

**Final Report****DEVELOPMENT OF BASELINE 2006 AND MIDTERM 2012 EMISSIONS FROM OIL  
AND GAS ACTIVITY IN THE NORTH SAN JUAN BASIN**

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## TABLE OF CONTENTS

<b>EXECUTIVE SUMMARY .....</b>	<b>ES-1</b>
<b>INTRODUCTION.....</b>	<b>1</b>
Temporal and Geographic Scope.....	2
Pollutants.....	5
Well Count and Production Data .....	5
<b>BASELINE 2006 EMISSIONS INVENTORY.....</b>	<b>7</b>
Sources Subject to APEN Reporting .....	7
SUIT PEA Inventory.....	7
Sources on State Land.....	10
Summary Results .....	15
<b>2012 MIDTERM EMISSIONS PROJECTIONS.....</b>	<b>21</b>
Methodology.....	21
2012 Midterm Emissions Results .....	28
<b>REFERENCES.....</b>	<b>34</b>

## LIST OF TABLES

Table ES-1. Summary of 2006 emissions from oil and gas operations in the North San Juan Basin. ....	ES-2
Table ES-2. Summary of 2012 emissions from oil and gas operations in the North San Juan Basin. ....	ES-2
Table ES-3. Comparison of 2006 North San Juan Basin emissions with those of other basins in this study. ....	ES-3
Table ES-4. Comparison of 2012 North San Juan Basin emissions with those of other basins in this study. ....	ES-3
Table ES-5. Comparison of production characteristics of all basins inventoried in this study to date. ....	ES-3
Table 1. 2006 well count by well type, by county and by tribal and non-tribal designation for the North San Juan Basin.....	6
Table 2. 2006 production by production type, by county and by tribal and non-tribal designation for the North San Juan Basin.....	6
Table 3. 2006 spud counts by county for the North San Juan Basin. ....	6
Table 4. Unit-level emissions factors for unpermitted compressor engines on state land in the North San Juan Basin .....	10
Table 5. Unit-level emissions factors for heaters/boilers on state land in the North San Juan Basin. ....	11
Table 6. Unit-level emissions factors for miscellaneous engines on state land in the North San Juan Basin. ....	11
Table 7. Unit-level emissions factors for dehydrators on state land in the North San Juan Basin .....	11

Table 8. Unit-level emissions factors for pneumatic devices on state land in the North San Juan Basin .....	12
Table 9. Unit-level emissions factors for fugitives on state land in the North San Juan Basin .....	13
Table 10. Unit-level emissions factors for well blowdowns on state land in the North San Juan Basin .....	13
Table 11. Unit-level emissions factors for flaring on state land in the North San Juan Basin .....	13
Table 12. Unit-level emissions factors for drilling rigs on state land in the North San Juan Basin .....	14
Table 13. Unit-level emissions factors for artificial lift engines on state land in the North San Juan Basin .....	14
Table 14. 2006 emissions of all criteria pollutants by county for the North San Juan Basin .....	19
Table 15. 2006 NO <sub>x</sub> emissions by county and by source category for the North San Juan Basin .....	20
Table 16. 2006 VOC emissions by county and by source category for the North San Juan Basin .....	20
Table 17. Scaling factors for the eight parameters used in the projection analysis for the North San Juan Basin .....	23
Table 18. Scaling parameter for each oil and gas source category considered in this inventory.....	23
Table 19. Summary of federal and state “on-the-books” regulations affecting the oil and gas source categories considered in this inventory. ....	25
Table 20. Percentage reduction control factors for the 2012 North San Juan Basin emissions projections from application of federal nonroad engine standards and fuel sulfur standards to drilling and workover rig engines .....	26
Table 21. Federal NSPS emissions standards for engines less than 25 horsepower.....	26
Table 22. Federal NSPS emissions standards for engines greater than 25 horsepower but less than 100 horsepower. ....	27
Table 23. Federal NSPS emissions standards for engines greater than 100 horsepower but less than 1350 horsepower .....	27
Table 24. Percentage reduction control factors for the 2012 North San Juan Basin emissions projections from application of CDPHE RICE requirements to permitted engines on state land.....	28
Table 25. 2012 emissions of all criteria pollutants by county for the North San Juan Basin .....	32
Table 26. 2012 NO <sub>x</sub> emissions by county and by source category for the North San Juan Basin .....	33
Table 27. 2012 VOC emissions by county and by source category for the North San Juan Basin .....	33

### **LIST OF FIGURES**

Figure 1. North San Juan Basin boundaries overlaid with 2006 oil and gas well locations.      4	
Figure 2. 2006 NO <sub>x</sub> emissions by source category and by county in the North San Juan Basin .....	15

Figure 3. 2006 NOx emissions on tribal and non-tribal land by county in the North San Juan Basin. .... 16

Figure 4. 2006 VOC emissions by source category and by county in the North San Juan Basin ..... 16

Figure 5. 2006 VOC emissions on tribal and non-tribal land by county in the North San Juan Basin. .... 17

Figure 6. North San Juan Basin 2006 NOx emissions proportional contributions by source category..... 17

Figure 7. North San Juan Basin 2006 VOC emissions proportional contributions by source category..... 18

Figure 8. 2012 NOx emissions by source category and by county in the North San Juan Basin ..... 29

Figure 9. 2012 NOx emissions on tribal and non-tribal land by county in the North San Juan Basin. .... 29

Figure 10. 2012 VOC emissions by source category and by county in the North San Juan Basin. .... 30

Figure 11. 2012 VOC emissions on tribal and non-tribal land by county in the North San Juan Basin. .... 30

Figure 12. North San Juan Basin 2012 NOx emissions proportional contributions by source category..... 31

Figure 13. North San Juan Basin 2012 VOC emissions proportional contributions by source category..... 31

## EXECUTIVE SUMMARY

This study provides an analysis of the criteria pollutant emissions for oil and gas exploration and production operations in the North San Juan Basin in Southwestern Colorado. The analysis is part of an effort sponsored by the Independent Petroleum Association of Mountain States (IPAMS) jointly with the Western Regional Air Partnership (WRAP) for the development of a Phase III regional oil and gas emission inventory for the inter-Mountain West. The overall effort will build on the Phase I and Phase II oil and gas inventory projects previously sponsored by WRAP. The North San Juan Basin emissions inventory is part of an overall effort that is focused on creating a comprehensive criteria pollutant emissions inventory for all activities associated with oil and gas field operations in the basins throughout the study region for year 2006 as well as projections for the midterm calendar year of 2012; that includes all point and area sources related to the oil and gas industry.

The primary source of information for this basin was a draft programmatic environmental assessment developed by the Southern Ute Indian Tribe (SUIT), which owns the land on which most of the major oil and gas development occurs in this basin. The detailed inventory of oil and gas emissions sources generated as part of the SUIT environmental assessment was used to create an overall emissions inventory for the whole basin, including oil and gas activity on state land outside of the SUIT tribal land. Well count and production data for the basin were obtained from a commercially available database of oil and gas data maintained by IHS Corporation (“the IHS database”). The focus of the IHS database was calendar year 2006.

The SUIT inventory generated as part of the programmatic environmental assessment contained data obtained from a large number of the oil and gas companies operating in the North San Juan Basin. This comprehensive data and the high level of detail of the data were the basis for considering the SUIT inventory to be representative of all oil and gas activity occurring in the basin. However, it should be noted that some source categories which are considered in the Phase III analysis were not included in the SUIT programmatic environmental assessment. These source categories – which are described below in detail – were evaluated individually and determined to be either negligible with respect to their contributions to the basin-wide inventory or could not be counted because of a lack of activity information. In addition, this study does not consider fugitive emissions from oil and gas pipelines from well heads to the main compressor stations. Accurate quantitative information on the length of pipeline in the basin was not available from sources queried as part of this effort or other data bases that were analyzed, and therefore a reasonable estimate of basin-wide pipeline fugitive emissions could not be derived.

The SUIT inventory also served as the basis for generating the 2012 midterm emissions projections, which are also detailed in this report. Unlike previous Phase III basins which have already been assessed, the SUIT programmatic environmental assessment was used extensively as a single resource document for generating both the 2006 baseline and 2012 midterm emissions. Activity projections and emissions projections were contained in the SUIT programmatic environmental assessment for calendar year 2012. The activity projections were used to generate projected emissions for oil and gas activity on state land outside of the SUIT tribal airshed.

Overall, the results show that the vast majority of oil and gas activities are concentrated in La Plata County, where most of the producing wells are located. Adjacent Archuleta County represents only a small fraction of the total oil and gas production and hence the emissions sources in the basin. The results also show that the vast majority of the oil and gas production activity and emissions occur within the SUIT tribal airshed, as inventoried by the SUIT in the programmatic environmental assessment. Total emissions of NO<sub>x</sub> in the North San Juan Basin were approximately 5,700 tons in 2006 and projected to be approximately 4,195 tons in 2012. Total emissions of VOCs in the North San Juan Basin were approximately 2,147 tons in 2006 and projected to be approximately 1,598 tons in 2012. It should be noted that Coal Bed Methane (CBM) production dominates the total gas production activity in the North San Juan Basin, and this production type produces very low VOC-content gas. Overall, compressor engines in 2006 accounted for almost 80% of NO<sub>x</sub> emissions basin-wide and almost 84% of VOC emissions basin-wide. As with the findings of the inventories for the Denver-Julesburg and Piceance Basins, a significant fraction of the North San Juan Basin emissions are from unpermitted sources located on tribal land, which is not under the permitting jurisdiction of the State of Colorado.

Tables ES-1 and ES-2 below contain summaries of the total emissions from oil and gas operations in the North San Juan Basin in 2006 and 2012, respectively.

**Table ES-1.** Summary of 2006 emissions from oil and gas operations in the North San Juan Basin.

County	NO <sub>x</sub> [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SO <sub>x</sub> [tons/yr]	PM [tons/yr]
Archuleta	68	32	61	1	2
La Plata	5,633	2,115	6,389	14	50
<b>Totals</b>	<b>5,700</b>	<b>2,147</b>	<b>6,450</b>	<b>15</b>	<b>52</b>

**Table ES-2.** Summary of 2012 emissions from oil and gas operations in the North San Juan Basin.

County	NO <sub>x</sub> [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SO <sub>x</sub> [tons/yr]	PM [tons/yr]
Archuleta	61	28	46	0.01	2
La Plata	4,134	1,571	4,614	0.32	45
<b>Totals</b>	<b>4,195</b>	<b>1,598</b>	<b>4,661</b>	<b>0.34</b>	<b>47</b>

Tables ES-3 and ES-4 below show summaries of the emissions inventory results for the basins which have already been inventoried as part of this Phase III effort for 2006 and 2012 respectively – the D-J, Uinta and Piceance Basins. These tables are intended for comparison purposes and therefore should be considered in conjunction with Table ES-5, which shows a summary of the production and well count characteristics of each of these basins in 2006. As these tables show, significant differences in production characteristics are observed among these basins, with subsequent effects on the emissions inventories for NO<sub>x</sub> and VOC. It should also be noted that significant variations in gas compositions and operational practices were observed among these basins, which also account for differences in the final basin-wide emissions.

**Table ES-3.** Comparison of 2006 North San Juan Basin emissions with those of other basins in this study.

Basin	Emissions (tons/yr)				
	NOx	VOC	CO	SOx	PM
D-J Basin	20,783	81,758	12,941	226	636
Piceance Basin	12,390	27,464	7,921	314	992
Uinta Basin	13,093	71,546	8,727	396	623
North San Juan Basin	5,700	2,147	6,450	15	52

**Table ES-4.** Comparison of 2012 North San Juan Basin emissions with those of other basins in this study.

Basin	Emissions (tons/yr)				
	NOx	VOC	CO	SOx	PM
D-J Basin	24,408	84,050	15,412	131	771
Piceance Basin	9,951	20,962	7,668	77	374
Uinta Basin	16,551	127,495	44,920	24	631
North San Juan Basin	4,195	1,598	4,661	0.34	47

**Table ES-5.** Comparison of production characteristics of all basins inventoried in this study to date.

Basin	Well Count			Oil Production (bbl)			Gas Production (MCF)			Spud Counts
	Total	Conv.	CBM	Total	Oil Well Oil	Gas Well Condensate	Total	Conv.	CBM	Total
D-J Basin	19,841	19,841	0	14,242,088	0	14,242,088	234,630,779	234,630,779	0	1,500
Piceance Basin	6,315	6,255	60	7,158,305	5,755,076	1,403,229	421,358,666	420,165,237	1,193,429	1,186
Uinta Basin	6,881	6,018	863	11,528,121	9,758,247	1,769,874	331,844,336	254,219,432	77,624,904	1,069
N. San Juan Basin	2,676	1,009	1,667	32,529	27,962	4,567	443,828,500	28,642,418	415,186,082	127

## INTRODUCTION

The Independent Petroleum Association of Mountain States (IPAMS) is sponsoring the development of a Phase III regional oil and gas emission inventory for the inter-Mountain West jointly with the Western Regional Air Partnership (WRAP), to build on the WRAP Phase I and Phase II inventory projects (Russell, 2005; Bar-Ilan, 2007). This effort is focused on creating a comprehensive criteria pollutant emissions inventory for all activities associated with oil and gas field operations in the basins throughout the study region for year 2006 as well as future projection years; that includes all point and area sources related to the oil and gas industry.

The region of interest for this emission inventory analysis is the North San Juan Basin, which consists of Archuleta, Hinsdale, La Plata, Mineral and San Juan Counties in Southwestern Colorado. Only Archuleta and La Plata Counties have oil and gas activity and thus the other counties in this basin are not considered further. This basin is not necessarily geologically distinct from the South San Juan Basin, which is entirely contained in Northwest New Mexico. However, the North San Juan Basin is treated as a separate entity for purposes of the Phase III inventory effort because of the large variations in permitting requirements for oil and gas sources operating in Colorado versus New Mexico, and because the North San Juan Basin is largely comprised of coal-bed methane (CBM) activity on Southern Ute Indian Tribal (SUIT) land.

