

Municipal Food Waste Collection Reduces Food Waste in Landfill and Promotes Positive Behavioral Spillovers.

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FINAL REPORT

Prepared for the
Environmental Research and Education Foundation

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EXECUTIVE SUMMARY

Duke University's Center for Advanced Hindsight, in partnership with the City of Durham, developed and tested a municipal food waste collection program to divert organic waste from landfills by composting these materials instead. In addition to diversion from landfills, our goals were to address diverse user needs, minimize contamination of materials, and study positive spillover behaviors that may result from participating in composting. Our approach was rooted in principles of behavioral economics, developed through human-centered design, and modified with the help of rigorous evaluation. The project consisted of three distinct phases:

In Phase I, exploration and Prototype, we aimed to learn about Durham residents' perspectives on composting and begin crafting a program to suit their needs. We developed two small prototypes informed by user feedback to gain insights about people's experiences of the composting process.

We found that Durham residents were likely to compost due to values around environmental preservation, which later led us to explore the possibility of activating pro-environmental identity and spillover behaviors (i.e., secondary behaviors that are causally linked to a related primary behavior (Nash et al., 2017)). We also found that if people chose not to compost, it was typically because of self-reported lack of knowledge about the process or concerns about cleanliness, odors and/or pests. Collaborations with Solid Waste Management staff also revealed concerns around contamination between compost and landfill trash that would harm the viability of the final compost product. This collection of motivators, barriers, and opportunities all informed our creation of a pilot program in Phase II.

In Phase II, the small-scale Pilot, we implemented findings from the prototypes to test operational capabilities of the municipal program, particularly around contamination. We piloted the program with 80 households in one neighborhood, and assessed effectiveness through collections data, participant surveys, and interviews. The surveys and interviews enabled exploration of the impact of composting on identity.

Despite our best efforts, the recruitment methods for Phase II lead to a sample that was not demographically representative of the City of Durham. This led us to alter recruitment methods in Phase III. Nevertheless, our results were encouraging: the educational efforts helped new composters to compost correctly (i.e. avoid contamination), and composting led residents to reduce the amount of waste they reported sending to landfills. We also gained additional insights about the positive impacts of composting on identities and *behaviors*, an area which took center-stage in Phase III. Above all, we showed the program was tenable.

In Phase III, the Randomized Control Trial (RCT), we aimed to test the program's effectiveness in reducing household waste sent to landfill, while also investigating the impact on pro-environmental and pro-community identities, and (as we hypothesized) resulting positive spillover behaviors. We conducted an RCT with 360 households assigned to either the treatment (first roll-out) or the control (later roll-out).

Although we experienced some setbacks, we ultimately found that treatment households sent 5.8 less pounds of waste per week to the landfill, suggesting that a municipal composting program may divert food waste from the landfill (a finding which was in line with our hypothesis as well as prior research). Additionally, the treatment group showed signs of improved relationships with Durham's municipal government, and also showed greater increases in some pro-environmental and pro-community spillover behaviors.

The City has since rolled out the compost program to the control group and will continue to analyze its effectiveness through follow-up interviews with participating residents from both original treatment and control groups. Following analysis by CAH, key takeaways from the interviews and surveys will inform not only future city-wide rollout, but also a how-to manual for other municipalities that aim to establish composting programs for the benefit of their environments and communities.

INTRODUCTION

Background: Why Compost?

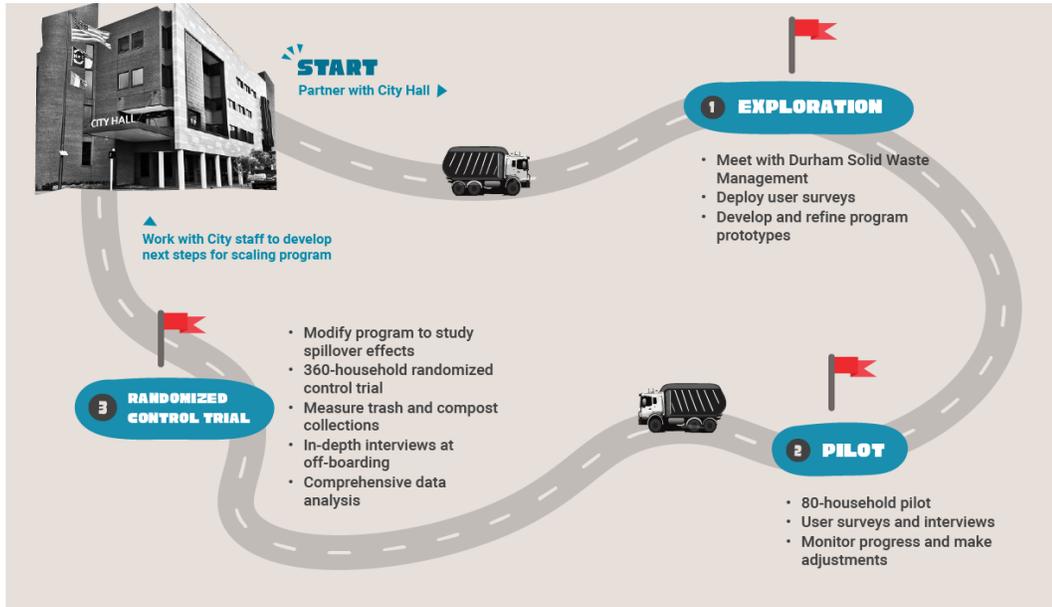
Roughly 39,620 tons of food made for human consumption were discarded in landfills in the US in 2019—close to a 12% increase from the year prior, and nearly three times as much as what was wasted in 1990. The enormous and rapidly increasing amount of food waste that ends up in landfills is devastating both for the climate and for human health. Globally, food waste is responsible for 8% of greenhouse gas emissions, and in the U.S., it constitutes 22% of municipal solid waste that ends up in landfills. Food waste in landfills releases methane, which holds a global warming potential more than 20 times greater than carbon dioxide. At a more local level, landfills cause air pollution that can sicken nearby residents. Landfill sites are also disproportionately located in low-income areas with high racial minority populations, making landfill impact a serious environmental justice issue. On top of the environmental and health impacts, landfills drain municipalities' financial resources— just one acre of landfill costs \$1 million to construct and maintain (U.S. EPA, 2014).

Composting food waste can reduce public health harms, increase communities' resilience to the effects of climate change, *and* save cities money. Compost is a rich soil amendment that increases soil's water-holding capacity, enabling the soil to absorb water during severe storms that will only become more common due to climate change. Composting also reduces greenhouse gasses by "improving carbon sequestration in the soil and by preventing methane emissions through aerobic decomposition" (U.S. EPA, 2020). However, despite the long-term benefits of composting, only 4% of food waste is composted. The city of Durham is no exception to this trend: a 2015 waste characterization study found that 30% of the waste the city sent to its landfill was compostable (City of Durham Solid Waste Management 2015).

In this study, we examine the extent to which a composting program can divert food waste from landfills. In doing so, we build on findings from studies of municipal composting programs' diversion of waste from landfills in Sweden and Australia (Alacevich et al., 2021; De Silva & Taylor, 2021). We also look past immediate environmental impacts and consider positive spillover behaviors, building on prior research that suggests environmental identities can mediate other pro-environmental behaviors (Cornelissen et al., 2008). We aim to test whether participation in a composting program might activate pro-social and pro-environmental identities, ultimately driving participants to act in other ways that benefit their community and natural environment.

Our Approach: Partnerships and Iteration

The Center for Advanced Hindsight at Duke University partnered on this project with two City of Durham stakeholders: the Innovation Team (I-Team), and the Solid Waste Management Department. These partnerships not only provided an exciting opportunity to test an intervention with its target resident population, but also ensured that the program itself would be informed by the needs of the city workers who may carry it forward. Additionally, the project is in strong alignment with the goals of "alternative, innovative" waste reduction strategies stated in the city's 2024-26 Strategic Plan.



Together, we developed and tested a municipal composting program in three phases. At the outset, our approach was grounded in behavioral economics— we designed an initial prototype (Phase I) that took into account psychological barriers to composting. We improved upon our program through human-centered design by re-prototyping after implementing feedback, and then conducting a small-scale pilot with several feedback opportunities (Phase II). We finally tested our program’s effectiveness in diverting food waste from landfills through rigorous evaluation in a Randomized Control Trial (Phase III). We also returned to our behavioral economics inquiries in this phase, testing whether participation in the program increased participants’ engagement in pro-environmental or community behaviors by way of pro-environmental and pro-community identity creation. We have now completed analysis of the program and its behavioral spillover effects, and the city is making plans to scale up – a process that will take time and added infrastructure, but will be facilitated by findings from our design and evaluation process.



Research Questions

Over the course of the three project phases, we were guided by the following questions:

1. **Diversion from Landfill:** Can a municipal curbside composting program reduce the amount of trash a city sends to the landfill?
2. **Centering Diverse Users:** How can we encourage participation in a curbside compost program among all Durham residents?
3. **Minimizing Contamination:** How should the curbside composting program be designed to minimize contamination in compost collections (i.e., inclusion of non-compostable trash)?
4. **Promoting Positive Spillovers:** Can participation in the curbside composting program promote other pro-community and pro-environmental behaviors in participants?

Review of Literature: The Need for Municipal Composting Programs

Harms Caused by Excessive Landfill Usage

55.9% of total food waste is disposed of in landfills, a practice which ultimately contributes to global warming (Recycle Track Systems, 2022). When food waste is disposed of in a landfill, it releases methane, which has a global warming potential 28-36 times more potent than carbon dioxide. According to the Environmental Protection Agency, landfills are the third-largest source of human-caused methane emissions in the US (EPA, 2021). A 2024 study of landfills in 18 US states found evidence that the emissions from these landfills were significant and persistent drivers of climate change (Cusworth et al., 2024). In addition to causing environmental harms, landfills are expensive—a 2012 study found that land for landfills in the US costs more than \$1 million per acre (Fitzwater, 2012).

Methane and volatile organic compounds that are emitted from landfills are also known to have deleterious health effects on nearby residents. Landfill sites are disproportionately located in neighborhoods with high proportions of people of color, and ultimately causing disproportionate harm to these communities (Schlanger, 2020). Given Durham's intent to redress racially inequitable outcomes in past community development policies, we believe that the racial inequities around landfill usage may make a composting program particularly beneficial for the City.

Environmental Benefits of a Transition to Composting

Transitioning to composting has been shown to reduce the amount of land taken up by landfills, and in doing so, mitigate landfills' negative environmental impacts. In an examination of the environmental impacts and energy use of landfills and compost systems, Behrooznia et al. (2018) found that composting is less harmful to the environment than landfills. Several studies have found that waste decomposition through composting produces far less methane and greenhouse gasses than decomposition in landfills (Brown, 2016; Lou & Nair, 2009).

In 2022, food waste was the most prevalent type of matter in American landfills. One method for addressing the problem of large and growing landfills is by composting food waste, but the practice is not currently commonplace. Across the US, estimates of how much of the municipal waste stream could be composted instead of landfilled vary between 20-35% (Project Drawdown, 2019). Many individuals have the option to compost on their own either in their backyard or through a private service, but these options are rarely adopted and are largely inaccessible for either physical reasons (e.g., living in multi-family housing) or financial reasons (e.g., because services are costly). Due to physical, financial, and other limitations, only about 4% of food waste in the US is composted, despite concerns around diminishing space and increasing environmental harms (U.S.EPA, 2020).

Some municipalities have begun to explore the potential of citywide, easily accessible compost systems to recycle food waste and divert it from landfills (Keng et al., 2020). A 2013 scenario analysis found that recycling organic waste, such as food and garden waste, can successfully reduce the presence of such waste in landfills—and therefore the space taken up in landfills—while also lessening greenhouse gas emissions produced from

waste sites (Seng et al., 2013). The analysis also found that implementing compost systems could generate economic benefits such as job creation from selling dry compost.

