

Draft Work Plan

**STATIONARY SOURCES JOINT FORUM: EMISSION INVENTORY
AND CONTROL TECHNOLOGY TECHNICAL SUPPORT**

Task 1.B: Oil and Gas Sources



Prepared for

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This work plan described procedures to be used for estimating emissions from oil and gas sources in the WRAP states. The procedures described will be applied to estimate oil and gas emissions in each state. Analogous methods will be followed to estimate oil and gas emissions on the four tribal lands that ENVIRON has been contracted to study, and those tribal emissions will be reconciled with and reported separately from State oil and gas emissions.

Emissions for these large oil and gas stationary sources – compressor stations and gas processing plants – have been estimated by the States as point sources. ENVIRON’s task relating to these sources is to contact state environmental departments (referred to in this document as DEQs) to determine and document the thresholds used for including these sources in states’ point source emissions inventories. Oil and gas sources below those thresholds will be considered area sources.

Given the importance of NOx as a visibility-impairing pollutant, we are focusing most of our efforts on three major NOx sources:

- drill rigs,
- natural gas compressor engines, and
- the generators used in coal bed methane production. The inventory methods to be employed for these important NOx sources are detailed below.

In addition to our principal effort of estimating emissions from major NOx sources, we will estimate emissions from major VOC sources and some minor NOx sources. The processes addressed in this second portion of the area source inventory will be:

- Tanks - Flashing & Standing/Working/Breathing;
- Glycol Dehydration Units;
- Heaters;
- Pneumatic Devices; and
- Completion - Flaring and Venting. The procedure for these sources is discussed in the final section of this work plan.

MAJOR NOX SOURCE INVENTORY

Drilling

The rigs used to drill oil and gas wells use very large engines. Some rigs host as much as 4,000 horsepower. These engines generally operate at a high load factor and over many weeks or months, depending on the intended depth of the well and the composition of the strata that must be drilled through. As a result of the intense and sustained work performed by these large engines, they are an important source of NOx emissions. Though some wells are drilled using power from the grid or natural gas, preliminary data suggests that the majority of drill rigs use diesel engines. Unless drill companies report significant usage of natural gas engines or grid power, this procedure will represent only the characteristics of the diesel engines. This will result in a conservative estimate. Drilling emissions will be estimated by multiplying activity data by the appropriate emission factors. Data sources will be:

Activity:

- **Duration:** To determine the duration of drilling at each well drilled in 2002, we will obtain permit data from the States. Every oil and gas commission, or similar agency (henceforth referred to as OGC), contacted thus far reports tracking the spud date (the date drilling begins) of each well drilled and in many cases the date that drilling ceases. It may be necessary in states with less detailed records to estimate the date drilling ceased based on the well completion date or on an average time needed to drill a well as reported by major drilling companies. Due to the wide range of drilling conditions, when possible we will use well-specific duration information rather than industry or state-wide averages.
- **Load:** We will contact the major drilling companies to obtain data (e.g., design capacity) about the engines that they use. The initial list of drilling companies that we will contact is shown in Table 1. The companies included in this list are the most active drillers in the western states. We will also attempt to obtain operation schedules from the drilling companies. Unless the drilling companies provide information, we will default to an assumed 24 hours per day, 7 day per week operation at 100 percent engine capacity for the duration of drilling.
- We will also ask the drilling companies if they use other generators, such as a power supply generator, on drill sites. If so, on what fraction of sites and what size generator is used.

Table 1. Initial list of drilling companies that ENVIRON will contact.

Drilling Company
Patterson UTI
Nabors Drilling
Grey Wolf
Williams

Emission Factors:

Manufacturers emissions data for the most common engine types will be used. If manufacturer's emissions data are unavailable, we will use other published factors for diesel engines such as those in EPA's NONROAD model.

Controls:

When we contact the state DEQs for information on sources in the point source inventory, we will also ask if any controls are required on the drill rig engines and if so, what is the assumed control efficiency, rule effectiveness and rule penetration.

