ENVIRON

via email: Lalter@westgov.org

August 7, 2006

Mr. Lee Alter
Western Governors' Association

Subject: **WRAP Oil & Gas Area Source Emission Inventories and Controls**

Dear Lee:

ENVIRON is pleased to provide this proposal for improvements in the WRAP 2002 and 2018 oil and gas area source emission inventories, and for evaluation of potential oil and gas area source controls. The proposed work would build upon ENVIRON's previous work for the Western Regional Air Partnership (WRAP) in which we developed and implemented uniform procedures for estimating emissions from oil and gas production operations across the western states (final report "Oil and Gas Emissions Inventories for the Western States," dated December 27, 2005). The emphasis of that study was placed on estimating emissions of pollutants with the potential to impair visibility near Class I areas in the west, in particular oxides of nitrogen (NOx). Some emissions estimates were also provided for SO2 from drill rigs and VOC from some wellhead processes. Emissions were estimated for the year 2002 and projected to 2018.

The oil and gas production industry includes a number of processes and equipment types that stretch from the wellhead to fuel distribution networks. While the largest oil and gas production facilities such as major compressor stations and gas plants had been inventoried in the past (as part of stationary source emission inventories), the equipment types that were the focus of this study are geographically distributed and are considered area sources. It should be noted that prior to this study there were essentially no emissions estimates for oil & gas area sources, and this study was the first regional emission inventory for these sources. The present proposal uses this prior ENVIRON work as the basis for further work to improve the estimates.

After the original WRAP oil & gas emissions work was completed, ENVIRON developed improvements to oil and gas area source emissions in two counties in northwest New Mexico (San Juan and Rio Arriba) under contract to the New Mexico Environment Department (NMED), ENVIRON. The work proposed here builds upon the work performed in New Mexico.

The purpose of this study is twofold. First, this study will include efforts to improve the previous estimates of emissions from oil and gas production for the years 2002 and 2018. Where appropriate, the additional work that ENVIRON conducted in NW NM will be used to improve the original WRAP emissions estimates. Further, specific areas have been identified where additional efforts may lead to a more accurate emissions inventory – this includes estimates of sulfur dioxide (SO_2) and particulate matter (PM) emissions from certain operations. Second, this

study will asses the sources in the 2018 inventory that have significant potential for reducing emissions through various control methods and technologies, and the potential emissions reductions from the most promising controls will be evaluated for each western state.

TECHNICAL APPROACH

The study will be divided into three tasks. First we have identified several areas where an evaluation will be conducted to improve the 2002 emissions inventory. These include improvements in emissions of VOC from various equipment types and efforts targeted at other portions of the inventory such as the NOx, PM, and SO2 from drill rigs and compressor engines. Task 2 will focus on the identification of a range of control technologies that can be employed to significantly reduce emissions from oil and gas operations and equipment. The third task will be focused on improvements to the 2018 emissions inventory, and estimates of potential reductions in emissions from implementation of controls. This will include an update on the 2018 emissions based on revised 2002 estimates as well as developing a range of 2018 emissions based on key uncertainties and assumptions in the forecast methodology.

To provide an overview of the emissions estimates made to data and on the areas that will be addressed in this work, Table 1 identifies the oil and gas equipment and pollutants that were addressed in the WRAP Emissions inventory, the equipment and pollutants that were addressed in the NMED work, and the equipment and pollutants that will be addressed under this proposed study. . Work proposed for this study is identified separately from work previously conducted for WRAP or NMED. Where work is identified for the same categories that were previously addressed, it is intended that improvements to the same emission estimates will be provided under this study.

Table 1. Equipment and pollutants addressed by WRAP, New Mexico work, and the proposed effort.

Equipment	NOx	PM	SO_2	VOCs
Drill Rigs	X		X	
	X		X	X
	X	X		
Compressor Engines	X			
	X		X	X
	X	X	X	
CBM Engines	X			
	X			
Artificial Lift Engines	X		X	X
Salt Water Disposal Engines	X		X	X
Tanks				X
				X
Fugitives-Oil and Gas				X
				X
Glycol Dehydration Units				X
				X
Heaters	X			
	X		X	

Pneumatic Devices	X			X
				X
Completions	X			X
			X	
Venting				X
				X

WRAP	NW NM	Proposed Effort

Task 1. 2002 Inventory Improvements

Improvements to the WRAP 2002 Emissions Inventory are addressed under this task. Potential improvements for specific sources and process are discussed below. However, depending on our preliminary findings, it may not be appropriate or possible to update the WRAP inventory for each area. In addition, because the available resources for improvements to the 2002 emissions estimates are limited, the improvements may be limited to a subregion(s) of the WRAP and/or to a subset of emission sources or processes. The first project deliverable will discuss the specifics of the potential improvements, and will recommend a work plan with specific recommended improvements to be implemented under Task 1 based on the relative magnitudes of the potential changes. This deliverable will discuss our preliminary findings for each category or emissions source discussed below in order of priority, and will include recommendations for the work that can be accomplished with available resources. This recommended work plan will be reviewed with the WRAP Stationary Sources Joint Forum (SSJF); we will work with the SSJF to revise the work plan in response to SSJF comments.

