A Comprehensive Emissions Inventory of Upstream Oil and Gas Activities in the Rocky Mountain States

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ABSTRACT

The Western Energy Alliance (WEA, formerly the Independent Petroleum Association of Mountain States) and the Western Governor's Association's Western Regional Air Partnership (WRAP) have co-sponsored a project to develop detailed emissions inventories for oil and gas upstream exploration and production activities. These inventories cover the Rocky Mountain States in the U.S., including New Mexico, Colorado, Utah, Wyoming and Montana. These inventories, conducted on the geological basin level, are the most comprehensive oil and gas emissions inventories to date in this region; they include all major processes and equipment types, from initial drilling through completion, production and processing activities in the major oil and gas fields of the Intermountain West. The inventories were developed by compiling detailed survey data collected from the major oil and gas companies, and include criteria pollutant emissions of NOx, VOC, CO, SOx and PM considering a base year of 2006 with future year projections for 2012. The basin-level inventories have been completed for the Wyoming basins, including an initial effort to conduct triennial updates to calendar year 2009, with anticipated regular triennial updates for all basins. The Wyoming basins, including baseline 2006 and projected 2012/2015 inventories, incorporate extensive analysis of permitted data, as well as the impacts of state regulatory controls. The inventory updates are also presented, showing rapidly evolving trends between 2006 and 2009. Finally, an analysis has been conducted to evaluate the impacts of recently passed national EPA regulations to implement controls on specific oil and gas source categories, as well as additional reporting requirements for tribal land.

INTRODUCTION

Oil and gas exploration and production activities occur extensively throughout the Rocky Mountain States in the United States – which includes the states of New Mexico, Colorado, Utah, Wyoming, Montana and North Dakota. These activities include a large number of processes and equipment which can generate air pollution emissions. Given the scope of these activities, these emissions can contribute significantly to the overall county-level or state-level emissions inventories of these Rocky Mountain States. Individual states have undertaken efforts to develop emissions inventories of oil and gas activities occurring within each state, such as those by New Mexico Environment Department (NMED) in the Four Corners Region[1] and the Wyoming Department of Environmental Quality (WYDEQ) state-wide oil and gas emissions inventory.[2] The Western Regional Air Partnership (WRAP) has sponsored the development of regional inventories for oil and gas, intended to cover multi-state regions in the Western United States. The WRAP inventories were developed in two phases – the Phase I inventory[3] which was the first-ever attempt to develop a comprehensive regional inventory of oil and gas activities, and the Phase II inventory[4] which included a more detailed

analysis of compressor engine and drilling rig emissions. Each of these past projects encountered limitations in the availability of data and the comprehensiveness and accuracy of the inventories they generated. Thus WRAP identified the need for a new, comprehensive inventory of oil and gas activities in the Rocky Mountain States. The current work, co-sponsored by WRAP and the WEA, builds on the older Phase I and Phase II inventories and is termed the Phase III inventory. The Phase III inventory project was begun in 2007, and is intended to be a comprehensive inventory of all major oil and gas exploration and production activities, processes and equipment in the Rocky Mountain States.

The Phase III project covers criteria pollutants, including nitrogen oxides (NOx), carbon monoxide (CO), volatile organic compounds (VOC), sulfur oxides (SOx) and particulate matter (PM). The inventory considers a base year of 2006, and "midterm" projections to 2012 or 2015, with a plan to generate regular triennial updates that would begin with calendar year 2009. The inventory considers both combustion-generated emissions and those from oil and gas exploration or production processes:

- Combustion-generated emissions – includes gas compressor engines, tank and separator heaters, boilers and reboilers in dehydrators and gas sweetening processes, flaring, drilling rig and workover rig engines, and miscellaneous engines (e.g. on-site generators, air compressors, vapor recovery units);
- Process emissions – includes flashing and working and breathing losses from condensate and oil tanks, venting emissions from dehydrators and gas sweetening units, fugitive emissions from well site and central facility components, vented emissions from pneumatic devices, vented emissions from pneumatic chemical injection pumps, vented emissions from well completions and recompletions, and vented emissions from well blowdowns.

The Phase III inventory considers all oil and gas exploration and production activities up to the outlet of a natural gas processing facility, or the inlet to a refinery. This scope is generally consistent with the definition of the "upstream" oil and gas sector, as defined separately from oil refining and natural gas transmission and distribution.[5] The Phase III inventory scope does not include on-road and off-road mobile sources associated with exploration and production activity, with the exception of drilling and workover rigs. However these mobile sources have been addressed in a new pilot study for the U.S. Environmental Protection Agency (EPA) that focused on the Piceance Basin in Northwestern Colorado.[6]

The Phase III project has many advantages over the previous inventory efforts conducted in this region. The inventory is regionally consistent in scope and methodology, and develops emissions at the level of the geologic basin, which is considered a reasonable geographic unit in which oil and gas activities and the produced gas and oil products are likely to be similar in nature. The Phase III project is significantly more comprehensive in scope than previous inventories, covering emissions source categories that had not previously been inventoried. The Phase III projects considers a more recent 2006 baseline year for the inventory than previous inventory projects, and includes the midterm emissions projection year of 2012 which both provides a third projection point to aid in developing the far future year projections and a more accurate future year projection. The detailed data in the Phase III inventory represents a better snapshot of actual equipment in use in fields throughout the region and can better capture the types of controls and practices in use than previous inventories.

Currently the Phase III project has completed 2006 baseline and 2012/2015 midterm projection emissions inventories for 8 geologic basins, including all of the Wyoming Basins which are the focus of this paper. The remaining work of the Phase III project will be to complete the inventories for the Williston Basin in northeastern Montana and western North Dakota. In addition the first 2009 triennial updates for the Wyoming Basins have been completed and results are also presented here. The completion of 2006 baseline, 2009 updated, and 2012/2015 projected inventories in the three Wyoming Basins (the Greater Green River Basin, Wind River Basin and Powder River Basin) allow for tracking the emissions from oil and gas activities in Wyoming in time, as well as to examine the effects of regulations on the inventories. We conclude with a qualitative summary of the potential impacts on oil and gas emissions from the EPA's recent federal regulations on permitting minor sources on Indian tribal land and NSPS requirements for some key oil and gas sources.

METHODS

The general methodology for developing the Phase III inventories for each basin is presented below, including the results for the Wyoming basin inventories. More detailed presentation of the specific emissions estimation methodologies by source category are presented in the series of technical reports which have been developed for each basin and published by WRAP.[7]

The Phase III baselines inventories are developed from a combination of (1) production statistics from a commercially available database; (2) survey data from oil and gas companies; and (3) permit data from states and the EPA for larger point-source facilities. These three data sources are then compiled to generate the complete baseline inventory for each basin.

Oil and Gas Production Statistics

Oil and gas related activity data for the Wyoming Basins were obtained from the IHS Enerdeq database queried via online interface. The IHS database uses data from Oil and Gas Conservation Commissions (or their equivalents) in each state as a source of information on oil and gas activity. The IHS database tool was evaluated and determined to be more complete and accurate than the Oil and Gas Conservation Commission databases for each state, since IHS makes significant efforts to gap-fill missing production data, clarify inconsistencies in data directly with the companies that report the data, and remove data that is erroneous or cannot be evaluated completely. Two types of data were queried from the Enerdeq database: production data and well data. Production data includes information relevant to producing wells in a given basin while well data includes information relevant to drilling activity ("spuds") and completions in the basin.

Production data were obtained for the counties that make up each basin in the form of PowerTools input files. PowerTools is an IHS application which, given PowerTools inputs queried from an IHS database, analyzes, integrates, and summarizes production data in an ACCESS database. From a database created by PowerTools, extractions of the following data relevant to the emissions inventory development were made:

- 2006 active wells, i.e. wells that reported any oil or gas production in 2006.
- 2006 oil, gas, and water production by well and by well type.

The production data are available by API number. The API number in the IHS database consists of 14 digits as follows:

- Digits 1 to 2: state identifier
- Digits 3 to 5: county identifier
- Digits 6 to 10: borehole identifier
- Digits 11 to 12: sidetracks
- Digits 13 to 14: event sequence code (recompletions)

Based on the expectation that the first 10 digits, which include geographic and borehole identifiers, would predict unique sets of well head equipment, the unique wells were identified by the first 10 digits of the API number. Well data were also obtained from the IHS Enerdeq database for the counties in each basin in the form of "297" well data. The "297" well data contain information regarding spuds and completions. The "297"well data were processed to arrive at a database of by-API-number, spud and completion dates with latitude and longitude information. Drilling events in 2006 were identified by indication that the spud occurred within 2006. If the well API number indicated the well was a recompletion, it was not counted as a drilling event, though if the API number indicated the well was a sidetrack, it was counted as a drilling event.

Tables 1 and 2 below show the 2006 baseline and 2009 updated production statistics for the Wyoming Basins, and help to explain some of the variation in basin inventories.

Table 1. 2006 and 2009 oil and gas production statistics summary for the Wyoming Basins in the Phase III Project.

Basin	Oil Production (barrels)			Gas Production (thousand cubic feet)		
	Total	Oil Well Oil	Gas Well Condensate	Total	Conventional	CBM
2006 Statistics						
Wind River Basin	3,043,459	2,563,912	479,547	198,190,024	197,166,868	1,023,156
Powder River Basin	19,662,896	19,144,596	518,300	452,813,743	64,019,159	388,794,584
SW Wyoming Basin	16,109,922	6,324,849	9,785,073	1,468,167,385	1,461,271,032	6,896,353
2009 Statistics						
Wind River Basin	3,041,729	2,614,448	427,281	163,702,027	160,481,355	3,220,672
Powder River Basin	18,478,966	18,002,318	476,648	622,594,717	53,854,796	568,739,921
SW Wyoming Basin	17,176,848	11,961,101	5,215,747	1,750,353,786	1,728,074,831	22,278,955
Percentage Change (% 2006 to 2009)						
Wind River Basin	0.0%	+2.0%	-10.9%	-17.4%	-18.6%	+214.8%
Powder River Basin	-6.0%	-6.0%	-8.0%	+37.5%	-15.9%	+46.3%
SW Wyoming Basin	+6.6%	+89.1%	-46.7%	+19.2%	+18.3%	+223.1%

Table 2. 2006 and 2009 oil and gas well count statistics summary for the Wyoming Basins in the Phase III Project.

Basin	Well Counts			Spud Counts
	Total	Conv.	CBM	Total
2006 Statistics				
Wind River Basin	1,350	1,330	20	98
Powder River Basin	25,652	7,793	17,859	3,275
SW Wyoming Basin	9,173	9,019	154	1,146
2009 Statistics				
Wind River Basin	1,389	1,371	18	37
Powder River Basin	26,671	7,584	19,087	530
SW Wyoming Basin	11,580	11,290	290	689
Percentage Change (% 2006 to 2009)				
Wind River Basin	+3.6%	+3.1%	-10.0%	-62.2%
Powder River Basin	+4.0%	-2.7%	+6.9%	-83.8%
SW Wyoming Basin	+26.2%	+25.2%	+88.3%	-39.9%

As Tables 1-2 demonstrate, wide variation is observed in the total production of gas, oil and condensate, and in the number of wells and spuds occurring in the three Wyoming Basins, and variations between the baseline year 2006 and the update year 2009. The Southwest Wyoming Basin (also referred to as the Greater Green River Basin) is by far the dominant gas production basin in Wyoming. The Powder River Basin is a also a significant CBM gas production basin, and the Wind River Basin represents the smallest of the three gas producing basins in Wyoming. Both the Southwest Wyoming and Powder River Basins produce significant quantities of liquid hydrocarbon, with the Powder River Basin producing primary oil and the Southwest Wyoming Basin producing a mix of oil and condensate. In general the 2009 updates show that the Wind River Basin is either in decline or holding steady production, while the Southwest Wyoming and Powder River Basins show increases in gas production. Primary oil production in the Powder River Basin is declining and in the Southwest Wyoming Basin is increasing. Finally, drilling statistics suggest that in 2009 drilling activity in all three Wyoming Basins has decreased significantly, which may coincide with the sharp drop in natural gas prices in the U.S. and the economic downturn beginning in the 2008-2009 time frame. Despite the drop in drilling activity in 2009, the well counts have increased in all three Wyoming Basins as they are the result of cumulative drilling activities in the period 2006-2009.

The extracted oil and gas well locations by type and maps for the three Wyoming basins for 2006 and 2009 are presented in Figures 1-6 below.

Figure 1. 2006 oil and gas well locations by well type within the Wind River Basin.

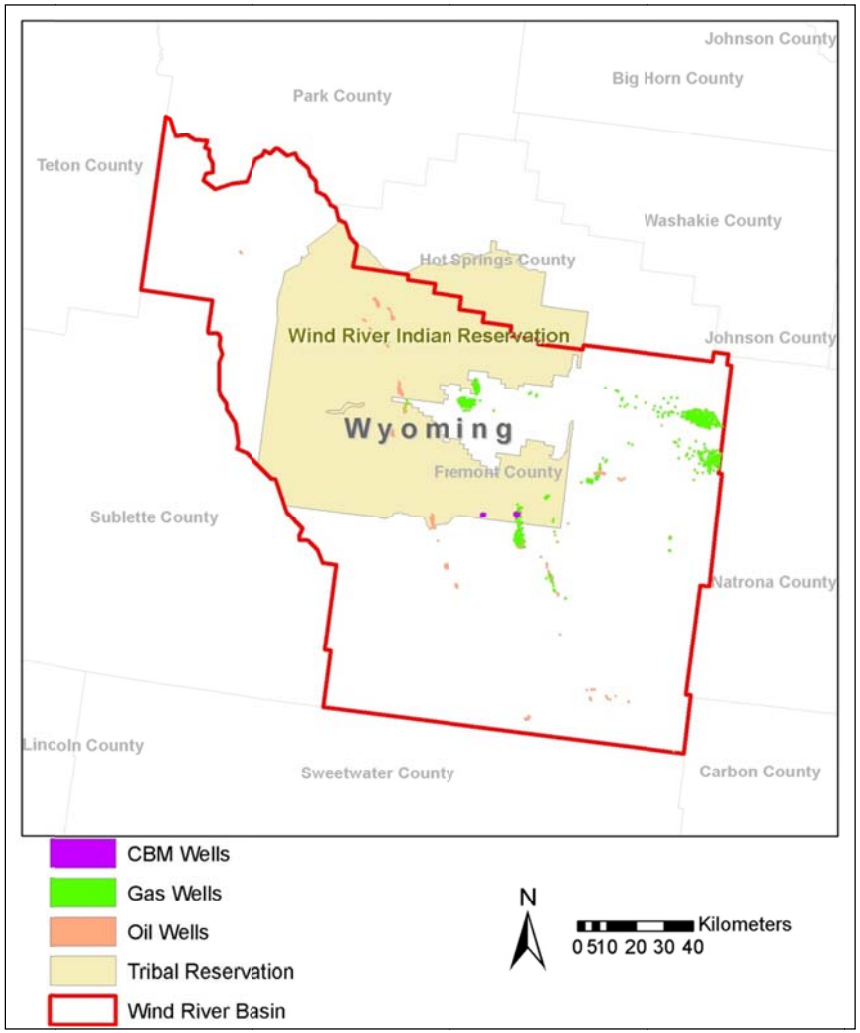


Figure 2. 2009 oil and gas well locations by well type within the Wind River Basin.

