New Mexico Oil and Gas Greenhouse Gas Emissions Inventory for Year 2005

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New Mexico Environment Department

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1 Introduction

In 2019, Governor Michelle Lujan Grisham issued an Executive Order for the State of New Mexico to join the United States Climate Alliance and set an economy-wide greenhouse gas (GHG) emissions target of 45 percent 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.[1]

New Mexico has implemented several regulatory initiatives to meet these objectives. The New Mexico Energy, Minerals and Natural Resources Department (EMNRD) promulgated Title 19, Chapter 15, Part 27 “Venting and Flaring of Natural Gas”[2] and Part 28 “Natural Gas Gathering Systems”[3] in 2021 to reduce CH_4 emissions and prevent waste of natural gas. In addition, the New Mexico 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 (NO_x).[4] 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 New Mexico’s policy objectives and high levels of oil and gas activity, the NMED first sought assistance to conduct a detailed study of the oil and gas (O&G) industry and to develop an updated GHG emissions inventory for the O&G industry for 2020 (2020 NM O&G GHGI). The results for the 2020 NM O&G GHGI were finalized in August 2022. Subsequent to developing the 2020 NM O&G GHGI, NMED also requested assistance to develop a new baseline inventory for the O&G industry for 2005 (2005 NM O&G GHGI). As discussed above, 2005 is the baseline year for the GHG emissions reduction target of 45 percent. Specifically, assistance was sought in determining activity data for 2005, characterizing O&G operations in 2005, and estimating 2005 GHG emissions. This report presents the results of the 2005 NM O&G GHGI and was prepared by Eastern Research Group, Inc. (ERG) under Task Order 6 of Contract #23-667-1800-40077.

Emissions are included in the 2005 NM O&G GHGI for the following four industry segments:

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

Emissions from natural gas distribution to end users (e.g. local utilities and industrial, commercial, and residential customers) are not included in the inventory.

[1] Governor Lujan Grisham, “Executive Order 2019-003: Executive Order Addressing Climate Change and Energy Waste Prevention.”
[2] https://www.srca.nm.gov/parts/title19/19.015.0027.html
[3] https://www.srca.nm.gov/parts/title19/19.015.0028.html
[4] https://www.srca.nm.gov/parts/title20/20.002.0050.html

Section 2 of this report presents our assessment of the relevant 2005 activity data for each industry segment included in the 2005 NM O&G GHGI. Section 3 presents a characterization of 2005 operations for each industry segment, emphasizing changes between 2005 and 2020. Section 4 presents a summary of the 2005 NM O&G GHGI emissions for each industry segment. Section 5 presents the findings of an analysis to estimate 2025 and 2030 emissions (based on the 2020 NM O&G GHGI) reflecting industry growth along with the impact of recent regulatory initiatives to reduce emissions.

2 2005 Industry Segment Activity Data

As a first step to estimate year 2005 emissions, we compiled activity data for each industry segment for the year 2005. We also compared the 2005 data to the 2020 activity available in the 2020 NM O&G GHGI. Comparing years allowed us to assess trends over time and identify where decreases or increases in activity occurred. In most cases, 2005 activity were lower than 2020 activity, but there are exceptions. Sections 2.1 through 2.4 present the year 2005 activity data results for each industry segment compared to 2020 activity.

2.1 Production

We used oil and gas production volumes and well counts to assess the production segment in 2005. The NM Oil Conservation Division (NM OCD)[5] has some of these data available on their website; however, we received this information directly from NM OCD. Table 1 presents the 2005 production data and well counts, compared to 2020 data.

Table 1. Oil and Gas Production Volumes and Well Counts for 2005 and 2020

Basin	2005			2020		
	Oil Production (MMbbl)	Gas Production (BCF)	Total Wells	Oil Production (MMbbl)	Gas Production (BCF)	Total Wells
Permian	58	551	22,509	361	1,356	27,621
San Juan	3	1,016	19,638	8	525	20,468
Las Vegas-Raton	0	25	510	0	15	828
Sierra Grande Uplift	0	0	0	0	44	681
Total	**61**	**1,592**	**42,657**	**369**	**1,941**	**49,598**

There was a 500 percent increase in oil production between 2005 and 2020, a 24 percent increase in gas production between 2005 and 2020, and a 16 percent increase in wells between 2005 and 2020. Most production is in the Permian and San Juan basins. In 2005, the Permian Basin accounted for 96 percent of oil production, 35 percent of gas production, and 53 percent of wells. In 2005, the San Juan Basin accounted for 4 percent of oil production, 64 percent of gas production, and 46 percent of wells. While the Permian Basin had significant increases in both oil and gas production between 2005 and 2020, the San Juan Basin had increased oil production but its gas production decreased by approximately half.

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

2.2 Gathering and Boosting

In the 2020 NM O&G GHGI, detailed information were available to determine the number of gathering and boosting stations. However, information for the gathering and boosting segment is limited for 2005. As such, we used gas production (see Table 1) as a surrogate to scale gathering and boosting activity from 2020 to 2005. We calculated gas production scaling ratios by dividing the gas production in 2005 by the 2020 gas production. Table 2 presents the resultant ratio for each basin. These ratios were used to adjust emissions, as discussed in Section 0. Section 0 also presents other ratios that were used to scale gathering and boosting (G&B) emissions.

Table 2. Gas Production Ratios Used as Surrogates to Scale 2020 G&B Activity to 2005

Basin	Gas Production Ratio
Permian	0.4
San Juan	1.9
Las Vegas-Raton	1.6
Sierra Grande Uplift	n/a

2.3 Natural Gas Processing

Processing plant data are available from the *Oil and Gas Journal*, through its Worldwide Gas Processing Plant Survey.[6] We reviewed both the 2005 survey and 2006 survey results. The number of plants in operation as of January 1, 2005 (in its 2005 survey) and January 1, 2006 (in the 2006 survey) are equal. This shows that no new plants were built during 2005. Table 3 presents the 2005 natural gas processing plant counts from the *Oil and Gas Journal* Worldwide Gas Processing Plant Survey, compared to the number of plants in operation from the 2020 NM O&G GHGI.

Table 3. Summary of Natural Gas Processing Plant Counts

2005 Plant Counts – O&G Journal Gas Processing Plant Survey	2020 NM O&G GHGI Plant Counts
27	33

2.4 Transmission and Storage

We reviewed multiple data sources to estimate the number of transmission compressor stations in 2005. The Federal Energy Regulatory Commission (FERC) collects information from large transmission companies. The FERC data are a subset of total New Mexico operations, but as discussed below, provides information on both compressor station and pipelines. Total transmission pipeline miles for New Mexico are available from the Pipeline and Hazardous Materials Safety Administration (PHMSA).[7]

FERC requires major natural gas interstate transmission companies to report annual information on transmission pipeline miles, transmission compression station locations, and number of

[6] Available via subscription or purchase at: < https://www.ogj.com/ogj-survey-downloads/worldwide-gas-processing>
[7] https://www.phmsa.dot.gov/data-and-statistics/pipeline/gas-distribution-gas-gathering-gas-transmission-hazardous-liquids

compressor units.[8] Information on the type of compressor (i.e., reciprocating, centrifugal) is not available. Companies report this information annually using FERC Form 2 and this reported information is available on FERC's website.[9] We reviewed FERC data for 2005 and 2020 and compared this information to the 2020 NM O&G GHGI results; see Table 4.

