Mancal Energy Inc.
(Tamarack Valley Energy Ltd.)
Alt-FEMP Pilot Program
2024 Performance Report

Date: 31st March 2025

Submitted by:

Jeff Hayes
Operations Manager, Mancal Energy Inc.

Connor Deering
Emissions Analyst, Arolytics

Table of Contents

Figures & Tables

Executive Summary

Mancal Energy Inc. (Mancal) and Tamarack Valley Energy Ltd. (Tamarack) are two distinct Canadian energy companies with active oil and gas operations in Alberta. In 2023, Tamarack (in a joint process with i3 Energy) received approval from the Alberta Energy Regulator (AER) to implement a pilot alternative Fugitive Emissions Management Program (alt-FEMP) from April 13, 2023 to December 31, 2024. For Tamarack, this alt-FEMP included 68 facilities located on 63 sites or legal subdivisions (LSDs). This report outlines the compliance aspects of the alt-FEMP in accordance with the approval issued by the AER.

As of November 1, 2023, Tamarack sold all alt-FEMP assets to Mancal and Mancal committed to continuing the alt-FEMP's implementation going forward. With this, Tamarack implemented the alt-FEMP from April 13 to October 31, 2023, and Mancal implemented the same alt-FEMP onwards.

For methane detection, this alt-FEMP utilized Montrose Environmental Group (Montrose) optical gas imaging cameras (OGI) along with site-level emission-screening by Bridger Photonics, Inc.'s (Bridger) aerial-based technology.

With the alt-FEMP screenings and surveys completed, Mancal will continue to use the data collected to track progress towards methane reduction targets and inform areas of improvement. This report summarizes data collected during the alt-FEMP screenings, follow-up OGI surveys and Control Region OGI surveys. The schedule of the program was as followed:

Quarter-Year	Site Level Screening	OGI Surveys	Status
Q3 2023	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 20% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed
Q4 2023	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 40% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed
Q2 2024	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 20% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed
Q4 2024	Aerial-based, site-level screening by Bridger of alt-FEMP facilities.	Followed by Montrose OGI follow-up surveys at the top 20% of all screened LSDs ranked by total emission rate for fugitive emission localization and repair.	Completed

1. Screening Data

Table 1 summarizes various statistics regarding the screening campaigns across the alt-FEMP. Please note emissions detected during the screenings can be a combination of fugitive, vented and sporadic operations-related emissions. The detailed screening data is provided in an Excel attachment with this report, and the tables summarizing each site's total and individual emissions detected during each screening are provided in Appendix B and C, respectively. The number and percentage of sites followed-up on after screening only considered followed-up sites with emissions.

Table 1. Combined summary of screening data for 2023 and 2024.

Parameter	2023	2024
Number of sites screened	114	121
Number of screened sites with detections	43	31
Number of detections during screenings	77	57
Percentage of screened sites with detections (%)	38%	26%
Average emissions per screened site with a detection (m^3/day)	252.3	162.1
Total emission rate identified (m^3/day)	10 848	5025
Number of sites followed-up on	34	21
Percentage of sites followed-up on vs. screened (%)	30%	17%
Number of follow-up sites with no screening detections	0	0
Number of follow-up emissions with emission source not detected by the screening technology	0	0
Average time between detection and follow-up to site (days)	40.7	46
Percentage of follow-up sites that are recurring (%)	26%	57%
Number of emissions from the screenings that were followed-up on	68	44
Number of emissions from the screenings that were followed-up and identified as fugitive emissions	36	27
Total emission rate of fugitives identified and repaired for the calendar year (m^3/day)	164.6	75

2. Follow-up Data

Table 2 summarizes statistics regarding the OGI follow-up surveys of the alt-FEMP region conducted after a screening campaign. The raw detailed follow-up data is provided in an Excel attachment with this report.

OGI has the capability to localize emissions to a source-level. Also, the OGI operator can normally determine the emission type. Table 3 shows the emission source equipment types for all identified emissions including the number and volume for each equipment type.

Table 2. Summary of OGI follow-up data.

Year		2023	2024
Number of sites followed-up on for the year [a]		34	21
Percentage of screened sites followed-up on (%)[a]		30%	17%
Percentage of sites with screening detections followed-up on (%)		79%	68%
Number of follow-up surveys where no emissions were found[a]		0	0
Average time between detection and follow-up to site (days)		40.7	46
Percentage of follow-up sites that are recurring (for the calendar year – following-up on a site more than once)		26%	57%
Identified emission source types per follow-up per screening campaign (vent, fugitive, methane slip, other)		Fugitives and Vents	Fugitives and Vents
Number of detections by emission source type (n)	**Fugitives**	24	28
	Vents	176	87
	Total	200	115
Volume of detections by emission source type (m^3/day)	**Fugitives**	164.6	86
	Vents	1777.5	702
	Total	1942.1	788

Average emissions per follow-up site (m^3/day)	57.1	37.5
Identified emission source equipment types per follow-up per screening campaign (e.g., tank, compressor seal)	11	7
Number of recurring leaks observed (if the leak occurred more than once per year)	1	0

[a] Only sites with emission were considered

Table 3. Number and volume (m^3/d) of emission detections by equipment type.