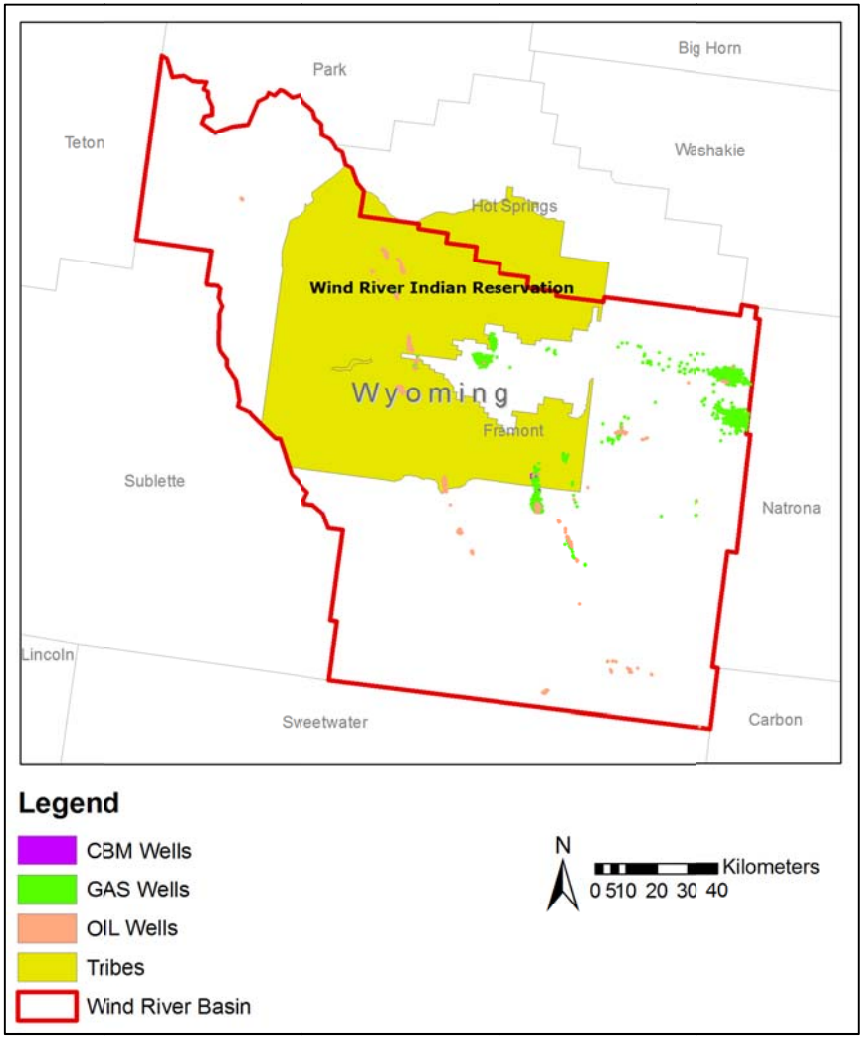


Figure 3. 2006 oil and gas well locations by well type within the Powder River Basin.

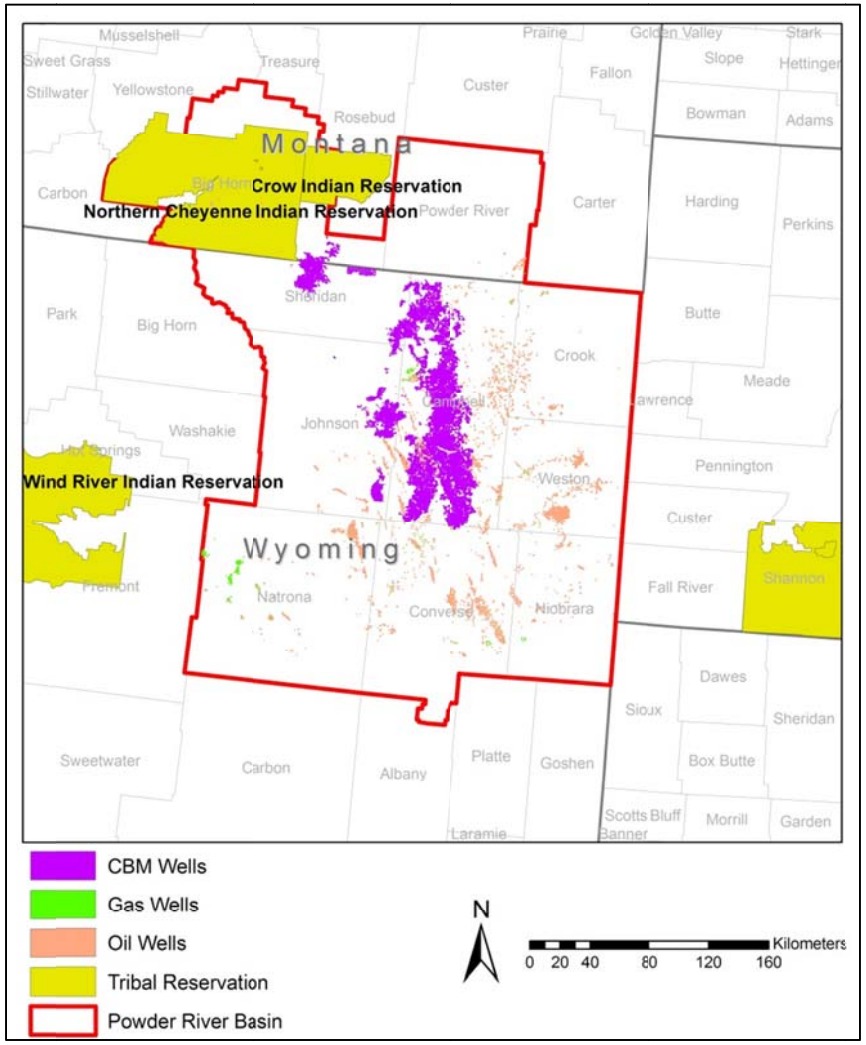


Figure 4. 2009 oil and gas well locations by well type within the Powder River Basin.

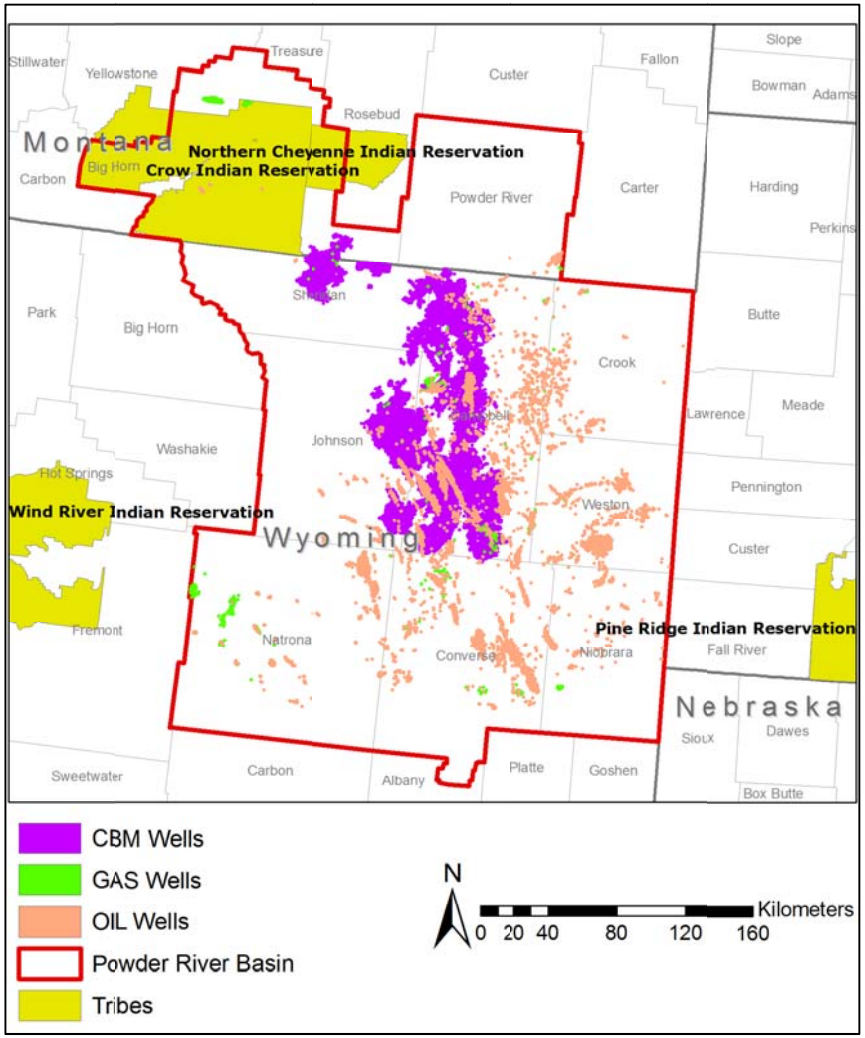


Figure 5. 2006 oil and gas well locations by well type within the Southwest Wyoming Basin.

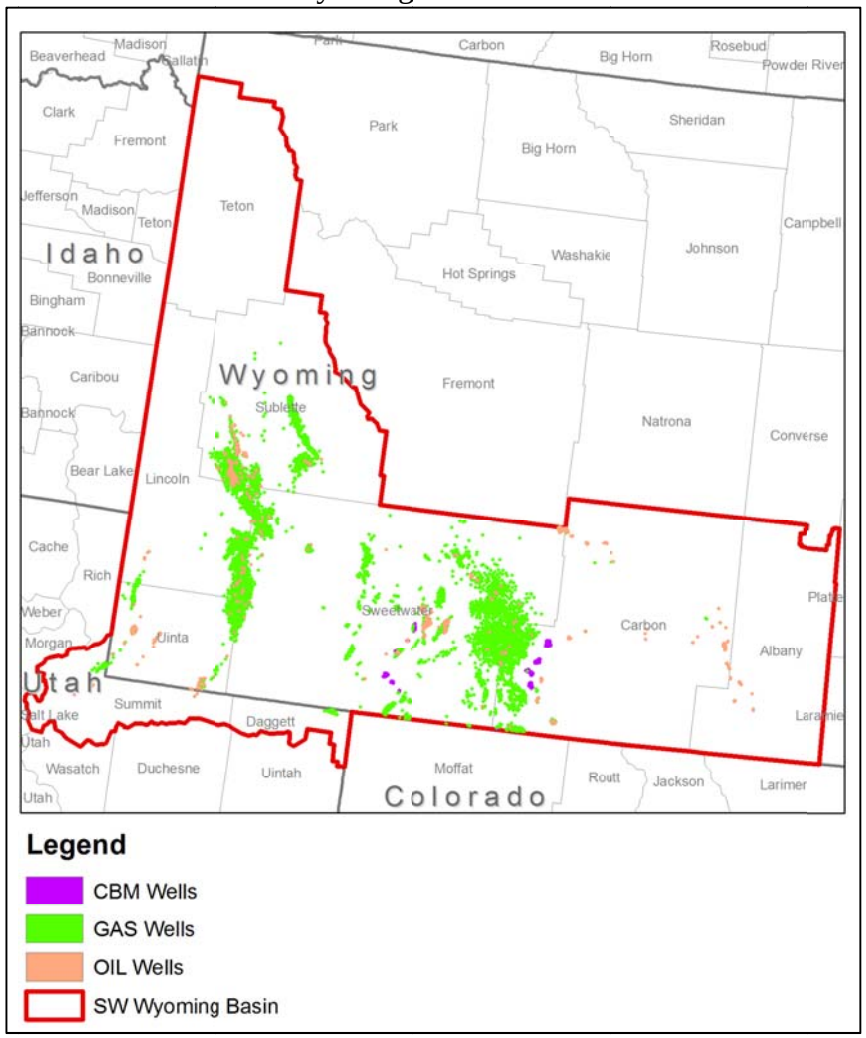
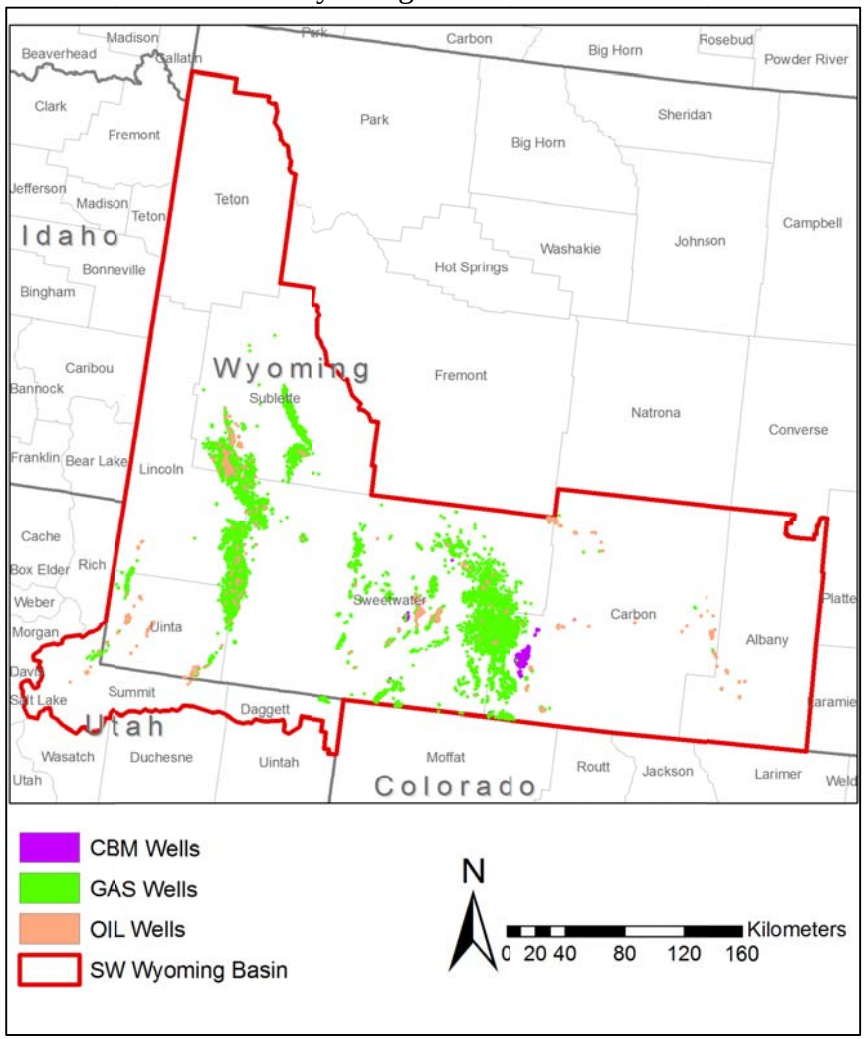


Figure 6. 2009 oil and gas well locations by well type within the Southwest Wyoming Basin.



