

MEMORANDUM

Date: **July 18, 2019**

To: **Western Regional Air Partnership Oil (WRAP) and Gas Working Group (OGWG)**

From: **John Grant and Amnon Bar-Ilan**

Subject: **Gas Composition Profile Results from the WRAP OGWG Survey**

Gas composition profile data were collected as part of the Western Regional Air Partnership (WRAP) Oil and Gas Working Group (OGWG) baseline emission inventory survey efforts documented in the Baseline Report¹. Ramboll reviewed, compiled, and analyzed the gas composition data to develop representative gas composition profiles for specific basins, well types, and emission streams.

Over 300 gas composition profiles were submitted by operators and state agencies in response to the WRAP OGWG survey effort. The steps taken to develop representative gas composition profiles are described below.

1. Ramboll reviewed and converted the gas composition profile data into spreadsheet format. Gas composition profiles were provided in many different formats. Each profile was reviewed and transferred into EXCEL spreadsheet format in the most efficient manner feasible. For example, some profiles were provided as spreadsheet model output (e.g., ProMax model output). For these, Ramboll reviewed the model output and copied applicable gas composition data into the master spreadsheet. Some profiles were provided as a laboratory output PDF in picture format; for these Ramboll performed manual spreadsheet data entry of applicable profiles. Some profiles were provided as PDF selectable text format; these were transferred to an EXCEL file via visual basic macro and formatted for inclusion in the master spreadsheet.
2. Ramboll reviewed the profiles to determine whether any profiles needed to be removed from consideration in estimating representative basin-wide average profiles. Samples with species that were identified as outliers were investigated to determine whether they should be removed. Outliers were removed if the sample was not valid. Sample invalidation was primarily due to the wrong sample media (i.e., liquid rather than gas).
3. Ramboll compiled average gas composition profiles weighting by activity surrogate. For produced gas, the activity surrogate is primary gas (for gas wells) and associated gas (for oil wells). For tank flash gas, the activity surrogate is condensate production (for gas wells) and oil production (for oil wells).

¹ Grant et al., 2019. "Circa-2014 Baseline Oil and Gas Emission Inventory for the WESTAR-WRAP Region". Prepared for: Western Regional Air Partnership Oil and Gas Working Group. July 2019.

A vast majority of gas composition profiles were received for Williston Basin oil well produced gas and flash gas. Gas compositions received for basins other than Williston Basin and Central Montana Uplift were not received from sufficient survey respondents to develop a representative gas composition profile. Publishing a single operator's data is not permissible under this effort according to the data confidentiality agreements made with operators for survey data collection.

Table 1 shows the representative gas compositions compiled in this effort. The representative compositions are provided by well type (oil, gas, and coalbed methane), but independent of spud type (horizontal, vertical, and directional) because the emission inventory distinguishes emissions by well type, but not by spud type.

Table 1. Representative Gas Compositions.

Basin (State)	Williston (ND)	Basin (State)	Williston (MT)	Basin (State)	Williston (ND)	Basin (State)	Williston (MT)	Basin (State)	Central Montana Uplift (MT)
Well Type	Oil	Well Type	Oil	Well Type	Oil	Well Type	Oil	Well Type	Gas
Profile Type	Flash Gas	Profile Type	Flash Gas	Profile Type	Produced Gas	Profile Type	Produced Gas	Profile Type	Produced Gas
No. Samples	53	No. Samples	126	No. Samples	87	No. Samples	65	No. Samples	6
Percent of Activity Surrogate	25%	Percent of Activity Surrogate	43%	Percent of Activity Surrogate	60%	Percent of Activity Surrogate	44%	Percent of Activity Surrogate	85%
Component	Mole Percent	Component	Mole Percent	Component	Mole Percent	Component	Mole Percent	Component	Mole Percent
Methane	12.5756	Methane	17.0443	Methane	55.2939	Methane	56.3874	Methane	93.3852
Ethane	29.8529	Ethane	31.5896	Ethane	19.2455	Ethane	19.0020	Ethane	1.8075
Propane	31.6877	Propane	31.5435	Propane	11.5017	Propane	10.8450	Propane	0.4100
i-Butane	3.8695	i-Butane	3.0899	i-Butane	1.4178	i-Butane	1.2089	i-Butane	0.0644
n-Butane	12.1955	n-Butane	9.1097	n-Butane	4.3794	n-Butane	3.6688	n-Butane	0.0845
i-Pentane	1.9019	i-Pentane	1.5012	i-Pentane	0.9310	i-Pentane	1.0981	i-Pentane	0.0242
n-Pentane	2.6252	n-Pentane	2.0560	n-Pentane	1.3628	n-Pentane	1.1682	n-Pentane	0.0154
Other Hexanes	0.6923	Hexanes+	0.8520	Other Hexanes	0.3549	Other Hexanes	0.2770	Hexanes	0.0245
Heptanes	0.5425	Benzene	0.0855	Heptanes	0.4707	Heptanes	0.2628	Oxygen	0.0024
Octanes+	0.2394	Toluene	0.0559	Octanes+	0.1064	Octanes+	0.1507	Nitrogen	3.9598
Benzene	0.0750	Ethylbenzene	0.0055	Cyclohexane	0.1653	Cyclohexane	0.0417	Carbon Dioxide	0.2221
Toluene	0.0565	Xylenes	0.0171	Cyclopentane	0.1145	Cyclopentane	0.0188		
Ethylbenzene	0.0089	n-Hexane	0.3960	Methylcyclohexane	0.0612	Methylcyclohexane	0.0268		
Xylenes	0.0230	Carbon Dioxide	1.1450	2,2,4-Trimethylpentane	0.0081	2,2,4-Trimethylpentane	0.0046		
n-Hexane	0.4438	Nitrogen	1.5087	Benzene	0.0698	Benzene	0.0672		
Carbon Dioxide	0.7021			Toluene	0.0506	Toluene	0.0576		
Nitrogen	2.5082			Ethylbenzene	0.0318	Ethylbenzene	0.0425		
				Xylenes	0.0678	Xylenes	0.0507		
				n-Hexane	0.3705	n-Hexane	0.1976		
				Carbon Dioxide	0.7534	Carbon Dioxide	1.1465		
				Nitrogen	3.2294	Nitrogen	4.2766		
				Hydrogen Sulfide	0.0135	Hydrogen Sulfide	0.0006		