

Personalized Recycling Education to Reduce Contamination

Custom mailers continued to drive contamination downward for 6 months after intervention.

East Lansing, MI – 2022/2023

The smaller a community is, the harder it can be to devote time and budget to a recycling program. The Recycling Partnership's (The Partnership) Feet on the Street program has proven effective in helping communities reduce recycling contamination among single-family residents. Through this program, trained teams check residents' recycling carts and leave a tag, letting them know if an item that does not belong in the community's recycling program is detected. Educational mailings and cart rejections are also used throughout the program to teach residents about their recycling habits.

Success of personalized feedback through Feet on the Street is undeniable. However, it can be labor-restrictive, weather-dependent, and costly. Small communities must be innovative to keep costs low and projects efficient while still making an impact. Enter cameras on collection trucks paired with AI (Artificial Intelligence) technology. Can these technologies answer budget and efficiency needs? Can AI be as effective as a cart tag at reducing contamination and increasing participation and capture?

To answer these questions, The Partnership collaborated with [Prairie Robotics](#) to develop and pilot an AI technology-based project in the City of East Lansing, Michigan, with a focus on learning if motivational messaging, delivered by direct mail, was the most effective in increasing recycling quality and whether the AI-generated response mailers were as effective as traditional cart tags. After the quality pilot was complete, a second pilot was conducted to increase participation in the recycling program. Once complete, a survey was mailed to residents to gather feedback.

The Recycling Partnership is grateful for the generosity of the City of East Lansing, the Michigan Department of Environment, Great Lakes, and Energy (EGLE), and Prairie Robotics for collaborating with us and graciously offering their staff time, resources, and ideas to strengthen this study. Without their partnership, this would not have been possible.

Key Takeaways:

- Contamination decreased by 22.5%.
- Educational and Emotional messaging decreased contaminant occurrences and increased set-out rate; however, Emotional messaging recipients contaminated 23% less and set-out 45% more.
- Survey results indicate that 76% of East Lansing households find a response mailer helpful, and 69% reported positive reactions to the correspondence.

Phase 1 - Quality


Study Design and Implementation

For this East Lansing pilot project, The Partnership wanted to learn if Prairie Robotics' AI technology could accurately detect contamination at the cart and whether a direct mailing with a picture of the household's specific contamination would decrease said contamination without the aid of cart rejection.

To accomplish this, each truck was outfitted with at least two cameras to identify recycling carts and to capture images of each cart's collected recyclables. The cameras were programmed to send images with a geo-tag of the street address for AI contamination analysis. If contamination was identified, the images were flagged and imported onto a response mailer to be sent to the resident as personalized feedback. Everything in the picture besides the contamination was blurred out for security purposes.

Two different response mailers were used to decide if there was a difference in the contamination reduction based on the message type. The Partnership used messaging created and evaluated by The Center for Sustainable Behavior and Impact (The Center) and incorporated it into the response mailers below.

	<p>Response Mailer Front: All response mailers included this front design with the non-recyclable materials highlighted and a household-specific contamination picture featured.</p>
	<p>Educational Nudge: Focused on pure education of what is recyclable with no emotional implications.</p>



ARE YOU WISHCYCLING?

EAST LANSING
City of East Lansing DPM
300 E State Rd
East Lansing, MI 48823

Download our 'Recycle Coach' App! Reminders, alerts, and tips on what can be recycled. Learn more online or download in the app store.