The Impact of Municipal Composting Programs

Through iterative design and rigorous evaluation, several cities have found that municipal composting programs have the capacity to divert waste from landfills, ultimately reducing contributions to global warming and related public health harms.

Through a multi-phased design process, the city of Ottawa, Canada developed a composting program that successfully diverted over 10,000 metric tons of organic material from landfills in their compost program (NYC Global Partners, 2012). Similarly, over the course of three years and several design iterations, the city of Portland, Oregon developed a municipal composting program that ultimately reduced landfill-bound trash by 37%.

Ek and Miliute-Plepiene (2018) are the first to study the impact of municipal food waste collection through a randomized control trial. Relying on aggregate level household waste data and a difference-in-difference model, they exploit the staggered implementation of food-waste collection across Swedish municipalities. Similar results have been found in another municipality in Sweden (Alacevich et al., 2021) and in New South Wales, Australia (De Silva & Taylor, 2021). We build on these results through our RCT in Durham, but in addition to evaluating program effectiveness, our RCT investigates positive spillover behaviors.

Spillover Effects and Composting

Behavioral spillovers occur when engaging in one behavior has a causal effect on other behaviors (Nash et al., 2017). Behavioral spillovers can have positive or negative impacts on an individual's community or environment. Governments therefore are wise to consider the potential spillover impacts of policies and programs they plan to implement.

In recent years, there has been an explosion of research into pro-environmental spillover behaviors to promote environmental benefits. For instance, a series of studies published in 2015 on reusable grocery bag use and purchasing behavior found that bringing your own bags can increase the likelihood of both purchasing organic products and purchasing indulgent products, suggesting both positive and negative spillover mechanisms were at play (Karmarkar & Bollinger, 2015). A 2019 meta-analysis of environmental spillover studies found evidence of small but significant positive spillovers from positive environmental behaviors into intent to perform a second behavior, but a very small *negative* spillover into actual behavior (Maki et al., 2019).

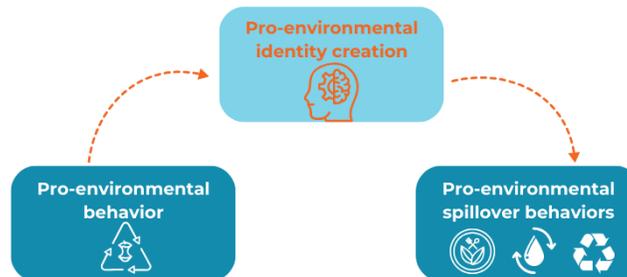
A smaller group of studies have focused on the positive spillover effects of composting programs in particular. Alacevich, Bonev and Soderber (2021) found that a composting program not only reduced food waste headed to the landfill, but also had a positive spillover on other pro-environmental behaviors, specifically recycling. Similarly, Sintov et al. (2017) assessed spillovers from participation in a new district-run compost system on other household waste prevention behaviors related to food, energy, and water. Results support the theory that composting can spillover to water and energy waste reduction behaviors, but the effect size was small.

While the psychological source of spillover behaviors is difficult to pinpoint empirically, spillovers may be related to cognitive dissonance theory, which posits that people aim to maintain consistency in their behaviors and therefore will enact behaviors similar to those they have enacted before (e.g., trying composting if they already recycle) (Festinger, 1957). Van der Werff et al. (2013) found evidence supporting cognitive dissonance theory as a driver of pro-environmental spillover behaviors: they found that when people were reminded of their own previous performance on a range of pro-environmental behaviors, they were more likely to behave consistently than if they were reminded of environmentally unfriendly actions.

Pro-environmental identity also may play a role in spillover behaviors: Cornelissen et al. (2008) demonstrate that cueing the impact of a person's pro-environmental behavior leads them to view themselves as a pro-environmental person, which then leads them to behave consistently. Maki et al.'s 77-study meta-analysis

similarly finds that interventions that targeted identity led to more positive effect sizes for pro-environmental spillover behaviors and policy support.

Following the development of a composting program for the city of Durham, we aim to build on research about pro-environmental spillovers by exploring the composting program’s potential to 1) form pro-environmental identity among participants and 2) promote pro-environmental spillovers by way of that identity.



Phase I: Exploration through Prototyping

The first phase of the composting program—conducted in the summer of 2019— was dedicated to exploratory program design through prototyping. We aimed to test our assumptions about what would make an “effective” program by soliciting extensive user feedback. Recognizing the impossibility of achieving a “perfect” service from the outset, the CAH team and the City of Durham embraced the idea that the composting program could be continuously improved and expanded over time.

i. Goals of Prototype Phase

Through prototyping, we set out to:

Divert Food Waste from Landfill: Diverting food waste from Durham’s landfill was our primary reason for developing a municipal composting system and therefore our core motivation for maximizing its effectiveness.

Center Diverse User Needs: In order to create a user-centered and effective program, we recruited groups who would provide perspectives both of people completely inexperienced with a program like municipal composting, and people who may have some indirect but relevant experience. For the first group, we recruited people with no composting experience. For the second group, we chose to recruit people who had taken part in the City’s yard waste collection program, and therefore had some knowledge about contamination concerns and collections practices.

Minimize Contamination: In both prototypes, we sought to gain a preliminary understanding of how to make a curbside composting program effective—specifically, we aimed to minimize residents’ tendencies to put non-food waste in their compost carts (a key concern of Solid Waste Management staff). Minimizing contamination requires residents to thoroughly understand composting, and our educational materials in both prototypes aim to solidify that understanding.

Study Spillover Identities: We also began investigating questions about motivations for composting, which in later phases evolved into questions about pro-environmental and pro-community identities, and the possibility of mobilizing those identities to promote positive spillover behaviors.

ii. Prototyping Methods

We ran 2 prototypes, with the second building on the findings of the first:

	Prototype A	Prototype B
Participants	8 households from diverse demographics and with little to no composting experience.	7 households with experience participating in the city's yard waste collection service
Materials Provided	<ul style="list-style-type: none"> ● Laminated "Do's and Don'ts" one-pager with best practices ● One 1.5 gal indoor bin with "Do's and Don'ts" printed on lid ● A limited amount of green "bio bags" and paper bags. 	<ul style="list-style-type: none"> ● Updated educational materials ● A new outdoor compost cart ● 1.5 gal indoor bin with "Do's and Don'ts" printed on lid ● Limited amount of green "bio bags" and paper bags
Process	<ul style="list-style-type: none"> ● Compost collected weekly by City of Durham Innovation Team ● Contamination assessed at private collection site 	<ul style="list-style-type: none"> ● Compost collected weekly by City of Durham's Innovation Team with SWM team members. ● Materials processed and contamination assessed at SWM facility.
Evaluation	<p>Quantitative:</p> <ul style="list-style-type: none"> ● Weight of material collected ● Amount of contamination <p>Qualitative:</p> <ul style="list-style-type: none"> ● Photos of process and materials ● Support line usage ● Midpoint survey ● Feedback interview 	<p>Quantitative:</p> <ul style="list-style-type: none"> ● Weight of material collected ● Amount of contamination <p>Qualitative:</p> <ul style="list-style-type: none"> ● Support line usage ● Feedback interview

iii. Prototype Findings and Takeaways

Below, we provide key findings from our prototype phase and show in the graphic how those findings ultimately impacted our future phases.

Diverting Food Waste from Landfill

In Prototype A, a total of 216.8 pounds of food waste was collected, with some instances of contamination. In Prototype B, a total of 104.35 pounds of food waste was collected and minimal contamination was discovered (after refining education materials in Prototype A).

Overall, we found that users had trouble remembering to put out their carts for pick-up, and requested several forms of reminders. They were motivated by updated statistics that they received about the success of the program, and how much waste had been diverted from the landfill.

Centering Diverse User Needs

Cleanliness was a key concern for new composters. After the prototype, those concerns were partly put to rest, but some wariness remained. Participants liked that composting kept their trash from smelling while also helping them reduce their use of trash bags. The security and cleanliness of the bin was particularly important to users, and many still worried about insects and rodents.

New composters also relied heavily on educational materials at first, but didn't need them for long. Surprisingly, the participants who had past experience with composting in their backyards actually had a more difficult time adjusting to the programs than the new composters did - most likely a result of needing to adjust to changes in the permitted items from backyard to municipal collection.

Minimizing Contamination

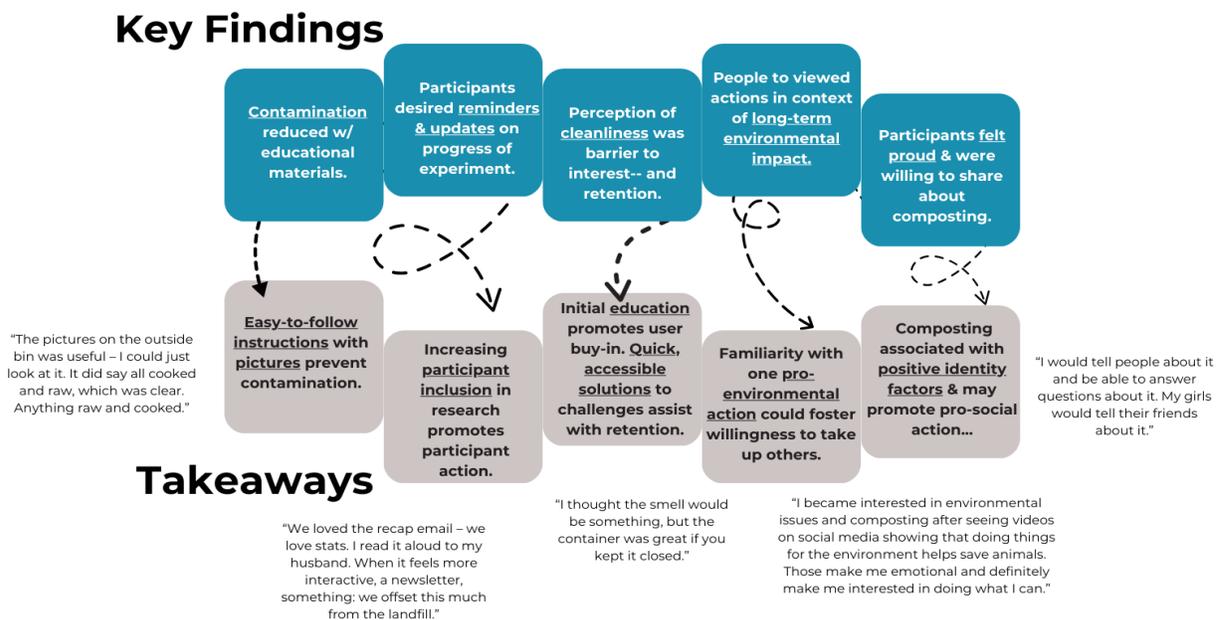
Contamination arose largely from user confusion, which we predicted as a problem given that many were concerned about their lack of composting knowledge. Some people threw questionably compostable items in the trash instead of risking contamination. Others risked contamination by putting questionable items in compost, hoping that someone on the receiving side would make the ultimate decision. Concise yet descriptive messaging around accepted materials was essential to minimizing this contamination. Pictures of what was compostable and what was not were especially helpful.

Studying Spillovers

New composters were surprised by how easy composting turned out to be, and found that the process enlightened them about their waste behaviors. As a result, several participants expressed aspirations to reduce food waste at the source (i.e. decrease purchasing), but found it challenging. The act of composting therefore helped to reduce the guilt of throwing things away. Several also liked that composting helped them to reduce their use of trash bags.

