

# WRAP/WEA Phase III Oil and Gas Emissions Inventory Development for the Intermountain West

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# Overview

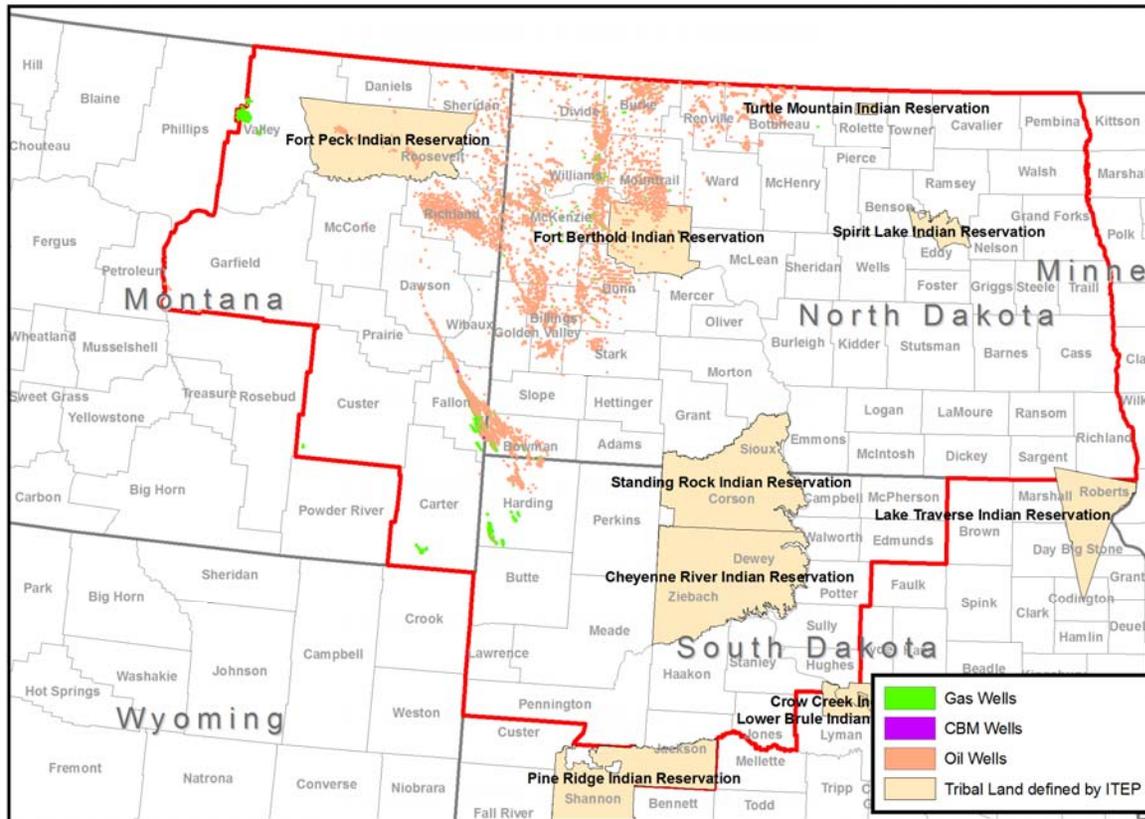
- **Phase III project overview**
- **Williston Basin – geographic scope and background**
- **Williston Basin – 2009 baseline emissions results**
- **Williston Basin – midterm projections methodology**
- **Williston Basin – 2015 midterm emissions results**
- **Observations**

## Phase III – Overview of Inventory Effort

- Inventory is conducted on a basin-by-basin level
- Phase III has now completed most major oil and gas production basins in the Intermountain West
- Inventories include most major oil and gas sources including area sources and point sources – but does not include mobile sources (with the exception of drilling rigs)
- Temporal scope considers a 2009 baseline year, 2015 midterm projections for the Williston Basin
- Only criteria pollutants are covered: NO<sub>x</sub>, VOC, CO, SO<sub>x</sub>, PM

# Williston Basin – Geographic Scope

## Williston Basin - 2009 Wells



- Large geographic area including North Dakota, Montana and small portion of South Dakota with oil and gas activity on both tribal and non-tribal land
- Basin boundaries re-defined to align with the county boundary to simplify reporting
- County-level emissions generated for all counties as well as separately for tribal and non-tribal land fractions

## Williston Basin – Overview and Observations

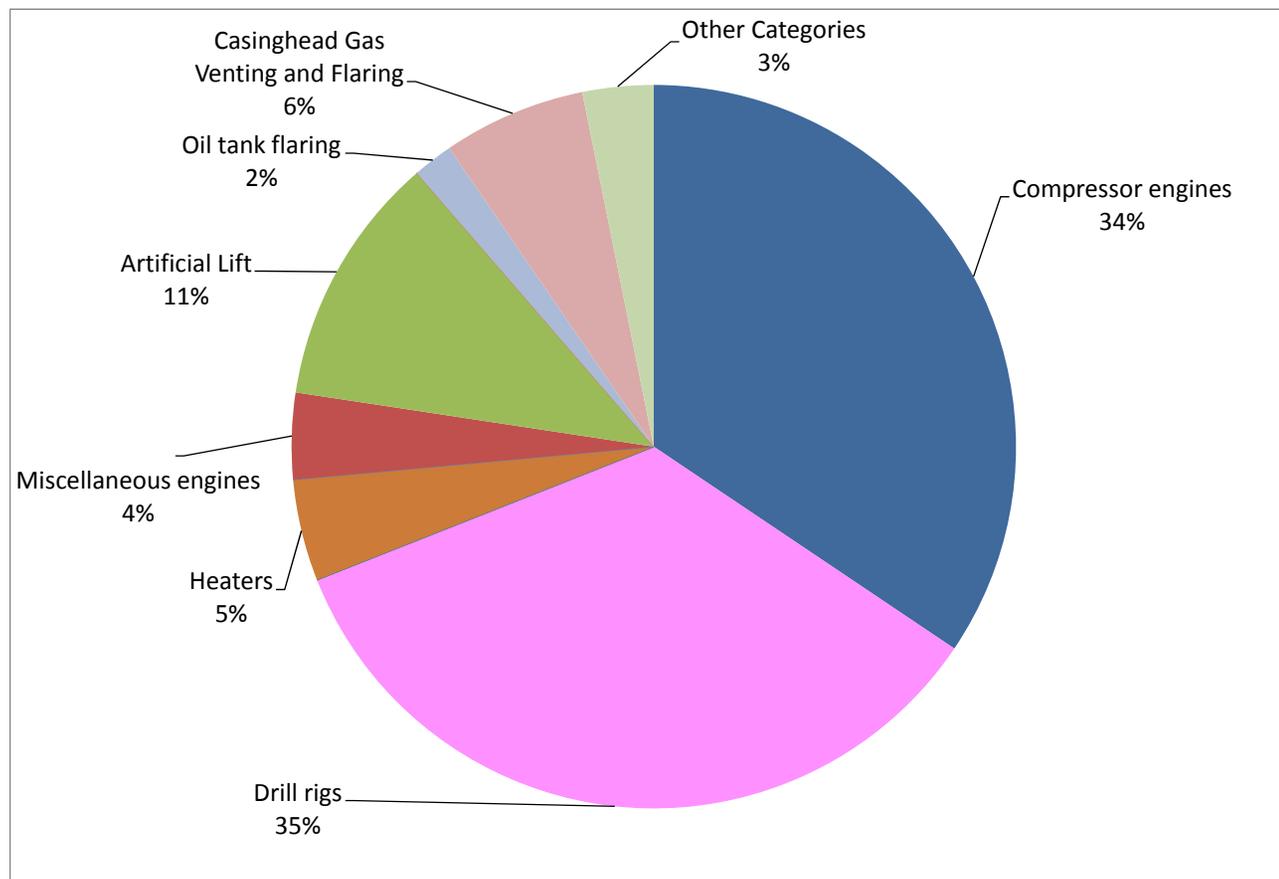
- Williston Basin is the largest basin in the Phase III study by geographic area including major production areas in Montana and North Dakota and a small portion of northwest South Dakota, and significant activity on Fort Berthold Indian Reservation (FBIR)
- Largest oil production basin in the Phase III study, and one of the largest oil producing regions in the US; some gas production mainly associated gas from oil wells and some conventional gas – minimal CBM production
- Primary oil development in the Bakken Shale with additional production from the Cedar Creek Anticline
- Approximately 7% of primary oil production and 2% of gas production in the basin occurs on the FBIR
- Significant flaring of associated gas occurs in the Williston Basin