Oil and gas emissions sources on the SUIT land have been previously inventoried by the tribe in 2002, as part of the “*Air Emissions Inventory of Criteria and Hazardous Air Pollutants on the Southern Ute Indian Reservation, Colorado Base Year 2002*” analysis (SUIT, 2002). That inventory considered most of the major combustion source categories in oil and gas exploration and production, and some VOC source categories. The 2002 inventory analysis showed that SUIT land was already reaching a maximum density of well spacing and thus little new drilling activity occurred between 2002 and the present. SUIT recently undertook a programmatic environmental assessment (PEA) to determine environmental impacts from allowing in-fill drilling on SUIT land (SUIT, 2009). As part of the PEA, the inventory of oil and gas emissions sources on SUIT land was updated to a 2005 base year, and projected forward for each year from 2005 to 2012 considering both current well spacing limitations and the in-fill drilling alternatives. This document represents the basis for the IPAMS/WRAP North San Juan Basin inventory. The PEA inventory analysis already covers nearly all major oil and gas source categories of NO<sub>x</sub> and VOC emissions in the tribal land, which represents a significant portion of total production in the North San Juan Basin.

The focus of this inventory analysis was therefore to expand the PEA inventory for tribal land to the entire North San Juan Basin, which includes some oil and gas production on state/fee land in Archuleta and La Plata Counties outside of the SUIT land. The inventory was generated for a baseline year of 2006. The development of the combined North San Juan Basin inventory consisted of four primary tasks:

- (1) Compilation of data on sources that are permitted by the Colorado Department of Public Health and Environment (CDPHE) by extracting emissions information on these sources from the CDPHE Air Pollutant Emission Notice (APEN) database;

- (2) Development of unit-level emissions estimates for all oil and gas source categories considered in the IPAMS/WRAP Phase III inventory analysis that are not permitted by CDPHE through the APENs database, using the SUIT PEA inventory and production data specific to SUIT tribal land in the baseline 2006 year;
- (3) Scaling of the unit level emissions estimates to the state/fee land portion of the North San Juan Basin using production data and statistics for the non-tribal portion of the basin;
- (4) Compilation of the tribal (SUIT PEA) and non-tribal (scaled unit-level estimates) inventories to generate a complete inventory of emissions from oil and gas exploration and production activities in the North San Juan Basin.

Detailed descriptions of the processes used in these four tasks are provided below.

This report also addresses the development of projected emissions for a calendar year of 2012 for the North San Juan Basin. The projections focused on the year 2012, consistent with the midterm projections for other basins in the Phase III project. The 2012 inventory for the North San Juan Basin was developed by creating activity projection factors for a variety of oil and gas production surrogates and using these to create growth or decline estimates for different source categories in 2012. Subsequently, current or future regulations which would affect emissions in the projection year of 2012 were considered and applied to the projected inventory and the total emissions adjusted as appropriate to each regulation for the source categories affected. The detailed process by which the 2012 emissions projections for this basin were developed is presented below.

### **Temporal and Geographic Scope**

This inventory considers a base year of 2006 for purposes of estimating emissions. For the 2006 calendar year all well count and production data for tribal and non-tribal land within the basin was obtained from the IHS database, a commercially available database which accesses the data set compiled by the Colorado Oil and Gas Conservation Commission (COGCC). Previous work has shown that there is good agreement between the production statistics derived from the IHS database and from the COGCC database. The IHS database includes additional error corrections, such as gap-filling information for wells with missing locations or production data, and was therefore chosen as the primary database for deriving production statistics for all basins in the Phase III analyses.

This inventory also considers a future year of 2012 for purposes of projecting emissions. The year 2012 is selected consistent with other Phase III basins, but also because it has been determined that this future year is not so remote that detailed projections of activity – with information from major production companies in the basin – can be derived with reasonable confidence. Data on the activity projections for 2012 is discussed further below and is derived primarily from models of projected well activity within SUIT land.

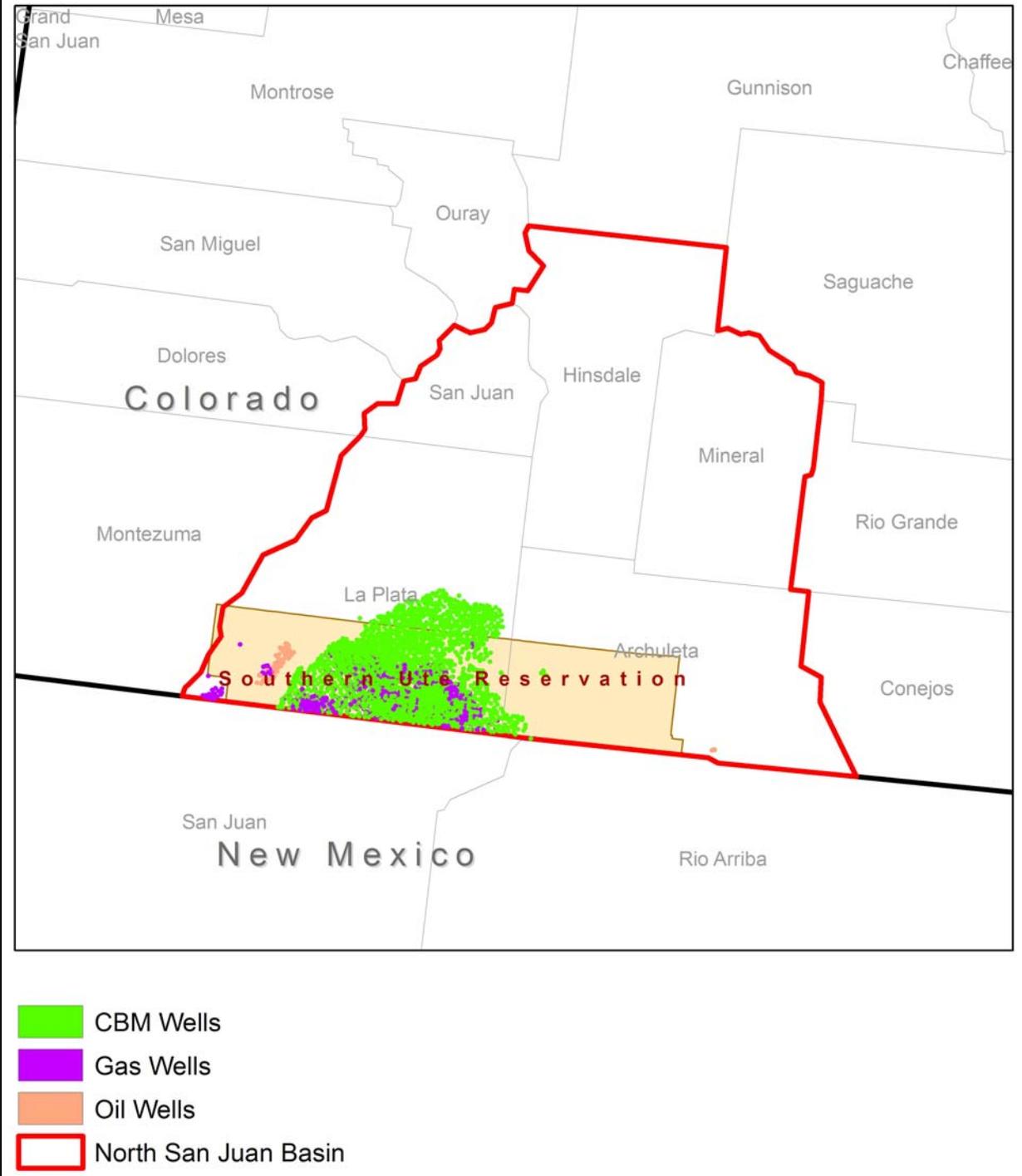
The geographic scope of this inventory is the North San Juan Basin in Colorado. For the purposes of this study, the boundaries for the North San Juan Basin were modified from those of the US Geological Survey (USGS) to wholly include the counties of San Juan, La Plata, Hinsdale, Mineral and Archuleta (USGS, 2008). However, no oil and gas activity occurs in San Juan, Hinsdale and Mineral Counties, and thus these counties were not considered further in this analysis. Only Archuleta and La Plata Counties were analyzed for this inventory. Figure 1

shows the boundaries of the North San Juan Basin, with the 2006 well locations extracted from the IHS database overlaid.

As noted above, a significant portion of the primary oil and gas production area of the North San Juan Basin lies within SUIIT land. The boundaries of the SUIIT land, as indicated by the tribe and by the Institute of Tribal Environmental Professionals (ITEP) (ITEP, 2009), are smaller than the actual boundaries used in the SUIIT PEA. The SUIIT PEA considered the “tribal airshed” which has outer boundaries larger than the tribal land boundaries indicated by ITEP. Because this formed the domain over which the SUIIT PEA inventory was constructed, this larger SUIIT tribal airshed domain was considered in this analysis to be representative of tribal sources. This is the region shaded in beige relief in Figure 1.

Figure 1 shows that the North San Juan Basin is primarily a CBM gas production basin, with the majority of this activity occurring within the boundaries of the SUIIT tribal airshed. There are some conventional gas wells and some older conventional oil wells within the SUIIT airshed. The majority of the oil and gas activity is in La Plata County, with some minor activity in Archuleta County.

# Northern San Juan Basin - 2006 Well Location



**Figure 1.** North San Juan Basin boundaries overlaid with 2006 oil and gas well locations.

## **Pollutants**

This analysis considers only criteria pollutant emissions, including NO<sub>x</sub>, VOC, CO, SO<sub>x</sub> and PM. Greenhouse gases (GHG) and hazardous air pollutants (HAPs) are not included in the emissions inventories generated as part of the Phase III analyses.

## **Well Count and Production Data**

Oil and gas related activity data on tribal and non-tribal land across the entire North San Juan Basin were obtained from the IHS Enerdeq database queried via online interface. The IHS database uses data from the COGCC as a source of information for Colorado oil and gas activity. Two types of data were queried from the Enerdeq database: production data and well data. Production data includes information relevant to producing wells in the 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 the North San Juan 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. The North San Juan Basin PowerTools input files were loaded into the PowerTools application. From ACCESS database created by PowerTools, extractions of the following data relevant to the emissions inventory development were made:

1. 2006 active wells, i.e. wells that reported any oil or gas production in 2006.
2. 2006 oil, gas, and water production by well.

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 that make up the North San Juan basin in the form of “297” well data. The “297” well data contain information regarding spuds and completions. The “297” well data were processed with a PERL script 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.

The well counts, oil and gas production and spud counts by county and by tribal and non-tribal designation for the basin are presented in Tables 1, 2, and 3 below.

**Table 1.** 2006 well count by well type, by county and by tribal and non-tribal designation for the North San Juan Basin.

County	Well Count		
	Conventional Oil	Conventional Gas	CBM Gas
<b>Activity data on non-tribal land</b>			
ARCHULETA CO.	5	0	5
LA PLATA CO.	0	6	323
Non-tribal Total	5	6	328
<b>Activity data on tribal land</b>			
ARCHULETA CO.	0	0	36
LA PLATA CO.	83	915	1,303
Tribal Total	83	915	1,339
<b>Basin-wide activity data</b>			
<b>TOTAL</b>	88	921	1,667

**Table 2.** 2006 production by production type, by county and by tribal and non-tribal designation for the North San Juan Basin.

County	Oil Production [bbl]		Gas Production [mcf]		Water Production [bbl]
	Oil	Condensate	Conventional Gas	CBM Gas	
<b>Activity data on non-tribal land</b>					
ARCHULETA CO.	2,310	0	0	414,893	13,657
LA PLATA CO.	0	0	135,088	65,144,904	11,460,339
Non-tribal Total	2,310	0	135,088	65,559,797	11,473,996
<b>Activity data on tribal land</b>					
ARCHULETA CO.	0	0	0	3,300,523	446,747
LA PLATA CO.	25,652	4,558	28,507,330	346,325,762	12,624,767
Tribal Total	25,652	4,558	28,507,330	349,626,285	13,071,514
<b>Basin-wide activity data</b>					
<b>TOTAL</b>	27,962	4,558	28,642,418	415,186,082	24,545,510

**Table 3.** 2006 spud counts by county for the North San Juan Basin.

County	Total Number of Spuds in 2006
<b>Activity data on non-tribal land</b>	
ARCHULETA CO.	0
LA PLATA CO.	3
Non-tribal Total	3
<b>Activity data on tribal land</b>	
ARCHULETA CO.	5
LA PLATA CO.	49
Tribal Total	54
<b>Basin-wide activity data</b>	
<b>TOTAL</b>	57

## **BASELINE 2006 EMISSIONS INVENTORY**

The baseline 2006 emissions inventory for the North San Juan Basin was constructed using the detailed inventory compiled by the SUIIT as part of the PEA, and additional permit data available from the State of Colorado CDPHE APENs database. Some source categories which were not covered by either of these data sources were estimated using bottom-up calculations. Activity and configuration data for these “unpermitted” sources was obtained either through the SUIIT PEA or average data was used from the survey data gathered as part of other Phase III basins. Detailed descriptions of the compilation of these 3 data sources are provided below.

### **Sources Subject to APEN Reporting**

On October 31, 2007 a request was made to the APCD for the 2006 Colorado APEN database for all oil and gas related emission sources covered by the following SCC and SIC codes:

- All of the SCCs 202002\*, 310\*, 404003\* (where \* indicates all sub-SCCs for the SCC)
- And only those with the following SICs: 13\*, 492\*, 4612.