After becoming comfortable with the program, many people felt empowered to establish their own composting practices that worked for them—for instance, investing in a small bin for their countertop.

Participants felt proud to compost, with some being willing to spread the word about composting throughout their community. Composters in the program viewed themselves as more environmentally-conscious than the general population, pointing to the potential for identity-priming interventions in later stages of this project.



Phase II: Small-Scale Pilot of Compost Program

Phase II was a soft launch of the twice-prototyped compost program. This phase allowed us to roll out the new program on a slightly larger scale, but with a small enough group that we were able to continue soliciting and implementing feedback prior to a larger-scale evaluation. Once again, we drew on our three grounding principles of Behavioral Economics, Human-Centered Design, and Rigorous Evaluation.

iv. Goals of Pilot Phase

Divert Food Waste from Landfill

By measuring the amount of food waste in participants' compost carts (and the frequency with which they put out their carts), we investigated how much food waste was successfully diverted from the landfill.

Center Diverse Users' Needs

We selected the neighborhood of Walltown because of its demographic representativeness of the highly diverse City of Durham.

Minimize Contamination

Once again, we aimed to minimize contamination of materials, given that it was a concern in the first prototype. In this phase, we operationalized our goal with the help of Solid Waste Management (SWM) staff. SWM compost collectors checked each compost cart for contamination while they were performing their weekly collection services, and gave "Oops!" door hangers to households who had contamination in their carts each time it occurred. The door hangers informed participants that there were items in their cart that could not be composted, and the contents of their cart therefore could not be collected.

Study Spillovers

In Phase II, we began our investigation of spillover behaviors in earnest. We used the surveys and interviews not only to gain user feedback, but also to explore the extent to which users experienced increases in pro-environmental and pro-community identities, and ultimately, correspondingly positive spillover behaviors.

v. Pilot Methods

Recruitment Process and Onboarding Materials

Our goal was to enroll 100 Walltown residents in Phase II of the compost program. The recruitment methods for the program included email campaigns, flyers distribution, and social media posts on Nextdoor. The recruitment messages informed residents about the pilot program and provided a link to the intake survey that allowed recipients to enroll in it.

After households enrolled in the program, they were provided with an indoor compost bin and outdoor collection cart to use for the disposal of compostable waste. The indoor bins are designed to be placed on kitchen counters and store household compost until it is transferred into the outdoor collection carts. We tested three different indoor bins to gather participants' feedback on the different options (photos of bins can be found in Appendix A). Two different plastic bins and one metal bin were randomly distributed to program participants. We also tested two different outdoor collection carts. Participants were instructed to empty their indoor compost bins into these carts and place the carts on their curb for collection.

During their onboarding, all participants also received a handout which detailed the items that could be composted through this program. Participants also received a list of suggestions for reducing odor from their indoor compost bins. We developed these materials based on the feedback from the two prototypes. Please see Appendix A for copies of these materials.

Surveys

Participants completed four surveys: intake, one month prior to roll-out; onboarding, during week 1; midway, during week 3; and offboarding, during week 6. These surveys collected information about:

- *Participant demographics*
- *Experience/ familiarity with composting*
- *Perceived difficulty of composting*
- *Perceived usefulness of materials*

- *Reasons for composting*
- *Identification with pro-environmental values*
- *Frequency of pro-environmental spillover behaviors*

vi. Pilot Results

Diversion from Landfill

At the curbside composting pilot’s 6-week mark—when participants completed offboarding surveys— 2,640 pounds of food waste had been diverted from the landfill. The average weight of food waste collected per person in the program changed from week to week, with the low being three pounds and the high being nine pounds. Many participants chose to continue participating in the pilot after the offboarding survey. As of August 2023, 29,530 lbs of food waste had been diverted from the landfill through the composting pilot.



Figure 1: Pounds of Food Waste Collected Each Week from Pilot Participants

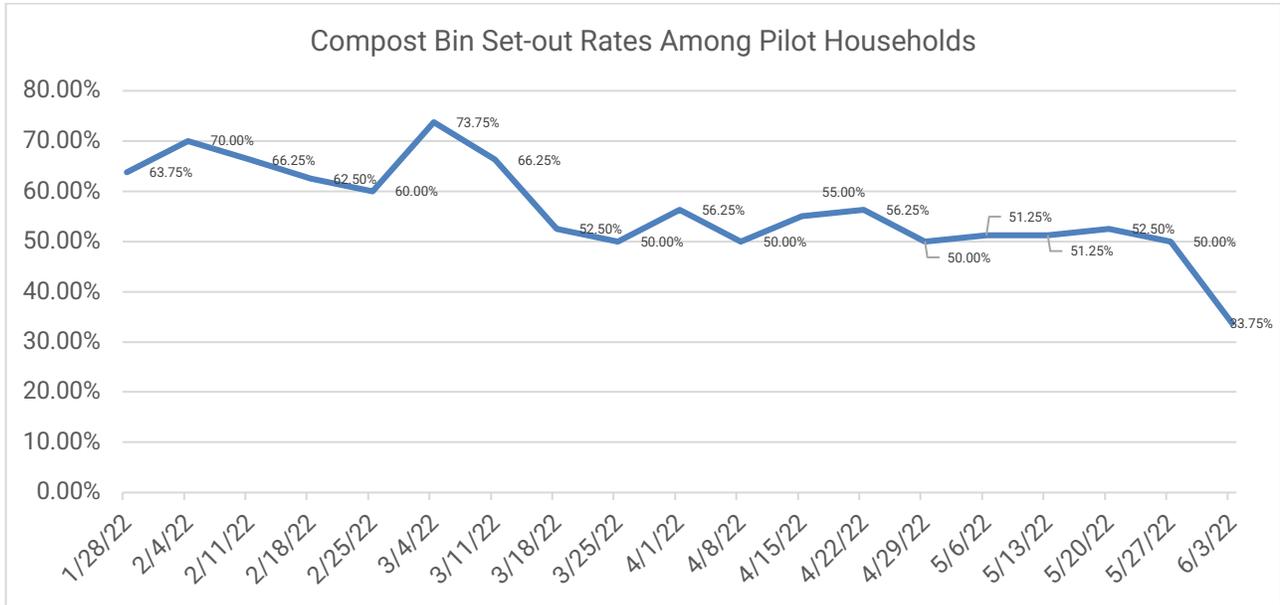


Figure 2: Set Out Rates Each Week from Pilot Participants

The variations in amount of waste collected was in part the result of participants' inconsistency in bringing their carts to their curb for pick-up: the proportion of participating households that put out their carts for pick-up ranged from week to week, from 40 to 80% of households. We mitigated this issue by sending email reminders prior to pick-up.

Through participant surveys, we also used self-reported trash bag usage as a proxy measurement for the amount of trash sent to landfills. We found that participants significantly reduced their trash bag usage over the course of the pilot: Households that produced one bag or less of landfill waste per week increased from 54% to 70% from week one to week six of the program. People who were not composting prior to participation in the pilot had a greater reduction in trash bag usage than those who had been composting previously, suggesting that the act of composting may have decreased the amount of waste people sent to the landfill. In the next phase, we set out to experimentally test whether this reduction can be causally attributed to participation in the composting program.

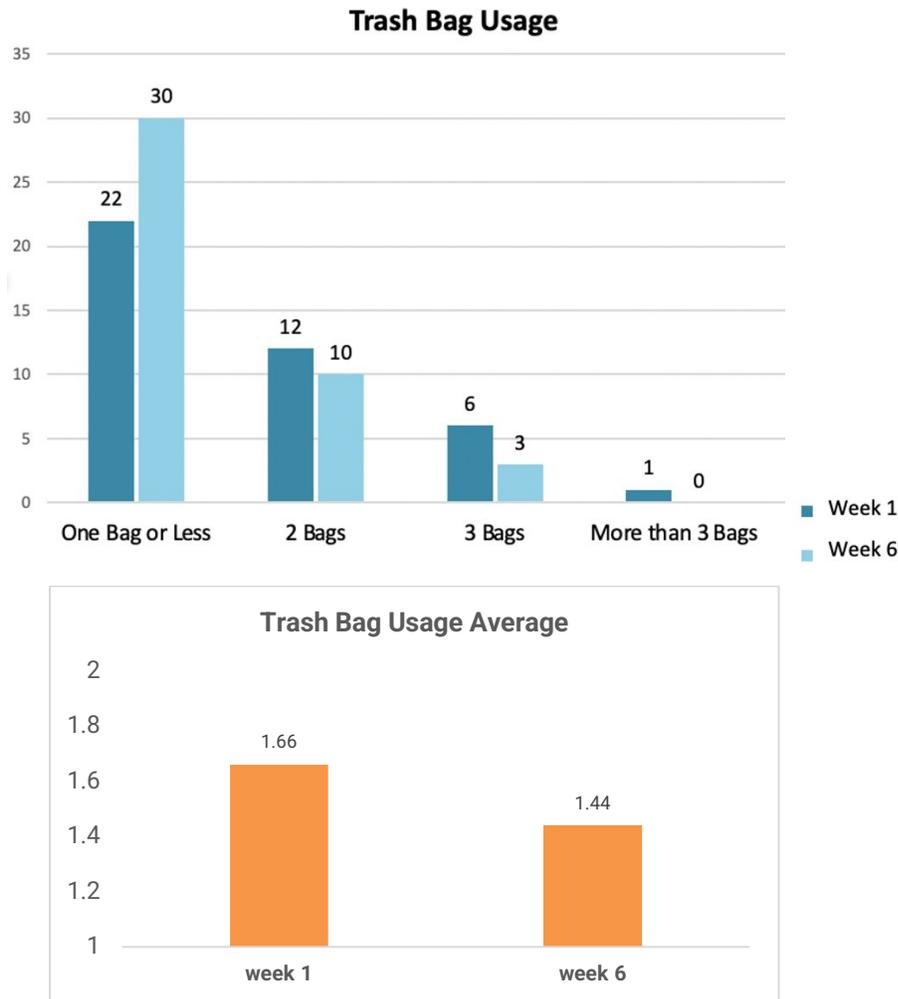


Figure 3: Participants' Self-Reported Number of Trash Bags Used in the Past in Week 1 and Week 6 of Composting Program

Centering Diverse Users' Needs

Despite our selection of the diverse neighborhood of Walltown, our sample was not as diverse as the population of Durham. The majority of the sample (68%) was female, non-Hispanic (92%) and White (84%).

Furthermore, a significant majority of participants expressed familiarity with how composting worked at onboarding. 43% of participants were current composters when they enrolled in the program. Only one participant had never heard of composting before. This over-selection of people who were familiar with the process of composting may have played a role in our efforts to minimize contamination, which were largely successful.

Minimizing Contamination

A central goal of the pilot was to make effective composting with minimal contamination as easy for users as possible (with ease of use being a key goal in programs informed by behavioral economics). Our efforts were largely successful: SWM staff reported minimal contamination, and a substantial majority of participants (65%) expressed that “everything is clear and the (composting) system is easy” at the midway point.

As is demonstrated in the visualization, most participants found the educational materials provided to be helpful, particularly the “Do’s and Don’ts” sheet that we developed specifically to help participants minimize contamination.

