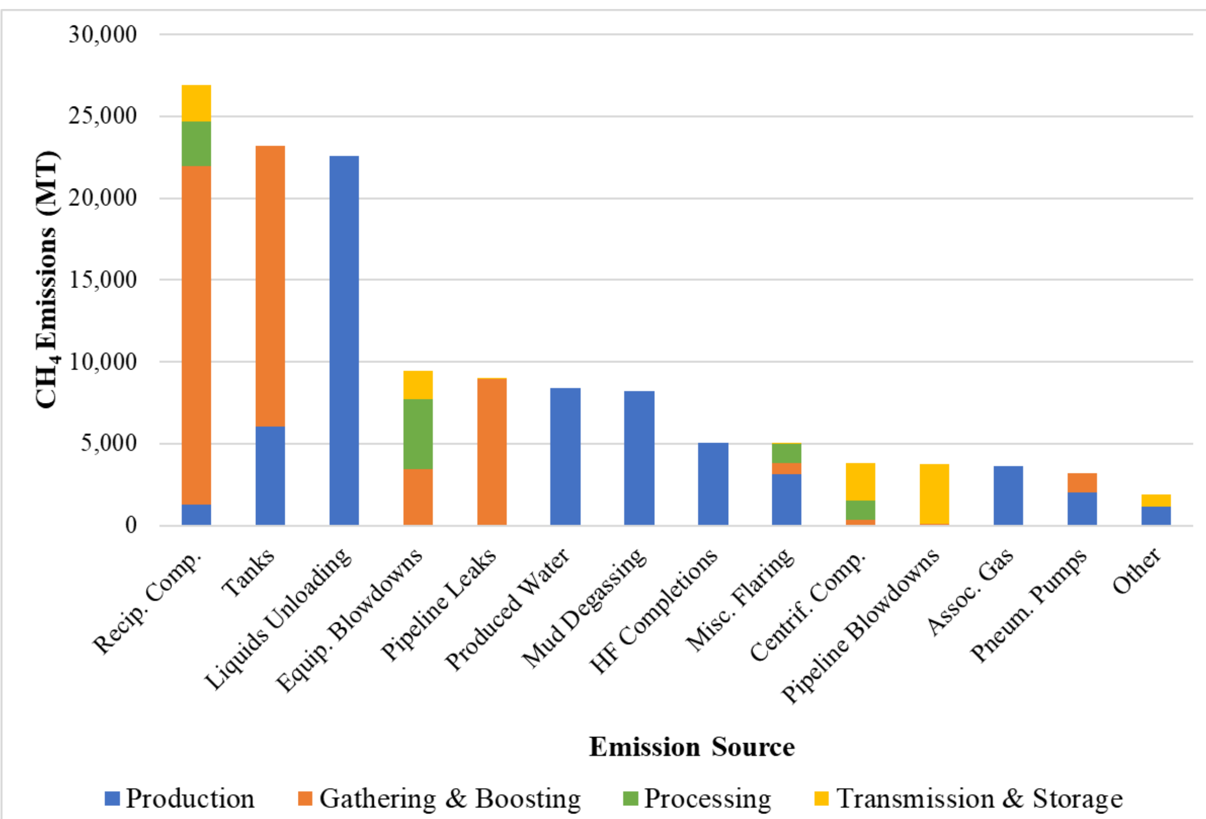

Figure 4. CH_4 Emissions for Select Emission Sources by Segment (Metric Tons)

