



EXECUTIVE SUMMARY

The Earth Rangers Centre for Sustainable Technology (ERC) was retained to complete an independent study of the Molok in-ground waste and organics storage system for its ability to buffer changes in outdoor temperature and thus reduce odours.

The following two (2) findings are discussed in more detail in the report below and represent a testing over one (1) year of measurements.

FINDING 1: Temperatures measured from 50" from the top to the bottom of both the waste and organics Moloks at all times were lower than the average temperature of our temperature controlled waste room. From the top to 25" below the top, temperatures were on average lower than that of our conditioned waste room 78.7% of the time.

FINDING 2: At no time did odours, measured by our calibrated odour meter, directly outside the Molok exceed that of our temperature controlled waste room

Overall, our findings indicate that the Molok outperformed our temperature controlled waste room in slowing decomposition by keeping waste and organics at lower temperatures and reducing odours emanating from Moloks.

METHODOLOGY

Temperature probes were installed in the interior bag of the Molok waste organics container and on the interior tube of the Molok organics container. In total, four (4) temperature probes were installed on each Molok container at the following levels:

- Top of Bin
- 25" from Top of Bin
- 50" from Top of Bin
- Bottom of Bin

The temperature data logger on both Molok containers was set to measure temperatures every hour. This log was downloaded every 2 weeks and the data collected for one (1) years.

Odours were measured using the following equipment:

- Levitt Safety IAQ monitor set to measure CO₂, SO₂, NO, O₂, and ambient temperature
- KanoMax Handheld Odor Meter OMX-ADM, which measure hydrogen sulfide, methyl mercaptan, ammonia and other odour causing substances.

Odours and temperatures were measured bi-weekly (every 2 weeks) for a period of one (1) year. Odours were measured at the Molok area and also in our waste room for comparison purposes.



SUMMARY OF FINDINGS

Based on the results of our one (1) year study on temperatures and odours emanating from the Waste and Organics Molok containers, we measured the temperatures at intervals of one (1) hour for at four (4) different depths for each Molok container. The below colour coded chart represents the average temperatures for each month found at the different depths of measurement. Note that the average summer temperature of the ERC conditioned waste room was 22.0°C.

	Avg. Temp. (°C)							
	Waste Molok Container				Organics Molok Container			
	TOP OF BIN	25" from TOP	50" from TOP	BOTTOM	TOP OF BIN	25" from TOP	50" from TOP	BOTTOM
Jan	0.9	0.7	0.9	3.2	0.4	0.2	1.3	2.4
Feb	-0.6	-0.3	0.1	2.2	1.7	1.5	0.7	1.5
Mar	0.2	-0.3	0.2	1.6	2.1	1.8	1.2	2.0
Apr	9.0	7.3	6.4	5.4	11.9	12.9	7.8	7.1
May	12.2	11.6	10.8	9.1	14.8	14.4	13.4	11.0
Jun	20.4	18.4	16.8	13.8	22.3	20.9	21.5	17.9
Jul	22.4	21.3	20.2	17.4	24.6	24.0	21.4	19.5
Aug	21.9	20.9	19.9	18.5	23.6	23.0	19.6	19.7
Sep	20.7	19.3	18.0	18.0	22.6	21.7	19.0	18.8
Oct	16.2	15.5	15.4	16.5	17.2	16.7	16.4	16.1
Nov	Malfunction in Data Logger				9.3	9.3	9.3	11.0
Dec	0.6	0.6	1.1	2.9	1.2	1.3	3.2	5.0
Fall	11.1	10.5	10.6	11.7	11.9	11.6	11.6	12.4
Winter	-0.3	-0.3	0.2	2.1	1.0	0.8	1.1	2.1
Spring	11.8	10.4	9.4	7.9	14.3	14.2	12.0	10.2
Summer	21.6	20.4	19.2	17.6	23.4	22.7	20.1	19.3

Areas shaded in blue represent Molok temperatures that are lower than the average summer ERC conditioned waste room temperature and areas shaded in red represent temperatures that are above. From this we can see that the top 25" of the Organics Molok container, on average, in the months of July and August, may cause temperatures to be slightly higher. However, the bottom of the Organics Molok container to 50" from the top are significantly cooler.