Table 4. Summary of Transmission Data from FERC and the 2020 NM O&G GHGI

Parameter	2005 FERC	2020 FERC	2020 NM O&G GHGI
Pipeline Miles	4,409	4,375	6,394
Number of Compressor Stations	35	30	32
Number of Compressors	150	99	130
Miles between Stations	126	146	200
Compressors per Station	4.3	3.3	4.0
Horsepower per Compressor	3,409	4,605	N/A
MMhp-hr per Station[a]	8,823	12,855	N/A

a. MMhp-hr = million horsepower hours

There is a rather large disconnect between the 2020 data from FERC and in the 2020 NM O&G GHGI. The 2020 NM O&G GHGI shows an average of 200 miles between compressor stations (indicating very large stations that are spread out), compared to 146 miles between compressor stations in FERC. Because FERC only collects information from major companies, we would expect the FERC data to represent the largest stations, but that is not the case based strictly on comparing the miles between stations and the average number of compressors per station in these two datasets. Acknowledging this disconnect, we used the 2005 FERC data to determine the 2005 compressor station population. 2005 FERC data indicate there were more compressor stations in 2005 than 2020, and each station had more (but smaller) compressors. Using MMhp-hr as a surrogate to review and adjust combustion emissions, 2005 FERC MMhp-hr are 69 percent of the 2020 FERC MMhp-hr. Table 5 presents the estimated number of compressor stations in 2005 and a ratio that will be applied to estimate combustion emissions in 2005.

Table 5. Transmission Compression Activity Data for 2005

Parameter	2005 Transmission Population
Total Miles (PHMSA)	6,468
Total Compressor Stations	51[a]
Combustion Ratio	1.1[b]

a. Equals total miles multiplied by "compressors per station" from 2005 FERC data in Table 4.
b. Equals the ratio of compressor stations in 2005 to 2020 (i.e., 51/32) multiplied by the ratio of MMhp-hr per station in 2005 to 2020 (8,823/12,855).

[8] Only "major" natural gas companies provide facility details in Form 2. "Major" companies are those whose combined gas transported or stored exceed 50 million dekatherms (1 dekatherm, Dth = 1 MMBtu) in each of the previous three years. "Non-major" companies complete Form 2A, which does not include detailed station information.

[9] FERC Form 2 Historical Data is available at: <https://ferc.gov/industries-data/natural-gas/industry-forms/form-2-2a-3-q-gas-historical-vfp-data>

For underground natural gas storage, we assumed the characteristics of underground natural gas storage activity in the 2020 NM O&G GHGI was still applicable to 2005. In general, there is little underground natural gas storage activity in New Mexico. The U.S. Energy Information Administration (EIA) provides historical storage field locations.[10] There were two storage fields in 2020 and three storage fields in 2005. However, the EIA's working capacity information shows that the three storage fields had slightly lower, though similar, capacity in 2005 than the two storage fields in 2020. One of the 2005 storage fields also has very low capacity, accounting for only 2 percent of the 2005 capacity. Based on this, using storage field counts strictly to scale emissions from 2020 to 2005 would not be appropriate. Because the working capacities are similar, we assumed that 2005 activity levels are similar to 2020 and are not making adjustments to 2005 emissions based on changes in activity between the two years.

3 2005 Industry Characterization

After estimating the 2005 activity data for each industry segment in Section 2, we next characterized New Mexico's O&G industry operations in 2005. In particular, we considered whether the operations in 2020 were similar to the operations in 2005. If they were, we could rely strictly on changes in activity data to estimate year 2005 emissions, using 2020 emissions as a starting reference point. However, as seen below, this was often not the case and there were significant differences between 2005 and 2020 O&G industry operations.

In many cases below, we analyzed data reported under EPA's Greenhouse Gas Reporting Program (GHGRP). Specifically, GHGRP subpart C and subpart W.[11,12] 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. GHGRP's subpart W collects data from petroleum and natural gas systems facilities, while 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 natural gas storage stations, and natural gas processing plants is defined as each individual station and plant, consistent with other regulatory definitions of a facility.

For production and G&B facilities, subpart W defines facilities using 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

[10] http://www.eia.gov/cfapps/ngqs/ngqs.cfm?f_report=RP7
[11] https://www.epa.gov/ghgreporting/subpart-c-general-stationary-fuel-combustion-sources
[12] https://www.epa.gov/ghgreporting/subpart-w-petroleum-and-natural-gas-systems

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 Permian Basin is located in both New Mexico and Texas, and for purposes of this 2005 NM O&G GHGI, we evaluated subpart W data reported for the Permian Basin as a whole and did not distinguish between data reported to New Mexico versus Texas to determine if state differences exist. While there are instances where subpart W production segment data are available at the state-level, there are many instances where it is not and thus considering differences between New Mexico and Texas activities would not always be possible.

Subpart W and subpart C data were collected beginning in reporting year (RY) 2011 for the production, natural gas processing, and transmission and storage industry segments. Of note, the data collected for the production segment changed over time. For RY2011 through RY2014, well counts are available for each production facility but oil and gas production volumes are not available. Therefore, we evaluated the average emissions for some production sources on a per well basis because evaluating the average emissions on a production basis was not an option. In addition, hydraulically fractured oil well completions and workovers data were not collected until RY2016. The G&B industry segment was not added to subpart W until later and its first year of reporting was also for RY2016.

We evaluated early years (i.e., RY2011 and RY2012) of the subpart W and subpart C data for the production, natural gas processing, and transmission industry segments, as discussed in the following sections. These early year data are frequently the most relevant data point for characterizing the O&G industry in 2005.

3.1 Production

The following sections present our results of production segment emission source-specific analyses that we conducted to characterize their operations and emissions in 2005. The analyses focus on the two dominant basins, the Permian and San Juan.

To estimate 2005 emissions for the Las Vegas-Raton Basin, as appropriate, we applied the results from the San Juan Basin. The Las Vegas-Raton and San Juan basins are both predominantly gas producing regions and their operations would be more comparable versus using Permian Basin data (i.e., a predominantly oil producing region) for the Las Vegas-Raton Basin.

3.1.1 Venting versus Flaring Emissions

An important consideration for the production segment is the prevalence of venting emissions versus mitigating emissions using flares. The 2020 NM O&G GHGI showed significant flaring emissions. To assess venting versus flaring emissions in 2005, we considered information from prior emissions assessment projects for New Mexico and subpart W data.

3.1.1.1 Permian Basin

The Permian Basin was examined in an emissions modeling report conducted for the Western Regional Air Partnership (WRAP) for year 2008.[13] Of particular note for this 2005 NM O&G GHGI, the 2008 report assumed that 25 percent of storage tank emissions were controlled by a flare and the remaining tank emissions were not controlled.

We also examined Permian Basin data in subpart W. For RY2011, 29 percent of storage tank emissions were controlled with flares and 45 percent of associated gas emissions were controlled with flares. Subpart W data indicated completion and workover emissions were more commonly controlled, with more than 80 percent of emissions controlled using flares.

We would expect less flaring in 2005, compared to 2008 and 2011. The RY2011 subpart W data were similar to the 2008 value for storage tank flaring but higher for associated gas flaring and completion and workover flaring. Without specific data for 2005, we applied a similar flaring assumption as the 2008 report for production activities in the Permian Basin and assumed that 25 percent of emissions were controlled by flares. We applied this assumption to multiple production segment emission sources, including storage tanks, associated gas, miscellaneous venting/flaring, and completions and workovers.

3.1.1.2 San Juan Basin

A WRAP study on San Juan Basin emissions was conducted for year 2006.[14] As part of the study, surveys were sent out to production companies in the San Juan Basin. According to the survey responses, flaring was not significantly used to control storage tank emissions.

We also examined San Juan Basin data in subpart W. For RY2011, no storage tanks were controlled with flares and only 6 percent of completion and workover emissions were controlled with flares. Associated gas is not prevalent in the San Juan Basin, and none was controlled in RY2011 subpart W data.

The practice of controlling emissions using flares is not common, according to both the 2006 WRAP study and subpart W data. As such, we assumed that no flaring occurred in the San Juan Basin production segment in 2005.