## Williston Basin – Phase III inventory

- Phase III inventory for Williston Basin used the same methodology as developed for past basins that we have reported on; however survey data responses were extremely limited
- Data sources included: detailed survey data sent to major oil and gas producers in the basin; permit data from MTDEQ and NDDOH primarily for midstream sources located on state-administered land; EPA permit data for major sources on tribal land; broader regional or national data to gap-fill missing information
- Emissions inventory was developed for 2009 baseline year and 2015 midterm projections for all criteria pollutants  
(NO<sub>x</sub>, VOC, CO, SO<sub>x</sub>, PM)

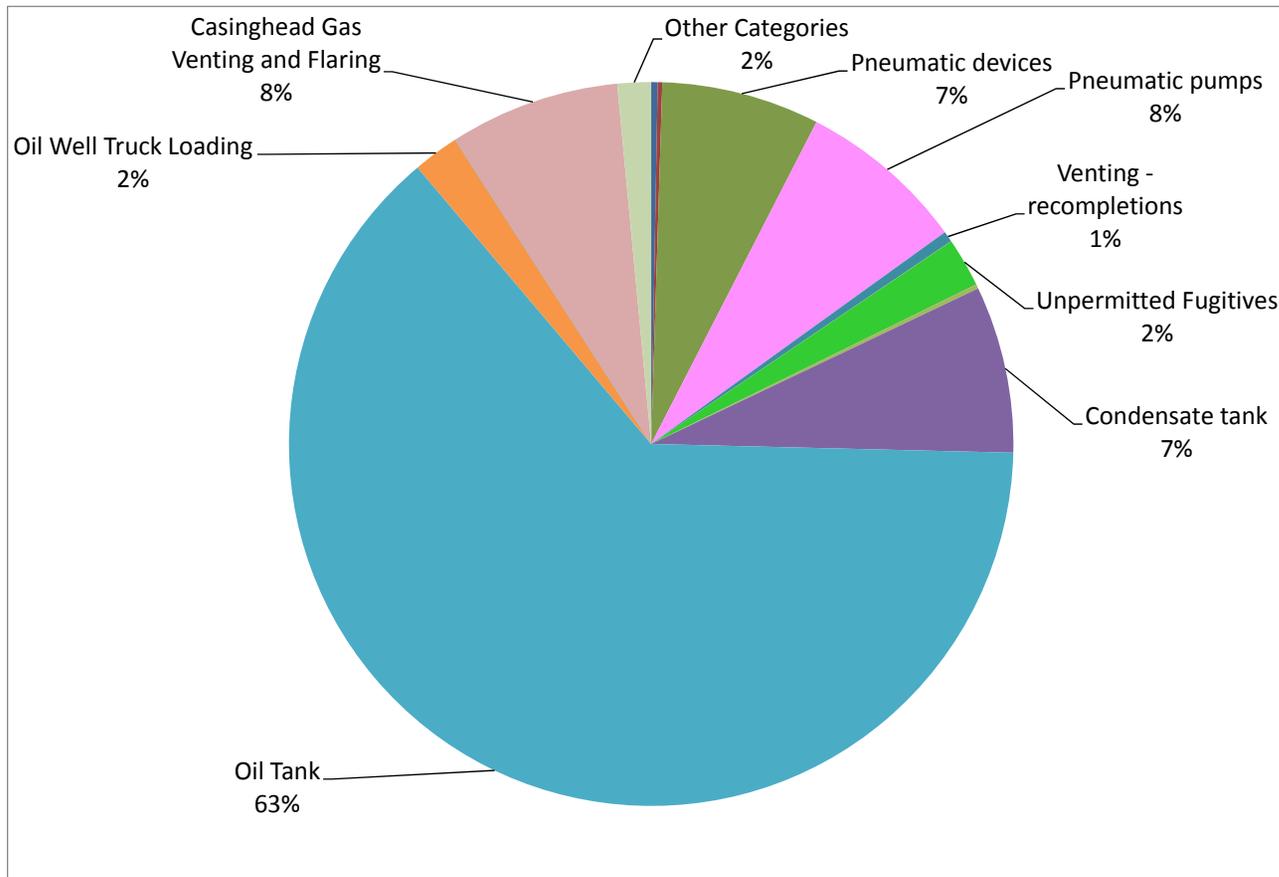
## Williston Basin 2009 Baseline Results NOx Emissions By Source Category

**Basin-wide NOx total:  
14,387 (tpy)**



- NOx emissions dominated by drilling rigs and compressor engines due to significant drilling activity in 2009

