To request translation or disability-related accommodations, please contact us at **DTDcompliance@clackamas.us** | **503-742-4400**.

Si quiere solicitar servicios de traducción o adaptaciones para la discapacidad, contáctenos en/al **DTDcompliance@clackamas.us** | **503-742-4400**.

Чтобы запросить перевод или приспособления, связанные с инвалидностью, пожалуйста, свяжитесь с нами по:
DTDcompliance@clackamas.us | **503-742-4400**.

Щоб попросити переклад або спеціальні послуги для осіб з особливими потребами, зверніться до нас, скориставшись такими контактними даними:
DTDcompliance@clackamas.us | **503-742-4400**.

如需翻译服务或残障相关的协助，请与我们联系：
DTDcompliance@clackamas.us | **503-742-4400**。

Để yêu cầu dịch vụ dịch thuật hoặc điều chỉnh liên quan đến tình trạng khuyết tật, vui lòng liên hệ với chúng tôi qua **DTDcompliance@clackamas.us** | **503-742-4400.**

Clackamas County
www.clackamas.us



Single-Family Residential Recycling Cart Tagging Project

CLACKAMAS COUNTY

TOMOLLA CONSULTING | PORTLAND, OREGON JULY 2018

Contents

Executive Summary 1
Primary Findings 1
Totals 1
Observed Tagging Results Over Time 1
Statistical Analysis 1
Recommendations 2
Introduction and Context 2
Project Design & Implementation 2
Project Structure 2
Maps with Waste Hauler 3
Data Collection 3
Obstacles Overcome 4
The Human Factor 4
Hauler Servicing Recycling Bins 5
Recyclable, Yes or No? 5
Findings 5
Totals 6
Observed Tagging Results Over Time 6
Types of Contamination Observed 9
Statistical Analysis 10
Methodology 10
Outcome 11
Field Notes 13
Travis McGee, Crewmember, Weeks 1-3 13
Rachel Zarfas, Crewmember, Weeks 1-7 14
Nick Isbister, Crewmember, Weeks 1-7 15
Dave Muller, Crewmember, Weeks 1-7 16
Recommendations 17
Conclusion 19
Acknowledgements 20
Clackamas County: 20
Tomolla Data Cleaning and Analysis Team: 20
Tomolla Crewmembers: 20
Waste Haulers: 20
Appendix 1: Waste Hauler Maps 21
Appendix 2: Wednesday Clackamas El Dorado Walking Route 37
Appendix 3: Cart Tagging Summary Data 38

Executive Summary

Working closely with Clackamas County (Clackamas), Tomolla Consulting (Tomolla) designed and implemented the Single Family Residential Recycling Cart Tagging Project, a comprehensive effort to gather information and evaluate recycling practices at single-family residences in unincorporated Clackamas County. From March through June 2018 Tomolla created project protocols, managed over 22,000 household visits, interfaced with waste haulers and Clackamas, synthesized and cleaned a substantial data set, and analyzed findings. Clackamas supported project efforts by facilitating access to waste haulers, project route site, and providing ongoing feedback throughout the project.

The project purpose was to 1) gain a baseline knowledge of recycling participation and contamination in commingled recycling; and 2) explore how cart tagging impacted curbside recycling practices across multiple visits to individual households.

Primary Findings

Totals

Tomolla crews recorded on average 3,714 visits to single-family residences in Clackamas County per week. A total of 22,286 household visits were logged during the 6-week data collection timeframe. Of these households:

- The observed curbside recycling setouts rate was 52.9%
- Glass setout rate was 9.2%

Of all recycling setouts[1] recorded:

- "Oops tags were issued to 55.3% of households and;
- "Gold Star" tags were issued to 47.3% of households.

Observed Tagging Results Over Time

Qualitative findings indicated a trend towards contamination reduction in observed curbside recycling rollcarts over the 6-week data collection period.

- Week 1 data collection indicated nearly 63% percent of carts across all routes were observed to have been contaminated and received "Oops" tags.
- Week 5 marked the first week in the study where total "Gold Star" tags outnumbered "Oops" Tags deployed.
- By Week 6 the percentage of contamination ("Oops" tags) across all routes had fallen to 46%.

