May 12, 2017

# MEMORANDUM

To: Tom Moore, WESTAR; Mark Jones, NMED
From: John Grant, Rajashi Parikh, Amnon Bar-Ilan
Subject: EPA O&G Tool 2014 O&G Input Factor Recommendations for the Portion of Greater San Juan and Permian Basins in New Mexico

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As part of updates for the 2014 (v2) National Emission Inventory (NEI) development, the US Environmental Protection Agency (EPA) has solicited updates to basin factors and speciation factors that are inputs to nonpoint oil and gas (O&G) emissions estimated in the O&G Tool. Under contract to the Western States Air Resources Council (WESTAR), Ramboll Environ has developed recommendations for Permian Basin and Greater San Juan Basin O&G Tool Inputs as described below. Corresponding electronic spreadsheet files are provided separately with the recommended updates.

## Permian Basin Input Factor Review

Current Permian Basin O&G Tool inputs for basin factors and speciation factors are primarily based on Subpart W, Texas Commission on Environmental Quality (TCEQ), CenSARA (2012)[1], and national data sets. Table 1 shows Permian Basin nitrogen oxides (NOx) and volatile organic compound (VOC) O&G emission contributions as estimated in the 2014 (v2) O&G Tool. Ramboll Environ reviewed basin factors for specific source categories (highlighted rows in Table 1) per direction from New Mexico Environmental Department (NMED) staff[2]. Ramboll Environ made a generalized review of speciation factors.

**Table 1. Permian Basin 2014 (v2) O&G Tool NOx and VOC emissions[3].**

| NMED Review Request?[2] | Source Category | NOx Emissions | | VOC Emissions | |
|---|---|---|---|---|---|
| | | (tpy) | (%) | (tpy) | (%) |
| N | Artificial Lifts | 2,628 | 23% | 34 | 0% |
| Y | Associated Gas | 1 | 0% | 1,969 | 2% |
| N | Condensate Tanks | 1 | 0% | 477 | 0% |
| Y | Crude Oil Tanks | 25 | 0% | 80,306 | 70% |
| N | Dehydrators | 57 | 0% | 590 | 1% |
| N | Drill Rigs | 3,900 | 34% | 246 | 0% |
| Y | Fugitives | 0 | 0% | 10,108 | 9% |
| N | Gas-Actuated Pumps | 0 | 0% | 2,821 | 2% |
| N | Heaters | 399 | 3% | 38 | 0% |

[1] www.censara.org/filedepot_download/56064/14
[2] Email from Mark Jones (New Mexico Environment Department), April 19, 2017.
[3] 2014 (v2) Permian Basin O&G emission results provided via email from Regi Oommen (ERG), April 11, 2017.

Ramboll Environ, 773 San Marin Drive, Suite 2115, Novato, CA 94998
V +1 415.899.0700 F +1 415.899.0707
www.ramboll-environ.com

| NMED Review Request?[2] | Source Category | NOx Emissions (tpy) | NOx Emissions (%) | VOC Emissions (tpy) | VOC Emissions (%) |
|---|---|---|---|---|---|
| Y | Hydraulic Fracturing | 981 | 9% | 62 | 0% |
| Y[A] | Lateral/Gathering Compressor Engines | 1,828 | 16% | 50 | 0% |
| Y | Liquids Unloading | 28 | 0% | 3,832 | 3% |
| N | Loading Emissions | 0 | 0% | 16 | 0% |
| N | Mud Degassing | 0 | 0% | 2,052 | 2% |
| Y | Pneumatic Devices | 0 | 0% | 7,628 | 7% |
| Y | Produced Water | 0 | 0% | 1,551 | 1% |
| Y | Well Completions | 10 | 0% | 2,265 | 2% |
| Y[1] | Wellhead Compressor Engines | 1,553 | 14% | 37 | 0% |
| | **Grand Total** | **11,410** | **100%** | **114,081** | **100%** |

[A] Compressor engine input factors for the Permian basin are being evaluated by TCEQ staff (Michael Ege). Ramboll Environ will not perform additional analysis for this source category.

