O&G EMISSIONS INVENTORY PROJECT:
GREATER SAN JUAN AND PERMIAN BASIN

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WESTAR & WRAP

U.S. Bureau of Land Management
OUTLINE

• Project overview
  • Basin maps: O&G well-site and midstream facility locations

• Inventory inputs
  • GHGRP subpart W

• Draft base year (2014) Greater San Juan inventory

• Draft future year (2028) emission inventory methodology
EMISSION INVENTORY OVERVIEW

- **Objective**: Develop O&G emission inventories
  - Base year 2014 and future year 2028
  - O&G Basins
    - Greater San Juan Basin in southern Colorado and northern New Mexico
    - Permian Basin (portion of the basin in New Mexico only)
- **Emission Sources**:
  - nonpoint (O&G well-sites)
  - point (midstream gas gathering and gas processing)
- **Pollutants**: NOx, VOC, CO, SOx, PM, GHGs
- **Mineral ownership**: Private/state fee, tribal, and federal
GREATER SAN JUAN BASIN: 2014 WELL LOCATIONS BY TYPE

Legend
- Greater San Juan Basin (consistent with GHGRP Subpart W definition)
- Tribal Lands

Well Type
- Oil
- CBM
- Gas
GREATER SAN JUAN BASIN:
2014 WELL LOCATIONS BY MINERAL OWNERSHIP

Legend
- Greater San Juan Basin (consistent with GHGRP Subpart W definition)
- Tribal Lands

Mineral Ownership (2014 Wells)
- Private/State
- Tribal
- Federal
GREATER SAN JUAN BASIN: 2014 MIDSTREAM FACILITIES BY SURFACE OWNERSHIP

Legend
- Greater San Juan Basin (consistent with GHGRP Subpart W definition)
- Tribal Lands

Ownership
- Federal
- Private/State
- Tribal
**INVENTORY INPUTS**

**Input**

- **O&G activity data** by county, well type, and mineral designation
- **Point (midstream) source emissions** by facility
- **Greater San Juan well-site source input factors**
- **Permian Basin well-site source input factors**

**Source**

- IHS Enerdeq Database
- Federal / State / Local /Tribal Agency Permit Databases
- Operator survey, Subpart W GHGRP, EPA O&G Tool, CARMMS O&G Inventory
- Literature Review, EPA O&G Tool

INVENTORY INPUTS:
GHGRP SUBPART W

• **Segment applicable to well-site inputs development:** Onshore petroleum and natural gas production
  
  • **Reporting requirement:** Owners or operators of facilities that contain petroleum and natural gas systems and emit 25,000 metric tons or more of GHGs per year

• **Typical Input Data Available from Subpart W reporting:** population, emission factors for some sources and partial control information

• Subpart W data used to develop **Greater San Juan Basin input factors**
  
  • Operator provided Subpart W submissions as survey inputs for applicable source categories
  
  • Compiled data from publicly released data for companies that did not respond to survey
    
    • Facility Level Information on GreenHouse Gases Tool (FLIGHT) ([https://ghgdata.epa.gov/ghgp/main.do](https://ghgdata.epa.gov/ghgp/main.do))
    
    • Envirofacts ([https://www.epa.gov/enviro/greenhouse-gas-customized-search](https://www.epa.gov/enviro/greenhouse-gas-customized-search))
## INVENTORY INPUTS: GHGRP SUBPART W

### Well-site inventory and GHGRP Subpart W emission source categories

<table>
<thead>
<tr>
<th>Source Category</th>
<th>Emission Inventory</th>
<th>GHGRP Subpart W</th>
<th>Source Category</th>
<th>Emission Inventory</th>
<th>GHGRP Subpart W</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pneumatic Devices</td>
<td>✓</td>
<td>✓</td>
<td>Hydraulic Fracturing Pumps</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Gas-Actuated Pumps</td>
<td>✓</td>
<td>✓</td>
<td>Artificial Lift Engines</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Dehydrators</td>
<td>✓</td>
<td>✓</td>
<td>Drilling Rigs</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Liquids Unloading (Blowdowns)</td>
<td>✓</td>
<td>✓</td>
<td>Refracing</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Well Completion Venting</td>
<td>✓</td>
<td>✓</td>
<td>Workover</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Crude Oil Tanks</td>
<td>✓</td>
<td>✓</td>
<td>Water Pump</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Condensate Tanks</td>
<td>✓</td>
<td>✓</td>
<td>Produced Water Tanks</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Associated Gas Venting</td>
<td>✓</td>
<td>✓</td>
<td>Hydrocarbon Liquids Loading</td>
<td>✓</td>
<td>✗</td>
</tr>
<tr>
<td>Wellhead Compressor Engines</td>
<td>✓</td>
<td>✓</td>
<td>Injection Pump Blowdown</td>
<td>✗</td>
<td>✓</td>
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<tr>
<td>Lateral Compressor Engines</td>
<td>✓</td>
<td>✓</td>
<td>Hydrocarbon Liquids Dissolved CO2</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Fugitive Emissions</td>
<td>✓</td>
<td>✓</td>
<td>Well Testing Venting and Flaring</td>
<td>✗</td>
<td>✓</td>
</tr>
<tr>
<td>Heaters</td>
<td>✓</td>
<td>✓</td>
<td>Acid Gas Removal Units</td>
<td>✗</td>
<td>✓</td>
</tr>
</tbody>
</table>
2014 EMISSIONS (DRAFT): GREATER SAN JUAN BASIN