3.1.2 Equipment Leaks

We used information from the 2020 NM O&G GHGI to estimate equipment leak emissions in 2005. For the 2020 NM O&G GHGI, we applied separate emission factors for equipment on well pads that were subject to leak detection and repair (LDAR) provisions and those that were not. Well pads subject to LDAR provisions were based on whether the well completion date was after September 2015, the time at which the New Source Performance Standards (NSPS) OOOOa provisions took effect.[15] The NSPS OOOOa provisions did not exist in 2005 and there were no

[13] Final Emissions Technical Memorandum No. 4d. Source of Oil and Gas Emissions for the WestJumpAQMS 2008 Photochemical Modeling. Environ to WRAP. April 24, 2013. Available at: <https://www.wrapair2.org/pdf/Memo_4d_OG_Apr24_2013_Final.pdf>

[14] Development of Baseline 2006 Emissions from Oil and Gas Activity in the South San Juan Basin. Environ to WRAP. November 25, 2009. Available at: < https://www.wrapair2.org/phaseiii.aspx.>

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

other equipment leak standards applicable to these sources in 2005. As such, we assumed that none of the 2005 wells were subject to LDAR and applied the higher equipment leak emission data to all wells. To do this, we calculated the average emissions per well for the population of wells in the 2020 NM O&G GHGI that were not subject to LDAR. Table 6 presents the calculated equipment leak emission factors (EFs) for oil wells and gas wells in the Permian and San Juan basins. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 6 by the well counts in each basin (see Table 1).

Table 6. Average Equipment Leak CH_4 Emissions Per Well, from the 2020 NM O&G GHGI

Basin	Oil Well CH_4 EF (mt/well)	Gas Well CH_4 EF (mt/well)
Permian	1.3	9.9
San Juan	1.3	5.5

3.1.3 Pneumatic Controllers

To estimate 2005 pneumatic controller emissions, we examined subpart W data and focused on adjustments to RY2011 data for the Permian and San Juan basins.

We first examined the fraction of pneumatic controllers that are high bleed, low bleed, and intermittent bleed. Table 7 presents the pneumatic controller bleed type fractions, based on data reported to subpart W in the Permian and San Juan basins for RY2011 and RY2020.

Table 7. Fraction of Pneumatic Controllers, by Bleed Type, for Subpart W RY2011 and RY2020

Pneumatic Controller Type	Pneumatic Controller Fraction			
	Permian Basin		San Juan Basin	
	RY2011	RY2020	RY2011	RY2020
High Bleed	0.11	0.01	0.15	<0.01
Low Bleed	0.3	0.39	0.11	0.51
Intermittent Bleed	0.6	0.6	0.74	0.48

Over this nine-year period, there were noticeable changes in the controller population. In both basins, high bleed controllers dropped to near zero in 2020 and were predominantly replaced with low bleed controllers. Considering the implications to 2005 pneumatic controllers, we first considered assuming a linear relationship between the high bleed controller fractions in 2011 and 2020 and scaling this relationship back to 2005. However, while there has been a particular emphasis in recent years to replace high bleed pneumatic controllers by the O&G industry, the dynamic was so extreme over this nine-year period that applying this relationship to 2005 led to fractions that may overestimate the high bleed pneumatic controller population in 2005. This was particularly true for the San Juan Basin. Therefore, for high bleed controllers, we first assumed the linear relationship to 2005 and then averaged the interpolated 2005 value and the 2011 value. Table 8 presents the results of the high bleed controller fraction analysis, including the final 2005 values.

Table 8. Fraction of High Bleed Pneumatic Controllers and Final 2005 Fraction

High Bleed Controller Category	Fraction of High Bleed Controllers	
	Permian Basin	San Juan Basin
RY2020	0.01	<0.01
RY2011	0.11	0.15
2005 – Linear Relationship	0.17	0.25
2005 – Final Value	0.14	0.20

Both basins already had a very high intermittent bleed controller fraction in RY2011. Therefore, to estimate the final 2005 pneumatic controller bleed type fractions for intermittent bleed and low bleed controllers, we assumed the RY2011 intermittent bleed fractions were constant and reduced the low bleed fraction so the total fraction of controllers summed to one. Table 9 presents the final pneumatic controller bleed type fractions that we applied for 2005.

Table 9. Estimated 2005 Pneumatic Controller Bleed Type Fractions

Pneumatic Controller Type	Pneumatic Controller Fraction	
	Permian Basin	San Juan Basin
High Bleed	0.14	0.20
Low Bleed	0.27	0.06
Intermittent Bleed	0.60	0.74

In addition to changes in the types of pneumatic controllers being used, we analyzed the average emissions per pneumatic controller and the average number of pneumatic controllers per well. We did not expect much change in the average emissions per controller, based on bleed type, and the subpart W RY2011 and RY2020 data generally supported that trend. Table 10 summarizes the average pneumatic controller emissions, by bleed type, for subpart W RY2011 and RY2020. The RY2011 average emissions were slightly higher and we applied these values as-is for 2005. Differences in the average emissions per controller between each basin largely reflects the differing methane fractions, hence the San Juan Basin (which is predominantly gas wells versus the Permian Basin which is predominantly oil wells) has slightly higher average emissions per controller.

Table 10. Average CH_4 Emissions Per Controller, by Bleed Type, for RY2011 and RY2020 (mt CH_4 / controller)

Pneumatic Controller Type	Permian Basin EFs		San Juan Basin EFs	
	RY2011	RY2020	RY2011	RY2020
High Bleed	4.55	4.07	5.18	5.3
Low Bleed	0.14	0.16	0.19	0.16
Intermittent Bleed	1.57	1.33	1.83	1.68

The reported subpart W data shows an increase in the number of pneumatic controllers per well between 2011 and 2020. This is not unexpected as well sites have become more complicated and higher producing in recent years. Table 11 summarizes the average number of controllers per well for each year and basin. We applied the RY2011 factors as-is for 2005 for the Permian and San Juan basins.

Table 11. Average Number of Controllers Per Well in Subpart W, for RY2011 and RY2020

Permian Basin (controllers / well)		San Juan Basin (controllers / well)	
RY2011	RY2020	RY2011	RY2020
0.7	1.2	3.0	5.0

To estimate 2005 New Mexico-specific emissions, we multiplied the factors in Table 9, Table 10, and Table 11 by the well counts in each basin (see Table 1).

3.1.4 Associated Gas

To estimate 2005 associated gas emissions, we examined subpart W data and used RY2011 data for the Permian and San Juan basins.

The Permian Basin had significant associated gas emissions, with the volume of associated gas showing a clear upward trend over time from 2011 through 2020. RY2011 also shows the least amount of flaring. We assumed the volume of associated gas in RY2011 was the same as 2005, on a per-well basis, but adjusted the RY2011 data to correspond to 25 percent of the emissions being flared.

For the San Juan Basin, subpart W data showed minimal associated gas emissions, and no flaring in RY2011. As such, we relied on the RY2011 data, on a per-well basis, as-is for 2005.

Table 12 presents the reported subpart W associated gas emissions and well counts in the Permian and San Juan basins, for RY2011.

Table 12. Subpart W RY2011 Associated Gas Emissions and Well Counts

Subpart W Data Element	Permian Basin	San Juan Basin
Reported CH_4 Emissions (mt)	27,243	471
Reported CO_2 Emissions (mt)	80,240	16
Reported Total Wells	70,961	22,907

We adjusted the reported emissions to account for less flaring occurring in the year 2005 for the Permian Basin (see section 3.1.1). We then calculated emission factors by dividing the adjusted emissions by the reported well counts. Table 13 presents the adjusted emissions for each basin and the calculated emission factors. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 13 by the well counts in each basin (see Table 1).

