BLM/WRAP Williston and Great Plains Basin Emission Inventory Development

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WRAP O&G Workgroup - Stakeholders Meeting September 3, 2014

Outline

- Project overview/methods

  Williston Basin (1st) and Great Plains Basin (2nd)

  - 2011 Inventory
    - Geographic scope and background
    - Baseline emissions results
  - 2015 Inventory
    - Projection methodology
    - Midterm emissions results
  - Observations

Project Goals

- Develop more accurate regional oil and gas emissions
- Develop emission inventories for use in regional air quality modeling efforts
- Streamline future National Environmental Policy Act (NEPA) reviews by reducing the need for project-specific modeling

Previous Inventory Efforts

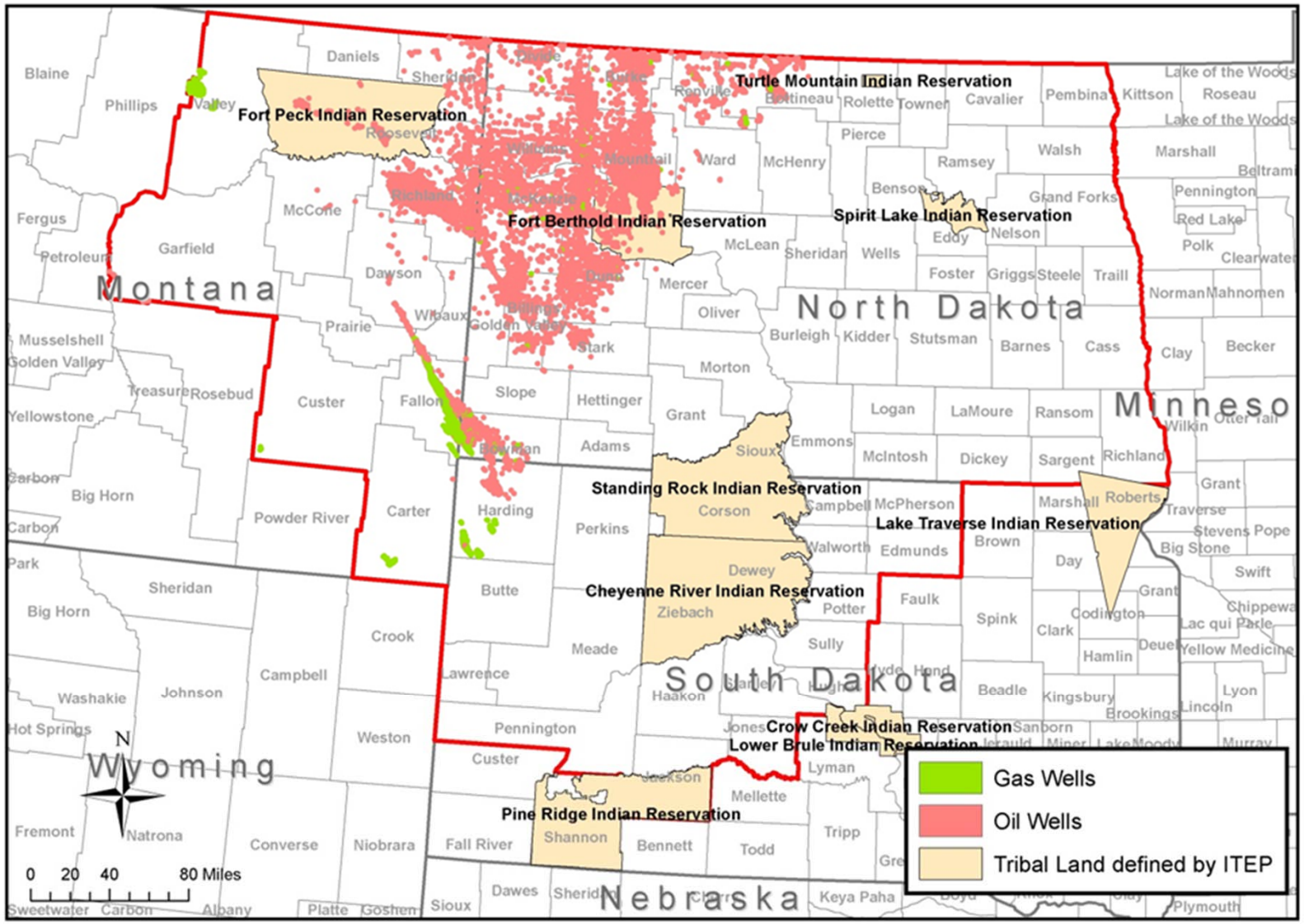
- WRAP Phase III: First regionally-consistent O&G inventory study in the Intermountain West
  - Baseline updates to 2008 for WestJump AQMS and to 2011 for 3-State Air Quality Study
- Williston Basin:
  - WRAP Phase III Inventory completed in 2013
  - Low survey response rate
- Great Plains Basin
  - No previous inventory

Overview of Inventory Effort

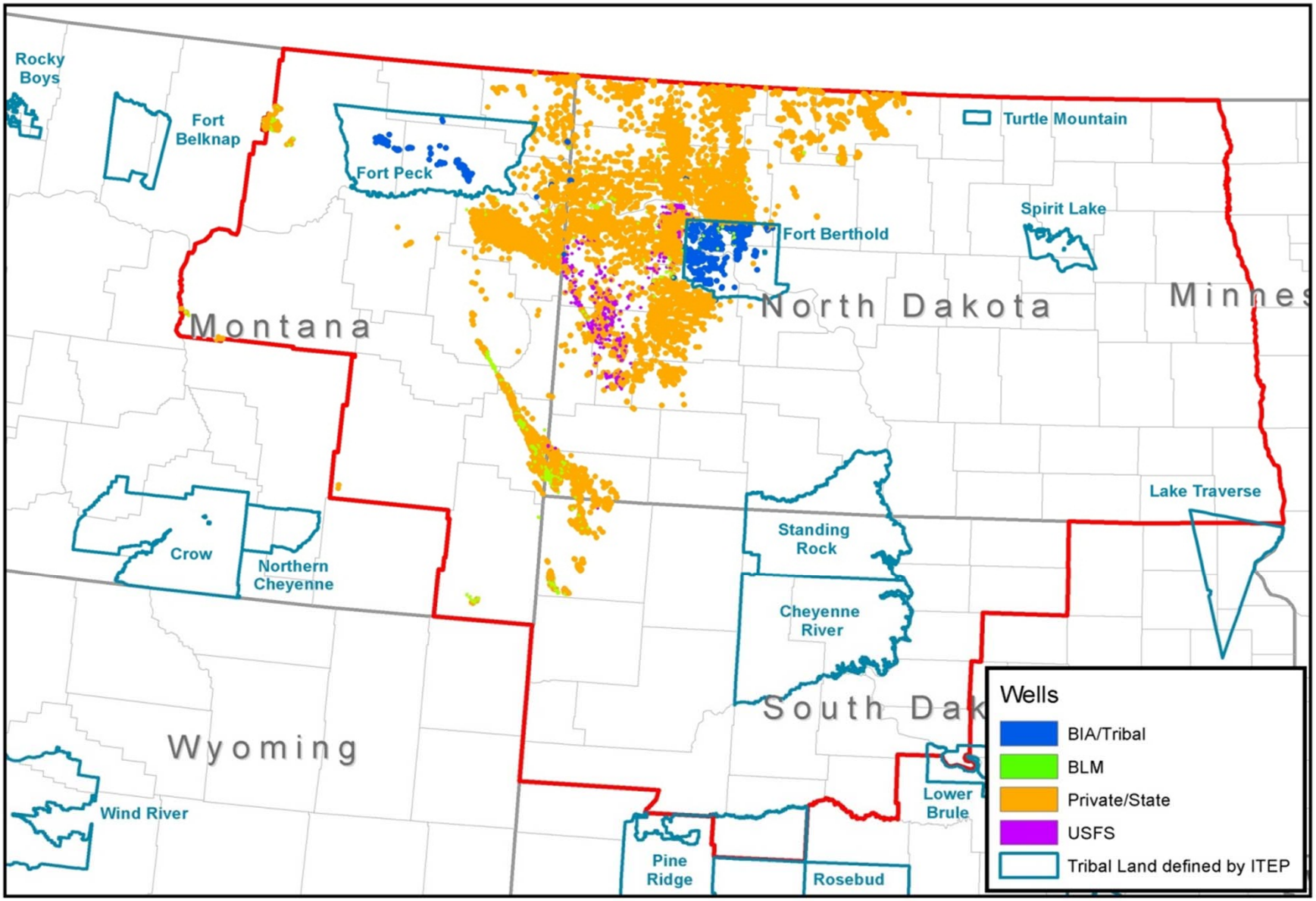
- Basin level inventories
- Inventory sources: area sources and point sources – but does not include mobile sources (with the exception of drilling rigs, fracing engines)
- Temporal scope: 2011 baseline year, 2015 midterm projections
- Only criteria pollutants : NOx, VOC, CO, SOx, PM
- Emissions by mineral ownership (Private/State Fee, Tribal, BLM, USFS)

Geographic Scope

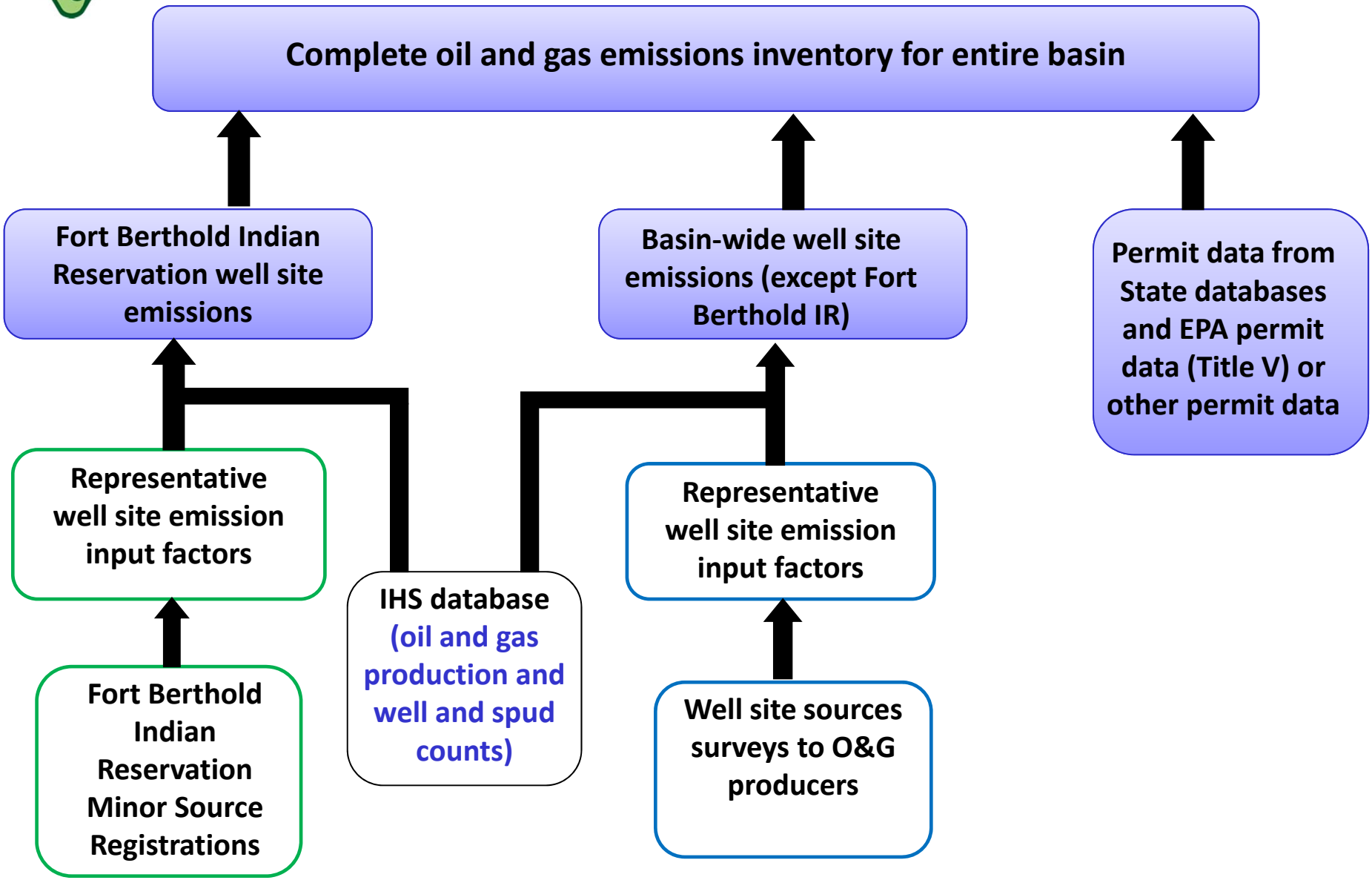
Williston Basin - 2011 Wells



Mineral Ownership
Williston Basin Wells



Methodology Diagram



Operator Survey Example

13a. Typical Oil Well Heater Data

Representative Heater Data					
	Sample Data	Separator	Tank	Reboiler	Line
Number of Heaters per well	2				
Heater MMBtu Rating (MMBtu/hr)	0.5				
Annual Heater Usage (hrs)	8760				
Heater Cycling (fraction of the time the heater is doing work when it is turned on)	1				

13b. Typical Gas Well Heater Data

Representative Heater Data					
	Sample Data	Separator	Tank	Reboiler	Line
Number of Heaters per well	2				
Heater MMBtu Rating (MMBtu/hr)	0.5				
Annual Heater Usage (hrs)	8760				
Heater Cycling (fraction of the time the heater is doing work when it is turned on)	1				

FBIR Minor Source Registration Examples

#1

Burner Data

I.D. No.	QTY	Burner Rating (MMBtu/Hr)	Equipment	Annual Op Time (hours)	Fuel Type	Fuel Htg Value (Btu/scf)	Fraction of VOC [1]
003	1	0.500	Heater Treater	8760	Field Gas	1509	0.51

1 - Fraction of VOC is derived from the fuel gas analysis (MW_{VOC}/MW_{TOTAL})

#2

Pollutant	Burner Rating *MMBtu/hr*	E.F. *lb/MMBtu*	Conv. *lb/ton*	Usage *hr/yr*
VOC	0.5	0.0054	2000	8760
HAP	0.5	1.77E-03	2000	8760
NO_X	0.5	0.0980	2000	8760
CO	0.5	0.0824	2000	8760

#3

Treater Burner(s)		Description
Total Btu/hr	1000000	Total burner rating for the h
Hours of Operation	8,760	The burner(s) is/are assume