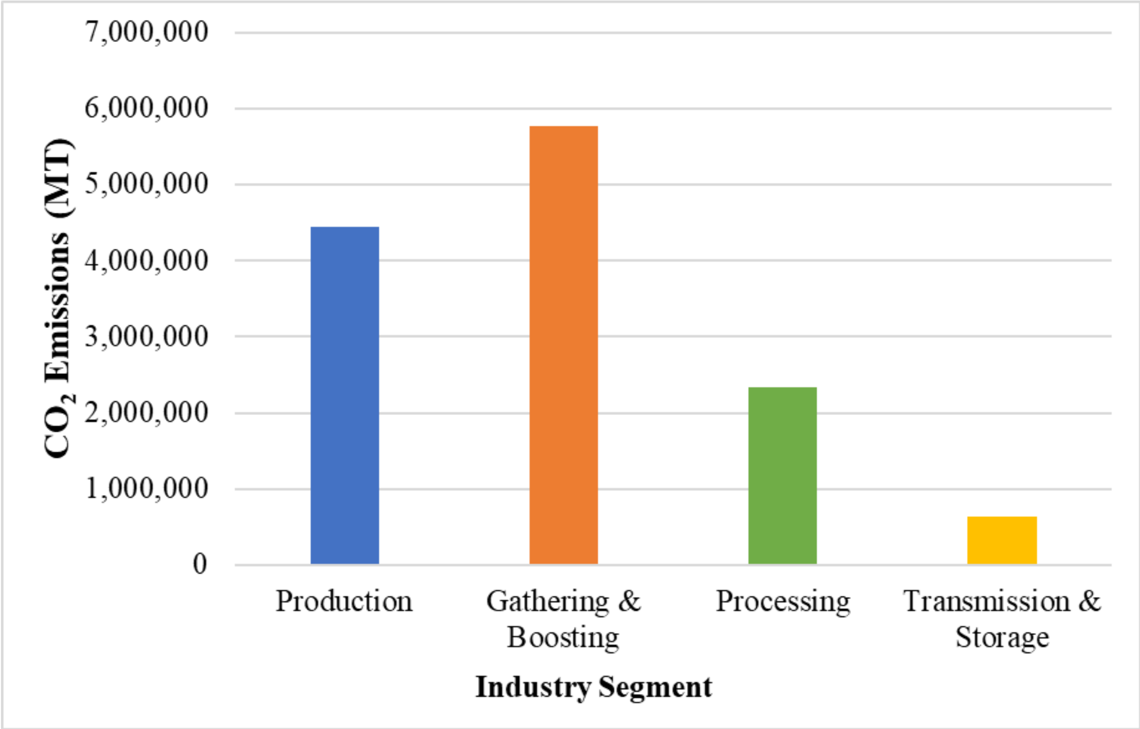

Figure 5. Combustion CO_2 Emissions by Segment (Metric Tons)