Table 13. Associated Gas Emissions Adjusted to Reflect 2005 Operations

Parameter	Permian Basin	San Juan Basin
CH_4 Emissions, if 25% flaring (mt)	36,885	N/A
CO_2 Emissions, if 25% flaring (mt)	43,272	N/A
CH_4 Emissions, if no flaring (mt)	N/A	471
CO_2 Emissions, if no flaring (mt)	N/A	16
CH_4 EF (mt/well)	0.52	0.02
CO_2 EF (mt/well)	0.61	0.001

3.1.5 Storage Tanks

To estimate 2005 storage tank emissions, we examined subpart W data and used RY2011 data for the San Juan Basin and RY2012 data for the Permian Basin.

The Permian Basin had significant storage tank emissions, with the oil throughput showing a clear upward trend over time from 2011 through 2020. RY2011 and RY2012 data were comparable in terms of tank throughput and total emissions. However, RY2011 data indicated a higher quantity of CO_2 emissions due to venting, compared to RY2012 and also to other years. As such, this year did not reflect data that were typical for the Permian Basin. Due to this, we assumed storage tank emissions in RY2012 were similar to 2005, on a per-well basis, with adjustments to correspond to 25 percent of the emissions being flared.

For the San Juan Basin, subpart W data showed minimal storage tank emissions, and no flaring in RY2011. As such, we relied on the RY2011 data, on a per-well basis, as-is for 2005.

Table 14 presents the reported subpart W storage tank emissions and well counts in the Permian Basin (for RY2012) and San Juan Basin (for RY2011).

Table 14. Subpart W Storage Tank Emissions and Well Counts

Subpart W Data Element	Permian Basin (RY2012 Data)	San Juan Basin (RY2011 Data)
Reported CH_4 Emissions (mt)	33,613	238
Reported CO_2 Emissions (mt)	68,885	3
Reported Total Wells	71,660	22,907

We adjusted the reported emissions to account for less flaring occurring in the year 2005 for the Permian Basin (see Section 3.1.1). We then calculated emission factors by dividing the adjusted emissions by the reported well counts. Table 15 presents the adjusted emissions for each basin and the calculated emission factors. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 15 by the well counts in each basin (see Table 1).

Table 15. Subpart W Storage Tank Emissions Adjusted to Reflect 2005 Operations

Parameter	Permian Basin	San Juan Basin
CH_4 Emissions, if 25% flaring (mt)	38,580	N/A
CO_2 Emissions, if 25% flaring (mt)	45,260	N/A
CH_4 Emissions, if no flaring (mt)	N/A	238
CO_2 Emissions, if no flaring (mt)	N/A	3
CH_4 EF (mt/well)	0.54	0.01
CO_2 EF (mt/well)	0.63	0.0001

3.1.6 Completions and Workovers

To estimate 2005 completion and workover emissions, we examined subpart W data and used RY2011 and RY2012 data to estimate gas well completion and workover emissions and RY2016 and RY2017 data to estimate oil well completion and workover emissions for the Permian and San Juan basins.

Completion and workover emissions in a particular year are dependent on the number of events. Subpart W data indicated varying levels of emissions and the number of completion and workover events across the 2011 through 2020 time period. As such, we averaged two years' data together to estimate completion and workover emissions, focusing on the years with the earliest available data. For gas well completion and workover events, RY2011 and RY2012 subpart W data were averaged. Oil well completion emissions were not collected under subpart W until RY2016, and we therefore averaged data for RY2016 and RY2017. We assumed the average completion and workover emissions for these years were similar as 2005, on a per-well basis, with adjustments for flaring.

Table 16 presents the reported subpart W gas well completion and workover emissions and well counts in the Permian and San Juan basins, for RY2011 and RY2012. Table 17 presents the reported subpart W oil well completion and workover emissions and oil well counts in the Permian and San Juan basins, for RY2016 and RY2017.

Table 16. Subpart W Gas Well Completion and Workover Emissions and Well Counts

Subpart W Data Element	Permian Basin		San Juan Basin	
	RY2011 Data	RY2012 Data	RY2011 Data	RY2012 Data
Reported CH_4 Emissions (mt)	2,926	2,896	16,895	4,951
Reported CO_2 Emissions (mt)	131,754	33,285	4,495	14,723
Reported Total Wells	70,961	71,660	22,907	22,835

Table 17. Subpart W Oil Well Completion and Workover Emissions and Oil Well Counts

Subpart W Data Element	Permian Basin		San Juan Basin	
	RY2016 Data	RY2017 Data	RY2016 Data	RY2017 Data
Reported CH_4 Emissions (mt)	3,765	6,155	121	101
Reported CO_2 Emissions (mt)	416,618	517,650	34,540	2,246
Reported Oil Wells	90,205	89,681	581	709

We adjusted the reported emissions to account for less flaring occurring in the year 2005 for the Permian and San Juan basins (see Section 3.1.1). We then calculated emission factors by dividing the adjusted emissions by the reported well counts. Table 18 and Table 19 present the adjusted completion and workover emissions for each basin and the calculated emission factors. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 18 and Table 19 by the well counts in each basin (see Table 1).

Table 18. Subpart W Gas Well Completion and Workover Emissions Adjusted to Reflect 2005 Operations

Subpart W Data Element	Permian Basin		San Juan Basin	
	RY2011 Data	RY2012 Data	RY2011 Data	RY2012 Data
CH_4 Emissions, if 25% flaring (mt)	31,137	9,275	N/A	N/A
CO_2 Emissions, if 25% flaring (mt)	36,529	10,882	N/A	N/A
CH_4 Emissions, if no flaring (mt)	N/A	N/A	17,969	9,132
CO_2 Emissions, if no flaring (mt)	N/A	N/A	851	546
CH_4 EF (mt/well)	0.28		0.59	
CO_2 EF (mt/well)	0.33		0.03	

Table 19. Subpart W Oil Well Completion and Workover Emissions Adjusted to Reflect 2005 Operations

Subpart W Data Element	Permian Basin		San Juan Basin	
	RY2016 Data	RY2017 Data	RY2016 Data	RY2017 Data
CH_4 Emissions, if 25% flaring (mt)	93,801	118,113	N/A	N/A
CO_2 Emissions, if 25% flaring (mt)	110,044	138,567	N/A	N/A
CH_4 Emissions, if no flaring (mt)	N/A	N/A	10,205	664
CO_2 Emissions, if no flaring (mt)	N/A	N/A	539	35
CH_4 EF (mt/oil well)	1.18		8.43	
CO_2 EF (mt/oil well)	1.38		0.44	

3.1.7 Dehydrators

To estimate 2005 dehydrator emissions, we examined subpart W data and used RY2011 data for the Permian and San Juan basins.

The Permian Basin had significant dehydrator emissions in the 2020 NM O&G GHGI, but early years of subpart W data presented a different picture, with much lower dehydrator emissions. The emissions were low in all years for RY2011 through RY2014, with flaring occurring. We assumed dehydrator emissions in RY2011 were similar as 2005, on a per-well basis, but adjusted the RY2011 data to correspond to 25 percent of the emissions being flared.

For the San Juan Basin, subpart W data showed minimal dehydrator emissions, and no flaring in RY2011. As such, we relied on the RY2011 data, on a per-well basis, as-is for 2005.

Table 20 presents the reported subpart W dehydrator emissions and well counts in the Permian Basin and San Juan Basin (for RY2011).

Table 20. Subpart W RY2011 Dehydrator Emissions and Well Counts

Subpart W Data Element	Permian Basin	San Juan Basin
Reported CH_4 Emissions (mt)	229	620
Reported CO_2 Emissions (mt)	17,728	1,245
Reported Total Wells	70,961	22,907

We adjusted the reported emissions to account for less flaring occurring in the year 2005 for the Permian Basin (see section 3.1.1). We then calculated emission factors by dividing the adjusted emissions by the reported well counts. Table 21 presents the adjusted emissions for each basin and the calculated emission factors. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 21 by the well counts in each basin (see Table 1).