Drill Rig NOx and PM Emissions

Drilling emissions for the existing WRAP 2002 NOx emissions inventory were based on data from a survey of drilling in Southwest Wyoming. The final estimates used several activity indicators from the drill permit data combined with the emission factors derived from the Wyoming survey to address local conditions. Drilling companies provided these data for 218 wells drilled in the Jonah-Pinedale area of Wyoming where intense drilling has occurred in the past several years. Several assumptions were necessary to apply this approach to the broader WRAP region due to the variation in drilling operations. These include the assumption that emissions from the prime mover on a drill rig for drilling a well are dependent upon the depth of the well, the composition of substrate and the characteristics of the engine.

The methodology used for estimating emissions in a particular formation was based on the average duration of well preparation activities and average well depth within the formation. Where no information was available for depth and duration, an average depth and duration of all wells in the particular formation was used. Another important assumption was the total duration of preparation activities. The actual information on the total duration was not available because the date that drilling ceased was not available. This is due to the fact that the completion date is not the date that the drilling ceased. Therefore we assumed that the capacity of the equipment used to drill a well is dependent upon the depth of the well. This information was then used to scale the emission factor for the Jonah-Pinedale area to the appropriate formation. In comparing

our work for NW NM with the previous WRAP inventory, we found that significantly more wells were drilled in Wyoming than in NW NM but emissions in NW NM were higher than Wyoming. This occurs because many of the Wyoming wells were drilled quickly and to a shallow depth, as commonly occurs for the Powder River Basin wells.

To improve the NOx emissions estimates, we propose to further investigate how long it actually takes to drill a well compared to the Jonah-Pinedale field where the original emission rates were determined. To evaluate the accuracy of the previous calculations, we propose to review a selected number of paper drill permits to get a sense of the time it takes to drill a well compared to the original estimates for a few focused areas. We also propose to look at the use of "air packages" for drilling. A recent trend in drilling is to drill using both gas and air to boost the compression for drilling. Air packages can significantly increase the rate of penetration. Again our evaluation will look at the significance of this practice to determine if this is the basis for wells in Wyoming being drilled so quickly. Finally, we will determine if the Oil and Gas Commissions (OGCs) have any information to refine the estimates from rotary versus workover rigs, as this information was probably not well accounted in the previous inventory. Emissions from workover rigs do not have the same constant, heavily loaded activity profile as rotary rigs so improving this information will be useful. Therefore, if we can get a count of the occurrences from the OGCs we will determine if the emissions estimates can be improved for specific areas and include a recommendation in our work plan for which areas will benefit from the information received.

PM emissions from drilling rigs (and compressor engines) were not included in either the previous WRAP work or the NW NM work. We will determine the basis for the emission factors provided in EPA's NONROAD2004 model and we will also contact the manufacturers to determine emission factors that we can then apply to the drilling rigs and compressor engines.

Compressor Engine NOx, PM, and SO2 Emissions

For NOx, we will assess the potential for improvements in wellhead compression given our previous assumptions that well head compression is used as opposed to larger centralized stations. The question to address here is whether well-head compression is used or are only large centralized stations used and is field formation pressure a big determinant of compression practices. As discussed above, we will estimate PM emissions using EPA's NONROAD2004 model and we will also contact the manufacturers to determine emission factors that we can then apply to the compressor engines

To determine SO_2 emissions from drilling rigs, compressors, flaring and heaters for the NMED, the method used by the NONROAD model for calculating missions based on fuel consumption and fuel sulfur content was used to derive the appropriate emission rate, based on fuel consumption data obtained from a survey of the producers. We will look at the possibility of using fuel consumption data developed from the NW NM survey that determined overall fuel consumption for new wells and workovers for both the Rio Arriba and San Juan counties. Our primary focus will be on areas with significant sour gas production to look at H_2S concentrations and potential revisions to compressor engine SO2 emissions. If such information can be obtained, we will include an estimate of the significance and resources necessary to determine

SO2 emissions to our recommended work plan.

CBM Engine NOx Emissions

For CBM engines, we will review the original methodology and assumptions used to estimate NOx emissions. We will include a recommendation in our proposed work plan if a more focused study of the assumptions we made for coal bed methane (CBM) fields would be appropriate. The previous inventories have not attributed many emissions to CBM development so we will reevaluate the assumptions made to derive those estimates and recommend adjustments as appropriate.