FLIP OVER
to see a photo of your recycling

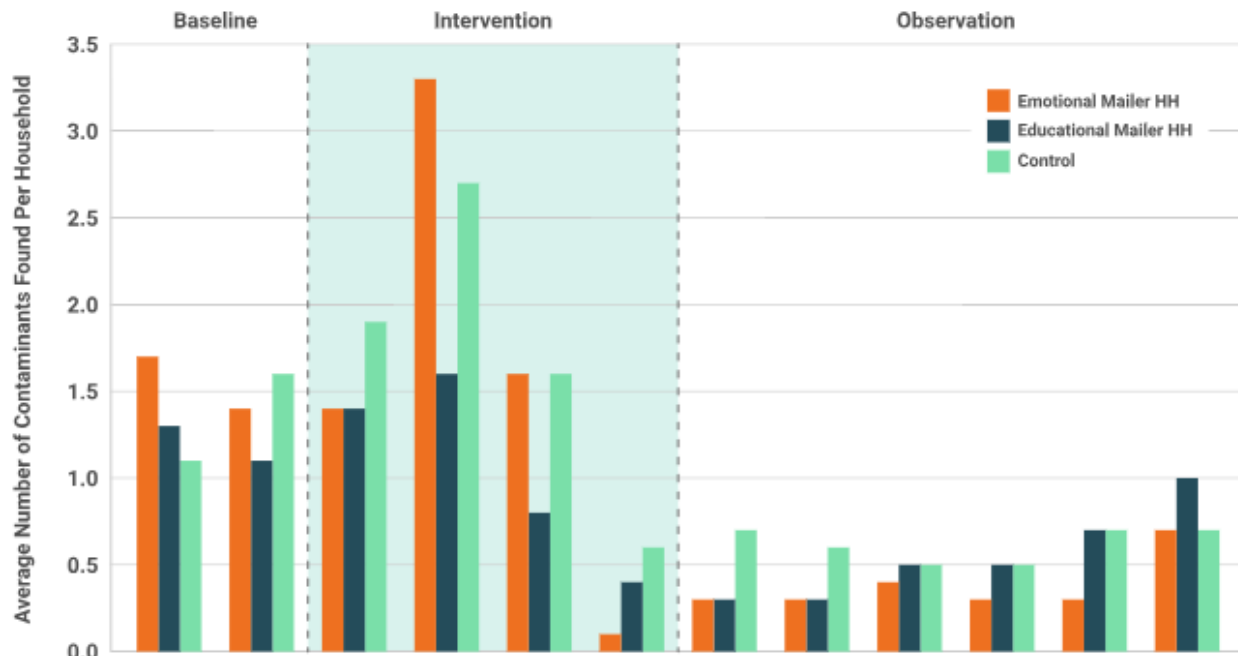
Scan this QR code to make sure you are recycling the right things and are helping to keep recyclables out of the landfill.

517-337-9459
cityofeastlansing.com/recycle

Emotional Nudge: Encouraged residents to think about the future of their waste and suggested an emotional implication to engage in the recycling program.

A city-wide recycling audit was conducted before the project to calculate the starting contamination rate in the three pilot areas. Households were then divided into three groups, each receiving the same informational mailer at the start, informing them of acceptable and non-acceptable materials. The control group did not receive contamination-specific response mailers, another group received response mailers with the Educational Nudge mailing panel, and the last group received response mailers with the Emotional Nudge mailing panel. Each group had an equal number of recycling routes and a similar demographic makeup based on average household income, race, and level of education, determined by the U.S. Census Bureau.

Response mailers were sent to any household that set out their recycling, and the picture taken of the material when collected indicated contamination of either one instance of bagged waste or recycling (black or non-black garbage bag) or two instances of any other type of flagged contamination (loose plastic film, loose plastic bags, EPS).



Baseline data collection occurred from September 26, 2022, to January 13, 2023, interventions were deployed over a twelve-week period from January 17 to April 7, 2023, and post-program data collection occurred from April 10 to October 2023. The extended baseline was due to fluctuations in the recycling generation during the holiday season. In total, 7,000 households received the informational postcard, and 1,853 quality response mailers were sent throughout the pilot. The cost per household was \$2.80 for print materials, camera hardware, and AI software.

Evaluation Methodology & Findings

To evaluate the impact of the interventions, we partnered with Ohio State University's Fisher College of Business. The impact of the interventions was measured in three ways.

1. Household set-out data was collected through software installed on trucks that determined if a recycling cart was set out or not set out. This data was collected one month before the interventions and then again during the month following the interventions. This data was also used to determine the recycling set-out rate.
2. The frequency of contaminant occurrences per set-out was a primary metric to determine if residents changed their behavior because of the informational and response mailer interventions. Contaminant occurrence data was collected using AI cameras on collection trucks servicing the respective routes and through the analysis of the pictures taken by the cameras. This data was collected for one month prior to the interventions, for the duration of the interventions, and for one month after the interventions.
3. A pre-and post-material audit was conducted at the MRF (Material Recovery Facility) to better understand the composition of recycling collected and how the contamination response mailers impacted the overall quality of the recycling collected throughout the city.