Survey Data

The Wyoming Basin inventories were developed using a combination of survey-based data and data from state permits or other state-sponsored inventories. The survey-based data for the 2006 baseline year inventories for the three Wyoming Basins were gathered using spreadsheet-based survey forms sent to major operators in the basins. This process has been described in technical memos previously developed for the WRAP Phase III project and summarized in past emissions inventory conference proceedings[8]. The reader is referred to these documents for detailed descriptions of the survey process used in the Phase III project.

For the 2009 updates to the three Wyoming basins, survey requests were sent to the group of operators who participated in the baseline 2006 inventory development for each basin. Operators responding to the 2009 survey update requests were provided the opportunity to update basic equipment assumptions, activity assumptions, process assumptions (for categories such as well venting, and gas dehydration), and controls assumptions. If a 2009 survey update was not provided by the operator, it was assumed that the activity/process/equipment data for that operator remained unchanged from their 2006 baseline data. The survey instrument developed for the 2009 updates was essentially identical to that developed for the 2006 baseline, and included all source categories which were estimated based on survey data and natural gas compositions in each basin. For the three Wyoming Basins this included the following source categories shown in Table 3.

Table 3. Summary of surveyed source categories in the three Wyoming basins.

Wind River Basin	**Powder River Basin**	**Southwest Wyoming Basin**
Amine Units	Artificial Lift	Well Blowdown
Artificial Lift	Well Blowdown	Well Completions/Recompletions
Well Blowdown	CBM Pump Engines	Compressor Startups/Shutdowns
Well Completions/Recompletions	Well Completions/Recompletions	Dehydrators
Compressor Engines	Wellhead Compressors	Drilling Rigs
Compressor Startups/Shutdowns	Compressor Startups/Shutdowns	Flaring
Dehydrators	Dehydrators	Fugitives
Drilling Rigs	Drilling Rigs	Heaters
Flaring	Flaring	Oil and Gas Well Truck Loading
Fugitives	Fugitives	Pneumatic Devices
Heaters	Heaters	Pneumatic Pumps
Miscellaneous Engines	Miscellaneous Engines	Oil and Condensate Tanks
Oil and Gas Well Truck Loading	Oil and Gas Well Truck Loading	Workover Rigs
Pneumatic Devices	Pneumatic Devices	
Pneumatic Pumps	Pneumatic Pumps	
Oil and Condensate Tanks	Oil and Condensate Tanks	
Workover Rigs	Workover Rigs	

As noted in the development of the 2006 baseline emissions inventory for the Southwest Wyoming Basin, data and emissions for engine categories (compressor engines and miscellaneous engines) for this basin were obtained directly from permit data.

Tables 4-6 show the percentage ownership of production and well counts represented by survey respondents for the 2006 baseline, and 2009 updates for all Wyoming basins.

Table 4. Percentage ownership of basin-wide production by survey respondents in the Wind River Basin.

	Percent Ownership of Basin-Wide Production		
	2006 Participating Companies	**2009 Survey Update Respondents**	**2009 All Companies[a]**
Well Count	54%	35%	52%
Gas Production	97%	20%	96%
Oil Production	23%	23%	25%

a – all companies includes those responding to the 2009 survey update request and those companies for which baseline 2006 survey data was used

Table 5. Percentage ownership of basin-wide production by survey respondents in the Powder River Basin.

	Percent Ownership of Basin-Wide Production		
	2006 Participating Companies	**2009 Survey Update Respondents**	**2009 All Companies[a]**
Well Count	30%	20%	34%
Gas Production	46%	33%	55%
Oil Production	24%	29%	38%

a – all companies includes those responding to the 2009 survey update request and those companies for which baseline 2006 survey data was used

Table 6. Percentage ownership of basin-wide production by survey respondents in the Southwest Wyoming Basin.

	Percent Ownership of Basin-Wide Production		
	2006 Participating Companies[a]	**2009 Survey Update Respondents**	**2009 All Companies[b]**
Well Count	60%	14%	61%
Gas Production	78%	6%	78%
Oil Production	59%	6%	62%

a – participating companies in the 2006 baseline inventory included those providing survey data and all companies that provided data to the WYDEQ for the Jonah-Pinedale inventory
b – all companies includes those responding to the 2009 survey update request, those companies for which baseline 2006 survey data was used, and those companies that provided data to the WYDEQ for the Sublette County inventory

In the Wind River Basin, it is noted that percentages of well count and oil production ownership do not reach the 70% targets set for the Phase III basins, but as with the baseline inventory for the Wind River it was determined that the inventory would proceed with the survey responses received. The percentage ownership representation for the 2009 update for the Wind River Basin does not change substantially from the 2006 baseline. Similarly for the Powder River Basin, neither the 2006 baseline nor 2009 updates achieve the 70% targets, but it is noted that there is an increase in the percentage ownership representation for oil production and gas production in the 2009 Powder River Basin update. Percentage ownership in the Southwest Wyoming Basin is considered reasonable for both the 2006 baseline and 2009 updates. It is noted that this percentage ownership representation is achieved in part by making use of the WYDEQ's extensive surveys and inventories for the Jonah-Pinedale Anticline Development (JPAD) area in the 2006 baseline, and the expanded WYDEQ inventory for all of Sublette County in the 2009 update. These are described more below.

Similar to the 2006 baseline inventory, the 2009 updated survey data for responding companies were combined with 2006 survey data for non-responding companies and aggregated. The aggregation used a by-company weighted average methodology, and the weighting factor was assigned based on the surrogate cross-reference for each source category (i.e. gas production, well count, oil production, etc.)

similar to the methodology for the 2006 baseline inventory. Surrogates were assigned to operators based on their percentage ownership of the surrogate in the basin in 2009.

Similar to the 2006 baseline inventory methodology, the basin-wide emissions for survey-based source categories were estimated by scaling the aggregated survey data from participating companies by the appropriate basin-wide surrogate. For tribal land in the Wind River and Powder River Basins, the allocation of emissions to tribal land was based on the fraction of the surrogate occurring on tribal land for each source category.

Permit Data

Permitted sources in this study refer primarily to larger sources in use in midstream, gas gathering applications that are generally treated in inventories as point sources. This includes large gas processing plants, major compressor stations, and other smaller compressor stations, including the associated equipment at these stations. The midstream sources are often not owned by the same production companies that responded to the surveys on upstream oil and gas activity in the basin, therefore the permit data was needed to capture emissions from these sources. The Wyoming Department of Environmental Quality (WYDEQ) provided permit data for sources in Wyoming and the US Environmental Protection Agency (USEPA) Region 8 office provided permit data for sources on tribal land in Wyoming. There are three principal sources of information for the permitted sources which were utilized. These are listed below with a description of the methodology by which they were incorporated:

1) WYDEQ Permitted Sources Data – this database contained by-facility and by-source emissions for all permitted facilities in the three Wyoming basins. Excluded from this were production site sources for which emissions were generally estimated using the survey-based calculations described above. This also included all Title V sources within the boundaries of the three Wyoming Basins.
2) WYDEQ Engines Database – in addition to the permitted sources data, WYDEQ compiled more detailed actual emissions for engines operating throughout the three Wyoming basins. These engine emissions were used in place of engines at the permitted facilities described in (1) above, with the exception of Title V sources for which emissions from the permitted sources data were retained. This engine emissions data was used for the compressor engine and miscellaneous engine source categories.
3) EPA Part 71 Sources on Tribal Land – a request was made to EPA for permit data provided for Part 71 sources in the Wind River and Powder River Basins for the 2006 baseline inventories and the 2009 updates.

Because WYDEQ permits both major and minor sources in the state, it was determined that the WYDEQ permit database would be the most comprehensive source of data on midstream facilities such as gas plants, compressor stations and associated equipment. Requests were made to the WYDEQ to query their database of permitted facilities to identify midstream oil and gas sources in the three Wyoming basins using a comprehensive list of midstream companies that was developed through data requests to operators and review of the list of companies owning permitted oil and gas facilities in Wyoming. The queries for permitted sources were conducted in several iterations, with review of the resulting database of sources and identification of additional companies that were added to the database in subsequent iterations. Although this query was focused on facilities and excluded production sites, it is noted that some production site sources were included in the database.

The WYDEQ field offices gathered more detailed and year-specific engine emission data on engines operating throughout the three Wyoming basins. WYDEQ requested that this engine data be incorporated into the Phase III inventory. This engine data included both engines at facilities identified above through the permit database queries, and engine at production sites (i.e. wellheads) throughout the

three Wyoming basins. For production site engines, the engine database was used as the only source of data on compressor engine emissions, and no additional compressor engine emissions estimates were conducted using survey data or any other data source. For facilities, the portion of the facility emissions from engines were removed from the facility inventories and the engine inventory wholly replaced these permitted emissions where applicable.

JPAD and UGRB Inventories

One additional source of information from the WYDEQ for the Southwest Wyoming Basin was a comprehensive production site emissions inventory conducted by the WYDEQ for the Jonah-Pinedale Anticline Development (JPAD) area. The JPAD area includes the highly productive Jonah and Pinedale gas fields in Sublette County. Because of the intensity of development and the observances of high wintertime ozone occurrences in this area, the WYDEQ has undertaken efforts to develop detailed emission inventories of all oil and gas activities in the JPAD area. To do this WYDEQ conducted surveys of equipment, processes, and activity targeted at all companies operating in the JPAD area. In 2006, this inventory consisted of the following source categories:

- Drilling rigs
- Heaters/burners
- Wellhead compressor engines
- Tank flashing emissions
- Dehydrators
- Well blowdowns
- Pneumatic pumps
- Well completions/recompletions

The WYDEQ requested that the JPAD inventory for 2006 be supplemented by data gathered from the Phase III survey process for the following source categories:

- Tank flaring
- Dehydrator flaring
- Dehydrator reboilers
- Pneumatic devices
- Fugitive emissions
- Truck loading
- Workover rigs

This inventory covered NOx, VOC and SOx emissions in the JPAD area, and was used wholly in the baseline 2006 inventory for the Southwest Wyoming Basin for oil and gas activity in the JPAD area with the supplemental source categories described above. The JPAD area represents significant fractions of 2006 gas and condensate production in Southwest Wyoming and a significant fraction of 2006 drilling activity.

Subsequent to the JPAD area WYDEQ inventory development, the WYDEQ compiled a highly detailed comprehensive inventory of all oil and gas sources (production site and midstream) for the Upper Green River Basin (UGRB) for analysis of ozone impacts in the Southwest Wyoming Basin. This WYDEQ UGRB inventory included all sources in Sublette County, and portions of Uinta and Sweetwater Counties which is an expansion on the geographic scope of the JPAD area inventory. The UGRB inventory was used in its entirety for Sublette County. The UGRB inventory is described in this report under the “permitted sources” category, but it should be noted that the inventory includes all production-site and midstream sources in Sublette County. Because of the difficulty in reconciling the partial WYDEQ inventories in Uinta and Sweetwater Counties with the sources in the remaining parts of these counties, the WYDEQ UGRB inventory was used only for Sublette County in its entirety.

Compilation

The survey and permit data were compiled in several steps to generate the baseline 2006 and updated 2009 inventories. A set of surrogates were applied to each survey-based source category for which survey data was compiled. The surrogates represented different oil and gas production statistics, such as conventional gas production, CBM gas production, oil or gas well counts and spud (drilling event) counts. For each source category, the total value of the surrogate represented by all responding oil and gas companies whose data contributed to the survey was compared to the total value of the surrogate in the basin. A scaling factor was developed, which was the ratio of the total value of the surrogate in the basin to that represented by the combined survey responses. The scaling factor was used to grow the total emissions for unpermitted sources for each source category from the survey data to the basin-wide emissions. This was done because the survey respondents did not represent all activity in the basin.

Following this, the emissions from permitted sources were added to the emissions from the unpermitted sources. The permitted sources were treated as point sources, since the exact locations of these sources were known. The resulting emissions inventory represented the total inventory. The surrogates for each source category were then used to scale the inventory down to the county level, such that the final inventories were reported on a county basis. The scaling factors for the county-level emissions estimates were the ratio of a surrogate's value in a single county to that of the entire basin. A similar analysis was conducted for tribal versus non-tribal land. An analysis was conducted to determine the values of surrogates within tribal land in the basin, as opposed to non-tribal land. A similar scaling was then conducted on the total inventory for the basin to determine the tribal portion of the inventory. More details on this methodology are available in the references[8].

2012/2015 Midterm Emissions Projections

In addition to the baseline 2006 inventory, the Phase III project considers midterm projections to 2012 or 2015 (2012 for the Wind River Basin and 2015 for the other Wyoming basins). These projections are more detailed than those conducted in previous inventory efforts[3,4] in that they project a greater number of activity parameters, and use more detailed information to develop the projection factors. Previous inventories have relied on only a single broad projection factor, such as oil or gas production projections. The Phase III midterm projections also use well and drilling count projections, and develop the gas and oil production projections from basic information about expected per-well production.

The projections are developed by first generating historic data curves for gas production by type, oil production, condensate production, well counts by type and spud counts. These historic trends include data from approximately the late 1970's through the present, depending on the initial year that statistics were kept and recorded by state oil and gas commissions. Projections of the drilling activity were developed by reviewing the recent historic data and creating a best-fit extrapolation from 2006 to 2012 or 2015, or by gathering actual planned drilling counts from the oil and gas companies participating in the survey process. A historic ratio of drilling events to the number of active wells in the basin were developed, and used as a means to estimate the success rate of drilling events. The drilling success rate and the projected drilling activity were used to develop the growth in number of new wells in the basin as a result of planned drilling activity. These projections were conducted separately for oil wells, conventional gas wells, and CBM gas wells. Well abandonment or well shut-in rates were also tracked historically, and the historic data was used to develop an estimate of the average annual well shut-in rate in each basin. The projected growth rate in well counts from drilling and the projected shut-in rate from the historic data were combined to develop the projected total active well counts in each basin in 2012 or 2015. Production decline curves were obtained for different well types in regions where active drilling was occurring or expected to occur in the time frame 2006 to 2015. The decline curves were used in combination with the projected well counts to project the production from these wells. The final results of this analysis were production and well and spud count projections for 2012 or

2015. This methodology allowed the projections to track both downturns in oil and gas production activities, and upturns in the activity that were projected for the near future.