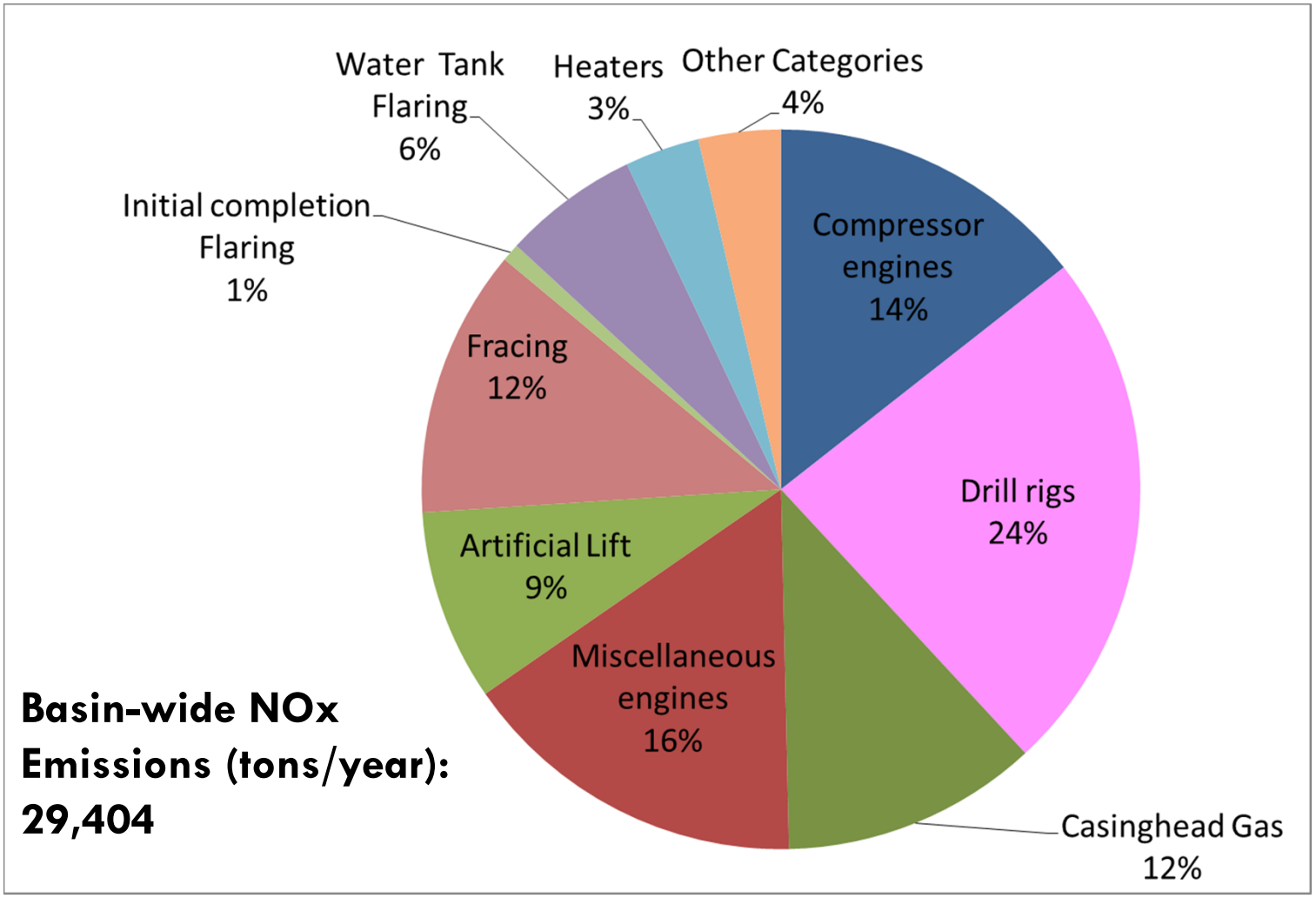
Williston Basin
Overview and Observations

- 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
- Fort Berthold is an important area of Bakken formation production
- Significant flaring of associated gas occurs in the Williston Basin

Revisions from the Draft to Final Inventories

- Per comments received on the draft inventory:
  - Added NSPS controls for artificial lift engines
  - Revised 2015 spud count forecasts based on ND DMR estimates
- Additional revisions:
  - Incorporation of FBIR minor new source review permit data
  - Inclusion of SOx emissions from flaring
  - SCCs revised for consistency with EPA oil and gas SCCs
  - Revised casinghead gas flared fraction to be consistent with NDOGC estimates of produced gas that was not sold

Williston Basin 2011 Baseline Results
NOx Emissions By Source Category



Basin-wide NOx Emissions (tons/year): 29,404

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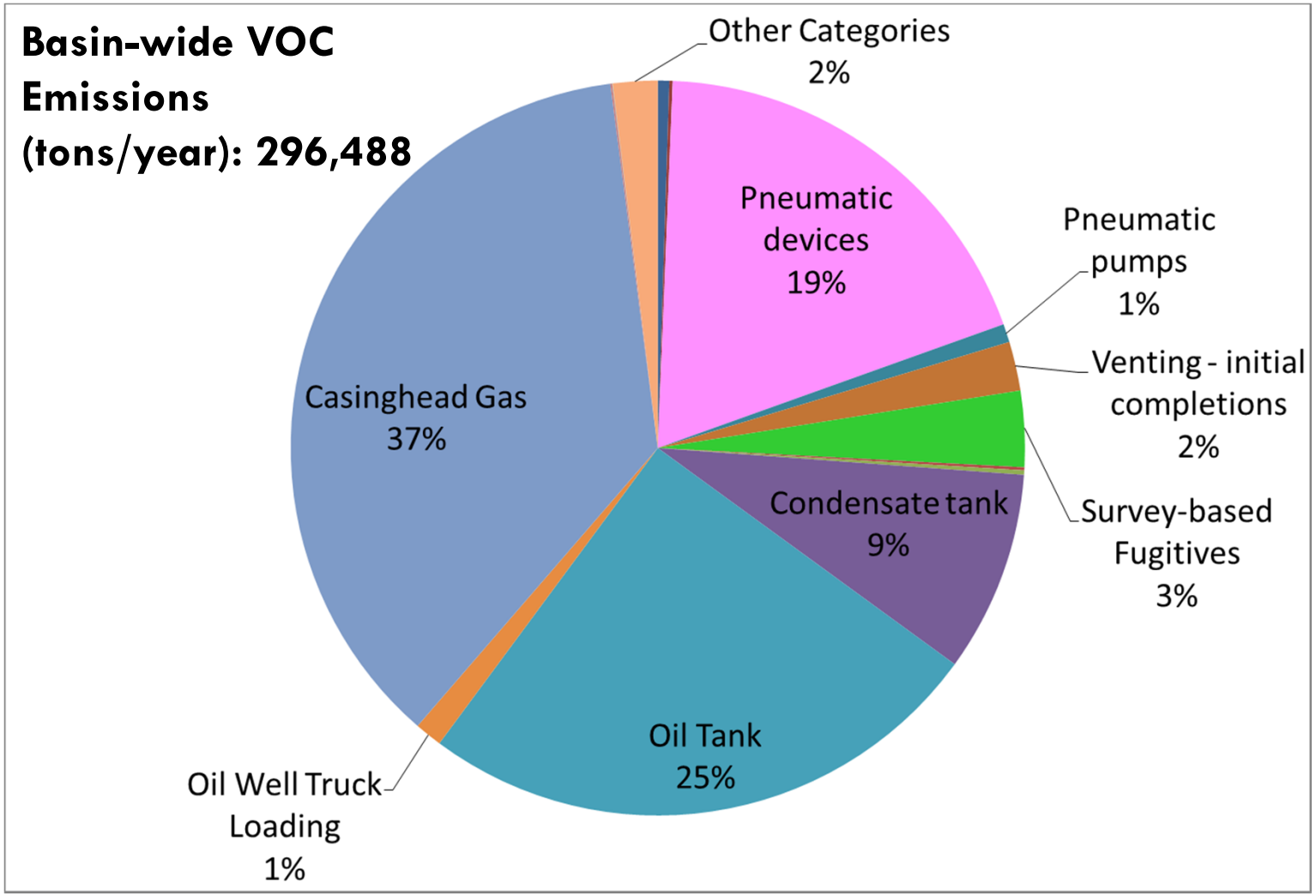
Williston Basin 2011 Baseline Results
VOC Emissions By Source Category



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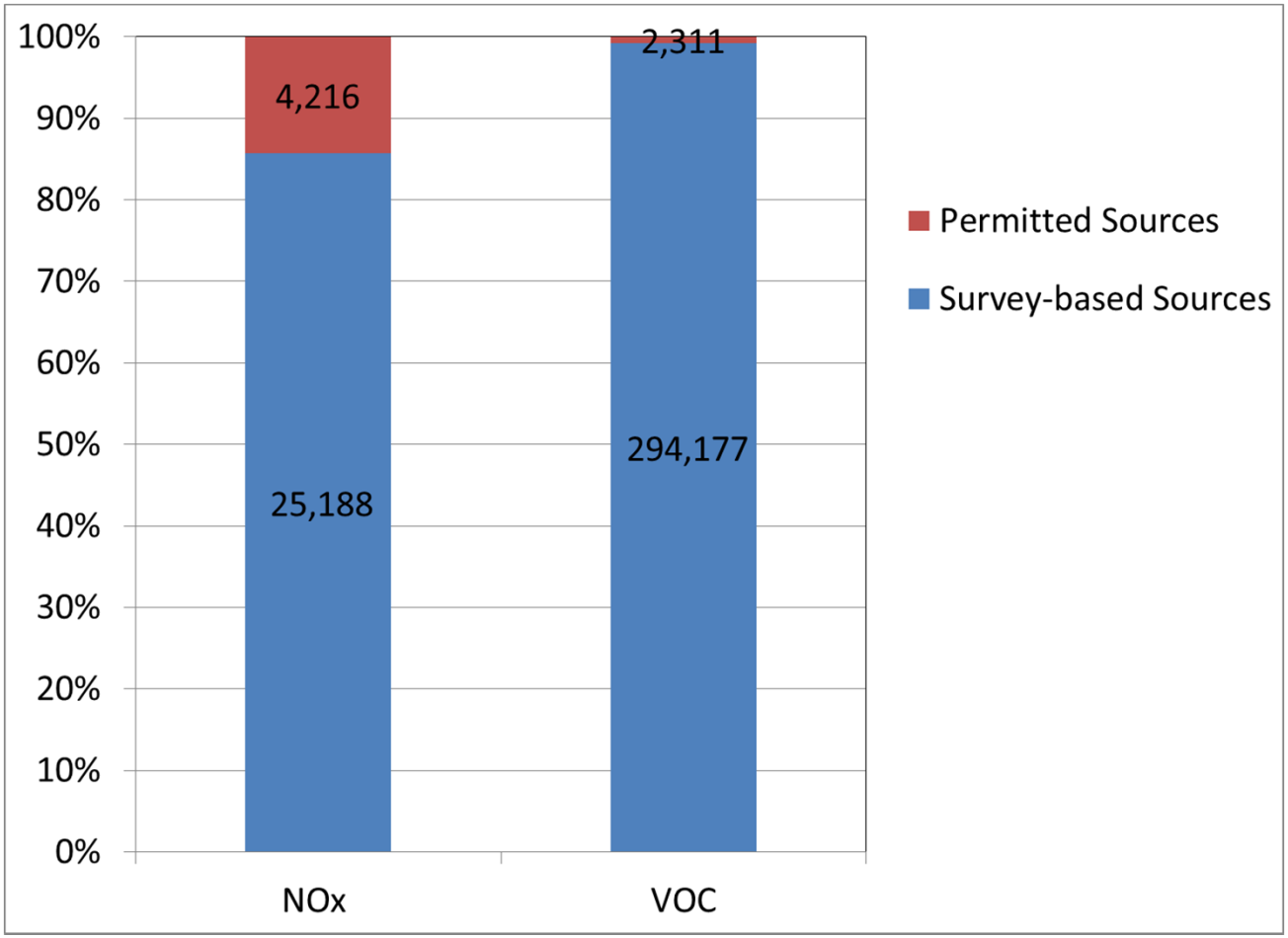
Williston Basin 2011 Baseline Results By Source Data



- Survey-based sources include wellsite emissions based on operator surveys and FBIR tribal minor source registrations.