The database of APENs sources was filtered to compile only those oil and gas sources located within the 5 counties in the North San Juan Basin. The North San Juan Basin oil and gas APENs sources were then further filtered by intersecting the latitude/longitude locations of these sources with the boundaries of the SUIIT tribal airshed. APENs sources located within the boundaries of the airshed were assumed to have been already inventoried in the SUIIT PEA and thus were excluded from the final filtered list of APENs sources.

APENs sources consisted primarily of engines and dehydrators on state land in the North San Juan Basin. Engines were all natural gas (NG)-fueled, and were primarily indicated as compressor engines. These included some larger turbines, although the majority of these engines were NG-fueled reciprocating internal combustion engines (RICE). It should be noted that where possible, data available from the APENs database on the type of engine was used to sort these engine sources into the appropriate source category, and the majority of these engines were determined to be compressor engines. Those engines for which no source description were available, or for which a description indicated a different usage of the engine, were allocated to the miscellaneous engines source category.

### **SUIIT PEA Inventory**

All quantitative emissions for sources within the SUIIT tribal airshed, as defined by the SUIIT PEA and shown in the beige shaded area in Figure 1, were taken directly from the SUIIT PEA inventory for 2006. The SUIIT PEA inventory was constructed for 2005, but included data on projected development for a number of future years, including 2006. The 2005 emissions were therefore adjusted to consider the baseline year of 2006 using the projection factors provided in the PEA.

The SUIIT PEA, which has been publicly released, considers two alternatives for in-fill development within the SUIIT tribal airshed. The first alternative, the Proposed Action, considers an expansion of the wells and production within the SUIIT tribal airshed through in-fill drilling commencing upon approval of SUIIT PEA. The second alternative, the No Action Alternative, considers projections of oil and gas activity including well counts, drilling, and oil and gas production within the SUIIT tribal airshed if no additional in-fill drilling were conducted. Consistent with the previous WRAP inventory projects for oil and gas development in the western states (Russell, 2005; Bar-Ilan, 2007), this analysis considers only the No Action Alternative, since the Proposed Action has not been approved. All WRAP projects consider only final or approved projects – through Resource Management Plans (RMP's), Environmental Impact Statements (EIS's), or Environmental Assessments (EA's) such as SUIIT's – for purposes of estimating future year oil and gas activity and any specific mitigation requirements that are part of these analyses. It should be noted that all emissions for the 2006 baseline inventory and 2012 midterm emissions projections are presented with sub-totals for tribal and non-tribal land. Therefore should the SUIIT PEA Proposed Action be approved, the emissions for any future year as estimated in the PEA can directly replace the tribal emissions in this Phase III analysis and a new total inventory for the basin can be derived. Further details are provided in the section below on the 2012 midterm projections.

The SUIIT PEA inventory considered the 2005 actual oil and gas production statistics – including oil and gas production, well counts and spud counts – and developed a criteria pollutant inventory considering most oil and gas sources. The complete list of sources that were considered in the SUIIT PEA for the 2006 baseline is as follows:

- Compressor engines
- Heaters and boilers
- Miscellaneous engines
- Dehydrators
- Pneumatic devices
- Fugitive emissions
- Well blowdowns
- Flaring
- Drilling rig emissions
- Artificial lift engines

Flashing and working & breathing loss emissions from condensate and oil tanks were not explicitly included as source categories in the SUIIT PEA, and were added to the tribal emissions total using a default emissions factor of 11.8 (lb-VOC/bbl) for all condensate and oil produced within the tribal airshed (CDPHE, 2004). The SUIIT PEA engine inventory has not estimated PM emissions from engines (compressors, artificial lift and miscellaneous engines). The AP-42 rich and lean burn emission factors of 0.0194 and 0.0100 (lb/MMbtu) were utilized to estimate PM emission from rich and lean burn compressor engines respectively (EPA, 1995). The EPA NONROAD model default PM emissions factors were used to estimate PM emissions from miscellaneous engines and artificial lift engines (EPA, 2005b). It should be noted that all compressor engines were treated in the SUIIT PEA inventory as point sources, with emissions assigned to specific latitude/longitude coordinates. No distinction was made for the compressors as to their usage in large, central facilities such as gas plants or compressor stations, or their usage at well sites as wellhead compressors. Heaters and boilers at large facilities such as gas

plants and compressor stations were also treated as point sources in the SUIIT PEA inventory, while wellhead heaters and boilers were treated as area sources. All other source categories listed above were treated as area sources in the SUIIT PEA inventory. More details of the calculation methodologies and inventory development can be found in the description of the No Action Alternative in the SUIIT PEA (SUIIT, 2009).

Other source categories which were considered in the Phase III inventories for other basins (Denver-Julesburg, Piceance and Uinta) were not estimated in the SUIIT PEA (Bar-Ilan, 2008; Bar-Ilan, 2009a; Bar-Ilan, 2009b). These source categories were determined to be negligible in the oil and gas operations on SUIIT land because the produced gas is CBM that contains negligible VOC content. These include:

- Vapor recovery units (VRU's) – the engines in VRU's have been a minor emissions source category in other basins and these devices are not widely used. They were thus considered negligible in this analysis.
- Truck loading – very little liquid hydrocarbon production occurs in the North San Juan Basin (including oil and condensate), so these emissions were considered negligible.
- Well completion and recompletion venting – under the assumptions of the No Action Alternative of the SUIIT PEA, there is very little drilling occurring in the SUIIT tribal airshed. Any completion venting associated with drilling would primarily be for CBM gas wells where the VOC content of the gas is very small. Therefore this source category was considered negligible.
- Workover rigs – no emissions from workover rigs were included in the SUIIT PEA inventory, indicating that these sources are not used extensively in the North San Juan Basin.
- Pneumatic pumps – no distinction was made between this source category and the general pneumatic devices source category for purposes of the SUIIT PEA inventory.
- Water tanks and disposal pits – no activity data has been made available on water tank or water disposal pit emissions in the previous Phase III basins except for a limited study on water tank emissions in the D-J Basin. Based on that study it was determined that water tank emissions are negligible, and given the lack of activity and emissions factor information this source category could not be estimated.
- Amine units – no emissions from amine units were included in the SUIIT PEA inventory, indicating that these devices are not used extensively in the North San Juan Basin.
- Compressor startups and shutdowns – compressor startups and shutdowns have been a minor VOC source categories in previous Phase III basins, and given the prevalence of low-VOC content CBM gas in the North San Juan Basin, these emissions were considered negligible.
- Salt water disposal engines – these engines would fall under the miscellaneous engine category.
- CBM pump engines – these engines would fall under the miscellaneous engine category.

The emissions inventory for tribal sources is presented in the results section below. This inventory information in the SUIIT PEA was used to develop the emissions estimates for sources on state land considering the same list of source categories as above.

## Sources on State Land

The 2005 emission inventory developed in the SUIT PEA, which covers the entire tribal air shed in the North San Juan Basin, was used directly for baseline emissions on tribal land as described above. Emissions on state (non-tribal) land in the basin were generated using the basic emissions and activity data for the source categories listed above from the SUIT PEA inventory. For each of the above source categories, the 2006 baseline emissions within the SUIT tribal airshed were scaled down to create unit-level emissions factors, where the “unit” is the oil and gas production activity surrogate used to scale down the emissions. These unit-level emissions factors were then combined with the oil and gas production activity data on state land to scale up the emissions to all state land in the basin, based on the 2006 state land activity data.

The detailed descriptions of the process for generating emissions on state land for each of the source categories follow. The descriptions provide details on the unit-level emissions factors used and the activity surrogates used to scale up all source categories considered in this analysis.

### Compressor Engines

The list of point-source compressor engines in the SUIT PEA was filtered to remove any compressor engine with total emissions of any criteria pollutant equal to or greater than 2 tpy. This was done so that only those compressors which were considered “unpermitted” sources in Colorado state land would be included for purposes of scaling the SUIT compressor emissions to the state land. All other compressors with emissions of 2 tpy or greater were assumed to have been already captured through the APENs data set described above.

The unpermitted compressor engines were scaled down to unit-level emissions using total gas production as the surrogate, as shown in Table 4.

**Table 4.** Unit-level emissions factors for unpermitted compressor engines on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Unpermitted Compressors	g/MCF/yr	0.080	0.030	0.088	0.002	0.000	Total Gas Production

Unpermitted compressor engine emissions on state land were estimated by multiplying the unit-level emissions factors above by total gas production on state land.

### Heaters and Boilers

Heaters and boilers were treated as both point sources in individual facilities (gas plants and large compressor stations) and as area sources in the SUIT PEA inventory. For purposes of this analysis, all heaters and boilers were combined into a single “heaters/boilers” source category.

The heaters/boilers were scaled down to unit level emissions using total well counts as the surrogate, as shown in Table 5. This was done because wellhead heaters and boilers were assumed to be utilized in configurations that were typical for each well. This is consistent with the scaling surrogates for other Phase III basins.

**Table 5.** Unit-level emissions factors for heaters/boilers on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Heaters/Boilers	g/well/yr	149,796	5,530	67,316	8,182	0	Total Well Count

Heaters/boilers emissions on state land were estimated by multiplying the unit-level emissions factors above by total well counts on state land.

### Miscellaneous Engines

Miscellaneous engines represented all engines in the SUIT PEA inventory that were not specifically designated as compressor engines. This includes some engines for which a designation was missing, and others indicated to be used for other purposes. This includes generators, air compressors or other miscellaneous uses.

The miscellaneous engines were scaled down to unit level emissions using total well counts as the surrogate, as shown in Table 6.

**Table 6.** Unit-level emissions factors for miscellaneous engines on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Misc. Engines	g/well/yr	15,701	1,815	7,351	144	0	Total Well Count

Miscellaneous engine emissions on state land were estimated by multiplying the unit-level emissions factors above by total well counts on state land.

### Dehydrators

Dehydrator usage was captured in the SUIT PEA as an area source, including both dehydration at well sites and dehydration that would occur at central facilities. It should be noted that this source category refers to both vented emissions from dehydrator still vents, and to combustion emissions from the dehydrator reboiler. Dehydrator reboilers are not included in the heaters/boilers category above. Because the gas production in the North San Juan Basin is dominated by CBM gas with a low VOC content, VOC emissions from dehydrators are relatively small.

The dehydrators were scaled down to unit level emissions using total gas production as the surrogate, as shown in Table 7.

**Table 7.** Unit-level emissions factors for dehydrators on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Dehydrators	g/MCF/yr	0.008	0.029	0.006	0	0	Total Gas Production

Dehydrator emissions on state land were estimated by multiplying the unit-level emissions factors above by total gas production on state land.

### Pneumatic Devices

Pneumatic devices refer primarily to wellhead pneumatic devices such as liquid level controllers and pressure transducers used to regulate gas flow where an electric power source is not available. Many of the pneumatic devices in the North San Juan Basin have been converted to low-bleed devices, or are run on compressed air, eliminating VOC emissions associated with gas consumed by the devices. Since CBM wells are expected to have very minor VOC emissions from gas vented from pneumatic devices, this source category refers only to pneumatic devices located at conventional gas wells.

The pneumatic devices were scaled down to unit level emissions using conventional gas well counts as the surrogate, as shown in Table 8. This is consistent with the approach used in the previous Phase III basins, since the number of devices per well is used to determine the total device count in a basin.

**Table 8.** Unit-level emissions factors for pneumatic devices on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Pneumatic Devices	g/well/yr	0	233	0	0	0	Conv. Gas Well Count

Pneumatic device emissions on state land were estimated by multiplying the unit-level emissions factors above by the conventional gas well count on state land.

### Fugitive Emissions

The fugitives source category refers to leaks of produced gas from components at well sites, and at large facilities such as gas plants and compressor stations. Components include fittings and valves as well as compressor seals. It should be noted that pipeline fugitives are not included in this source category, as no information was available to estimate pipeline fugitives. Similar to pneumatics, this source category refers to fugitive emissions from conventional gas wells and conventional gas gathering and processing only, since the CBM gas in the North San Juan Basin has a negligible VOC content.

The fugitive emissions were scaled down to unit level emissions using conventional gas well counts as the surrogate, as shown in Table 9. This is consistent with the approach used in the previous Phase III basins, since the number of components per well is used to determine the total component count in a basin.

**Table 9.** Unit-level emissions factors for fugitives on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Fugitives	g/well/yr	0	311	0	0	0	Conv. Gas Well Count

Fugitive emissions on state land were estimated by multiplying the unit-level emissions factors above by the conventional gas well count on state land.

### Well Blowdowns

The well blowdowns source category refers to venting of wells to atmosphere during a well cleanup in which liquid build-up is removed from the well to restore gas pressure. As with other source categories in which produced gas is directly vented, this is primarily a VOC source category but is small due to the low VOC content in the CBM gas produced in the basin.

The well blowdown emissions were scaled down to unit level emissions using total gas production as the surrogate, as shown in Table 10.

**Table 10.** Unit-level emissions factors for well blowdowns on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Well blowdowns	g/MCF/yr	0	0.039	0	0	0	Total Gas Production

Well blowdown emissions on state land were estimated by multiplying the unit-level emissions factors above by the total gas production on state land.

### Flaring

Flaring emissions in the SUIT PEA inventory refers to process and emergency flares primarily from large central facilities (gas plants). However, this source category is treated as an area source in the SUIT PEA inventory and is not linked to specific facilities.

The flaring emissions were scaled down to unit-level emissions using conventional gas production as the surrogate, as shown in Table 11.