Identified emission source equipment types	2023		2024	
	Number of detections by equipment type	Volume of detections by equipment type (m^3/d)	Number of detections by equipment type	Volume of detections by equipment type (m^3/d)
controlled tank	3	127.4		
dehydrator	6	14.4		
flare stack				
header				
heater				
meter				
other	6	23.6	12	35.7
pig sender/receiver				
pipeline - aboveground	3	20.0		
pipeline - buried				
pneumatic instrument	52	183.5		
pneumatic pump	14	36.8		
reciprocating compressor	13	134.3	20	168.4
screw compressor	8	40.6	2	3.5
separator	53	199.7	47	242.1
surface casing vent			1	3.1
sweetening process				
treater				
uncontrolled tank	37	1151.0	31	330.6
vent stack				
wellhead	5	10.8	2	5.1
Total	**200**	**1942.1**	**115**	**788.5**

3. Emissions Summary

3.1 Screening Summary

Figure 1 shows the distribution for site-total methane emission rates detected during screening campaigns in 2023 and 2024, capturing all types of methane emissions (fugitives, vents, methane slip and others). The graph allows one to discern how many site-total emission measurements reported emission rates within a certain range (e.g. emissions with rates between 0 and 100 m^3/day where individual emissions on a single site from one screening are summed).

Figure 2 shows the distribution for individual emission rates detected during the 2023 and 2024 screening campaigns. Screening technologies are generally unable to determine the type of methane emission measured (fugitives, vents, methane slip and others). The graph allows one to discern how many individual emission measurements had an emission rate within a certain range (e.g., emissions with rates between 0 and 100 m^3/day).

