Attachment A

Earth System Sciences LLC Analysis in Support of API Comments April 23, 2018
BLM Proposed Rule "Waste Prevention, Production Subject to Royalties, and Resource Conservation; Rescission or Revision of Certain Requirements"
83 Fed. Reg. 7924 (Feb. 22, 2018) (RIN 1004-AE53)

The data presented in the tables in this Attachment A, are compiled by Earth System Sciences of Albuquerque, New Mexico (ESS).

Table 1: From state well databases, and from its own previous modeling efforts, ESS provides a table of the estimated number of Federal and Indian wells in each state and the estimated number that would be impacted by the LDAR requirement from the 2016 BLM rule. ESS finds a total of 81,593 federal and tribal wells, of which 63,152 are determined to be impacted by the BLM Rule. Wells are considered to be impacted by the Rule for LDAR if they were not subject to EPA NSPS OOOOa, not subject to equally or more stringent regulations of the states where the wells are located, and were not identified as wellhead only wells [1]. The 2026 population of wells includes these restrictions, and also removes wells that are predicted to be shut-in or plugged and abandoned by the end of 2026. Well lifetimes were estimated using historical data of well lifetimes from each state. Using the criteria that wells were classified as marginal if they produced less than 15 BOE/day, or if they generated less than $505/day in revenue, assuming a gas price of $2.80/Mcf and an oil price of $50.50/BBL (prices from RIA Table 7-5). As Table 1 of this Attachment shows, the percent of wells classified as marginal by virtue of producing less than 15 BOE per day that were impacted by the LDAR requirements in each state ranges as follows for the six states with the largest numbers of Federal and Indian wells: North Dakota 10% (138 out of 1,383 wells); Montana 65% (1,270 out of 1,961 wells); Colorado 60 % (4,480 out of 7,416 wells); Utah 66% (4970 out of 7,527 wells); Wyoming 67% (9,746 out of 14,458 wells); and New Mexico 80% (20,430 out of 25,529 wells). As a review of Table 1 will show similar, though slightly different, percentages were found for wells classified as marginal by virtue of producing less than $505 per day in revenue.

Table 2: Next, using the assumptions from Table 7-12d from the RIA, ESS generated data for LDAR emissions reductions and the costs of achieving those reductions, with both emissions reductions and recovered gas scaled by two assumed rates for reduced leak frequency (a base case of 1.18% leak frequency and an alternative case of 0.4% leak frequency[2]), as well as for both semi-annual and annual inspection frequencies. The estimates for net annual cost take into account the value of recovered gas sold available for sales assuming a $2.80 /Mcf gas price [RIA Table 7-5]. These data are also organized by state and estimated both for 2018 and for 2026. For the 1.18% leak frequency, emissions reductions for 2018 are estimated to be 57,900 tons per year (tpy) for annual LDAR inspections (at a 2018 net annual cost of $32,355,373 or $683 per ton CH4), and 85,749 tpy for inspections at a semi-annual frequency (at a 2018 net annual cost of 58,234,883 or $813 per ton CH4). The "marginal cost per ton of methane emission reduction" for moving from annual inspections to semi-annual inspections is $929 for each additional ton of reduction estimated by BLM. API also notes that BLM used only 80% of the annual inspection cost for adding a second inspection in their semi-annual cost estimate. Doubling the number of

[1] For the purpose of this analysis, Federal and Tribal wells in CO, ND and MT were not directly identified by a state database as having federal or tribal mineral interests. Wells were identified by overlaying surface well locations with federal minerals ownership, surface management, or tribal surface ownership.

[2] Both a study commissioned by the California Energy Commission (KUO 2012) and a survey conducted by ERM on behalf of API (ERM 2018) found component leak frequencies of ~ 0.4%.

inspections per annum should double the cost per annum for an LDAR survey and repair. The cost for semi-annual inspections would move from $58,234,883 to $64,710,746 and the cost per marginal ton of methane reduction would be $1,162. As Table 2 shows, these costs increase significantly for the alternative case of a 0.4% leak frequency, because of the spread of costs attributable to the LDAR inspections over fewer tons CH4 recovered.