**Table 11.** Unit-level emissions factors for flaring on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Flaring	g/well/yr	0.09	0.18	0.47	0.00	0.00	Conv. Gas Production

Flaring emissions on state land were estimated by multiplying the unit-level emissions factors above by the conventional gas production on state land.

### Drilling Rigs

Although this analysis considers the No Action Alternative in the SUI PEA, there is some drilling that occurred within the tribal and state land in the North San Juan Basin in calendar year 2006. Drilling rig emissions refers to emissions from all engines on the drilling rig, but not to emissions associated with hydraulic fracturing or other completion activities, consistent with the approach used for previous Phase III basins. It is assumed that all drilling rigs are diesel-fueled, as there was no indication in the SUI PEA data that any other alternative fuel drilling rig was used.

The drilling rig emissions were scaled down to unit-level emissions using spud counts as the surrogate, as shown in Table 12.

**Table 12.** Unit-level emissions factors for drilling rigs on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Drilling rigs	g/spud/yr	3,605,830	290,793	776,998	255,898	238,450	Spud Count

Drilling rig emissions on state land were estimated by multiplying the unit-level emissions factors above by the spud count on state land.

### Artificial Lift Engines

This source category refers specifically to NG-fueled engines at oil wells used to provide additional lift to assist in maintaining oil flow at these wells. Since there are a small number of oil wells in the basin, and relatively little oil production compared to previous Phase III basins, this is a relatively minor source category. It is assumed that artificial lift engines are used only at oil wells, not at conventional gas wells that have some condensate production.

The artificial lift engine emissions were scaled down to unit-level emissions using total oil production as the surrogate, as shown in Table 13.

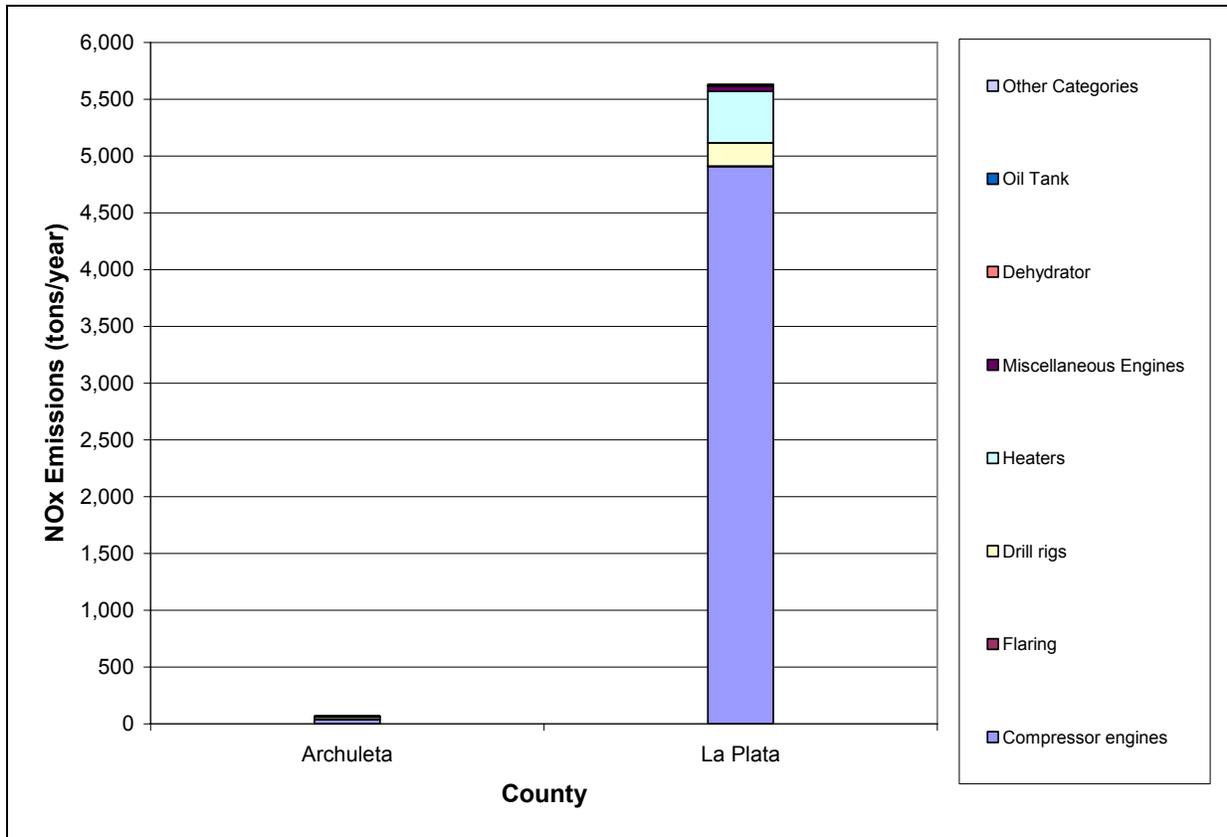
**Table 13.** Unit-level emissions factors for artificial lift engines on state land in the North San Juan Basin.

Source Category	Unit of Emissions Factors	Baseline Emissions Per Activity (grams/unit of activity)					Activity Surrogate
		NOx	VOC	CO	PM	SOx	
Artificial Lift Engines	g/bbl-oil/yr	396	16	179	1	0	Total Oil Production

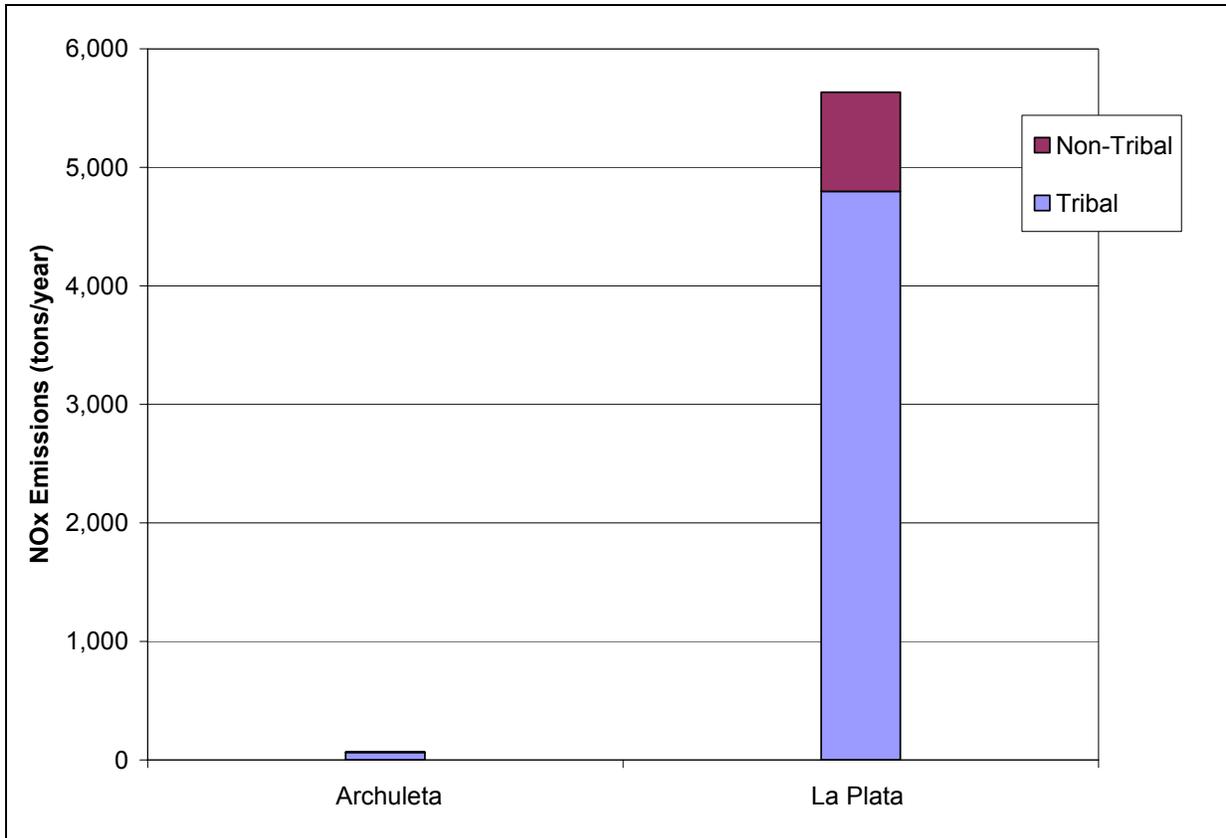
Artificial lift engine emissions on state land were estimated by multiplying the unit-level emissions factors above by the total oil production on state land.

### Summary Results

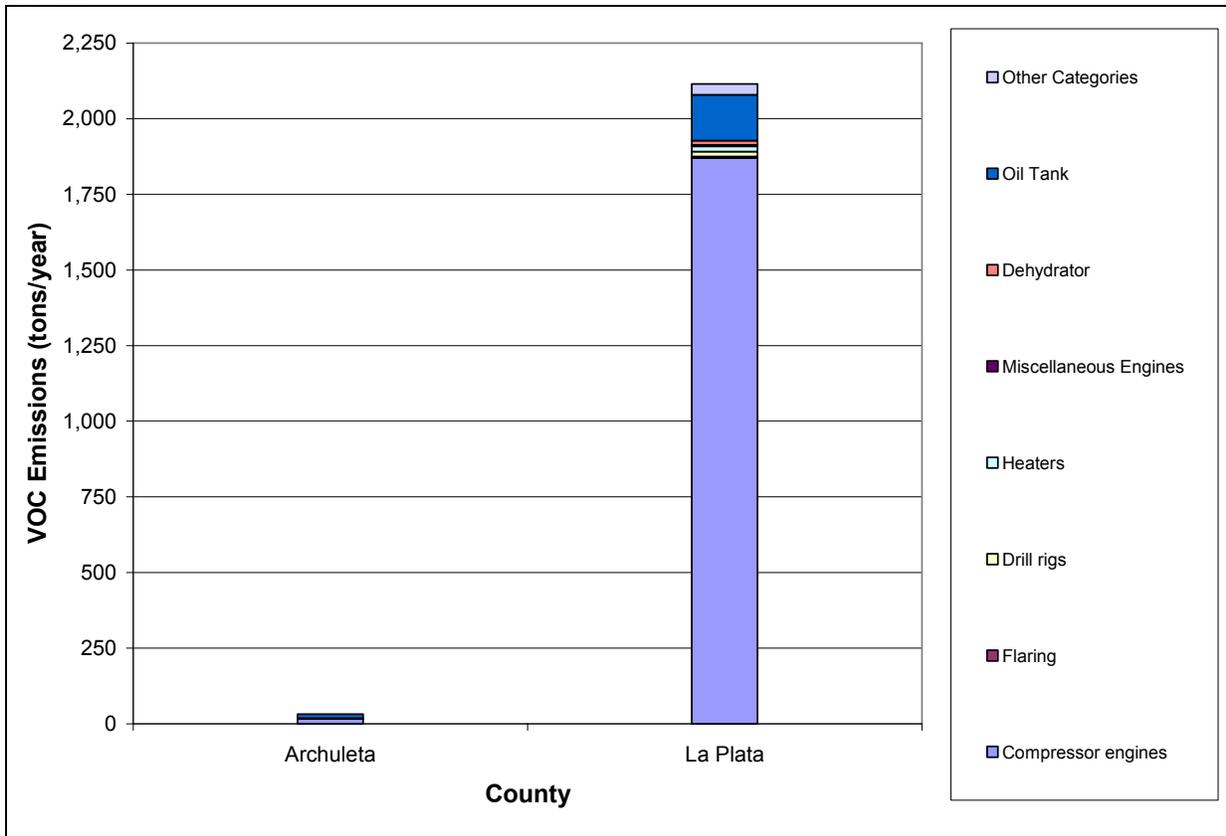
The emissions totals from sources on tribal land (from the SUIIT PEA inventory), permitted sources on state land (from the APENs database) and the additional unpermitted source categories on state land estimated from the SUIIT PEA inventory data were combined into total emissions for the North San Juan Basin. Emissions are presented below in both graphical and tabular formats, and for county-level and source category-specific emissions. Emissions are also summarized for the tribal and non-tribal land in the basin.