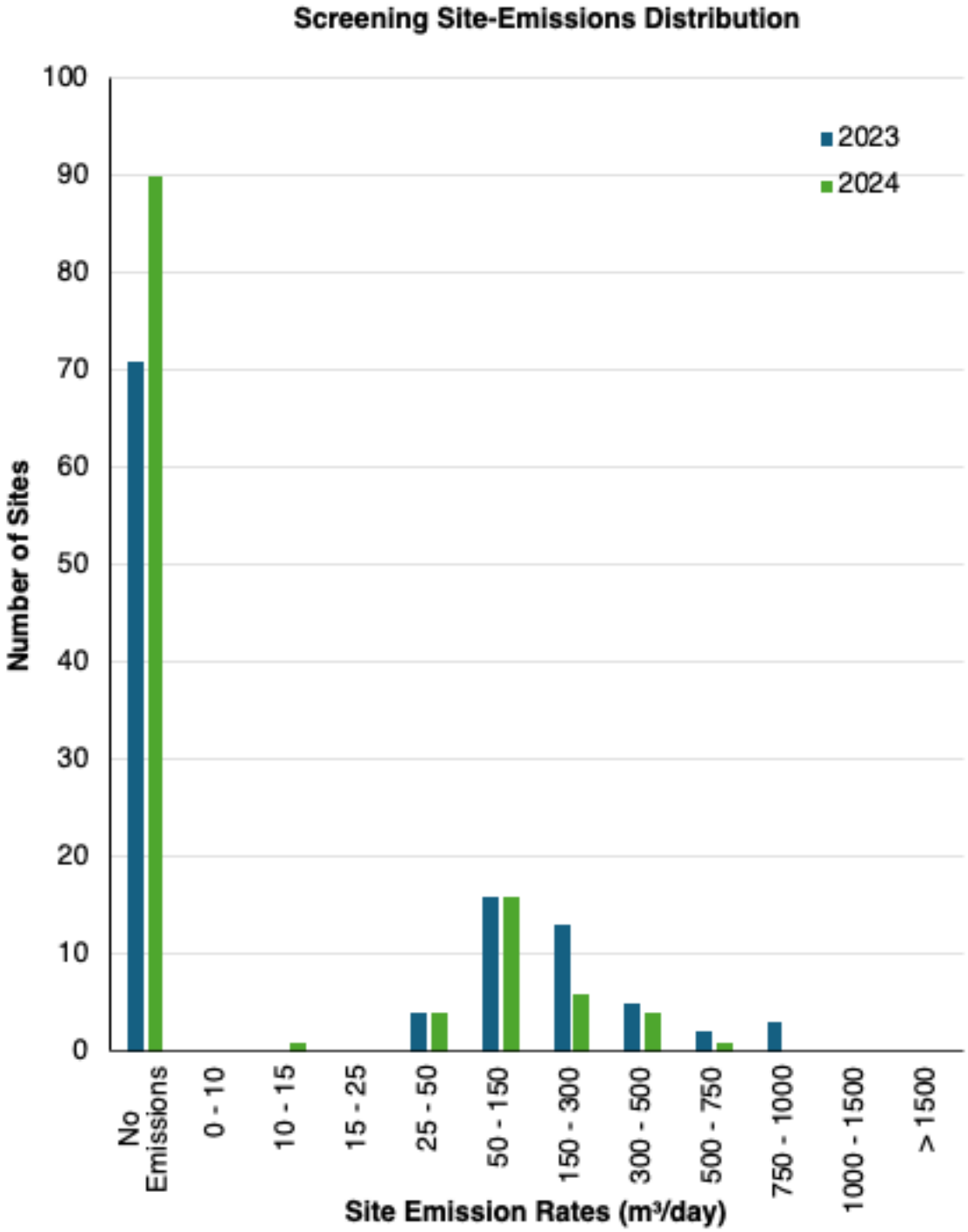

Figure 1: Distribution of site-total emission rates measured during screening campaigns.

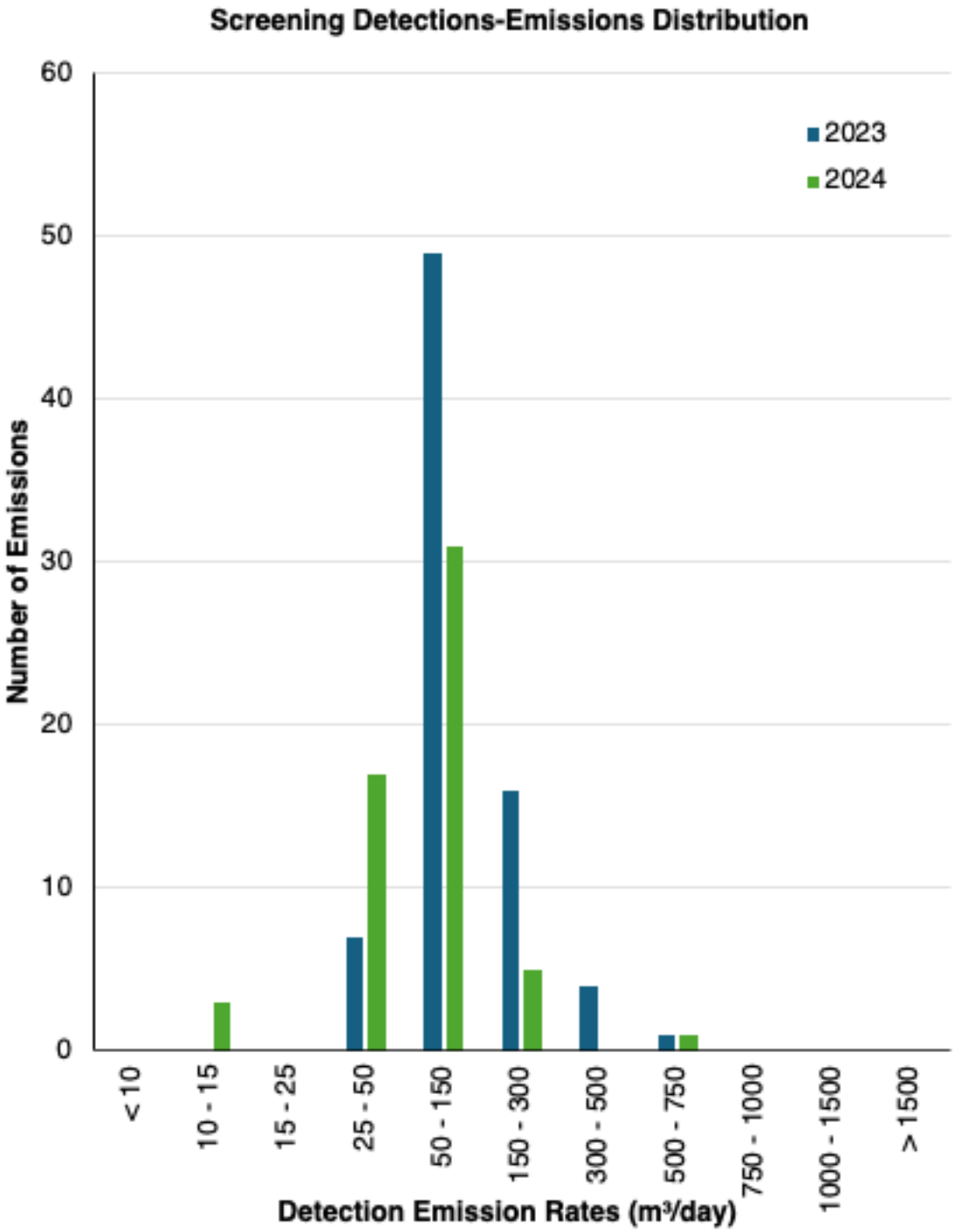

Figure 2: Distribution of individual emissions, by rate, measured during screening campaigns.