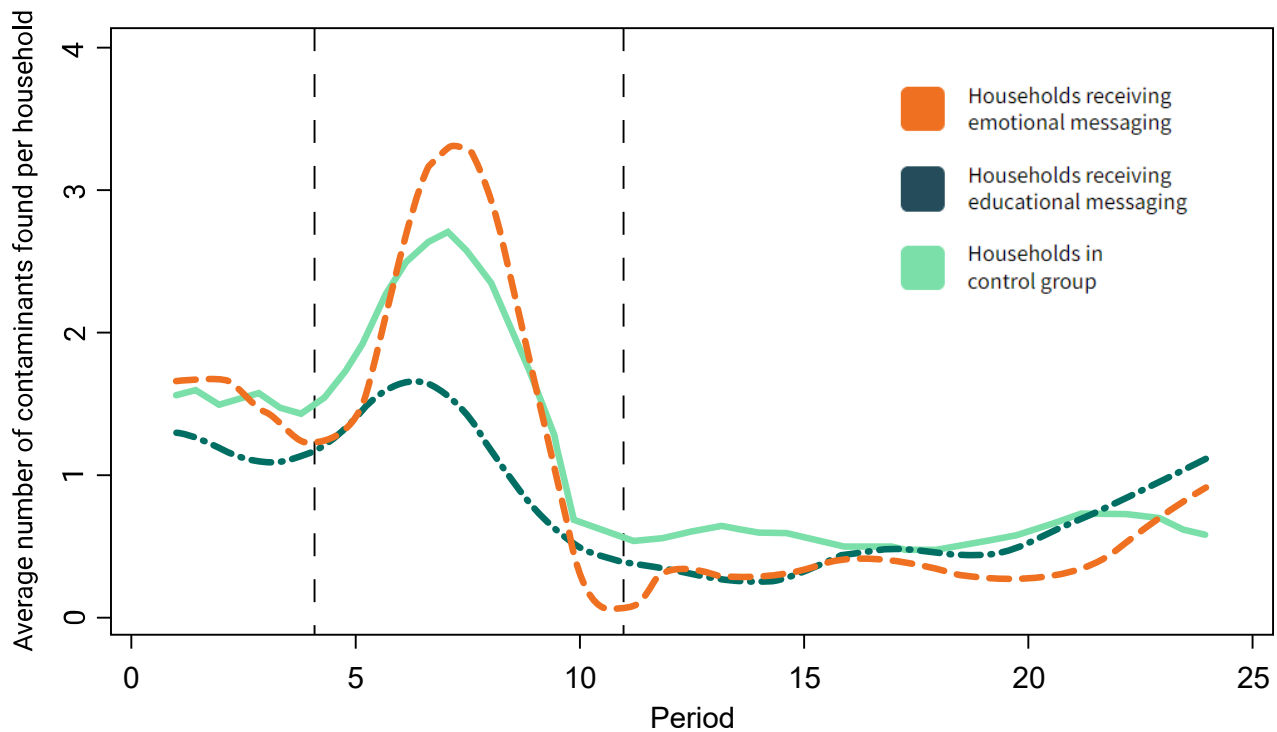
Impact on Community Recycling Set-Out

Results found households that received at least one Educational Nudge mailer increased the likelihood of cart set-out by 32%. In comparison, households that received at least one Emotional Nudge mailer increased the likelihood of cart set-out by 45%. While both the Educational Nudge and Emotional Nudge mailers increased recycling set-out throughout the project, the Emotional Nudge was more effective overall and more likely to lead to increased capture

Solid waste data has a lot of variability due to changes in resident behaviors such as moves, parties, holidays, or other events that can impact solid waste and recycling generation. East Lansing is also a university community, so the seasonality of the population could be responsible for swings in the recycling data. Considering this variability, it is important to note that the percentage increases in recycling set-out in this study are significant when compared to the control group.

Impact on Frequency of Contaminant Occurrence

Both Educational and Emotional messaging decreased contamination per set-out compared to the control group, and this behavior persisted through the end of the post-data collection. Households that received at least one Educational Nudge mailer contaminated 11% less than the control group. In comparison, households that received at least one Emotional Nudge mailer contaminated 23% less than the control group. While both Educational and Emotional response mailers decreased the frequency of contaminant occurrences in recycling setouts, resident response to the Emotional messaging appears stronger and more effective over time.