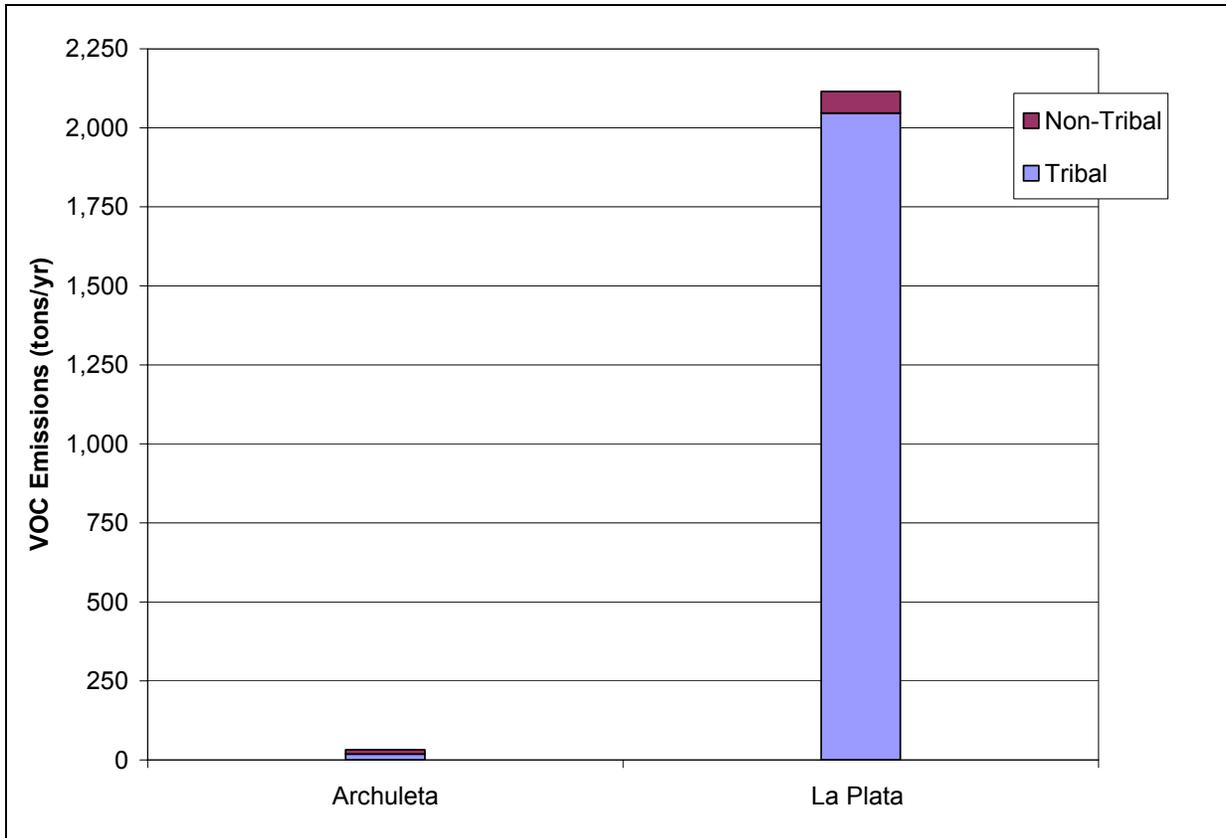
**Figure 2.** 2006 NOx emissions by source category and by county in the North San Juan Basin.



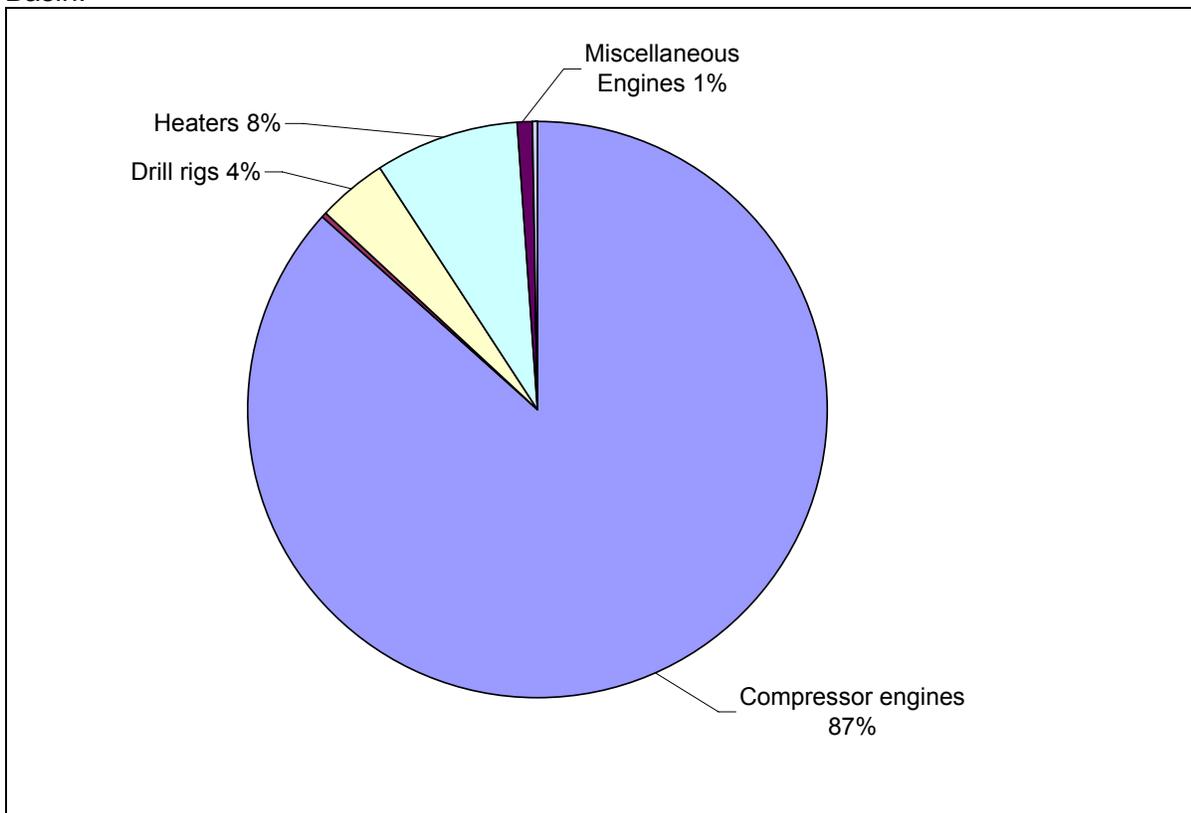
**Figure 3.** 2006 NOx emissions on tribal and non-tribal land by county in the North San Juan Basin.



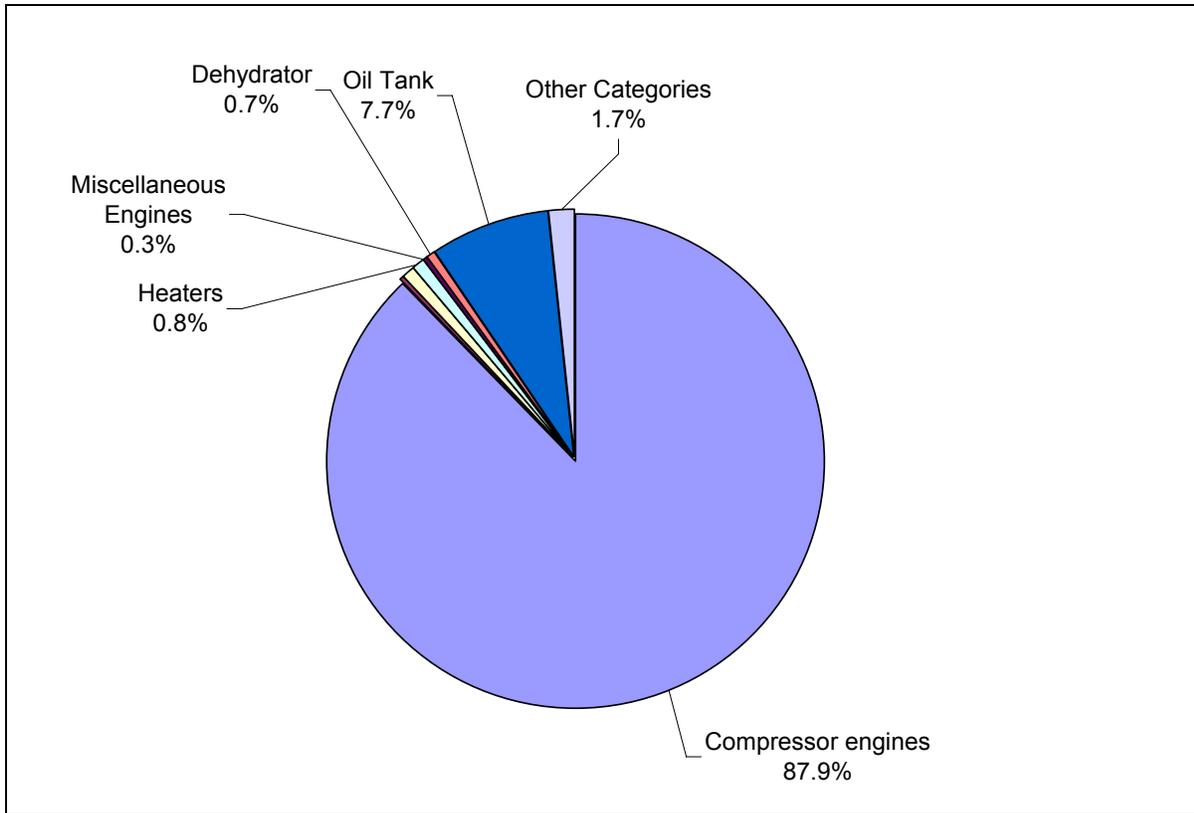
**Figure 4.** 2006 VOC emissions by source category and by county in the North San Juan Basin.



**Figure 5.** 2006 VOC emissions on tribal and non-tribal land by county in the North San Juan Basin.



**Figure 6.** North San Juan Basin 2006 NOx emissions proportional contributions by source category.



**Figure 7.** North San Juan Basin 2006 VOC emissions proportional contributions by source category.

**Table 14.** 2006 emissions of all criteria pollutants by county for the North San Juan Basin.

County	NOx [tons/yr]	VOC [tons/yr]	CO [tons/yr]	SOx [tons/yr]	PM [tons/yr]
Archuleta	68	32	61	1	2
La Plata	5,633	2,115	6,389	14	50
Archuleta (Tribal)	64	18	59	1	2
La Plata (Tribal)	4,798	2,046	6,068	13	40
Archuleta (Non-Tribal)	4	14	2	0	0
La Plata (Non-Tribal)	835	69	321	1	10
<b>Totals</b>	<b>5,700</b>	<b>2,147</b>	<b>6,450</b>	<b>15</b>	<b>52</b>
<b>Total Tribal</b>	<b>4,862</b>	<b>2,064</b>	<b>6,127</b>	<b>14</b>	<b>42</b>
<b>Total Non-Tribal</b>	<b>839</b>	<b>83</b>	<b>323</b>	<b>1</b>	<b>10</b>

**Table 15.** 2006 annual NOx emissions [tons/yr] by county and by source category for the North San Juan Basin.

County	Compressor Engines	Drill Rigs	Miscellaneous Engines	Heaters/ Boilers	Dehydrators	Oil Tanks	Flaring	Other Categories	Totals
Archuleta	37	21	1	8	0	0	0	1	68
La Plata	4,909	204	48	454	4	0	3	11	5,633
Archuleta (Tribal)	37	21	1	6	0	0	0	0	64
La Plata (Tribal)	4,147	192	42	400	3	0	2	11	4,798
Archuleta (Non-Tribal)	1	0	0	2	0	0	0	1	4
La Plata (Non-Tribal)	762	12	6	54	1	0	0	0	835
<b>Totals</b>	<b>4,947</b>	<b>225</b>	<b>48</b>	<b>462</b>	<b>4</b>	<b>0</b>	<b>3</b>	<b>12</b>	<b>5,700</b>
<b>Total Tribal</b>	<b>4,184</b>	<b>213</b>	<b>43</b>	<b>406</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>11</b>	<b>4,862</b>
<b>Total Non-Tribal</b>	<b>763</b>	<b>12</b>	<b>6</b>	<b>56</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>839</b>

**Table 16.** 2006 annual VOC emissions [tons/yr] by county and by source category for the North San Juan Basin.

County	Compressor Engines	Drill Rigs	Miscellaneous Engines	Heaters/ Boilers	Dehydrators	Oil Tanks	Flaring	Other Categories	Totals
Archuleta	16	2	0	0	0	14	0	0	32
La Plata	1,870	17	6	17	14	151	5	36	2,115
Archuleta (Tribal)	16	2	0	0	0	0	0	0	18
La Plata (Tribal)	1,814	16	5	15	12	151	5	29	2,046
Archuleta (Non-Tribal)	0	0	0	0	0	14	0	0	14
La Plata (Non-Tribal)	56	1	1	2	2	0	0	7	69
<b>Totals</b>	<b>1,886</b>	<b>18</b>	<b>6</b>	<b>17</b>	<b>14</b>	<b>165</b>	<b>5</b>	<b>36</b>	<b>2,147</b>
<b>Total Tribal</b>	<b>1,830</b>	<b>18</b>	<b>5</b>	<b>15</b>	<b>12</b>	<b>151</b>	<b>5</b>	<b>29</b>	<b>2,064</b>
<b>Total Non-Tribal</b>	<b>56</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>2</b>	<b>14</b>	<b>0</b>	<b>7</b>	<b>83</b>

## 2012 MIDTERM EMISSIONS PROJECTIONS

This analysis considers the 2006 baseline emissions, and projects these emissions to a “midterm” year of 2012, consistent with the previous basins analyzed as part of the Phase III project. The midterm projections for the North San Juan Basin are projected using a different methodology from previous Phase III basins, in that they rely on the No Action Alternative activity projections already developed as part of the SUIT PEA inventory. A detailed discussion of the development of the 2012 midterm emissions projections, and the methodology used to develop these projections, is provided below.

### Methodology

The basic methodology by which the 2012 midterm projections are generated is described in this section. The methodology consists of three primary steps: (1) the development of scaling factors for different oil and gas activity parameters from 2006 to 2012; (2) the application of the scaling factors to different source categories to develop “uncontrolled” emissions projections; and (3) the application of controls associated with regulations to the uncontrolled 2012 emissions.

The methodology description for the North San Juan Basin is broken down into subsections which describe:

- Geographic grouping of data – regional differences in production or activity are factored into the projection methodology by geographic region
- Projected parameters – seven basic parameters are projected forward to 2012 for purposes of developing scaling factors: total well counts, conventional gas well counts, CBM well counts, spud counts, gas production, oil production and condensate production
- Scaling factors and developing uncontrolled emissions projections – the projected parameters are used to develop scaling factors (incorporating geographic groupings), and these scaling factors are applied to the 2006 baseline emissions
- Application of “on-the-books” regulations and control measures – existing regulations are summarized for their impacts on the future year emissions and applied to adjust the uncontrolled 2012 inventory.

Projections for years beyond 2012 (not addressed in this methodology) will likely include additional parameters and will be based on these 2012 projections as the start year. The methodology for developing far future year projections will be detailed in a separate analysis.