In general, screening technologies cannot discern fugitive emissions from other emission types, thus a graph depicting the emissions distribution specifically for fugitives detected during screenings could not be generated.

3.2 OGI Survey Summary

Figure 3 shows the emission rate distribution for site-total emissions detected during OGI survey campaigns of the alt-FEMP region, aggregating all methane emissions measured during that OGI campaign. The graph allows one to discern how many site-total emission measurements, by OGI, reported an emission rate within a certain range.

Figure 4 below shows the emission rate distribution for individual emissions detected during OGI survey campaigns. The graph allows one to discern how many individual OGI measurements had an emission rate within a certain range.

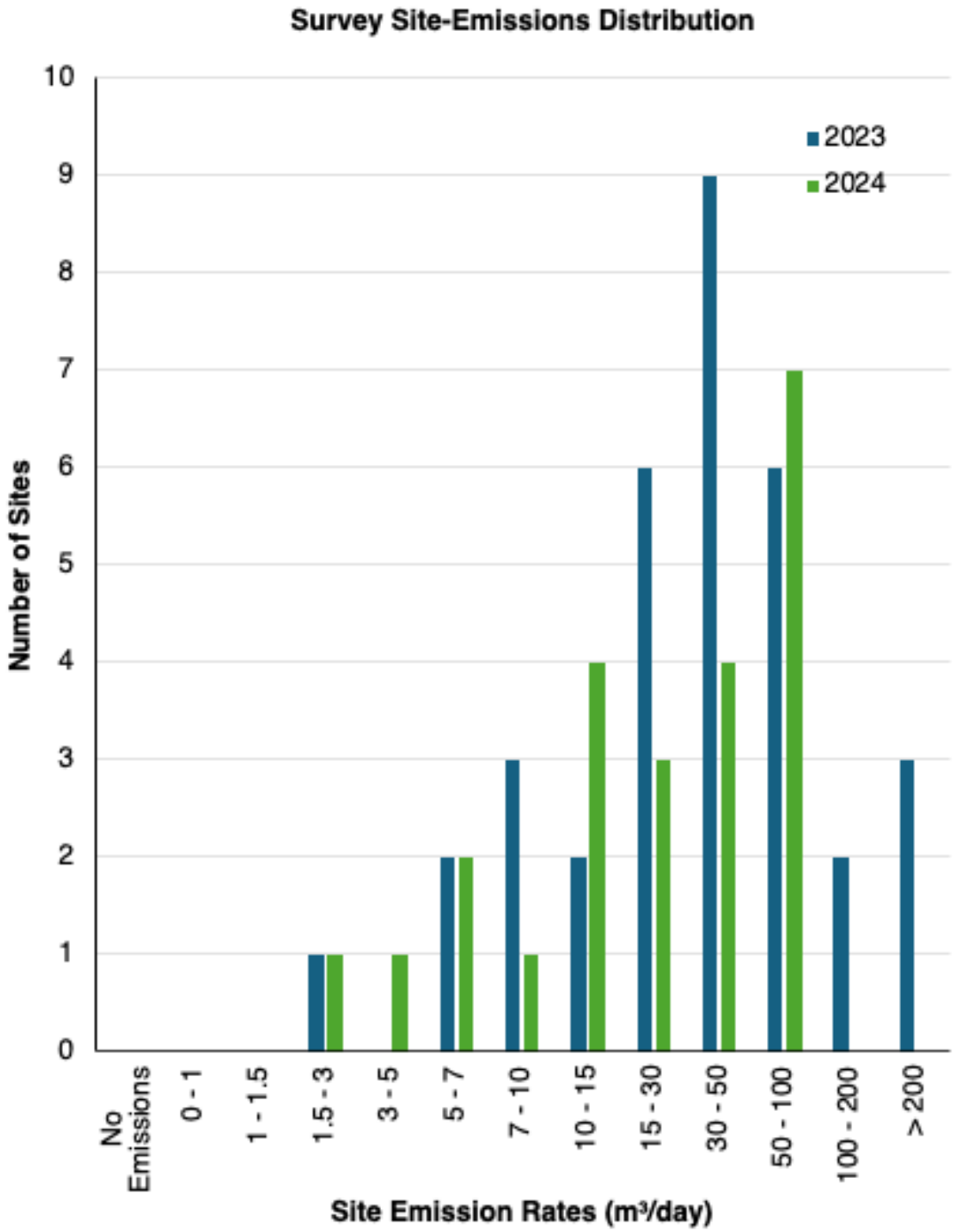

Figure 3: Distribution of site-total emission rates measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.