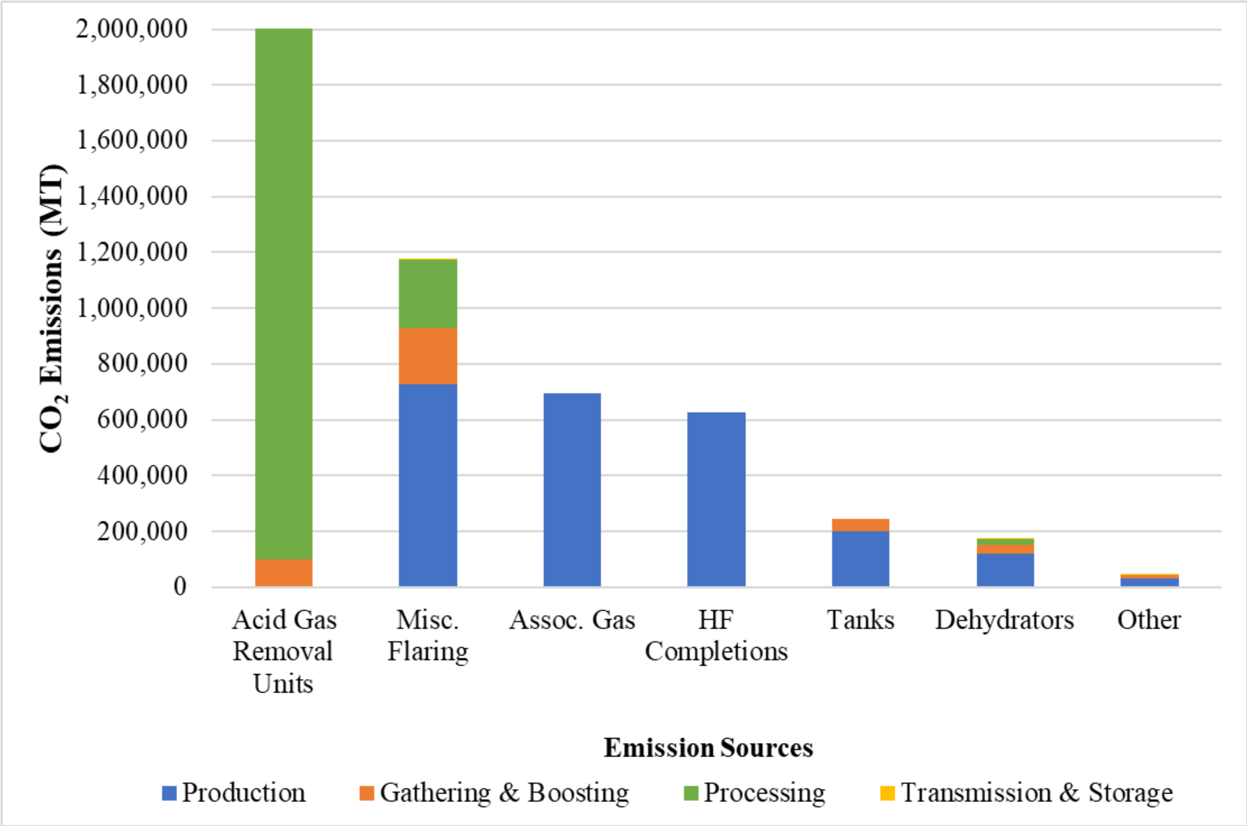

Figure 6. CO_2 Emissions for Select Emission Sources by Segment (Metric Tons)

Detailed NM O&G GHGI emissions for the five categories (four industry segments and inactive wells) are summarized in the following sections. Emissions are shown by emission source, basin, and county.

6.1 Exploration and Production

State-level GHG emissions from the Exploration and Production segment are shown in Table 50. Combustion emissions were the single largest source for CO_2 emissions in the segment, accounting for 65 percent of the total. Other notable contributions to the CO_2 total were associated gas venting and flaring, miscellaneous flaring, and HF completions, contributing a combined 30 percent. Well pad equipment leaks and pneumatic controllers were the largest sources of CH_4 emissions, contributing to 49 and 34 percent of the total respectively.

Table 50. Exploration and Production Emissions by Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Associated Gas Venting and Flaring	3,651	695,755	794,333
Centrifugal Compressors	0	0	0
Combustion	11,034	4,437,587	4,735,500
Dehydrators	852	120,230	143,240
HF Completions	5,047	626,332	762,595
HF Workovers	0	0	0
Liquids Unloading	22,574	3,203	612,689
Miscellaneous Flaring	3,167	725,225	810,725
Mud Degassing	8,244	588	223,186
Non-HF Workovers	44	16	1,210
Pneumatic Controllers	129,316	23,129	3,514,669
Pneumatic Pumps	2,011	187	54,495
Produced Water	8,400	173	226,960
Reciprocating Compressors	1,303	244	35,416
Tank Unloading	247	5	6,669
Tanks	6,034	198,700	361,626
Well Testing	0	0	0
Well Pad Equipment Leaks	185,900	5,346	5,024,650
Grand Total	**387,824**	**6,836,720**	**17,307,964**

Basin- and county-level annual emissions estimates for the Exploration and Production segment are shown in Table 51. The Permian basin accounted for 37 percent of CH_4 emissions and 85 percent of CO_2 emissions. The San Juan basin accounted for 59 percent of CH_4 emissions and 13 percent of CO_2 emissions. Within the Permian basin, Eddy and Lea counties had similar emissions from all sources and combined to represent 92 percent of the CH_4 emissions from the basin and 99 percent of the CO_2 emissions. In the San Juan basin, Rio Arriba and San Juan counties had similar emissions for all sources and combined to represent 99 percent of the CH_4 emissions and 95 percent of the CO_2 emissions from the basin.

Table 51. Exploration and Production Emissions by Basin and County (Metric Tons)

Basin	County	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	Chaves	11,573	54,543	367,008
Permian	Eddy	75,423	2,894,519	4,930,951
Permian	Lea	64,609	2,877,066	4,621,498
Permian	Roosevelt	684	15,756	34,234
Permian	***Total***	***152,289***	***5,841,884***	***9,953,692***
San Juan	McKinley	169	233	4,789
San Juan	Rio Arriba	91,520	334,474	2,805,502
San Juan	San Juan	129,431	523,970	4,018,604
San Juan	Sandoval	2,113	43,804	100,845
San Juan	***Total***	***223,232***	***902,480***	***6,929,740***
Las Vegas-Raton	Colfax	8,319	25,674	250,277
Las Vegas-Raton	***Total***	***8,319***	***25,674***	***250,277***
Sierra Grande Uplift	Harding	1,963	33,388	86,395
Sierra Grande Uplift	Union	2,021	33,294	87,860
Sierra Grande Uplift	***Total***	***3,984***	***66,682***	***174,255***
Total	**All NM Counties**	**387,824**	**6,836,720**	**17,307,964**