## Williston Basin 2009 Baseline Results VOC Emissions By Source Category

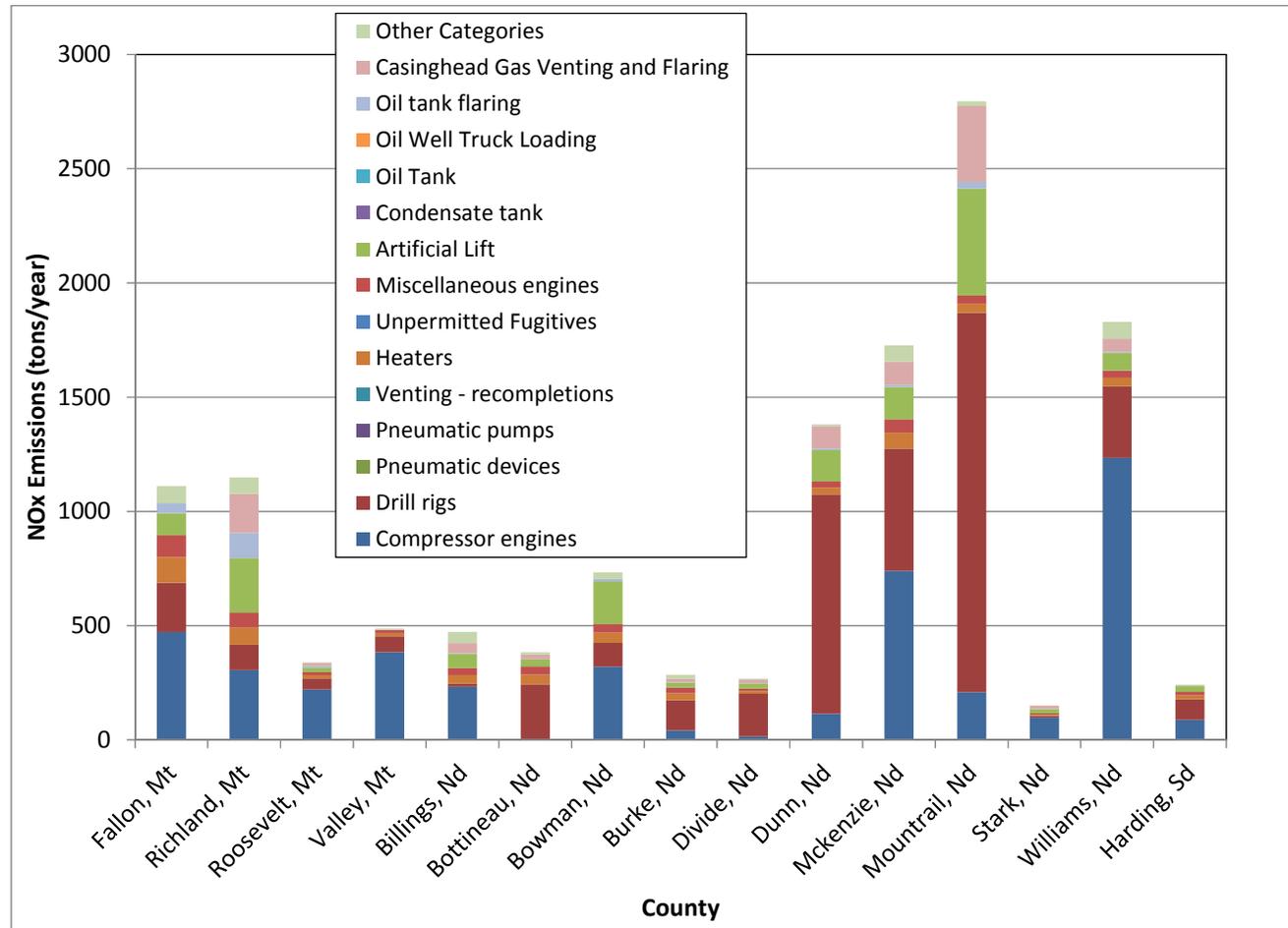


**Basin-wide VOC  
total: 357,798 (tpy)**

•VOC emissions dominated by oil tank flashing, estimated to account for approximately 63% of basin-wide VOC emissions with additional emissions from casinghead gas flaring, and pneumatics

## Williston Basin 2009 Baseline Results NOx Emissions by County

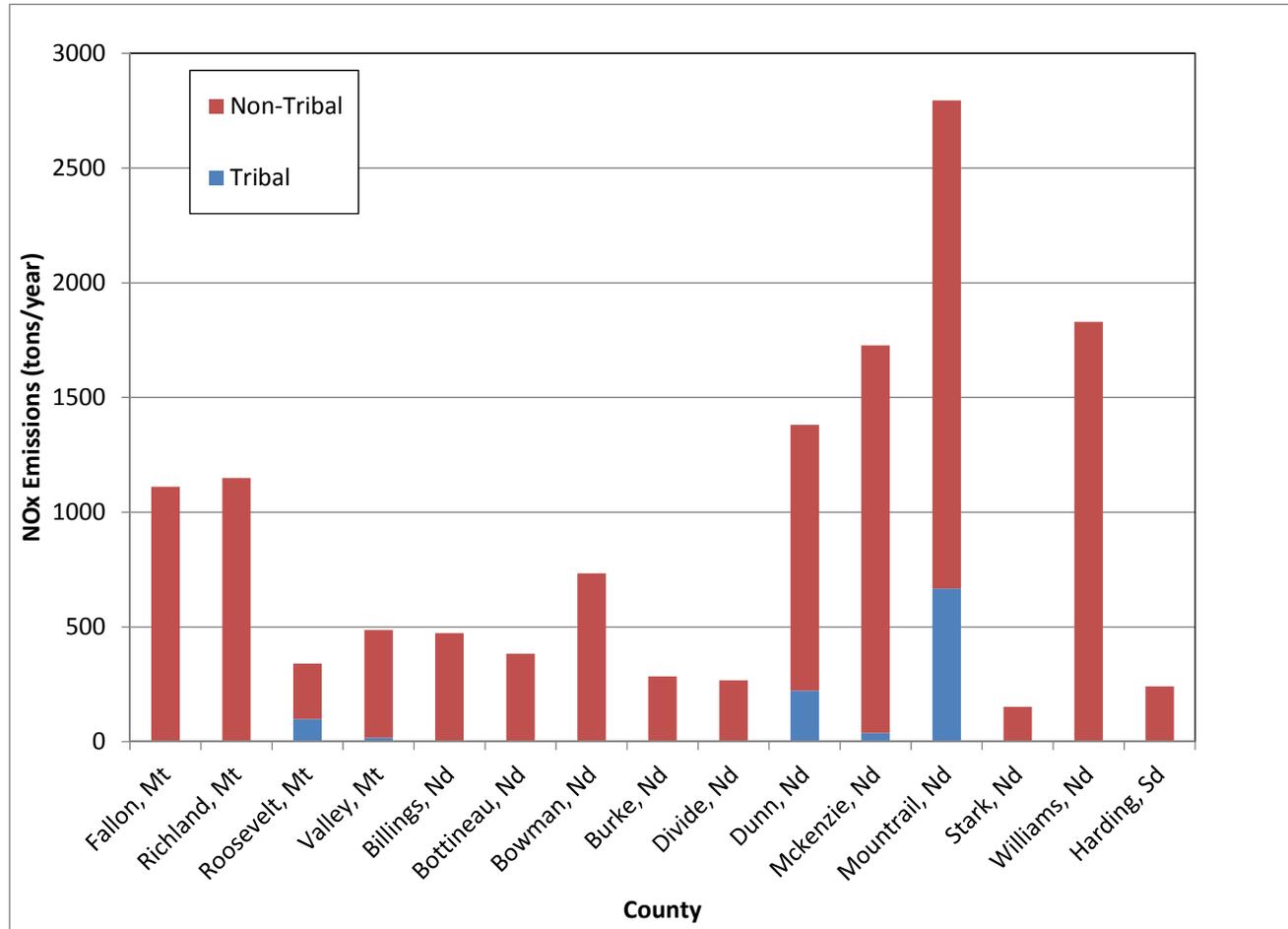
**Basin-wide NOx total:  
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•Counties with less than 1% of basin-wide emissions are not shown