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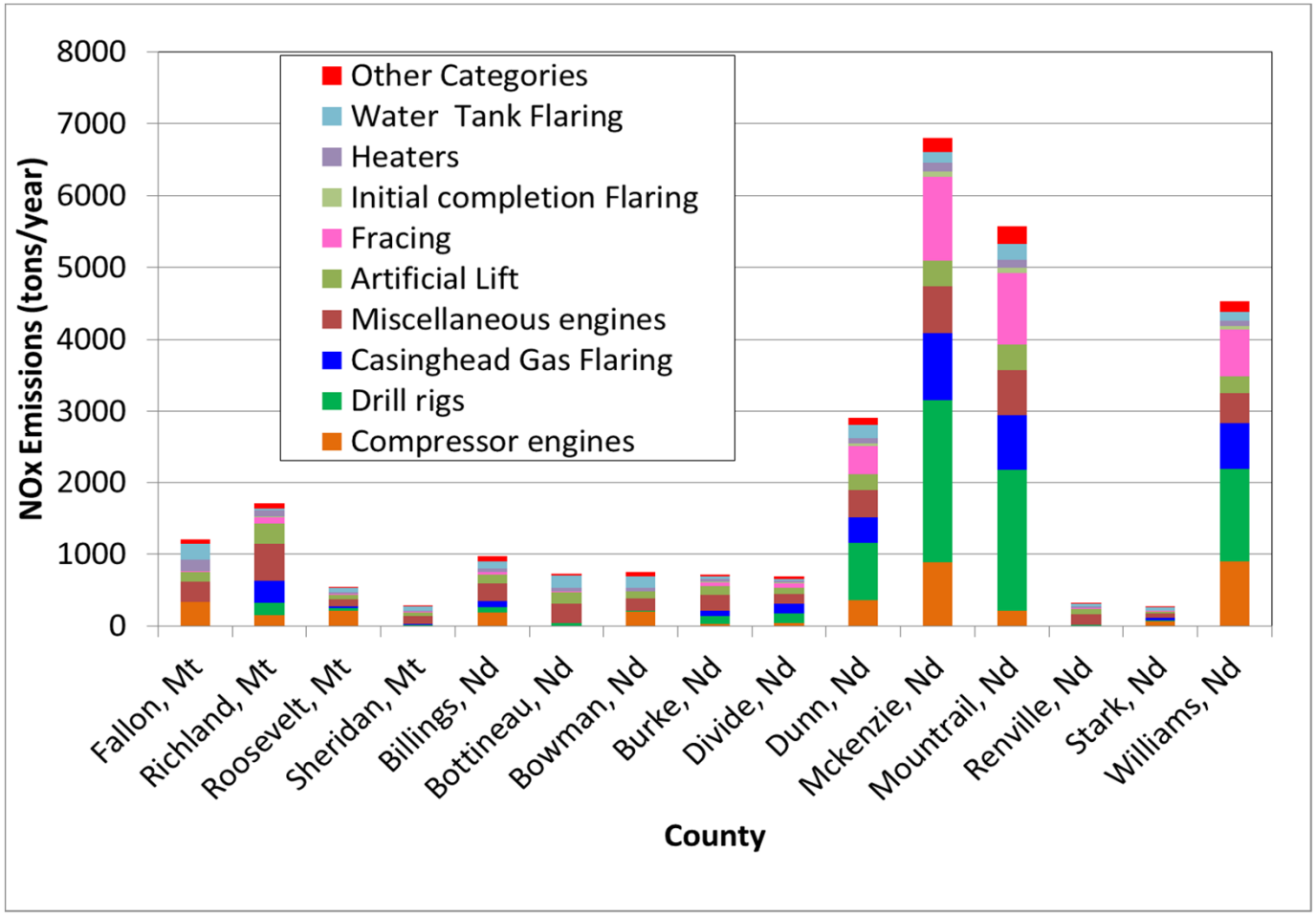
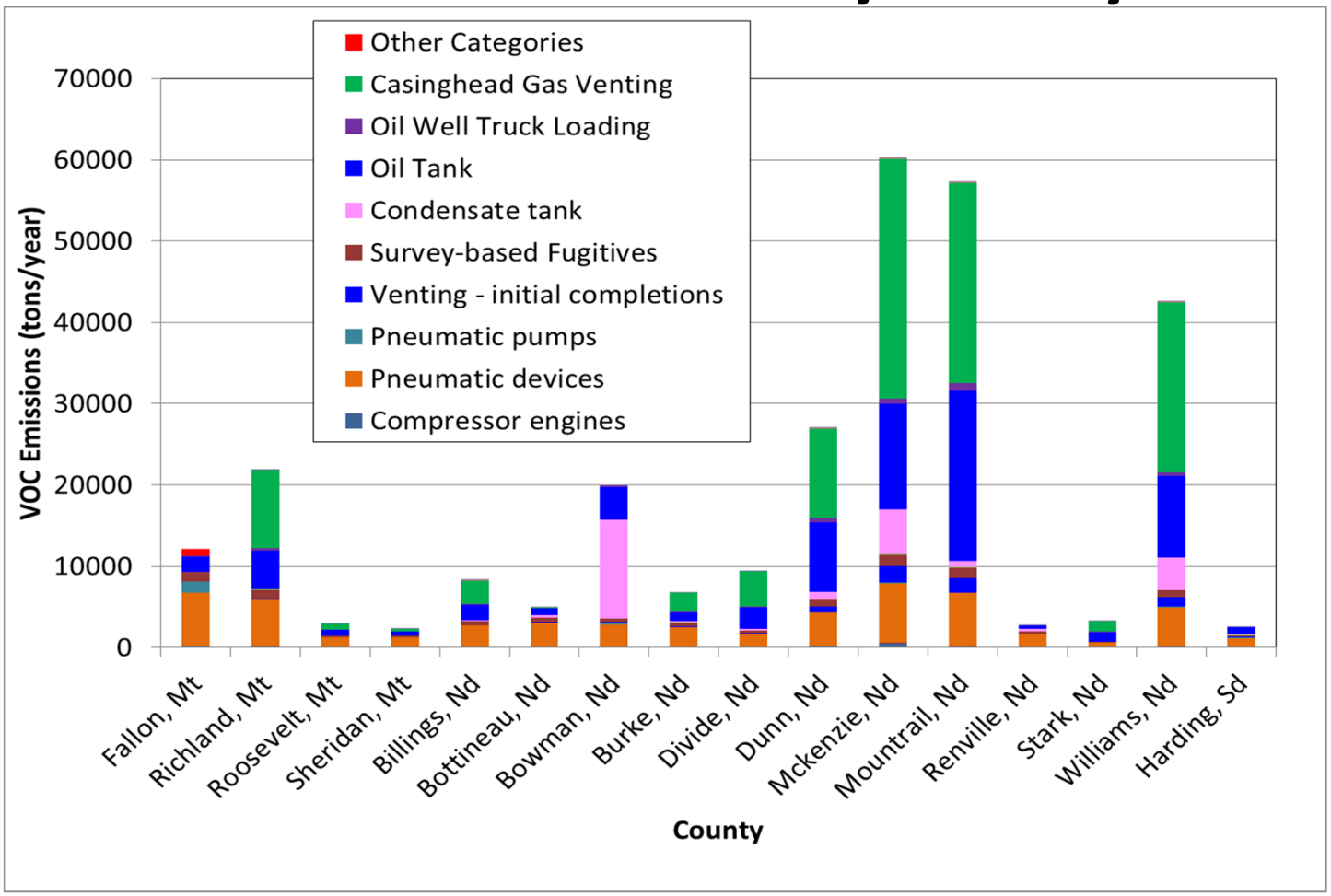
Williston Basin 2011 Baseline Results
NOx Emissions by County



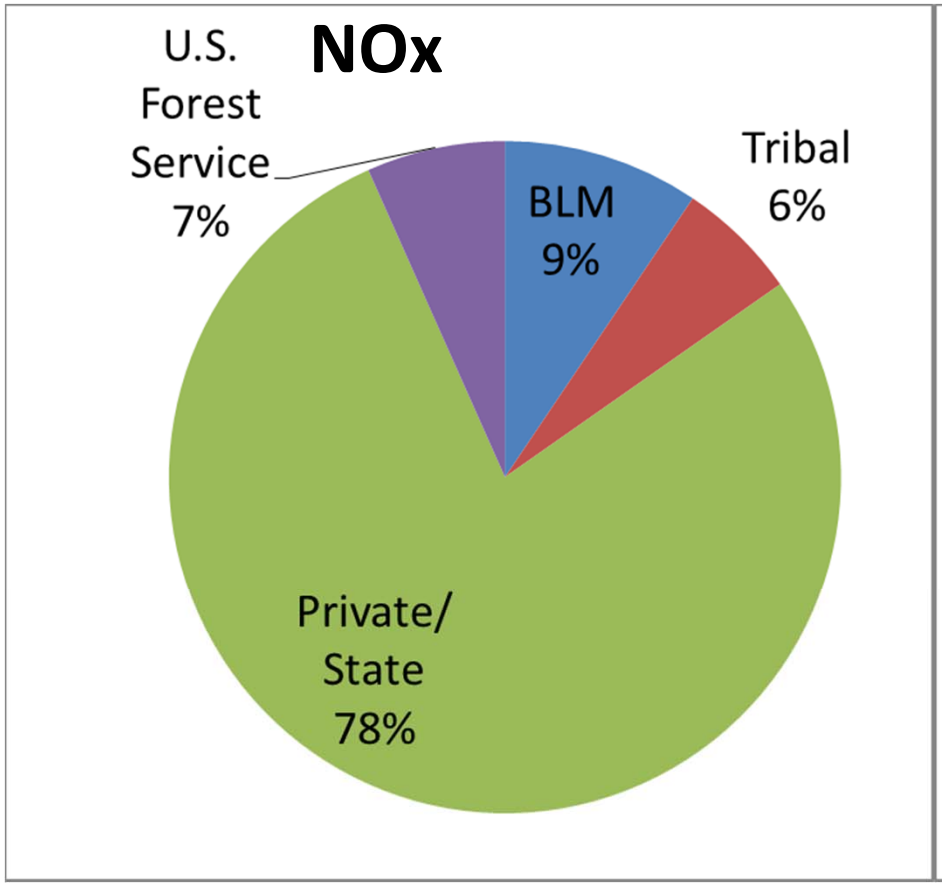
- Counties with less than 1% of basin-wide emissions are not shown.

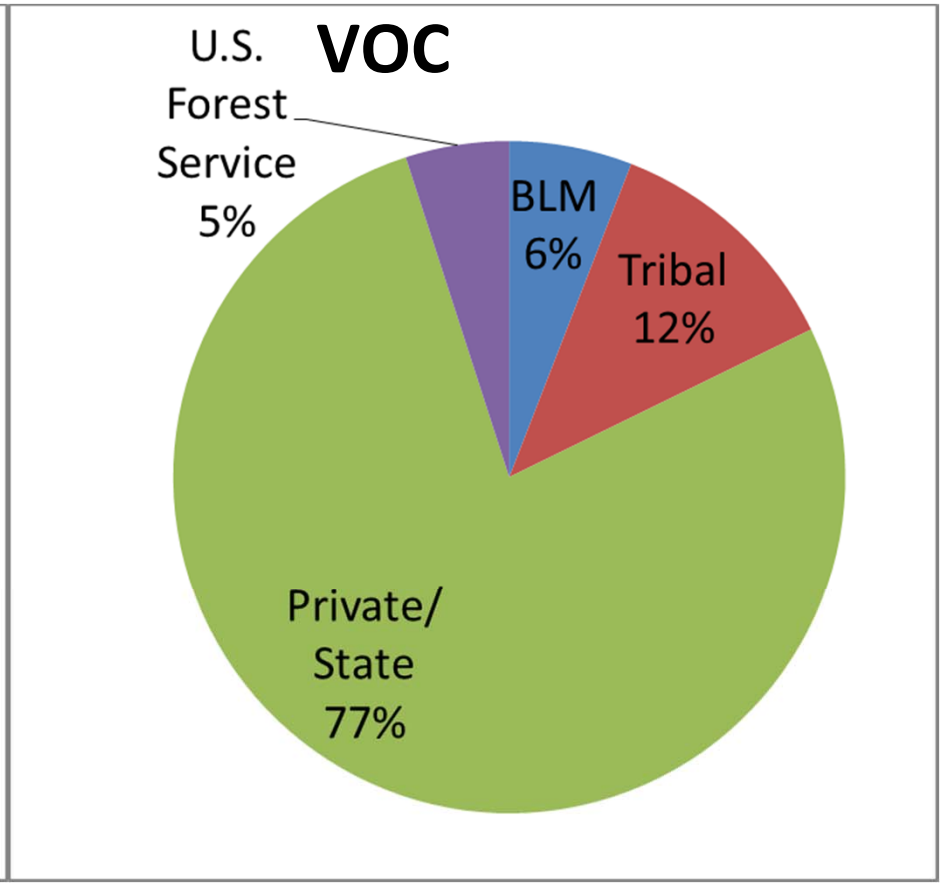
Williston Basin 2011 Baseline Results
VOC Emissions by County



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

Williston Basin 2011 Baseline Results By Mineral Ownership





Williston Basin Mid-Term Projections Methodology

- 2015 scenario year
- Projections were developed for three separate geographic groupings: (1) the Bakken Shale; (2) the Cedar Creek Anticline; and (3) all remaining counties;
- IHS database was used to identify 2011 production statistics in the basin and to compile all historical data on production, drilling and well counts for the basin

Williston Basin Mid-Term Projections, O&G Activity

- Spud count projections consistent with North Dakota Department of Mineral Resources estimates. Well counts are consistent with spudding activity.
- 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	Gas Production	Oil / Condensate Production	Spuds	Well Count
All Wells				
Bakken	3.08	2.82	1.35	1.90
Cedar Creek Anticline	0.91	0.95	1.45	1.00
All Other Counties	0.63	1.00	-	0.97
Basinwide	2.61	2.62	1.35	1.68

- Activity projections used to create scaling factors
- Scaling factors are ratio of value of activity parameter in 2015 to value in 2011
- Different source categories' emissions are projected using different activity parameters and their scaling factors

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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 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

Williston Basin Mid-Term Projections "On-the-Books" Regulations

- Where not specifically applicable to all sources, state controls were conservatively applied only to new sources brought on-line between the 2011 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
"On-the-Books" Regulations

<table>
<tr><th>Federal</th><th>State of Montana</th><th>State of North Dakota</th></tr>
<tr><td>Nonroad engine Tier standards (1-4)</td><td>MT ARM 36.22.1221
Completion venting controls.</td><td rowspan="2">NDAC 33-15-07 and Bakken Pool O&G Control Permitting & Compliance Guidance
Tank Controls</td></tr>
<tr><td>Nonroad diesel fuel sulfur standards</td><td>MT ARM 17.8.1603(1)(b)
VOC vapors from oil or condensate storage tanks</td></tr>
<tr><td>New Source Performance Standards (NSPS) Subpart JJJJ for Spark-Ignition Engines</td><td>MT ARM 17.8.1711(1)(b)
Liquids loading/unloading</td><td rowspan="2">NDAC 33-15-07
Submerged filling requirements</td></tr>
<tr><td>New Source Performance Standards (NSPS) Subpart OOOO for Oil and Gas Sources</td><td rowspan="3">MT ARM 17.8.1711(1)(a), MT ARM 17.8.1603(1)(a), MT ARM 17.8.752, MT ARM 17.8.1711(1)(a)
VOC vapors from O&G well facility equipment</td></tr>
<tr><td>National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart HH for Dehydrators</td><td rowspan="2">Order No. 24665
Casinghead gas flaring</td></tr>
<tr><td>Minor Source Reporting Requirements on Indian Tribal Land</td></tr>
</table>

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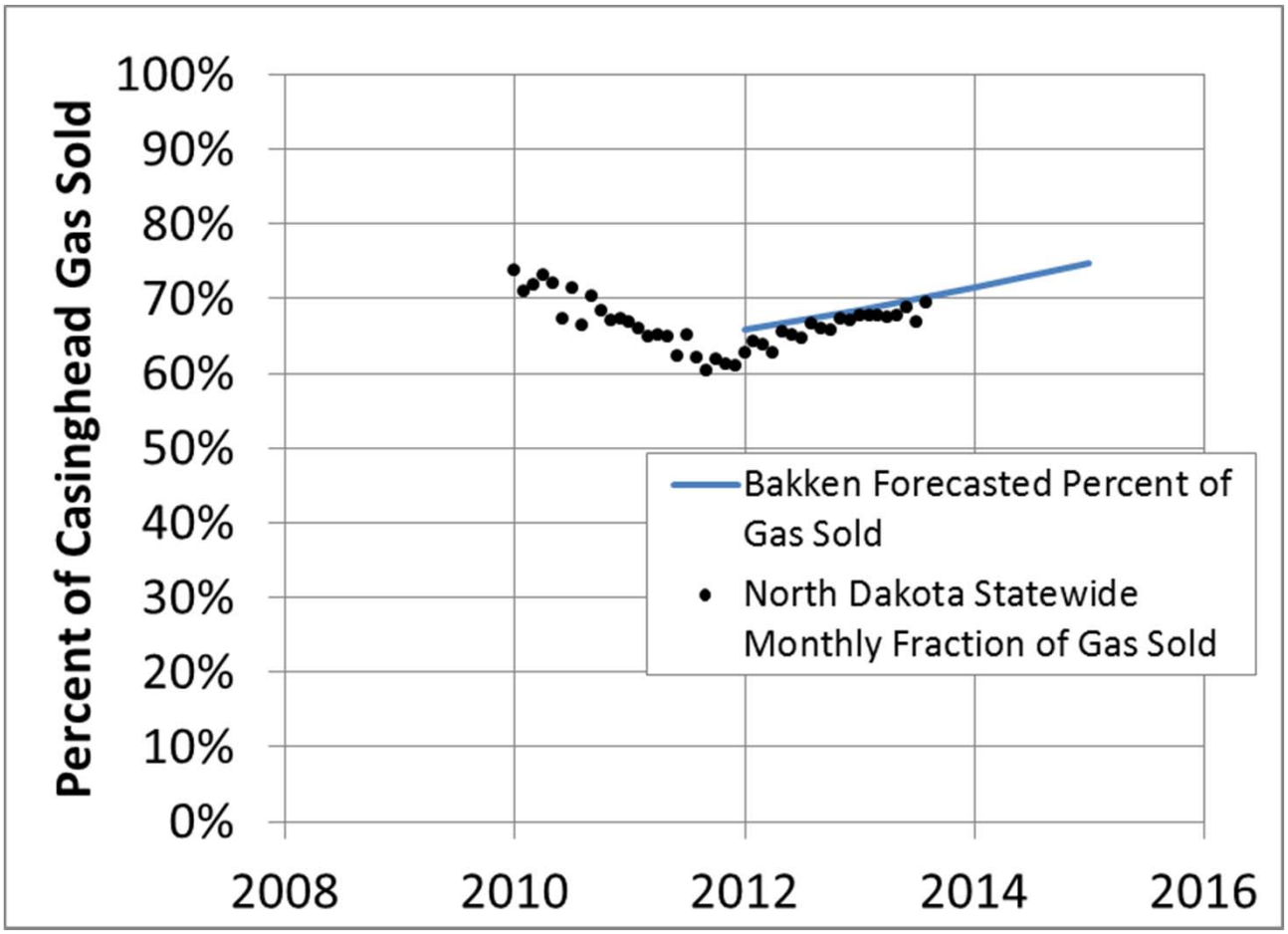
Casinghead Gas Flaring Projection



- NDIC order requires 77% casinghead gas capture by 1/1/2015 and 85% gas capture by 1/1/2016.
- Conservatively assumed 75% casinghead gas capture (and 25% casinghead gas flaring) in 2015 based on historical trends.