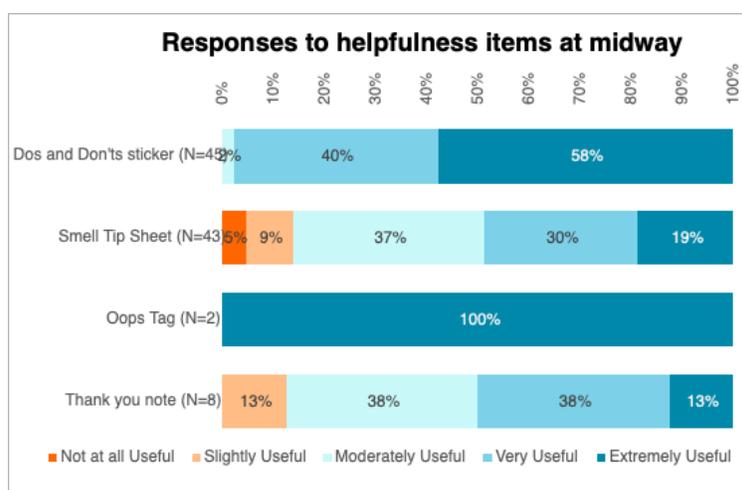


Figure 4: Pilot Participants' Perceptions of the Helpfulness of Materials Provided in the Composting Pilot

Studying Spillovers

In the pilot phase, we began our investigation of the composting program's impact on pro-environmental identity and related spillover behaviors. We tested this pro-environmental identity through survey questions that asked participants the extent to which they considered themselves an "environmentally-friendly consumer," and "someone who is very concerned about environmental issues." Participants responded more positively to these questions at offboarding than at onboarding, suggesting that they had a stronger environmental identity after participating in the program.

People who were less familiar with composting before the program had a greater increase than those who were more familiar, suggesting that the program may have influenced their levels of pro-environmental identity.

In all surveys, we also inquired about participants' pro-environmental behaviors beyond composting, given that we aimed to explore the potential of the composting program to promote other positive behavioral "spillovers". We found little change between onboarding and offboarding surveys for most pro-environmental behaviors, with the exception of purchasing products with minimal packaging. We attribute this in part to the brevity of the pilot program. In phase III, we therefore further explore the impact of pro-environmental identity from the composting program by investigating changes in spillovers over a longer period of time, through a randomized control trial.

Phase III: Scaling Up for a Randomized Control Trial

Following the completion of the prototype and pilot, we were confident that the composting program was both successful in mitigating contamination and attentive to the needs of users. In Phase III, we turned to the task of testing our primary hypothesis about the composting program: that it could cause a city to send less food waste to the landfill. We assessed not only whether the program could divert food waste from the landfill, but how much it could divert. We also tested the program's ability to promote pro-environmental and pro-community spillover behaviors by way of correspondingly pro-environmental and pro-community identity creation.

i. Goals of RCT Phase

Divert Food Waste from Landfill:

We experimentally tested our hypothesis that the municipal composting program can cause a reduction in food waste sent to the landfill.

Center Diverse User Needs:

We carried forward program attributes that had been designed through user feedback (e.g., the compost cart that was most popular among users).

Minimize Contamination:

We carried forward the program attributes that minimized contamination in previous phases (e.g., successful educational materials).

Study Spillovers:

We experimentally tested our hypothesis that the composting program can increase pro-environmental and pro-community identity, and as a result, lead to pro-environmental and pro-community spillover behaviors.

ii. Hypotheses

1. The municipal composting program will divert food waste from landfills.
2. The municipal composting program will contribute to increased pro-environmental and pro-community identity formation among participants.
3. Pro-environmental and pro-community identity formed through the composting program will lead to increased pro-environmental and pro-community spillover behaviors.

iii. Study Methods

Recruitment and Group Assignment

Participant households were recruited by the SWM Department. We originally aimed to recruit ~1,000 Durham households that we would then randomly assign to one of the four condition groups. However, our target areas decreased as we faced technical setbacks with onboard truck scales, which were crucial to the design of the study, given that we were primarily interested in the impact of the composting program on the weight of landfill-bound waste.

Due to logistic constraints with scale technology, we ultimately reduced the number of trucks in use for the study, and therefore the number of routes from which we could collect data. We therefore simplified our design to include two condition groups: one treatment and one control.

We recruited 360 households through:

1. Hangtags affixed to garbage carts of approximately 3,000 households on the target collection routes.
2. Direct emails and text messages when possible.
3. Messages on relevant neighborhood listservs.

Our household identification through RFIDs allowed us to randomize at the individual household level, rather than the neighborhood or route-level. We used the variable of whether the person was currently composting to stratify our randomization. This stratification allowed us to 1) ensure that we had a similar number of people who were already composting and those who were not across treatment and control groups and 2) reduce the likelihood of our results leading to an underestimation of the treatment effect.

Study Procedure

This study was a blinded randomized control trial. CAH randomly assigned approximately half of the participants (181) to a treatment group that would receive the composting service during the study period, and approximately half (179) to a control group that would not receive the composting service during the study period. We did not inform participants of their assignment to treatment or control groups—instead, we told them their assigned start dates, with the control group receiving the program after the treatment group. Please see Appendix D for demographic data about participants.

Participants in the treatment group received curbside food waste collections every Friday, as well as onboarding materials, and a series of email communications encouraging environmentally friendly behaviors (e.g. using a

reusable grocery bag). Participants in the control group did not receive compost services or any compost-related educational materials until the “second rollout” (after the end of the study).

Our method of measuring trash weight was novel and experimental: we measured landfill-bound waste through the use of onboard truck scales, which weighed landfill-bound trash as it was collected by Durham SWM. But we did not just measure aggregate weight of treatment and control groups: we used RFID (Radio Frequency Identification) tags on trash carts to assign weight measurements to specific households.

We also used onboard truck scales to measure the weight of the compost material collected from treatment households on Fridays. Participants received emailed reminders from SWM to set out their compost carts.

Participants were asked via email to complete surveys at three points throughout the study, which allowed us to track changes in spillover identities and behaviors, among other data points (a complete copy of the offboarding survey can be found in Appendix H). All participants also received emails prompting them to reduce water usage, a key environmental key spillover behavior.

A complete timeline of study procedures and correspondences can be found in Appendix B, along with examples of materials and correspondences in Appendices E and F, respectively.

Outcome Variables of Interest

We tested our hypotheses by measuring changes in the following variables over the course of the study:

Variable	Measurement Method
Amount of Food waste Diverted from Landfill	<ul style="list-style-type: none"> change in self-reported trash bag usage (from surveys) weight in pounds of weekly curbside landfill-bound waste collections over 16 weeks (plus 3 weeks of baseline data). weight in pounds of weekly food waste collections over the 16 weeks of the intervention for those in the treatment groups.
Pro-Environmental Identity Formation	<ul style="list-style-type: none"> pro-environmental identity indices across the intake, onboarding, midpoint, and offboarding using (Participants indicated on a scale of 1-5 how strongly they identified with identity statements).
Pro-Community Identity Formation	<ul style="list-style-type: none"> pro-community identity indices across the intake, onboarding, midpoint, and offboarding using (Participants indicated on a scale of 1-5 how strongly they identified with identity statements).
Pro-Environmental Spillover Behaviors	<ul style="list-style-type: none"> self-reported pro-environmental across the intake, onboarding, midpoint, and offboarding surveys. (e.g. sorted recyclable waste) Reduction in water usage (collected through metered administrative water data) Intent to reduce water usage, e.g. by purchasing a rain barrel (measured through link clicks and QR code scans in emails sent to all participants)
Pro-Community Spillover Behaviors	<ul style="list-style-type: none"> self-reported pro-community behaviors across the intake, onboarding, midpoint, and offboarding surveys. (e.g. attending a community event)

iv. Results and Discussion

Due to our project’s situation at the intersection of local government and behavioral science, it has culminated in useful findings for both fields:

Findings for the City of Durham: Program Effectiveness

1. The compost program does divert food waste from the landfill.

We find that residents in the treatment (composting group) report using statistically significantly fewer trash bags in between the onboarding and offboarding surveys – see figure 5. Further, by weighing the non-food

waste trash carts of treatment and control group participants over the course of 16 weeks, we ultimately found that the control group (non-composters) sent an average of 5.8 pounds of waste more per week to the landfill than those taking part in the compost program. When run a longitudinal model, we see this result is statistically significant.

Taken together, we interpret these finding as a sign that the compost program led individuals to send more of their food waste to the composting facility, rather than the landfill. Nevertheless, our results were limited due to technical setbacks with the onboard truck scales. Ultimately, our sample size was not as large as originally planned, due in part to the scale on one truck malfunctioning. The measurements of the assumed-functional scales were also not as precise as anticipated for household-level measurement of waste, which ultimately forced us to exclude some data. Details on our process for dealing with these setbacks are included in Appendix C. As such we are cautious about being overly confident in the trash weight data.



Figure 5: Average Weekly Trash Weight and Self-Reported Increase in Trash Bag Use During Randomized Control Trial.

Our program’s apparent effectiveness is bolstered, however, by significant findings about larger municipal composting programs’ success in diverting waste from landfills in cities in Australia (De Silva & Taylor, 2021) and Sweden (Alacevich, Bonev & Soderber, 2021). And our confidence in the result is further bolstered by the corroboration between self-report and behavioral data. Indeed, these effect sizes are similar. We found that over the course of the study, treatment group participants reported a smaller average increase in weekly trash bag usage (0.7 bags) than control group participants (1.1 bags), with the difference being approximately 0.4 bags. The average full household trash bag weighs between 10 and 15 pounds, depending on the size (Davis 2024). 5.8 pounds (the difference between treatment and control average trash weights) would take up 0.4 trash bags, if the bag was filled to 14.5 pounds (which is feasible, given the average weight of full trash bags). Therefore, our finding of difference in trash bag usage supports our finding that landfill-bound waste of the treatment group weighed less than that of the control group, ultimately supporting our hypothesis that the composting program diverts food waste from the landfill.

Overall, our finding of program effectiveness may assist our partners in the City of Durham in advocating for a citywide program funding and implementation. And should add weight to arguments in favor of the proliferation of municipal food waste collection.

2. The compost program may improve residents’ perceptions about their local government.

Over the course of the study, both control and treatment group participants reported a decrease in the extent to which they feel their views matter to Durham’s local government. We speculate that this may be the result of local elections that took place during the study cycle, or highly publicized city worker strikes. However, our survey results revealed that people who took part in the municipal composting program experienced a smaller decrease in their sense that their views mattered to Durham’s local government, as compared to people who did

not take part in the composting program (trending significant when controlling for demographic factors, $p=0.055$).

We see these results as a sign that a municipal composting program may have benefits for local governments, beyond reduction in land use and costs associated with landfills: it may have the capacity to improve residents’ relationships with their local governments.

This finding may be a result of increasing incentive alignment with residents – that is, a feeling that the government’s values are more closely aligned with their own. We did find that 88% of residents viewed themselves as “an environmentally-friendly person” at onboarding, meaning that our study was potentially biased towards people with environmentally-friendly values. Therefore, by taking part in a government-run program that was explicitly designed for environmental reasons, many residents may have felt that the government cared more about their pro-environmental views.

Another potential explanation for this finding is the human-centered design methods that we used to develop this project. We relied heavily on feedback interviews and surveys in the development of this project, meaning that residents were often sharing their views with their city government – and, through our consistent communication, we showed that participants’ views were valuable. While not specific to municipal composting programs in general, feedback is a core tenet of human-centered design work, and may point to a need for more programs designed with similar methods in local governments.

Irrespective of exact causal mechanism, this municipal composting program – developed through behavioral science, human-centered design, and rigorous evaluation – shows potential for improving residents’ perceptions of their relationships with Durham’s local government.

Findings for the Behavioral Science Community: Spillover Behaviors

- We have not found significant evidence supporting our hypothesis that that the composting program leads to pro-community and pro-environment identity creation.**



Figure 6: Changes in Pro-Environmental and Pro-Community Identity from Onboarding to Offboarding in RCT.

We found mixed results about the composting program’s ability to form pro-environmental and pro-community identity among participants. We did not find a significant change in pro-environmental self-identification in the treatment group over the course of the study; the average score increased only very slightly (from 4.15 to 4.17 on a Likert scale, where 4 indicates “somewhat” agreeing with pro-environmental identity statements and 5 indicating strong agreement). The control group, on the other hand, showed a small decrease in pro-environmental identity (4.22 to 4.19 on the same scale).