Following the discussion of the methodology, the results of the 2012 emissions projections for the Uinta Basin are presented in graphical and tabular formats.

### Geographic Grouping

Two geographic groupings were used to derive scaling factors in the North San Juan Basin: Archuleta and La Plata Counties individually. This grouping was selected since there are only two production counties in this basin and each could be treated separately. All projections were

conducted for both tribal and non-tribal (state) land, although regulations that would affect state land were considered separately from those which would affect tribal land, as described below.

### Projected Parameters

A total of 8 parameters were projected from 2006 to 2012 to derive scaling factors. The projection methodologies are described in more detail below. The 8 parameters are:

- Total well counts
- Conventional gas well counts
- Spud counts
- Total gas production
- Total liquid production (oil and condensate)
- Conventional gas production
- Oil production
- Condensate production

It should be noted that some parameters were determined from combinations of other parameters. For example, CBM gas production was determined as the difference between total gas production and conventional gas production. For purposes of these projections, oil production was defined as any liquid hydrocarbon production from wells classified as oil wells in the IHS database. Condensate production was defined as any liquid hydrocarbon production from wells classified as gas wells in the IHS database.

### Scaling Factors

Scaling factors were derived for the 8 projected parameters above for the two North San Juan Basin counties – Archuleta and La Plata. The application of the scaling parameters to the 2006 baseline emissions generated the uncontrolled 2012 emissions.

The projected 2012 values of each of the 8 parameters for the North San Juan Basin were ratioed to the value of the respective parameter in 2006, following Equation (1):

$$\text{Equation (1)} \quad f_i = \frac{W_{2012}}{W_{2006}}$$

where:

$f_i$  is the scaling factor for parameter  $i$  (total well count, conventional gas well count, spud counts, total gas production, total liquid production, conventional gas production, oil production, or condensate production)

$W_{2006}$  is the value of parameter  $i$  in 2006

$W_{2012}$  is the projected value of parameter  $i$  in 2012

The values of the 8 parameters in 2012 were taken from the projections derived in the SUIT PEA considering the No Action Alternative for non-tribal land and Proposed Action Alternative for tribal land. These projections were the result of modeling the projected growth in number of wells under the 2002 Final Environmental Impact Statement (FEIS) Oil and Gas Development on the Southern Ute Indian Reservation (USDI, 2002a) and the corresponding Record of Decision (ROD) (USDI, 2002b) released by the Federal Bureau of Land Management, Bureau of

Indian Affairs and the SUI. From the well count growth, projections were made of the anticipated gas and oil production growth in the SUI tribal airshed. This forms the basis for the No Action and Proposed Action Alternatives in the SUI PEA, and the scaling parameters used in this analysis. The scaling factor for each county for tribal and non-tribal land is based on the fraction of 2006 activities that occurred on tribal and non-tribal land respectively in each county.

The scaling factors for the seven parameters used in this analysis for the North San Juan Basin are presented in Table 17 below.

**Table 17.** Scaling factors for the eight parameters used in the projection analysis for the North San Juan Basin.

Geographic Grouping	Total Well Count	Conv. Gas Well Count	Spud Count	Total Gas Prod.	Total Liquid Prod.	Condensate Prod.	Oil Prod.	Conv. Gas Prod.
Archuleta Tribal County	1.13	0.91	1.66	0.72	1	1	1	1
La Plata Tribal County	1.13	0.91	1.66	0.72	1	1	1	0.72
Archuleta Nontribal County	0.98	0.91	0.37	0.49	1	1	1	1
La Plata Nontribal County	0.98	0.91	0.37	0.49	1	1	1	0.72

The scaling factors described in Table 18 are used to scale total 2006 emissions for both the SUI tribal and non-tribal land in the North San Juan Basin for specific source categories. The cross-reference of the specific scaling factor used to generate uncontrolled 2012 emissions for specific source categories is provided in Table 19.

**Table 18.** Scaling parameter for each oil and gas source category considered in this inventory.

Source	SCC	Description	Projection Parameter
Unpermitted Source	2310000100	Heaters	Total Well Counts
Unpermitted Source	2310000220	Drill Rigs	Spud Counts
Unpermitted Source	2310000300	Pneumatic Devices	Conv. Gas Well Count
Unpermitted Source	2310000700	Unpermitted Fugitives	Conv. Gas Well Count
Unpermitted Source	2310001630	Venting - Blowdowns	Conv. Gas Prod
Unpermitted Source	2310002230	Condensate tank	Condensate Prod.
Unpermitted Source	2310002240	Oil Tank	Oil Prod.
Unpermitted Source	2310003100	Misc. Engines	Total Well Counts
Unpermitted Source	2310003500	Flaring	Conv. Gas Well Count
Unpermitted Source	2310020600	Compressor Engines	Total Gas Prod.
Unpermitted Source	2310021410	Dehydrators	Total Gas Prod.
Unpermitted Source	2310000330	Artificial Lift Engines	Oil Prod.
Permitted Source	20200201	Compressor Engines	Total Gas Prod.
Permitted Source	20200202	Compressor Engines	Total Gas Prod.
Permitted Source	20200203	Compressor Engines	Total Gas Prod.
Permitted Source	20200252	Compressor Engines	Total Gas Prod.
Permitted Source	20200253	Compressor Engines	Total Gas Prod.
Permitted Source	20200254	Compressor Engines	Total Gas Prod.
Permitted Source	31000101	Permitted Fugitives	Total Oil Prod.
Permitted Source	31000102	Oil Production, Miscellaneous Well: General	Total Oil Prod.
Permitted Source	31000123	Oil Production, Well Casing Vents	Total Oil Prod.
Permitted Source	31000130	Oil Production, Fugitives: Compressor Seals	Total Oil Prod.
Permitted Source	31000132	Oil Production, Atmospheric Wash Tank: Flashing Loss	Total Oil Prod.
Permitted Source	31000199	Oil Production, Processing Operations: Not Classified	Total Oil Prod.
Permitted Source	31000201	Natural Gas Production, Gas Sweetening:	Total Gas Prod.

Source	SCC	Description	Projection Parameter
		Amine Process	
Permitted Source	31000202	Natural Gas Production, Gas Stripping Operations	Total Gas Prod.
Permitted Source	31000203	Compressor Engines	Total Gas Prod.
Permitted Source	31000205	Natural Gas Production, Flares	Total Gas Prod.
Permitted Source	31000207	Permitted Fugitives	Total Gas Prod.
Permitted Source	31000209	Natural Gas Production, Incinerators Burning Waste Gas or Augmented Waste Gas	Total Gas Prod.
Permitted Source	31000215	Natural Gas Production, Flares Combusting Gases >1000 BTU/scf	Total Gas Prod.
Permitted Source	31000216	Natural Gas Production, Flares Combusting Gases <1000 BTU/scf	Total Gas Prod.
Permitted Source	31000220	Natural Gas Production, All Equip Leak Fugitives	Total Gas Prod.
Permitted Source	31000225	Natural Gas Production, Compressor Seals	Total Gas Prod.
Permitted Source	31000227	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000228	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000230	Natural Gas Production, Hydrocarbon Skimmer	Total Gas Prod.
Permitted Source	31000299	Natural Gas Production, Other Not Classified	Total Gas Prod.
Permitted Source	31000301	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000302	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000303	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000304	Glycol Dehydrator	Total Gas Prod.
Permitted Source	31000305	Natural Gas Processing Facilities, Gas Sweetening: Amine Process	Total Gas Prod.
Permitted Source	31000306	Natural Gas Processing Facilities, Process Valves	Total Gas Prod.
Permitted Source	31000309	Natural Gas Processing Facilities, Compressor Seals	Total Gas Prod.
Permitted Source	31000311	Natural Gas Processing Facilities, Flanges and Connections	Total Gas Prod.
Permitted Source	31000404	Process Heaters	Total Well Counts
Permitted Source	31000405	Process Heaters	Total Well Counts
Permitted Source	31000406	Process Heaters	Total Well Counts
Permitted Source	31000502	Liquid Separator	Total Well Counts
Permitted Source	31088801	Permitted Fugitives	Total Gas Prod.
Permitted Source	31088803	Permitted Fugitives	Total Gas Prod.
Permitted Source	31088804	Permitted Fugitives	Total Gas Prod.
Permitted Source	31088805	Permitted Fugitives	Total Gas Prod.
Permitted Source	31088811	Permitted Fugitives	Total Gas Prod.
Permitted Source	40400311	Tank Losses	Total Oil Prod.
Permitted Source	40400322	Tank Losses	Total Oil Prod.

### Controls and Regulations

This methodology considered any “on-the-books” federal or state regulations that would affect the uncontrolled 2012 emissions projections described above.

Table 19 below lists the “on-the-books” federal and state regulations that affect emissions source categories in the oil and gas industry, and the action taken to adjust the 2012 emissions inventory appropriately. A more detailed description follows of the methodology used to address each of

these regulations as they affected the uncontrolled 2012 North San Juan Basin emissions projections.

The uncontrolled 2012 emissions were adjusted based on the proposed actions or control factors developed for each regulation described in Table 19 to account for how these regulations may affect any oil and gas source category considered in this inventory. It should be noted that this analysis used conservative assumptions with respect to the application of these regulations to the 2012 uncontrolled emissions.

**Table 19.** Summary of federal and state “on-the-books” regulations affecting the oil and gas source categories considered in this inventory.

Source Category	Regulation	Enforcing Agency	Effective Date	Implementation in the 2012 Piceance Basin Emissions Projections
<b>Federal</b>				
Drilling Rigs	Nonroad engine Tier standards (1-4) (EPA, 2005a)	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.
Drilling Rigs	Nonroad diesel fuel sulfur standards (EPA, 2006)	US EPA	Phase in beginning in 2010	Assume 15 ppm sulfur in nonroad diesel fuel throughout Piceance 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 but determined to not be applicable to the Piceance Basin engine inventory due to gas production decline (see below).
<b>State (Non-Tribal Land)</b>				
Engines	Regulation 7 (CDPHE, 2008)	CDPHE	Phase in from 2007 – 2011	NOx and VOC controls required for new or relocated engines in Colorado on a phase-in schedule. (see below)
Glycol Dehydrators	Regulation 7 (CDPHE, 2008)	CDPHE	May 2008	Apply a control factor of 90% on still vent emissions for any glycol dehydrator emitting more than 15 tpy VOC. (see below)
Condensate Tanks	Regulation 7 (CDPHE, 2008)	CDPHE	May 2008	Apply 95% control to any tank emitting more than 20 tpy VOC. (see below)
Pneumatic Devices	COGCC Rule 805 (b)(2)(E) (COGCC, 2009)	COGCC	April/July 2009	Utilize low-bleed or no-bleed pneumatic devices if newly installed, replaced, or repaired. (see below)

### *Nonroad Diesel Engine Standards and Fuel Sulfur Standards*

The EPA NONROAD2005 model was run with fuel inputs based on a 2002 study entitled “WRAP Mobile Sources Emission Inventory Update” (Pollack, 2006). 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. 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. The ratios of the per unit emissions in 2012 to

those in 2006 for each county of interest were used to determine the percentage reduction 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 SO<sub>x</sub> 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 and the 2012 future year. A similar approach was used as for the federal tier standards to develop percentage reduction control factors. The ratio of per unit SO<sub>x</sub> emissions in 2012 to those in 2006 were used to determine a percentage reduction control factor to apply to uncontrolled 2012 SO<sub>x</sub> emissions for drilling rigs and workover rigs to account for federal non-road diesel fuel standards.

The resulting percentage reduction control factors from application of nonroad diesel engine standards and fuel sulfur standards are presented below in Table 20.

**Table 20.** Percentage reduction control factors for the 2012 North San Juan Basin emissions projections from application of federal nonroad engine standards and fuel sulfur standards to drilling and workover rig engines.

Source Category	SCCs	Percentage Reduction Control Factors				
		NOX	VOC	CO	SO <sub>x</sub>	PM
Drill rigs	2310000220	30%	39%	42%	99%	53%

#### *New Source Performance Standards for Stationary Spark-Ignited Engines*

The EPA has promulgated a new regulation covering new stationary, spark-ignited engines of various horsepower classes. The regulation is assumed to apply to central compressor engines, wellhead and lateral compressor engines, and artificial lift engines as well as any other miscellaneous APEN exempt engines that are stationary, spark-ignited natural gas engines. The regulation requires new engines of various horsepower classes to meet increasingly stringent NO<sub>x</sub> and VOC emission standards over the phase-in period of the regulation.

For engines less than 25 horsepower, Table 21 shows the requirements of the NSPS regulation.

**Table 21.** Federal NSPS emissions standards for engines less than 25 horsepower.

HP Range <sup>a</sup>	Emissions Standards Requirement in (g/hp-hr) <sup>b</sup>		
	HC + NO <sub>x</sub>	NMHC + NO <sub>x</sub> <sup>c</sup>	CO
≤ 25 Hp			
Class I	16.1 (12.0)	14.8 (11.0)	610 (455)
Class I -A	50-37	-	-
Class I -B	40 (30)	37 (27.6)	
Class II	12.1 (9.0)	11.3 (8.4)	

a – Class I-A: Engines with displacement less than 66 cubic centimeters (cc); Class I-B: Engines with displacement greater than or equal to 66cc and less than 100cc; Class I: Engines with displacement greater than or equal to 100 cc and less than 225 cc

b – Modified and reconstructed engines manufactured prior to July 1, 2008, must meet the standards applicable to engines manufactured after July 1, 2008

c – NMHC+NO<sub>x</sub> standards are applicable only to natural gas fueled engines at the option of the manufacturer, in lieu of HC+NO<sub>x</sub> standards

For engines in the horsepower range 25 – 100 horsepower, Table 22 shows the requirements of the NSPS regulation.