## Williston Basin 2009 Baseline Results NOx Emissions by Tribal and Non-Tribal Land

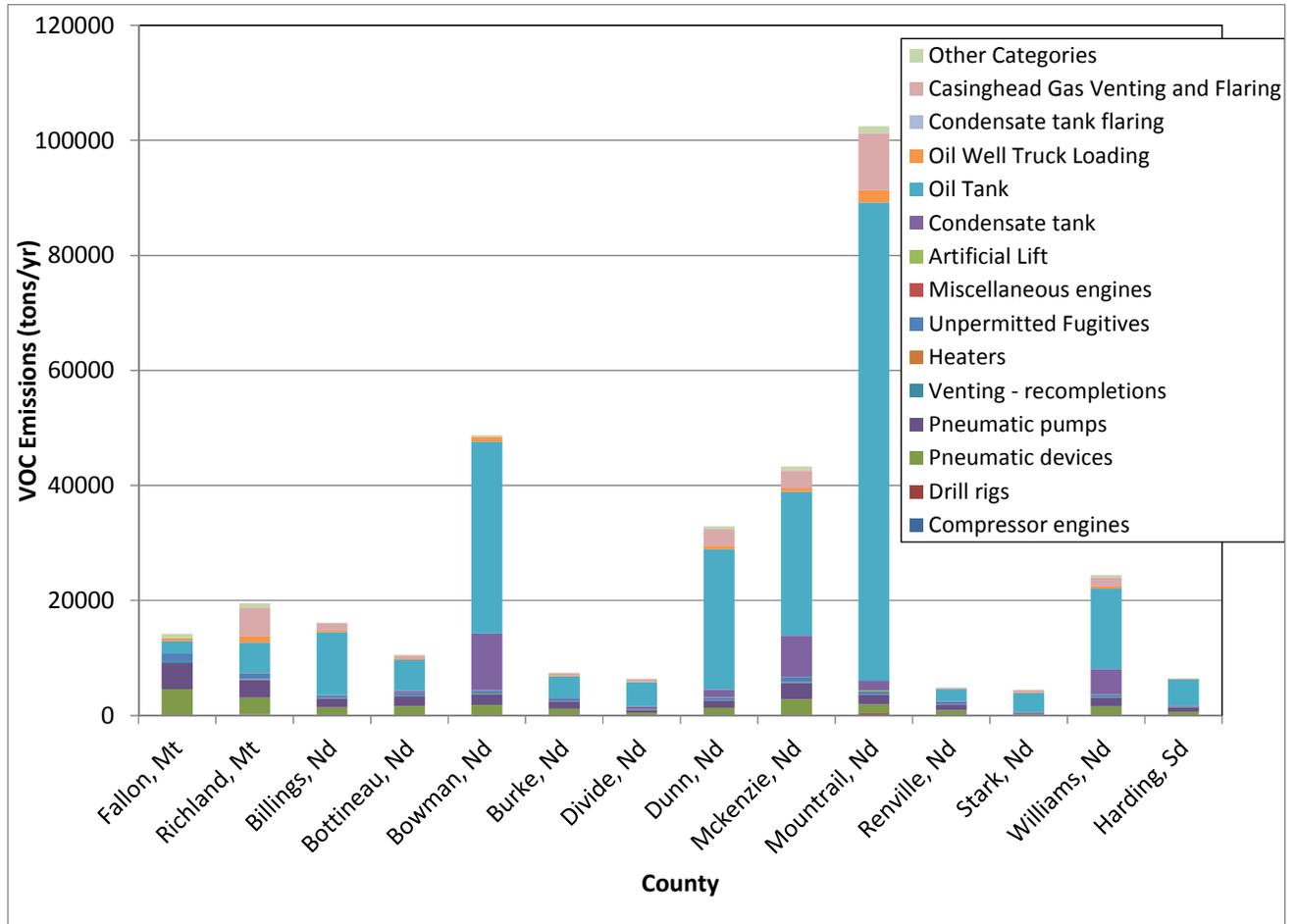
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## Williston Basin 2009 Baseline Results VOC Emissions by County