If planned drilling activity was not available, or average well decline curves could not be determined or were not consistent with recent historic data, projections were made using only the historic data. Best-fit extrapolations were conducted on the historic well count or production data, and these were used to determine the projected activity levels in 2012 or 2015.

The ratios of the value of the projected parameters in 2012 or 2015 to the values in 2006 were considered the scaling factors for purposes of the midterm projections. The scaling factors by activity parameter were applied to the baseline 2006 emissions to generate "uncontrolled" 2012 or 2015 emissions projections. The application of the scaling factors to various source categories followed the same cross-reference between parameter and source category as was used to scale the combined survey response data to develop baseline emissions for each basin. The final step in developing the 2012 or 2015 emissions projections was to apply control factors to the uncontrolled emissions, representing state and federal regulations that require implementation of emissions control devices or practices. The controls requirements in Wyoming are summarized below in Table 7, noting that requirements differ in the JPAD area, concentrated development area (including most of the Southwest Wyoming and Wind River Basins) and for the remainder of the counties in the state (including the Powder River Basin). These differences between regions of Wyoming primarily affect the ability of controls

Table 7. Summary of federal and Wyoming state regulations applicable to midterm projected oil and gas emissions for Wyoming basins.

Source Category	**Regulation**	**Enforcing Agency**	**Effective Date**	**Implementation in the 2012 Powder River Basin Emissions Projections**
Drill Rigs, Workover Rigs	Nonroad engine Tier standards (1-4) (EPA, 2005)	US EPA	Phase in from 1996 - 2014	EPA NONROAD model used to create county-level control factors for the drill rig SCC to account for fleet turnover.
Drill Rigs, Workover Rigs	Nonroad diesel fuel sulfur standards (EPA, 2006)	US EPA	Phase in beginning in 2010	Assume 15 ppm sulfur in nonroad diesel fuel throughout Powder River Basin. Control factors derived from EPA NONROAD model (see above).
All New Spark-Ignited Stationary Engines	New Source Performance Stds. (NSPS) (EPA, 2008)	US EPA	Phase in from 2008 - 2011	Control factors developed considering the specific composition of engines in the inventory (described in more detail below).
New or Relocated Stationary Engines	WYDEQ BACT Requirements for New or Relocated Stationary Engines	WYDEQ	2007	Control factors developed considering the specific composition of engines in the inventory (described in more detail below).
Pneumatic Devices	WYDEQ BACT Requirements for Pneumatic Devices	WYDEQ	2007	New or added pneumatic devices assumed to be low- or no-bleed
Pneumatic Pumps	WYDEQ BACT Requirements for NG-Operated Pumps	WYDEQ	2007	98% control of all emissions or pump vent streams must be routed into a closed loop system. Control assumed for any growth in gas production.

Source Category	Regulation	Enforcing Agency	Effective Date	Implementation in the 2012 Powder River Basin Emissions Projections
Dehydrators	WYDEQ BACT Requirements for Dehydrators	WYDEQ	2007	98% control of dehydrator emissions if uncontrolled emissions > 8TPY. Control implemented (described in more detail below).
Tank Flashing	WYDEQ BACT Requirements for Condensate and Oil Tanks	WYDEQ	2007	98% control of tank flashing emissions if uncontrolled emissions > 8TPY. Control assumed for any growth in condensate/oil production.

Engine Emissions Controls

The EPA NONROAD2005 model was run with fuel inputs based on a 2002 study entitled "WRAP Mobile Sources Emission Inventory Update" conducted for the WRAP[9]. The model outputs were used to develop county-level emissions per unit population for "other oil field equipment" (SCC 2270010010) for the calendar year 2006, and then separately for the calendar year 2012 or 2015. These emissions per unit population reflect the predicted fleet mix of engines – for various tier standards from baseline uncontrolled engines through Tier IV engines – and are used as a representation of fleet turnover for drilling rigs and workover rigs. The ratios of the per unit emissions in 2012 or 2015 to those in 2006 for each county of interest were taken to be the control factors accounting for federal non-road tier standards. In addition, the NONROAD model runs with the fuel inputs used for developing the tier standards control factors were also used to develop the control factors for SOx emissions factors for drilling rigs and workover rigs. The model is capable of tracking the expected reduction in fuel sulfur content from the baseline 2006 year – assumed to be the same as the WRAP 2002 inventory – and the 2012 or 2015 future year. A similar approach was used as for the federal tier standards to develop control factors. The ratio of per unit SOx emissions in 2012 or 2015 to those in 2006 were taken to be a control factor to apply to uncontrolled 2012 SOx emissions for drilling rigs and workover rigs to account for federal non-road diesel fuel standards.

A combined analysis was undertaken to implement both the US EPA NSPS and the NOx emissions standards required in Wyoming through the state-wide BACT rules that would apply to spark-ignited natural gas-fired wellhead compressor engines, since both of these rules affect the same source category and had overlapping requirements in some cases. In previous basin analyses of NSPS application, it was assumed that a flat or declining gas production projection would indicate no need for additional horsepower of compression[10]. This was coupled with the assumption that there would be negligible turnover of engines during the period of the projections to conclude that controls did not need to be applied to existing engines in the baseline 2006 inventories for the three Wyoming Basins. Only during a period of gas production growth was an analysis conducted to determine the impact of the NSPS and WY BACT requirements on the engine inventory.

In the case of the Wind River Basin, engine emissions from tribal and non-tribal land were treated separately. Tribal land experienced an overall decline in gas production and therefore the tribal portion of total wellhead compressor emissions was not subject to any controls analysis. For non-tribal land the growth in gas production was used to estimate the growth in added horsepower of compression. This added compression horsepower was assumed to be subject to both NSPS and the WY BACT requirements. The WY BACT requirements for NOx were a 1.0 g/bhp-hr emissions standard, while the NSPS requirements for NOx were phased from a 2.0 g/bhp-hr standard beginning July 2008 to a 1.0 g/bhp-hr standard beginning January 2011. Because the WY BACT requirement is more stringent, all added compression horsepower was assumed to meet the 1.0 g/bhp-hr NOx standard.

In the case of the Powder River Basin, it is noted that for some geographic groupings gas production was projected to increase and in other geographic groupings it was projected to decrease. Where gas production was projected to increase, NSPS and Wyoming BACT requirements were applied, similar to the assumptions made in developing projected emissions for the Wind River Basin. The Wyoming DEQ provided assumptions for modeling the NOx BACT requirements for engines in the Powder River Basin 2015 projected inventory. These assumptions indicated that new or modified engines would be required to meet a 2 g/bhp-hr NOx emission standard in 2007, and a 1 g/bhp-hr NOx emission standard in 2008 and beyond. Similar to the NSPS regulation, described above, the Wyoming BACT requirement for engines was assumed to apply only to the grown portion of compression emissions. Existing engines were assumed to not turn over during the period of this projection. As noted above, the more stringent of the NSPS and Wyoming BACT requirement for engines was applied.

In the case of the Southwest Wyoming Basin, it is noted that for some geographic groupings gas production is projected to increase and in other geographic groupings it is projected to decrease. Where gas production is projected to increase, NSPS and Wyoming BACT requirements were applied, similar to the assumptions made in developing projected emissions for other basins. The Wyoming DEQ provided assumptions for modeling the NOx BACT requirements for engines in the Southwest Wyoming Basin 2015 projected inventory. These assumptions indicated that new or modified engines would be required to meet a 2 g/bhp-hr NOx emission standard in 2007, a 1 g/bhp-hr NOx emission standard in 2008, and a 0.5 g/bhp-hr NOx emission standard in 2009 and beyond. Similar to the NSPS regulation, described above, the Wyoming BACT requirement for engines was assumed to apply only to the grown portion of compression emissions. Existing engines were assumed to not turn over during the period of this projection. As noted above, the more stringent of the NSPS and Wyoming BACT requirement for engines was applied.

Pneumatic Devices and Pneumatic Pumps

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a control requirement for pneumatic devices beginning in 2010. The guidance requires new devices installed to be low- or no-bleed. As with compressor engines, new pneumatic devices were only assumed to be installed if well count growth occurred during a specific period. This analysis conservatively assumed that no turnover of existing pneumatic devices occurred prior to 2012 or 2015. The WYDEQ Permitting Guidance also included a control requirement for pneumatic pumps beginning in 2010. Pump emissions were required to be controlled by 98% or to have pump vent streams routed to a closed-loop system (effectively a 100% control). This analysis conservatively used only the 98% control requirement. Pneumatic pump controls were only assumed to apply if growth in the well count was projected.

In the case of the Wind River Basin, the well count growth in the period 2010-2012 was used to determine a growth factor for pneumatic device and pneumatic pump VOC emissions and only this grown portion of pneumatic device and pneumatic pump VOC emissions was subject to the WYDEQ requirements. For pneumatic devices it was assumed that some of the growth in pneumatic device count in the period 2010-2012 would already be low-bleed. The fraction of the total pneumatic device count that was low-bleed devices was determined from the 2006 producer-supplied data. These were excluded from the control analysis. For pneumatic pumps, the grown portion of the pneumatic pump VOC emissions was controlled by 98%, and then added back to the 2010 emissions. This analysis was applied only to non-tribal pneumatic device VOC emissions.

In the case of the Powder River Basin, a similar analysis to that of the Wind River Basin was performed for pneumatic devices. Any projected growth in pneumatic device emissions in the period 2006-2015 was subject to the WYDEQ low-bleed or no-bleed pneumatic device requirement. Data form the baseline survey indicated that pneumatic pumps were used only at conventional gas and oil wells (not at CBM wells), and conventional well gas production was projected to decline in the period 2006-2015. Therefore no controls requirements were implemented for pneumatic pumps.

In the case of the Southwest Wyoming Basin, a similar analysis to that of the Wind River and Powder River Basins was conducted. Growth in pneumatic device or pneumatic pump emissions was assumed to be subject to the applicable WYDEQ requirement.

Gas Dehydrators

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a revised control requirement for emissions from dehydrators beginning in 2010, requiring control of dehydrator emissions by 98%. The revision lowered the uncontrolled emissions threshold for which the controls requirements would be applicable from 15 tpy VOC to 8 tpy. The baseline 2006 emissions inventory for dehydrators was not developed for individual units, and instead used a top-down methodology based on a basin-average dehydrator venting VOC emissions factor. Therefore there was no way to determine whether dehydrators met the threshold requirements for application of the rule. As with other source categories that are scaled by gas production, it was assumed that new dehydrator units would only be installed if gas production growth occurred.

In the case of the Wind River Basin, the growth in gas production was used to determine the growth in dehydrator VOC emissions. This grown portion of the dehydrator VOC emissions was subject to the WYDEQ dehydrator control requirements. This control requirement was not applied to sources on tribal land.

In the case of the Powder River Basin, dehydrator VOC emissions from CBM gas wells were observed to be negligible. Therefore the WYDEQ dehydrator control requirement was considered applicable only to the conventional gas production. Conventional gas production was observed to decline in the period 2006-2015 and therefore the dehydrator control requirement was not applied.

In the case of the Southwest Wyoming Basin, the 2015 projections for Southwest Wyoming did not provide a unit-by-unit inventory for gas dehydrators and therefore it was not possible to determine whether an individual dehydrator would fall below the threshold for the BACT requirement. The survey data for gas dehydrators gathered for the 2006 baseline was reviewed to determine the fraction of emissions from dehydrators whose individual emissions were greater than 8 tpy (for those instances for which dehydrator unit emissions were provided). This fraction was assumed to apply to the 2015 projections as well, therefore controls for dehydrators were only applied to this fraction of projected dehydrator emissions.

Condensate/Oil Tanks

The WYDEQ Permitting Guidance for Oil and Gas Production Facilities included a revised control requirement for flashing emissions from condensate and oil tanks beginning in 2010, requiring control of flash emissions by 98%. The revision lowered the uncontrolled emissions threshold for which the controls requirements would be applicable from 20 tpy to 10 tpy. However, the analysis to develop the baseline 2006 inventory for the Wyoming basins did not consider emissions from individual tanks. The inventories used emissions factors and total production of condensate or oil to determine total emissions. Thus it was not possible to determine the fraction of tanks that would be subject to the revised or previous rule by meeting the uncontrolled emissions thresholds.

In the case of the Wind River Basin, this rule was applied to all condensate tank emissions beginning in 2010, assuming that before 2010 condensate tanks would not meet the rule requirements and after 2010 all condensate tanks would meet the rule requirements. For oil tanks, all oil tanks were assumed to meet the rule requirements and the rule was applied. These control requirements were not applied to sources on tribal land.

In the case of the Powder River Basin, there is negligible gas well condensate production and therefore no controls were applied to any condensate tank emissions. A review of oil tank unit emissions was conducted using permit data from the WYDEQ and it was determined that the majority of oil tanks in the Powder River Basin would be unlikely to meet the uncontrolled emissions threshold. Therefore no controls were applied to the oil tanks.

In the case of the Southwest Wyoming Basin, any growth in condensate/oil production was assumed to trigger the requirements for control of flashing emissions, which was applied to the grown portion of the condensate/oil tank VOC emissions.

RESULTS AND DISCUSSION

Inventory Results

The 2006 baseline, 2009 updated and 2012/2015 midterm projection emissions inventories for the three Wyoming basins are presented below in Tables 8-10.

Table 8. Baseline 2006 emissions inventories for the Three Wyoming Basins.

	Emissions (tons/yr)				
Basin	**NOx**	**VOC**	**CO**	**SOx**	**PM**
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

Table 9. Updated 2009 emissions inventories for the Three Wyoming Basins.

	Emissions (tons/yr)				
Basin	**NOx**	**VOC**	**CO**	**SOx**	**PM**
Wind River Basin	1,886	11,289	4,296	2,484	32
Powder River Basin	31,647	22,136	25,151	93	578
Southwest Wyoming Basin	15,991	84,964	8,596	1,813	398

Table 10. Midterm emissions projections for the Three Wyoming Basins.