Statistical Analysis

A logistic regression statistical analysis run in R studio (version 1.1.453) using a generalized linear mixed model, fit by maximum likelihood found:

- Statistically significant reductions in contamination across time for nine (9) of fourteen (14) routes, with variation among routes observed.
- Results suggesting that cart tagging meaningfully impacted behavior and reduced overall contamination observed in commingled recycling rollcarts.

[1] Does not include early hauler pickups and field data entry errors.

Recommendations

This study yielded statistically significant results indicating reduced recycling contamination, and a strong baseline from which to further improve residential recycling in unincorporated Clackamas County. Future opportunities to add additional insight towards improving curbside recycling practices and outreach include:

- Follow-up analyses to examine more covariates such as socio-economic status and average age of resident.
- Deeper statistical exploration into the nature of how residents responded to feedback about specific types of contamination, thus revealing opportunities for targeted outreach.
- Additional tactical outreach efforts (cart tagging and otherwise) to test and expand upon the data gathered from this study.

Introduction and Context

Clackamas contracted Tomolla to develop and execute a comprehensive effort to gather information and evaluate residential recycling practices at single-family residential recycling bins in unincorporated Clackamas County. Combining specialized industry expertise gleaned from over fifteen years developing materials management strategies (including the City of Portland Single Family Residential Weight Study and the Metro-funded Residential Recycling Campaign) with available best practices and templatized outreach materials pioneered by the Recycling Partnership, Tomolla worked with Clackamas County to design the Single Family Residential Recycling Cart Tagging Project.

Broadly, Clackamas sought to better understand the state of participation in the county's curbside recycling program by initiating a direct outreach campaign via educational "leave behind" tags delivered at single-family residences. Project design protocols required customized feedback be delivered in a public setting to provide insight and educational information about recycling contaminants and recognize well-sorted carts. Data collected from the tagging effort was to be recorded at a discrete, house-by house level -- illuminating a point-in-time snapshot of participation rates in the curbside commingled recycling and glass program, opportunities for improvement, and potential trends that could warrant further evaluation by Clackamas. At the project outset, Clackamas' primary goals were to 1) ascertain a baseline knowledge of recycling contamination in commingled recycling; and 2) determine how direct public feedback via "tagging" impacted proper recycling participation over multiple visits to individual households (HH).

Project Design & Implementation

Project Structure

After considering multiple strategies for outreach and data collection, Clackamas and Tomolla settled on the following parameters for project execution: Tomolla would deploy three (3) teams of two (2) individuals to complete fourteen (14) residential routes per week over a six (6) week period of field activity. It was estimated that between 225 and 250 HH would be visited per route, allowing field crew to attempt reaching between 3,375 and 3,750 homes per week. Each HH per route would receive an attempted visit once a week over six (6) weeks. It was estimated that three (3) routes

would be executed each day of the week, Monday through Thursday, with two (2) routes on Friday, for the first three weeks (weeks 1-3). This was to be followed by a check-in during week four to review initial data findings and potentially alter data collection & tagging protocols as needed. Field crews would then complete the remaining three (3) HH contacts on all fourteen (14) routes during weeks 5-7.

Maps with Waste Hauler

To meet the aggressive evaluation goals, a high-level of pre-project preparation and collaboration with participating waste haulers was paramount to project success. In early April, Tomolla and key staff from Clackamas, met with each of the four (4) waste haulers that were identified for inclusion in the project by the county: 1) Clackamas Garbage; 2) Hoodview Disposal; 3) Sunset Garbage; and 4) Waste Management. Goals of the face-to-face meetings were to discuss the scope, protocols, and hauler requirements of the project, and to garner direct input on potential route selection and field data collection protocols.