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Oil Tank Controls

Oil Tank Control	2011	2015
ND & SD (except FBIR)		
% Uncontrolled	10%	0%
% Controlled by Flare	70%	79%[1]
% Controlled by VRU	13%	14%
% Controlled by Enclosed Combustor	6%	7%
FBIR		
% Uncontrolled	0%	0%
% Controlled by Flare	0%	0%
% Controlled by VRU	0%	0%
% Controlled by Enclosed Combustor	100%	100%
MT		
% Uncontrolled	10%	2%
% Controlled by Flare	70%	79%
% Controlled by VRU	13%	13%
% Controlled by Enclosed Combustor	6%	6%

[1] Accounts for vast majority of control by 98% efficient devices

- Base year 2011 emission control based on operator surveys and FBIR minor source registrations
- Future year 2015 emission control was based on phase-in of NSPS Subpart OOOO and ND and MT state regulations

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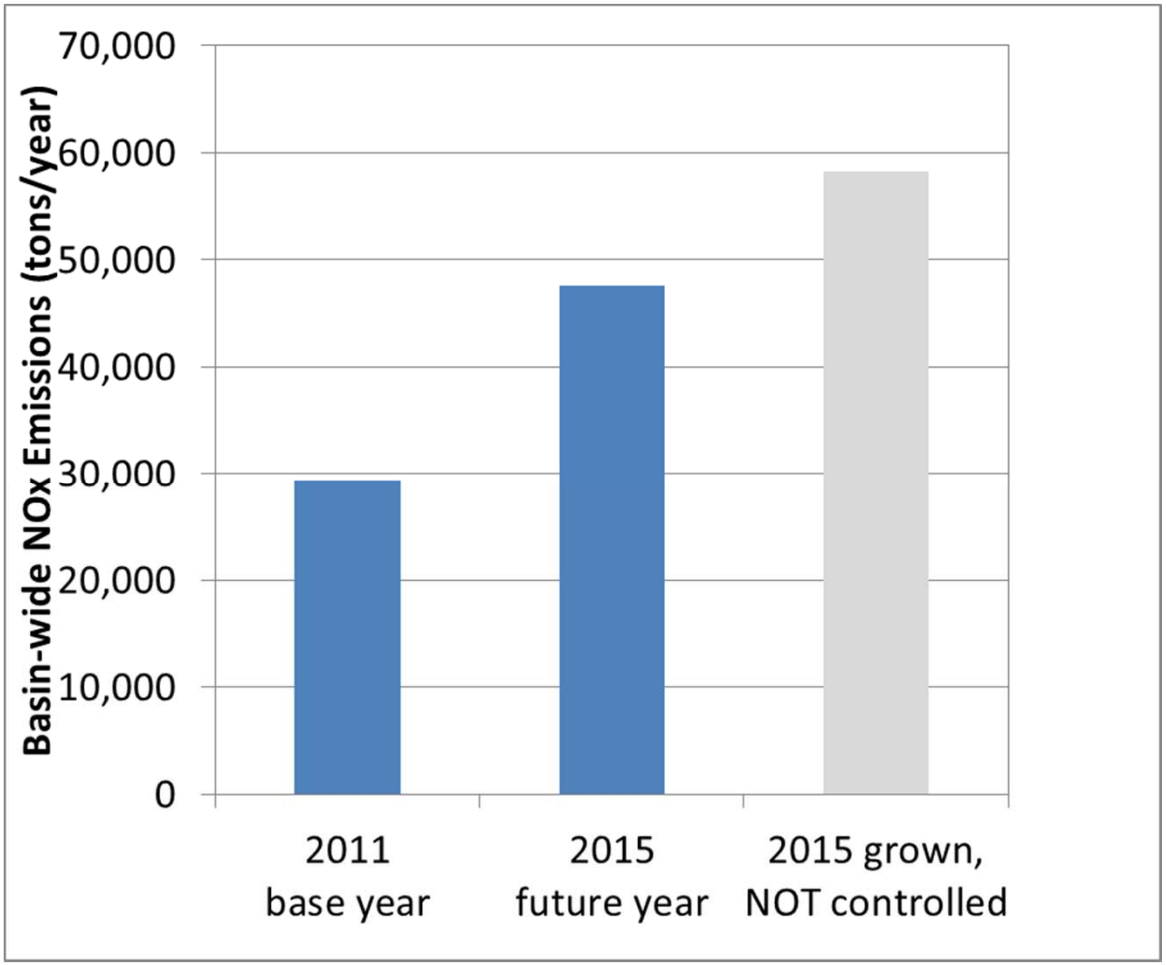
Williston Basin Mid-Term Projections
2015 NOx Emissions



- Increase in well counts and oil and associated gas production lead to increased emissions
- Increases in spuds are offset by lower 2015 drill rig emission rates due to fleet turnover
- 2015 controls reduce NOx emissions by ~11,000 TPY. Casinghead gas and nonroad engine controls account for >90% of NOx emission reductions

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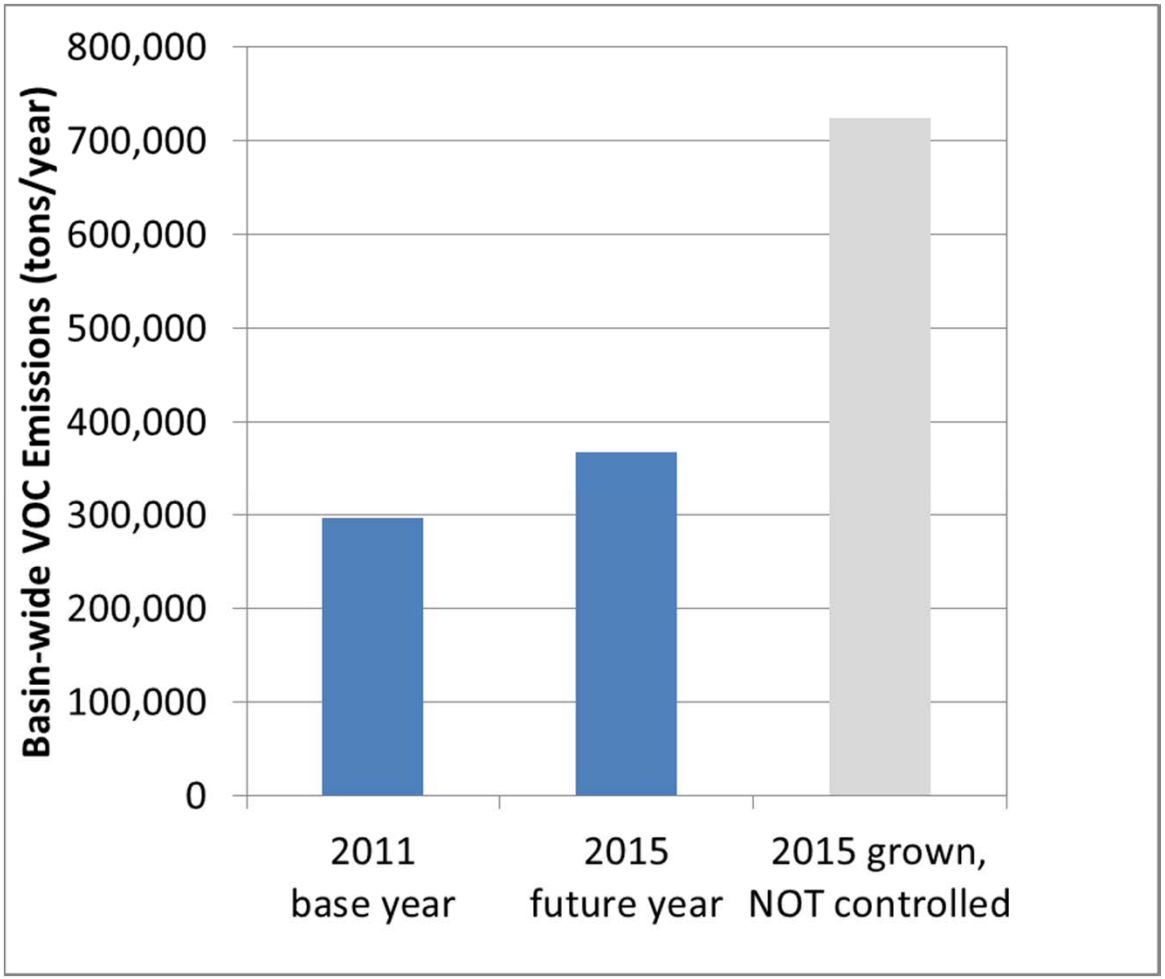
Williston Basin Mid-Term Projections
2015 VOC Emissions



- Increases in activity are partially offset by additional oil tank control and reductions in casinghead gas flaring
- 2015 controls reduce VOC emissions by ~360,000 TPY. Casinghead gas and oil tank controls account for >90% of VOC emission reductions

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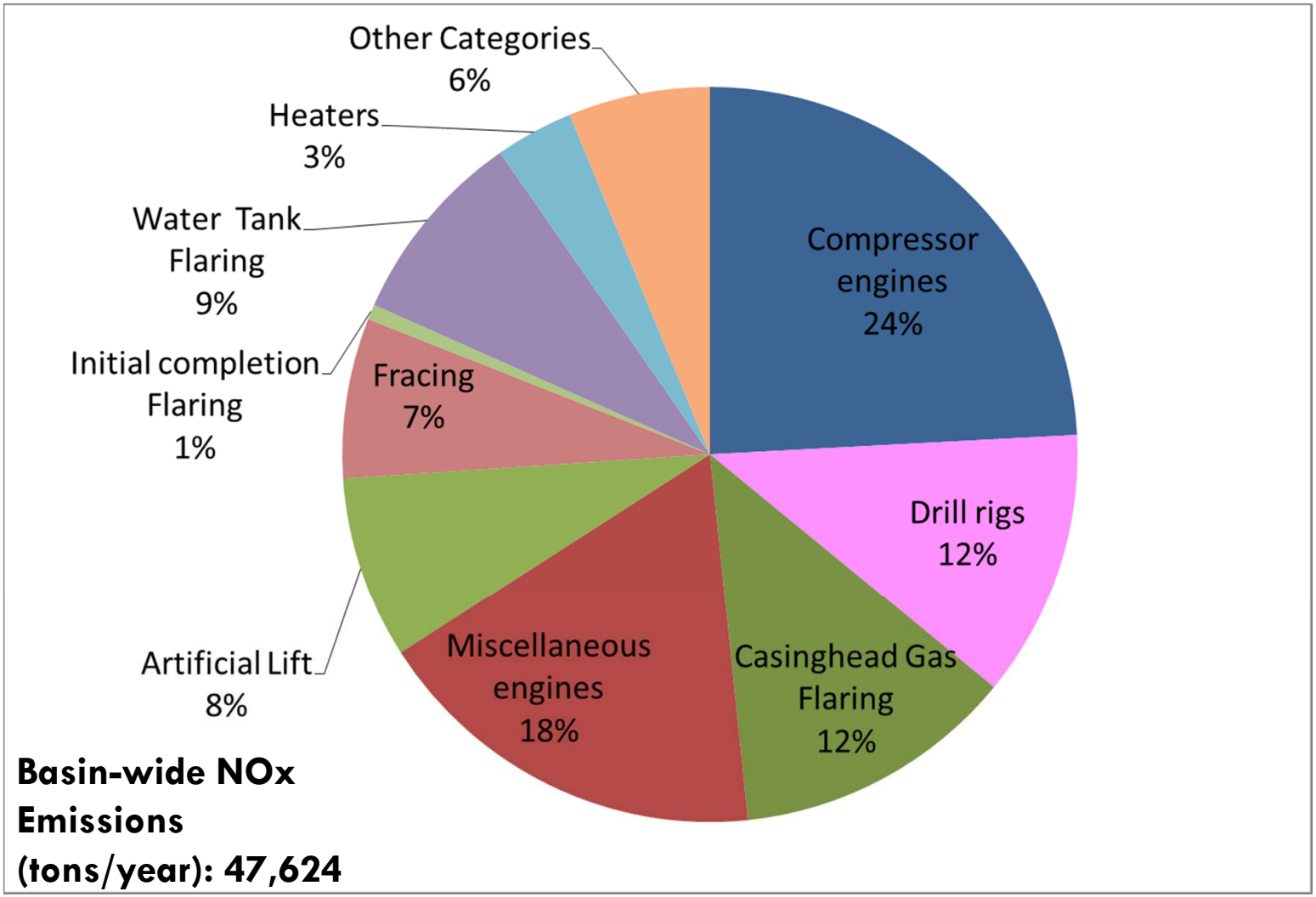
Williston Basin 2015 Midterm Results
NOx Emissions By Source Category