We hypothesize that the Organics Molok container has warmer temperatures than the waste container due to 3 possible differences:

- 1) As organics decompose, they release heat;
- 2) The organics Molok container is made of a rigid plastic that insulates better than the waste Molok container bag; and
- 3) The larger diameter of the waste Molok container and shape of the bag (i.e. tied at the bottom) allow for better natural convection than the relatively slimmer profile and rigid cylindrical shape of the organics Molok container

The Kanomax odour monitor was provided the most accurate readings of odours and measured odours on a scale from 0 to 999 with 0 being no detectable presence of any odour causing

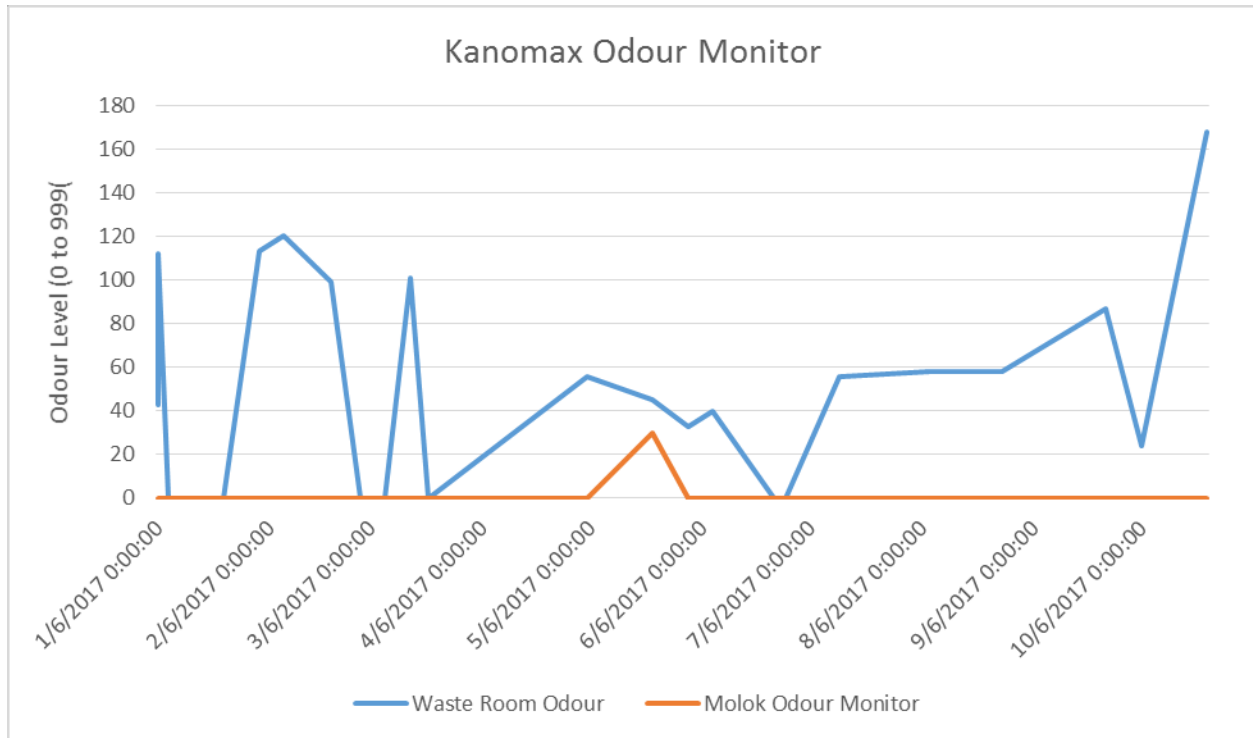


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molecules. Odours were detected in the waste room throughout the year while odours were only detected from Molok in May, directly following a recent Molok pick-up.





OTHER FINDINGS

A chart of the standard deviation for temperature is expressed as the average of the deviations per month away from the mean temperature is below. A trend is that the further from the top of the Molok container reduces the standard deviation of the temperatures – meaning that there is less variance and overall swing in temperatures towards the bottom of the Molok container.

	Std. Dev. (°C)							
	Waste				Organics			
	TOP OF BIN	25" from TOP	50" from TOP	BOTTOM	TOP OF BIN	25" from TOP	50" from TOP	BOTTOM
Jan	2.3	2.0	1.6	1.2	3.3	2.8	1.7	1.6
Feb	2.8	2.1	1.8	1.2	5.5	4.7	1.7	1.4
Mar	5.0	3.7	2.2	1.3	6.3	5.1	2.3	1.8
Apr	5.5	3.5	3.0	1.6	7.5	7.8	2.8	2.1
May	5.7	4.6	4.0	1.6	7.3	6.6	1.8	1.6
Jun	5.9	3.7	2.3	1.8	7.6	7.4	3.5	2.1
Jul	4.9	3.2	2.3	0.9	7.1	6.4	2.0	0.7
Aug	5.5	3.5	2.2	1.0	7.2	6.7	1.1	1.1
Sep	7.8	5.0	3.3	1.2	8.5	7.5	1.2	1.0
Oct	5.7	4.1	2.6	2.6	6.3	5.6	1.4	1.8
Nov	Malfunction in Data Logger				2.2	1.8	1.0	0.8
Dec	2.9	2.8	2.5	2.2	3.1	2.9	2.0	2.2
Fall	10.2	9.1	8.2	7.4	10.9	10.3	6.9	6.0
Winter	3.6	2.8	1.8	1.4	4.8	3.9	1.8	1.7
Spring	8.1	6.7	5.8	4.0	9.2	8.7	6.8	5.2
Summer	5.9	3.8	2.7	1.3	7.4	6.8	1.9	1.0