## Permian Basin Factors

We compared basin factor inputs for select source categories to those documented in Grant et al. (2016)[4]. Grant et al. (2016) input factors for the Permian Basin are based primarily on the O&G emission inventory for the portion of the Permian Basin in Texas compiled by TCEQ. Appendix A documents Permian basin factors in the O&G Tool side-by-side with input factors from Grant et al. (2016) for select source categories. Table 2 provides recommendations for Permian basin factor updates by source category and well type; only minor updates are recommended.

**Table 2. Permian basin factor update recommendations (U=update, N = no update).**

| Source Category | Gas Wells | Oil Wells |
|---|---|---|
| Associated Gas | N | - |
| Crude Oil Tanks[C] | - | Y |
| Fugitive Components[A] | U | U |
| Hydraulic Fracturing | N | |
| Liquids Unloading[B] | U | - |
| Pneumatic Controllers | N | N |
| Produced Water | N | N |
| Well Completions | N | N |

[A] Minor update for pump seals components
[B] Minor update for liquid unloading controls
[C] Update for crude oil tank control fraction only

## Permian Speciation Factors

Our professional judgment is that Permian Basin speciation factors are generally reasonable and need not be updated at this time. Detailed analysis of these speciation factors was not feasible given schedule and resource constraints for this analysis.

[4] https://www.wrapair2.org/pdf/2016-11y_Final%20GSJB-Permian%20EI%20Inputs%20Report%20(11-09).pdf

## Greater San Juan Basin Input Factor Review

Current San Juan Basin O&G Tool inputs for basin factors and speciation factors are primarily based on Subpart W, WRAP Phase III[5], CenSARA (2012), and other national data sets. Ramboll Environ has recommended updates based on Grant et al. (2016).

### Greater San Juan Basin Factors

Greater San Juan Basin O&G Tool basin factor updates have been compiled from Grant et al. (2016). Grant et al. (2016) input factors for the Greater San Juan Basin are based primarily on operator surveys and Subpart W data. Table 3 shows the basin factor updates by well type and source category. For fugitive components, service types available in the O&G Tool are restricted by well type; not all components were able to be included in the updated basin factor tables (see Table 4).

**Table 3. Greater San Juan basin factor update recommendations (U=update, N = no update).**

| Source Category | Gas Wells | CBM[6] Wells | Oil Wells |
|---|---|---|---|
| Artificial Lift Engines[A] | U | - | - |
| Associated Gas | U | - | - |
| Condensate Tank | U | U | - |
| Crude Oil Tanks | - | - | U |
| Dehydrators | U | | - |
| Drill Rigs (Horizontal) | U | | |
| Drill Rigs (Vertical) | U | | |
| Fugitive Components | U | U | U |
| Gas Actuated Pumps[D] | N | N | N |
| Heaters | U | | U |
| Hydraulic Fracturing | U | | |
| Lateral Compressor Engines | U | | - |
| Liquids Unloading | U | U | - |
| Loading | U | U | U |
| Mud Degassing | N | N | N |
| Pneumatic Controllers | U | U | U |
| Produced Water[B] | N | N | N |
| Well Completions | U | U | U |
| Wellhead Compressor Engines[C] | U | U | U |
| *Refracturing Engines* | *not in O&G Tool; consider inclusion in future versions* | | |
| *Workover Rigs* | | | |
| *Water Pump Engines* | | | |

[A] Grant et al. (2016) identifies artificial lift engine prevalence at oil wells as 0.99 engines per well; this update should be made in a separate O&G Tool activity input table.
[B] No updates are recommended since Grant et al. (2016) input data are based on an earlier version of the O&G Tool.
[C] Grant et al. (2016) identifies wellhead compressor engine prevalence at gas wells and CBM wells as 0.94 engines per well; this update should be made in a separate O&G Tool activity input table.
[D] Methodology differences do not allow for use of Grant et al. (2016) gas actuated pump inputs to estimate O&G Tool basin factors.