Based on Maki et al’s (2019) finding of the impact of identity on environmental spillover behaviors, we had predicted that the composting pilot would have identity-creation effects, and that due to identity change, participants would take part in corresponding spillover behaviors. However, at this stage in analysis, our results show that these occurrences did not play out in the order we had expected.

- We did see an increase in pro-environmental and pro-community spillover behaviors.**

Participants in the composting program reported significantly more positive changes in pro-environmental and pro-community behaviors than those in the control group, as demonstrated Figure 7 below (additional results can be found in Appendix G). It seems that when we activated a pro-environmental, pro-community behavior by enrolling participants in the composting program, we may have led them to carry out increases in positive spillovers, without activating the predicted mediating factor of pro-environmental self-identification.

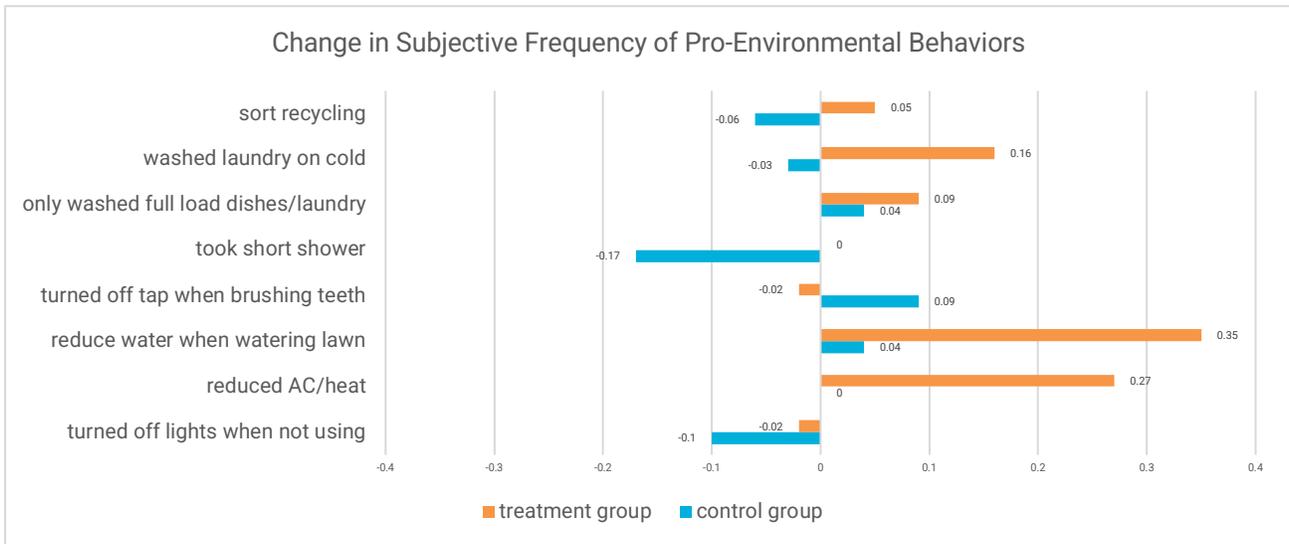


Figure 7: Change in Frequency of Pro-Environmental Behaviors Between Onboarding and Offboarding in Compost Program. (measured through Likert Scale in Onboarding and Offboarding Surveys; 1= never; 5= always)

There are several possible reasons for this outcome in the contexts of our study:

- **The Ceiling Effect.** A large proportion of participants in *both* the treatment and control group expressed pro-environmental values at the start of the study, leaving little space for increase in pro-environmental identity. To mitigate this issue, we would recommend future studies finding recruitment methods to avoid self-selection, for instance, through financial incentives.
- **Foot-in-door theory.** Perhaps we activated individuals' desire to behave consistently, irrespective of what value-based identity may be associated with that behavior. If this is the case, we would be supporting the foot-in-the-door theory, which claims that once an individual has agreed to a small action (e.g., participating in composting program), they will be more likely to agree to a larger related action (e.g., taking up a series of other pro-environmental behaviors) (Freedman & Fraser, 1966). This theory would potentially explain composters taking up spillover behaviors without the requirement of identity change, particularly if they perceived us (the researchers) as asking that they take up the spillover behaviors we were attempting to measure.
- **Self-perception theory.** Self-perception theory counters cognitive dissonance theory by proposing that rather than individuals' identities predicting their behavior, individuals must observe consistencies in their own behaviors before forming identities (Bem, 1967). If this is the case, then our study may have begun the identity formation process through promotion of pro-environmental behaviors, but we may not have promoted the critical mass of aligned behaviors necessary to impact identity.

3. Participants in the treatment group report greater increases in spillover behaviors than participants in the control group, particularly when it comes to subjective frequencies.

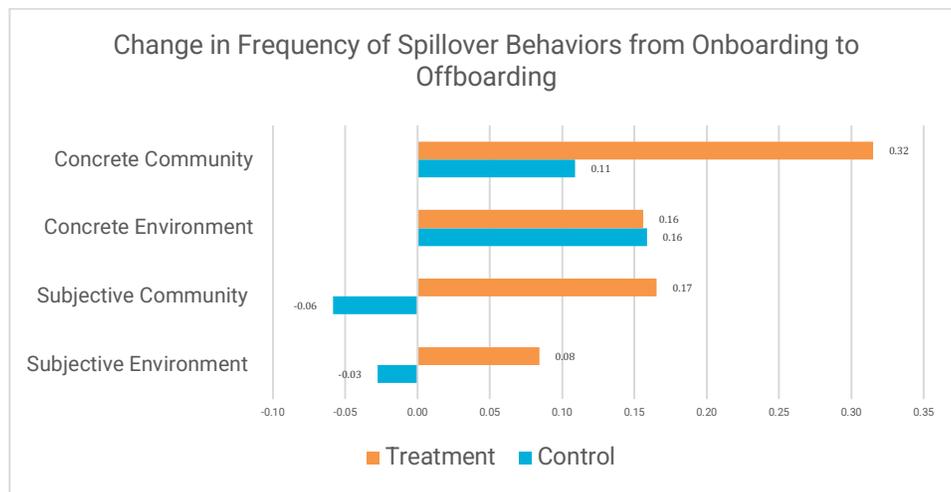


Figure 8: Change in Frequency of Spillover Behaviors.

When measuring spillover behaviors, we relied on two batteries of behaviors – one was measured in concrete terms (In the last week, how many times did you take each action? 0-20) and one in subjective terms (In the last week, please indicate how often you took each action. Never -Always). We see the positive effect of the program on spillover behaviors is largely driven by an effect on behaviors measured with the subjective scale. Similarly, the City’s collection of water data did not show any decrease in water use among composters – in fact, composters used slightly (and not significantly) more water each month on average than non-composters (a difference we speculate may be related to the extra water necessary to clean a compost bin).

We are not sure exactly why this contrast exists. It may be a result of the behaviors in the concrete battery being harder to change or having a ceiling effect. It may also have been harder for residents to show a social desirability bias on the concrete behaviors. Further, it may be a result of an intention-behavior gap. Our study is not the first to point to this gap in the realm of environmentalism: Kennedy et al. (2009) saw such a substantial self-reported gap in behaviors and actions in a Canadian survey study that they coined the term “the Environmental Values-Behavior Gap.” Our finding of a difference between quantitative, concrete frequencies and subjective (perhaps aspirational) frequencies of pro-environmental behaviors potentially supports Kennedy et al.’s argument that “good intentions do not always translate into environmentally supportive behavior.” Other studies refer to this phenomenon more broadly as the “intention-action gap.”

The finding of an intention-action gap, if true, builds on a key point in Maki et al.’s (2019) meta-analysis on pro-environmental spillover studies: individuals typically expressed a small but significant increase in intent to take up pro-environmental spillovers, but in reality exhibited small *negative* spillover behaviors– in short, their intentions were offset by their actions. Other behavioral researchers have found that when policies successfully persuade people to take up a beneficial intervention, people often feel “morally licensed” to take part in negative “compensatory” behavior, or to reduce other positive behaviors (Emery et al. 2021).

Future studies may consider offsetting the intention-action gap’s impact on spillover behaviors through behavioral interventions, for instance:

- **Identity Priming.** In our pro-environmental and pro-community identity formation through composting, we aimed to develop identities that would translate to behavior. Future studies may consider promoting spillover behaviors more explicitly by addressing people as pro-environmental actors– not by asking them if they see themselves as such.
- **Commitment Devices.** Future programs aiming to increase environmental spillovers may go beyond asking people to track their positive behaviors, and ask them to commit to those behaviors. Popular commitment devices include public agreements (e.g., making a social media post about a goal of being environmentally friendly) and accountability partnerships (e.g., agreeing to regularly report one’s progress

on environmentally friendly habits to a friend). Commitment devices may assist in bridging the intention-action gap, ultimately helping people live their environmentally-friendly values through positive spillover behaviors.

Conclusion

In consistent collaboration with the City of Durham, we have developed a unique municipal composting program by way of an equally unique three-phased approach. From the start, we rooted our ideas about an effective composting program in behavioral science by considering psychological barriers to composting. We then challenged our ideas through iterative human-centered design in our prototype and pilot. With the help of extensive user feedback, we were able to work through issues like concerns about cleanliness and contamination due to user error. Overall, we believe that our design process culminated in a composting program that is responsive to the needs of Durham's residents and effective at diverting foodwaste from landfill.

Although the novelty of our approach led to some evaluation challenges, our data suggests that the program succeeded in its goal of demonstrating the effectiveness of municipal food waste collection at diverting food waste from the landfill – a finding that is well-supported by prior research in the field. We also found that the program may improve residents' relationships with their local government. Finally, we found some evidence that the program leads to pro-environmental and pro-community spillover behaviors beyond composting (although, contrary to our hypothesis, these behaviors do not seem to be related to pro-environmental and pro-community identity formed by the composting program).

This study has prepared our partners in the City of Durham both to advocate for the funding of a citywide composting program *and* to implement one that works for residents. We hope that by scaling up the municipal composting program and continuing to divert food waste from landfills, Durham will serve as an example to other cities of the environmental stewardship that our planet needs.

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Appendices

Appendix A: Pilot Bins and Materials



Figure 9: Compost bins tested in pilot phase.



Figure 10: Do's and Don'ts Handout from 90-Household Pilot



Figure 11: Smell Tip Sheet from 90-Household Pilot



Figure 12: "Oops!" Contamination Hangtag from 90-Household Pilot

Appendix B: Randomized Control Trial Timeline

Week of study	Dates	Notes
Recruitment	June 2023	Intake survey distributed through sign-up email and QR code on trash cart hang tags
T/C Assignment	6/30/23	Start date assignments sent to participants
Baseline 1	7/16/23- 7/22/23	Baseline data
Baseline 2	7/23/23- 7/29/23	Data missing
Baseline 3	7/30/23- 8/5/23	Baseline data; Compost carts delivered to treatment group
Week 1	8/6/23- 8-12/23	Onboarding survey; first compost pick-up for treatment
Week 2	8/13/23- 8/19/23	Pick-up 2
Week 3	8/20/23- 8/26/23	Pick-up 3
Week 4	8/27/23- 9/2/23	Pick-up 4
Week 5	9/3/23- 9/9/23	Pickup 5
Week 6	9/10/23- 9/16/23	Pickup 6.
Week 7	9/17/23- 9/23/23	Pick-up 7; Midpoint survey sent to all participants
Week 8	9/24/23- 9/30/23	Pick-up 8
Week 9	10/1/23- 10/7/23	Pick-up 9
Week 10	10/8/23- 10/14/23	Pick-up 10
Week 11	10/15/23- 10/21/23	Pick-up 11; Landfill-bound waste data missing
Week 12	10/22/23- 10/28/23	Pick-up 12; Landfill-bound waste data missing
Week 13	10/29/23- 11/4/23	Pick-up 13
Week 14	11/5/23- 11/11/23	Pick-up 14
Week 15	11/12/23- 11/18/23	Pick-up 15; Landfill-bound waste data missing
Week 16	11/19/23-11/25/23	Pick-up 16; Offboarding survey sent to all participants; water reduction challenge email sent to all participants
Week 17	11/26/23- 12/2/23	Collection of follow-up data
Week 18	12/3/23- 12/9/23	Collection of follow-up data. Carts delivered to the control group.
Week 19	12/10/23-12/16/23	First food waste pick-up for control group

Appendix C: RCT Method Details and Challenges

Trash and Compost Measurements

In addition to the data collected via surveys and interviews, CAH team members accompanied City of Durham staff to weigh participants' trash carts prior to SWM pick-up. One team member weighed trash carts on a portable scale, while the others recorded weights, trash cart RFID numbers, and additional notes to facilitate future analysis.