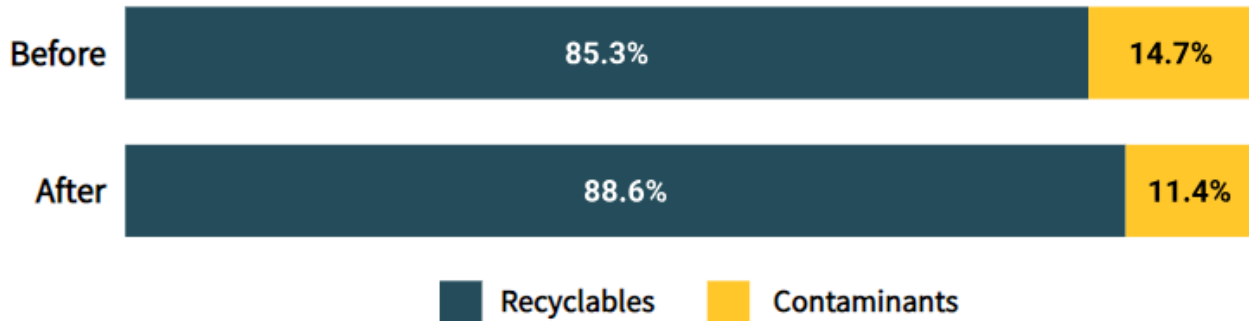


McKie, E.C., Sharma, N., Chandrasekaran, A. (2024). *Optimizing Recycling Behaviors through AI & Green Nudges* [PowerPoint Slides]. Operations & Business Analytics Department, Fisher College of Business, Ohio State University.

Overall analysis shows that Educational and Emotional Nudge messaging are more effective when administered to households with moderate to high education and income levels, as well as communities with low to moderate population densities. Messaging was also most effective at reducing the presence of plastic film, non-black grocery bags, and Styrofoam.

Impact on Recycling Quality

IRIS Waste Diversion Consultants and MSW Consultants conducted pre- and post-intervention audits on recycling. Due to the complex nature of the interventions, contamination rates could not be determined by intervention message type; rates could only be measured city-wide. Before the interventions occurred, the city-wide contamination rate was 14.7%. This rate decreased to 11.4% after the interventions were complete. This resulted in a 22.52% decrease of recycling contamination.



Phase 2 - Participation

Study Design and Implementation

After evaluating the project’s quality phase, the City of East Lansing focused the remainder of the project on increasing participation in no-to-low set-out households within the community. It was determined that participation education would be mailed three consecutive times, with six weeks in between, to all households that set out 0-3 times (<25% set out rate). Based on all data, the official mailing list for these households represented 26.6% of the city’s households.

A mailer created by The Center that had previously been successful in increasing participation was utilized for this second pilot and customized for East Lansing (see below). The same mailer was sent to all designated households three times, with 6-8 weeks between each mailer. The difference in time between mailers allowed for variations in mail delivery and accounted for holidays that fell within the pilot timeline. At least six weeks of collection to evaluate behavior was guaranteed.



Participation interventions were deployed from May to October 2023. Overall, 1,727 households received motivational messaging during the second phase participation pilot. The total cost per household was \$2.85 for print materials and postage.

Evaluation Methodology & Findings

To evaluate the impact of the participation interventions, we partnered with Jackson Somers, Assistant Professor of Agricultural and Resource Economics at the University of Connecticut. Intervention impact was measured in three ways against the set-out and participation data of the entire East Lansing population as a control group:

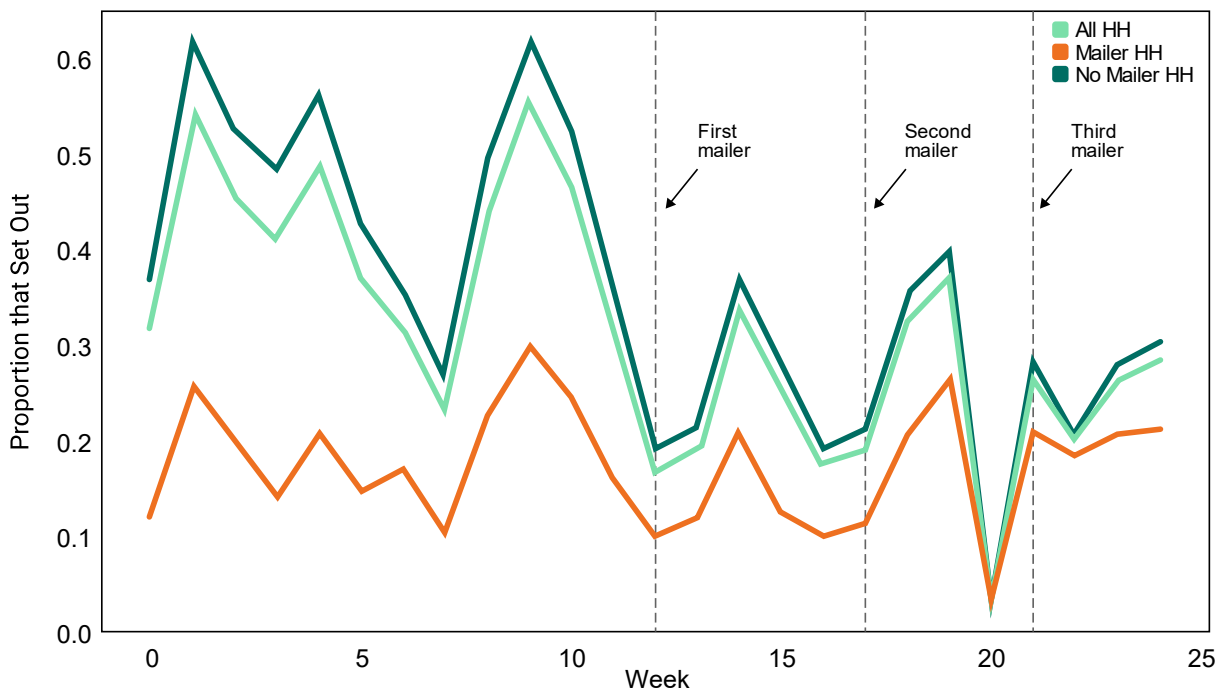
1. Set out as a result of all mailers – Each household’s set out was measured at the end of the project to determine the impact of all three mailers on the likelihood of the household increasing their set out.
2. Set out change after each mailer – Set out data was evaluated to determine if the likelihood of set out changed with each subsequent message.
3. Impact of mailers on non-set-out households versus low-set-out households – Set-out data was analyzed after all mailers were sent to determine if the impact varied based on whether the household was a zero-set out household or if they were a low-set-out household (1-3 set-outs).