Table 21. Subpart W Dehydrator Emissions Adjusted to Reflect 2005 Operations

Parameter	Permian Basin	San Juan Basin
CH_4 Emissions, if 25% flaring (mt)	3,977	N/A
CO_2 Emissions, if 25% flaring (mt)	4,666	N/A
CH_4 Emissions, if no flaring (mt)	N/A	949
CO_2 Emissions, if no flaring (mt)	N/A	147
CH_4 EF (mt/well)	0.06	0.04
CO_2 EF (mt/well)	0.07	0.01

3.1.8 Miscellaneous Venting/Flaring

Miscellaneous venting/flaring is a modification in terminology for the miscellaneous flaring source in the 2020 NM O&G GHGI. Under subpart W, facilities must report their flaring emissions under the source the emissions originated from (e.g., tanks, associated gas, completions and workovers). However, if a facility flares emissions from a source that is not directly covered under subpart W, then these emissions must be reported under the "flare stacks" source. The specific sources that contribute these emissions are not provided to EPA, and hence the term "miscellaneous flaring" was used in the 2020 NM O&G GHGI to represent the emissions that are reported under the flare stacks source. Because we are assuming that less flaring occurs in 2005 than in 2020 (see Section 3.1.1 for this discussion), we must still account for these emissions in 2005. As such, we assumed the sources that are contributing to miscellaneous flaring emissions were still in operation in 2005, except that the emissions would have been mostly vented instead. For the 2005 NM O&G GHGI, we modified the term "miscellaneous flaring" to be "miscellaneous venting/flaring" to reflect this.

To estimate 2005 miscellaneous venting/flaring emissions, we examined subpart W data and used RY2012 data for the Permian Basin and the San Juan Basin.

The Permian Basin had significant miscellaneous venting/flaring emissions, but the RY2011 data indicated much lower CO_2 emissions compared to RY2012 through RY2020. This indicated that RY2011 data did not reflect typical flaring emission levels for the Permian Basin. Therefore, we assumed miscellaneous venting/flaring emissions in RY2012 were similar to 2005, on a per-well basis, with adjustments to correspond to 25 percent of the emissions being flared.

For the San Juan Basin, subpart W data showed minimal miscellaneous venting/flaring emissions in RY2011 and RY2012. To maintain consistency with the Permian Basin, we relied on the RY2012 data for the San Juan Basin, on a per-well basis, with adjustments to correspond to none of the emissions being flared.

Table 22 presents the reported subpart W miscellaneous venting/flaring emissions and well counts in the Permian Basin and San Juan Basin (for RY2012).

Table 22. Subpart W Miscellaneous Venting/Flaring Emissions and Well Counts

Subpart W Data Element	Permian Basin	San Juan Basin
Reported CH_4 Emissions (mt)	7,352	0.4
Reported CO_2 Emissions (mt)	1,953,904	64
Reported Total Wells	71,660	22,835

We adjusted the reported emissions to account for less flaring occurring in the year 2005 for both the Permian Basin and the San Juan Basin (see Section 3.1.1). We then calculated emission factors by dividing the adjusted emissions by the reported well counts. Table 23 presents the adjusted emissions for each basin and the calculated emission factors. To estimate 2005 New Mexico-specific emissions, we multiplied the emission factors in Table 23 by the well counts in each basin (see Table 1).

Table 23. Subpart W Miscellaneous Venting/Flaring Emissions Adjusted to Reflect 2005 Operations

Parameter	Permian Basin	San Juan Basin
CH_4 Emissions, if 25% flaring (mt)	435,863	N/A
CO_2 Emissions, if 25% flaring (mt)	511,342	N/A

Parameter	Permian Basin	San Juan Basin
CH_4 Emissions, if no flaring (mt)	N/A	19
CO_2 Emissions, if no flaring (mt)	N/A	1
CH_4 EF (mt/well)	6.08	0.0008
CO_2 EF (mt/well)	7.14	0.00004

3.1.9 Liquids Unloading

To estimate 2005 liquids unloading emissions, we examined subpart W data and used RY2011 data for the Permian Basin and the San Juan Basin.

For the Permian Basin, subpart W data showed minimal liquids unloading emissions in RY2011 and in subsequent years. Subpart W data also showed only venting emissions and no flaring emissions. As such, we relied on the RY2011 data, on a per-well basis, with no adjustments for flaring for 2005.

The San Juan Basin had significant liquids unloading emissions, and RY2011 data showed higher emissions than the subsequent years. However, there is a downward trend in reported emissions from 2011 to 2020. As with the Permian Basin, subpart W data showed only venting emissions and no flaring emissions. Therefore, we relied on the RY2011 data, on a per-well basis, with no adjustments for flaring for 2005.

Table 24 presents the reported subpart W liquids unloading emissions and well counts in the Permian Basin and San Juan Basin (for RY2011).

Table 24. Subpart W Liquids Unloading Emissions and Well Counts

Subpart W Data Element	Permian Basin	San Juan Basin
Reported CH_4 Emissions (mt)	4,052	113,039
Reported CO_2 Emissions (mt)	200	5,519
Reported Total Wells	70,961	22,907

We did not adjust the reported emissions to account for less flaring occurring in the year 2005 because no flaring emissions were reported in subpart W for liquids unloading. We calculated emission factors by dividing the reported emissions by the reported well counts. Table 25 presents the calculated emission factors for each basin. To estimate 2005 New Mexico-specific emissions for the Permian and San Juan basins, we multiplied the emission factors in Table 25 by the well counts in each basin (see Table 1).

Table 25. Subpart W Liquids Unloading Emission Factors

Parameter	Permian Basin	San Juan Basin
CH_4 EF (mt/well)	0.06	4.93
CO_2 EF (mt/well)	0.003	0.24

3.1.10 Combustion

To estimate 2005 production segment combustion emissions, we used production segment combustion emissions data from the 2020 NM O&G GHGI. We assumed that production segment combustion emissions would scale according to production or production-related events between 2020 and 2005.

For the Permian Basin, we scaled combustion emissions based on gas production and number of completions and workover events. Based upon a review of the subpart C data, combustion emissions in the Permian Basin are due to gas compressors and diesel fuel combustion units, with each contributing about 50 percent of overall combustion CO_2 emissions. To scale gas compressor combustion emissions, we selected gas production as a surrogate. There may be multiple contributors to diesel fuel combustion emissions, but drilling rigs are a common source. As such, we used completion and workover events as a surrogate to scale diesel fuel combustion emissions. We first calculated a combustion scaling ratio for the Permian Basin based on gas production by dividing the total gas production in 2005 by the total gas production in 2020.

We calculated a second combustion scaling ratio for the Permian Basin by first dividing the total number of completion and workover events in 2020 by the total number of wells in 2020 in the Permian Basin, as reported in subpart W. We then multiplied this value by the 2020 well count for the Permian Basin to calculate the New Mexico-specific total number of completions and workover events in 2020 in the Permian Basin. Similarly, we used RY2011 subpart W data and the 2005 well count for the Permian Basin to calculate the total number of completion and workover events in 2005 in the Permian Basin. We then calculated the second combustion scaling ratio by dividing the calculated number of completion and workover events in 2005 by the calculated number of completion and workover events in 2020.

For the San Juan Basin, we scaled combustion emissions based on gas production only. Based upon a review of the subpart C data, combustion emissions in the San Juan Basin are due almost exclusively to gas compressors, and gas production was selected as the surrogate. We calculated the combustion scaling ratio by dividing the total gas production in the San Juan Basin in 2005 by the total gas production in the San Juan Basin in 2020. We multiplied this ratio by the total production segment combustion emissions in the San Juan Basin in 2020 to calculate the total production segment combustion emissions in 2005.

Table 26 presents the combustion scaling ratios between 2005 and 2020 based on gas production (Table 1 shows the gas production volumes in each basin).

Table 26. Gas Production Ratios (2005 Versus 2020) for Scaling Combustion Emissions

Parameter	Permian Basin		San Juan Basin	
	2005	2020	2005	2020
Gas Production Scaling Ratio	0.41		1.93	

Table 27 presents the reported subpart W completion and workover events and total wells in the Permian Basin for 2011 and 2020, as well as the calculated events per well.