	Emissions (tons/yr)				
Basin	**NOx**	**VOC**	**CO**	**SOx**	**PM**
Wind River Basin*	1,758	12,480	2,738	1,618	39
Powder River Basin	25,920	19,994	27,157	604	744
Southwest Wyoming Basin	21,136	105,498	13,158	5,486	611

**Projections for the Wind River Basin were conducted for 2012 and for all other basins for 2015.*

The baseline 2006 emissions inventory results show significant variation in the inventories between the three Wyoming basins for NOx and VOC emissions particularly, but also for SOx emissions. This is a result of a number of factors, including the differences in production levels in each basin the type of production occurring (the Powder River Basin produces primarily CBM gas), and controls requirements and their implementation in the 2006 baseline year or 2009 update year. It is observed that the lowest emissions levels occur in the Wind River Basin. This is the smallest basin in Wyoming in geographic extent, and the basin with the least oil and gas production. The Wind River Basin produces a substantial amount of gas from very few wells relative to the well counts observed in other basins. Therefore emissions of NOx and to some extent emissions of VOC are lower than in other basins normalized to the amount of gas produced. The Powder River Basin is observed to have substantially higher NOx and VOC emissions than the Wind River Basin. The Powder River Basin produces primarily CBM gas with low VOC content, but also produces a substantial amount of primary oil which drives VOC emissions from tanks and other liquid hydrocarbon related sources. Relative to the Southwest Wyoming Basin and other non-CBM Phase III basins, the Powder River Basin has low VOC emissions normalized to the amount of gas produced. The Southwest Wyoming Basin produces the most gas of the three Wyoming Basins, and produces both primary oil and condensate in amounts comparable to that of the Powder River Basin. The gas being produced in the Southwest Wyoming Basin is primarily non-CBM gas. For this reason, and due to the large amount of condensate production, VOC emissions in the Southwest Wyoming Basin are higher than the other Wyoming basins normalized

to the amount of gas produced. The Southwest Wyoming Basin also contains several gas fields which produce "sour gas" (gas containing significant quantities of hydrogen sulfide, H_2S), which generate higher SOx emissions than the other Wyoming basins.

The 2009 updated inventories for the three Wyoming basins show variations in the trends in emissions in these basins. The Wind River Basin is noted to be in decline, with the 2009 updated inventory showing declines in NOx and VOC emissions driven by decreasing gas production in the basin. Although SOx emissions increase, this is primarily due to the increase in emissions from large gas processing plants handling sour gas and not directly connected to the increase in basin-wide gas production. By contrast, significant increases in gas production activity are observed in the Powder River Basin between 2006 and 2009. This is observed in an increase in compression requirements and corresponding NOx emissions, as well as increases in VOC emissions from conventional gas production. In the Southwest Wyoming Basin, significant reductions in NOx and VOC emissions are observed between 2006 and 2009. These are likely due to a combination of the change in methodology for inventorying emissions in Sublette County (i.e. improved data collection by the WYDEQ to generate the complete Upper Green River Basin inventory vs. the baseline 2006 Jonah-Pinedale inventory), and the increasing implementation of required controls throughout the Southwest Wyoming Basin which lies in the concentrated development area of the state.

The midterm projection results for the three Wyoming Basins also show variation among the basins, but all basin midterm inventories demonstrate the impact of state and federal regulatory controls on the NOx and VOC emissions. The Wind River Basin is projected to grow in gas production in the period between 2006 and 2012, which drives some increase in VOC emissions. Despite controls requirements for VOC emissions, significant production in the Wind River Basin occurs on tribal land and is not subject to state regulations. NOx emissions in the Wind River Basin however are projected to decrease, as all engine sources (which make up the majority of the NOx emissions inventory for the basin) are subject to either the Wyoming BACT requirements or the federal NSPS requirements. Thus all engine sources are projected to be subject to controls requirements. The 2015 midterm projection for the Powder River Basin shows continued projected growth in gas production and a decline in oil production. However NOx emissions in the basin are lower in 2015 than in 2009, reflecting the state and federal requirements for controls on compressor engines which are the dominant NOx source. VOC emissions are also observed to be lower in 2015 than in 2009, reflecting both state controls requirements on VOC emissions sources, and the decline in oil production. In the Southwest Wyoming Basin 2015 projected inventory, it is noted that the WYDEQ has implemented an emissions offset program for Sublette County. Per the recommendations of the WYDEQ, the 2015 midterm projection for the Southwest Wyoming Basin assumed that Sublette County emissions would be held constant at 2010 levels for all future years. Sublette County represents the majority of all projected gas production in the Southwest Wyoming Basin, and although some growth is projected to occur in gas production outside of Sublette County the NOx emissions basin-wide are projected to remain essentially unchanged from the 2006 baseline due to controls requirements. Similarly, although growth is projected in gas production, controls requirements limit the 2015 VOC emissions increase to a modest level in the Southwest Wyoming Basin relative to the 2006 baseline.

Emissions are also summarized by source category for the baseline 2006 emissions inventories for each basin, as shown in Figures 7-12 below for both NOx and VOC emissions. The by-source-category breakdown of the emissions inventories for the basins shown below demonstrate the variability between basins in equipment usage and activities, and further demonstrate the importance of regional inventories at the basin level to capture this variability. It is observed that compressor engines and drilling rigs are the two largest NOx emissions source categories in all Wyoming basins. In the Wind River Basin, NOx emissions are dominated by compression as drilling activity is minor compared to the other Wyoming basins. In the Powder River Basin drilling levels are highest among the Wyoming basins and consequently the drilling category is a larger fraction of the basin-wide NOx than in other basins. Miscellaneous engine NOx emissions in the Powder River Basin are also significant, and represent the extensive use of portable pumps and generators used to dewater the CBM wells in the basin. VOC emissions in the Wind River Basin are dominated by pneumatic devices, with additional

VOC emissions from well blowdowns and gas dehydration. Because of the fraction of activity in the Wind River Basin that occurs on tribal land, it is observed that there is not a significant usage of low-bleed or no-bleed pneumatic devices in this basin. In the Powder River Basin, VOC emissions are a combination of compressor exhaust emissions, pneumatic device emissions and fugitives. Because of the predominance of CBM gas production in this basin and the heavy usage of compression for this gas the compressor exhaust source category is significant. Other significant VOC source categories arise from the conventional gas production in the basin. In the Southwest Wyoming Basin the VOC emissions are a combination of condensate tank flashing, pneumatic devices and pneumatic pumps, gas dehydration and fugitive emissions. This is consistent with the findings of other basin inventories where significant quantities of non-CBM gas are produced with condensate.

Figure 7. 2006 baseline NOx emissions by major source category for the Wind River Basin.

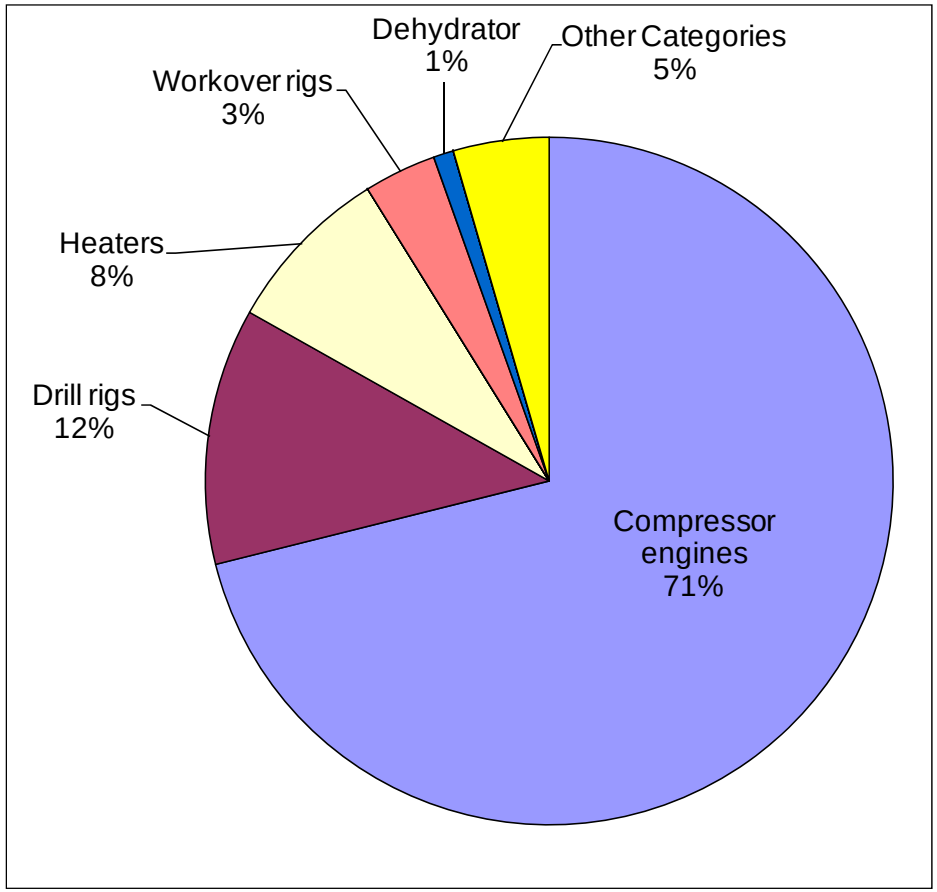


Figure 8. 2006 baseline VOC emissions by major source category for the Wind River Basin.

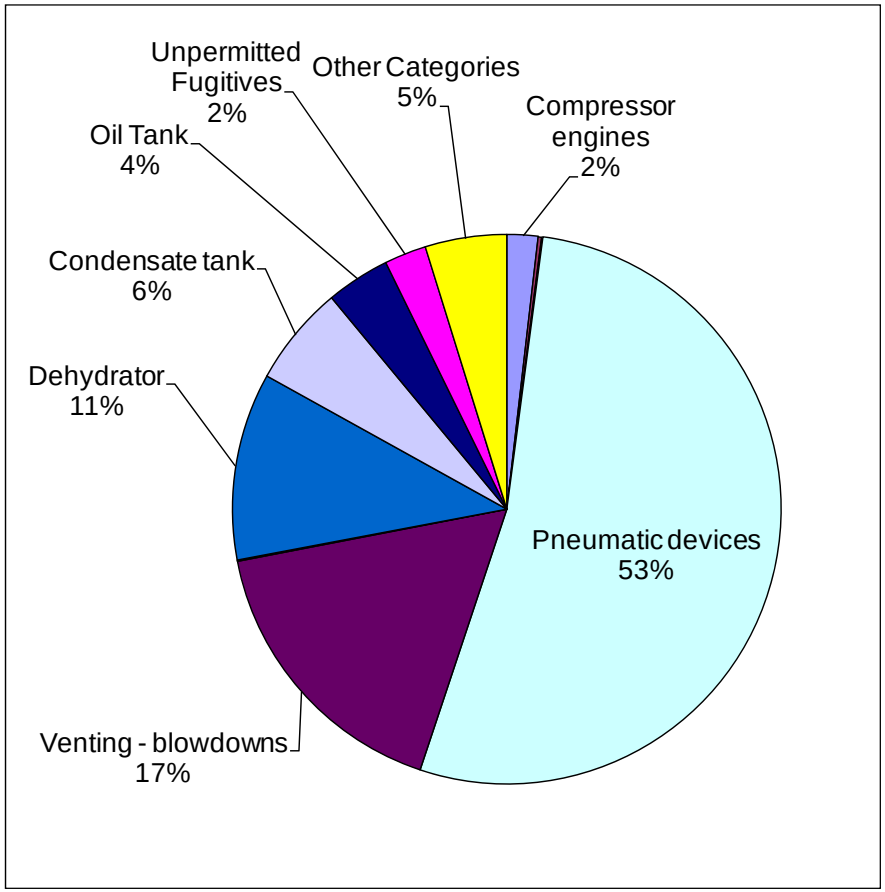


Figure 9. 2006 baseline NOx emissions by major source category for the Powder River Basin.

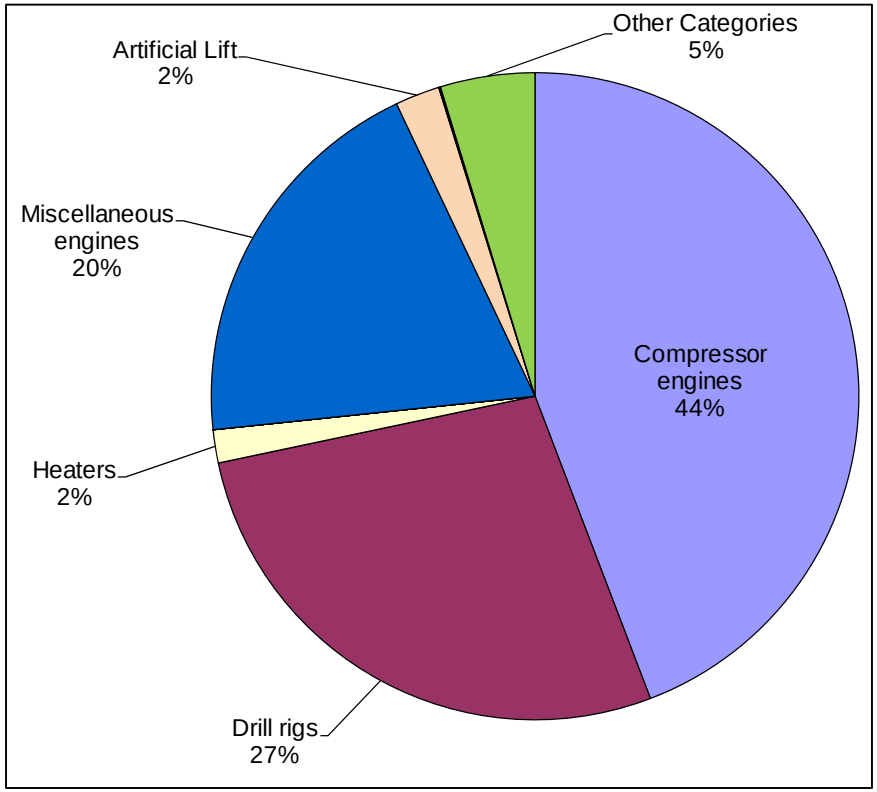


Figure 10. 2006 baseline VOC emissions by major source category for the Powder River Basin.