Impact on Set-Out After Multiple Mailers

When comparing all the households that received the participation mailers and their base set-out rate, the average set-out rate was 18.23%. After three mailers, the likelihood of set-out increased to 34.94%.

Impact on Set-Out After Each Mailer

Based on the set-out data measured over six weeks after each mailer and compared to the rest of the population as the control, it was determined that the first mailer resulted in an average of 13.88% increase in set out, a 16.55% increase in set out after the second mailer, and a 19.92% increase in set out after the third mailer.



Somers, Jackson. (2024) *Brief East Lansing Report*. University of Connecticut

Impact on Zero-Set-Out Versus Low-Set-Out Households After Multiple Mailers

When comparing the effect of the three mailers on zero-set-out households versus low-set-out households, we see a striking difference in impact. Households that had previously not set out were 28.52% more likely to set out after receiving the three mailers. For households that had only set out once, the increase in set-out was 17.92%. For households with two set outs, the increase in set-out was 17.87%, and for households with three set outs, the set-out increased by 13.2%.

Based on data collected in East Lansing, we can affirm that utilizing multiple participation mailers increased set out and participation in the curbside recycling program and had a greater impact on households that had not participated versus those that had low set out during the study.

Phase 3 – Resident Survey

Study Design and Implementation

Because this project included cameras and AI technology and is a new and emerging option in the recycling field, there was discussion about whether residents would find the pictures to be an over-step and/or create negative feelings toward the recycling service and the City. To answer this question, a survey was created by [OpinionWorks](#) to gauge household's feelings towards the city services and the response mailers used during the quality project. A 13-question survey was mailed to all households in East Lansing a year after the original project was completed, with the option of online or mail-back completion. There were a total of 418 respondents, representing 5.9% of the households.

General questions about the city recycling services showed positive responses (96% reported satisfaction with curbside recycling services, and 83% reported satisfaction with the service information provided). The survey results related to the response mailer were also very positive (76% reported finding the response mailer helpful, and 69% reported feeling positive about the response mailer if received). Most respondents categorized themselves as White (90%) and highly educated (88% had a four-year college degree or more), which does not provide a diverse perspective and should be considered when examining the survey results.

Conclusion

Each piece of this project provided specific insight into resident behavior and better equips us to tailor new projects to replicate and continue testing these methods. Based on the positive results, The Partnership will continue using the response mailers with real-time pictures but will look to survey additional communities with more diverse populations. The response mailers will also utilize Emotional messaging in future projects to evaluate whether this message continues to have better and more long-lasting results concerning the quality of recycling and decreasing contaminant occurrences. Additionally, to increase the set-out and participation rates in the future, communities will be encouraged to mail multiple participation mailers to all households that did not set out during the quality project.

While this study represents one community and one data point, it does provide applicable data to use when applying behavior change methods to recycling. The Recycling Partnership is grateful to each partner who contributed to this project and its outcomes. Additional information about this project and The Partnership's tools and resources for communities, counties, and states can be found at recyclingpartnership.org.