Table 27. Subpart W Reported Completion and Workover Events and Total Wells

Parameter	Permian Basin	
	2011	2020
Reported Completion and Workover Events	2,148	14,575
Reported Total Wells	70,961	109,716
Events / Well	0.03	0.13

To estimate the total number of completions and workover events in 2005 and 2020, we multiplied the well count by the calculated events per well (see Table 27). Table 28 presents the total number of estimated completion and workover events in 2005 and 2020 in the Permian Basin as well as the combustion scaling ratio between 2020 and 2011 based on completion and workover events.

Table 28. Completion and Workover Events Ratios (2005 Versus 2020) for Scaling Combustion Emissions

Parameter	Permian Basin	
	2011	2020
Completion and Workover Events	681	3,669
Events-Based Scaling Ratio	0.19	

For the Permian Basin, the scaling ratio based on gas production was more than twice as large as the scaling ratio based on completions and workovers events, so we equally weighted the two scaling ratios to calculate a final combustion scaling ratio. Table 29 presents the final combustion scaling ratios between 2005 and 2020 for the Permian and San Juan basins. We multiplied the final ratio by the total production segment combustion emissions for each basin in 2020 to calculate the total production segment combustion emissions in 2005.

Table 29. Final Combustion Scaling Ratios

Parameter	Permian Basin	San Juan Basin
Final Combustion Scaling Ratio	0.30	1.93

3.1.11 Other Emission Sources

For several other emission sources that do not contribute significantly to the overall production segment emissions, we scaled 2020 emissions to 2005 based on changes in gas production or oil production only. We calculated a scaling ratio for each basin by dividing the total 2005 gas or oil production by the total 2020 gas or oil production (see Table 1 for these data). To calculate reciprocating compressor emissions, pneumatic pumps emissions, and mud degassing emissions, we scaled 2020 emissions to 2005 based on gas production. To calculate tank unloading emissions and produced water emissions, we scaled 2020 emissions to 2005 based on oil production.

Table 30 presents the scaling ratios between 2005 and 2020 for the Permian and San Juan basins.

Table 30. Oil and Gas Production Scaling Ratios (2005 Versus 2020)

Parameter	Permian Basin		San Juan Basin	
	2005	2020	2005	2020
Gas Production Scaling Ratio	0.41		1.9	
Oil Production Scaling Ratio	0.16		0.33	

3.2 Gathering and Boosting

As noted in Section 2.2, there is limited data for gathering and boosting for 2005. In addition, subpart W only started collecting G&B data in RY2016. While we could analyze the RY2016 subpart W data and compare it to RY2020 data, its relevance to year 2005 data would be less impactful than the subpart W analyses conducted for production and natural gas processing. Subpart W data for the production and natural gas processing segments are available for RY2011, which is much more representative of year 2005 operations (with additional adjustments, where appropriate). Based on this, we did not use subpart W data to estimate G&B emissions for 2005.

We accounted for changes in venting versus flaring practices identically for G&B as for production. For the production segment, we adjusted emissions to account for less flaring occurring in 2005 (see Section 3.1.1). We applied the results from the production segment to the G&B segment and assumed that no flaring occurred in the San Juan Basin and 25 percent of emissions were flared in the Permian Basin for tanks, dehydrators, and miscellaneous venting/flaring.

In addition to adjustments for flaring, we otherwise scaled G&B segment emissions data from the 2020 NM O&G GHGI to estimate 2005 emissions. We applied three approaches to scale G&B 2020 emissions to 2005:

1. Using gas production ratios (see Table 2)
2. Using production segment equipment leak ratios (see Section 3.2.1)
3. Using production segment pneumatic controller ratios (see Section 3.2.2)

Table 31 identifies the approach we used for each G&B emission source.

Table 31. Scaling Approach Used for Each G&B Emission Source

Emission Source	Scaling Approach
Centrifugal Compressors	Equipment Leaks Ratio
Combustion	Gas Production Ratio
Dehydrator	Gas Production Ratio + Flaring Adjustment
Equipment Leaks	Equipment Leaks Ratio
Miscellaneous Venting/Flaring	Gas Production Ratio + Flaring Adjustment
Pipeline Blowdowns	Gas Production Ratio
Pipeline Leaks	Gas Production Ratio
Pneumatic Controllers	Pneumatic Controllers Ratio

Emission Source	Scaling Approach
Pneumatic Pumps	Pneumatic Controllers Ratio
Reciprocating Compressors	Equipment Leaks Ratio
Station Blowdowns	Gas Production Ratio
Storage Tanks	Gas Production Ratio + Flaring Adjustment

3.2.1 Equipment Leaks Ratio

Changes in emissions for some sources are more impacted by changes in equipment counts, and less directly related to changes in gas production. Because there is not G&B data to perform an assessment of changes in equipment counts, we assumed changes in production segment equipment leak emissions between 2020 and 2005 would provide a reasonable surrogate. We calculated equipment leaks scaling ratios by dividing the production segment equipment leak emissions in 2005 by the 2020 equipment leak emissions for each basin. Table 32 presents the resulting ratio for each basin. We set the ratio for the Las Vegas-Raton Basin equal to the San Juan Basin ratio.

Table 32. Equipment Leaks Ratios Used as Surrogates to Scale 2020 G&B Emissions to 2005 for Select Sources

Basin	CH_4 Equipment Leaks Ratio
Permian	1.02
San Juan	0.96
Las Vegas-Raton	0.96

3.2.2 Pneumatic Controllers Ratio

For G&B pneumatic controllers, we assumed the changes in pneumatic controller emissions for the production segment would be an appropriate surrogate for G&B pneumatic controller emissions. We calculated pneumatic controller scaling ratios by dividing the production segment pneumatic controller emissions in 2005 by the 2020 pneumatic controller emissions for each basin. Table 33 presents the resulting ratio for each basin. We set the ratio for the Las Vegas-Raton Basin equal to the San Juan Basin ratio.

Table 33. Pneumatic Controllers Ratios Used as Surrogates to Scale 2020 G&B Pneumatic Controller Emissions to 2005

Basin	CH_4 Pneumatic Controllers Ratio
Permian	0.90
San Juan	1.54
Las Vegas-Raton	1.54

3.3 Natural Gas Processing

We reviewed GHGRP subpart W and subpart C data for RY2011 through RY2020 to analyze the natural gas processing plant emissions trends over time. For processing plants in New Mexico, there is a clear downward trend in average emissions per plant between RY2011 and RY2020. To estimate year 2005 processing plant emissions, we used data from RY2011 and RY2012 (i.e., two earliest years of data) to develop emission factors. In both years, 23 processing plants in New Mexico reported data. We calculated emission factors for each emission source at a processing plant as the average emissions per plant (i.e., sum of emissions divided by the total number of plants), considering both RY2011 and RY2012 data. There are two caveats to this approach for combustion CH_4 emissions and pneumatic controllers. The combustion CH_4 emission factors equals the CO_2 emission factor multiplied by the ratio between CH_4 and CO_2 combustion emissions in the 2020 NM O&G GHGI. The pneumatic controller emission factors equal the average emissions per plant from the 2020 NM O&G GHGI. Table 34 presents the emission factors we calculated for each emission source. We applied these emission factors to the number of processing plants in 2005 (see Table 3) to calculate total 2005 gas processing plant emissions.