[5] https://www.wrapair2.org/PhaseIII.aspx
[6] CBM refers to coalbed-methane

**Table 4. Fugitive component counts for the Greater San Juan Basin.**

| Location, service type, component type | Component count/well[A] | | |
|---|---|---|---|
| | Oil Well[B] | Gas Wells[C] | CBM Wells[C] |
| Onshore, gas service - valve | 47 | 81 | 80 |
| Onshore, gas service - connector | 147 | 264 | 256 |
| Onshore, gas service - open-ended line | 6 | 10 | 9 |
| Onshore, gas service - pressure relief valve | 2 | 4 | 4 |
| Onshore, gas service – other[D] | <1 | <1 | 0 |
| Onshore, light crude service - valve | 5 | <1 | <1 |
| Onshore, light crude service - flange | 10 | <1 | <1 |
| Onshore, light crude service - connector | 6 | <1 | <1 |
| Onshore, light crude service - open-ended line | <1 | 0 | 0 |
| Onshore, light crude service - pump | 0 | 0 | 0 |
| Onshore, light crude service - other[D] | <1 | <1 | <1 |
| Onshore, heavy crude service - valve | 0 | 0 | 0 |
| Onshore, heavy crude service - flange | 0 | 0 | 0 |
| Onshore, heavy crude service - connector | 0 | 0 | 0 |
| Onshore, heavy crude service - open-ended line | 0 | 0 | 0 |
| Onshore, heavy crude service - other[D] | 0 | 0 | 0 |
| Onshore, water service - valve | <1 | 0 | 0 |
| Onshore, water service - connector | <1 | 0 | 0 |
| Onshore, water service - open-ended line | <1 | 0 | 0 |
| Onshore, water service - pressure relief valve | 0 | 0 | 0 |
| Onshore, water service - other[D] | 12 | 0 | 0 |

[A] Highlighted cells not able to be included in updated basin factors because these fields do not exist in the basin factor input table.
[B] Gas service components at oil wells are not included in the basin factor table.
[C] No light crude, heavy crude, or water service component counts at gas or CBM wells are available for input to the basin factor table.
[D] No "other" device type input field is available in the basin factor table.

## Greater San Juan Basin Speciation Factors

Our professional judgment is that Greater San Juan Basin compositions are generally reasonable, except for 1) CBM well venting/loss profiles and 2) profiles for oil well and gas well venting/loss sources which indicate 0% weight fractions for hazardous air pollutants. We have provided CBM wells source category speciation factor file updates, but have not updated speciation factor files for oil or gas wells to resolve the issue of 0% weight fractions for hazardous air pollutants due to project schedule and resource constraints.

## Recommendations

O&G Tool input factor implementation recommendations are as follows:

1. Update Permian basin factors as specified in Table 2.
2. Make no updates to Permian basin speciation factors.
3. Update Greater San Juan basin factors as specified in Table 3. Artificial lift and wellhead compressor engine prevalence listed in Table 3 footnotes should be updated in O&G Tool activity input tables.
4. Update Greater San Juan speciation factors for CBM venting/loss source categories.

Potential enhancements to the O&G Tool that would allow for inclusion of additional O&G emission sources are as follows:

1. Expand basin factor inputs to allow entry of fugitive component counts for all service types across all well types.
2. Add source categories to capture production phase emissions from water pump engines, hydraulic fracturing engines, and workover rig engines.