SWM team members also collected food waste weight each week for all participating households and documented contamination presence and type.

Handling of Missing Data in RCT

One major setback in the collection of weight data was around precision of measurements at the household-level, a factor which was essential to our study design, given that we had randomized participants by household. The RFID measure unfortunately did not correctly assign trash bins to addresses, leading to a lack of clarity about the group assignments of some bin weights.

In order to salvage as much collections data as possible, our dedicated collaborators on the City of Durham's Innovation Team took part in a rigorous data verification process:

After downloading all study-period data from the database of the trash scale company, the team went into virtual maps provided by the trash scale company and manually assigned 371 unattached loads to the houses to which they most likely belonged.

The team then searched the dataset week-by-week for duplicate entries (multiple loads for one household in a given week), and examined the locations of duplicates on the virtual map. If it was too difficult to determine which load belonged to the address in question, all duplicates were eliminated. If a duplicate was the result of one manual and one automatically assigned address, the manual assignment was eliminated.

Participant Surveys

In addition to the intake survey, participants completed three surveys throughout the study: onboarding, midway and offboarding. The onboarding survey was completed in the first month of the study, during which baseline measures were being collected. The midway survey was conducted at the 6-week mark. Shortly after the end of the program, participants completed an offboarding survey. All three surveys following intake collected self-reported information on participants' identities and behaviors pertaining to the natural environment and their Durham community.

Throughout the study, participants received communications via mail and email. All groups received communications around potential direct spillover behaviors as specific calls to action (conserving water and taking part in participatory budgeting). These communications were delivered biweekly via mail during the first six weeks of the program, with follow up email communications. Click rates from emails, scan rates from QR codes on print media, and completion of interest forms were collected in addition to data on the completion of the calls to action.

All participants received a \$5 e-gift card and an entry into a lottery for a \$100 e-gift card for each survey (onboarding, midway, and offboarding survey) they completed throughout this study. One winner was selected to win the \$100 at the end of the 16 week collection cycle of this study. Unfortunately due to staff turnover during the RCT phase, the midway survey data was lost and is not recoverable. As a result we have not been able to include it in the analysis.

Spillover Measurements

We surveyed both treatment and control participants over time to measure their environmental and community identities over time. While only fostering environmental identities through our communications with the treatment group, we were also measuring community identities to see if participating in the composting program led to positive spillover effects outside of an environmental context, in the realm of community engagement.

Example Spillover Identity Survey Questions
<p>Please indicate how strongly you agree with the following statements.</p> <ol style="list-style-type: none"> 1. I think of myself as an environmentally-friendly consumer 2. I think of myself as someone who is very concerned with environmental issues 3. I am the type of person who acts environmentally-friendly <p>Please indicate how strongly you agree with the following statements.</p> <ol style="list-style-type: none"> 1. I think of myself as a member of the local community 2. I think of myself as someone who is very concerned with local community issues 3. I am the type of person who engages with their local community.

Appendix D: RCT Participant Demographics

Gender	n	%
female	244	67%
male	95	26%
nonbinary	15	4%
other	2	<1%
Prefer not to answer/ no response	10	3%
Race/ Ethnicity		
White	266	68%
Black or African American	49	13%
Hispanic or Latino	26	7%
Asian	21	5%
American Indian or Alaska Native	3	1%
Other	5	1%
Prefer not to answer/ no response	20	5%
Annual Household Income		
\$0- \$30,000	19	5%
\$31,000- \$60,0000	51	14%

\$61,000- \$90,000	50	14%
\$91,000- \$120,000	56	16%
\$120,000 +	139	39%
Prefer not to answer/ no response	45	13%
Political Affiliation		
Democrat	228	63%
Republican	2	1%
Independent	57	16%
Other	21	6%
Prefer not to answer/ no response	52	14%
Educational Attainment		
Graduate degree	184	51%
Bachelor's degree	123	34%
Associate degree	10	3%
Some college but no degree	21	6%
High school degree or equivalent	5	2%
Less than a high school degree	1	<1%
Prefer not to answer/ no response	16	4%

Appendix E: RCT Recruitment and Onboarding Materials

FRONT





Curious about Composting?

Free to Participate

12-WEEK PILOT

How will this pilot work?

Sort food scraps at home! Solid Waste Management will collect your food scraps at the curb every Friday to be composted!



What is composting?

It's the natural process of recycling organic matter, like food scraps, into fertilizer that enriches soil and feeds plants.

What happens after?

After 12 weeks your compost will continue to be picked up and more Durhamites will be joining the program.

What will pilot participants get?

- Containers to collect your food scraps.
- Information about what to collect (and not collect) as well as tips on how to improve your experience.
- Regular contact in the form of online surveys to share feedback and experiences so Durham can create the best possible compost program for the community.

As a participant, you will complete up to six surveys during the 12 week study. You will receive \$5 for each survey and will be entered into a lottery to win \$100!



Visit bit.ly/durhamfoodwaste, call 919-560-4186 or scan this QR code using the camera on your phone to express your interest

BACK





¿Curioso sobre el Compostaje?

Es Gratis Participar

Piloto de 12 Semanas

¿Cómo funcionará este piloto?

¡Separe sus restos de comida en casa! Solid Waste Management recolectará sus residuos de comida en la banqueta cada viernes para ser llevados a compostaje.



¿Qué es el compostaje?

Es el proceso natural de reciclar materia orgánica, como los restos de comida, en fertilizante que enriquece la tierra y alimenta las plantas.

¿Qué sucederá después?

Después de 12 semanas, su composta continuará siendo recogida y más Durhamitas se unirán al programa.

¿Qué obtendrán los participantes del piloto?

- **Contenedores** para recolectar sus residuos de alimentos.
- **Información** sobre qué recolectar (y qué no recolectar), así como consejos sobre cómo mejorar su experiencia.
- **Contacto Regular** a través de encuestas en línea para compartir retroalimentación y experiencias para que Durham pueda crear el mejor programa de composta para la comunidad.

Como un participante, responderá hasta seis encuestas a lo largo de las 12 semanas del estudio. ¡Recibirá \$5 por cada encuesta que llene y entrará a una lotería para ganar \$100!



Visite bit.ly/durhamfoodwaste, llame 919-560-4186, o escanee este código QR para mostrar su interés

Figure 13: Hangtag Attached to Garbage Bins to Recruit Randomized Control Trial Participants

QUICK START GUIDE

Thank you for participating in Durham's food waste pilot! You have received all the materials you need to begin sorting your food waste. Read the instructions below to get started!

1. Bin and Cart

Put your metal Indoor Bin in your kitchen somewhere accessible when you're preparing food. Whenever you're preparing food, sort your food scraps and waste into the bin. Find a spot to place your Outdoor Cart. Check out the Bin Care Sticker for more tips!

2. Reminders

Put the Checklist on your fridge to help you keep track of your surveys for the program. All surveys will be sent to your email. Scan to download the Durham Rollout App to receive real time reminders and collection information.



iOS



Android

3. Guidelines

Take a moment now to review the Dos and Don'ts Sticker on your Indoor Bin. This is your guide to what can and cannot be composted- contaminated food waste will have to be sent to the landfill. Be sure to teach all members of your household these rules.

Remember to put your cart out every single week -even if it's not full- by 6am on Friday!

Figure 2: Quick Start Guide Distributed to Randomized Control Trial Treatment Group (Front)

FOOD WASTE PILOT GUIDE

Thank you for your interest in the food waste collection program and for signing up to participate in our pilot!

1. Surveys

We will be sending you three short surveys via email over 12 weeks before beginning the food waste program. Each survey should take no more than 10 minutes to complete.

2. Rewards

For each survey you complete, you will receive a \$5 Amazon gift card and an entry into a lottery for a \$100 Amazon gift card.

3. Checklist

Put the checklist on your fridge as a reminder for the surveys to come. We look forward to providing you with the food waste program soon!

Keep an eye out in your mailbox and email inbox for your notification to begin composting, surveys, and more!

Figure 15: Quick Start Guide Distributed to Randomized Control Trial Treatment Group (Back)

Food Waste Pilot Tasks

-  Sign up survey
-  Download the Durham Rollout app
- Week 1**
 1st survey
[check your inbox now!]
- Week 6**
 2nd survey
- Week 12**
 3rd survey

Food Waste Pilot Tasks

-  Sign up survey
-  **Week 1**
1st survey
-  **In 6 WEEKS**
2nd survey
-  **In 12 WEEKS**
3rd survey

Keep an eye out in your email inbox for your notification to begin composting and more!



SOLID WASTE MANAGEMENT
CITY OF DURHAM

Questions about the program?
Call (919) 560-4186

BIN CARE TIPS

Keep your indoor bin and outdoor cart in good shape with these tips!

If you're worried about:

<p>Smell</p> <p>Sprinkle baking soda inside your containers to absorb odors if needed.</p>	<p>Mess</p> <p>Line your bin or cart with compostable paper like paper plates or newspaper to absorb liquid.</p>	<p>Spills</p> <p>Always keep the lid of your indoor bin closed when not in use.</p>
<p>Decay</p> <p>Keep your scraps in the freezer until you're ready to move them to the outdoor cart.</p>	<p>Heat</p> <p>Secure the lid and store your outdoor cart in a shaded spot to prevent pests and the elements from getting in.</p>	<p>Cleanliness</p> <p>Regularly rinse out your indoor bin and outdoor cart to keep them in good shape.</p>

Figure16: Bin Care and Smell Tips Sheet Distributed to Randomized Control Trial Treatment Group

Appendix F: RCT Email Correspondences

Recruitment

Subject Line: Pilot Program for Food Waste Composting

Hello. You may have recently received a recruitment flier attached to your garbage cart regarding a City of Durham pilot program for collection of food scraps. The City of Durham Solid Waste Department is collaborating with Duke University's Center for Advanced Hindsight to develop a pilot program for the collection of food waste and is looking for a group of Durham households to help us test it out! If you are interested in participating in this program, you can sign-up [HERE](#). If you have questions or would like further information before committing, please check out our program web page here: [Food Waste Collection Pilot | Durham, NC \(durhamnc.gov\)](#)

Durham's Solid Waste Management Department is developing a plan for the eventual citywide collection of food waste for composting and to start, we're looking for residents who live on several collection routes who would like to help us by taking part in a 12-week pilot program. Participants in the pilot program may be offered the opportunity to continue receiving collection beyond the 12-week pilot program period.

If you are selected to participate (based on location and sign-up availability), you will receive all necessary materials for separating food waste, including a "How-to" guide, indoor countertop container and outdoor collection cart. Participants will be provided with support and information throughout the pilot program. Participants will be asked for their feedback along the way, so Durham can create a food waste collection and composting program that works best for our community.