6.2 Gathering and Boosting

State-level GHG emissions from the G&B segment are shown in Table 52. Combustion emissions at G&B stations were the single largest GHG emission source accounting for over 43 percent of CH_4 emissions and over 95 percent of CO_2 emissions from the G&B segment. Other notable CH_4 emission sources were reciprocating compressors and tanks, collectively accounting for approximately 30 percent of CH_4 emissions from the G&B segment. Pneumatic controllers accounted for about 8 percent of total CH_4 emissions from the G&B segment. Intermittent-bleed pneumatic controllers accounted for almost 77 percent of CH_4 from pneumatic controllers.

Table 52 G&B Emissions by Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Acid Gas Removal Units	0	97,632	97,632
Centrifugal Compressors	376	13	10,160
Combustion	54,346	5,772,935	7,240,276
Dehydrators	7	33,517	33,702

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Equipment Blowdowns	3,444	581	93,570
Equipment Leaks	9,360	217	252,929
High Bleed Pneumatic Controllers	1,916	351	52,085
Intermittent Bleed Pneumatic Controllers	7,529	1,287	204,565
Low Bleed Pneumatic Controllers	389	32	10,546
Miscellaneous Flaring	634	200,967	218,074
Pipeline Blowdowns	118	4	3,190
Pipeline Leaks	8,940	5,785	247,162
Pneumatic Pumps	1,177	196	31,963
Reciprocating Compressors	20,636	488	557,650
Tanks	17,143	44,399	507,251
Total	**126,013**	**6,158,406**	**9,560,754**

Basin- and county-level annual emissions estimates for the G&B segment are presented in Table 53. The Permian basin accounts for approximately 78 percent of CH_4 emissions and 73 percent of CO_2 emissions. Within the Permian basin counties, Eddy accounted for about 62 percent of basin-level CH_4 emissions and 55 percent of CO_2 emissions. Eddy County was also the largest source of G&B emissions, accounting for over 48 percent of state-level CH_4 emissions and 40 percent of CO_2 emissions. Eddy County was followed by Lea County which accounted for over 28 percent of state-level CH4 emissions and 32 percent of CO_2 emissions. McKinley, Sandoval, and Colfax counties had the lowest county-level G&B emissions, collectively contributing less than 1 percent of state-level CH_4 and CO_2 emissions.

Table 53 G&B Emissions by Basin and County (Metric Tons)

Basin	County	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	Chaves	1,272	39,278	73,621
Permian	Eddy	61,114	2,451,449	4,101,537
Permian	Lea	35,795	2,043,702	3,010,155
Permian	***Total***	***98,181***	***4,534,430***	***7,185,313***
San Juan	McKinley	246	14,371	21,022
San Juan	Rio Arriba	8,444	499,181	727,183
San Juan	San Juan	18,649	1,081,680	1,585,194
San Juan	Sandoval	246	14,371	21,022
San Juan	***Total***	***27,586***	***1,609,605***	***2,354,420***
Raton	Colfax	246	14,371	21,022

Basin	County	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Raton	***Total***	***246***	***14,371***	***21,022***
Total	**All NM Counties**	**126,013**	**6,158,406**	**9,560,754**

6.3 Natural Gas Processing

Table 54 presents the state-level GHG emissions for the natural gas processing industry segment. Combustion emissions are the largest source of CO_2 emissions and CH_4 emissions. Other large CH_4 emission sources are reciprocating compressors and blowdowns. Acid gas removal units and flare stacks are the other key CO_2 emission sources.

Table 54. Natural Gas Processing Emissions by Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Acid Gas Removal Units	0	1,949,741	1,949,741
Blowdown Vent Stacks	4,244	183	114,758
Centrifugal Compressors	1,136	37	30,719
Combustion	9,209	2,339,343	2,587,994
Dehydrators	37	16,686	17,694
Equipment Leaks	490	125	13,348
Flare Stacks	1,218	246,710	279,595
Pneumatic Controllers	106	13	2,864
Reciprocating Compressors	2,770	149	74,934
Total	**19,210**	**4,552,987**	**5,071,647**

Table 55 shows the basin- and county-level GHG emissions for the natural gas processing segment. All processing plants are in the Permian and San Juan basins, with the Permian accounting for about 65 percent of CH_4 and CO_2 emissions.