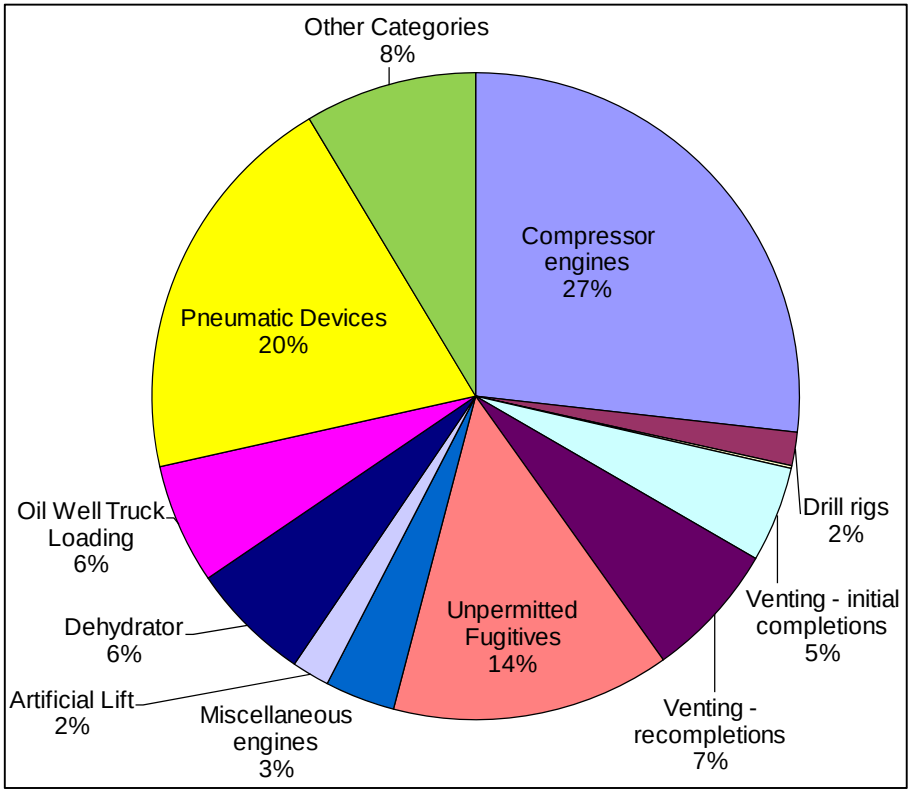


Figure 11. 2006 baseline NOx emissions by major source category for the Southwest Wyoming Basin.

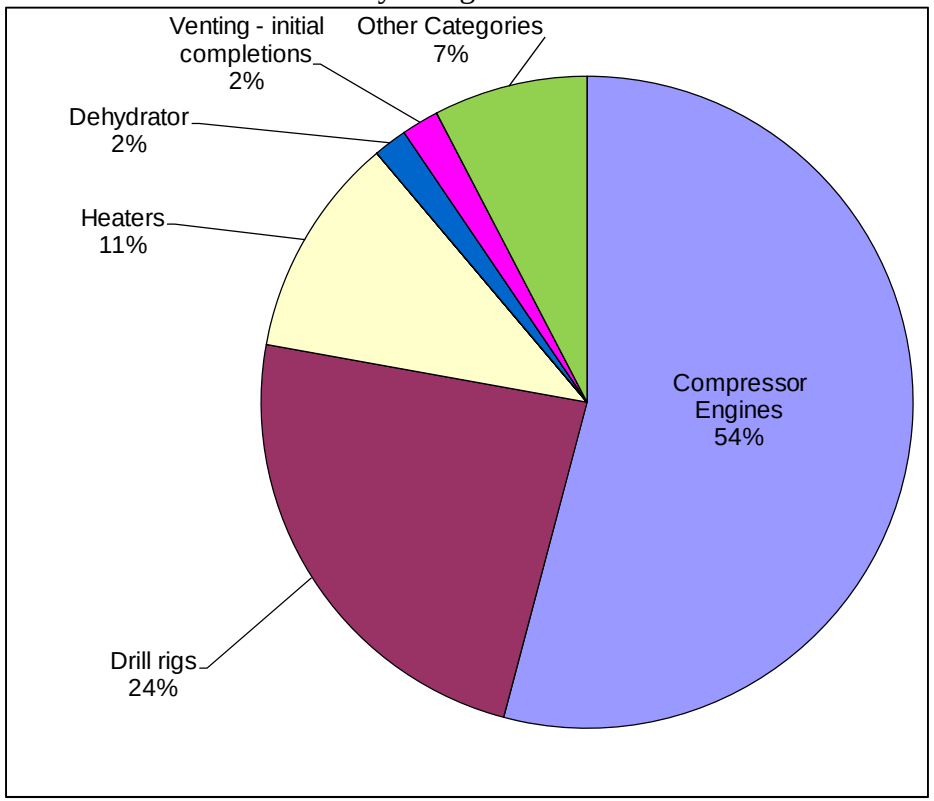


Figure 12. 2006 baseline VOC emissions by major source category for the Southwest Wyoming Basin.

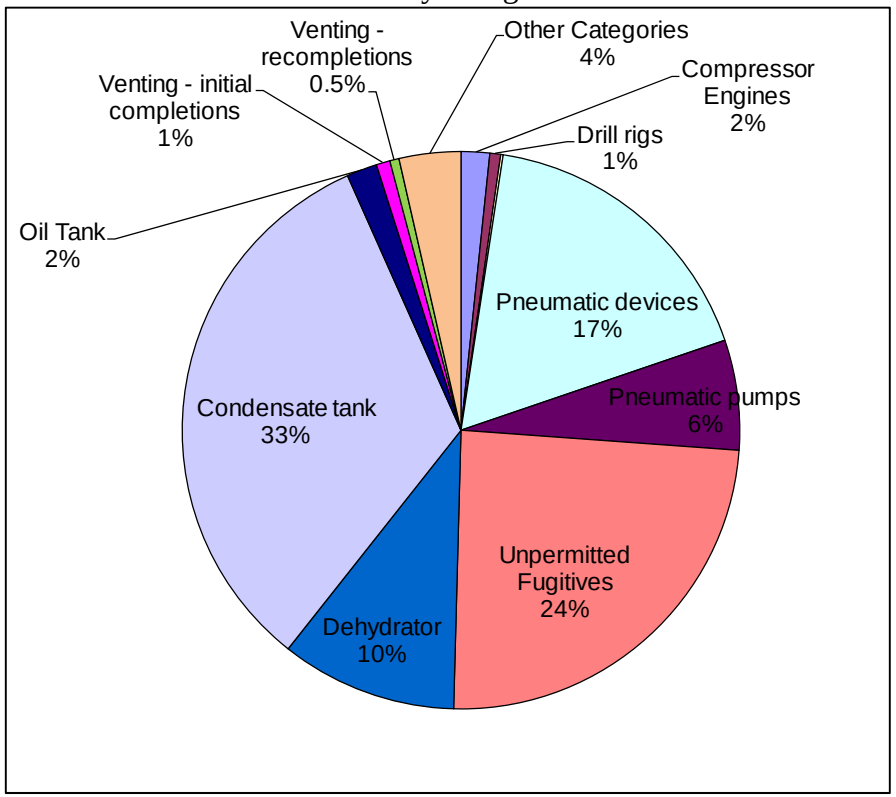


Figure 13. 2006 baseline and 2015 midterm projection NOx emissions per well for Wyoming Basins.

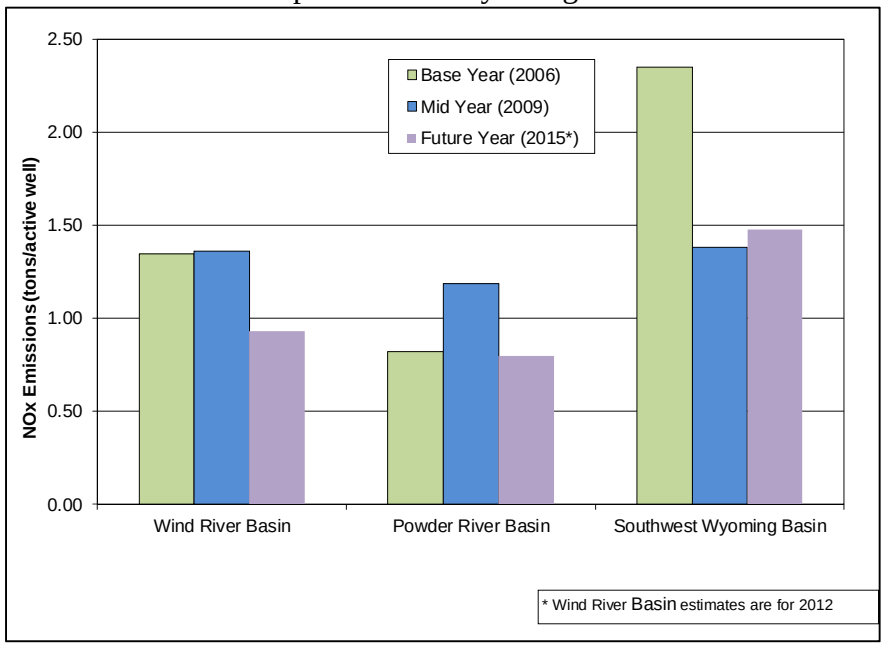
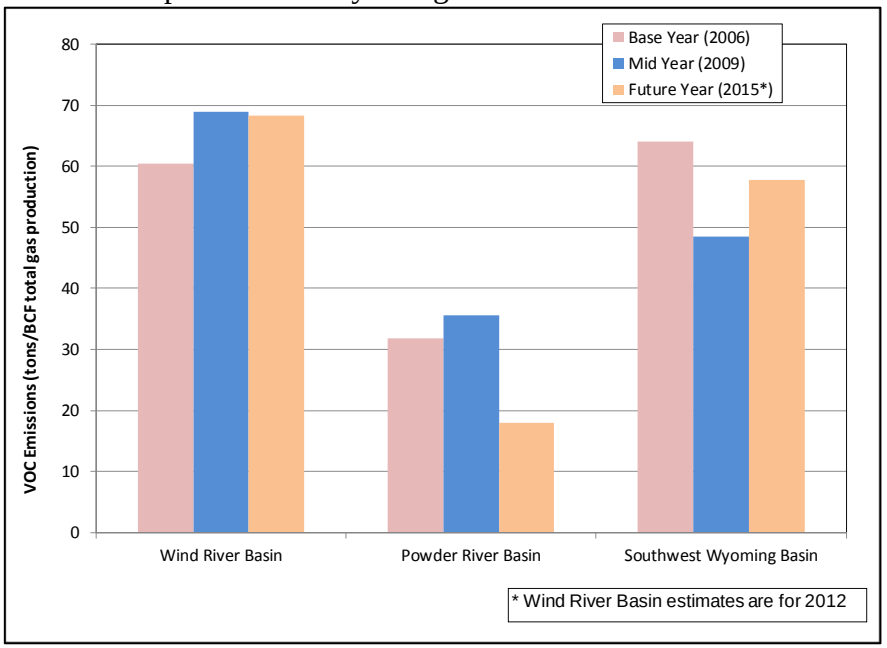


Figure 14. 2006 baseline and 2015 midterm projection VOC emissions per well for Wyoming Basins.



Given the wide variation in production levels in each basin, a direct comparison of total basin-wide inventories across basins does not allow for a complete characterization of basin-to-basin variations in emissions sources. For this reason, comparisons were developed of NOx emissions across basins on a per-well basis and of VOC emissions across basins on a per-unit-gas-production basis. This was done because most NOx sources scale by the number of wells (or spuds) in the basin, and most VOC sources are driven by the amount of gas production (or condensate production which closely tracks gas production). The NOx emissions per well and VOC emissions per unit gas production are plotted below in Figures 13 and 14.

As Figures 13 and 14 show, NOx emissions per well per year vary among the three Wyoming Basins in the 2006 baseline year. The Southwest Wyoming Basin has the highest per well NOx emissions but comparable to those of basins where wellhead compression is used significantly such as the South San Juan Basin[8]. The Wind River Basin has lower per well NOx emissions than the Southwest Wyoming Basin, in part due to the relatively small number of producing wells in the basin. The Powder River Basin has the lowest per well NOx emissions due to the centralized nature of compression in the basin (despite a significant number of active wells, very few wells in the Powder River Basin utilize wellhead compression). It is noted that centralized compression tends to be targeted early for controls as large compression sources trigger permitting requirements and greater regulatory scrutiny. As Figure 13 shows, in the Southwest Wyoming Basin the increasing stringency of controls for NOx emissions sources (through both the Wyoming BACT and federal NSPS requirements) lead to a substantial reduction in per well NOx emissions in the future years. In the Wind River Basin a similar reduction in per well NOx emissions is observed by the 2012 midterm projection when gas growth (and therefore new compression) is projected. In the Powder River Basin, the high growth rate in gas production between 2006 and 2009 leads to an increase in per well NOx, as there is insufficient time during this period for turnover of engines to substantially reduce NOx emissions. By 2015 Powder River Basin NOx emissions per well decrease as the Wyoming BACT and NSPS requirements impact the compression NOx emissions in the basin. Much greater variability among basins is observed in the VOC emissions per unit gas production. In general, the Powder River Basin shows significantly lower values than both the Southwest Wyoming and Wind River Basins over all inventory years due to the large fraction of low-VOC CBM gas being produced in the Powder River Basin. Both the Wind River Basin and Southwest Wyoming Basin VOC emissions per unit gas production are comparable to those of the Piceance Basin[8]; these are basins with a combination of non-CBM gas and condensate production with stringent VOC emissions controls requirements at the state level. VOC emissions per unit gas production in the Wind River Basin are projected to increase due to growth in gas production and additional controls only for the non-tribal land sources in the basin. VOC emissions per unit gas production in the Southwest Wyoming Basin are observed to initially decrease from the baseline due to implementation of stringent controls in this basin, and subsequently increase as gas production and condensate production are projected to increase. This variability in VOC emissions is the result of varying characteristics of the production, controls requirements, and gas and condensate speciation. These variations demonstrate the need for basin-level emissions inventories to capture this variability.

Impact of EPA Oil and Gas Controls Requirements on Rocky Mountain Basins

In 2011 WRAP sponsored an analysis to examine the effect that two new federal air quality actions might have on the air pollution emissions from the oil and natural gas industry exploration and production sector[11]. The document also examines the current O&G emission control regulations in place in the western U.S. O&G producing states to determine where the new federal rules might overlap existing State rules and which source types could be affected. The seven O&G producing states in the WRAP region interviewed for this analysis include Alaska, Colorado, Montana, New Mexico, North Dakota, Utah and Wyoming. California is also an O&G producing state, but because control of O&G exploration and production sector sources is handled by local Air Pollution Control Districts in that state rather than by the California Air Resources Board, it was not possible to contact each of these 35 Districts individually to assess their current regulations under the scope

of this project. This analysis uses data from the WRAP Phase III project, which accounts for state O&G rules in place at the time the Phase III inventories were compiled.