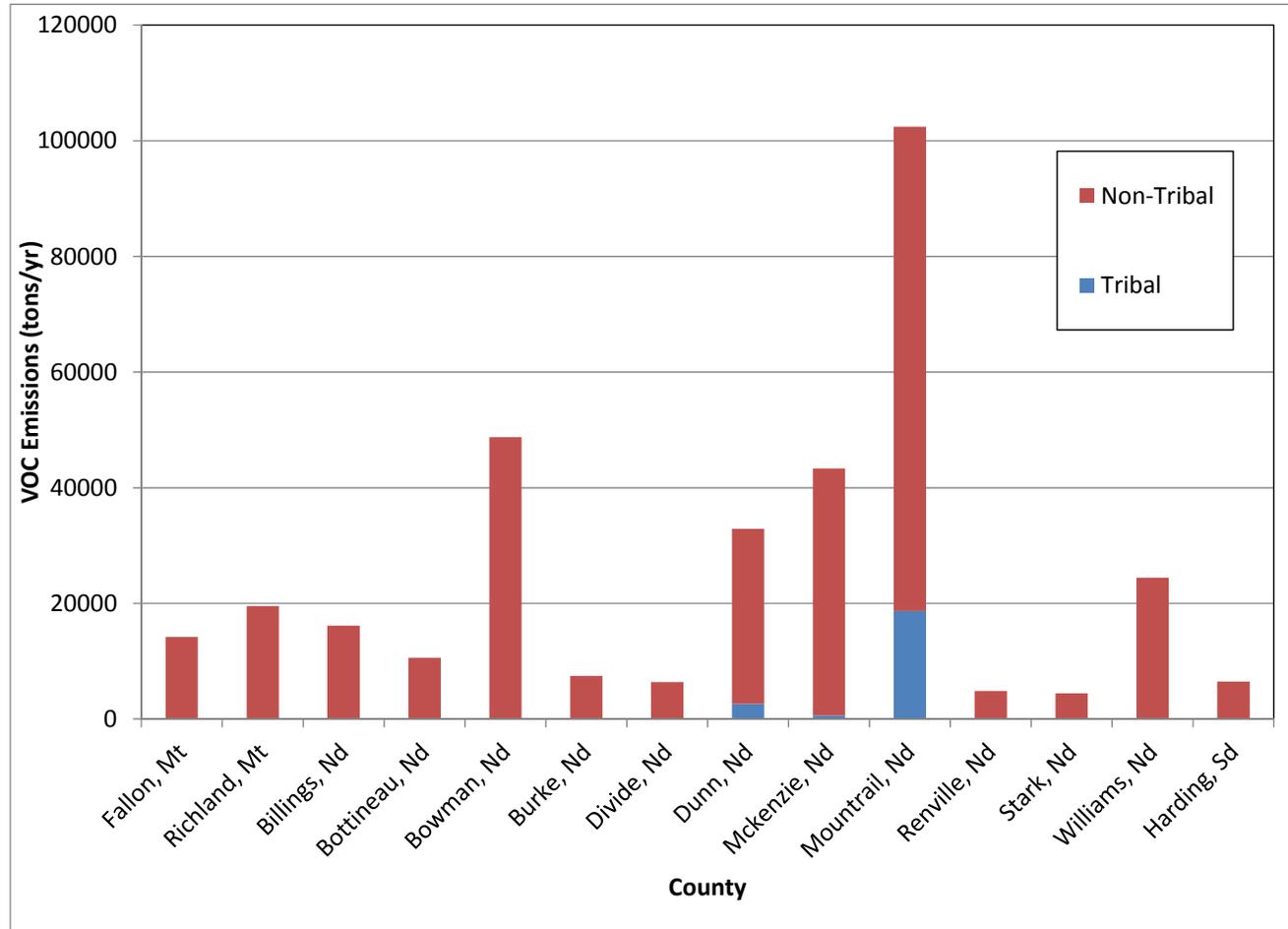
**Basin-wide VOC total:  
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## Williston Basin 2009 Baseline Results VOC Emissions by Tribal and Non-Tribal Land

**Basin-wide VOC total:  
357,798 (tpy)**



•Counties with less than 1% of basin-wide emissions are not shown

## Williston Basin 2009 Baseline Emissions - Observations

| Basin                   | Well Count |        |        | Oil Production (bbl) |              |                     | Gas Production (MCF) |               |             | Spud Counts |
|-------------------------|------------|--------|--------|----------------------|--------------|---------------------|----------------------|---------------|-------------|-------------|
|                         | Total      | CONV   | CBM    | Total                | Oil Well Oil | Gas Well Condensate | Total                | CONV          | CBM         | Total       |
| D-J Basin               | 16,774     | 16,774 | 0      | 14,242,088           | 0            | 14,242,088          | 234,630,779          | 234,630,779   | 0           | 1500        |
| Uinta Basin             | 6,881      | 6,018  | 863    | 11,528,121           | 9,758,247    | 1,769,874           | 331,844,336          | 254,219,432   | 77,624,904  | 1069        |
| Piceance Basin          | 6,315      | 6,255  | 60     | 7,158,305            | 5,755,076    | 1,403,229           | 421,358,666          | 420,165,237   | 1,193,429   | 1186        |
| North San Juan Basin    | 2,676      | 1,009  | 1,667  | 32,529               | 27,962       | 4,567               | 443,828,500          | 28,642,418    | 415,186,082 | 127         |
| South San Juan Basin    | 20,649     | 16,486 | 4,163  | 2,636,811            | 1,002,060    | 1,634,751           | 1,020,014,851        | 520,060,869   | 499,953,982 | 919         |
| Wind River Basin        | 1,350      | 1,330  | 20     | 3,043,459            | 2,563,912    | 479,547             | 198,190,024          | 197,166,868   | 1,023,156   | 98          |
| Powder River Basin      | 25,652     | 7,793  | 17,859 | 19,662,896           | 19,144,596   | 518,300             | 452,813,743          | 64,019,159    | 388,794,584 | 3,275       |
| Southwest Wyoming Basin | 9,173      | 9,019  | 154    | 16,109,922           | 6,324,849    | 9,785,073           | 1,468,167,385        | 1,461,271,032 | 6,896,353   | 1,146       |
| Williston Basin*        | 8,144      | 8,141  | 3      | 105,868,409          | 101,729,112  | 4,139,297           | 150,025,060          | 149,979,559   | 45,501      | 716         |

| Basin                   | Emissions (tons/yr) |         |        |       |       |
|-------------------------|---------------------|---------|--------|-------|-------|
|                         | NOx                 | VOC     | CO     | SOx   | PM    |
| D-J Basin               | 20,783              | 81,758  | 12,941 | 226   | 636   |
| Uinta Basin             | 13,093              | 71,546  | 8,727  | 396   | 623   |
| Piceance Basin          | 12,390              | 27,464  | 7,921  | 314   | 992   |
| North San Juan Basin    | 5,700               | 2,147   | 6,450  | 15    | 52    |
| South San Juan Basin    | 42,075              | 60,697  | 23,471 | 305   | 574   |
| Wind River Basin        | 1,814               | 11,981  | 2,840  | 1,792 | 37    |
| Powder River Basin      | 21,086              | 14,367  | 12,873 | 609   | 681   |
| Southwest Wyoming Basin | 21,569              | 94,013  | 13,150 | 5,259 | 541   |
| Williston Basin*        | 14,387              | 357,798 | 18,765 | 2,081 | 1,045 |