Table 55. Natural Gas Processing Emissions by Basin and County (Metric Tons)

Basin	County	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	Chaves	322	71,408	80,107
Permian	Eddy	4,315	789,586	906,102
Permian	Lea	7,917	2,058,367	2,272,134
Permian	***Total***	***12,555***	***2,919,361***	***3,258,343***
San Juan	San Juan	6,655	1,633,626	1,813,304
San Juan	***Total***	***6,655***	***1,633,626***	***1,813,304***
Total	**All NM Counties**	**19,210**	**4,552,987**	**5,071,647**

6.4 Transmission and Underground NG Storage

Table 56 presents the state-level GHG emissions for transmission compressor stations and transmission pipelines. Combustion emissions from engines and turbines are the dominant CO_2 emissions source, accounting for more than 99 percent of CO_2 emissions. Transmission pipeline blowdowns are the largest source of CH_4 emissions (accounting for 31 percent of total CH_4), with centrifugal compressors, engine combustion, station blowdowns, and reciprocating compressors each accounting for between 13 to 20 percent of CH_4 emissions.

Table 56. Transmission Compressor Station and Transmission Pipelines Emissions by Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Pneumatic Controllers	135	4	3,649
Centrifugal Compressors	2,331	51	62,990
Reciprocating Compressors	1,579	31	42,656
Flare Stacks	1	387	422
Blowdown Vent Stacks	1,605	46	43,383
Equipment Leaks	247	7	6,677
Transmission Storage Tanks	185	5	4,995
Engines	1,744	174,199	221,296
Turbines	167	414,086	418,582
Pipeline Blowdowns	3,642	105	98,428
Pipeline Leaks	70	2	1,883
Total	**11,705**	**588,922**	**904,961**

Table 57 shows the basin-level GHG emissions for transmission compressor stations and pipelines. These transmission sources exist across the state of NM, with the top 3 emitting basins (Permian, San Juan, and Pedregosa) accounting for 74 percent of total GHG emissions.

Table 57. Transmission Compressor Station and Transmission Pipelines Emissions by Basin (Metric Tons)

Basin	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Permian	4,859	179,433	310,631
Palo Duro	63	1.8	1,702
Sierra Grande Uplift	11	0.3	294
Las Vegas-Raton	93	2.7	2,508
Estancia	619	33,968	50,680
Orogrande	1,019	68,086	95,601
Pedregosa	451	104,932	117,099
Basin-And-Range Province	686	65,290	83,821
San Luis	54	1.6	1,470

Basin	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
San Juan	3,850	137,207	241,157
Total	**11,705**	**588,922**	**904,961**

Table 58 presents the state-level GHG emissions for underground NG storage stations. Combustion emissions are the dominant CO_2 emissions source. Reciprocating compressors and metering and regulating equipment contribute the most to CH_4 emissions.

Table 58. Underground NG Storage Emissions by Source (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Station Leaks	142	4	3,838
Reciprocating Compressors	598	18	16,164
Dehydrators	26	1	703
Flares	7	696	874
Station Blowdowns	168	5	4,541
Pneumatic Controllers (High, Low, and Intermittent)	100	3	2,703
Storage Wells	66	2	1,784
Metering and Regulating Equipment	438	13	11,839
Engine Combustion	132	39,600	43,164
Total	**1,677**	**40,342**	**85,610**

6.5 Inactive Oil and Gas Wells

Table 59 shows the state-level GHG emissions for plugged and unplugged inactive wells. Unplugged inactive wells account for more than 99 percent of emissions.

Table 59. Plugged and Unplugged Inactive Oil and Gas Well Emissions (Metric Tons)

Emission Source	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CO_2e Emissions
Plugged Inactive Wells	0.8	0.023	21
Unplugged Inactive Wells	783	23.4	21,172
Total	**784**	**23.5**	**21,193**

Table 60 shows the basin-level GHG emissions for inactive wells. Most unplugged inactive wells are in the Permian basin (87 percent of CH_4 emissions) and San Juan basin (12 percent of CH_4 emissions).