Non-point Natural Gas Compressor Engines

Small natural gas compressors are located near the wellhead to raise the pressure of produced gas. Unlike the large compressor stations on natural gas transmission pipelines, these small stations often consist of a single compressor powered by a natural gas fired engine. The size of these engines varies with the volume of gas channeled to the compressor, but commonly the engines are around 200 to 300 horsepower. Due to the constant nature of gas production, these engines operate steadily 24 hours per day, 365 days per year. In some gas producing states there are many hundreds of small compressors operating. In others, centralized batteries serve many wells. The engines driving these compressors are expected to be a significant source of NOx emissions. Natural gas compressor engine emissions will be estimated by multiplying activity information by the appropriate emission factors. Data sources will be:

Activity:

• Preferred Method:

We will first contact the largest exploration and production (E&P) and gathering companies to determine if they own or rent these compressors. Of those companies that own their own compressors we will request data on the fleet of compressors deployed in 2002. Specifically we will request information on:

- location the compressors were installed (county & field),
- engine used (capacity, manufacturer & model),
- fuel used,
- load, and
- operational schedule

We expect companies will at minimum be able to provide the number of compressors operating in 2002 and the counties that they operated in. If the other data elements are not available, we will default to the values in table 2.

Table 2. Default values for compressors.

Engine Size	Average engine size based on available data
Fuel	Natural gas
Load	100 percent
Operational Schedule	24 hours per day, 365 days per year

After contacting the producing and gathering companies we will then contact the largest compressor rental companies in each state to obtain data on the compressors they had in the field in 2002.

Table 3 shows the list of producing/gathering companies and compressor rental companies that we have thus far identified to contact. To all these companies and any others that we contact we will offer to make the information they provide anonymous so as to protect business confidentiality.

Table 3. Preliminary list of contacts for compressor data.

Producing/Gathering Companies	Rental Companies
Chevron-Texaco	Universal Compression
Duke Energy Field Services	Hanover Compression
BP	
ExxonMobil	
Burlington Resources	
Conoco Philips	
Marathon	
Devon	
Encana	
Williams	

From the rental companies we will request the same information as from the E&P companies. In addition, we will request from each company an estimate of its market share. This will serve as a useful check to be sure that between the E&P companies and the rental companies we are

obtaining data on all compressors in the state. If there is a significant number of smaller operators such that the number of companies makes calling each to obtain data prohibitively time consuming, we can use the estimates of market share to scale the activity data we collect to represent the entire population of compressors.

In those states that do track compressors we can evaluate the completeness of the process described above by comparing the total number of compressors estimated against the number of compressors tracked by the state. For each state we will also use the information collected from the DEQ to ensure that we are not including sources that have already been listed in the point source inventory.

- **Alternative Method:** If rental companies are unable or unwilling to give us a description of compressor activity, our first fallback will be to the tracking statistics maintained by some states. In cases where these are not available, we will use the local studies that have been performed – such as an industry-produced study of the San Juan Basin which we are requesting permission to use and the Wyoming permits - and other data we obtain to derive a relationship between the MMscf of gas produced and the work done by compressor engines. Using that relationship we will be able to estimate the activity (horsepower-hours) done by compressors based on natural gas production data.

Emission Factors:

We will obtain from the rental companies the typical engine types and obtain manufacturer emissions specifications for those engines.

Controls:

When we contact the state DEQ for information on sources in the point source inventory, we will also ask if any controls are required on the compressor engines and if so, what is the assumed control efficiency, rule effectiveness and rule penetration.

Coal Bed Methane Generators

Coal bed methane wells produce methane by pumping water from the coal bed to release the trapped gas, a process termed dewatering. This water is brought to the surface by pumps that are powered by line electricity or by diesel or natural gas fired generators. In areas without line power, the generators operate continuously and range in size from under 50 horsepower to several hundred horsepower. Some generators provide power for only one pump, but more commonly one generator supplies power to multiple pumps at proximate wellheads. In 2002, the State of Wyoming tracked 603 diesel fired generators used for dewatering at CBM wells. Thus while each individual generator may not be a large emissions source, these generators in the aggregate are certainly important. CBM generator emissions will be estimated by multiplying the activity data by the appropriate emission factors using the following data sources:

Activity:

- **Preferred Method:** Some states maintain a database containing these generators. The State of Wyoming's database contains all diesel generators associated with CBM production. The State of Colorado's database contains these generators down to a 50 horsepower minimum. Where available, the information on generator size, emissions characteristic and duration of use will be collected from state databases.