*\*Williston Basin inventory is for 2009 base year*

- NOx emissions in the Williston Basin are similar on a per-well basis to other basins;
- Williston Basin is the largest oil producing basin in the Phase III, significantly higher VOC emissions than any other basin; VOC emissions primarily from oil tank flashing and breathing losses;

## Williston Basin Mid-Term Projections Methodology

- Mid-term projections are conducted for the scenario year of 2015 for the Williston Basin
- Projections were developed for three separate geographic groupings: (1) the Bakken Shale; (2) the Cedar Creek Anticline; and (3) all remaining counties;
- IHS database is used to identify 2009 production statistics in the basin and to compile all historical data on production, drilling and well counts for the basin
- Oil and gas well count projections made by extrapolating from historic growth rates in well counts; spud counts matched to the well count growth rate and corrected for drilling success rate
- Oil and gas production growth rates developed by extrapolating from historic growth rates and in conjunction with data from Bentek study
- Declining parameters (in the historic period reviewed) were conservatively assumed to remain at constant levels through 2015

## Williston Basin Mid-Term Projections Uncontrolled Scaling Factors

| Geographic Grouping   | Total Well Count | Spud Count | Total Gas Production | Oil Production | Condensate Production |
|-----------------------|------------------|------------|----------------------|----------------|-----------------------|
| Bakken                | 2.30             | 4.30       | 5.51                 | 5.46           | 1.04                  |
| Cedar Creek Anticline | 1.14             | 1.53       | 0.86                 | 0.85           | 2.46                  |
| All Other Counties    | 1.25             | 0.67       | 0.90                 | 0.77           | 1.00                  |

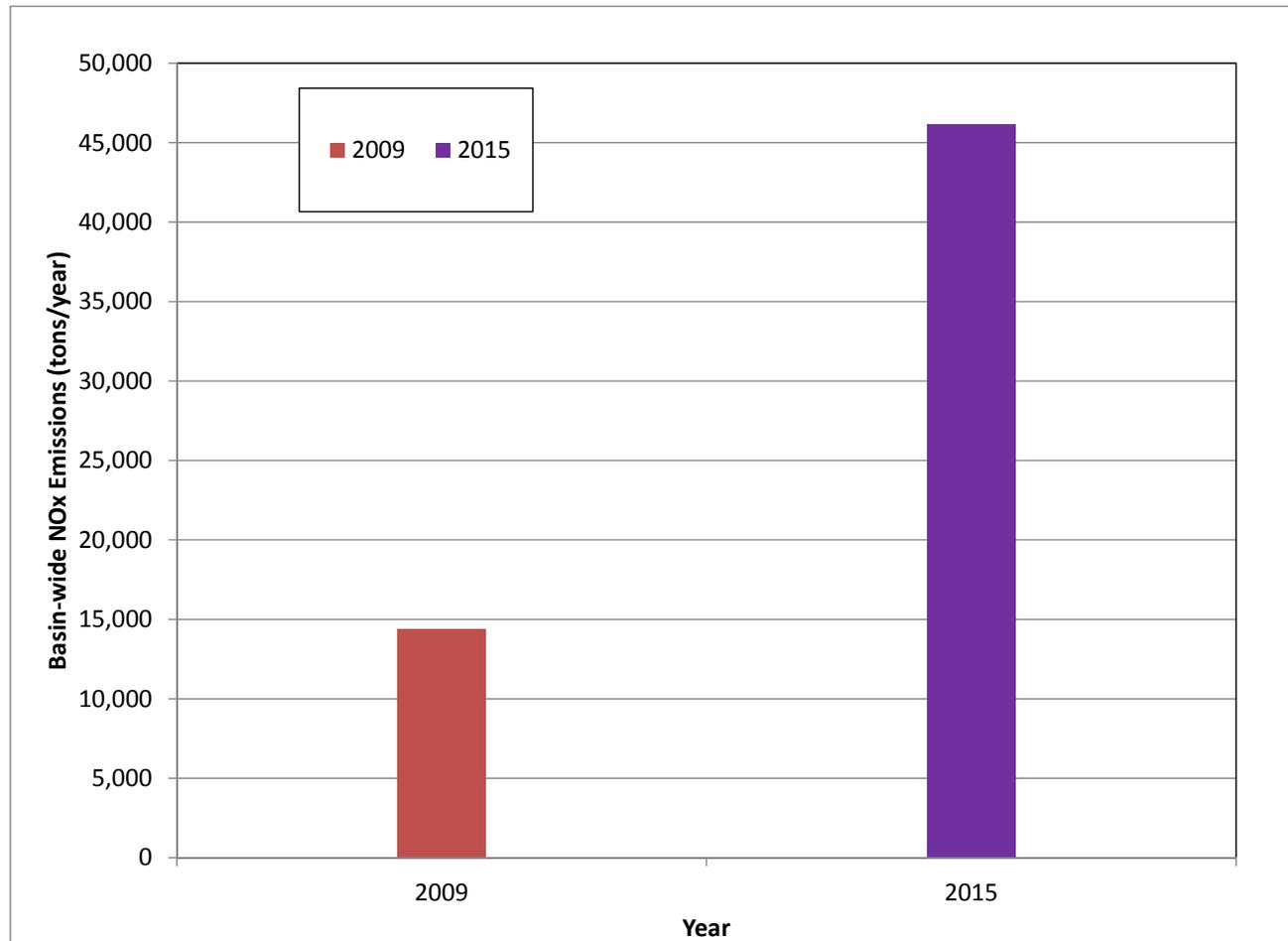
- Activity projections used to create scaling factors
- Scaling factors are ratio of value of activity parameter in 2015 to value in 2009
- Different source categories' emissions are projected using different activity parameters and their scaling factors
- An additional parameter projected is the growth in gas gathering infrastructure – tracked using the fraction of gas produced that is not sold in the Bakken Shale area; projected that more than 80% of produced gas captured and processed by 2015

## Williston Basin Mid-Term Projections “On-the-Books” Regulations

- After uncontrolled scaling factors are applied, “on-the-books” regulations are considered which would impact 2015 emissions projections
- Federal controls include Tier standards for non-road mobile sources (e.g. drilling rigs), fuel sulfur controls, New Source Performance Standards (NSPS) for stationary spark-ignited engines, and the recent NSPS Subpart OOOO for other oil and gas sources
- State controls for tank flashing, tank loading, well completions and general VOC control requirements for well sites were applied
- Where not specifically applicable to all sources, state controls were conservatively applied only to new sources brought on-line between the 2009 and 2015 years, leaving some existing sources uncontrolled
- Changes in the regulatory requirements were tracked and the changes implemented in the specific years where a phase-in occurs (for example NSPS Subpart JJJJ and Subpart OOOO)