Table 3: Finally, ESS estimated the emission reductions due to control requirements other than LDAR in the 2016 BLM rule from the Federal and Indian wells as estimated in Table 1 above, scaling the BLM's published emission reduction estimates to account for the lower well count. Table 3 provides estimates of the numbers of wells that would be subject to the tank, high bleed controller, and pneumatic pump emission reduction requirements under the 2016 Rule for years 2018 and 2026. In the data presented in Table 3, estimated emissions are scaled by multiplying BLM's emission reductions by the ratio of the well count in 2018 and 2026 for each source type to the well count shown in Table 1 for Federal and Indian wells (81,593), with Intermediate years linearly interpolated between 2018 and 2026. These calculations show that the methane/CH4 reductions integrated from 2018 to 2026 for tanks are 54 percent less than estimated by BLM, for high bleed controllers 58 percent less than estimated by BLM, and for pneumatic pumps 49 percent less than estimated by BLM.

Wells impacted by BLM LDAR requirements

	New Mexico	Wyoming	Utah	Colorado[1]	Montana[1]	North Dakota[1]	Other States[2]	Total
Federal and Tribal Wells	34,582	20,893	8,212	9,011	2,471	1,546	4878	81,593
Active wells impacted by BLM VF Rule [2018][3]	25,529	14,458	7,527	7,416	1,961	1,383	4878	63,152
Active marginal wells impacted by BLM VF Rule [2018][4]	20,430	9,746	4,970	4,480	1,270	138		
Percent of wells impacted classified as marginal [2018][4]	80%	67%	66%	60%	65%	10%		
Active marginal wells impacted by BLM VF Rule [2018][5]	22,715	11,201	5,624	5,639	1,123	111		
Percent of wells impacted classified as marginal [2018][5]	89%	77%	75%	76%	57%	8%		
Active wells impacted by BLM VF Rule [2026][6]	12,282	4,471	3,433	3,402	461	727	4878*	24,776
Average Age of Federal Wells in 2018 (years)	26	19	13	17	17	26		
Average Age of Tribal Wells in 2018 (years)	33	26	16	25	26	6		

[1]Federal and Tribal wells in these states were not directly identified by a state database as having federal or tribal mineral interests. Wells were identified by overlaying surface well locations with federal minerals ownership, surface management, or tribal surface ownership.

[2]Well counts in 'other states' were estimated by randomly assigning the number active wells in each state to account for reported federal and tribal gas and oil production. Identification of individual wells was not attempted for these states.

[3]Wells were considered impacted by the BLM Venting and Flaring rule for LDAR if they were not subject to OOOOa, not subject to equally or more stringent state regulations, and were not identified as wellhead only wells.

[4] Marginal wells were classified as wells with less than 15 BOE/day production.

[5] Marginal wells were classified as wells with less than $505/day in revenue assuming a gas price of $2.80/Mcf and an oil price of $50.50/BBL. Prices from RIA Table 7-5.

[6] Wells that were predicted to shut-in or be plugged and abandoned by the end of 2026 were removed from the active wells identified in 2018. Well lifetimes were estimated using historical records of well lifetime, and do not take into account any technological advancements that may increase the lifetime of wells in the future.

*Because indvidual wells in other states were not identified, we did not project well shut-ins or P & A.