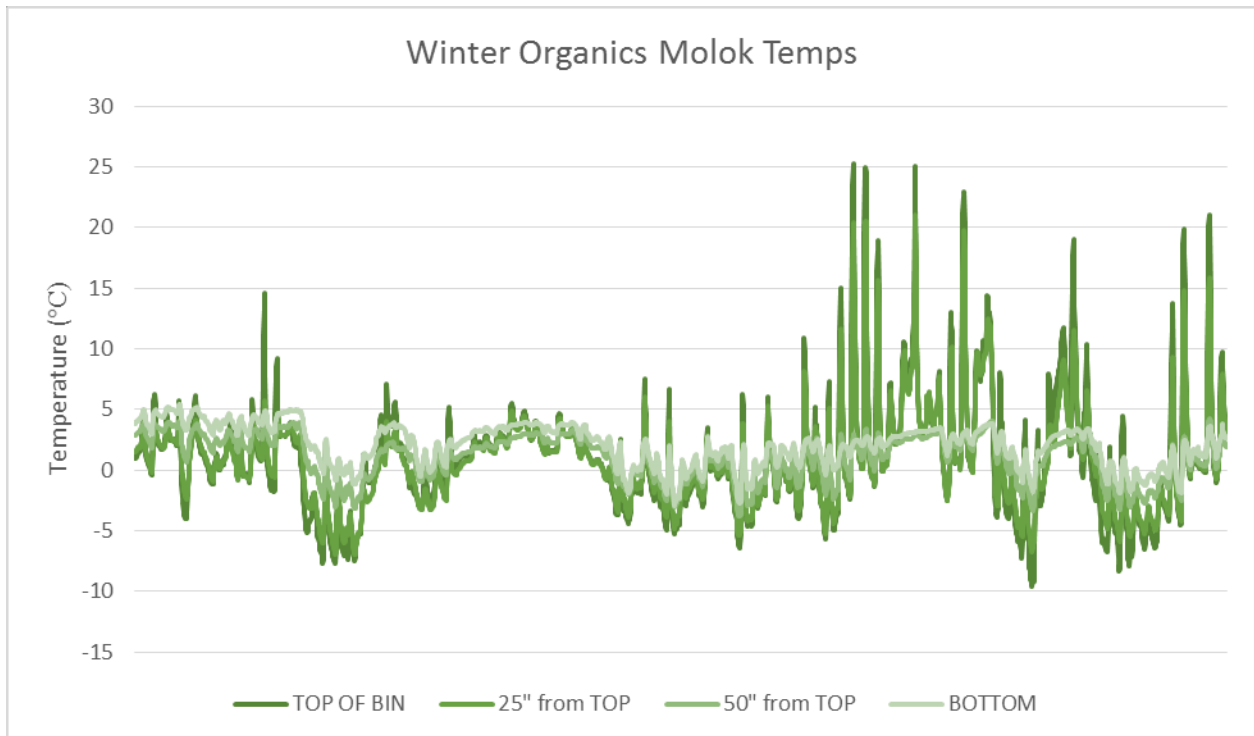
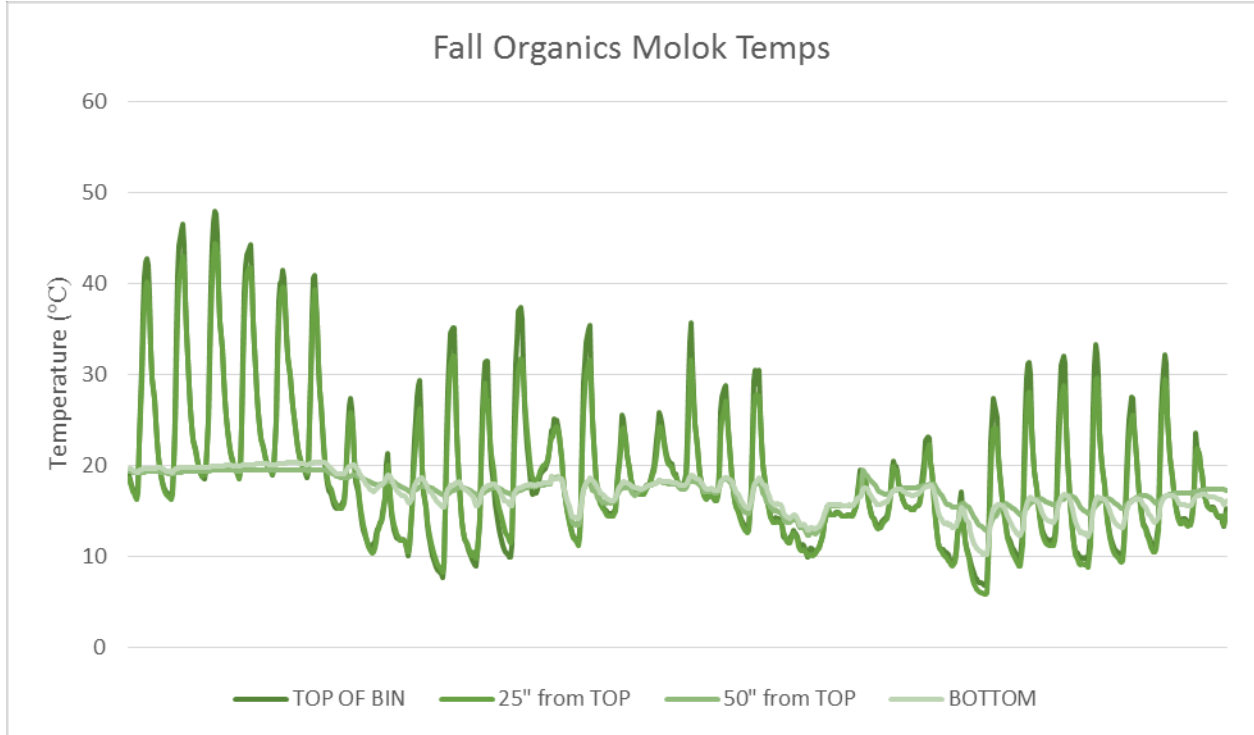
This is further illustrated in the below charts that plot the hour by hour temperature for the waste and organics Molok containers for all four (4) temperature probes.