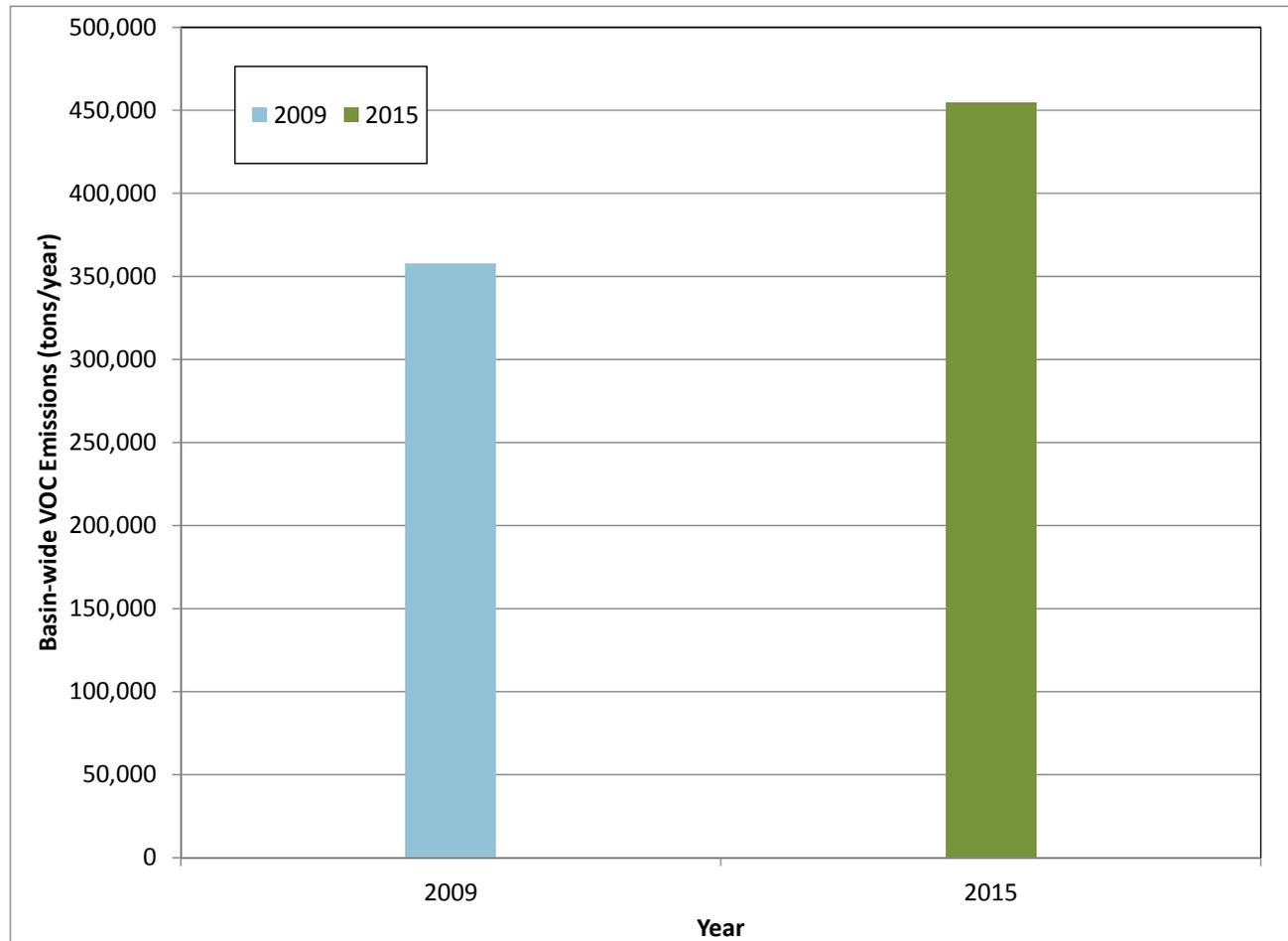
# Williston Basin Mid-Term Projections 2015 NOx Emissions

- Comparison of Williston Basin baseline 2009 and mid-term 2015 NOx emissions



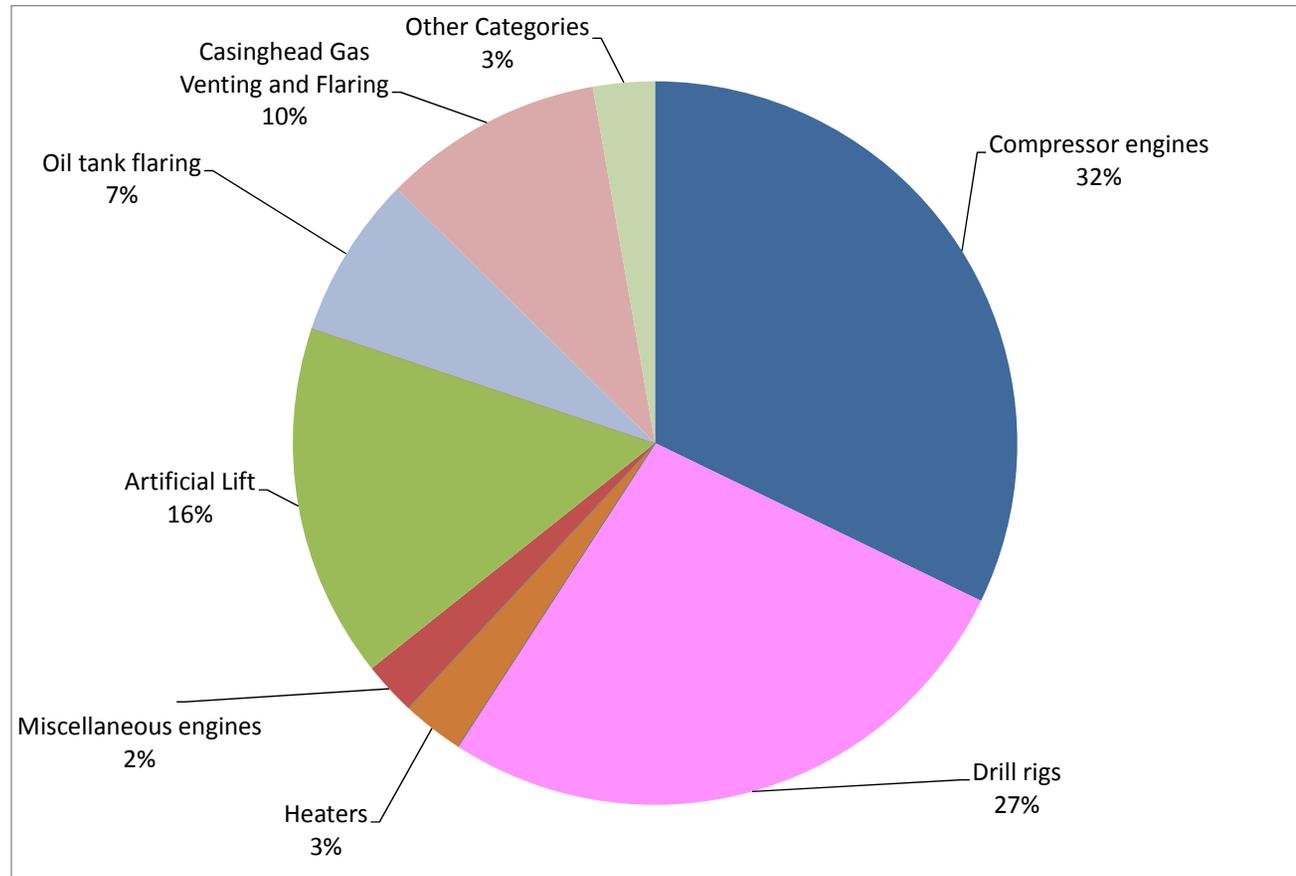
# Williston Basin Mid-Term Projections 2012 VOC Emissions