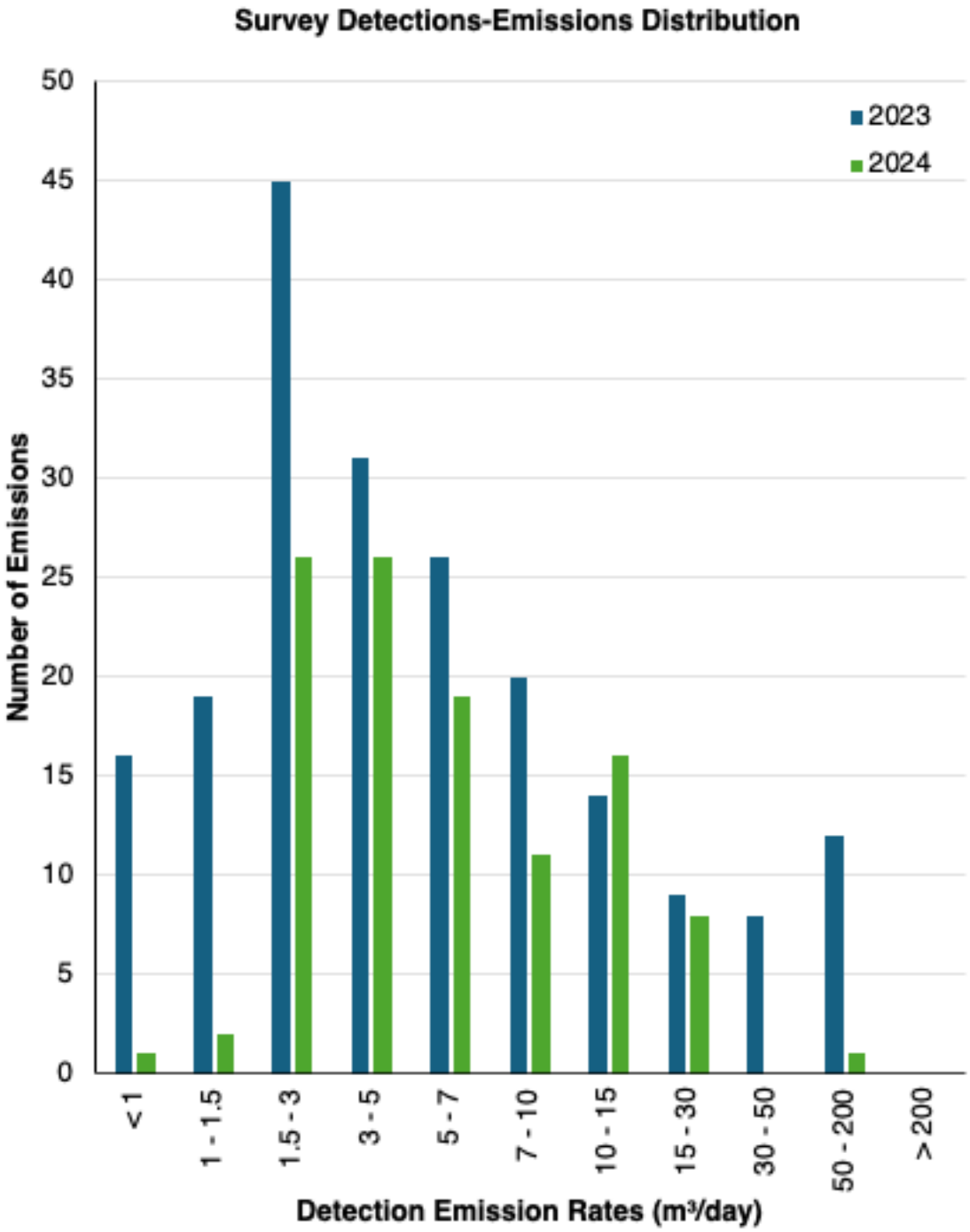

Figure 4: Distribution of individual emissions, by rate, measured during OGI survey campaigns (e.g. follow-up and independent campaigns) of the alt-FEMP region.

Figure 5 below shows the emission rate distribution for individual fugitive emissions detected during OGI survey campaigns. The graph allows one to discern how many individual fugitive emission measurements reported an emission rate within a certain range.