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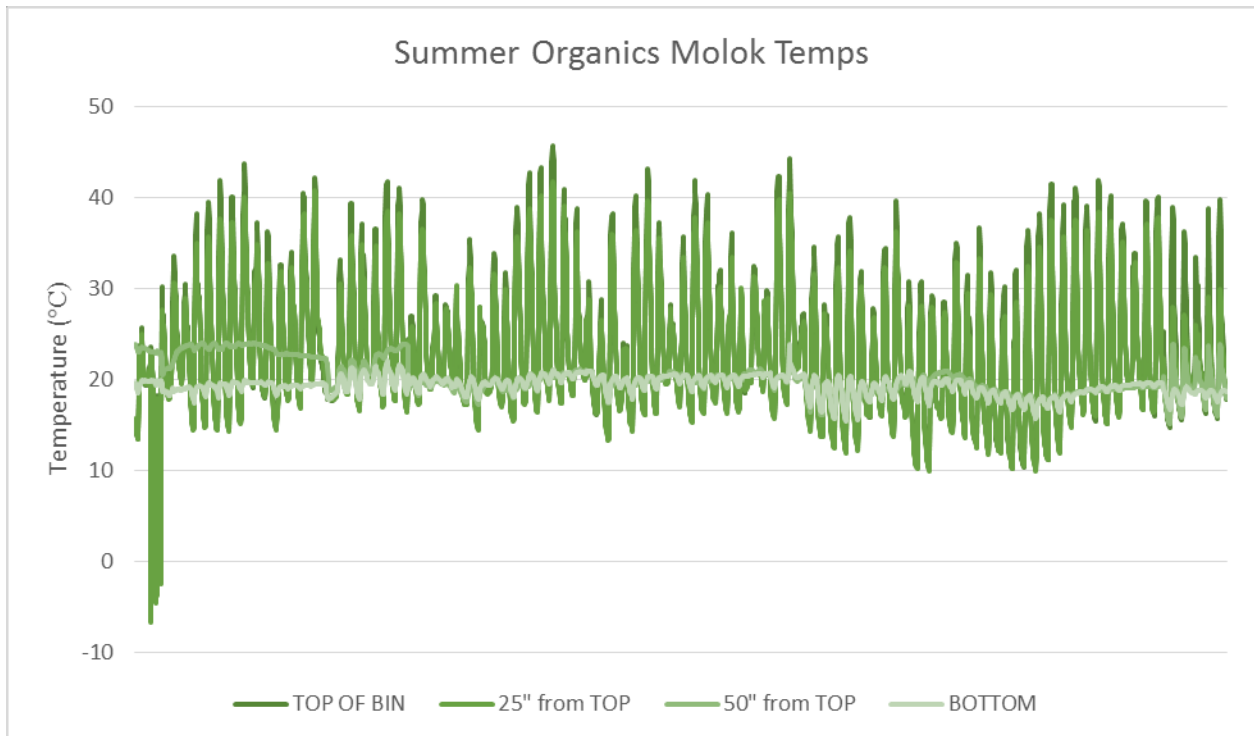
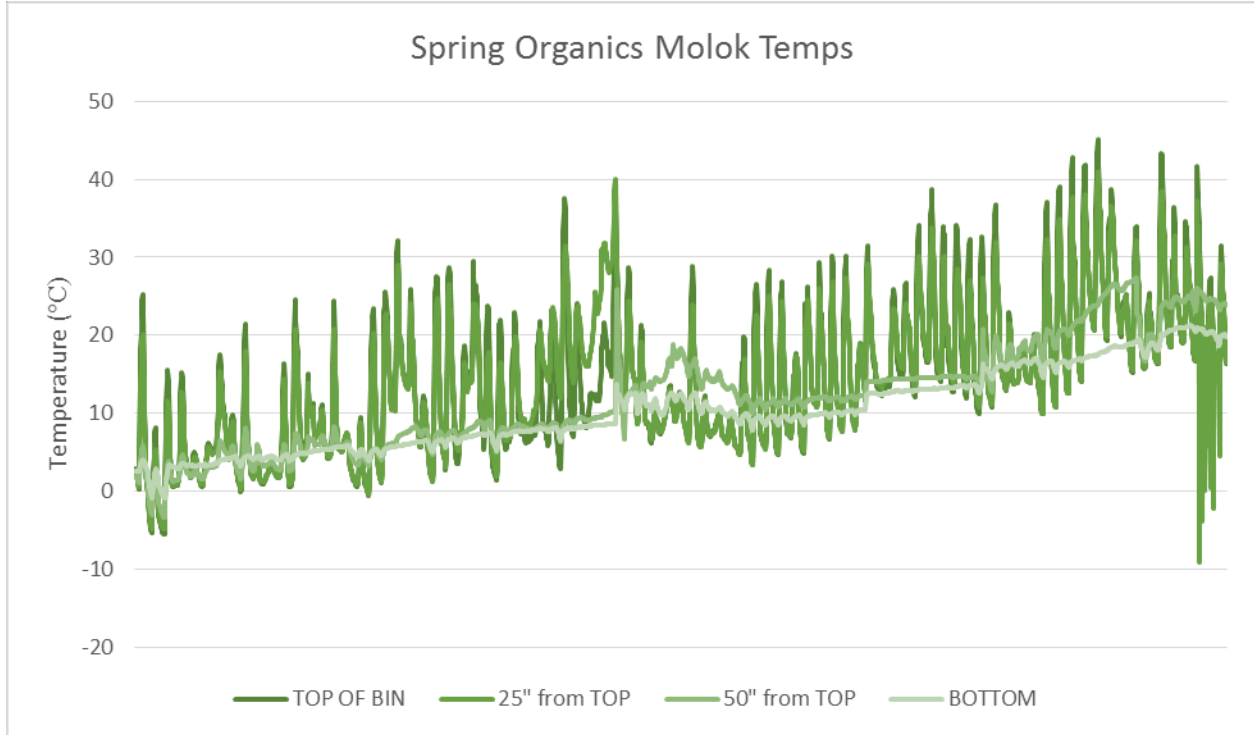