Basin-wide NOx Emissions (tons/year): 47,624

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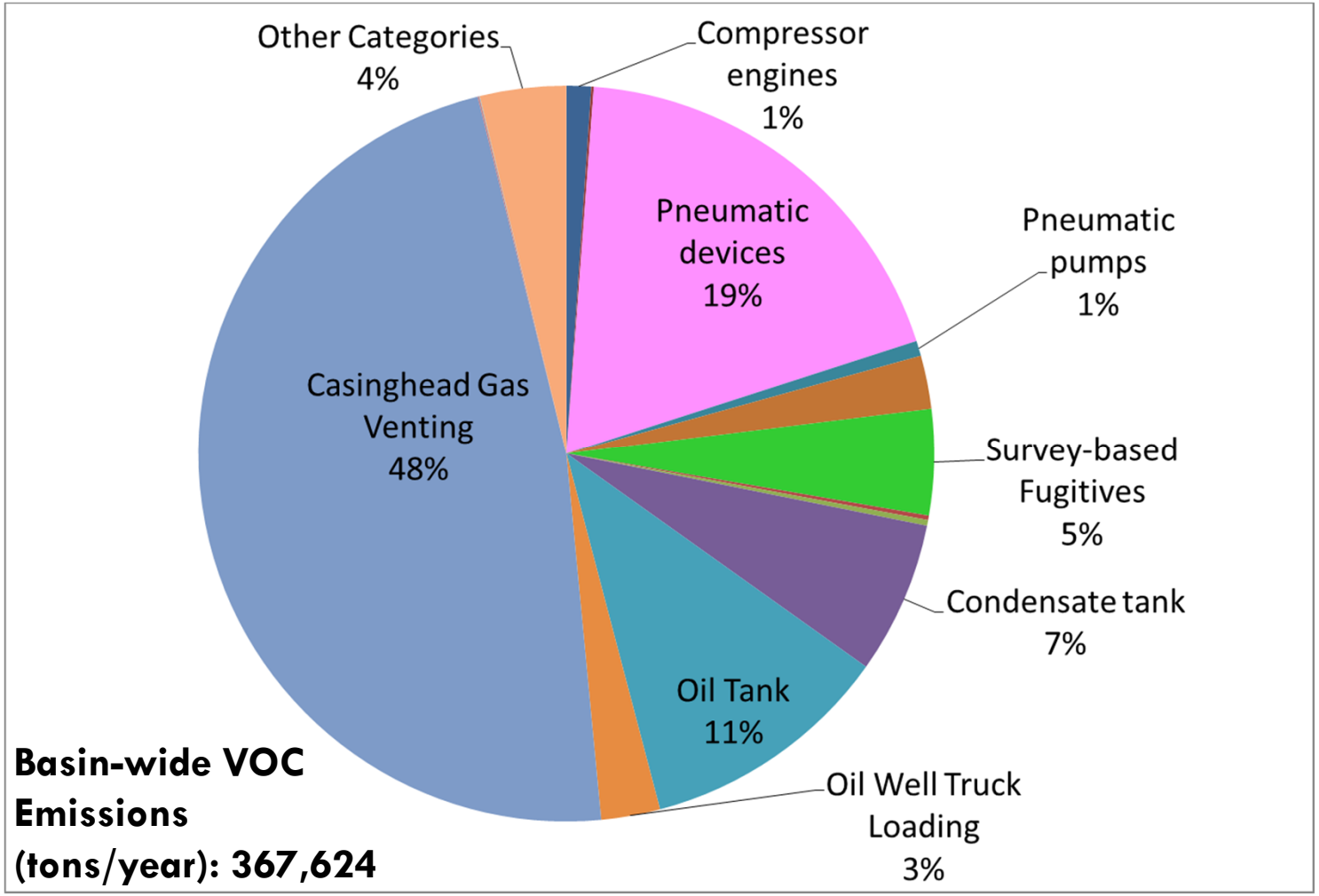
Williston Basin 2015 Midterm Results
VOC Emissions By Source Category



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All Pollutant Emissions By Year

Williston Basin-wide Emissions (tons/year)					
Year	NOx	VOC	CO	SOx	PM
WRAP Phase III 2009	14,387	357,798	18,765	2,081	1,045
2011	29,404	296,488	46,305	6,895	1,060
2015	47,624	367,624	92,942	15,075	1,598

- Majority of SOx emissions in 2011 and 2015 are from well site flaring associated with casinghead gas and oil tanks. These emissions are highly sensitive to the small fraction of H_2S in flared gas and could be refined with additional data.

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 and ND Department of Mineral Resources Bakken drilling forecasts. Additional data would improve these estimates

2015 Future Year Inventory Use

- 2015 inventory is a starting point based on current activity forecasts and on-the-books regulations
- Oil and gas activity changes can happen quickly, particularly in the Williston Basin
- Future year inventory may be revised as new information becomes available for the following:
  - Oil and gas activity levels
  - Oil and gas activity locations
  - Infrastructure improvements (e.g., pipelines, electrification) and their effect on emission sources
  - New EPA and state regulations and implementation/efficacy of recent regulations
- If the 2015 inventory is used as a "baseline year", oil and gas activity should be revised to reflect actual spud counts, well counts, and production estimates

Williston Basin Questions

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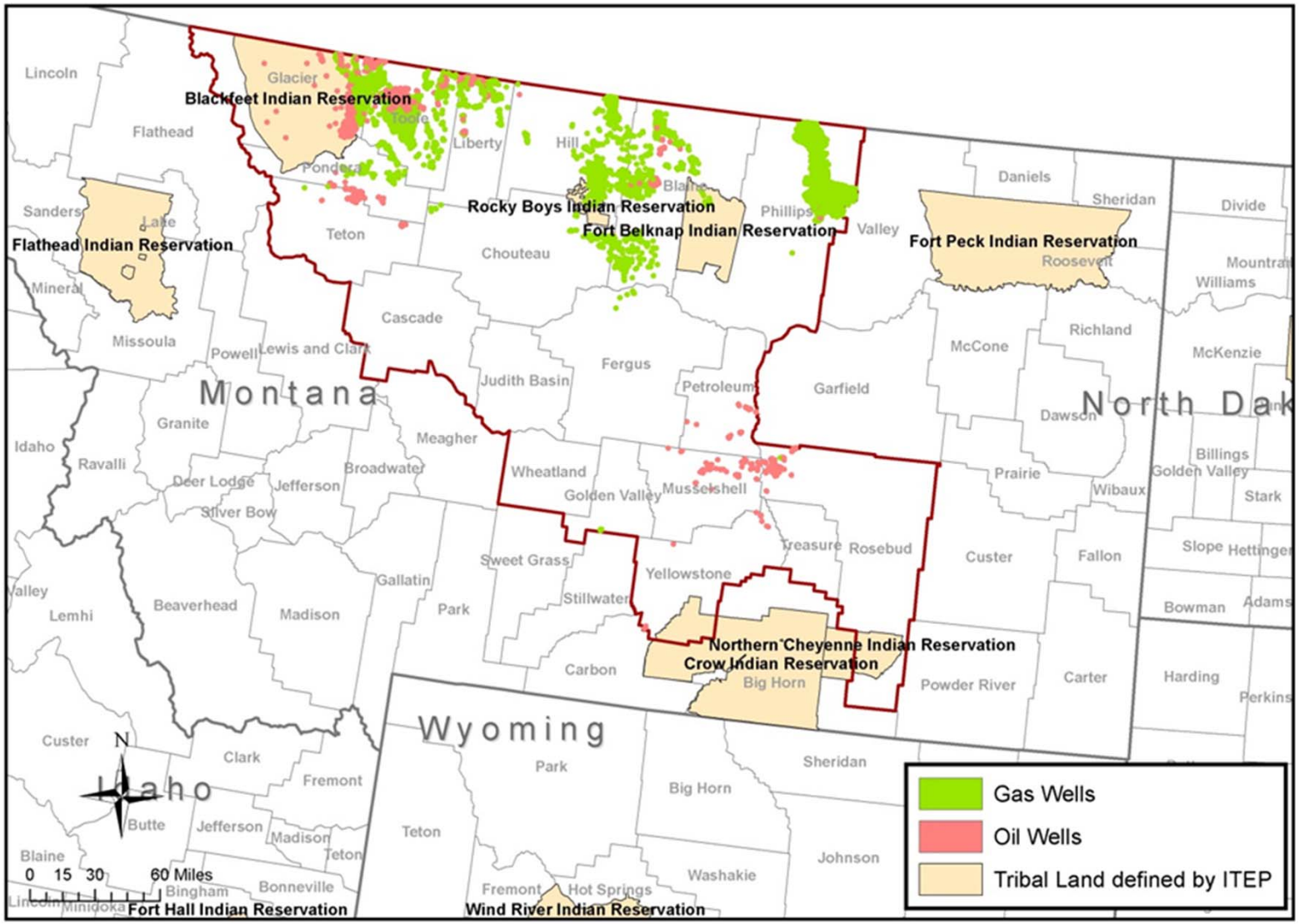
Part II: Great Plains Basin Emission Inventory Development Outline

- 2011 Inventory
  - Geographic scope and background
  - Baseline emissions results
- 2015 Inventory
  - Projection methodology
  - Midterm emissions results
- Observations

Geographic Scope

Great Plains Basin - 2011 Wells



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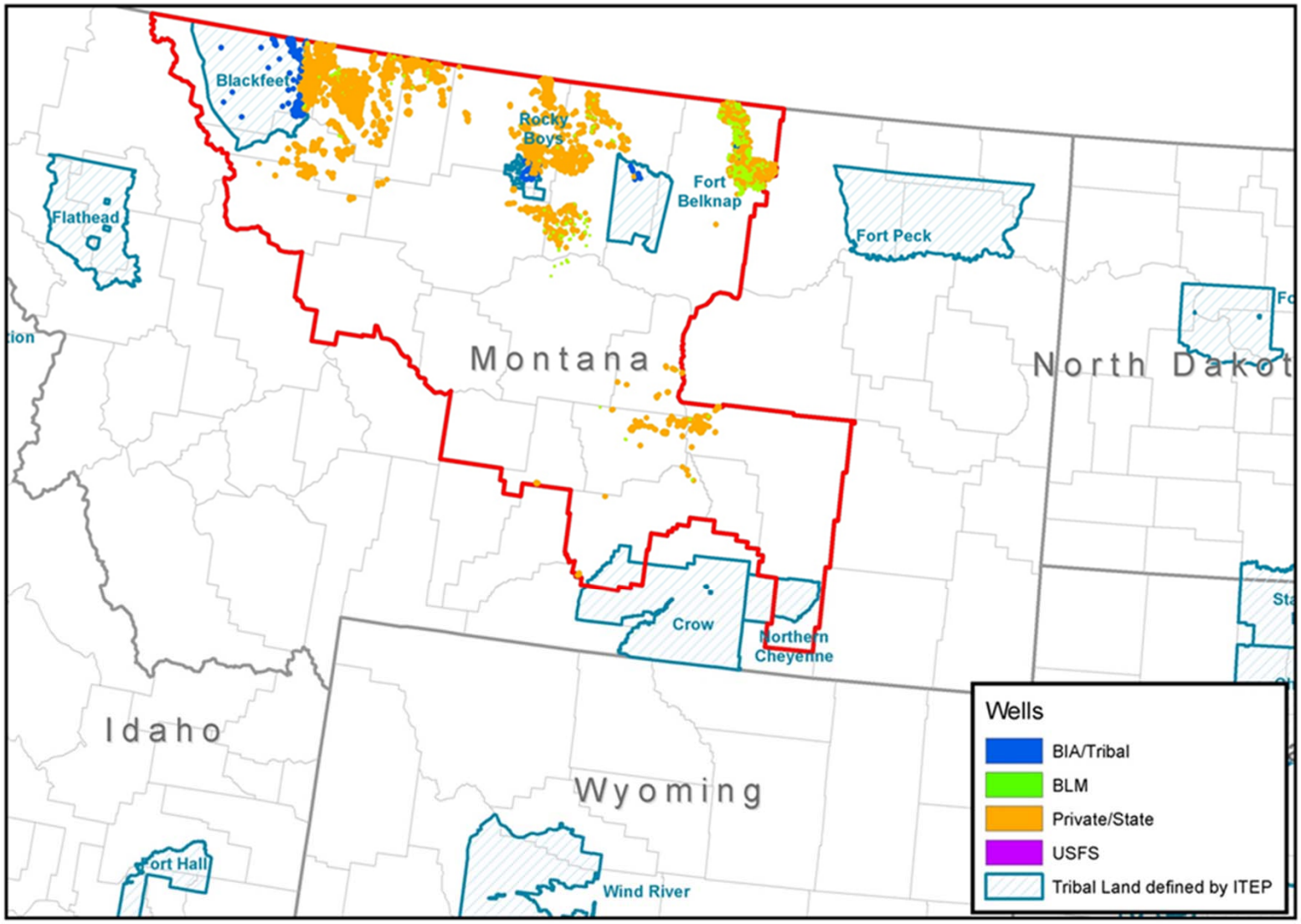
Mineral Ownership

Great Plains Basin Wells



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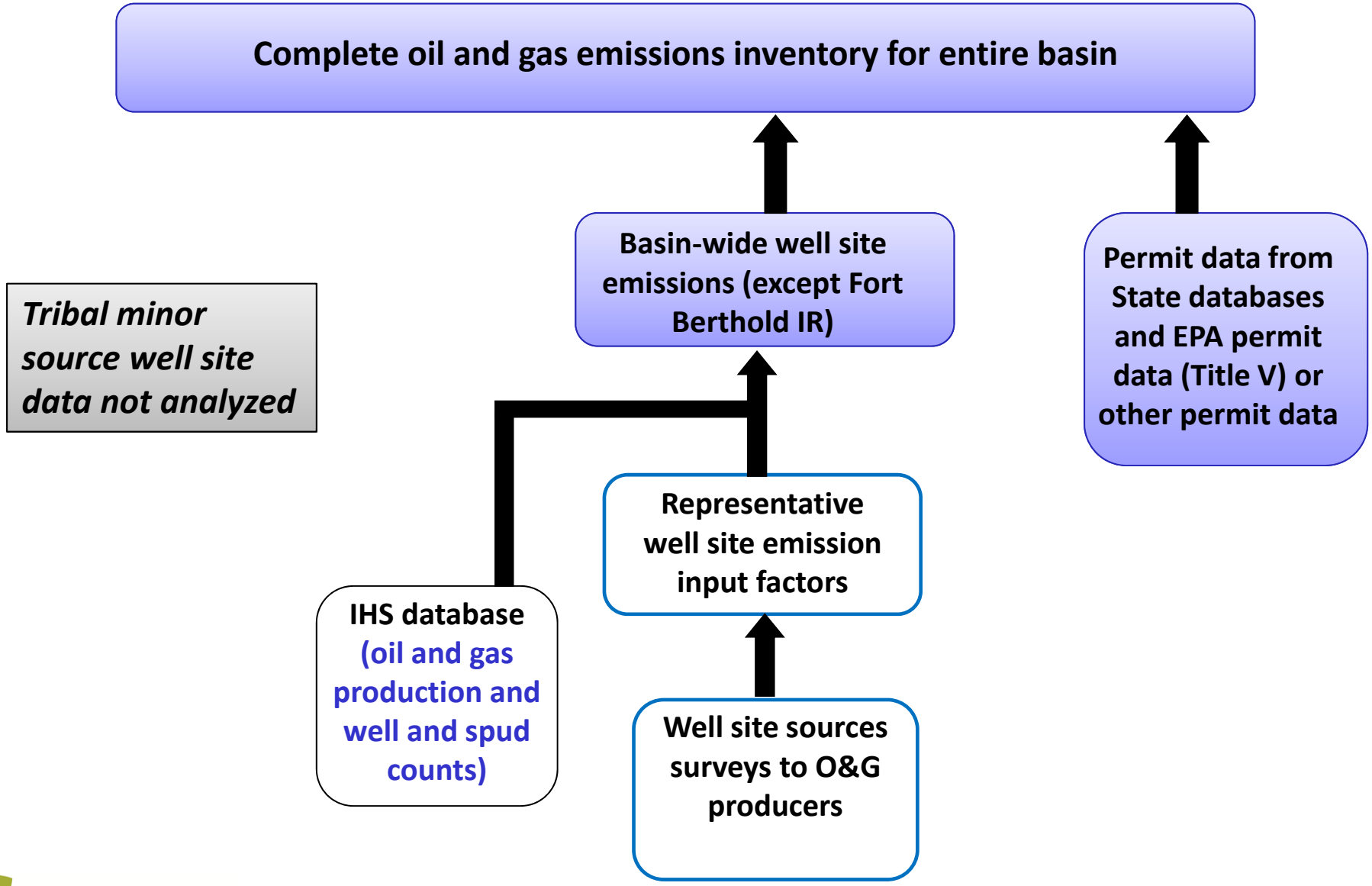
Methodology Diagram