# Appendix A

## Permian Basin Factors Comparison

**Table A1. Permian basin factors comparison for select source categories.**

| Data Category | O&G Tool | | Grant et al. (2016) |
|---|---|---|---|
| | Current Value | Current Reference | |
| **Associated Gas** | | | |
| Gas Venting Rate (MCF gas/BBL Oil) | 0.004 | NM_2013 | not available |
| Fraction of Gas Vented | 0.055 | EPA_2015d | not available |
| Flaring Control Efficiency (%) | 98% | CENSARA_STUDY_2012_EXTENSION | not available |
| Flaring Capture Efficiency (%) | 100% | CENSARA_STUDY_2012_EXTENSION | not available |
| **Crude Oil Tanks** | | | |
| Crude Oil Fraction directed to Tanks | 100% | CENSARA_STUDY_2012_EXTENSION | not available |
| Fraction of Oil Tanks with Flares | 15% | EPA_2015d | 27%[1,2] |
| Average VOCs Loss (lb VOCs/BBL Crude Oil) | 1.60 | CENSARA_STUDY_2012_EXTENSION | 1.60 |
| Flaring Capture Efficiency (%) | 100% | CENSARA_STUDY_2012_EXTENSION | not available |
| Flaring Control Efficiency (%) | 98% | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Venting Rate (MCF gas/BBL Crude Oil) | 0.02 | CENSARA_STUDY_2012_EXTENSION | not available |
| **Fugitives - Gas Wells** | | | |
| Gas Wells - Number of Valves | 19 | CENSARA_STUDY_2012_EXTENSION | 19 |
| Gas Wells - Number of Connectors | 43 | CENSARA_STUDY_2012_EXTENSION | 43 |
| Gas Wells - Number of Flanges | 29 | CENSARA_STUDY_2012_EXTENSION | 29 |
| Gas Wells - Number of Open Ended Lines | 3 | CENSARA_STUDY_2012_EXTENSION | 3 |
| Gas Wells - Count of Compressor Seals | 0 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Wells - Number of Pump Seals | 0 | CENSARA_STUDY_2012_EXTENSION | 2[1] |
| Gas Wells - Methane Leak rate/compressor per hour | 12 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Wells - Number of wells/ lateral compressor | 35 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Wells - Number of Others | Field not available in Basin Factor Table | | 10 |
| **Fugitives - Oil Wells** | | | |
| Light Oil Wells Service - Number of Valves | 16 | CENSARA_STUDY_2012_EXTENSION | 16 |
| Light Oil Wells Service - Number of Pump Seals | 0 | CENSARA_STUDY_2012_EXTENSION | 2[1] |
| Light Oil Wells Service - Number of Connectors | 58 | CENSARA_STUDY_2012_EXTENSION | 58 |
| Light Oil Wells Service - Number of Flanges | 12 | CENSARA_STUDY_2012_EXTENSION | 12 |
| Light Oil Wells Service - Number of Open Ended Lines | 2 | CENSARA_STUDY_2012_EXTENSION | 2 |
| Oil Wells - Number of Others | Field not available in Basin Factor Table | | 10 |

| Data Category | O&G Tool | | Grant et al. (2016) |
|---|---|---|---|
| | Current Value | Current Reference | |
| **Hydraulic Fracturing** | | | |
| Hydraulic Fracture Horsepower (HP) | 2,313 | TX_ERG_STUDY_2014_EXTENSION | 1,258 |
| Hydraulic Fracture Load Factor | 0.36 | TX_ERG_STUDY_2014_EXTENSION | 0.63 |
| Number of Stages per Fracturing Event (count) | 16.80 | TX_ERG_STUDY_2014_EXTENSION | 5.75 |
| Total Duration for fracturing (hrs/year) | 1.38 | TX_ERG_STUDY_2014_EXTENSION | 1.50 |
| Number of fracturing engines per fracturing event (count) | 9.80 | TX_ERG_STUDY_2014_EXTENSION | 3.50 |
| Alternate Hyrdraulic Fracture Emission Factor (grams/HP-HR) | 0.00 | CENSARA_STUDY_2012 | not available |
| **Liquids Unloading - Gas Wells** | | | |
| Annual Frequency of Events (# DAYS) | 5.00 | CENSARA_STUDY_2012_EXTENSION | 5.00 |
| Volume of Gas Flared (MCF/event) | 50.00 | CENSARA_STUDY_2012_EXTENSION | 0.00[1] |
| Volume of Gas Vented (MCF/event) | 50.00 | CENSARA_STUDY_2012_EXTENSION | 50.00 |
| Control Method Used | FLARE | CENSARA_STUDY_2012_EXTENSION | not available |
| Fraction of Liquids Unloading Controlled | 0.50 | CENSARA_STUDY_2012_EXTENSION | 0.00[1] |
| Control Efficiency (%) | 98.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| **Pneumatic Devices - Gas Wells** | | | |
| Gas wells: Number of No Bleed devices (COUNT) | 0.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas wells: Bleed rate, No Bleed devices (SCF/HR/DEVICE) | 0.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas wells: Number of Low Bleed devices (COUNT) | 0.09 | EPA_2015d | not available |
| Gas wells: Bleed rate, Low Bleed devices (SCF/HR/DEVICE) | 3.15 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas wells: Number of High Bleed devices (COUNT) | 0.07 | EPA_2015d | not available |
| Gas wells: Bleed rate, High Bleed devices (SCF/HR/DEVICE) | 32.07 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas wells: Number of Intermittent Bleed devices (COUNT) | 0.43 | EPA_2015d | not available |
| Gas wells: Bleed rate, Intermittent Bleed devices (SCF/HR/DEVICE) | 8.58 | CENSARA_STUDY_2012_EXTENSION | not available |