- **Alternative Method:** In some areas, a similar generator database may not be available. However, the areas of CBM activity are discrete and we expect that through contacts in OGCs we can determine the number of wells that will be run on line power versus generators. Then, using data on water produced from the well production database we can estimate the work done by generators using a relationship derived from water production and generator activities in the areas with known CBM generator activity.

The preferred method is expected to provide good results for diesel fired generators. However, industry contacts have noted that a significant fraction of the producers use natural gas fired engines. To determine if there is significant use of natural gas engines we will ask the state DEQs and OGCs if they're aware of any use of natural gas generators. If they indicate that natural gas fired engine use is significant, we will ask to obtain any permit data or databases they may have that contain information on the natural gas fired engines. If they have no such data we will obtain estimates of the fraction of generators that are diesel and the fraction that are natural gas from the DEQ, from the OGC or from CBM producers. Knowing the fraction of engines that are natural gas fired we will assume they have approximately the same capacities and perform the same work as the diesel generators.

Emission Factors:

For areas with generator databases, the emission factors contained in those databases will be used. For other areas, AP-42 emission factors or emission factors from EPA's NONROAD model will be used.

Controls:

When we contact the state DEQs for information on sources in the point source inventory, we will also ask if any controls are required on the CBM generators and if so, what is the assumed control efficiency, rule effectiveness and rule penetration.

VOC AND MINOR NOX SOURCE INVENTORY

For the sources to be addressed in this portion of the inventory, the Wyoming Department of Environmental Quality (WY DEQ) has developed emission factors for a previous inventory effort; these are provided in the Appendix. These emission factors have units of emissions per well or emissions per quantity of oil/gas produced. These emission factors were developed based on well characteristics and typical equipment in the State of Wyoming. While the general activities are expected to be similar in other states, the composition of gas and specific well-site equipment needs vary from region to region and even from field to field. Thus, while our default will be to use the WY DEQ emission factors, if any states or stakeholders opt to provide factors specific to their operations or adjustments to the WY DEQ factors we will use those. Significant changes to the emission factors may result if states or stakeholders modify the inputs used to generate these emission factors; particularly the state weighted average VOC content and moisture content of produced gas. The methods used to develop the WYDEQ factors and the underlying assumptions are presented for reference at the end of this section. The processes for which we will estimate emissions, the pollutants to be estimated and the units of the WY DEQ emission factors are shown in Table 4.

Table 4. VOC and minor NOx processes, pollutants and emission factor units.

Process	Pollutants	EF Units
Tanks - Flashing & Standing/Working/Breathing	VOC	lbs per year / barrel per day of condensate production
Glycol Dehydration Units	VOC	lbs per year / million cubic feet per day of gas production
Heaters	NOx, CO	lbs per year / well site
Pneumatic Devices	VOC	tons per year / well
Completion - Flaring and Venting	VOC, NOx, CO	tons / completion

Activity:

We will request well-specific production data from each oil and gas producing state. In general, this information is available from the state OGC or a similar entity. If states or stakeholders choose to provide emission factors specific to their operations those factors will need to be compatible with the production data we are collecting or the appropriate data will need to be supplied. The data we will request from each state are:

- oil produced
- gas produced
- water produced
- well location (latitude/longitude)
- well field
- well formation
- well depth
- well class (oil/gas)
- coal bed methane (yes/no)
- completion date

Emission Factors:

Unless a state or stakeholder provides local emission factors, we will use the factors developed by WY DEQ.