The first of the two federal actions is a Federal Implementation Plan (FIP) known as "Review of New Sources and Modifications in Indian Country", promulgated in final form on June 10, 2011. The second action is a suite of four proposed air regulations for the oil and natural gas industry: 1) a New Source Performance Standard (NSPS) for VOCs; 2) a New Source Performance Standard (NSPS) for sulfur dioxide; 3) a National Emissions Standard for Hazardous Air Pollutants (NESHAP) standard for oil and natural gas production; and 4) a National Emissions Standard for Hazardous Air Pollutants (NESHAP) standard for natural gas transmission and storage. The EPA proposed the rules on July 28, 2011, and was taking comment on the rules through November 30, 2011. The minor source rule for Indian Country was finalized in August 2011, and the suite of air regulations for oil and gas sources was signed by the EPA administrator in April 2012 and is being finalized for publication in the federal register.

The two federal actions are briefly summarized below, while the analysis conducted for the WRAP member states provides more detail on the details of the federal actions.

Review of New Sources and Modifications in Indian Country

On June 10, 2011, EPA finalized a Federal Implementation Plan (FIP) to ensure that Clean Air Act permitting requirements are applied consistently to facilities in Indian country. This FIP is known as "Review of New Sources and Modifications in Indian Country". The FIP puts in place the two remaining pieces of the New Source Review (NSR) preconstruction air permitting program (Nonattainment and Minor Sources) in Indian country. It lays out requirements for EPA to issue air permits to sources in Indian country, or allows tribes to take responsibility for issuing air permits according to EPA's requirements. Together with existing Prevention of Significant Deterioration (PSD) rules for permitting major sources in areas of Indian country that currently meet clean air health standards, the provisions of this new FIP completes the federal program for issuing all preconstruction air permits in Indian country. This permit program is similar to the existing permit programs of the states and will provide industries the same permitting opportunities and requirements as they have in states.

EPA already had the federal PSD plan in place for major sources in attainment areas in Indian country and had been issuing permits prior to this new action. The June 10, 2011 action puts a plan in place for a nonattainment major NSR program and a minor NSR program in Indian country. According to EPA only a few tribes have been administering an EPA approved minor NSR program and no tribes have been administering EPA approved nonattainment major NSR programs.

This FIP is made up of two rules to protect air quality:

- The minor NSR rule applies to new and modified small facilities or to minor modifications at large facilities in all of Indian country.
- The nonattainment major NSR rule applies to new major sources or major sources that make significant modifications in areas of Indian country that do not meet national clean air health standards.

Under the rules, a source owner or operator will need to apply for a permit before building a new facility or expanding an existing one if the facility increases emissions above any of the thresholds included in these rules. The permitting authority, either EPA or a tribe, will review the application and grant or deny the air permit.

The minor NSR rule applies to all of Indian country. New or modified industrial facilities with a potential to emit equal to or more than the minor NSR thresholds but less than the major NSR thresholds, generally 100 to 250 tons per year (tpy), are "minor sources" of emissions and subject to the rule requirements.

The rule requirements include:

- Case-by-case review of control technology for source-specific permits by the reviewing authority,

- Air quality impact analysis upon request by the reviewing authority,
- Monitoring, recordkeeping and reporting by the source owner or operator,
- Public participation through public notices and comment requirements and administrative and judicial review upon a permit appeal and
- Source registration with the reviewing authority.

The nonattainment major NSR rule only applies to areas of Indian country that do not meet national air quality standards. New or modified industrial facilities with a potential to emit equal to or more than the major NSR thresholds, generally 100 tpy, are "major sources" of emissions and subject to the rule requirements.

The requirements include:

- Installing emissions controls that meet the requirements of Lowest Achievable Emission Rate (LAER) control technology,
- Obtaining emissions offsets – New or modified major sources contributing to increased emissions would have to obtain emissions reductions from other sources to offset that increase. These emissions offsets would provide a net air quality benefit in the affected area and
- Certifying compliance – Each permit applicant must certify that all other facilities owned or operated by the applicant in the same state as the new or modified source are in compliance with all applicable air quality regulations.

These requirements are the same as the requirements that apply in states for areas that do not have a State Implementation Plan (SIP) for implementing certain NSR provisions, the transitional NSR program commonly known as "Appendix S."

Oil and Natural Gas Air Regulations

On July 28, 2011, the U.S. Environmental Protection Agency (EPA) proposed a suite of four air regulations for the oil and natural gas industry: (1) a New Source Performance Standard (NSPS) for VOC's; (2) a New Source Performance Standard (NSPS) for sulfur dioxide; (3) a National Emissions Standard for Hazardous Air Pollutants (NESHAP) standard for oil and natural gas production; and (4) a National Emissions Standard for Hazardous Air Pollutants (NESHAP) standard for natural gas transmission and storage. Since the gas transmission and storage sector is not within the scope of the Phase III project, this portion of the new regulations is not considered in this analysis. EPA asserts that the estimated revenues from selling the gas that currently goes to waste are significant – so much so that today's proposed rule is anticipated to quickly result in a net savings of nearly $30,000,000 annually, while significantly reducing pollution from the O&G industry.

The proposed rules would apply to the more than 25,000 wells that are fractured and refractured each year, as well as to storage tanks and other pieces of equipment. The rule was signed by EPA Administrator Lisa Jackson on April 17, 2012 and EPA has submitted the final rule for publication in the federal register. The four air regulations that comprise the new suite of regulations are described below.

New Source Performance Standards (NSPS) for Volatile Organic Compounds (VOCs)

EPA's existing NSPS for VOCs (Subpart KKK) was issued in1985. The existing standards address only VOC leak detection and repair (LDAR) at new and modified natural gas process processing plants, meaning significant sources of VOC emissions in the oil and gas industry currently are not subject to nationwide regulation. EPA proposed new standards under Subpart OOOO for several processes or pieces of equipment used in oil and gas production that have not previously been subject to federal regulation.

The proposal would require VOC reductions from five categories of sources including:

1) Completions – completions of new hydraulically fractured natural gas wells and re-completions of existing natural gas wells that undergo fracturing or refracturing. VOC emissions would be minimized through the use of "green completions," also called "reduced emissions completions." In a green completion, special equipment separates gas and liquid hydrocarbons from the flowback that comes from the well as it is being prepared for production. The gas and hydrocarbons can then be treated and sold. EPA estimates that use of this equipment for the three to 10 day flowback period reduces VOC emissions from completions and recompletions of hydraulically fractured wells by 95 percent. When natural gas cannot be collected, VOCs would be reduced through pit flaring, unless it is a safety hazard.
2) Compressors – centrifugal compressors would have to be equipped with dry seal systems. Owners/operators of reciprocating compressors would have to replace rod packing systems every 26,000 hours of operation.
3) Pneumatic controllers – for new or replaced pneumatic controllers at gas processing plants, the proposed limits would eliminate VOC emissions. These limits could be met through using controllers that are not natural gas driven. For controllers used at other sites, such as compressor stations, the emission limits could be met by using controllers that emit no more than six cubic feet of gas per hour (referred to as low bleed pneumatic controllers).
4) Condensate and crude oil storage tanks – tanks with a throughput of at least 1 barrel per day of condensate or 20 barrels per day of crude oil (these throughput volumes are estimated to be cause approximately 6 tpy of VOC emissions from uncontrolled tanks according to EPA's analysis) must reduce VOC emissions by 95 percent.
5) Natural gas processing plants – EPA is proposing to amend the existing NSPS for natural gas processing plants to strengthen the leak detection and repair requirements that apply to these plants to reduce VOC emissions.

New Source Performance Standards for Sulfur Dioxide

The new source performance standards for sulfur dioxide (SO_2) were issued in1985 under Subpart LLL and apply to natural gas processing plants. The EPA is proposing to strengthen the performance standards for plants processing gas with the highest hydrogen sulfide content (at least 50 percent) or sulfur feed of at least 5 long tons per day, in order to further reduce sulfur dioxide emissions from these facilities.

National Emissions Standards for Hazardous Air Pollutants (NESHAP) –Standards for Oil & Natural Gas Production

To address the potential health risk from emissions of hazardous air pollutants from the oil and gas sector, EPA is proposing to remove the 1 ton per year benzene compliance option for large glycol dehydrators (used to remove excess water vapor from natural gas). Under the revised requirements, all large dehydrators would have to reduce air toxics their emissions by 95 percent.

In addition, EPA is proposing to:

1) Establish emission limits for small glycol dehydrators at major sources. Under Subpart HH a dehydrator would be considered small if it has an annual average natural gas throughput of less than 85,000 standard cubic meters per day (approximately 3 million cubic feet per day) or if it has actual annual average benzene emissions of less than 0.90 megagrams per year (approximately 1 tpy).
2) Require all crude oil and condensate tanks at major sources to control their air toxics by at least 95 percent. In addition, emissions from these tanks will be counted toward determining whether a facility is a major source. By way of explanation, currently there are only requirements for control/counting tanks with the Potential for Flash Emissions (PFE) and this action would extend that requirement to those tanks without PFE (non-flashing tanks with only working & breathing losses).

3) Tighten the definition of a leak for valves at natural gas processing plants. This change is a result of the technology review.

The proposed changes to this rule do not apply to sources that are considered "area sources," meaning they have fewer than 10 tons a year of emissions of a single air toxic and less than 25 tons a year of a combination of toxics. Standards for these sources were issued in 2007.

Overlap Analysis with Existing State Regulations

Oil and gas regulations in the states covered by the Phase III inventory have been previously summarized[11]. These are examined below by state for the Phase III basins.

Colorado

There are no Indian tribal lands in the Denver-Julesburg (D-J) and Piceance Basins, therefore the new regulation for permitting of minor sources on tribal lands will have no effect on the emissions in these areas. Thus the overall effect of this regulation is likely to be negligible for the D-J and Piceance Basins. Most of the NOx and VOC emissions in the North San Juan Basin are on tribal lands. Although new sources will have lower emissions from previously unpermitted small sources like field compressors, artificial lift engines and heaters than previously projected due to the new federal regulation for permitting of minor sources on tribal lands, there will be a number of existing sources that were never reported in the past and with the federal reporting requirements they will now be included in emission inventories. Thus some increased emissions on tribal lands may be observed in future emission inventories.

The new regulations of NSPS Subpart OOOO will address VOC emissions from the largest sources in the D-J and Piceance Basins, condensate tanks, requiring tanks with 1 bbl/day condensate throughput (or 20 bbl/day crude oil throughput) to reduce VOC by 95%. However the State of Colorado already requires 95% VOC reduction for tanks containing unstabilized condensate at gas processing plants if uncontrolled emissions are greater than or equal to 2 tpy (Reg. 7, XII.G.2 – applies only in ozone nonattainment areas). The 95% control applies for all condensate tanks if uncontrolled emissions are greater than or equal to 20 tpy (Reg. 7, XVII.C.1). In addition condensate tanks in ozone non-attainment areas shall be controlled under a system-wide approach (Reg. 7, XII.D). Furthermore if the tanks are within ¼ mile of an affected building (COGCC HB-07-1341, Section 805.b(2)A), the threshold for condensate and crude oil tanks is lowered to a level of uncontrolled emissions greater than or equal to 5 tpy. There are other requirements for auto-ignitors and surveillance at controlled locations based on emission level. Thus the effect of Subpart OOOO on the gross emission inventory will be minimized in the D-J and Piceance Basins by existing Colorado regulations.

Regarding pneumatic devices, under Subpart OOOO no VOC emissions would be allowed from devices located at gas processing plants, and devices at other sites would be limited to emissions of 6 ft^3/day (this is equivalent to low bleed devices). Regulation 7, XVIII.C.1 of the CDPHE already requires no or low-bleed pneumatic controllers for all new and existing applications in ozone non-attainment areas (exceptions allowed). The COGCC HB-07-1341, Section 805.b(2)E requires no or low-bleed required for new, repaired or replaced devices where technically feasible. So the impact of Subpart OOOO on the gross emission inventory of the D-J and Piceance Basins would also be minimized by this existing Colorado regulation.

The new regulations of NSPS Subpart OOOO will address VOC emissions from any new or existing non-exploratory or non-delineation wells (wells that are in close proximity to a gathering line) that have undergone high pressure hydraulic fracturing (fracing). The regulation will require "Green Completions" for these wells, in combination with pit flaring for gas unsuitable to enter a sales pipeline. However the Colorado Oil & Gas Conservation Commission HB-07-1341, Section 805.b(3) requires green completions when technically and economically feasible. If not feasible, Best Management Practices shall be used. Thus the effect of Subpart OOOO will be minimized in the D-J and Piceance Basins by existing Colorado regulations.

Regarding glycol dehydrators, revisions to NESHAPS Subpart HH would remove the 1 ton per year benzene compliance alternative for large dehydrators (actual annual average natural gas flow rate greater than 3 million cubic feet per day or annual average benzene emissions of greater than 1 tpy). Instead, all large dehydrators would be required to reduce their VOC emissions by 95%. The State of Colorado Regulation 7, XII.H and XVII.D requires 90% reduction of VOCs where uncontrolled VOC emissions greater than or equal to 15 tpy. The threshold is reduced to greater than or equal to 5 tpy within ¼ mile of an affected building under COGCC HB-07-1341, Section 805.b(2)C). So once again the effect of Subpart OOOO will be minimized in the D-J and Piceance Basins.

A vast majority of VOC emissions in the North San Juan come from Indian tribal lands, therefore the new requirements for permitting of minor sources on tribal lands, will likely have some effect of lowering VOC emission totals in this area on new sources in the future. But as pointed out, it is likely there will be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirements. Thus some increased VOC emissions on tribal lands may be observed in future emission inventories.

New Mexico

The new federal rules for permitting of minor sources on tribal lands will likely affect the emissions of previously unpermitted small sources like field compressors, miscellaneous engines and heaters in the future, therefore the new requirements for Permitting of Minor sources on tribal lands will likely have some effect of lowering NOx emission totals in this area on new sources in the future. However, it is likely there will be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirements. Thus increased NOx emissions on tribal lands may be observed in future emission inventories.

The State of New Mexico has no regulations on green completions, pneumatic devices or condensate tanks, so Subpart OOOO would likely reduce VOC emissions in future inventories from these key source categories in the South San Juan Basin. The South San Juan Basin also has significant VOC emissions from compressors. NSPS Subpart OOOO does address VOC emissions from this source category, mandating that centrifugal units be equipped with a dry seal system, and reciprocating engines have a maintenance schedule to replace rod packing every 26,000 hours. The State of New Mexico has no existing regulations on compressor fugitive emissions, so Subpart OOOO would likely reduce VOC emissions in future inventories from this source category in the South San Juan Basin.