Table 34. Emission Factors Calculated from Reported Subpart W and Subpart C Data for RY2011 and RY2012

Emission Source	CO_2 EF (mt/plant)	CH_4 EF (mt/plant)
Acid Gas Removal Units	106,178	0.0
Blowdown Vent Stacks	2.0	20
Centrifugal Compressors	33	260
Combustion	119,488	471
Dehydrators	73	4.6
Equipment Leaks	2.1	29
Flare Stacks	7,228	36
Pneumatic Controllers	0.38	3.2
Reciprocating Compressors	30	137

3.4 Transmission and Storage

We reviewed GHGRP subpart W and subpart C data for RY2011 through RY2020 to analyze the transmission compressor station emissions trends over time. For compressor stations in New Mexico, there is a downward trend in average emissions per station between RY2011 and RY2020. However, few compressor stations report to subpart W (e.g., 4 stations reported in 2011 and 6 reported in 2012). To estimate year 2005 compressor station emissions, we used data from RY2011 and RY2012, the two earliest years of data, to develop emission factors. We calculated emission factors for each emission source at a compressor station as the average emissions per station (i.e., sum of emissions divided by the total number of compressor stations), considering both RY2011 and RY2012 data. There is one caveat to this approach for combustion emissions. Instead of calculating combustion emission factors, we scaled emissions using compressor size (horsepower) and operating hours; we present the combustion ratio in Table 5. Table 35 presents the emission factors we calculated for each emission source. We applied these emission factors to the number of compressor stations in 2005 (see Table 5) to calculate total 2005 compressor station emissions.

Table 35. Compressor Station Emission Factors Calculated from Reported Subpart W Data for RY2011 and RY2012

Emission Source	CO_2 EF (mt/station)	CH_4 EF (mt/station)
Blowdown Vent Stacks	3.5	79
Centrifugal Compressors	0.9	35
Equipment Leaks	0.5	16
Flare Stacks	0.0	0.0
Pneumatic Controllers	0.3	8
Reciprocating Compressors	2.7	98
Transmission Tanks	0.4	17

For transmission pipelines, we reviewed GHGRP subpart W for RY2016 through RY2022 to analyze the pipeline blowdown CH_4 emissions trend over time. There is a clear and steady decrease in emissions over this time. We assumed this trend was linear back to 2011 and applied this approximate 2011 emission factor to estimate 2005 emissions. Table 36 presents the resulting pipeline blowdowns emission factor.

Table 36. Transmission Pipeline Blowdowns CH_4 Emission Factor, Derived from Linear Interpolation of Subpart W Data

Emission Source	CH_4 EF (mt/mile)
Pipeline Blowdowns	0.96

For underground natural gas storage stations, we did not adjust the emissions to account for changes between 2020 and 2005. Underground natural gas storage is a limited activity in New Mexico.

4 2005 GHG Emissions Summary

This section presents results for the 2005 NM O&G GHGI for each of the industry segments and their emission sources. We first present emission summaries for each segment and the emissions sources. Then, detailed emissions results are provided for each industry segment in Sections 4.1 through 4.4.

Table 37 presents a summary of CH_4, CO_2, and CO_2e emissions for the 2005 NM O&G GHGI for each segment. CO_2e emissions are estimated for CH_4 using a global warming potential (GWP) of 27.

Table 37. GHG Emissions by Industry Segment (Metric Tons/Year)

Industry Segment	CH_4	CO_2	CO_2e
Production	682,474	2,961,364	21,388,162
Gathering and Boosting	126,398	4,856,063	8,268,809
Natural Gas Processing	25,934	6,291,918	6,992,136
Transmission and Storage	22,978	688,056	1,308,451
Total	**857,784**	**14,797,401**	**37,957,558**

Table 38 presents a summary of CH_4, CO_2, and CO_2e emissions for 2005 for each emission source. Table 38 is ordered by descending CO_2e emissions. The highest emitting CH_4 sources are equipment leaks, pneumatic controllers, miscellaneous venting/flaring (which assumes most of these emissions are now vented in 2005 as opposed to flared in 2020), and liquids unloading which cumulatively account for 74 percent of CH_4 emissions. Combustion (e.g., from engines and turbines driving compressors) is the highest emitting CO_2 source, accounting for 77 percent of CO_2 emissions. Acid gas removal units is the other significant CO_2 source, accounting for 20 percent of CO_2 emissions.

Table 38. GHG Emissions by Emission Source (Metric Tons/Year)

Emission Source	CH_4	CO_2	CO_2e
Combustion	65,975	11,387,180	13,168,505
Equipment Leaks	194,282	5,689	5,251,303
Pneumatic Controllers	182,920	30,788	4,969,628
Miscellaneous Venting/Flaring	156,062	182,056	4,395,730
Acid Gas Removal Units	0	2,906,843	2,906,843
Liquids Unloading	100,709	4,918	2,724,061
Completions and Workovers	50,092	31,822	1,384,306
Reciprocating Compressors	30,375	1,613	821,738
Tanks	21,503	24,387	604,968
Associated Gas	12,114	13,740	340,818
Centrifugal Compressors	9,190	947	249,077
Flaring	968	195,843	221,968
Equipment Blowdowns	8,138	1,006	220,732
Pipeline Blowdowns	6,229	187	168,370
Dehydrators	5,848	7,090	164,986
Pipeline Leaks	5,371	2,748	147,765
Mud Degassing	3,517	249	95,208
Pneumatic Pumps	1,770	234	48,024
Produced Water	1,313	27	35,478
Transmission Storage Tanks	865	18	23,373
Metering and Regulating Equipment	438	13	11,839

Emission Source	CH_4	CO_2	CO_2e
Storage Wells	66	2	1,784
Tank Unloading	39	1	1,054
Total	**857,784**	**14,797,401**	**37,957,558**

4.1 Production

State-level GHG emissions from the production segment are shown in Table 39. The four largest sources of CH_4 emissions are well pad equipment leaks, pneumatic controllers, miscellaneous flaring (which assumes most of these emissions are now vented in 2005 as opposed to flared in 2020), and liquids unloading; cumulatively, these sources account for 87 percent of the total. Combustion emissions were the single largest source for CO_2 emissions in the segment, accounting for 91 percent of the total.

Table 39. Production Emissions by Source (Metric Tons/Year)

Emission Source	CH_4	CO_2	CO_2e
Equipment Leaks	183,081	5,328	4,948,515
Pneumatic Controllers	170,867	28,711	4,642,120
Miscellaneous Venting/Flaring	136,925	160,618	3,857,593
Combustion	8,488	2,700,045	2,929,221
Liquids Unloading	100,709	4,918	2,724,061
Completions and Workovers	50,092	31,822	1,384,306
Tanks	12,327	14,219	347,048
Associated Gas	12,114	13,740	340,818
Mud Degassing	3,517	249	95,208
Dehydrators	2,096	1,609	58,201
Produced Water	1,313	27	35,478
Pneumatic Pumps	606	32	16,394
Reciprocating Compressors	300	45	8,145
Tank Unloading	39	1	1,054
Grand Total	**682,474**	**2,961,364**	**21,388,162**

4.2 Gathering and Boosting

State-level GHG emissions from the G&B segment are shown in Table 40. Combustion emissions at G&B stations were the single largest GHG emission source accounting for 34 percent of CH_4 emissions and 98 percent of CO_2 emissions from the G&B segment. Other notable CH_4 emission sources were reciprocating compressors, miscellaneous flaring (which assumes most of these emissions are now vented in 2005 as opposed to flared in 2020), and pneumatic controllers, collectively accounting for approximately 41 percent of CH_4 emissions from the G&B segment.

Table 40. G&B Emissions by Source (Metric Tons/Year)

Emission Source	CH_4	CO_2	CO_2e
Combustion	42,535	4,774,257	5,922,702
Reciprocating Compressors	20,784	605	561,773
Miscellaneous Venting/Flaring	19,137	21,438	538,137
Pneumatic Controllers	11,453	2,051	311,282
Tanks	9,176	10,168	257,920
Equipment Leaks	9,445	275	255,290
Pipeline Leaks	5,301	2,746	145,873
Dehydrators	3,601	3,508	100,735
Equipment Blowdowns	3,393	771	92,382
Acid Gas Removal Units	0	40,029	40,029
Pneumatic Pumps	1,164	202	31,630
Centrifugal Compressors	361	11	9,758
Pipeline Blowdowns	48	2	1,298
Grand Total	**126,398**	**4,856,063**	**8,268,809**

4.3 Natural Gas Processing

Table 41 presents the state-level GHG emissions for the natural gas processing industry segment. Processing emissions are dominated by two emission sources, combustion and acid gas removal units, which collectively account for 92 percent of total CO_2e emissions.