**Basin-wide NOx Percent Contribution by Source Category**
- Nonpoint Compressor Engines: 68%
- Midstream Unclassified: 6%
- Point Source Compressor Engines: 17%
- Nonpoint Heaters: 2%
- Water Pump Engines: 4%
- Other Categories: 3%

Basin-wide NOx Emissions (tons/year): 59,989

**Basin-wide VOC Percent Contribution by Source Category**
- Pneumatic devices: 28%
- Point Source Compressor Engines: 3%
- Nonpoint Fugitives: 13%
- Pneumatic pumps: 12%
- Venting - blowdowns: 2%
- Other Categories: 3%
- Baseline VOC Emissions (tons/year): 90,064

- Nonpoint Compressor Engines: 1%
- Nonpoint Heaters: 1%
- Oil Tank: 4%
- Condensate tank: 4%
- Dehydrator: 9%
**2014 EMISSIONS (DRAFT): GREATER SAN JUAN BASIN**

- GHG emissions were not estimated for point source facilities for which process level emissions were unavailable
- Super-emitters were not included in emission inventory estimates

### 2014 Greater San Juan Basin emissions by mineral ownership:

<table>
<thead>
<tr>
<th>Mineral Ownership</th>
<th>NOx</th>
<th>VOC</th>
<th>CO</th>
<th>SOx</th>
<th>PM</th>
<th>CO\textsubscript{2}(e)\textsuperscript{1}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tribal</td>
<td>14,049</td>
<td>12,471</td>
<td>13,029</td>
<td>65</td>
<td>359</td>
<td>4,718,641</td>
</tr>
<tr>
<td>Private/State</td>
<td>17,095</td>
<td>17,121</td>
<td>20,326</td>
<td>188</td>
<td>473</td>
<td>5,627,585</td>
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<tr>
<td>Federal</td>
<td>28,845</td>
<td>60,472</td>
<td>52,189</td>
<td>66</td>
<td>876</td>
<td>11,508,499</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>59,989</td>
<td>90,064</td>
<td>85,544</td>
<td>319</td>
<td>1,708</td>
<td><strong>21,854,726</strong></td>
</tr>
</tbody>
</table>

\textsuperscript{1} GHG emissions were not estimated for point source facilities for which process level emissions were unavailable. Super-emitters were not included in emission inventory estimates.
FUTURE YEAR INVENTORY DEVELOPMENT: OVERVIEW

• 2028 future year for both Greater San Juan and Permian Basins
• Forecasts will be developed by well type and source category at the basin or sub-basin level
• Forecast will account for:
  • O&G activity change from base year 2014 to future year 2028
  • On-the-books regulatory controls effects on emissions in 2028
## FUTURE YEAR INVENTORY DEVELOPMENT: CONTROLS

<table>
<thead>
<tr>
<th>Regulations for which Control Scalars WILL be developed</th>
<th>Regulations for which Control Scalars WILL NOT be developed</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Federal Regulations</strong></td>
<td></td>
</tr>
<tr>
<td>NSPS OOOO – O&amp;G Phase I</td>
<td>NESHAP Subpart HH (dehydrators)</td>
</tr>
<tr>
<td>NSPS OOOOa – O&amp;G Phase II</td>
<td>Tribal MNSR</td>
</tr>
<tr>
<td>NSPS JJJJ – Spark-ignited engines</td>
<td>Subpart KKKK (turbines)</td>
</tr>
<tr>
<td>Farmington RMP Conditions of Approval Standards for Gas Compressors</td>
<td>Point Source Process Heater/Boiler MACT, NSPS</td>
</tr>
<tr>
<td>Federal Tier Standards for off-road diesel engines</td>
<td></td>
</tr>
<tr>
<td>BLM Methane Rule</td>
<td></td>
</tr>
<tr>
<td><strong>State Regulations</strong></td>
<td></td>
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<tr>
<td>Colorado Regulation 7</td>
<td>None</td>
</tr>
</tbody>
</table>
FUTURE YEAR INVENTORY DEVELOPMENT: ACTIVITY FORECASTS (GREATER SAN JUAN BASIN)