Because field staff would begin data collection at 6:00am, and would also require 3-6 hours to collect the HH-level data from +/-250 homes, it was essential that the teams, Clackamas, and waste haulers all had open communication and were upfront with project expectations. With scope, goals, and procedures all understood, waste haulers assisted the team by self-selecting particular areas within their service routes that could serve as one of the routes to include in the study. Along with convenience, good timing was essential for the commercial drivers, and routes needed to encompass +/-250 HH, be densely populated or grid-like (for walking field staff), have minimal busy streets, and contain a good mix of socio-economic diversity overall. Tomolla initially received 29 potential routes from the selected haulers: five (5) routes from Clackamas Garbage; five (5) routes from Hoodview Disposal; seven (7) routes from Sunset Garbage; and twelve (12) routes from Waste Management. After extensive review and meetings with haulers, Tomolla and Clackamas agreed to four (4) routes with Clackamas Garbage, two (2) routes with Hoodview disposal, three (3) routes with Sunset Garbage, and five (5) routes with Waste Management for inclusion in the study. All fourteen (14) route maps can be found in Appendix 1.

Data Collection

In order to streamline the field data collection & data management systems for the project, Tomolla sought to implement a cloud-based/mobile data collection process. Moving beyond an analog (paper-based) data collection system to one that utilized newer, mobile-friendly software, was an intentional attempt to access "real-time" data collection results while also saving staff/management time. Utilizing staff's extant smart phones, equipping them with water/weather-proof cases and accessing the Google®-based GDrive and Google Sheets allowed the team to successfully transition to the mobile/cloud-based system.

A simple field data collection sheet was developed by Tomolla and was shared with Clackamas for feedback prior to project execution. The form used a binary system (0=No; 1=Yes) to collect the quantitative data desired by the County and included the following data points which also directly corresponded to the leave-behind messaging utilized:

- Recycling Bin Out? (Y=1/N=0)
- Glass Bin Out? (Y=1/N=0)

- Proper Recycling Bin Sorting? (Y=1/N=0)
- Contamination? (Y=1/N=0)
    - #1 Clamshells (Y=1/N=0)
    - #2 Plastic Bags (Y=1/N=0)
    - #3 Food or Liquids (Y=1/N=0)
    - #4 Clothing or Linens (Y=1/N=0)
    - #5 Tangles/Electronics (Y=1/N=0)
    - #6 Other (add to notes) (Y=1/N=0)
- Leave Behind Tag Used? (Y=1/N=0)
- Gold Star (Y=1/N=0)
- Oops! (Y=1/N=0)

The form also directed collection of pertinent information such as street-level address, qualitative field notes & staff observations, and a description of any "#6 Other" contaminant observed in the recycling bins (i.e., paper to-go cup, napkin, etc.).

While it was developed with simplicity in mind, allowed field staff to collect the desired data points/HH attributes, and facilitated the ultimate statistical analysis within R studio (version 1.1.453), it was found to be somewhat over-engineered and issues arose once on-route vetting by field staff began (see *Obstacles Overcome* section below).

Obstacles Overcome

Three (3) main challenges materialized during the fieldwork and data collection phase of this project. To prevent similar difficulties from occurring on future projects, this section will examine these obstacles in detail and how Tomolla sought to overcome them.

These obstacles, in no particular order of importance, were: 1) the "Human Factor" and data collection errors/messy data; 2) commercial waste haulers intervention on route days (i.e., driving into the designated route area(s) and servicing the recycling bins prior to the field team's HH-level observations); and 3) confusion/subjectivity amongst field staff, Clackamas, and management about particular items' recyclability and whether or not the material(s) in question were acceptable in the county's curbside collection program.

The Human Factor

As mentioned previously, Tomolla attempted to transition data collection from a paper-based system to one that utilized cloud-computing via mobile field devices. While this saved time on data transposition and allowed for easier/quicker access to the data in "real-time", it proved challenging in some regards for field staff (i.e., small device screen size, short duration of battery life on phone/mobile device). In addition, the data collection sheet was designed in such a way as to allow for more expedient data review by management, but it did require more data entries per HH for field staff. On any one route that encompassed +/- 250 HH, with potentially thirteen (13) different columns of data entry fields, staff were often responsible for well over 3,250 different data entry inputs. This, coupled with the open-source/open-sheet aspect unknowingly introduced the potential for more human error. In retrospect, designing the data entry process with a pre-set collection form (i.e. Google Forms) with limited entry options (via drop-down menu) or a more linear decision-tree

model would have mitigated most of the data entry issues and prevented significant data-cleaning issues that continued long after the completion of fieldwork.