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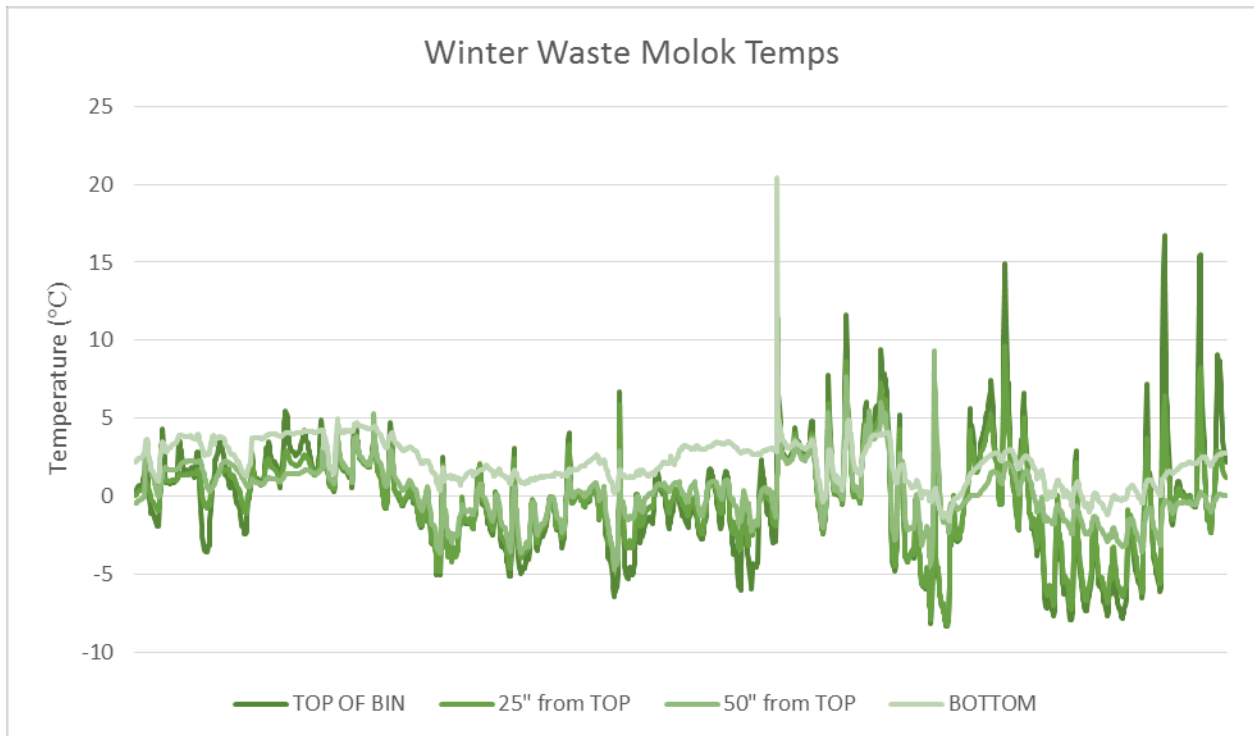
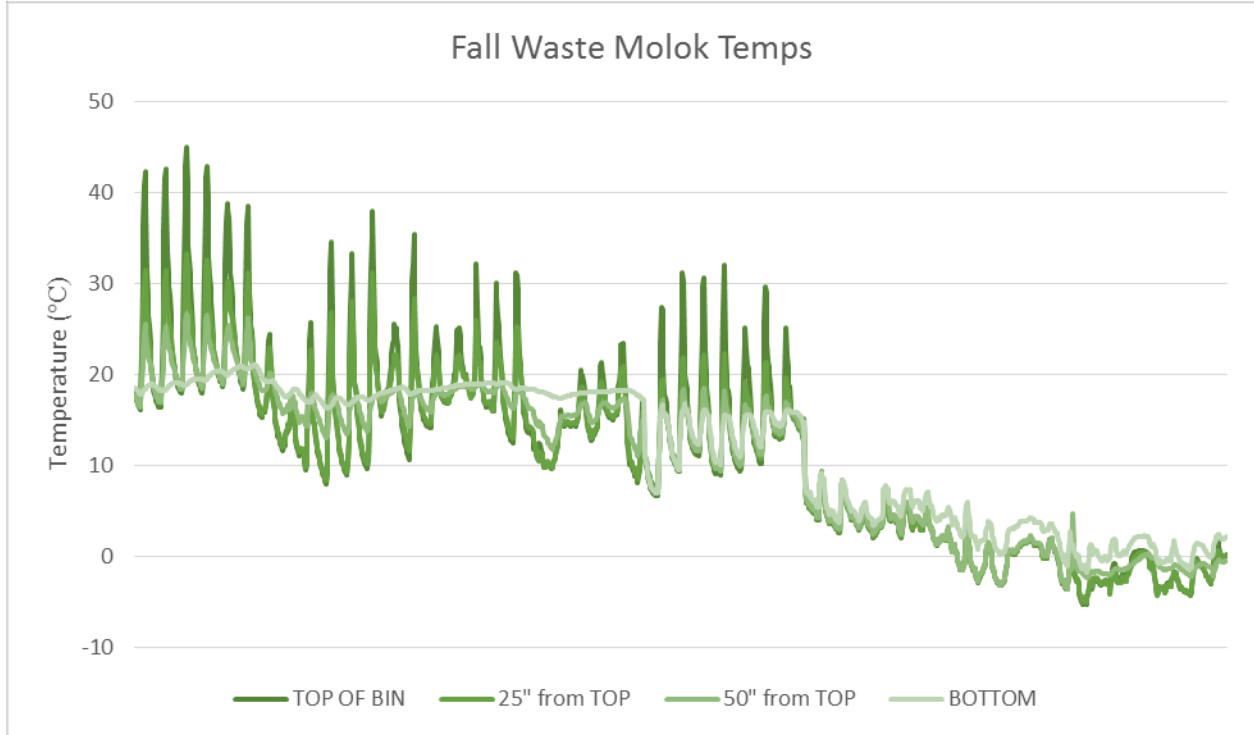