LDAR Emissions and Costs - Base Case (1.18% Leak Frequency)	Inspection Frequency	New Mexico	Wyoming	Utah	Colorado*	Montana*	North Dakota*	Other States	**TOTALS**
2018 Emission Reductions (tpy)	Annual	24,556	12,235	6,468	7,901	1,204	771	3,951	**57,088**
	Semi-Annual	36,896	18,366	9,712	11,868	1,809	1,163	5,934	**85,749**
2026 Emission Reductions (tpy)	Annual	11,836	4,209	3,011	3,722	295	405	3,951	**27,430**
	Semi-Annual	17,786	6,321	4,522	5,591	443	611	5,934	**41,208**
2018 Net Annual Cost	Annual	$ 12,835,168	$ 7,540,731	$ 3,912,390	$ 3,612,142	$ 1,096,474	$ 785,775	$ 2,572,694	**$ 32,355,373**
	Semi-Annual	$ 23,171,212	$ 13,533,231	$ 7,025,826	$ 6,557,304	$ 1,946,724	$ 1,391,649	$ 4,608,938	**$ 58,234,883**
2026 Net Annual Cost	Annual	$ 6,287,251	$ 2,262,812	$ 1,773,274	$ 1,678,421	$ 255,898	$ 413,072	$ 2,572,694	**$ 15,243,422**
	Semi-Annual	$ 11,343,230	$ 4,080,709	$ 3,187,345	$ 3,048,779	$ 454,818	$ 731,564	$ 4,608,938	**$ 27,455,383**
2018 Cost per ton CH4	Annual	$ 523	$ 616	$ 605	$ 457	$ 910	$ 1,019	$ 651	**$ 683**
	Semi-Annual	$ 628	$ 737	$ 723	$ 553	$ 1,076	$ 1,196	$ 777	**$ 813**
2026 Cost per ton CH4	Annual	$ 531	$ 538	$ 589	$ 451	$ 869	$ 1,019	$ 651	**$ 664**
	Semi-Annual	$ 638	$ 646	$ 705	$ 545	$ 1,027	$ 1,196	$ 777	**$ 791**

These data were generated using the assumptions from table 7-12d from the RIA. Net annual cost takes into account the value of recovered gas sold available for sales assuming a $2.80 /Mcf gas price [RIA Table 7-5].

LDAR Emissions and Costs - Alternative Case (0.4% Leak Frequency)	Inspection Frequency	New Mexico	Wyoming	Utah	Colorado*	Montana*	North Dakota*	Other States	**TOTALS**
2018 Emission Reductions (tpy)	Annual	8,324	4,148	2,193	2,678	408	261	1,339	**19,352**
	Semi-Annual	12,507	6,226	3,292	4,023	613	394	2,012	**29,068**
2026 Emission Reductions (tpy)	Annual	4,012	1,427	1,021	1,262	100	137	1,339	**9,298**
	Semi-Annual	6,029	2,143	1,533	1,895	150	207	2,012	**13,969**
2018 Net Annual Cost	Annual	$ 15,471,596	$ 8,854,232	$ 4,606,814	$ 4,460,167	$ 1,225,918	$ 868,813	$ 2,997,006	**$ 38,484,546**
	Semi-Annual	$ 27,134,452	$ 15,506,389	$ 8,069,136	$ 7,832,529	$ 2,140,877	$ 1,516,203	$ 5,246,275	**$ 67,445,861**
2026 Net Annual Cost	Annual	$ 7,558,103	$ 2,714,668	$ 2,096,559	$ 2,077,910	$ 287,561	$ 456,713	$ 2,997,006	**$ 18,188,521**
	Semi-Annual	$ 13,253,592	$ 4,759,844	$ 3,673,098	$ 3,649,538	$ 502,328	$ 797,027	$ 5,246,275	**$ 31,881,703**
2018 Cost per ton CH4	Annual	$ 1,859	$ 2,135	$ 2,101	$ 1,665	$ 3,003	$ 3,323	$ 2,237	**$ 2,332**
	Semi-Annual	$ 2,170	$ 2,491	$ 2,451	$ 1,947	$ 3,490	$ 3,845	$ 2,608	**$ 2,715**
2026 Cost per ton CH4	Annual	$ 1,884	$ 1,902	$ 2,054	$ 1,647	$ 2,880	$ 3,324	$ 2,237	**$ 2,275**
	Semi-Annual	$ 2,198	$ 2,221	$ 2,396	$ 1,926	$ 3,346	$ 3,845	$ 2,608	**$ 2,649**