We would love for you to be a part of this unique opportunity to work with us and take part in designing this service to divert food waste from disposal in landfill and instead create a beneficial soil product.

Click [here](#) to let us know of your interest. Still have questions? Reply to this e-mail with your questions and we will reply to them promptly.

Thank you,
City of Durham
Solid Waste Management Department
foodwasteinfo@durhamnc.gov

Onboarding Survey Email Template: Treatment

Subject Line: Composting Program Survey- Get a \$5 gift card!

Content:

Hi [First Name]!

Thank you for your interest in being part of Durham's composting program. You have been selected to start the program this XX. Congratulations!

To get you started, you will shortly receive a compost curbside cart, an indoors compost bin, and a packet of information to better understand what and how to compost with the City of Durham.

In this email, you will find the first out of three surveys that we need you to complete over the next 12 weeks to evaluate the progress and efficiency of the composting program.

This first survey should take less than 10 minutes. As a thank you for participating and completing the survey, you will receive a \$5 Amazon gift card and you will receive an entry into a lottery to win a \$100 Amazon gift card.

Please complete the survey by XX of XX to ensure that we receive your response with the rest of your community and so we can send your gift card.

Click this link to start the survey.

Let us know if we can be of any assistance. We will reach out with the next survey in six weeks!

Durham's Solid Waste Management

Onboarding Survey Email Template: Control

Subject Line: Interest in Composting Program Survey- Get a \$5 gift card!

Content:

Hi [First Name]!

Thank you for your interest in being part of Durham's composting program study. You have been approved to begin the compost program in three to four months. Congratulations!

Even though you will not start composting until XX, you are already serving an important role in the study to improve the development of Durham's composting program. As such, in this email you will find the first out of three surveys that we need you to complete in the next 12 weeks to better understand the Durham community's engagement with composting.

The survey should take less than 10 min. As a thank you for participating and completing the survey, you will receive a \$5 Amazon gift card and you will receive an entry into a lottery to win a \$100 Amazon gift card.

Click this link to start the survey.

Please complete the survey by XX to ensure that we receive your response with the rest of your community and so we can send you your gift card.

Please let us know if we can be of any assistance. We will reach out with the next survey in six weeks.

Durham's Solid Waste Management

Midway Survey Email Template: Treatment

Hi [First Name],

Thank you for composting with the City of Durham's composting program!

This is the midpoint check in for the program, we're looking forward to hearing about your experience so far in the survey linked below.

This is the second of three surveys you will receive and should take about 10 minutes to complete. As a thank you for completing the survey you will receive a \$5 Amazon gift card and will be entered into a lottery for a \$100 Amazon gift card.

Please complete the survey by [DATE] to ensure we're able to incorporate your thoughts into improving the program

Click here to start the survey

Happy composting and keep an eye out for the final survey in 6 weeks!

Unfortunately due to staff turnover during the RCT phase, the midway survey for the control group was lost and is not recoverable.

Midway Survey Reminder Template: Treatment

This is a friendly reminder to complete your midpoint check in for Durham's new composting program!

In order to help us build a better composting program for the future, please complete the survey as soon as possible!

Click this link to start the survey.

Offboarding Survey Email Template: Treatment

Hi [First Name],

Congratulations on 12 weeks of composting with the City of Durham!

You have just one more task to complete before the finish line- the final survey.

We're excited to hear about your experience to make the program better for all Durhamites.

This last survey should take about 10 minutes to complete and you will receive a \$5 Amazon gift card for completing it. Additionally you'll receive another entry into the \$100 Amazon gift card lottery.

Please complete the survey by [DATE] so we can hear about your experience with your fellow composters.

Thank you again for your participation in this program, we hope

Click here to start the survey

Happy composting!

Offboarding Survey Email Template: Control

Hi [First Name],

Thank you for your interest in the City of Durham's compost program!
This is the final survey for Phase 2 of the program, we're looking forward to learning about your experience in the survey linked below. This survey should take about 10 minutes to complete. As a thank you for completing the survey you will receive a \$5 Amazon gift card and will be entered into a lottery for a \$100 Amazon gift card. Please complete the survey by [DATE] to ensure we're able to incorporate your experience into improving the program.

Click here to start the survey

We will be commencing Phase 3 of the program in the near future and will invite you to participate as an active composter shortly.

Offboarding Survey Reminder Template

Hi [First Name],

This is a friendly reminder to complete your final survey for Durham's composting program study!
In order to help us build a better composting program for the future, please complete the survey as soon as possible.

Click this link to start the survey.

RCT Water Reduction Challenge Email

Dear Food Waste Pilot Participant,

Thank you for supporting the environment with your composting efforts. Try taking on another pro-environment challenge!

Level 1: Reduce your use

Limit showers to 5 minutes.

Water lawns only when needed.

Run dishwashers with full loads only.

GO HERE (*hyperlink*) for further water reduction tips...

Level 2: Check for leaks

Leaking fixtures cost you money with every drip. The City of Durham sells water saving fixture kits for \$3!

GO HERE (*hyperlink*) for a shower kit...

Level 3: Catch the Rain

Collect rainwater to use to water plants and reduce tap water use. The City of Durham sells discounted rain barrels for \$73!

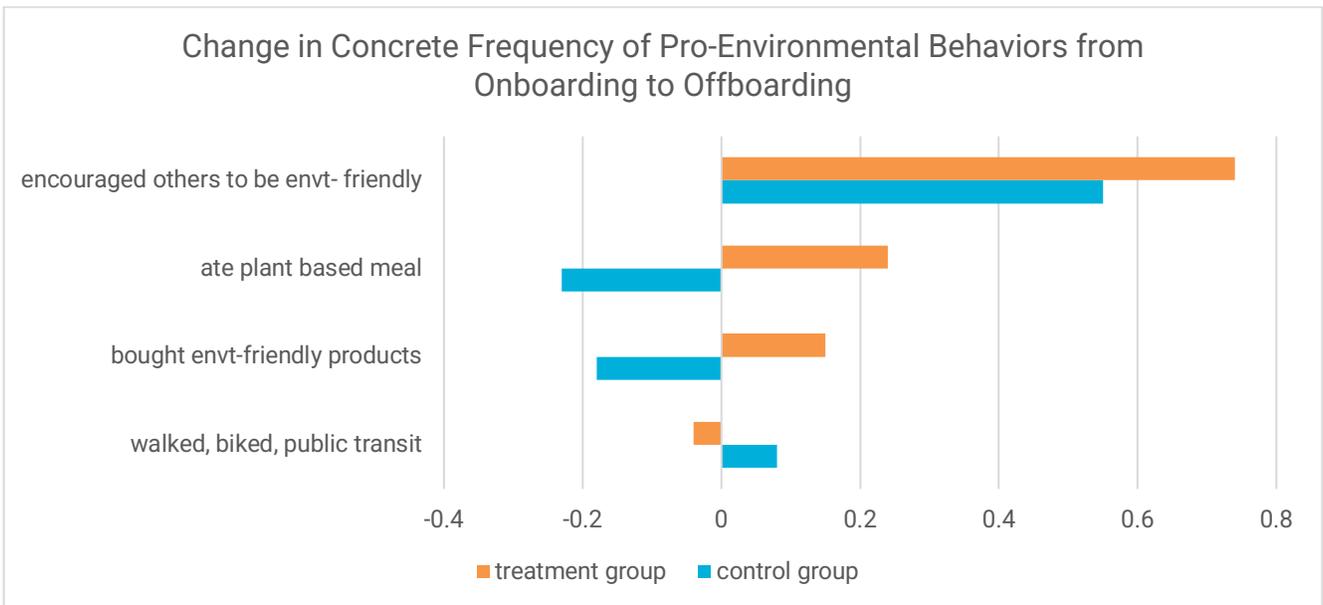
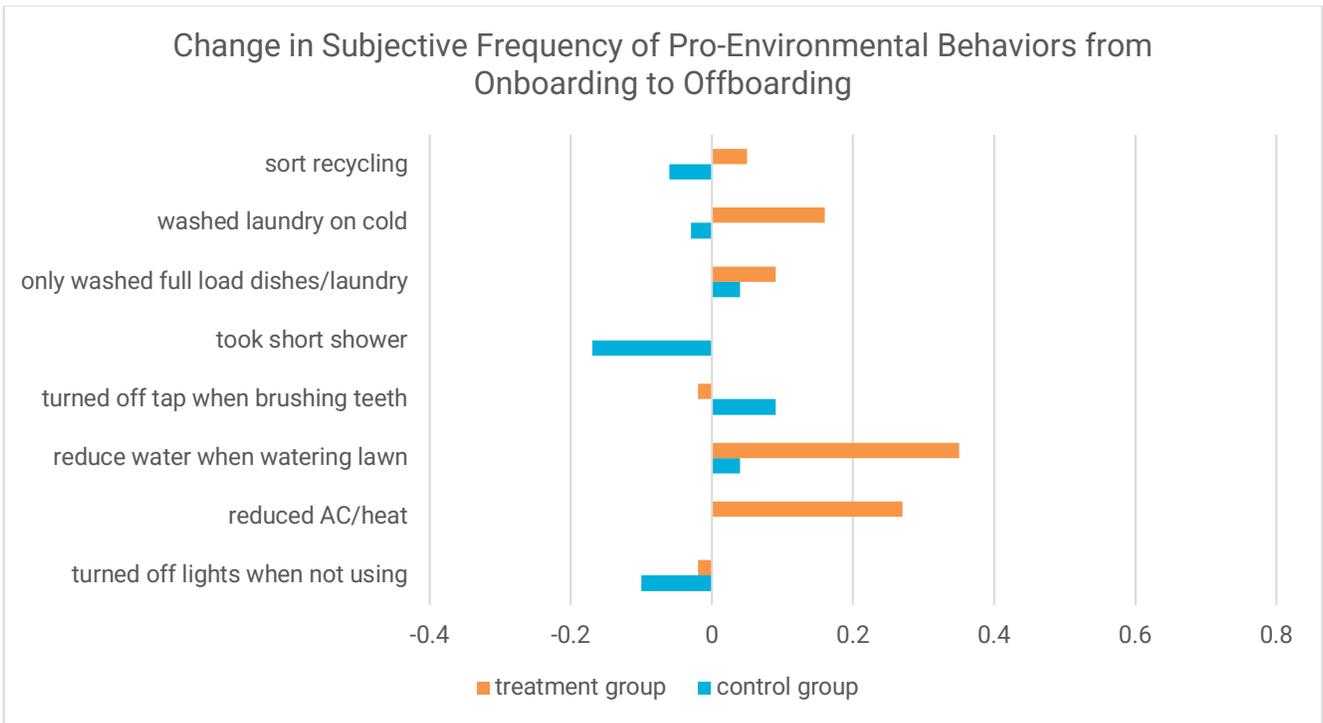
GO HERE (*hyperlink*) for a barrel...

Decreasing your household's water consumption helps lower your energy use and carbon footprint by reducing the demands of water treatment.