- Comparison of Williston Basin baseline 2006 and mid-term 2012 VOC emissions



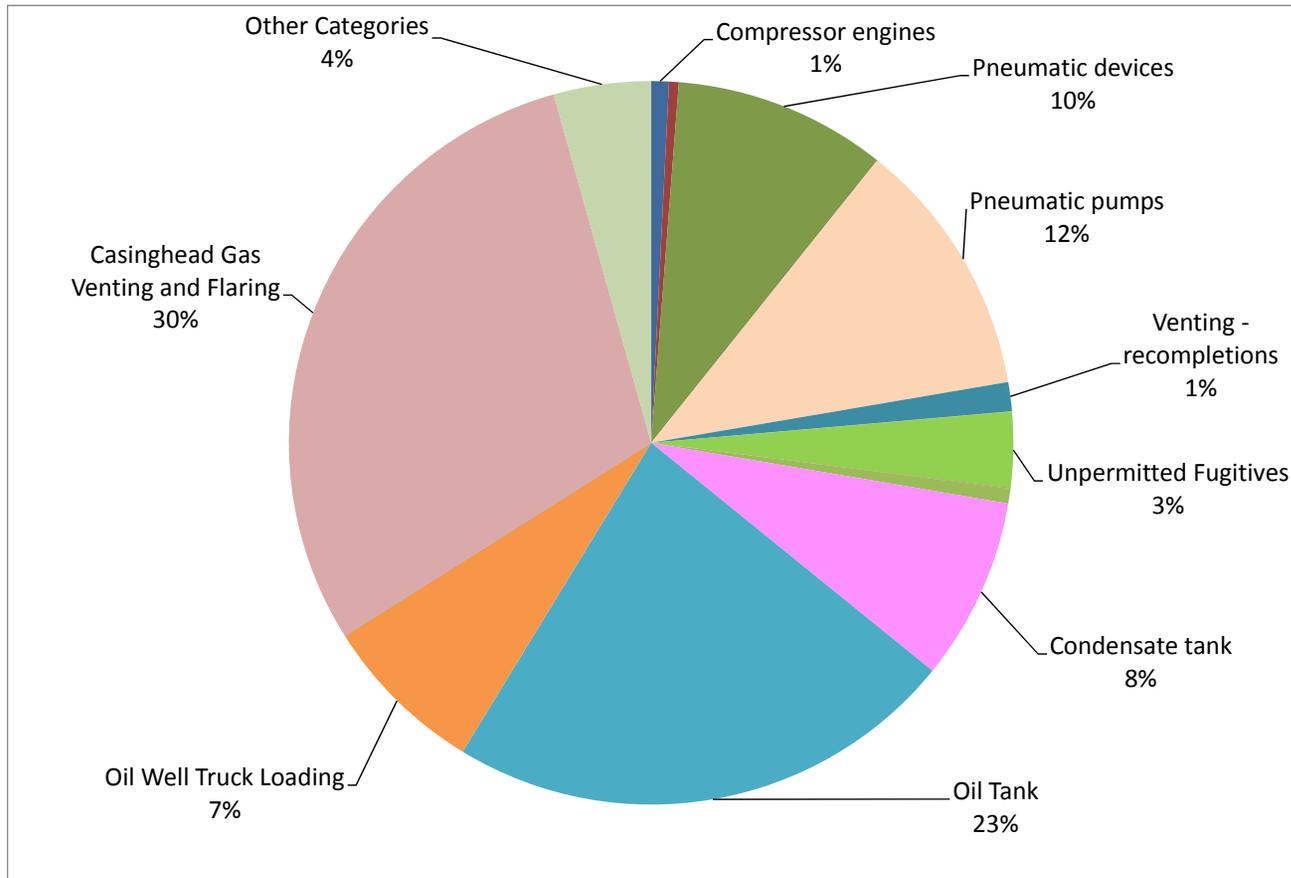
## Williston Basin 2015 Midterm Results NOx Emissions By Source Category

**Basin-wide NOx total:  
46,114 (tpy)**



- **NOx emissions still dominated by drilling rigs and compressor engines but lower contribution from drilling**

## Williston Basin 2015 Midterm Results VOC Emissions By Source Category



**Basin-wide VOC  
total: 454,443 (tpy)**

•VOC emissions from oil tank flashing significantly reduced, emissions from casinghead gas flaring and venting increase

## Observations

- **NOx and VOC emission increases projected for 2015 due to high growth rate of activity in the Bakken Shale area**
- **Federal and state regulatory controls requirements for oil tanks significantly reduce the contribution of this category to VOC emissions**
- **Large growth in associated gas production and flaring/venting of this gas result in significant increase in VOC emissions despite projected growth in gas gathering infrastructure**
- **Emissions projections are sensitive to assumptions on growth in oil production and drilling activity – growth projections are consistent with Bentek report but additional data would improve these estimates**