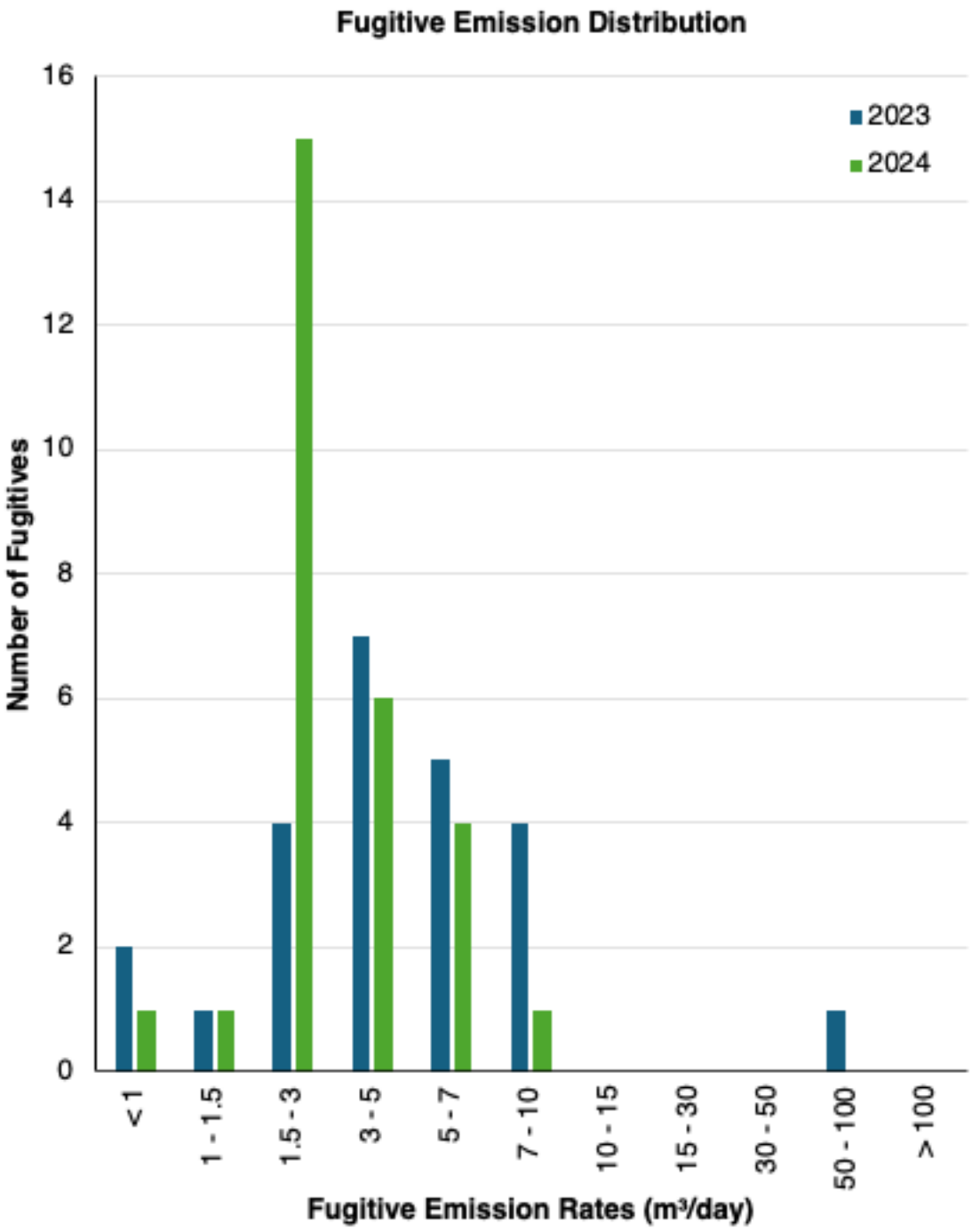

Figure 5: Distribution of fugitive emissions, by rate, measured during OGI survey campaigns (e.g. follow-up) of the alt-FEMP region.

3.3 Control vs. alt-FEMP Summary

Table 4 compares several metrics related to the sites surveyed and emissions detected via OGI surveys in the alt-FEMP vs. Control regions for 2024. The average rates in the table are calculated per site per survey (e.g. the control site was surveyed six times in the two years and the average of these six was taken).

Table 4. Comparison of the alt-FEMP and Control regions in 2024.