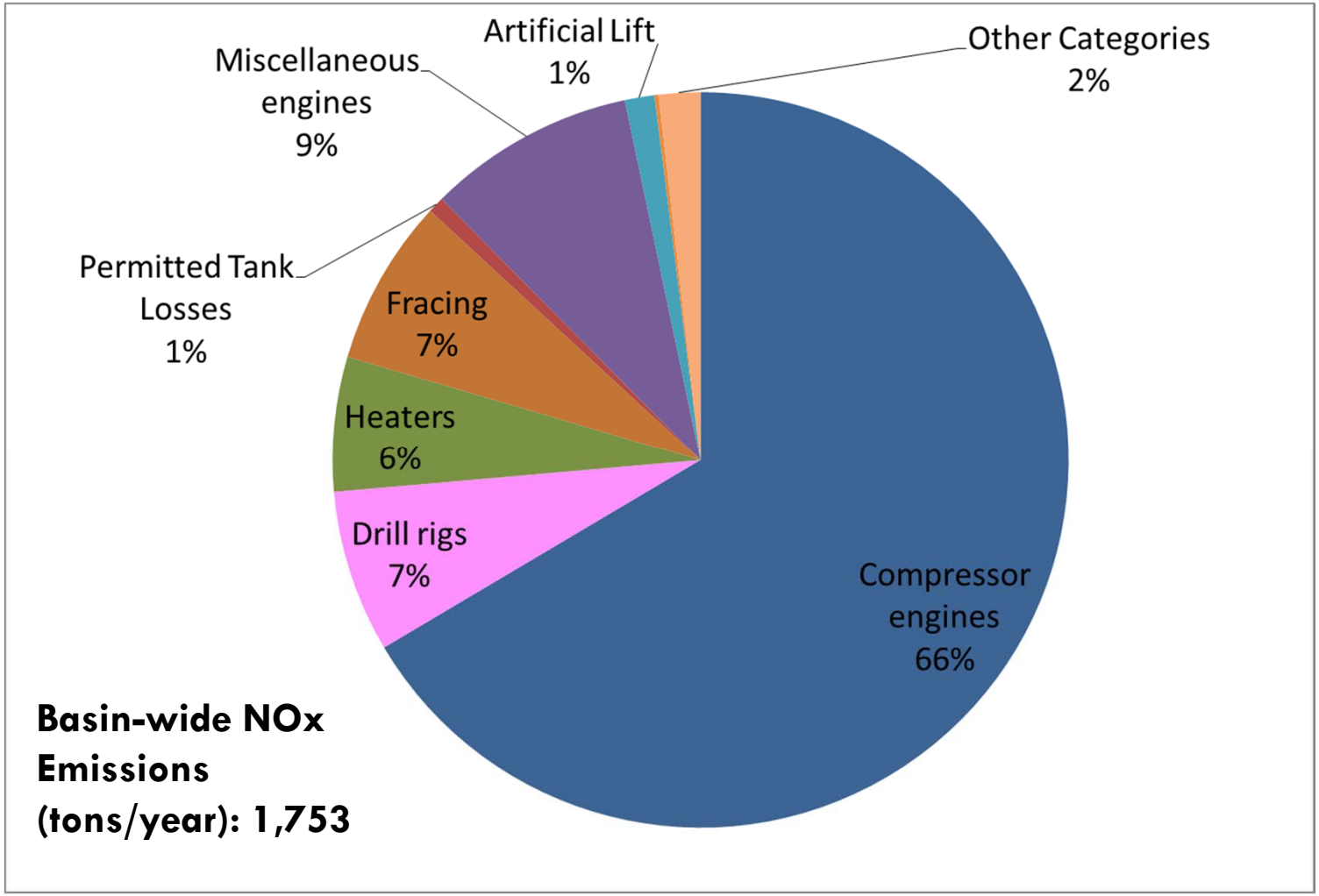
Great Plains Basin
Overview and Observations

- Relatively smaller oil and gas production than the Williston Basin; gas production primarily from gas wells and oil production primarily from oil wells – minimal CBM production
- Four main producing areas:
  - Western Area, including Blackfeet IR – both oil and gas wells
  - Central Area, including Rocky Boys –primarily gas wells
  - Phillips County in the East – gas wells with minimal liquid hydrocarbon production;
  - Southern Area –primarily oil production areas
- Significant activity on tribal lands: Blackfeet, Rocky Boys

Revisions from the Draft to Final Inventories

- Per comments received on the draft inventory:
  - None
- Additional revisions:
  - SCCs revised for consistency with EPA oil and gas SCCs
  - Small changes to emissions by county and by mineral ownership based on a spatial allocation correction

Great Plains Basin 2011 Baseline Results
NOx Emissions By Source Category



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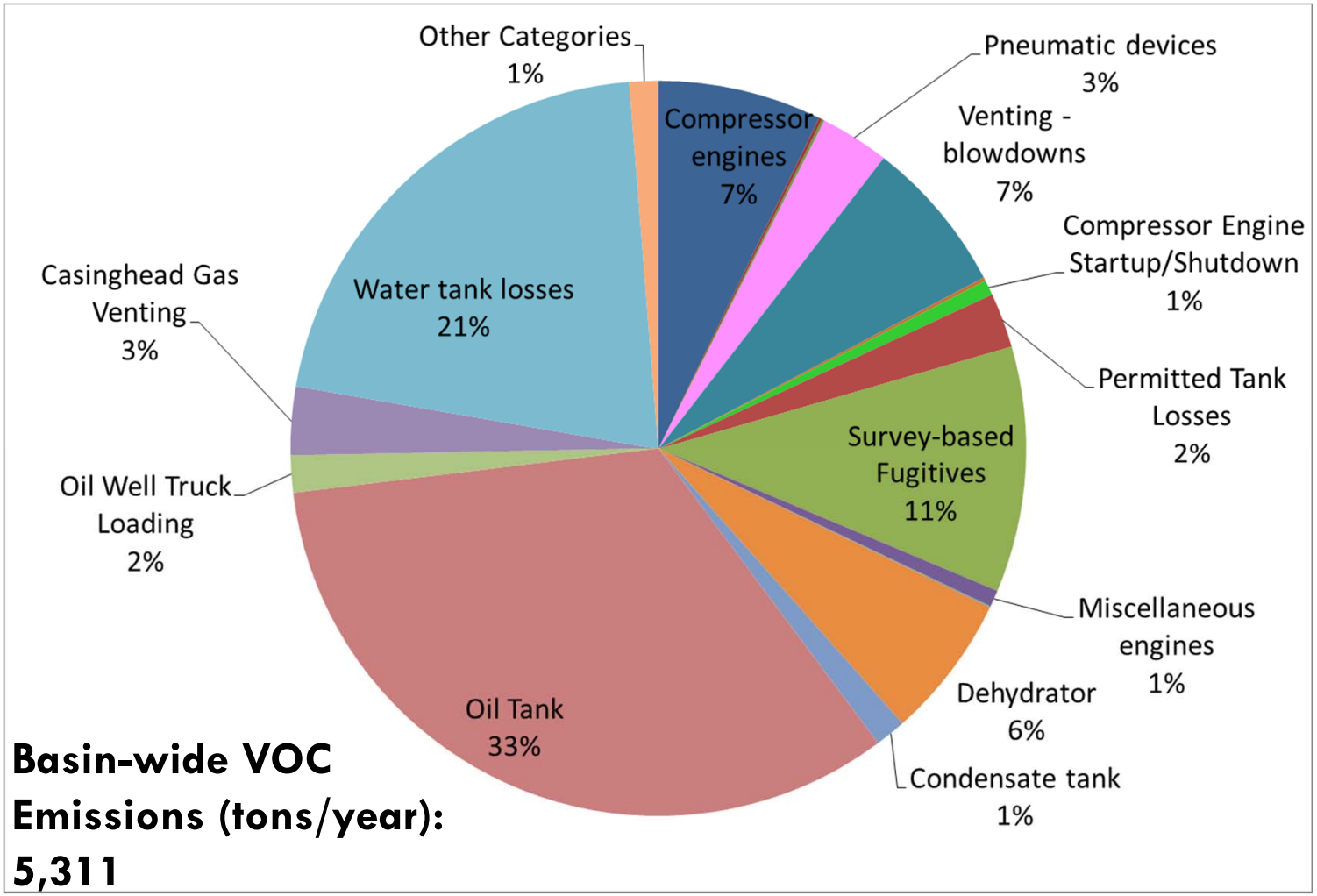
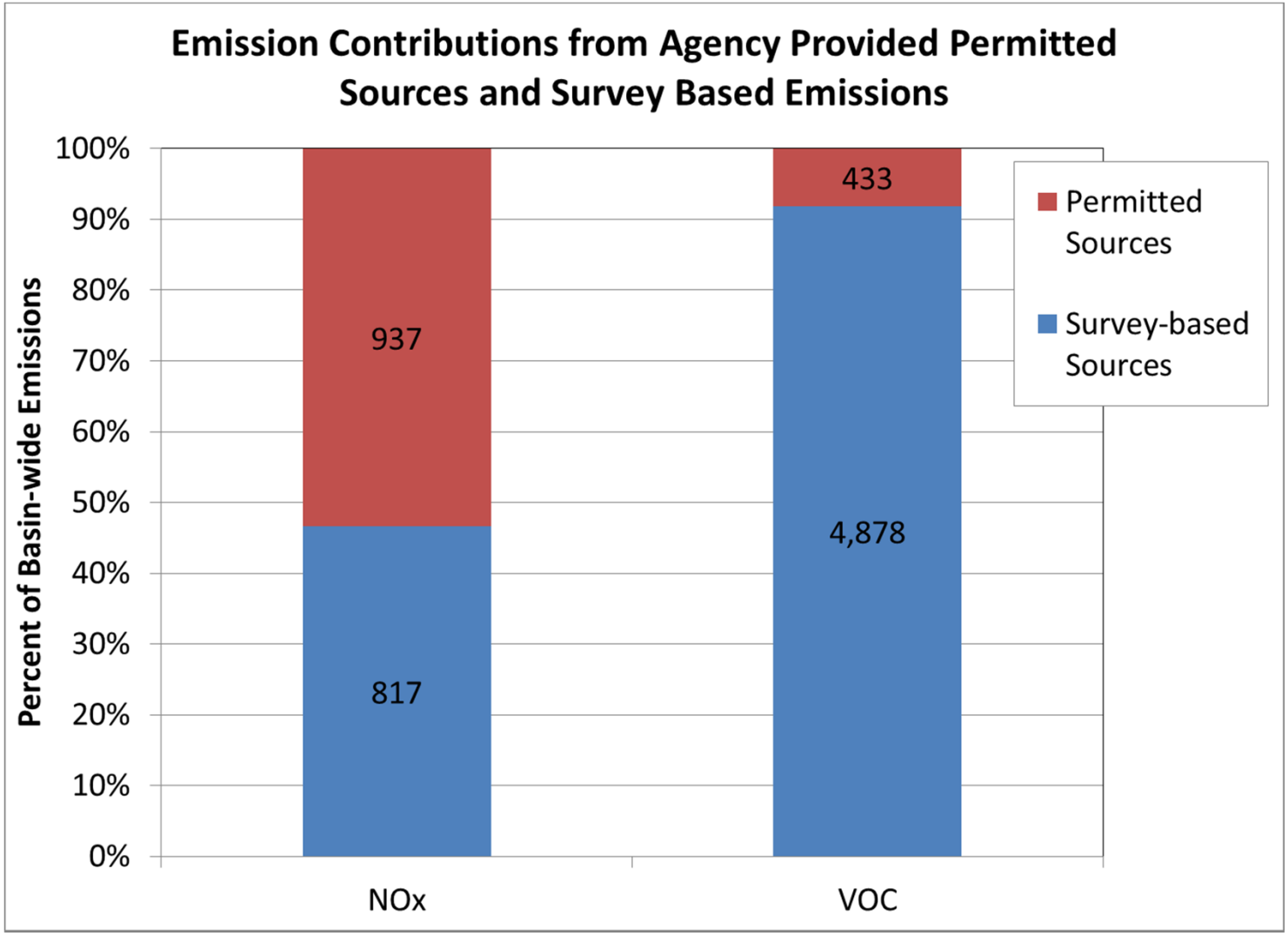
Great Plains Basin 2011 Baseline Results
VOC Emissions By Source Category