Fugitive Dust Emissions

We will look at the feasibility of evaluating dust emissions from vehicle traffic on unpaved road and for drilling wells to the extent that appropriate activity information and emission factors can be obtained. BP (Reid Smith) has provided some information on vehicle traffic on unpaved roads for vehicles performing routine well maintenance; we will evaluate these data for estimating reentrained road dust emissions. With regard to dust emissions from construction activities associated with drilling wells (i.e., road and well pad construction), some quantification of the area disturbed by wells may be available; however, it is uncertain at this point. Another area is new wells but again information may be difficult to obtain One method that we will look into is the use of satellite photos (such as those available from Google Earth) to determine those areas with relatively large numbers of unpaved roads associated with oil and gas production. Again, this will be added to our recommended work plan. However, because this is a whole new area of work, and because we anticipate that large resources would be required for this effort, we will not likely be able to evaluate dust emissions in addition to the other emissions of interest

VOC emissions - Venting, Glycol Dehydrators, and Fugitives

VOC emissions were estimated in the 2002 WRAP inventory for tanks including flashing, working and breathing losses, glycol dehydration units, pneumatic devices and completion activities (flaring and venting). The emission factors used for estimating VOC emissions were those developed by the Wyoming DEQ and the Colorado DPHE. Because these emission factors are based on production, well-specific production data were used to estimate the emissions. Adjustments were necessary to account for the lack of specific data such as the oil versus gas production where not available (e.g., Colorado), and the identification of coalbed methane versus traditional gas wells where not available (e.g., Northwest New Mexico).

Emissions of venting and fugitives will be evaluated to determine if significant improvements can be made to the previous emissions estimates using the procedures and assumptions from work conducted for the NMED. For venting emissions, BP (the largest producer in NW NM) has provided their estimates of venting flow rates. While the venting rates may differ from other producers, these estimates provide an updated method for estimating venting emissions. Comparing BP's venting rates to similar gas productions we arrived at an estimate of the volume of gas vented per volume of gas produced for Northwest New Mexico (NW). A similar

approach will be evaluated to estimate emissions for other areas. An attempt will also be made to obtain venting rates from other large producers.

Emissions from fugitives were estimated for NMED by defining a typical well setup for oil, conventional gas and CBM wells. Typical well diagrams were developed to provide an estimate of equipment counts for conventional wells. Emission rates were estimated for each gas well by combining the equipment counts and emission rates from EPA. We propose to evaluate this approach for specific focus areas to improve existing estimates. The criteria for selecting areas to focus on will include anticipated growth in oil and gas exploration and production, and areas with different formation pressures to get a sense of how such pressures affect venting.

In the NW NM work, we did not estimate emissions for glycol dehydrators because it was not practical given the low field pressures in the San Juan Basin. Any dehydration would be performed in gas plants and should therefore be accounted for in the point source inventory. For this effort, we propose to check the appropriateness of this assumption by reevaluating if field dehydration is performed in specific areas of interest.

Potential improvements identified under this task will be summarized, with a recommended work plan, in a memorandum to the WRAP SSJF Oil and Gas Work Group. Most of the improvements discussed above (with the exception of PM emissions from drill rigs and compressors) would be limited to specific focus areas. The work plan will identify which inventory revisions can be made to the whole WRAP region.

At the completion of the emission revisions, we will prepare a summary technical memorandum that will include all updates made, the data and assumptions used to generate updated emissions, and a summary comparison by state of the emissions with the previous inventory. Spreadsheets will also be provided with a comparison of previous and revised emissions by county for all sources and pollutants revised.

Task 2. Control Strategy Evaluation

Under this task, we will evaluate potential control technology that can be applied to the sources of NOx, PM, SO_2 and VOC as listed in Table 2.

Table 2. Control technology evaluations to be conducted.

Equipment	NOx	PM	SO_2	VOC
Drill Rigs	x	x	x	
Compressor Engines	x	x	x	
CBM Engines	x	x	x	
Tanks				x
Glycol Dehydration Units				x
Heaters	x			
Pneumatic Devices				x

Completion-Flaring and Venting	x			x

For each of the sources identified in Table 2, we will identify the current baseline of controls for each state including current federal and state regulations and requirements that have been included by states under their permitting programs; we will also identify any controls that are "in the works" or anticipated in the near future by the states. This will include an assessment of which engines are covered under federal nonroad and/or stationary source rules. We will also consider fleet turnover, i.e., how rapidly the fleet of older uncontrolled engines can be expected to be replaced by newer cleaner engines. In many cases, these sources are not controlled due to the size and location of the equipment. Once the current levels of controls have been identified, we will evaluate the potential for additional controls beyond current requirements. In evaluating the potential for additional controls, we will evaluate a range of viable control options. For each control option, we will evaluate the range of control efficiencies, the range of costs and cost-effectiveness and the potential for applying the controls to existing equipment (i.e., retrofit applications) versus new equipment. Finally, an estimate of the potential emission reductions will be provided for each control option for each state. The results of this effort will therefore be a menu of control options for each state.