Controls:

When we contact the state DEQs for information on sources in the point source inventory, we will also ask if any controls are required or commonly used on the processes included in this portion of the inventory. Wyoming DEQ assumed certain controls when preparing their emission factors, such as flaring of completion emissions with 50 percent efficiency. We will ensure that any assumptions made by WY DEQ related to controls are appropriate for other states and make adjustments as necessary.

PROJECTIONS

Once we have estimated the 2002 emissions for the sources detailed above and entered these emissions in the WRAP EDMS we will then project emissions to 2018. To determine the increase or decrease in production activity, we will consult existing oil and gas production forecasts. Emissions are not expected to increase at the same rate as production due to the imposition of controls. EPA and State DEQs will be contacted to determine if any controls have

been imposed or are expected to be placed on the equipment included in this emissions inventory between 2002 and 2018. If there are any anticipated controls, the projection will be adjusted to account for those based on estimated control efficiencies as reported by EPA or the DEQ.

Numerous projections of oil and gas production have already been identified. The bases for these assumptions vary as do the regions and time spans that they cover. The Energy Information Administration provides annual production estimates out to 2025, differentiating between production in Alaska and production in the rest of the nation. The Bureau of Land Management has prepared several production forecasts for important oil and gas producing regions as part of Environmental Impact Statements for Resource Management Plans. State OGCs have also been asked to provide any forecasts they may have prepared. The list of sources of useful oil and gas production forecasts identified thus far is presented in Table 5. The different production forecasts will be evaluated to determine which provides the most appropriate information for each area.

Table 5. Sources of oil and gas production forecasts identified to date.

Document (source)
Draft Environmental Impact Statement; Northern San Juan Basin Coal Bed Methane Project; La Plata and Archuleta Counties (http://www.nsjb-eis.org/default.htm)
Final Statewide Oil and Gas Environmental Impact Statement and Proposed Amendment of the Powder River and Billings Resource Management Plans (http://bogc.dnrc.state.mt.us/Final%20CBM%20EIS.htm)
Powder River Basin Oil and Gas Project Final EIS and Proposed Plan Amendment (http://www.wy.blm.gov/nepa/prb-feis/)
Colorado Oil and Gas Leasing and Development, Final Environmental Impact Statement (ftp://ftp.co.blm.gov/pub/planning/RMPs/ENV_IMPACT/)
White River Resource Area Proposed Resource Management Plan and Environmental Impact Statement (ftp://ftp.co.blm.gov/pub/planning/RMPs/ENV_IMPACT/)
Proposed Resource Management Plan Amendment and Final Environmental Impact Statement for Federal Fluid Minerals Leasing and Development in Sierra and Otero Counties (http://www.nm.blm.gov/lcfo/white_sands_rmpa_eis/docs/Vol%20I.pdf)
Dakota Prairie Grasslands Oil and Gas Leasing Record of Decision (http://www.mt.blm.gov/oilgas/Grasslands/og_rod_final.pdf)
Annual Energy Outlook 2005 (http://www.eia.doe.gov/oiaf/aeo/index.html)
Rocky Mountain States Natural Gas Resource Potential and Prerequisites to Expanded Production (http://fossil.energy.gov/programs/oilgas/publications/naturalgas_general/rockymtn_final.pdf)

In addition, we will update the oil and gas point source emissions with any new sources that we learn of that are coming on line past 2002. At this point in time, we know of a new natural gas compressor station coming on line in Pinal County in 2004.

APPENDIX**WYDEQ METHODS AND ASSUMPTIONS FOR ESTIMATING AREA SOURCE OIL AND GAS EMISSIONS**

Following is a description of the methods and assumptions the Wyoming DEQ used to prepare emission factors for the oil and gas processes that we will address in the VOC and Minor NO_x Source Inventory. This information is provided so that states and/or stakeholders can review the inputs and determine if they wish to replace the WY DEQ emission factors with their own.