- O&G activity growth will be based on forecasts from the US Bureau of Land Management (BLM) study, Colorado Air Resource Management Modeling Study 2.0 (CARMMS)\(^1\)

- O&G activity forecasts available from CARMMS by subarea:
  - Mancos Shale
  - Southern Ute Indian Tribe (SUIT) Shale Supplemental Environmental Impact Study (SEIS)
  - Tres Rios Field Office (TRFO)
  - Farmington Field Office (FFO)

\(^1\)Not yet published
**FUTURE YEAR INVENTORY DEVELOPMENT: ACTIVITY FORECASTS (GREATER SAN JUAN BASIN)**

CARMMS O&G activity forecasts for 2015, 2023, and 2025:

<table>
<thead>
<tr>
<th>Area1</th>
<th>Year</th>
<th>Spud Count</th>
<th>Active Well Count</th>
<th>Gas Production (BCF/yr)</th>
<th>Oil Production (Mbbl/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Low Scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mancos Shale</td>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
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<tr>
<td></td>
<td>2023</td>
<td>173</td>
<td>1,166</td>
<td>245</td>
<td>21,114</td>
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<td>2025</td>
<td>173</td>
<td>1,513</td>
<td>283</td>
<td>23,950</td>
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<tr>
<td>SUIT (SEIS)</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2023</td>
<td>20</td>
<td>104</td>
<td>49</td>
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<td></td>
<td>2025</td>
<td>48</td>
<td>200</td>
<td>102</td>
<td>211</td>
</tr>
<tr>
<td>TRFO</td>
<td>2015</td>
<td>68</td>
<td>3,498</td>
<td>339</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>2023</td>
<td>33</td>
<td>3,831</td>
<td>260</td>
<td>66</td>
</tr>
<tr>
<td></td>
<td>2025</td>
<td>33</td>
<td>3,897</td>
<td>247</td>
<td>59</td>
</tr>
<tr>
<td><strong>High Scenario</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mancos Shale</td>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2023</td>
<td>347</td>
<td>2,333</td>
<td>489</td>
<td>42,228</td>
</tr>
<tr>
<td></td>
<td>2025</td>
<td>347</td>
<td>3,026</td>
<td>566</td>
<td>47,901</td>
</tr>
<tr>
<td>SUIT (SEIS)</td>
<td>2015</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>2023</td>
<td>40</td>
<td>208</td>
<td>99</td>
<td>187</td>
</tr>
<tr>
<td></td>
<td>2025</td>
<td>96</td>
<td>400</td>
<td>204</td>
<td>423</td>
</tr>
<tr>
<td>TRFO</td>
<td>2015</td>
<td>68</td>
<td>3,498</td>
<td>339</td>
<td>135</td>
</tr>
<tr>
<td></td>
<td>2023</td>
<td>82</td>
<td>4,224</td>
<td>323</td>
<td>79</td>
</tr>
<tr>
<td></td>
<td>2025</td>
<td>82</td>
<td>4,389</td>
<td>322</td>
<td>72</td>
</tr>
</tbody>
</table>

1 O&G activity in the Farmington Field Office outside of the Mancos Shale conservatively assumed unchanged from base year.
Report & other project materials available at:
http://www.wrapair2.org/SanJuanPermian.aspx
DRAFT FUTURE YEAR ACTIVITY FORECASTS: CARMMS SUB-AREAS

Colorado Field Office (FO) Planning Areas

Source Regions
- Colorado River Valley FO except Roan Plateau
- Grand Junction FO
- Kremmling FO
- Little Snake FO
- Roan Plateau
- Tres Rios FO
- Uncompahgre FO
- White River FO
- Farmington FO
- RGFO_Area_1_03_NAA
- RGFO_Area_2_South_Park
- RGFO_Area_3_North
- RGFO_Area_4_South
- Southern Ute (SUIT modeling boundary)