Hauler Servicing Recycling Bins

Primarily during the early weeks of the project, commercial recycling drivers entered route areas before staff had completed all HH observations and serviced many recycling roll carts early. Over 330 recycling bins were serviced early by haulers and recorded by field staff over the six weeks of data collection, impacting initial data collection and analysis (see *Observed Tagging Results Over Time* section below). While some minor route intrusion was anticipated, the regularity, and severity, of some of the interference called for a more direct resolution with the haulers. In order to resolve this problem, Tomolla worked directly with field staff and the haulers to create detailed walking-route maps for the particular routes where repeat intrusions occurred (see Appendix 2). Once shared with the hauler managers and drivers, the intrusions dropped off substantially. Tomolla recommends developing these directional walking maps with haulers during pre-project face-to-face meetings in the future, so as to prevent as many early HH pick-ups as possible.

Recyclable, Yes or No?

Rigorous discussions about material contamination in recycling arose from the outset of the project. While most standard recyclable materials are well understood and agreed upon by field staff, management, and Clackamas (plastic bottles, tubs, ONP, magazines, OCC, aluminum cans, etc.), many "other materials/potential contaminants" are not. The subjectivity and discretion given to field staff early on in the project for listing and tagging "#6 Other" in the HH observations, lead to over 230 different items/material descriptions being tagged as a contaminant in HH recycling bins in the first two weeks of data collection. To further complicate this issue, the team received mixed messaging from multiple regional resources, including Metro's Recycling Hotline (which offered conflicting responses about recyclability of freezer boxes on different days). Should Clackamas or another jurisdiction consider tagging "Other" while executing a similar study in the future, it is recommended that they simplify the "Other" category by pre-selecting and listing out materials for staff prior to project execution. See *Types of Contamination Observed* section below for the most observed "Other" material categories from this study.

Findings

The size of the dataset, complexities associated with field collection among thirteen (13) different crew members, and basic methodological difficulties with the collection interface (see *Obstacles Overcome* section above) all combined for a lengthy and challenging data processing scenario. However, once correctly formatted and sufficiently cleaned, the data gleaned from the Single Family Residential Cart Tagging Project yielded highly consequential and statistically significant results. These findings have compelling implications for Clackamas County, and also provide meaningful insight into current regional challenges associated with curbside recycling contamination. Prior to describing statistical discoveries generated from route information, it is helpful to understand the basic data context. The following represents a summary of relevant household information collected.

Totals

Throughout the duration of the six (6) week cart tagging and field data collection process, Tomolla crewmembers recorded on average 3,714 visits to single-family residences in Clackamas County per week, hitting the upper-end of the outreach goal per the project contract. A total of 22,286 HH visits were logged during this timeframe. Of the HH visited, a total of 11,809 curbside recycling setouts were recorded over the six (6) weeks, accounting for a total setout rate of 52.9%. Total glass setouts numbered 2,042 – a 9.2% setout rate (see *Table #1* below).

Weeks #1 - 6 Data Collection Summary	
Total Households Visited	**22,286**
Total Visits Per Week	**3,714**
Total Recycling Set-out Overall	**11,809***
Recycling Bin Set-out Rate	**52.9%**
Total Glass Set-out	**2,042**
Glass Set-out Rate	**9.2%**

**Number includes early hauler pick-ups*

Table #1: Weeks #1-6 Data Collection Summary

Of the 11,809 curbside recycling setouts recorded, 6,348 resulted in deployment of an "Oops" tag, while 5,128 resulted in "Gold Star" tags being left behind. The remaining curbside recycling setouts that received neither "Oops" nor "Gold Star" tags are primarily the result of early hauler pickups, and in relatively fewer instances, inconclusive and/or unreliable field data tracking.