Gas WellsFlashing & Standing/Working/Breathing of Condensate Tanks

Method: E&P Tanks

Assumptions:

- Weighted average of condensate composition for each formation for which analysis were available. We are in the process of obtaining the details of this composition from WY DEQ.
- Statewide average temperature and pressure of upstream separator
- Controls with an efficiency of 98% on wells producing over 18.3 BPD of condensate

Factors:

Wells under 18.3 BPD
 3,271 lbs VOC per year / BPD
 Wells over 18.3 BPD
 65.74 lbs VOC per year / BPD

Dehydration Unit

Method: GlyCalc

Assumptions:

- Weighted average of wet gas composition for each formation for which analysis were available (see Table 6)
- Pump rate = 0.425 gpm or 25.0 spm
- Kimray 4015 glycol pump
- Water content of dry gas between 5 and 7 pounds per MMCF

Factors:

27,485 lbs per year / MMCFD

Table 6. Weighted average Wyoming statewide gas composition.

Component	mol %	M.W.	(mol % X MW)/100	WT% of i
O2	0.000	16.00	0	0.0000
CO2	1.297	44.01	0.571	0.0309
N2	0.386	28.01	0.108	0.0059
Methane C1	89.479	16.04	14.352	0.7776
Ethane C2	5.602	30.07	1.685	0.0913
Propane C3	1.893	44.10	0.835	0.0452
i-Butane i-C4	0.391	58.12	0.227	0.0123
n-Butane n-C4	0.416	58.12	0.242	0.0131
i-Pentane iC5	0.154	72.15	0.111	0.0060
n-Pentane nC5	0.112	72.15	0.081	0.0044
n-Hexane n-C6	0.035	86.18	0.030	0.0016
Hexanes C6	0.120	84.18	0.101	0.0055
Heptanes C7	0.057	100.20	0.057	0.0031
Octanes C8	0.023	114.23	0.026	0.0014
Nonanes C9	0.000	128.26	0.000	0.0000
Decanes Plus C10+	0.000	142.29	0.000	0.0000
Benzene	0.012	78.11	0.009	0.0005
Toluene	0.017	92.14	0.016	0.0009
e-Benzene	0.000	106.17	0.000	0.0000
Xylenes	0.004	106.17	0.005	0.0003
H2S	0.000	34.08	0.000	0.0000
	99.999			
Gas Molecular Weight (lb/lb-mol) =			18.456	
Total VOCs Weight Percent =			9.4%	

Heater Emissions

Method: Engineering calculation using AP-42 emission factors for fuel boilers and heaters

Assumptions:

- At average gas well approximately 2.0 MMBtu/hr are used in heaters and burners
- Average heat content of fuel is 1000 Btu/scf

Factors:

1,752.0 lbs NO_x per year / well
 367.92 lbs CO per year / well

Completion Emissions from Flaring and Venting

Method: Engineering calculations and AP-42 flare emission factors

Assumptions:

- Weighted average statewide produced gas composition (VOC weight percent = 9.43)
- 5.0 MMCFD gas flared/vented (from well completion log)
- Gas flared 50 percent of the time, vented other 50 percent
- 50 percent destruction efficiency when flaring

Factors:

86.0 tons VOC / well completion
1.75 tons NOx / well completion
0.44 tons CO / well completion

Pneumatic Devices

Method: Engineering calculation

Assumptions:

- The average pneumatic pump emits 5.0 SCF/hr
- Gas wells have two pneumatic pumps for methanol injection
- Weighted statewide average gas composition

Factors:

0.2 tons VOC per year / well

Oil Wells

Pneumatic Devices

Method: Engineering calculation

Assumptions:

- The average pneumatic pump emits 5.0 SCF/hr
- Oil wells have one pneumatic pump for methanol injection
- Weighted statewide average gas composition

Factors:

0.1 tons VOC per year / well

Heater Emissions

Method: Engineering calculation using AP-42 emission factors

Assumptions:

- Average throughput at central battery type facility of 2000 BPD

- 4.0 MMBtu/hr total heat input

Factors:

0.005 lbs NOx per year / BPD

0.01 lbs CO per year / BPD

Flashing & Standing/Working/Breathing

Method: E&P Tanks

Assumptions:

- Sales oil with API gravity of 30.0 and Reid Vapor Pressure of 2.7 psi

Factors:

160.0 lbs VOC per year / BPD