Table 41. Natural Gas Processing Emissions by Source (Metric Tons/Year)

Emission Source	CH_4	CO_2	CO_2e
Combustion	12,718	3,226,165	3,569,551
Acid Gas Removal Units	0	2,866,814	2,866,814
Flaring	961	195,147	221,094
Centrifugal Compressors	7,033	891	190,782
Reciprocating Compressors	3,686	809	100,331
Equipment Leaks	782	56	21,170
Equipment Blowdowns	543	54	14,715
Dehydrators	125	1,972	5,347
Pneumatic Controllers	86	10	2,332
Grand Total	**25,934**	**6,291,918**	**6,992,136**

4.4 Transmission and Underground Natural Gas Storage

Table 42 presents the state-level GHG emissions for transmission compressor stations and transmission pipelines. Combustion emissions are the dominant CO_2 emissions source, accounting for more than 99 percent of CO_2 emissions. The largest sources of CH_4 emissions are transmission pipeline blowdowns (29 percent of CH_4 emissions), reciprocating compressors (24 percent of CH_4 emissions), and equipment blowdowns (19 percent of CH_4 emissions).

Table 42. Transmission Compressor Station and Transmission Pipelines Emissions by Source (Metric Tons/Year)

Emission Source	CH_4	CO_2	CO_2e
Combustion	2,102	647,113	703,867
Pipeline Blowdowns	6,181	185	167,072
Reciprocating Compressors	5,007	136	135,325
Equipment Blowdowns	4,034	176	109,094
Centrifugal Compressors	1,796	45	48,537
Transmission Storage Tanks	865	18	23,373
Equipment Leaks	832	26	22,490
Pneumatic Controllers	414	13	11,191
Pipeline Leaks	70	2	1,892
Grand Total	**21,301**	**647,714**	**1,222,841**

Table 43 presents the state-level GHG emissions for underground natural gas storage stations. Combustion emissions are the dominant CO_2 emissions source, accounting for 98 percent of CO_2 emissions. Reciprocating compressors and metering and regulating equipment contribute the most to CH_4 emissions, accounting for 62 percent of CH_4 emissions.

Table 43. Underground Natural Gas Storage Emissions by Source (Metric Tons/Year)

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

5 Year 2025 and 2030 Projections

We used the 2020 NM O&G GHGI, which estimated emissions for 2020, 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 New Mexico regulatory initiatives are expected to have on emission levels. We used the following methodology to develop the projected inventories:

$$E_x = E_{2020} \times \left(\frac{100 + A_x}{100}\right) \times \left(\frac{1 - Reductions_x}{100}\right)$$

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 5.1 and 5.2 describe how these variables were estimated for each of the projected inventory years, and Section 5.3 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.

5.1 Projected Year Activity

We obtained projected year activity increase (A_x) estimates for 2025 and 2030 from the U.S. Energy Information Administration Annual Energy Outlook (AEO) 2023.[16] The EIA AEO report provides estimates of U.S. 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. We developed separate estimates of A_x for crude oil production and natural gas production using the EIA data.

Table 44 provides the production estimates and the 2025 and 2030 projected inventory values of A_x for oil production under each production scenario.

Table 44. 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	12.86	16.07	10.44	14%	42%	-7%
2030	13.31	21.07	10.03	18%	87%	-11%

a. Production in (MMBL/day).

Table 45 provides the natural gas production estimates and the 2025 and 2030 projected inventory values of A_x for gas production under each production scenario.

16 US Energy Information Administration "Annual Energy Outlook 2023", March 16, 2023. https://www.eia.gov/outlooks/aeo/

Table 45. 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	34.50	35.92	33.33	3%	7%	0%
2030	35.35	39.71	32.12	6%	19%	-4%

a. Production in trillion cubic feet.

We then applied the projected industry growth factors (A_x) in 2025 and 2030 for either oil production (Table 44) or gas production (Table 45) 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 45 was used for liquids unloading. Similarly, the oil production A_x data in Table 44 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 production (e.g., storage tanks), an average of the data in Table 44 and Table 45 were used for A_x. Attachment B identifies the commodity type (oil, gas, or mixed) used for each emission source.

5.2 Emission Reductions

VOC emission reductions were estimated during development of NMED's Part 50 ozone precursor regulation for the oil and gas sector.[17] As part of the rule development effort, the 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.[18] For purposes of developing the projected inventories presented in this report, we reviewed and revised the estimated reductions to reflect changes made in the final rule as well as a more comprehensive review of the existing equipment profiles available under NMED's permitting programs. Additionally, rule requirements for certain emission sources are phased in over time and will not be fully implemented until 2030. Therefore, we adjusted the estimated reductions for the 2025 projected inventory for these emission sources to reflect the expected reductions in place by 2025. We applied VOC reductions expected from the Part 50 rule 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. We assumed no reductions for CO_2 emissions based upon the Part 50 rule.

In addition to the NMED Part 50 rule, the EMNRD implemented a prohibition on the venting and flaring of associated gas (with some exceptions) through the "natural gas waste" rule.[19] Accordingly, we applied a 95 percent reduction in emissions from associated gas venting and flaring in the projected inventories for both CH_4 and CO_2 to account for this prohibition, which only allows venting or flaring under certain conditions.

[17] Title 20, Chapter 2, Part 50 "Oil and Gas Sector – Ozone Precursor Pollutants" [20.2.50 NMAC 08/05/2022]
[18] Memorandum "Emissions Inventory Reductions" from Mike Pring, Brian Palmer, and Stephen Treimel, ERG to Elizabeth Kuehn, NMED. June 4, 2021.
[19] Title 19, Chapter 15, Part 27 "Venting and Flaring of Natural Gas" [19.15.27 NMAC 05/25/2021]

Table 46 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 46 are not assumed to have regulatory reductions in the projected inventories.

Table 46. Estimated 2025 and 2030 CH_4 Reductions

Emission Source	2025 CH_4 Reduction (*$Reductions_x$*)	2030 CH_4 Reduction (*$Reductions_x$*)
Engines	1.7%	5.6%
Turbines	11.0%	36.5%
Reciprocating and Centrifugal Compressors	51.3%	51.3%
Equipment Leaks	75.1%	75.1%
Liquids Unloading	50.0%	50.0%
Dehydrators	47.9%	47.9%
Hydrocarbon Liquids Transfers	88.40%	88.40%
Pneumatic Controllers and Pumps	80.0%	90.6%
Storage Tanks	13.8%	46.1%
Associated Gas [a]	95%	95%

a. 95% reductions also applied for CO_2.

5.3 Year 2025 and 2030 Results

Table 47 presents the results of the projected inventories for 2025 and 2030.

Table 47. 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	270,113	-51%	300,378	-45%	246,749	-55%
2030	CH_4	250,261	-54%	318,216	-42%	214,870	-61%
2020	CO_2	18,177,400	NA	18,177,400	NA	18,177,400	NA
2025	CO_2	18,710,880	3%	20,918,760	15%	17,009,917	-6%
2030	CO_2	19,242,501	6%	24,898,332	37%	16,375,680	-10%
2020	CO2e	32,952,130	NA	32,952,130	NA	32,952,130	NA
2025	CO2e	26,003,936	-21%	29,028,960	-12%	23,672,136	-28%
2030	CO2e	25,999,550	-21%	33,490,161	2%	22,177,170	-33%

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