Basin-wide VOC Emissions (tons/year): 5,311

Great Plains Basin 2011 Baseline Results



- Survey-based sources include wellsite emissions based on operator survey data

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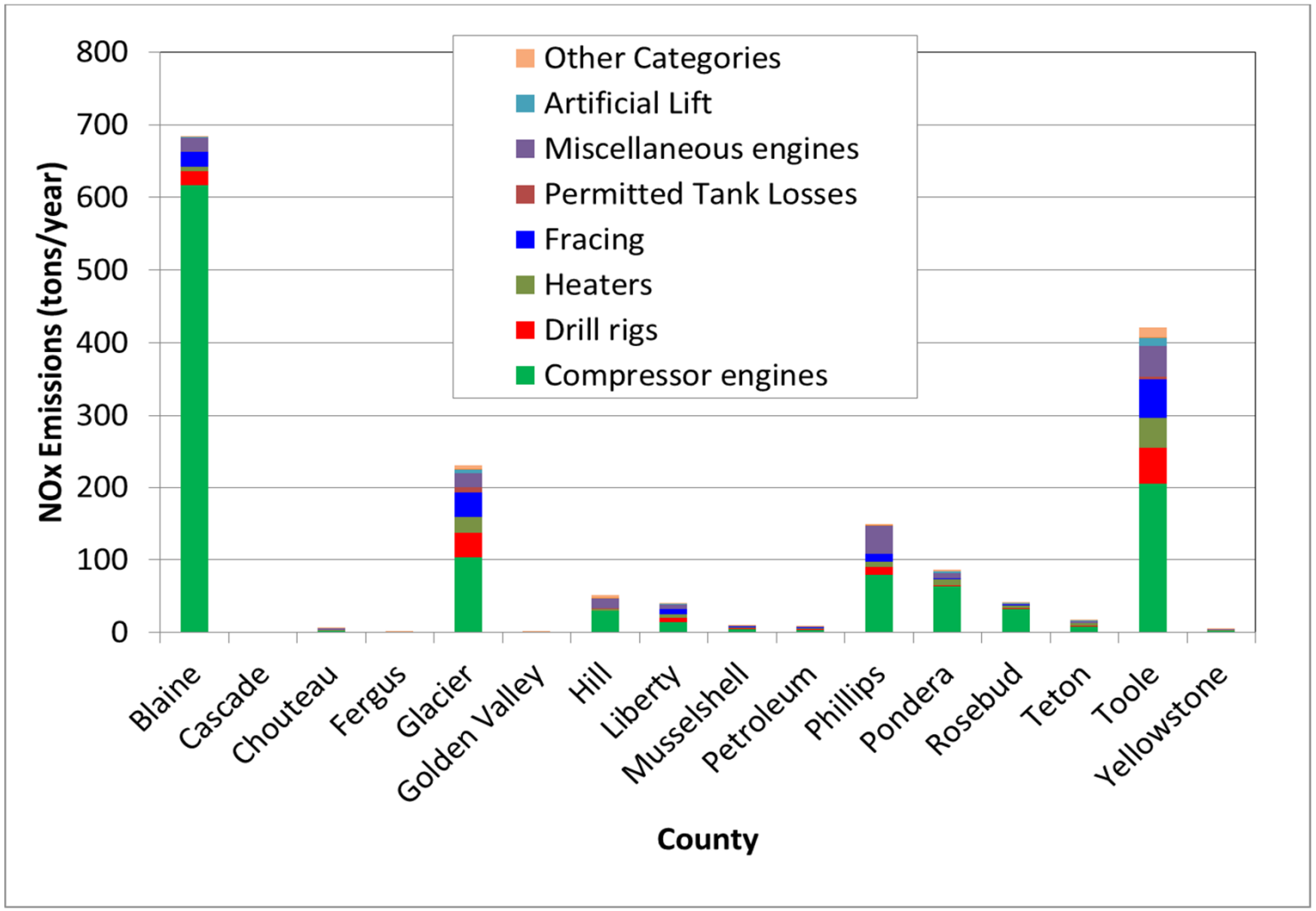
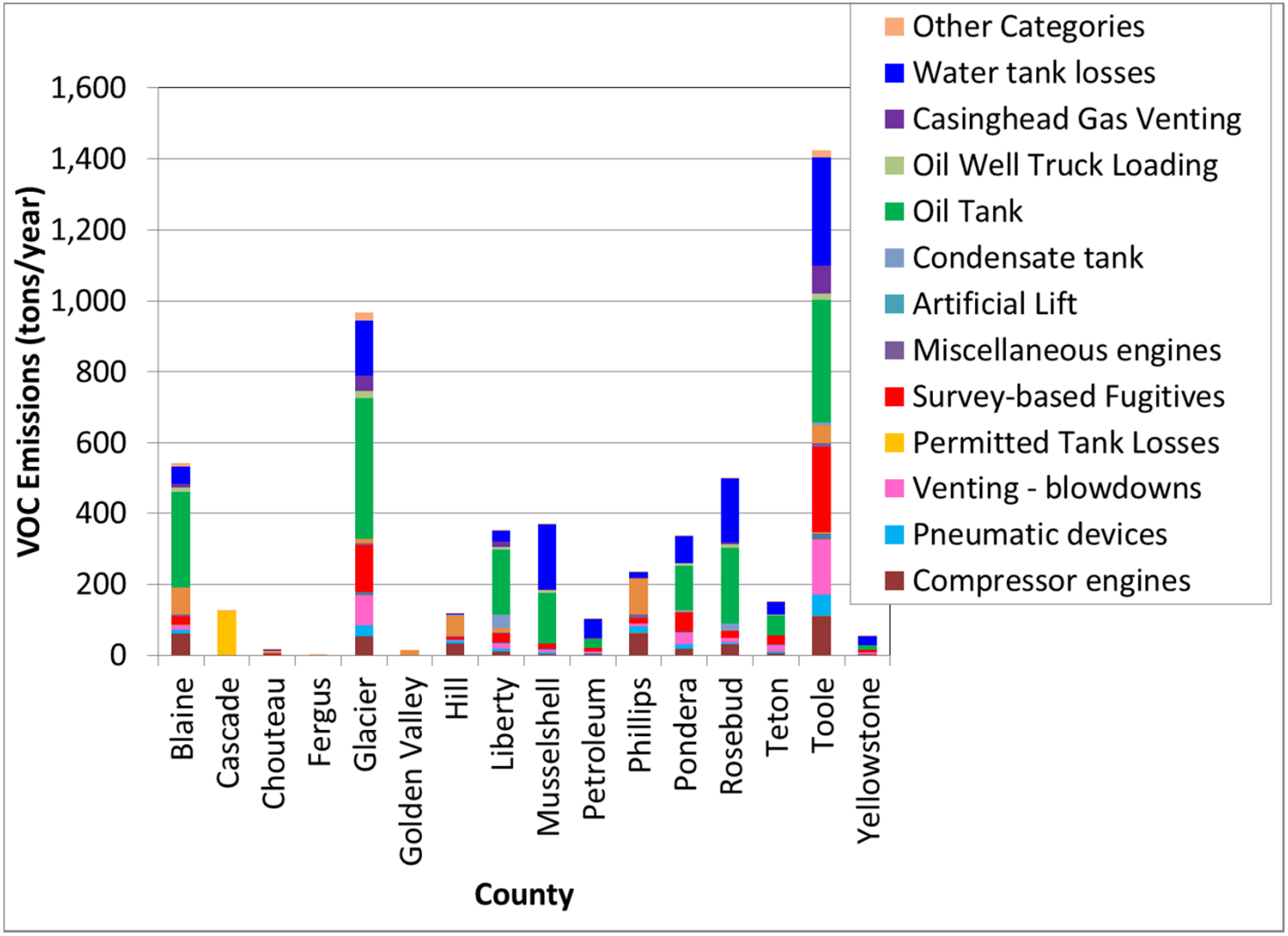
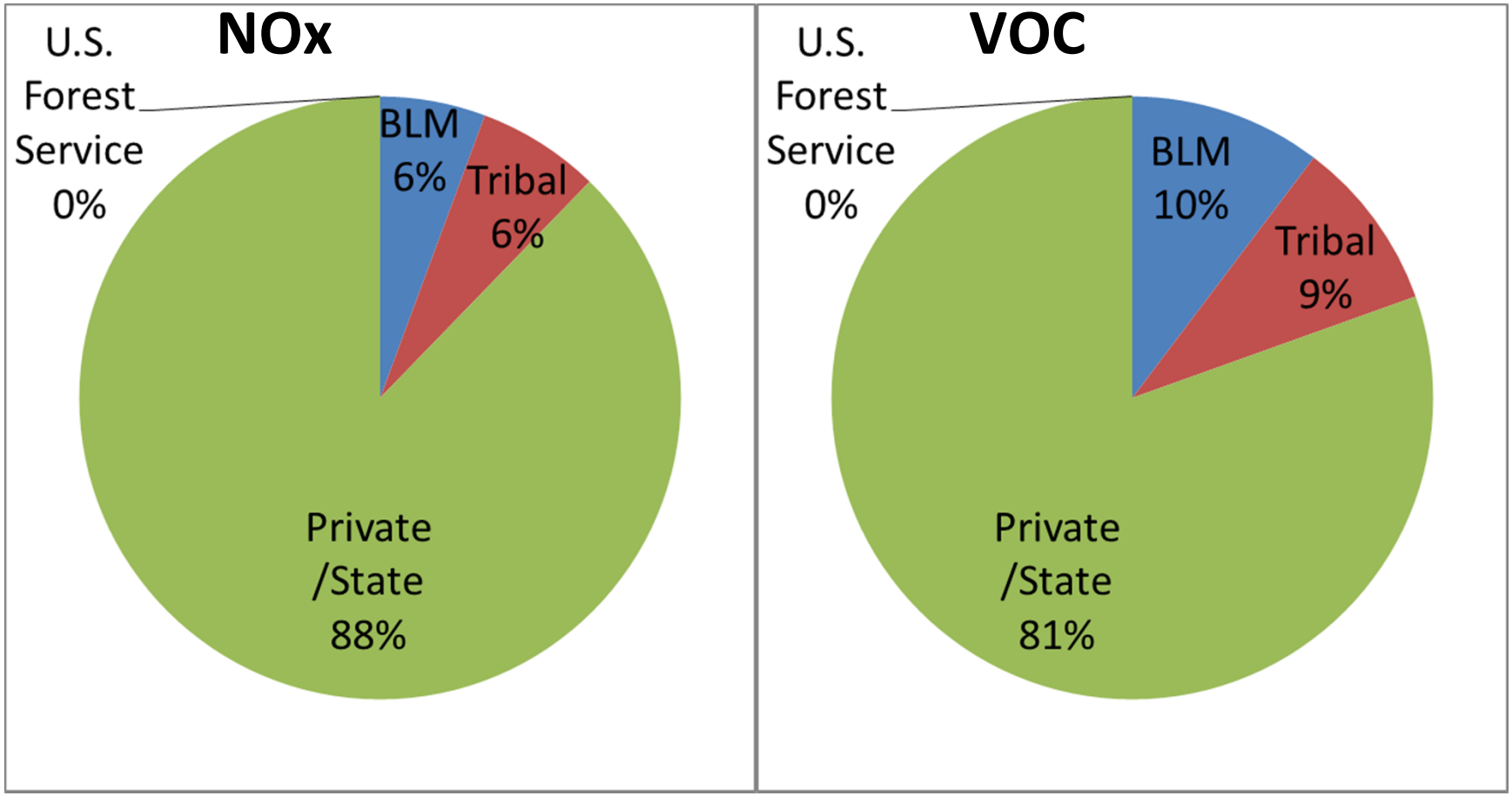
Great Plains Basin 2011 Baseline Results
NOx Emissions by County



Great Plains Basin 2011 Baseline Results
VOC Emissions by County



Great Plains Basin 2011 Baseline Results By Mineral Ownership



Great Plains Basin Mid-Term Projections Methodology

- 2015 scenario year
- Projections were developed for four separate geographic groupings: (1) Western Area, (2) Central Area, (3) Phillips County, (4) Southern Area
- IHS database is used to identify 2011 production statistics in the basin and to compile all historical data on production, drilling and well counts for the basin
- No growth or decline assumed from 2012 historical oil and gas activity data to 2015 projection

Great Plains Basin Mid-Term Projections Uncontrolled Scaling Factors

Geographic Grouping	Gas Production	Oil / Condensate Production	Spuds	Well Count
Western Counties	0.96	0.97	0.36	0.99
Central Counties	0.82	1.10	0.75	0.98
Phillips County	0.74	1.00	1.00	0.99
All Remaining Counties	0.86	1.27	0.62	1.08

- Assumed constant oil and gas activity from 2012
- Scaling factors are ratio of value of activity parameter in 2015 to value in 2011
- Different source categories' emissions are projected using different activity parameters and their scaling factors

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Great Plains 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 were applied
- Based on no growth assumption, additional control was assumed negligible for federal and state well site and midstream regulations

Great Plains Basin Mid-Term Projections "On-the-Books" Regulations

Federal	State of Montana
Nonroad engine Tier standards (1-4)	MT ARM 36.22.1221 Completion venting controls.
Nonroad diesel fuel sulfur standards	MT ARM 17.8.1603(1)(b) VOC vapors from oil or condensate storage tanks
New Source Performance Standards (NSPS) Subpart JJJJ for Spark-Ignition Engines	MT ARM 17.8.1711(1)(b) Liquids loading/unloading
New Source Performance Standards (NSPS) Subpart OOOO for Oil and Gas Sources	MT ARM 17.8.1711(1)(a), MT ARM 17.8.1603(1)(a), MT ARM 17.8.752, MT ARM 17.8.1711(1)(a) VOC vapors from O&G well facility equipment
National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart HH for Dehydrators	
Minor Source Reporting Requirements on Indian Tribal Land	