Weeks #1 - 6 Overall Tag Distribution Summary	
Total Recycling Set-out	**11,809***
Recycling Set-out, Gold Star	**44.7%**
Recycling Set-out, Oops	**55.3%**
Gold Star tags used	**5,128**
Oops tags used	**6,348**

**Number includes early hauler pick-ups*

Table #2: Weeks #1-6 Overall Tag Distribution Summary

Observed Tagging Results Over Time

From Week 1 to Week 6 of the cart tagging and field data collection process, observed contamination of curbside recycling containers (as noted by leave behind tags deployed) declined substantially. Below is a simple representation of cart tagging results.

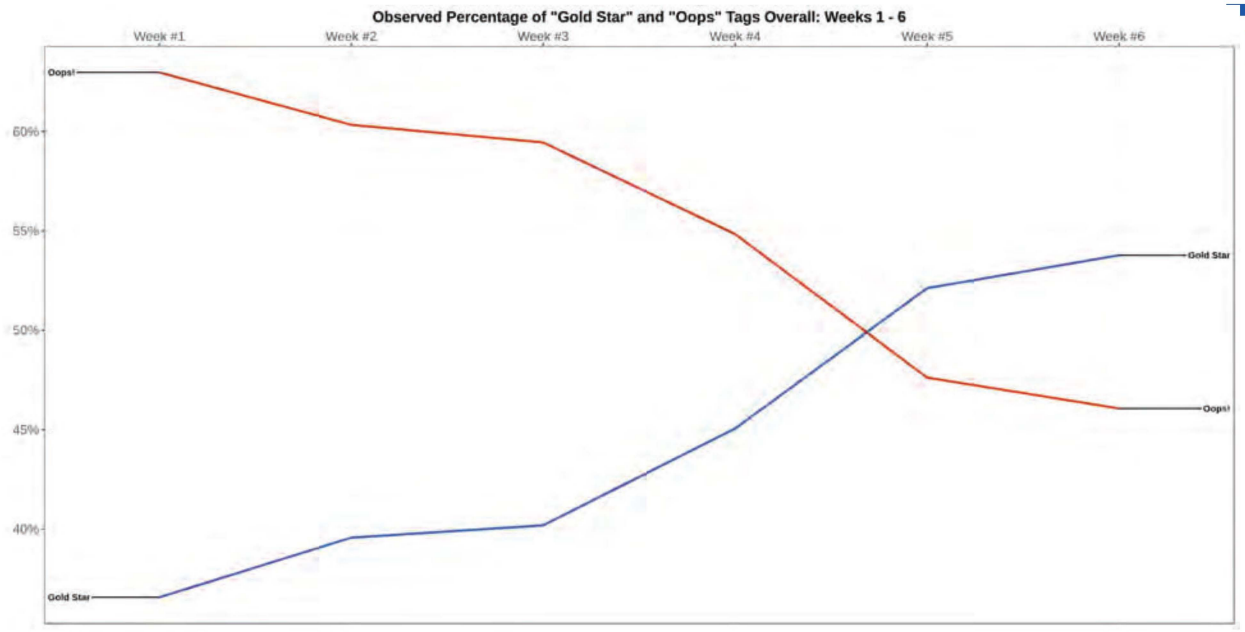


Figure #1: Observed Percentage of "Gold Star" and "Oops Tags Overall: Weeks 1-6

Totals from of Week 1 data collection indicate nearly 63% percent of carts[2] across all routes were observed to have been contaminated and received "Oops" tags. By Week 6 the percentage of contamination across all routes had declined to 46%. Accordingly, when viewed from the perspective of "Gold Star" tags left behind, proper sorting was observed in 37% of the carts in Week 1 as compared with 54% of carts in Week 6.

The net effect of 6 weeks of cart tagging activity is clearly indicative of a broader trend towards contamination reduction in observed curbside recycling rollcarts. Yet, within this larger narrative there exist a number of notable variations in performance across routes that warrant closer examination. The following figure represents a route-by-route look at contamination, as indicated by percentage of "Oops" tags.

[2] Data from Week 1 routes El Dorado and P1TZ were highly impacted by early hauler pickups, and thus skewed towards significantly reduced contamination. As such, Week 2 is used as a baseline for data for these routes.