Item	alt-FEMP Region	Control Region
Number of Sites Surveyed	21	6
Number of Surveyed Sites with Emissions Detected	21	6
Percentage of Surveyed Sites with Emissions Detected (%)	100%	100%
Number of Emissions Detected at Surveyed Sites	115	71
Number of Surveyed Sites with Fugitive Emissions Detected	11	5
Percentage of Surveyed Sites with Fugitive Emissions Detected (%)	52%	83%
Number of Fugitive Emissions Detected	28	41
Number of Vent Emissions Detected	87	30
Total Rate of Emissions Detected (m^3/day)	788	428
Total Rate of Fugitive Emissions Detected (m^3/day)	86	200
Total Rate of Vent Emissions Detected (m^3/day)	702	228

Average Fugitive Rate per Site with Fugitive Emissions Detected (m^3/day)	60.6	71.4
Average Fugitive Rate for all Fugitive Emissions Detected (m^3/day)	7.17	6.8
Number of Fugitive Emissions Repaired	23	39
Percentage of Fugitives Repaired (%)	82%	95%
Number of Sites Surveyed	21	6
Average Time to Repair	25	18

4. Emission Reduction Summary

The fugitive emission data collected during the alt-FEMP was used to generate the as-found “measured fugitive emission distribution”. This consisted of all fugitive emissions recorded during surveys of both the alt-FEMP. Figure 6 shows a comparison of the as-found “measured fugitive emission distribution” to the “assumed fugitive emission distribution” employed in the modelling initially used to design the approved alt-FEMP. Additionally, the minimum detection limit (MDL) at 90% probability of detection (PoD) for the screening technology is displayed for reference.

A default Directive 060 FEMP and the executed program were re-modelled using the as-found fugitive distribution using the AroFEMP software (Arolytics). The traditional default FEMP was predicted to have 1.4% more methane in volume from fugitives than the alt-FEMP. As can be seen in Figure 6, the as-found distribution would need supplementation for proper re-modelling of the programs. The as-found distribution also contained a significantly smaller proportion of large fugitive emissions.