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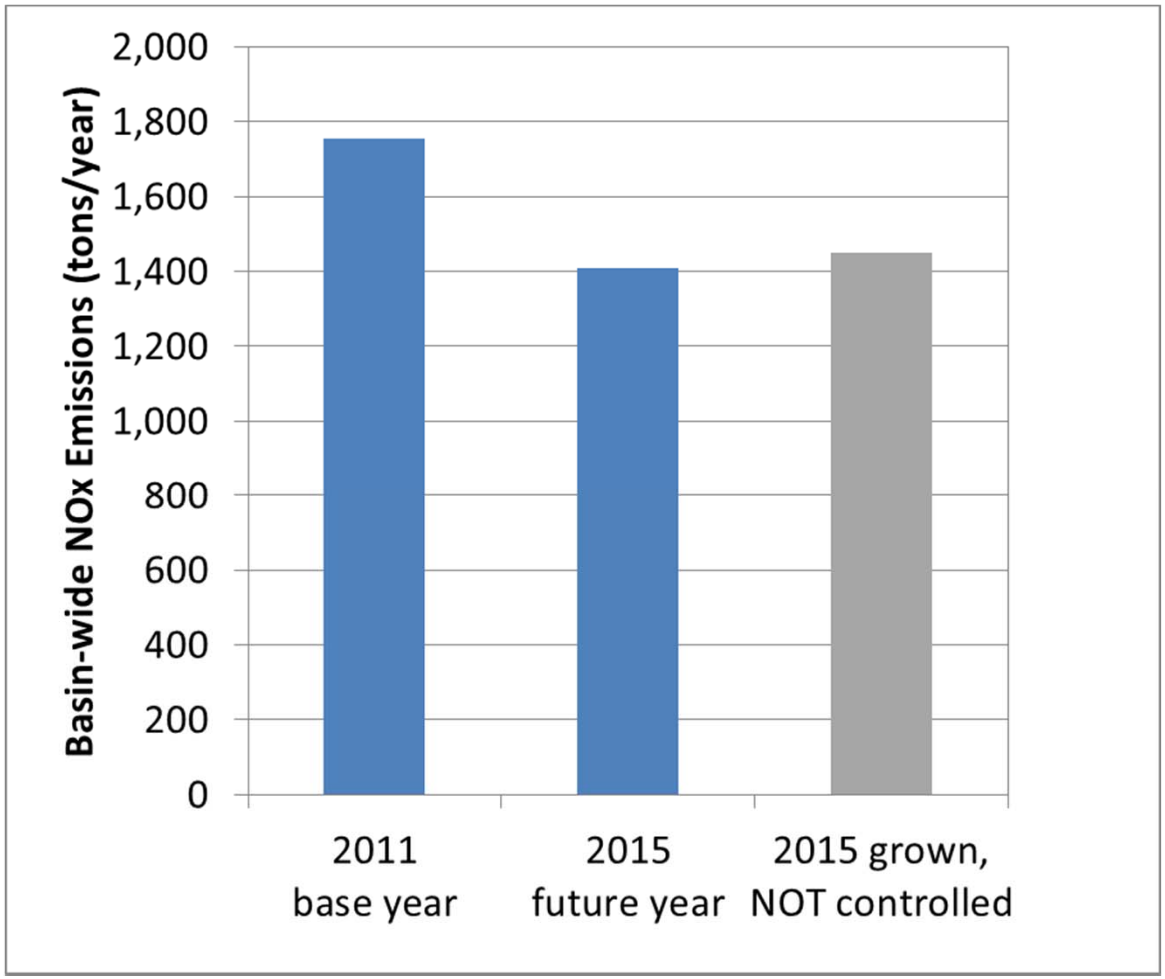
Great Plains Basin Mid-Term Projections
2015 NOx Emissions



- Fleet turnover and decreased spudding leads to decreased NOx emissions from drilling
- Decreased gas production leads to decreased compressor engine emissions
- 2015 controls have very little emission reduction effect due to no growth assumption

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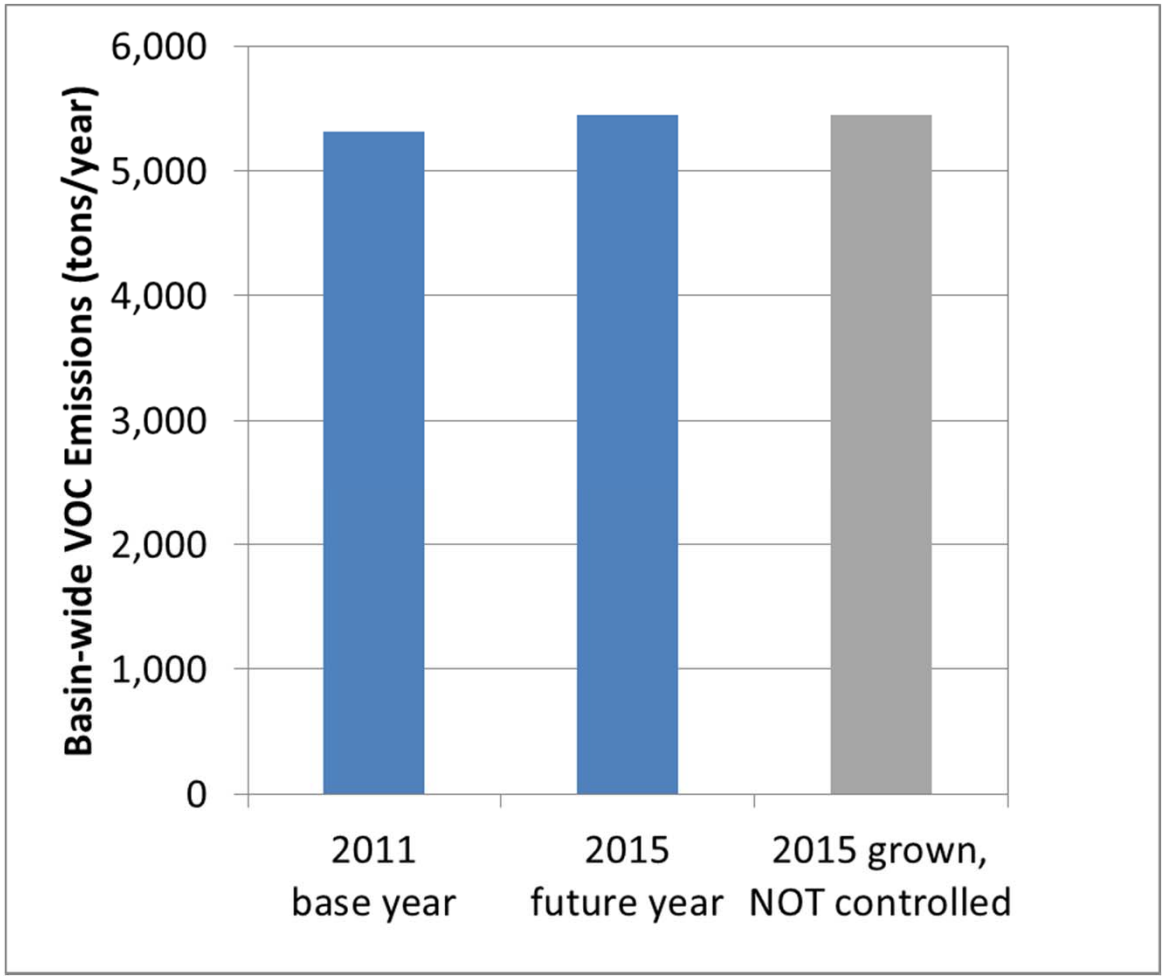
Great Plains Basin Mid-Term Projections 2015 VOC Emissions



- Consistent with activity trends VOC emissions remain relatively constant
- 2015 controls have very little emission reduction effect due to no growth assumption

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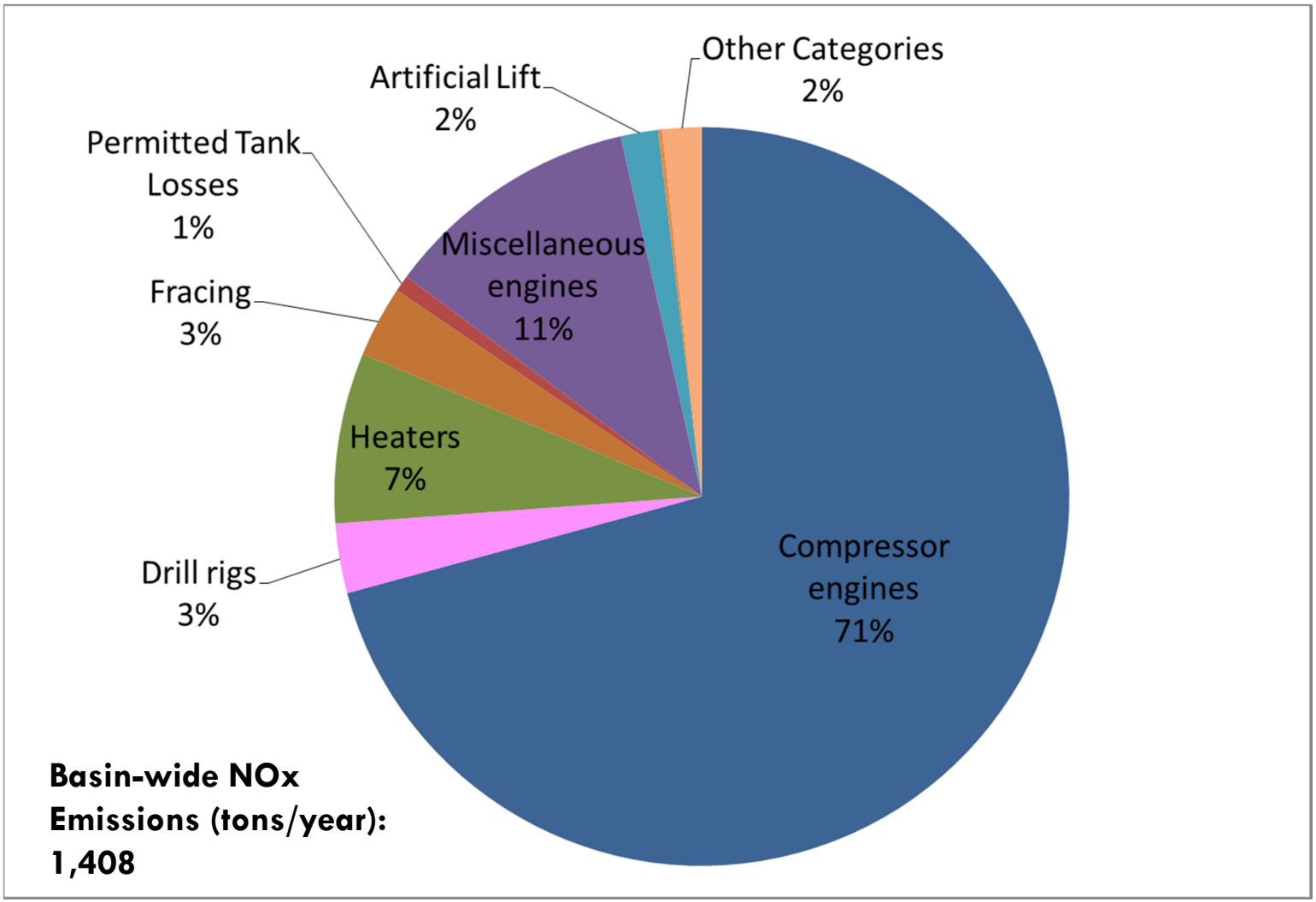
Great Plains Basin 2015 Midterm Results
NOx Emissions By Source Category



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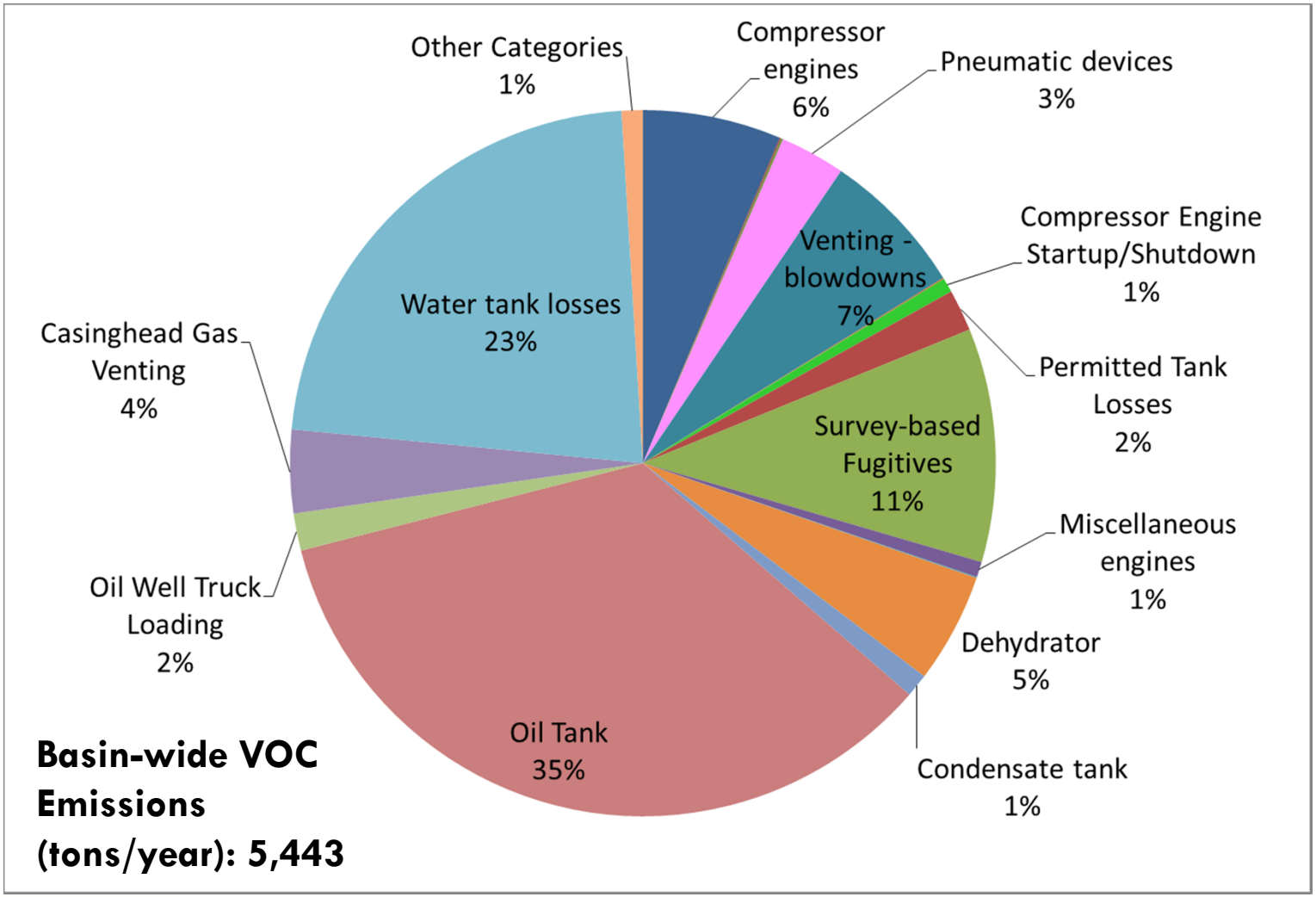
Great Plains Basin 2015 Midterm Results
VOC Emissions By Source Category



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All Pollutant Emissions By Year

Great Plains Basin-wide Emissions (tons/year)					
Year	NOx	VOC	CO	SOx	PM
2011	1,753	5,311	891	2	38
2015	1,408	5,443	765	1	28

- No growth assumptions, little change in emissions from 2011 to 2015
- No H_2S in average flared gas composition, very small SOx emissions

Observations

- Due to no growth assumptions, change in emissions from 2011 are moderate
- Future spudding rates have been assumed equivalent to 2012 activity. Additional data would allow for more certainty in growth assumptions.
- Additional data on future electrification and additional control due to NSPS would allow for estimation of the effect of these controls on emissions.

2015 Future Year Inventory Use

- 2015 inventory is a starting point based on current activity forecasts and on-the-books regulations
- Oil and gas activity changes can happen quickly
- Future year inventory may be revised as new information becomes available for the following:
  - Oil and gas activity levels
  - Oil and gas activity locations
  - Infrastructure improvements (e.g., pipelines, electrification) and their effect on emission sources
  - New EPA and state regulations and implementation/efficacy of recent regulations
- If the 2015 inventory is used as a "baseline year", oil and gas activity should be revised to reflect actual spud counts, well counts, and production estimates

Great Plains Basin Questions

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