These data were generated using the assumptions from table 7-12d from the RIA. Net annual cost takes into account the value of recovered gas sold available for sales assuming a $2.80 /Mcf gas price [RIA Table 7-5]. Both emission reductions and recovered gas were scaled by the reduced leak frequency (0.4% vs. 1.18%)

Well Counts								
	New Mexico	Wyoming	Utah	Colorado*	Montana*	North Dakota*	Other States	Total
# Fed & Tribal wells with tank requirements [2018]	22,919	13,015	5,000	2,353	1,633	386	4,878	50,184
# Fed & Tribal wells with tank requirements [2026]	10,500	4,033	2,299	982	320	189	4,878	23,201
#Fed & Tribal wells with high bleed requirements [2018]	22,919	12,273	1,158	2,353	1,633	386	4,878	45,600
#Fed & Tribal wells with high bleed requirements [2026]	10,500	3,813	495	982	320	189	4,878	21,177
#Fed & Tribal wells with pneumatic pump requirements [2018]	22,919	13,015	5,691	6,456	1,633	386	4,878	54,978
#Fed & Tribal wells with pneumatic pump requirements [2026]	10,500	4,033	2,625	2,857	320	189	4,878	25,402

BLM Methane & VOC Reductions (developed from RIA)										
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
BLM Methane Reductions - Tanks	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	7,100	71,000
BLM VOC Reductions - Tanks	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	32,500	325,000
BLM Methane Reductions - Hi-Bleed Controllers	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	180,000
BLM VOC Reductions - Hi-Bleed Controllers	64,900	64,900	64,900	64,900	64,900	64,900	64,900	64,900	64,900	64,900	649,000
BLM Methane Reductions - Pneumatic Pumps	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	27,000	270,000
BLM VOC Reductions - Pneumatic Pumps	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	7,000	70,000

Scaled Methane & VOC Reductions[1]											
	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	Total
Scaled Methane Reductions - Tanks	4,367	4,132	3,897	3,662	3,428	3,193	2,958	2,723	2,488	2,019	32,868
Scaled VOC Reductions - Tanks	19,989	18,914	17,840	16,765	15,690	14,615	13,541	12,466	11,391	9,241	150,452
Scaled Methane Reductions - Hi-Bleed Controllers	10,060	9,521	8,982	8,443	7,905	7,366	6,827	6,288	5,749	4,672	75,813
Scaled VOC Reductions - Hi-Bleed Controllers	36,271	34,328	32,385	30,443	28,500	26,558	24,615	22,672	20,730	16,844	273,346
Scaled Methane Reductions - Pneumatic Pumps	18,193	17,214	16,235	15,257	14,278	13,299	12,321	11,342	10,363	8,406	136,908
Scaled VOC Reductions - Pneumatic Pumps	4,717	4,463	4,209	3,955	3,702	3,448	3,194	2,940	2,687	2,179	35,495

[1]Emissions are scaled by multiplying BLM's emission reductions by the ratio of the well count in 2018 and 2026 for each source type to the BLM+Tribal well count (81,593); Intermediate years are linearly interpolated between 2018 and 2026.

Summary Comparison - Methane & VOC Emissions Reductions; BLM 2016 Rule			
	BLM	ESS Scaled	% Delta
BLM 2016 Rule Methane Reductions - Tanks	71,000	32,868	-54%
BLM 2016 Rule Methane Reductions - Hi-Bleed Controllers	180,000	75,813	-58%
BLM 2016 Rule Methane Reductions - Pneumatic Pumps	270,000	136,908	-49%
BLM 2016 Rule VOC Reductions - Tanks	325,000	150,452	-54%
BLM 2016 Rule VOC Reductions - Hi-Bleed Controllers	649,000	273,346	-58%
BLM 2016 Rule VOC Reductions - Pneumatic Pumps	70,000	35,495	-49%