

## Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2015: Update to Storage Segment Emissions Incorporating an estimate for the Aliso Canyon Leak

In fall of 2015, a well in a California storage field began leaking methane at an initial average rate of around 50 metric tons (mt) of methane (CH<sub>4</sub>) an hour, and continued leaking until it was permanently sealed in February of 2016.<sup>1</sup> After considering approaches and stakeholder feedback, the EPA included this emission source in its 2017 GHGI (which includes estimates from 1990-2015).<sup>2</sup>

The EPA applied the California Air Resources Board (ARB) estimate of the methane release from the leak.<sup>3</sup>

ARB calculated emissions for two phases of the leak. The first phase corresponds roughly to the first month of the leak (late October-late November 2015), a time of heightened activity at the well. ARB’s estimate for emissions in Phase I is 48,450 (+/- 8,810) metric tons of methane. Phase II covers the remainder of the leak period (around 2.5 months), when less site-level activity was occurring. ARB’s estimate for emissions in Phase II is 51,200 (+/- 2,970) metric tons of methane. The resulting total estimate of emissions for the duration of the leak is 99,650 (+/- 9,300) metric tons of methane.

For the 2015 estimate in the 2017 GHGI, the EPA calculated emissions from Aliso Canyon as the sum of Phase I emissions (48,444 metric tons) and the portion of Phase II emissions that occurred in 2015.

**Table 1. Use of ARB leak calculations to develop 2015 estimate for U.S. GHGI<sup>4</sup>**

Phase	Measurement Flight Date	Leak Rate (mt CH <sub>4</sub> per hour)	Assumed number of days at this leak rate	Leaked methane for this period (mt CH <sub>4</sub> )
Phase I	Three flights over 11/7-11/28/2015	46.9-60.4	37.0 (10/23-11/27)	48,445
Phase II 2015	11/28/2015	54.7	3.0 (11/29-12/1)	3,938
	12/4/2015	48.8	7.0 (12/2-12/8)	8,198
	12/12/2015	38.0	9.5 (12/9-12/18)	8,664
	12/23/2015	28.1	13.5 (12/18-12/31)	9,104

<sup>1</sup> For more information, please see Ensuring Safe and Reliable Underground Natural Gas Storage, Final Report of the Interagency Task Force on Natural Gas Storage Safety, available at <http://www.energy.gov/sites/prod/files/2016/10/f33/Ensuring%20Safe%20and%20Reliable%20Underground%20Natural%20Gas%20Storage%20-%20Final%20Report.pdf>.

<sup>2</sup> In this memo, “2016 GHGI” refers to the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990- 2014, published April 15, 2016, and “2017 GHGI” refers to the Inventory of U.S. Greenhouse Gas Emissions and Sinks: 1990-2015, to be published by April 15, 2017.

<sup>3</sup> For more information on the leak measurements and calculations, please see California Air Resources Board. Determination of Total Methane Emission from the Aliso Canyon Natural Gas Leak Incident. October 21, 2016. [https://www.arb.ca.gov/research/aliso\\_canyon/aliso\\_canyon\\_methane\\_emissions-arb\\_final.pdf](https://www.arb.ca.gov/research/aliso_canyon/aliso_canyon_methane_emissions-arb_final.pdf).

<sup>4</sup> Adapted from California Air Resources Board. Determination of Total Methane Emission from the Aliso Canyon Natural Gas Leak Incident. October 21, 2016. Table 4: Methane Emission Estimates of the Aliso Canyon Natural Gas Leak.