Regarding the federal rules for permitting of minor sources on tribal lands, in the South San Juan Basin tribal lands comprise a small portion of the VOC sources, therefore the new requirements for permitting of minor sources on tribal lands will likely have some effect of lowering VOC emission totals in this area on future new sources. However it is likely there will be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirements. Thus increased VOC emissions on tribal lands may be observed in future emission inventories.

Utah

The majority of NOx emissions in the Uinta Basin are located on tribal lands. Thus in the future, the new federal regulation for permitting of minor sources on tribal lands will likely affect a significant portion of NOx emissions from previously unpermitted small sources like field compressors, artificial lift engines and heaters from the Uinta Basin. Although new sources will have lower emissions than previously projected due to the new federal permitting review, there will likely be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirement. Thus increased NOx emissions on tribal lands may be observed in future emission inventories.

The Subpart OOOO regulation will require oil and condensate tanks with at least 1 bbl/day condensate throughput (or 20 bbl/day crude oil throughput) to reduce VOC by 95%. The State of Utah has an existing regulations for hydrocarbon storage tanks in ozone nonattainment areas (R307-327) which requires large tanks (greater than 40,000 gallons) with high vapor pressure (TVP greater than 1.52 psia at storage temperature) to be controlled to minimize vapor loss (new tanks shall be fitted with an internal floating roof resting on the liquid surface), but the only areas that regulation applies to are Salt Lake and Davis Counties. Since the Uinta Basin is located in northeast Utah and does not include these two nonattainment counties, the regulation does not apply to the Uinta O&G operations. The new federal regulation would likely reduce VOC emissions in future inventories from tanks in this basin. The State of Utah has no regulations on pneumatic devices, so Subpart OOOO would likely reduce VOC emissions in future inventories from this source category. As with other VOC sources, the State of Utah does not have regulations on dehydrators, so the new federal rule would likely reduce VOC emissions in future inventories from dehydrators in the Uinta basin. A large portion of VOC emissions in the Uinta Basin come from tribal lands, therefore the new requirements for permitting of minor sources on tribal lands, will likely have some effect of lowering VOC emission totals in this area on new sources in the future. Although new sources will have lower emissions than previously projected due to the new federal permitting review, there will be a number of existing sources that were never reported in the past and will be included in emission inventories under the federal reporting requirement. Thus increased VOC emissions on tribal lands may be observed in future emission inventories.

Wyoming

As cited throughout this analysis NOx is not covered by the proposed NSPS, therefore these emission rates should not be affected Subpart OOOO. There are some Indian tribal lands in both the Wind River and Powder River Basins, thus the new permitting of minor sources on tribal lands will affect the emissions of previously unpermitted small sources like field compressors, miscellaneous engines and heaters in the future and that will likely lower VOC emission totals on new sources in the future. However, it is likely there will be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirements. Thus some increased NOx emissions may be observed on tribal lands in future emission inventories.

The new regulations of NSPS Subpart OOOO will address VOC emissions from pneumatic devices, allowing no VOC emissions from devices located at gas processing plants, while devices at other sites would be limited to emissions of 6 ft^3/day (this is equivalent to low bleed devices). The Southwest Wyoming Basin and Wind River Basin are part of the Concentrated Development Area for the State of Wyoming and Chapter 6 Section 2 O&G Permitting Guidance, already requires installation of low or no-bleed at all new facilities. In the JPAD area in the Southwest Wyoming Basin the same requirements for pneumatic devices apply. Upon modification of facilities, new pneumatic controllers must be low/no-bleed and existing controllers must be replaced with no/low-bleed. (well site facilities only - not gas plants). Thus the impact of Subpart OOOO on pneumatic emissions would be minimized in the Southwest Wyoming and Wind River Basins. Similarly for the Powder River Basin which is subject to the Wyoming state-wide requirements for pneumatic devices the Wyoming regulations already control pneumatic devices as well as Subpart OOOO. Therefore VOC emissions in future inventories from this source category will not likely be affected in the Powder River Basin.

Also applicable to this basin, the Subpart OOOO regulation will require condensate tanks with 1 bbl/day condensate throughput (or 20 bbl/day crude oil throughput) to reduce VOC by 95%. Wyoming Chapter 6 Section 2 O&G Permitting Guidance requires 98% control of all new/modified tank emissions greater than 8 tpy VOC at start up in the JPAD area and concentrated development area. Thus the effect of Subpart OOOO will be minimized in the non-tribal portion of the Wind River Basin and in the Southwest Wyoming Basin by existing Wyoming regulations. Wyoming Chapter 6 Section 2 O&G Permitting Guidance state-wide (outside of the JPAD area or concentrated development area) requires 98% control of emissions greater than or equal to 10

tpy VOC within 60 days. Thus the effect of Subpart OOOO will be minimized in the non-tribal portion of the Powder River Basin by existing Wyoming regulations.

Regarding glycol dehydrators, as noted before, revisions to NESHAPS Subpart HH would remove the 1 ton per year benzene compliance alternative for large dehydrators (actual annual average natural gas flow rate greater than 3 million cubic feet per day or annual average benzene emissions of greater than 1 tpy). Instead, all large dehydrators would be required to reduce their VOC emissions by 95%. In the JPAD area and Concentrated Development Areas Wyoming Chapter 6 Section 2 O&G Permitting Guidance requires 98% control from multiple well (PAD) facilities upon startup/modification. Emissions from single well dehydration units must be controlled by 98% within 60 days of startup/modification for emissions greater than or equal to 6 tpy VOC (30 days for emissions greater than or equal to 8 tpy VOC) with removal allowed upon approval after various elapsed time scenarios. In the JPAD area all dehydrator emissions must be controlled by 98% for new or modified facilities with no allowance for removal of the controls. Thus the effect of Subpart OOOO will be minimized in the Southwest Wyoming Basin and the non-tribal portion of the Wind River Basin by existing Wyoming regulations. For the Powder River Basin the state-wide portion of the requirements for control of dehydrator emissions apply and are similar to those of the Concentrated Development Areas. Thus the effect of Subpart OOOO will be minimized in the non-tribal portion of the Powder River Basin by existing Wyoming regulations.

As noted new regulations of NSPS Subpart OOOO will address VOC emissions from completions at any new or existing non-exploratory or non-delineation wells (wells that are in close proximity to a gathering line) that have undergone high pressure hydraulic fracturing (fracing). The regulation will require green completions for these wells, in combination with pit flaring for gas unsuitable to enter a sales pipeline. As noted above Wyoming Chapter 6 Section 2 O&G Permitting Guidance defines 3 area categories; (1) Jonah-Pinedale Anticline Development (JPAD), (2) Concentrated Development Area; and (3) state-wide. Green completions are required in the JPAD and in Concentrated Development Areas in Wyoming as of August 1, 2011. The Southwest Wyoming and Wind River Basins are in the JPAD and Concentrated Development Areas, thus the effect of Subpart OOOO will be minimized in these basins by existing Wyoming regulations. The Powder River Basin is not classified as a Concentrated Development Area, therefore the requirement for green completions does not apply to this section. Thus the effect of Subpart OOOO will be to reduce completion/recompletion emissions in the non-tribal portion of the Powder River Basin.

Regarding gas fired engines NSPS Subpart OOOO addresses VOC emissions, mandating that centrifugal units be equipped with a dry seal system, and reciprocating engines have a maintenance schedule to replace rod packing every 26,000 hours. The State of Wyoming has no existing regulations on compressor fugitive emissions, so Subpart OOOO would likely reduce VOC emissions in future inventories from this source category in the Southwest Wyoming, Wind River and Powder River Basins.

Regarding the federal rules for permitting of minor sources on Indian tribal lands, the Wind River and Powder River Basins tribal lands comprise a minority of VOC sources, therefore the new requirements will likely have a small effect on VOC emission totals in these basins in the future. However, it is likely there will be a number of existing sources that were never reported in the past, and now will be caught up in the federal regulation reporting requirements. Thus increased VOC emissions may be observed on tribal lands in future emission inventories for the Wind River and Powder River Basins. No tribal lands are in the Southwest Wyoming Basin and therefore the new requirements will have no effect on emissions in the Southwest Wyoming Basin.

Summary of Analysis of New Federal Air Regulations for the Oil and Gas Sector

Tribal lands are dominant in two of the Rocky Mountain O&G basins examined in this analysis; those two being the Uinta and the North San Juan basins. Tribal lands hold a significant number of sources in two other basins; the South San Juan and the Wind River basins. Tribal lands are negligible in the Powder River basin, and nonexistent in Colorado's D-J and Piceance basins. On tribal lands, the new federal regulation for

permitting of minor sources on Indian Lands will likely affect a significant portion of NOx and VOC emissions from previously unpermitted small sources like field compressors, artificial lift engines and heaters. Although new sources will have lower emissions than previously projected due to the new federal permitting review, there will likely be a number of existing sources that were never reported in the past, which now will be caught up in the federal regulation reporting requirement. Thus we may see some increased emissions of these two pollutants show up on tribal lands in future emission inventories with the inclusion of these previously unreported sources. Regarding SO_2, sources on tribal lands are likely larger facilities (i.e. gas processing plants) that already are addressed by federal permitting requirements, thus the minor source rule will have less effect on emissions of this pollutant.

The proposed federal regulations for NSPS and NESHAPs do not address NOx. There is a new NSPS revision (Subpart LLL) for SO_2 from large throughput (greater than 5 ltpd sulfur) or high H_2S (greater than 50%) gas processing plants, but again these are likely larger facilities that already are addressed by federal and state permitting requirements. Thus this analysis does not look at the impact Subpart LLL may have on the minor or area sources assessed under the WRAP Phase III O&G exploration and production sector emission inventories. Consequently, this analysis looks primarily at the VOC emission changes that may be expected with implementation of the proposed federal NSPS and NESHAPs.

The source categories considered by the proposed federal NSPS and NESHAPs are: (1) well completions, (2) compressor leaks, (3) pneumatic controllers, (4) condensate and crude oil storage tanks, (5) natural gas processing plant fugitive emissions and (6) natural gas dehydrators.

Regarding the well completion category, of the interviewed states only Colorado and Wyoming have existing control regulations that are similar to the proposed federal control requirements, and for Wyoming their regulations only apply to limited portions of the state. Regarding compressor leaks, none of the seven states interviewed reported any existing regulations that address fugitive VOC leaks. For pneumatic controllers, of the interviewed states only Colorado and Wyoming have existing control regulations that are similar to the proposed federal control requirements. Regarding condensate tanks, Colorado and Wyoming both have existing control regulations that are similar to the proposed federal control requirements. Montana has a regulation to require capture of VOC vapors if the tank is near a gas pipeline after the source is either registered or permitted, but that allows VOC emissions until those administrative steps are taken. Montana and North Dakota require minimizing VOC emissions with submerged filling requirements (ND for large tanks greater than 1,000 gallon) and Utah requires minimizing VOC on large (greater than 40,000 gallons), high pressure (greater than 1.52 psia) new tanks through the use of floating roof technology. Regarding gas processing plant fugitive emissions, all states already require Leak Detection and Repair (LDAR) programs under NSPS Subpart KKK, but do not currently have the monitoring options (optical gas imaging, ultrasound equipment) proposed under Subpart OOOO. Subpart KKK does allow alternate methods to be approved by the responsible agency, however. Regarding dehydrator vents, of the interviewed states only Colorado and Wyoming have existing control regulations that are similar to the proposed federal 95% control standard.

As a final observation it is likely that although new sources will have lower emissions than previously projected due to the implementation of proposed federal NSPS and NESHAPs regulations in those basins located in states where there are no equivalent state control requirements. It was not possible to quantify these reductions within the scope of this analysis.

Future Work

Since the completion of the Wyoming Basin inventories, WRAP and EPA coordinated a pilot study focusing on the Piceance Basin in Northwestern Colorado known as the Piceance Pilot Project (P3). P3 evaluated the tailpipe exhaust, fuel evaporative emissions and particulate from tire/brake wear and paved/ unpaved road dust generated from vehicular activity (employee access, management and equipment service traffic, light and heavy duty delivery vans, etc.) and heavy duty construction equipment (graders, scrapers, bulldozers, cranes, etc.) operating continuously in western oil and gas fields. The emission totals were

compared against the point and area source emissions and determined that in-field oil and gas mobile source activity did not result in significant additional emissions, but that considering the entire trip from origin to destination the mobile sources may be significant. "Unit-level emission factors" were developed based on the results of the Piceance Basin mobile activity, and future work may include the application of these factors to other oil and gas basins in the Rocky Mountain west to provide initial estimates of the oil and gas mobile source emissions for these basins.

This study also demonstrated the value in developing 2009 updates to the 2006 baseline basin-level inventories. Because the oil and gas industry is a rapidly changing industry, with new operations starting and production from older fields eventually dropping off, the 2006 baseline inventory falls further out of date as time goes on. Therefore, extending the Phase IV inventory to develop additional 2009 updates for other basins is essential in tracking the emissions of the oil and gas sector in the Intermountain West.

CONCLUSIONS

This work presents the updated results of the WRAP Phase III inventory development project to estimate emissions from oil and gas exploration and production activities in the Rocky Mountain States. This update covers the development of the inventories for the three Wyoming Basins, noting that Wyoming is one of the most significant oil and gas production states in the Rocky Mountain region. The inventory describes both the development of base year 2006 inventories and the projections of those inventories to 2012 or 2015. In addition, the first in a series of planned updates of the base year inventories to 2009 have been completed for the Wyoming Basins. The wide variability in production activities and hence emissions among the Wyoming Basins, and the rapid changes in the oil and gas industry observed through the 2009 updates and midterm projections show the need to continue to develop inventories at the basin level and to track these inventories in time. These Phase III inventories are already being used in a variety of regional and local air quality projects with plans to incorporate the remaining uncompleted basin inventories into additional studies once these inventories have been completed. An analysis of the regulatory overlap of the new federal air regulations for the oil and gas sector and the new permitting requirements for minor sources on Indian tribal land has been presented. The results of this analysis show that the impacts of these new federal regulations will be uneven geographically, and depend on whether states already have implemented controls requirements for these sources. Both Colorado and Wyoming have already implemented extensive controls requirements for oil and gas sources and the effects of the regulation are expected to be minimized in these states.

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ACKNOWLEDGEMENTS

The authors wish to acknowledge the support of Brian Bohlmann and other air division staff at the Wyoming Department of Environmental Quality for their participation in the project and their assistance in obtaining information on permitted sources. The authors also wish to acknowledge the extensive support received from the oil and gas companies who have participated in this study by providing detailed survey data and other information.

KEY WORDS

Oil and Gas
Emissions Inventories
Wyoming
Rocky Mountain
Venting
Fugitive
EPA
Regulations