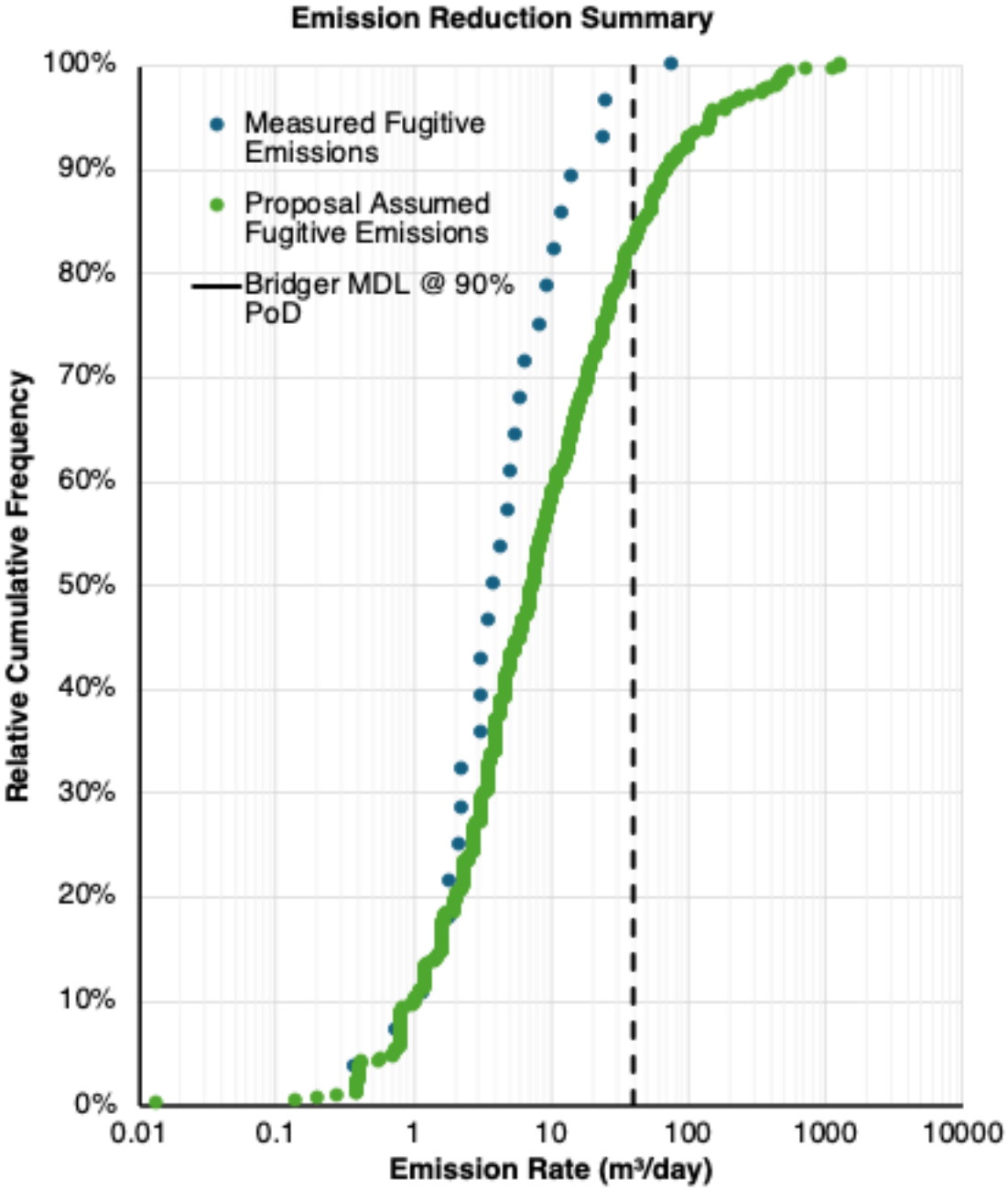

Figure 6. Comparison of relative cumulative frequencies for the "as-found" measured fugitive emissions versus the proposal-assumed fugitive emissions.

5. Technology Limitations

Bridger's detection sensitivity depends on factors including flight speed, flight altitude, measurement swath width, and wind speed. Many of these factors can be controlled by Bridger to tighten or loosen the sensitivity as required. Bridger's GML is an active, laser-based system, rather than a passive remote sensor that relies on the environment, so conditions such as cloud cover or shadows that can impair other aerial sensor technologies do not negatively impact GML. Regarding operations at northern latitudes, GML is moderately limited by snow cover and standing water. While GML will detect methane when there is snow on the ground, the detection sensitivity of the data is degraded. With standing water, Bridger's laser 'bounces' off and, as a result, no measurement is made. In several areas of Alberta, the muskeg landscape holds pockets of water in the warmer months. Based on testing and commercial projects completed in Alberta, the muskeg landscape has not negatively impacted Bridger's GML measurements. As a result of high winds rapidly dispersing emissions, Bridger limits its survey operations to ground wind speeds less than or equal to 25 mph. Bridger also implements a wind speed protocol to detect emissions at the lower end of GML's detection sensitivity. To avoid Bridger's limitations in snow, Bridger will only implement GML in snow-free months (between late Spring and early Winter). Bridger will also limit its survey operations to average ground wind speeds less than or equal to 25 mph.

6. Success of the alt-FEMP

The alt-FEMP was designed to meet methane emission equivalency to a default FEMP using alternative site screening technologies combined with OGI surveys. The execution of this program has been successfully completed.

7. Nonperforming Program Elements

The alt-FEMP application said the alt-FEMP's 2023 screenings and surveys would occur in Q1 and Q3 of 2023, but due to the alt-FEMP only being approved as of April 13, 2023, and the occurrence of wildfires from May – July 2023 that impacted the ability for sites to be screened by Bridger, the screenings and surveys occurred in Q3 and Q4 of 2023 instead. This is not believed to have impacted the effectiveness of the alt-FEMP in 2023, and the alt-FEMP's 2024 implementation will follow the timeline originally stated in the alt-FEMP application.

Due to the transfer of all alt-FEMP assets from Tamarack to MEI in Q4 2023, the OGI follow-up associated with the Bridger screening performed in October 2023 was delayed and ultimately performed in December 2023 (over 40 days after the associated screening). Further, only 1 of the 3

required Control Region OGI surveys was performed by Tamarack prior to the transfer of assets to MEI, and MEI completed the 2 remaining surveys in December 2023 with just 15 days between surveys. No such delays were encountered in 2024.

8. Additional Control Measures

Any sites that were missed during screenings were automatically added to be followed-up on by OGI survey.

9. Additional Information

N/A

10. Key Performance Indicators

- Mancal was successful in implementing alternative technologies to conduct LDAR screening, where emissions were detected at 74 of the 235 screened sites.
- A default D060 program would result in 73 site visits compared to the 55 that were visited with OGI under the alt-FEMP showcasing efficient LDAR program execution.
- In 2023 and 2024, a total of 15 873 m^3/day of methane was found to be emitting by screening technologies on 209 detections. Of which, 250.6 m^3/day was identified as fugitive emissions when followed-up with OGI.
- On average, leak repairs were completed 25 days after an OGI follow-up under the alt-FEMP. In the Control Region, leak repairs were completed about 18 days after an OGI survey on average.
- 82% of fugitive emissions sources were repaired under the alt-FEMP in 2024.

Appendix A: Raw Detailed Data

Please refer to the attached excel file of the raw data collected during the screening and follow-up surveys titled “Mancal 2024 femp-screening-data.xlsx”.

Appendix B: Screening Data – Site-total Emissions by Campaign

See attached “Mancal 2024-altFEMP-PerfomanceReport-Appendix.xlsx”.

Appendix C: Screening Data – Individual Emissions

See attached “Mancal 2024-altFEMP-PerfomanceReport-Appendix.xlsx”.