Phase II 2015 total emissions				29,905
<b>Sum of Phase I and Phase II 2015 emissions</b>				<b>78,350</b>
Phase II 2016	1/8/2016	22.7	10.0 (1/1 -1/10)	5,448
	1/12/2016	20.7	6.5 (1/11- 1/17)	3,229
	1/21/2016	19.1	7.0 (1/17-1/24)	3,208
	1/26/2016	19.0	7.0 (1/24- 1/31)	3,192
	2/4/2016	22.5	11.5 (1/31- 2/11)	6,210
<b>Phase II 2016 total emissions</b>				<b>21,288</b>

The EPA applied this estimate of 78,350 metric tons of methane to its estimate for 2015. This resulted in a total 2015 storage well emission estimate of 92,590 metric tons of CH<sub>4</sub> or 2.3 MMT CO<sub>2</sub>e (using AR4<sup>5</sup> GWP of CH<sub>4</sub>, consistent with GHGI), and total transmission and storage segment emissions of 42 MMT CO<sub>2</sub>e, compared with the 2014 estimate of 40 MMT CO<sub>2</sub>e.

**Table 2. Update to storage well emissions estimate in the 2017 GHGI, mt CH<sub>4</sub>**

	1990	2000	2005	2010	2014	2015
Storage wells	13,565	15,433	14,910	14,772	15,714	92,590

**Storage well emission estimates in the 2018 GHGI**

The EPA plans to include in the 2018 GHGI both the estimate of the Aliso Canyon leak for 2015, and an estimate for the portion of the leak that occurred in 2016. It is estimated that 21,288 (99,638 total minus 78,350 in 2015) metric tons of methane were emitted from the Aliso Canyon leak in 2016. This value would be applied to the 2016 estimate using the same approach selected for the 2015 estimate.

**January 2017 request for stakeholder feedback**

The EPA initially sought feedback on the questions below in the stakeholder version of this memo released January 2017. The EPA continues to welcome stakeholder feedback on these questions for potential updates to future GHG inventories.

1. The EPA seeks feedback on including this source under the storage well category.

<sup>5</sup> AR4 refers to the Fourth Assessment Report by the Intergovernmental Panel on Climate Change. *Climate Change 2007: The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Core Writing Team, Pachauri, R.K. and Reisinger, A. (eds)]. IPCC, Geneva, Switzerland, 2007.*

2. The EPA seeks feedback on whether adjustments to the estimate are needed to take into account other sources of methane potentially included in the measured data (calculated to be <0.1% of total).

The measurement results from studies conducted to assess the well leak at Aliso Canyon also included emissions from other sources at the storage site. In addition to other storage wells, the Aliso Canyon site had various CH<sub>4</sub>-emitting equipment. The data reported to GHGRP from the Aliso Canyon site included equipment counts of 100 pneumatic controllers (intermittent bleed), 10 reciprocating and 3 centrifugal compressors, and meters, valves and connectors.<sup>6</sup> Adding the estimate from the Aliso leak measurements to the existing storage well estimate would result in some minor double counting, for the fraction of emissions that are likely included in the ARB leak estimate.

The EPA has assessed 2015 GHGRP subpart W data reported by the facility to develop an estimate of other emissions occurring at the time of the leak. Total GHGRP CH<sub>4</sub> emissions reported by the facility in 2015 were 1360 metric tons.<sup>7</sup> For the duration of the leak, no compressors were used as no natural gas was being injected into the storage field. Deducting the emissions estimates for compressors (1065 metric tons of CH<sub>4</sub>) from the total reported to GHGRP results in emissions of 295 metric tons of CH<sub>4</sub>, and includes emissions from meters, valves and connectors. Apportioning these GHGRP-reported non-compressor CH<sub>4</sub> emissions to the 70 days of the leak in 2015 results in 57 metric tons (295 x 70 / 365).

The EPA could reduce the Aliso Canyon estimate by 57 tons, assuming that those tons are accounted for in the other estimates in the GHGI, or could make no adjustment, due to the small size of the emissions (calculated to be <0.1% of the total) and the uncertainty range of the Aliso leak. The EPA seeks comment on these approaches.

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<sup>6</sup> The GHGRP subpart W data used in the analyses discussed in this memorandum are those reported to the EPA as of August 13, 2016.

<sup>7</sup> The facility's actual 2015 emissions were higher than those reported to the GHGRP. The GHGRP provides well-vetted average emission factors to calculate emissions. The facility followed these GHGRP calculation methods for 2015 reporting. Actual emissions differ from those reported due to the Aliso Canyon leak event.