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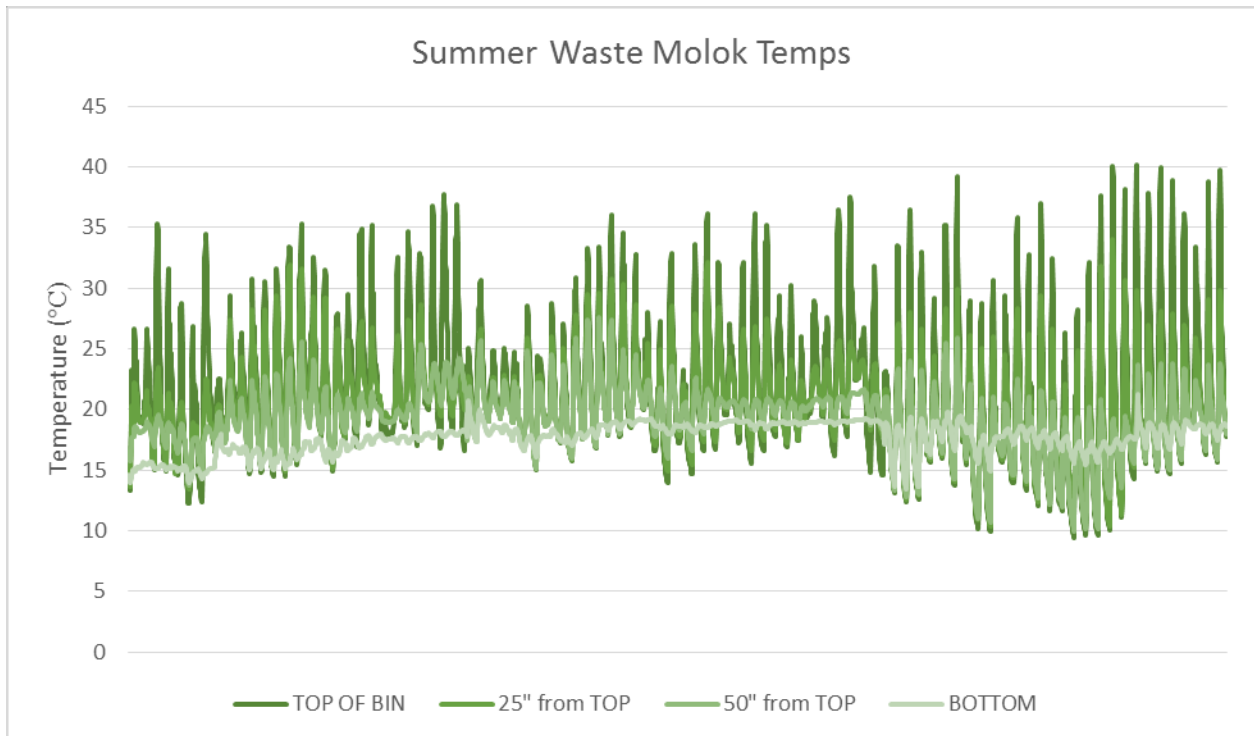
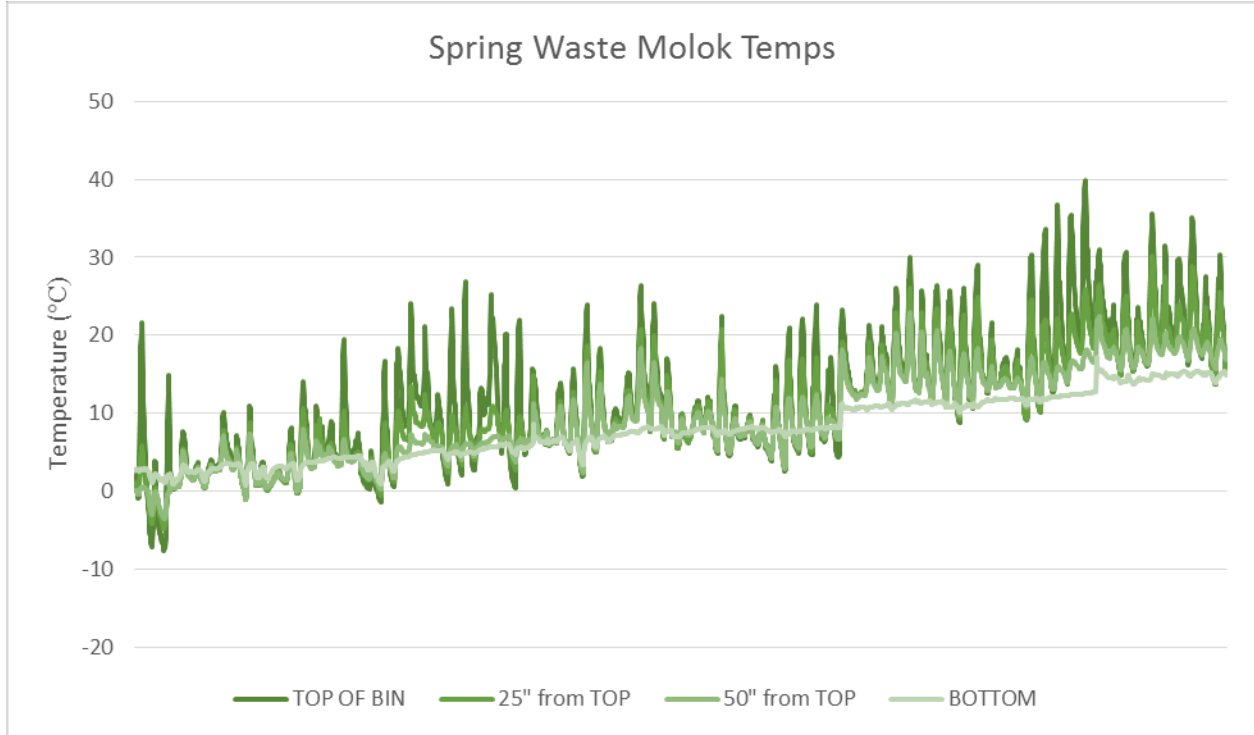