Table 60. Plugged and Unplugged Inactive Oil and Gas Well Emissions by Basin (Metric Tons)

Basin	Plugged Inactive Wells		Unplugged Inactive Wells		Annual CO_2e Emissions
	Annual CH_4 Emissions	Annual CO_2 Emissions	Annual CH_4 Emissions	Annual CO_2 Emissions	
Basin-And-Range Province	0.0013	0.00004	0.3	0.008	7
Estancia	0.0020	0.00006	0.1	0.003	3
Las Vegas-Raton	0.0034	0.00010	1.1	0.033	30
Orogrande	0.0033	0.00010	0.5	0.014	13
Palo Duro	0.0075	0.00023	1.0	0.029	26
Pedregosa	0.0005	0.00001	0	0	0.01
Permian	0.5487	0.01646	679.9	20.398	18,394
San Juan	0.2063	0.00619	91.7	2.752	2,485
Sierra Grande Uplift	0.0062	0.00019	8.7	0.261	235
Total	**0.7793**	**0.02338**	**783.3**	**23.499**	**21,193**

7 Year 2025 and 2030 Projections

The NM O&G GHGI, which estimated emissions for 2020, was used as the starting point to develop projected inventories for 2025 and 2030. The projected inventories reflect the impact that future increases in industry activity (oil and gas production) and current NM regulatory initiatives are expected to have on emission levels. The methodology used to develop the projected inventories is as follows:

$$E_x = E_{2020} \times (1 + A_x) \times (1 - Reductions_x)$$

where:

E_x = Projected emissions in year x
E_{2020} = 2020 emissions
A_x = Activity increase in year x relative to 2020 (%)
$Reductions_x$ = Emission reductions in year x relative to 2020 (%)

The values for A_x are based on expected oil and gas production in the projected inventory years, while the values for $Reductions_x$ are specific to the pollutant, emission source, and inventory year. Sections 7.1 and 7.2 describe how these variables were estimated for each of the projected inventory years, and Section 7.3 presents the projected inventory results.

Attachment B "2025_2030_Inventory Projections.xlsx" contains the complete set of data and results for the 2025 and 2030 projected inventories.

7.1 Projected Year Activity

Projected year activity increase (A_x) estimates for 2025 and 2030 were obtained from the US Energy Information Administration Annual Energy Outlook (AEO) 2022.[34] The EIA AEO report provides estimates of US oil and gas production each year through 2050 under multiple production scenarios and accounts for known oil and gas reserves. The scenarios considered for purposes of developing the 2025 and 2030 projected inventories include a reference case, a high oil price case, and a low oil price case. Separate estimates of A_x have been developed for crude oil production and natural gas production using the EIA data.

Table 61 provides the production estimates and the 2025 and 2030 projected inventory values of A_x for oil production under each production scenario.

Table 61. EIA Oil Production Growth Estimates and Corresponding A_x Values

Year	Oil Reference Case Production[a]	Oil High Oil Price Production[a]	Oil Low Oil Price Production[a]	Oil Reference Case % Change From base year (A_x)	Oil High Oil Price Case % Change From base year (A_x)	Oil Low Oil Price Case % Change From base year (A_x)
2020	11.28	11.28	11.28	0%	0%	0%
2025	13.05	16.13	11.38	16%	43%	1%
2030	13.29	18.10	11.12	18%	60%	-1%

a. Production in (MMBL/day).

Table 62 provides the natural gas production estimates and the 2025 and 2030 projected inventory values of A_x for gas production under each production scenario.

Table 62. EIA Gas Production Growth Estimates and Corresponding A_x Values

Year	Gas Reference Case Production[a]	Gas High Oil Price Production[a]	Gas Low Oil Price Production[a]	Gas Reference Case % Change From base year (A_x)	Gas High Oil Price Case % Change From base year (A_x)	Gas Low Oil Price Case % Change From base year (A_x)
2020	33.49	33.49	33.49	0%	0%	0%
2025	36.48	38.42	33.16	9%	15%	-1%
2030	37.62	41.25	34.40	12%	23%	3%

a. Production in trillion cubic feet.

The projected industry growth factors (A_x) in 2025 and 2030 for either oil production (Table 61) or gas production (Table 62) were applied to the emissions for each emission source included in the inventory, based upon the commodity most closely associated with emissions from that source. For example, the gas production A_x data in Table 62 was used for liquids unloading. Similarly, the oil production A_x data in Table 61 was used for associated gas as associated gas emissions are related to oil production. For emission sources that reflect emissions from both oil and gas

[34] US Energy Information Administration "Annual Energy Outlook 2022", March 3, 2022. https://www.eia.gov/outlooks/aeo/

production (e.g., storage tanks), an average of the data in Table 61 and Table 62 were used for A_x. Attachment B identifies the commodity type (oil, gas, or mixed) used for each emission source.