Mancos Shale (not shown) intersects the TRFO and FFO areas

Source: CARMMS report, not yet published
DRAFT FUTURE YEAR ACTIVITY FORECASTS: EIA O&G SUPPLY MODULE REGIONS

EIA Oil and Gas Supply Module Regions
Permian Basin oil plays

(note: Permian Basin forecasts will be developed for New Mexico only, Texas is not part of this study)
https://www.eia.gov/todayinenergy/detail.php?id=17031
PERMIAN BASIN: 2014 WELL LOCATIONS BY TYPE

Legend
- Permian Basin
- Tribal Lands

Well Type
- Oil
- Gas
PERMIAN BASIN:
2014 WELL LOCATIONS BY MINERAL OWNERSHIP

Legend
- Permian Basin
- Tribal Lands

Mineral Ownership (2014 Wells)
- Private/State
- Federal
PERMIAN BASIN:
2014 MIDSTREAM FACILITIES BY SURFACE OWNERSHIP

Legend
- Permian Basin
- Tribal Lands

Ownership
- Federal
- Private/State

New Mexico
Texas
Chaves
Roosevelt
Lea
Globe
2014 EMISSIONS (DRAFT):
PERMIAN BASIN

**Basin-wide NOx Percent Contribution by Source Category**
- Drill rigs: 16%
- Nonpoint Heaters: 3%
- Artificial Lift: 13%
- Frac ing: 4%
- Midstream Unclassified: 29%
- Point Source Compressor Engines: 33%
- Other Categories: 2%

**Basin-wide NOx Emissions (tons/year):** 30,351

**Basin-wide VOC Percent Contribution by Source Category**
- Oil Tank: 58%
- Water Tank Venting: 4%
- Point Source Compressor Engines: 1%
- Midstream Unclassified: 7%
- Casinghead Gas Venting: 2%
- Oil Well Truck Loading: 6%
- Other Categories: 2%
- Pneumatic devices: 7%
- Venting - blowdowns: 7%
- Venting - initial completions: 1%
- Condensate tank: 5%

**Basin-wide VOC Emissions (tons/year):** 121,644
2014 EMISSIONS (DRAFT):
GREATER SAN JUAN BASIN

- GHG emissions were not estimated for point source facilities for which process level emissions were unavailable

- Super-emitters were not included in emission inventory estimates

### 2014 Greater San Juan Basin emissions by mineral ownership:

<table>
<thead>
<tr>
<th>Mineral Ownership</th>
<th>NOx [tons/year]</th>
<th>VOC [tons/year]</th>
<th>CO [tons/year]</th>
<th>SOx [tons/year]</th>
<th>PM [tons/year]</th>
<th>CO₂ (e)¹ [tons/year]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Private/State</td>
<td>19,198</td>
<td>61,422</td>
<td>15,016</td>
<td>8,863</td>
<td>346</td>
<td>9,076,317</td>
</tr>
<tr>
<td>Federal</td>
<td>11,153</td>
<td>60,222</td>
<td>10,803</td>
<td>3,530</td>
<td>191</td>
<td>6,606,435</td>
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<tr>
<td>Total</td>
<td>30,351</td>
<td>121,644</td>
<td>25,819</td>
<td>12,393</td>
<td>537</td>
<td>15,682,752</td>
</tr>
</tbody>
</table>

¹ CO₂ (e) includes all CO₂ emissions and CO₂ (e) equivalent NOx, SOx, and PM emissions.
FUTURE YEAR INVENTORY DEVELOPMENT: ACTIVITY FORECASTS (PERMIAN BASIN)

- O&G activity growth will be based on US Energy Information Association (EIA) Annual Energy Outlook (AEO) forecasts

2017 AEO O&G production estimates for 2014 and forecasts to 2023 and 2028

<table>
<thead>
<tr>
<th>Region / Shale Play</th>
<th>Oil Production (million barrels per day)</th>
<th>Gas Production (trillion cubic feet per year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2014</td>
<td>2023</td>
</tr>
<tr>
<td>Southwest Region-wide</td>
<td>1.74</td>
<td>2.68</td>
</tr>
<tr>
<td>Southwest</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shale Plays in the Permian Basin (New Mexico)</td>
<td>0.19</td>
<td>0.44</td>
</tr>
<tr>
<td>Avalon/Bone Springs</td>
<td>0.2</td>
<td>0.68</td>
</tr>
<tr>
<td>Wolfcamp</td>
<td>0.2</td>
<td>0.68</td>
</tr>
</tbody>
</table>