**Table 22.** Federal NSPS emissions standards for engines greater than 25 horsepower but less than 100 horsepower.

HP Range	Manufacture Date	Emissions Standards Requirement (g/hp-hr)	
		HC + NOx	CO
25<HP<100	1-Jul-08	3.8	6.5
	1-Jul-08 (severe duty)	3.8	200

For engines in the horsepower range 100 – 1,350 horsepower, Table 23 shows the requirements of the NSPS regulation.

**Table 23.** Federal NSPS emissions standards for engines greater than 100 horsepower but less than 1350 horsepower.

Engine Type and Fuel	HP Range	Manufacture Date	Emissions Standards Requirement (g/hp-hr)		
			NOx	CO	VOC
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG	100≤HP<500	1-Jul-08	2	4	1
		1-Jan-11	1	2	1
Non-Emergency SI Lean Burn Natural Gas and LPG	500≥HP<1350	1-Jan-08	2	4	1
		1-Jul-10	1	2	1
Non-Emergency SI Natural Gas and Non-Emergency SI Lean Burn LPG (except lean burn 500≥HP<1350)	HP≥500	1-Jul-07	2	4	1

Consistent with previous WRAP basins, this analysis conservatively assumed that NSPS would only be applied to the portion of compression emissions that resulted from growth in gas production over the period 2006 – 2012. This analysis assumed that if gas production is not projected to increase, new compression will not need to be installed, and that no turn-over of existing engines would occur within the 2006 – 2012 time period. Because gas production is assumed to either remain constant or decrease in this time period, it was conservatively assumed that no new compression would be necessary and thus NSPS requirements were not applied.

#### *CDPHE RICE Requirements*

CDPHE regulations affecting new or existing reciprocating internal combustion engines were applied to compressor and other engines located on state lands. The RICE requirements affect only engines greater than 500 hp, and thus were assumed to apply only to permitted engines. Unpermitted engines on state land in the basin would emit less than 2 tpy of NOx and thus were assumed to be smaller than 500 hp. Because this regulation affects both new and existing engines, the same analysis as used above for the NSPS regulations was applied, and therefore the RICE requirements were applied only to existing APENs engines.

The APENs database for the North San Juan Basin was filtered to create a subset of entries representing engines with horsepower greater than 500 hp. Engines which were indicated to be turbines or engines with missing information on horsepower were excluded from this subset. For APENs sources that fell into the subset of engines subject to the RICE requirements, the control factors shown in Table 24 were applied to their uncontrolled 2012 emissions.

**Table 24.** Percentage reduction control factors for the 2012 North San Juan Basin emissions projections from application of CDPHE RICE requirements to permitted engines on state land.

Source Category	SCCs	Percentage Reduction Control Factors				
		NOX	VOC	CO	SOx <sup>a</sup>	PM <sup>a</sup>
Compressor engines	20200254	33%	67%	39%	100%	100%

*a – note that a percentage reduction control factor of 100% indicates no controls were applied for these pollutants*

### *CDPHE Regulation 7 – Glycol Dehydrators and Condensate Tanks*

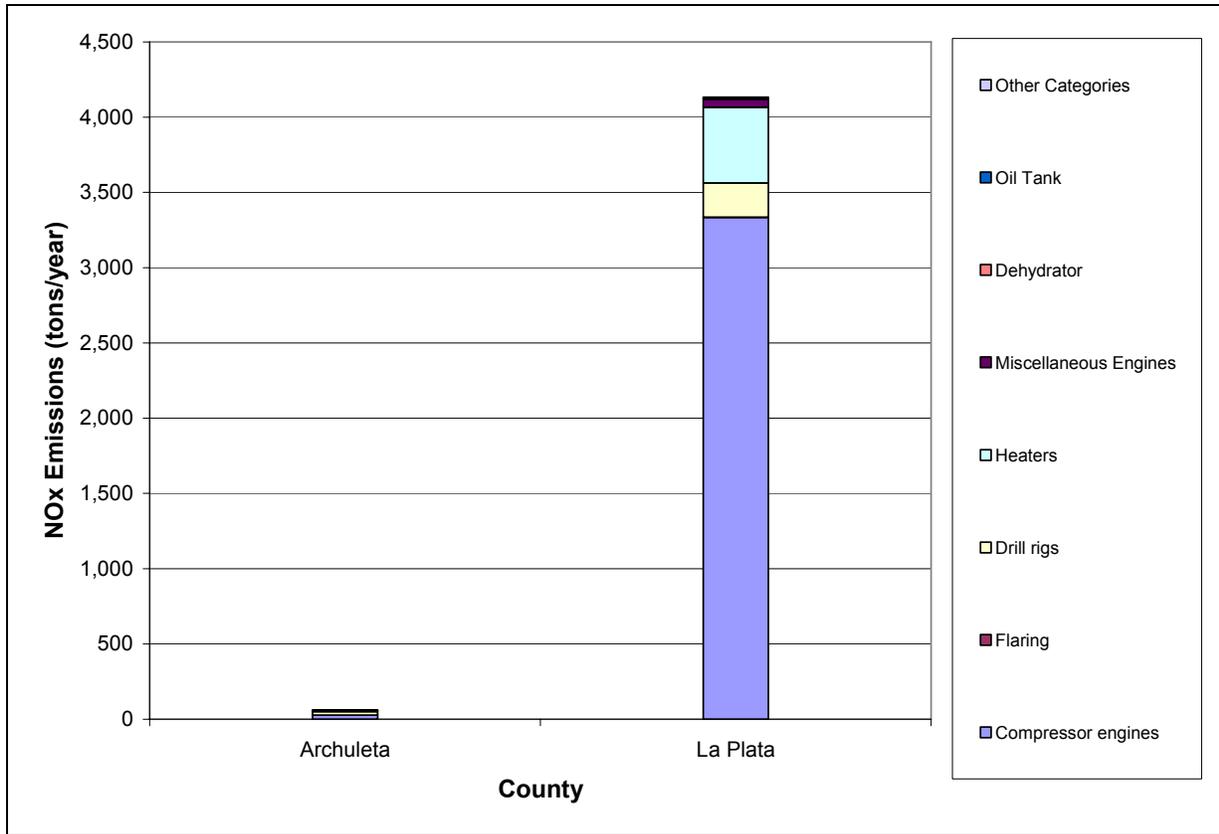
Analysis of the APENs database indicated that no glycol dehydrators which would meet the requirements of the regulation were found in the database. No condensate tanks were found in the APENs database.

### *COGCC Pneumatic Device Requirements*

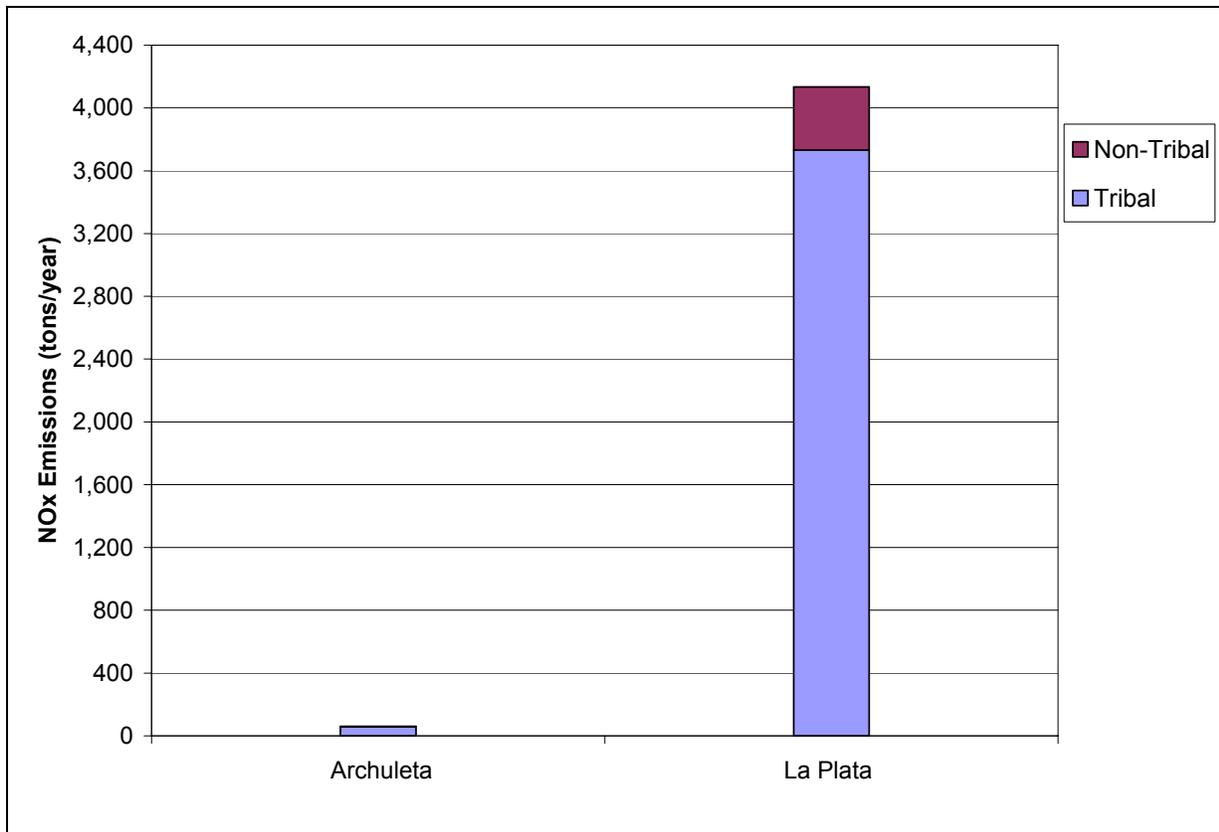
Pneumatic device requirements from recently promulgated COGCC rules apply to new, replaced or repaired pneumatic devices. The rule requires the use of low-bleed or no-bleed pneumatic devices when these new, replaced or repaired pneumatic devices are installed. The uncontrolled 2012 emissions for pneumatic devices on state land were negligible to within the level of precision used in this inventory. Thus this rule was not applied to the 2012 uncontrolled pneumatic device emissions.

### **2012 Midterm Emissions Results**

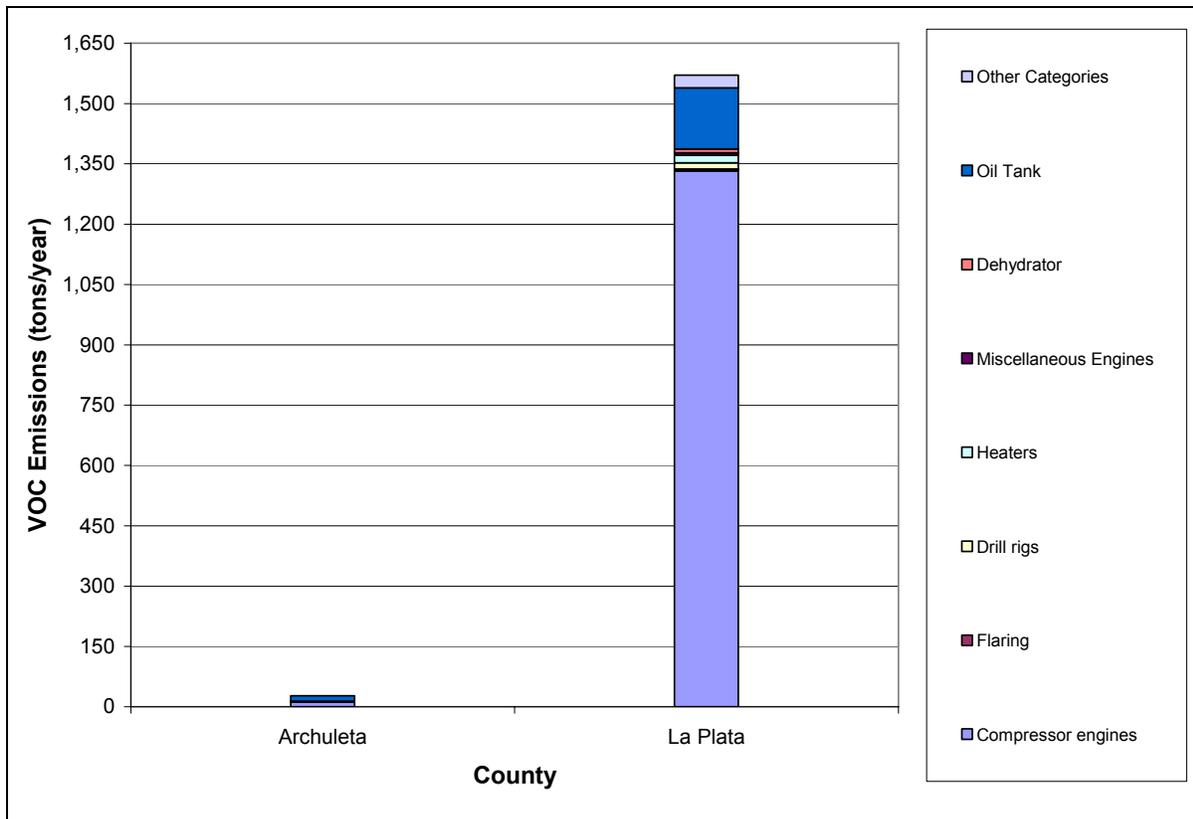
The scaling factors were applied to the baseline 2006 inventory, and “on-the-books” regulations were applied to the uncontrolled 2012 emissions projections to generate the final 2012 emissions projections. Results are presented below in graphical and tabular format.