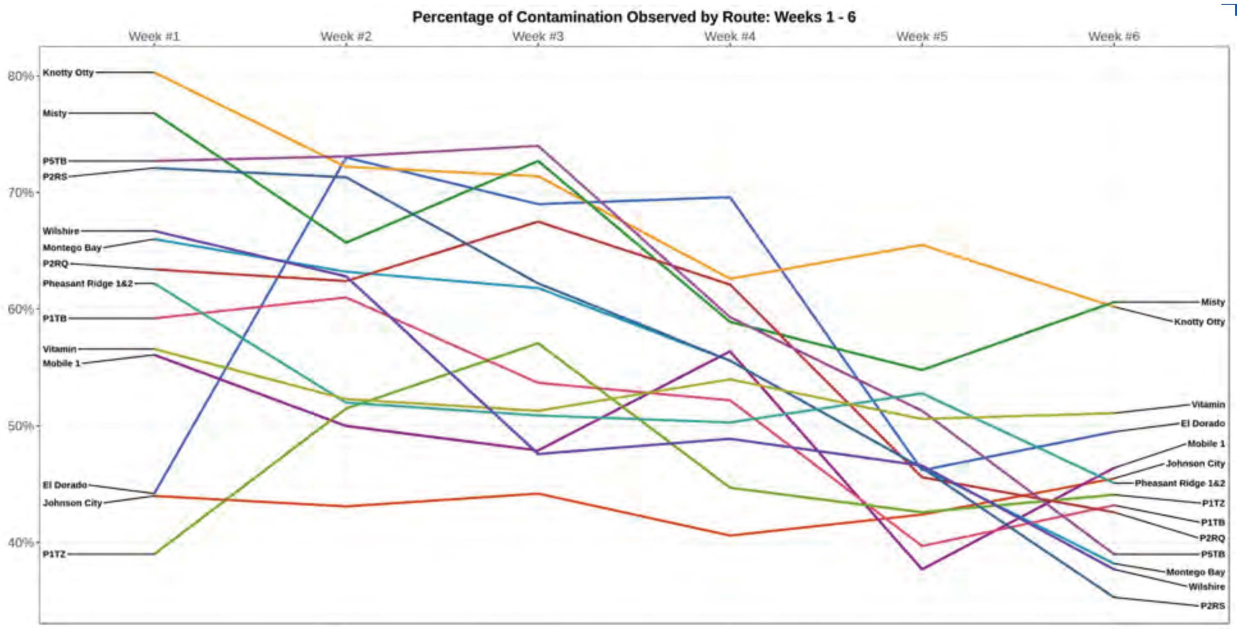


Figure #2: Percentage of Contamination Observed by Route: Weeks 1-6

A side-by-side comparison of all routes shows notable variation among route performance across the duration of the 6-week cart tagging timeline. Routes P2RS and P5TB displayed the largest reduction in contamination from Week 1 to Week 6. P2RS exhibited a baseline 72% "Oops" threshold in Week 1 and experienced a consistent downward trend, ending with a contamination rate of just 35% by Week 6. The single-largest drop in observed contamination on this route occurred between the final two weeks of tagging, wherein P2RS declined from 46% in Week 5 to 35% in Week 6. Similarly, P5TB began at a baseline 73% "Oops" threshold in Week 1 and concluded Week 6 with an observed rate of 39%. The largest decrease in contamination for P5TB occurred between Week 3 and Week 4 – dropping from 74% to 59%. The Wilshire and Montego Bay routes experienced a significant decline in observed contamination, with a reduction from Week 1 to Week 6 of 29% and 28%, respectively.

Half (7) of the fourteen (14) routes fell within observed contamination reduction of 10% to 20% over the course of the cart tagging effort, with most of these routes displaying a reduction on the higher end the continuum. Six (6) of the fourteen (14) total routes were observed to have a reduction over this threshold (in the 15% to 20% range).

The Johnson City route was unique in its performance over time. It never reached a change in observed contamination of more than 5% over the 6-week tagging period, with the highest noted contamination occurring in Week 6 (46%). It also had the lowest observed contamination[3] of all routes in Week 1.

Routes that experienced the smallest reduction in observed contamination were Vitamin, which fell from 57% in Week 1 to 51% in Week 6 and P1TZ that declined in observed contamination from 52% (Week 2) contamination to 44% in Week 6.