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CONTACT

This study was supervised by Gavin Yeung; contact provided below. All measurements and analysis were completed at the Earth Rangers Centre for Sustainable Technology located at 9520 Pine Valley Dr., Woodbridge, ON.

Please contact the undersigned should you have any additional questions or inquiries regarding this report.

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EXECUTIVE SUMMARY - INDEPENDENT STUDY

The Earth Rangers Centre for Sustainable Technology (ERC) was retained to complete an independent study of the Molok in-ground waste and organics storage system for its ability to buffer changes in outdoor temperature and thus reduce odours.

This study also encompassed a comparison of temperatures and odours from our temperature controlled waste room. ERC completed this study over a period of two (2) years. With the only differences being:

- in the second year of the study the measurement frequency for odours was greater than in the first year; and
- in the second year of the study we measured the energy consumption of our temperature controlled waste room in order to estimate the energy cost of operating our waste room

The following two (3) findings are discussed in more detail in the report below and represent a testing over two (2) year of measurements.

FINDING 1: Temperatures measured from 50" from the top to the bottom of both the waste and organics Molok containers at all times were lower than the average temperature of our temperature controlled waste room. From the top to 25" below the top, temperatures were on average lower than that of our conditioned waste room 78.7% of the time.

FINDING 2: At no time did odours, measured by our calibrated odour meter, directly outside the Molok container exceed that of our temperature controlled waste room

Overall, our findings indicate that the Molok container outperformed our temperature controlled waste room in slowing decomposition by keeping waste and organics at lower temperatures and reducing odours emanating from Molok containers.

FINDING 3: Based on data collected from building submeters. The total energy consumption to condition our waste room was 2,940 kWh which equates to a cost to condition our waste room of approximately \$323.42. The Molok containers did not cost any energy to condition or maintain in 2018. Therefore, the net savings if we were to only use the Moloks for waste, recycling and organics would be \$323.42 per year.

METHODOLOGY

Temperature probes were installed in the interior bag of the Molok waste organics container and on the interior tube of the Molok organics container. In total, four (4) temperature probes were installed on each Molok container at the following levels:

Top of Bin, 25" from Top of Bin, 50" from Top of Bin, Bottom of Bin
 The temperature data logger on both Molok containers was set to measure temperatures every hour. This log was downloaded every 2 weeks and the data collected for one (1) years.

Odours and temperatures were measured bi-weekly (every 2 weeks) for a period of one (1) year. Odours were measured at the Molok area and also in our waste room for comparison purposes.

SUMMARY OF FINDINGS

Based on the results of our two (2) year study on temperatures and odours emanating from the Waste and Organics Molok containers, we measured the temperatures at intervals of one (1) hour for at four (4) different depths for each Molok container. The below graph shows the temperatures from the waste and organics Molok containers vs the temperatures from our conditioned waste room. Please note that the temperatures were much more constant 50" from the top of the bin to the bottom of the bin for both the waste and organics Molok containers.