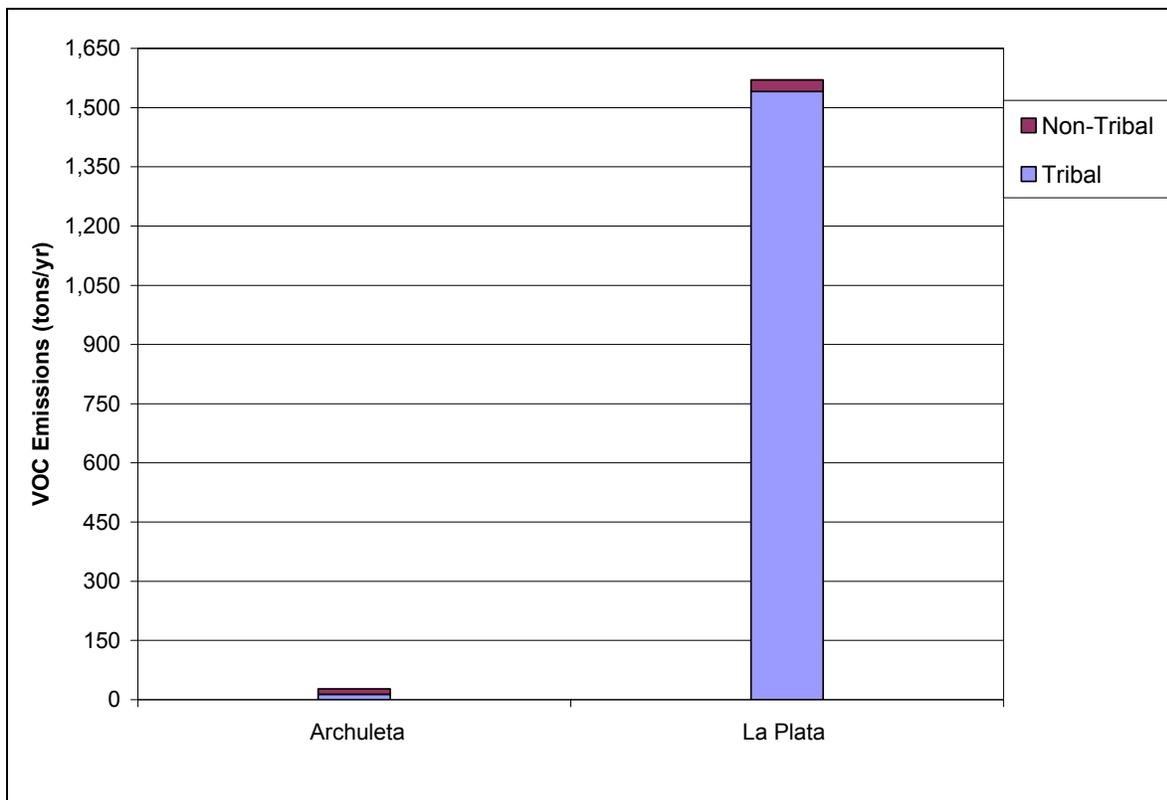
**Figure 8.** 2012 NOx emissions by source category and by county in the North San Juan Basin.



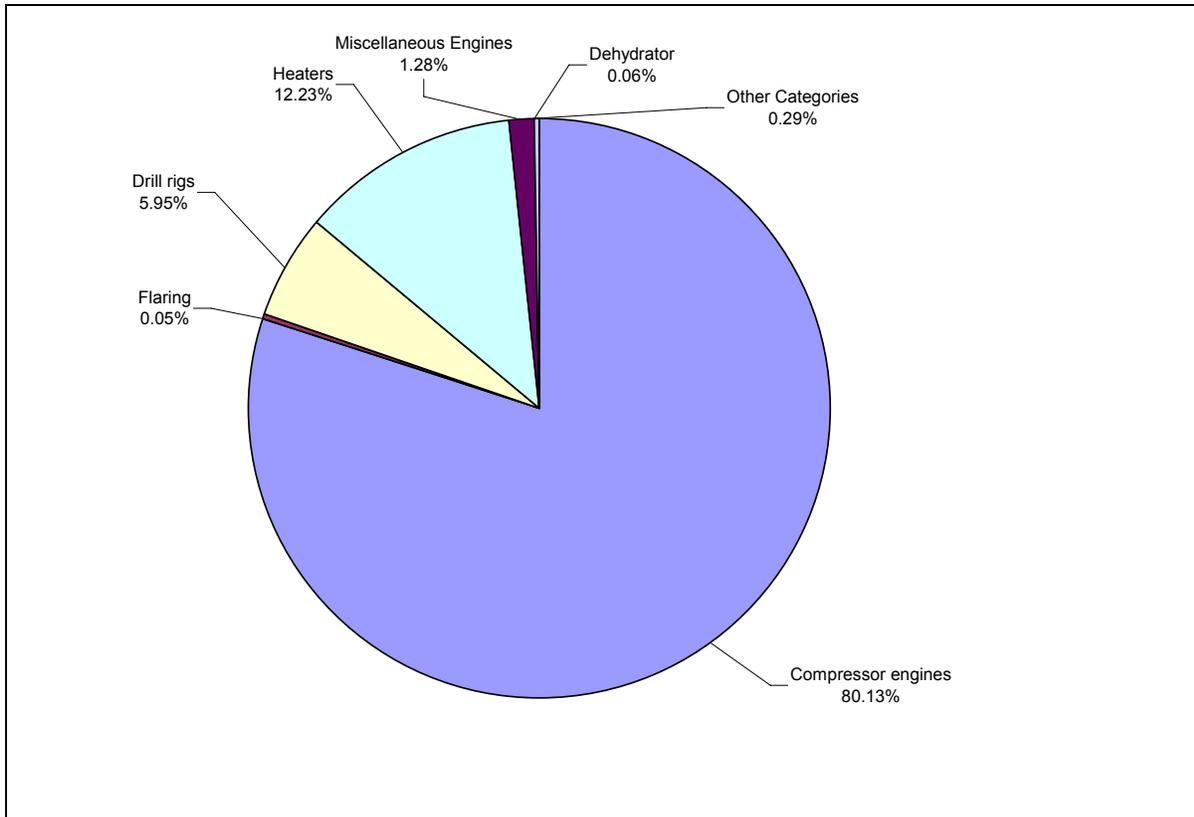
**Figure 9.** 2012 NOx emissions on tribal and non-tribal land by county in the North San Juan Basin.



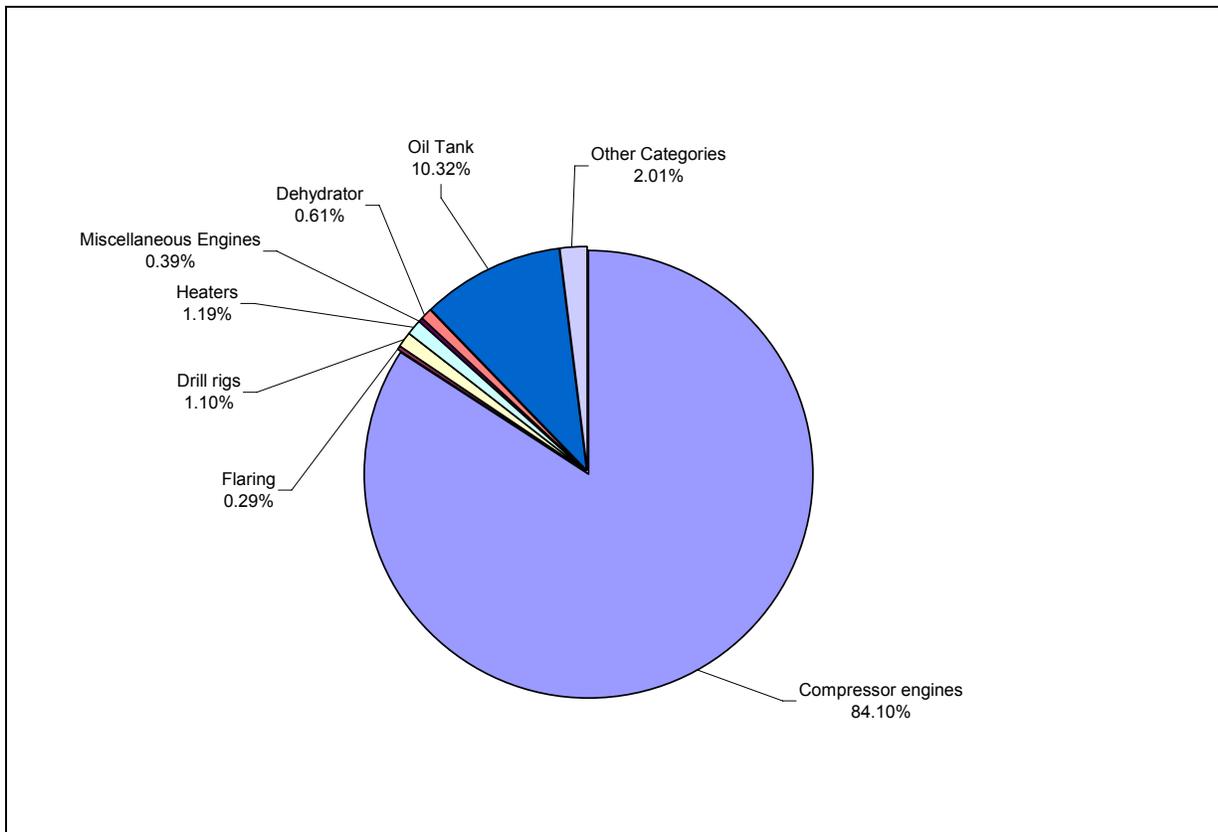
**Figure 10.** 2012 VOC emissions by source category and by county in the North San Juan Basin.



**Figure 11.** 2012 VOC emissions on tribal and non-tribal land by county in the North San Juan Basin.



**Figure 12.** North San Juan Basin 2012 NOx emissions proportional contributions by source category.



**Figure 13.** North San Juan Basin 2012 VOC emissions proportional contributions by source category.

**Table 25.** 2012 emissions of all criteria pollutants by county for the North San Juan Basin.

<b>County</b>	<b>NOx [tons/yr]</b>	<b>VOC [tons/yr]</b>	<b>CO [tons/yr]</b>	<b>SOx [tons/yr]</b>	<b>PM [tons/yr]</b>
Archuleta	61	28	46	0.01	2
La Plata	4,134	1,571	4,614	0.32	45
Archuleta (Tribal)	58	14	45	0.01	2
La Plata (Tribal)	3,732	1,541	4,477	0.13	39
Archuleta (Non-Tribal)	3	14	2	0.00	0
La Plata (Non-Tribal)	402	30	137	0.19	6
<b>Totals</b>	<b>4,195</b>	<b>1,598</b>	<b>4,661</b>	<b>0.34</b>	<b>47</b>
<b>Total Tribal</b>	<b>3,790</b>	<b>1,554</b>	<b>4,522</b>	<b>0.15</b>	<b>40</b>
<b>Total Non-Tribal</b>	<b>405</b>	<b>44</b>	<b>139</b>	<b>0.19</b>	<b>6</b>

**Table 26.** 2012 annual NOx emissions [tons/yr] by county and by source category for the North San Juan Basin.

County	Compressor Engines	Drill Rigs	Miscellaneous Engines	Heaters/ Boilers	Dehydrators	Oil Tanks	Flaring	Other Categories	Totals
Archuleta	27	24	1	9	0	0	0	1	61
La Plata	3,335	226	53	504	3	0	2	11	4,134
Archuleta (Tribal)	26	24	1	7	0	0	0	0	58
La Plata (Tribal)	2,995	223	47	451	2	0	2	11	3,732
Archuleta (Non-Tribal)	0	0	0	2	0	0	0	1	3
La Plata (Non-Tribal)	340	3	6	53	0	0	0	0	402
<b>Totals</b>	<b>3,362</b>	<b>249</b>	<b>54</b>	<b>513</b>	<b>3</b>	<b>0</b>	<b>2</b>	<b>12</b>	<b>4,195</b>
<b>Total Tribal</b>	<b>3,021</b>	<b>246</b>	<b>48</b>	<b>459</b>	<b>2</b>	<b>0</b>	<b>2</b>	<b>11</b>	<b>3,790</b>
<b>Total Non-Tribal</b>	<b>340</b>	<b>3</b>	<b>6</b>	<b>55</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>405</b>

**Table 27.** 2012 annual VOC emissions [tons/yr] by county and by source category for the North San Juan Basin.

County	Compressor Engines	Drill Rigs	Miscellaneous Engines	Heaters/ Boilers	Dehydrators	Oil Tanks	Flaring	Other Categories	Totals
Archuleta	12	2	0	0	0	14	0	0	28
La Plata	1,332	16	6	19	10	151	5	32	1,571
Archuleta (Tribal)	12	2	0	0	0	0	0	0	14
La Plata (Tribal)	1,310	16	5	17	9	151	5	29	1,541
Archuleta (Non-Tribal)	0	0	0	0	0	14	0	0	14
La Plata (Non-Tribal)	23	0	1	2	1	0	0	3	30
<b>Totals</b>	<b>1,344</b>	<b>18</b>	<b>6</b>	<b>19</b>	<b>10</b>	<b>165</b>	<b>5</b>	<b>32</b>	<b>1,598</b>
<b>Total Tribal</b>	<b>1,321</b>	<b>17</b>	<b>6</b>	<b>17</b>	<b>9</b>	<b>151</b>	<b>5</b>	<b>29</b>	<b>1,554</b>
<b>Total Non-Tribal</b>	<b>23</b>	<b>0</b>	<b>1</b>	<b>2</b>	<b>1</b>	<b>14</b>	<b>0</b>	<b>3</b>	<b>44</b>

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