7.2 Emission Reductions

VOC emission reductions were estimated during development of NMED's Part 50 ozone precursor regulation for the oil and gas sector.[35] As part of the rule development effort, the draft Part 50 rule provisions were evaluated with respect to existing emissions and in-place controls to estimate overall VOC reductions expected as the requirements in the rule are fully implemented.[36] For purposes of developing the projected inventories, these estimated reductions were reviewed and revised to reflect changes made in the final rule. Additionally, rule requirements for certain emission sources are phased in over time and will not be fully implemented until 2030. Therefore, the estimated reductions for the 2025 projected inventory for these emission sources have been adjusted to reflect the expected reductions in place by 2025. VOC reductions expected from the Part 50 rule were applied to CH_4 emissions in the projected inventories in those counties where the rule is applicable. As these reductions were estimated for the oil and gas industry overall (they are not segment specific), they have been applied to each industry segment equally. No reductions are assumed for CO_2 emissions based upon the Part 50 rule.

In addition to the NMED Part 50 rule, the New Mexico Department of Energy, Minerals, and Natural Resources (EMNRD) implemented a prohibition on the venting and flaring of associated gas (with some exceptions) thru the "natural gas waste" rule.[37] The projected inventories for both CH_4 and CO_2 apply a 95% reduction in emissions from associated gas venting and flaring to account for this prohibition, which only allows venting or flaring under certain conditions.

Table 63 provides the estimated CH_4 reductions ($Reductions_x$) for affected emission sources for the 2025 and 2030 inventories based on the impacts of Part 50 rule and the natural gas waste rule. Emission sources not shown in Table 63 were not assumed to have regulatory reductions in the projected inventories.

Table 63. Estimated 2025 and 2030 CH_4 Reductions

Emission Source	2025 CH_4 Reduction ($Reductions_x$)	2030 CH_4 Reduction ($Reductions_x$)
Engines and Turbines	2.0%	6.8%
Reciprocating and Centrifugal Compressors	51.3%	51.3%
Equipment Leaks	75.1%	75.1%
Liquids Unloading	50.0%	50.0%
Dehydrators	42.8%	42.8%
Hydrocarbon Liquids Transfers	84.1%	84.1%
Pneumatic Controllers and Pumps	80.0%	90.6%

[35] Title 20, Chapter 2, Part 50 "Oil and Gas Sector – Ozone Precursor Pollutants" [20.2.50 NMAC 08/05/2022]
[36] Memorandum "Emissions Inventory Reductions" from Mike Pring, Brian Palmer, and Stephen Treimel, ERG to Elizabeth Kuehn, NMED. June 4, 2021.
[37] Title 19, Chapter 15, Part 27 "Venting and Flaring of Natural Gas" [19.15.27 NMAC 05/05/2021]

Emission Source	2025 CH_4 Reduction (*$Reductions_x$*)	2030 CH_4 Reduction (*$Reductions_x$*)
Storage Tanks	10.5%	35.0%
Associated Gas [a]	95%	95%

a. 95% reductions also applied for CO_2.

7.3 Year 2025 and 2030 Results

Table 64 presents the results of the projected inventories for 2025 and 2030.

Table 64. Year 2025 and 2030 Projected Inventory Estimates

Year	Pollutant	Reference Case (MT)	Reference Case (Change from 2020)	High Oil Price Case (MT)	High Oil Price Case (Change from 2020)	Low Oil Price Case (MT)	Low Oil Price Case (Change from 2020)
2020	CH_4	547,212	NA	547,212	NA	547,212	NA
2025	CH_4	283,013	-48%	315,170	-42%	253,741	-54%
2030	CH_4	265,258	-52%	312,796	-43%	236,093	-57%
2020	CO_2	18,177,400	NA	18,177,400	NA	18,177,400	NA
2025	CO_2	20,255,314	11%	22,748,156	25%	18,121,631	0%
2030	CO_2	20,785,260	14%	24,891,312	37%	18,388,353	1%

Refer to Attachment B "2025_2030_Inventory Projections.xlsx" for detailed emission estimates for the 2025 and 2030 projected inventories for each county, emission source, and pollutant.