| Data Category | O&G Tool | | Grant et al. (2016) |
|---|---|---|---|
| | Current Value | Current Reference | |
| Gas well: Number of total devices (COUNT) | Direct comparison not possible | | 1.19 |
| Gas wells: Bleed rate, weighted average across all device types (SCF/HR/DEVICE) | Direct comparison not possible | | 8.79 |
| **Pneumatic Devices - Oil Wells** | | | |
| Oil wells: Number of No Bleed devices (COUNT) | 0.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil wells: Bleed rate, No Bleed devices (SCF/HR/DEVICE) | 0.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil wells: Number of Low Bleed devices (COUNT) | 0.26 | EPA_2015d | not available |
| Oil wells: Bleed rate, Low Bleed devices (SCF/HR/DEVICE) | 3.15 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil wells: Number of High Bleed devices (COUNT) | 0.04 | EPA_2015d | not available |
| Oil wells: Bleed rate, High Bleed devices (SCF/HR/DEVICE) | 32.07 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil wells: Number of Intermittent Bleed devices (COUNT) | 0.28 | EPA_2015d | not available |
| Oil wells: Bleed rate, Intermittent Bleed devices (SCF/HR/DEVICE) | 5.25 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas well: Number of total devices (COUNT) | Direct comparison not possible | | 0.43 |
| Gas wells: Bleed rate, weighted average across all device types (SCF/HR/DEVICE) | Direct comparison not possible | | 5.24 |
| **Produced Water** | | | |
| Fraction of Produced Water sent to Tanks | 100% | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Wells: Average Loss of Methane (lb CH4/BBL) | 0.11 | CENSARA_STUDY_2012_EXTENSION | not available |
| CBM Wells: Average Loss of Methane (lb CH4/BBL) | 0.11 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil Wells, Low Pressure: Average Loss of Methane (lb CH4/BBL) | 0.00 | CENSARA_STUDY_2012_EXTENSION | not available |
| Oil Wells, Regular Pressure: Average Loss of Methane (lb CH4/BBL) | 0.03 | CENSARA_STUDY_2012_EXTENSION | not available |
| Gas Wells: Average Loss of VOC (lb/bbl) | Direct comparison not possible | | 0.01 |
| **Well Completions** | | | |
| Oil Well - Volume of Gas Vented, unconventional | 736 | CENSARA_STUDY_2012_EXTENSION | 0 |

| Data Category | O&G Tool | | Grant et al. (2016) |
|---|---|---|---|
| | Current Value | Current Reference | |
| Oil Well - Volume of Gas Vented, conventional | 736 | CENSARA_STUDY_2012_EXTENSION | 0 |
| Gas Well - Volume of Gas Vented, unconventional | 9,000 | EPA_2012 | 0 |
| Gas Well - Volume of Gas Vented, conventional | 736 | CENSARA_STUDY_2012_EXTENSION | 0 |
| CBM Well - Volume of Gas Vented, unconventional | 9,000 | EPA_2012 | 0 |
| CBM Well - Volume of Gas Vented, conventional | 736 | CENSARA_STUDY_2012_EXTENSION | 0 |
| Fraction with Flaring | 28% | NM_2013 | 0 |
| Flaring Control Efficency (%) | 98% | CENSARA_STUDY_2012_EXTENSION | not available |
| Flaring Capture Efficency (%) | 90% | NM_2013 | not available |
| Fraction of wells that are Green Completed | 36% | NM_2013 | 0 |

[1] Basin factor update recommended

[2] Alternative data source: Email from Mark Pring (ERG), May 2, 2017