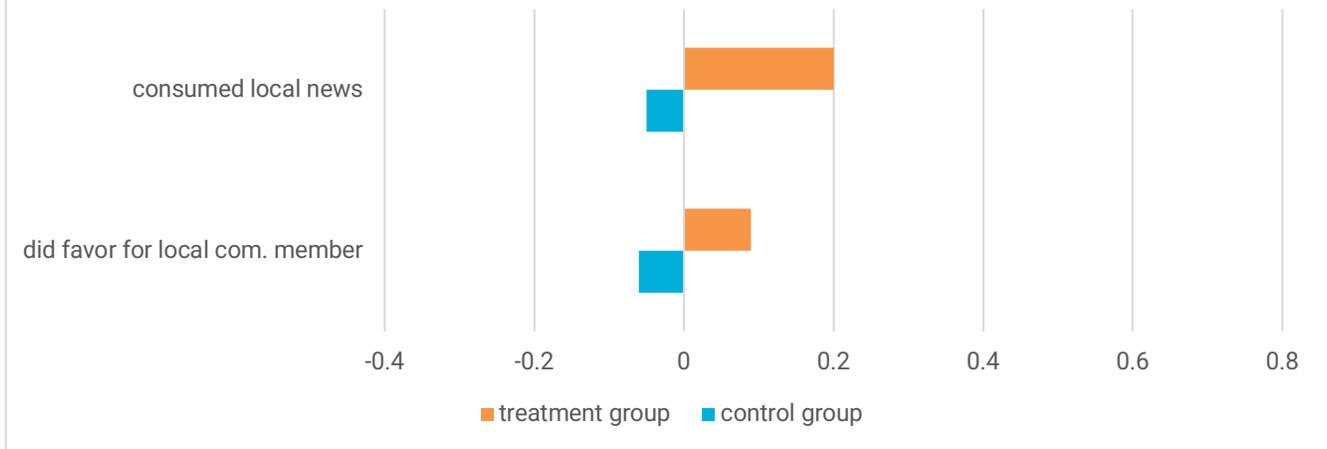
Good luck!

Durham Solid Waste Management

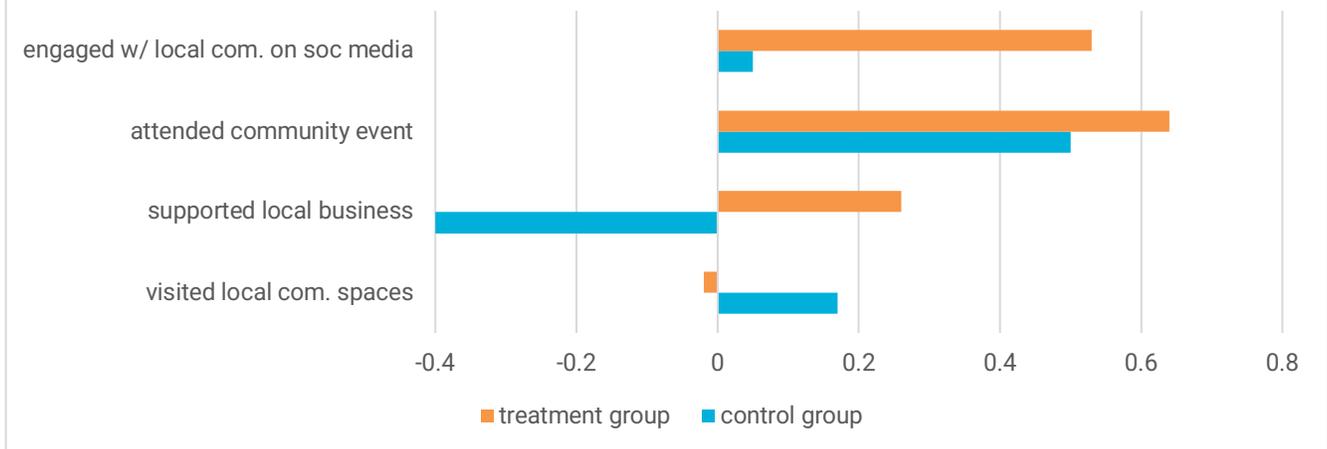
Appendix G: Changes in Pro-Environmental and Pro-Community Spillover Behaviors



Change in Subjective Frequency of Pro-Community Behaviors from Onboarding to Offboarding



Change in Concrete Frequency of Pro-Community Behaviors from Onboarding to Offboarding



Appendix H: Sample RCT Survey

Thank you for participating in the food waste collection pilot so far. As a thank you for participating, you will receive a \$5 Amazon gift card for completing this final survey.

This survey will take less than 10 minutes to complete.

Within the last week, how many trash bags (13 gallon size) have you gone through in your kitchen?

- Less than one bag (1)
- 1 bag (2)
- 2 bags (3)
- 3 bags (4)
- More than 3 bags (5)

Within the last week, how many times did you use your garbage disposal?

- Never (1)
- Seldom (2)
- Sometimes (3)
- Often (4)
- Almost Every Day (5)
- My home does not have a garbage disposal (6)

Please indicate how strongly you agree with the following statements. When we mention “local community”, we would like for you to think about your Durham community.

	Strongly Disagree (1)	Disagree (2)	Neither Agree or Disagree (3)	Agree (4)	Strongly Agree (5)
I think of myself as an environmentally-friendly consumer (1)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I think of myself as someone who is very concerned with environmental issues (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would be embarrassed to be seen as having an environmentally-friendly lifestyle (3)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I would not want my family or friends to think of me as someone who is concerned about environmental issues (4)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Acting environmentally friendly is an important part of who I am (5)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I am the type of person who acts environmentally friendly (6)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

I see myself as an environmentally friendly person (7)

I feel morally obliged to act in an environmentally friendly manner (8)

I would feel guilty if I did not act in an environmentally friendly manner (9)

I would be a better person if I would act in an environmentally friendly manner (10)

I think of myself as a member of the local community (11)

I think of myself as someone who is very concerned with local community issues (12)

I would be embarrassed to be seen as having an engaged lifestyle with my local community (13)

I do not want my family or friends to think of me as someone who is concerned about my local community (14)

Engaging with my local community is an important part of who I am (15)

I am the type of person who engages with their local community. (16)

I see myself as a local-community engaged person (17)

I feel morally obliged to act in favor of my local community (18)

I would feel guilty if I did not act in the benefit of my local community. (19)

I would be a better person if I acted in the benefit of my local community. (20)

In the last week, how many times did you take each action?

0 2 4 6 8 10 12 14 16 18 20

Walked, cycled, carpooled, or took public transit as a method of transportation ()	
Bought environmentally friendly products ()	
Ate a plant-based meal ()	
Talked to or encourage others to be environmentally friendly ()	
Visited your local park, library, community center, other common space ()	
Supported local businesses ()	
Attended community events ()	
Engaged with my local community through social media ()	

In the last week, please indicate how often you took each action.

	Never (1)	Rarely (2)	Sometimes (3)	Usually (4)	Always (5)	N/A (6)
Turned off lights I was not using (1)	<input type="radio"/>					
Reduced home AC or Heater use (24)	<input type="radio"/>					

Reduced the water used to water my lawn (25)

Turned off the tap while you brushed your teeth (26)

Took a short shower (27)

Did only full loads of laundry or dishes (28)

Did my laundry with cold water instead of hot water (29)

Sorted my recyclable waste (30)

Did favors for members of my local community (house sitting, watching each other's children, lending tools). (32)

Consumed local community news (33)

End of Block: Spillover Behaviors

Start of Block: Happiness, Trust, and Value

The following question will help us better understand how the compost program supports external government goals. Click how often you agree with the following statements

	Never (1)	Only some of the time (2)	Most of the time (3)	Just about always (4)
My opinions are valued by the Durham local government (2)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I trust the local Durham government to do what is right (7)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

The following questions are about the ways that the people in your household buy and use food. Please think about your whole household when answering.

Grocery Shopping Please answer the following question:

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always (5)
How often do you do the grocery shopping for your household? (FreqGroceryShopping)	<input type="radio"/>				

How important is the following in motivating you to reduce the amount of food your household discards?

	Not at all important (1)	Somewhat Important (2)	Important (3)	Very Important (4)
Thinking about people without enough to eat (Motivations_PeopleInNeed)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thinking about the possibility of saving money (Motivations_SavingMoney)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feeling regret about time spent shopping, storing, or preparing food not eaten (Motivations_WastingTime)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Wanting to manage my home efficiently (Motivations_Efficiency)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Feeling guilty about waste in general (Motivations_Guilt)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thinking about the greenhouse gases, energy and water resources it took to get the food to my plate (Motivations_EnvResources)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thinking about the idea that I can make a difference through my actions (Motivations_PositiveImpact)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Thinking about the environmental effects of food waste (Motivations_EnvEffectsWaste)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Now we will ask you some questions about things that can make it hard to prevent or reduce food waste. How much does each factor affect your ability to reduce food waste?

	Not much (1)	Some (2)	Quite a bit (3)

Produce goes bad in the refrigerator before we can use it.
(Obstacles_1)

Leftovers are hidden in the refrigerator and go bad (Obstacles_4)

Some take-out food gets wasted
(Obstacles_5)

Overbuy at the grocery store (Obstacles_7)

It's hard to keep track of food in the refrigerator
(Obstacles_11)

It's hard to keep track of food in the pantry
(Obstacles_12)

Don't adequately plan before shopping
(Obstacles_13)

Food that develops a blemish gets thrown out
(Obstacles_14)

It's hard to know what to do with leftovers
(Obstacles_15)

Family doesn't like leftovers
(Obstacles_16)

Don't have time to be creative with leftovers
(Obstacles_17)

In the last 12 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?

- Yes (1)
- No (2)
- Do not know (3)

Expenditure In the last week, about how much money did your household spend on food and beverages, including foods eaten at home and away from home?

0 50 100 150 200 250 300 350 400 450 500

\$USD ()	
----------	--

In the last week, about what percent of all the food that came into your household was thrown away?

0 10 20 30 40 50 60 70 80 90 100

Percentage Points ()	
----------------------	--

How much of this (throwing out food) could have been avoided?

- None (1)
- A little (2)
- A fair amount (3)
- A lot (4)

How often did you and/or your household members do the following with food in the last week?

	Never (1)	Rarely (2)	Sometimes (3)	Often (4)	Always (5)
Make a shopping list (1)	<input type="radio"/>				
Check to see what is in your refrigerator or cupboards before you go shopping (6)	<input type="radio"/>				
Plan meals before shopping (7)	<input type="radio"/>				
Estimate how much of various items you will need before shopping (8)	<input type="radio"/>				
Use leftovers or food scraps as ingredients in future meals (9)	<input type="radio"/>				
Prioritize eating leftovers and foods close to expiration or spoilage (10)	<input type="radio"/>				
Eat at home if you have food to use up, even if you feel like going out (11)	<input type="radio"/>				

Freeze meat or fish if you think you will not be able to eat it in time (12)

Buy more food than you are likely to use before it spoils due to sales (13)

Get tempted in the store and buy products not on your shopping list (14)

Due to the way food is packaged, buy food in larger packages than you are likely to use before it spoils (15)

Shop on an empty stomach (16)

Make too much food (17)

Eat when you are not hungry to avoid wasting food (18)

Not cook food before it goes bad (19)

Throw away leftovers because no one wanted to eat them (20)

Throw away food because a new recipe or unfamiliar item did not taste good to you or household members (21)

Forget about items in your fridge until they are too old to eat (22)

Pay attention to date labels on food, such as "use by," "sell by," and "best before"? (23)

Food Waste Attitudes Please indicate how much do you agree or disagree with the following statements:

Strongly Disagree (1) Disagree (2) Neither Agree or Disagree (3) Agree (4) Strongly Agree (5)

It is unnecessary to waste food; it can be used in some way (1)

It upsets me when unused products end up in the waste bin or garbage (2)

I think that wasting food is a waste of money (3)

I feel bad when I throw food away (4)

I have the feeling that I cannot do anything about the food wasted in my household. (5)

People who are important to me find my attempts to reduce the amount of food wasted unnecessary. (6)

In the next week, I will reduce how much food I throw away. (7)

Open Feedback Is there anything else you would like to share with us to make this program better?

Intent Do you intend to continue to participate in the composting program?

Yes (1)

No (2)

Unsure (3)

Why do you intend or not to continue?