Sources of information that will provide significant information include the EPA Natural Gas Star Program, Colorado's recent oil and gas control analysis, the Four Corners Air Quality Task Force, Argonne National Lab's Strategic Emissions Reduction Plan (SERP), and recent work by ENVIRON on retrofitting compressor engines in northeast Texas. Additional information that will be used in this task includes published reports on emission controls including EPA's Alternative Control Technique Documents for IC Engines, the E.H. Pechan & Associates Air Control Net Documentation, the California Air Resources Board (CARB) distributed generation regulation, as well as the CARB portable equipment registration program.

For each control measure evaluated, a one page summary will be prepared that provides a description of the control measure, an assessment of feasibility (current and future), the range of control efficiencies, the range of costs and cost-effectiveness and the potential for applying the controls to existing equipment (i.e., retrofit applications) versus new equipment. We will also provide a summary table of all controls for each piece of equipment identified, and a summary table of the potential emission reductions for each control option for each state.

Task 3. 2018 Emissions

The existing 2018 WRAP oil and gas emissions estimates were developed by projecting 2002 emissions based on a combination of production data and well based data. The dominant method used was to develop growth factors that were based on projecting 2002 oil and gas emissions based on the number of new oil, gas and possibly CBM wells anticipated, as provided in Resource Management Plans (RMPs). The second method was to look at anticipated oil and gas development using Department of Energy regional production forecasts. Under this task we will explore the sensitivity of switching several emission categories to production-based growth

factors rather than well count-based factors. This will require a focused study of the different areas to determine the differences in emissions growth. We will evaluate selected older RMPs to determine the accuracy of previous predictions. In looking at well counts in the Powder River Basin EIS, for example, we found a range of possible wells; we used the 'most likely' scenario, which was in the middle of the well counts. It is important to recognize that the upper end of the range contained tens of thousands more wells. We will include in the range of projection factors a scenario that uses the upper ranges of possible wells. We will also explore the impact of the under-prediction that has been common in RMPs and Environmental Impact Statements. We will review areas where we have recent well counts from state OGCs and compare those counts to the RMP forecasts and to the projection factors that we previously developed. In developing the updated factors, we will look at a range of estimates based on the information we obtain from assessing earlier predictions. We will include the suggested approach for modifications to the projection factors in the first project deliverable, the recommended work plan, and we will review those with the WRAP Oil and Gas Working Group prior to developing the final 2018 inventory.

We will recommend a control strategy that is a combination of the most promising controls based on feasibility and cost-effectiveness. We will then estimate the emissions reductions that could be achieved in each western state if this control strategy were in place in the year 2018. We will account for upcoming controls, if any, that have been adopted by states since the previous inventory, as well as controls "in the works", if any.

The deliverables for this task will include a technical memorandum describing the work that was performed, the data used, and the assumptions made. The memo will include summary tables and comparisons of previous and revised emissions by state. We will also provide spreadsheets with previous and revised projected emissions by county and a comparison of the two sets of estimates. for all sources and pollutants.

COSTS

ENVIRON's estimated costs for the three tasks are provided below. As discussed with the WRAP Oil and Gas Working Group, the breakdown by tasks shows a considerable amount of time for Task 2 as compared to Task 1 and Task 3.

Task	Description	Cost
1	2002 EI Improvements	30,500
2	Control Strategy Evaluation	45,000
3	2018 EI Improvements	24,500
Total		100,000

DELIVERABLES AND SCHEDULE

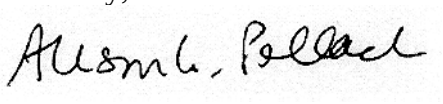
The proposed schedule of deliverables for the project is provided in Table 3. This schedule assumes a contract start date of September 1, 2006.

Table 3. Proposed schedule of deliverables.

Task	Milestone	Deliverable	Due Date
1-3	Recommended Work Plan	Technical Memorandum	October 13, 2006
1	2002 EI Improvements	Memorandum to WRAP on preliminary Findings	December 20, 2006
2	Control Technology Evaluation	Memorandum on Control Options Evaluated	January 20, 2007
3	2018 EI Improvements	Technical memorandum on revised 2018 emissions, control strategy emissions reductions	March 3, 2007
	Draft Final Report		March 24
	Final Report		Two weeks after receipt of comments on draft report

Please let me know if you have any questions about the proposed work, deliverables, schedule or budget.

Sincerely,



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