8 Uncertainty and Recommendations for Future Inventories

The 2020 NM O&G GHGI was compiled using the best data currently available, including O&G exploration and production activity tracked by the NM OCD, emissions data reported by industry directly to the NMED MSEI, emissions data reported by industry directly to EPA, and current research and studies on emissions from O&G activities. However, there are uncertainties in the estimated emissions as discussed in Section 8.1. In addition, based upon the analyses conducted for the inventory there are recommendations to improve future O&G GHGI Inventories. These are discussed in Section 8.2.

8.1 Uncertainties

Direct emissions and activity are not available for all O&G facilities. Emission estimates for the Group 2 facilities (those without reported emissions data available) were developed using data from the Group 1 facilities (those with reported emissions data). While the Group 1 facilities account for the majority of the O&G operations in NM (see coverage results in Section 4.3), the Group 2 facilities may have characteristics that are not represented by the Group 1 facilities. These unique characteristics could lead to their emissions being mis-characterized in the inventory.

The NM O&G GHGI relies on a bottom-up approach to estimate emissions (i.e., emissions are estimated for each emission source and then scaled up to the facility/county-level) versus a top-down approach (i.e., emissions are estimated using facility-level or regional-level emissions data).

While the bottom-up approach is preferred in order to identify the specific sources that contribute the most to GHG emissions, top-down GHG emissions estimates are commonly higher. The reasons for these differences are typically because a top-down approach accounts for emission events that are not accounted for in the bottom-up methodology. For example, emissions may not fully account for infrequently occurring super-emitter events that can disproportionately contribute to emissions. The NM O&G GHGI methodology did attempt to account for certain super-emitters for production well pad leaks (see Section 3.2.1) and the G&B segment (see Section 3.3.1). However, super-emitters are applicable to other industry segments and emission sources. In addition to super-emitters, the efficiency of flares is currently being evaluated by environmental and academic groups and assuming 98% flare efficiency (the current default assumption for subpart W flare emissions) may overestimate the actual efficiency. The emissions from a flare that is not operating correctly would be captured via top-down measurement methods but not bottom-up methods.

The numerical uncertainty bounds were not calculated for the NM O&G GHGI. However, the EPA GHGI does calculate uncertainty bounds for natural gas systems (which includes gas wells in production, G&B, processing, and transmission and storage) and petroleum systems (which includes oil wells in production) separately for CH_4 and CO_2 emissions. The EPA GHGI natural gas systems CH_4 emissions uncertainty bounds are -18% / +18% and petroleum systems CH_4 emissions uncertainty bounds are -28% / +32%.[38] The EPA GHGI and NM O&G GHGI methodologies do have a number of similarities, so the EPA GHGI uncertainty bounds are appropriate for context.

Finally, some records in the NMED MSEI listed zero or blank operating hours, indicating they did not operate in 2020. These same records also did not have emissions data. Records with zero and blank operating hours were excluded from the year 2020 emissions analysis. These facilities may not have operated in 2020 due to the impacts of Covid but may begin operating again in future years and may have operated in a more typical year. A revised, higher baseline level of emissions could have been estimated assuming all O&G facilities were operating and then using this higher baseline to do future year projections. However, this nuance was not considered in the projections estimates and it is not believed this would have significantly increased the emissions. NM was one of the few states in the US with increased production from 2019 to 2020 so the impact of Covid on production is unclear.

8.2 Recommendations

Recommendations to consider to improve future O&G GHG inventories include the following:

- Update Title 20, Chapter 2, Part 73 (Notice of Intent and Emissions Inventory Requirements) to require reporting of GHG emissions,
- Request reporters specify industry segment as part of the NMED MSEI data collection,
- Request pipeline gathering miles from owners/operators as part of the NMED MSEI data collection,

[38] The natural gas and petroleum systems information, including uncertainty bounds, are available in Chapter 3 (Energy Chapter) of the 2022 Annual Inventory Report. The 2022 Annual Inventory Report includes emissions for 1990 – 2020. The report can be accessed at: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks-1990-2020

- Coordinate between NMED and NM OCD to share facility data and determine if a shared facility database (identifying G&B facilities, natural gas processing plants, transmission compressor stations, inactive wells, and other facilities engaged in O&G production) is appropriate,
- Monitor ongoing research and field studies characterizing O&G GHG emissions, particularly in the Permian and San Juan basins.