[3] This takes into account anomalous Week 1 data from routes El Dorado and P1TZ.

Types of Contamination Observed

Throughout the cart tagging and field data collection process, categorical data (see *Data Collection* section above) was collected regarding specific types of observed contamination in curbside recycling containers. These criteria were set forth by Clackamas and were agreed upon collaboratively with Tomolla at the outset of the project. Observed Contamination from Week 1 through Week 6 is indicated in *Figure #3* below.

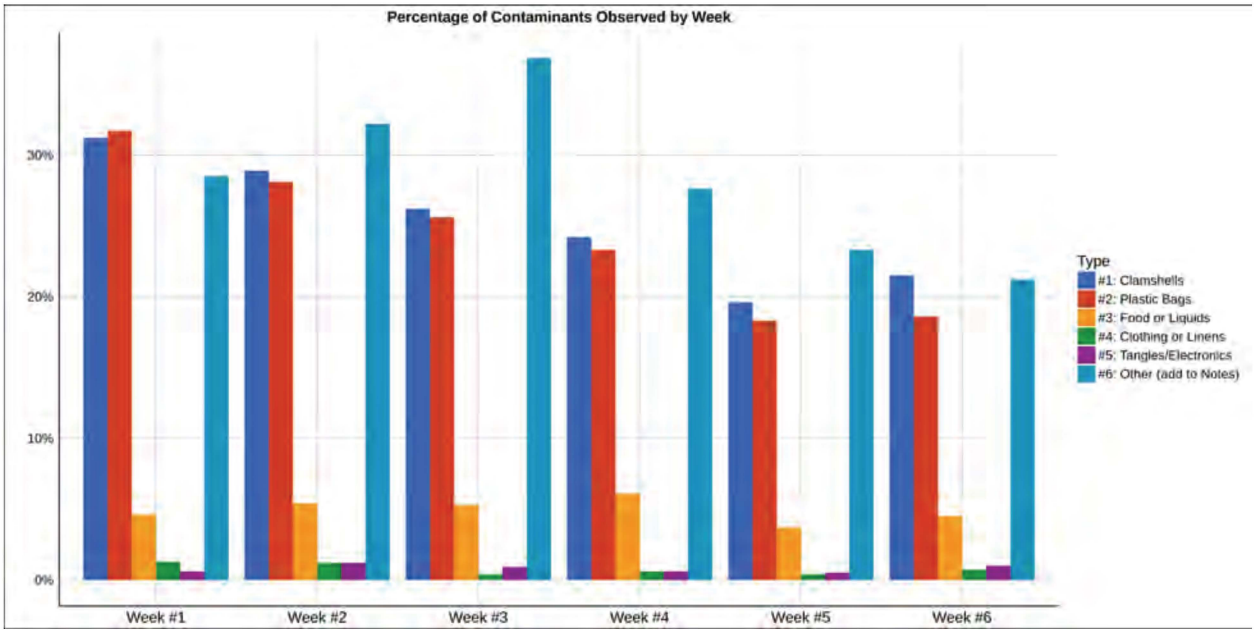


Figure #3: Percentage of Contaminants Observed by Week

Data collected by Tomolla crewmembers indicates that the primary contaminates observed, by category, were consistently "Other" materials, Clamshells, and Plastic bags. Food or Liquids also represented a consistent contaminant throughout the course of the project, yet to a significantly less degree. Clothing or Linens, and Tangles/Electronics were observed with substantially less frequency, some weeks occurring only a handful of times (Week 3, and Week 5).

Of the primary contaminates, the "Other" material category was noted with the most regularity, peaking[4] during Week 3 at 37%. By Week 6, "Other" was recorded 21% of the time by crewmembers. Clamshells were observed no less than 20% during any week during the period of data collection and were noted at the highest rate during Week 1 at 31%. A consistent downward trajectory was noted for Clamshells from Week 1 through Week 5, with an increase during Week 6. Plastic Bags were observed no less than 18% during any week during the period of data collection and were noted the most during Week 1 at 32%. A consistent downward trend was also noted for Plastic Bags from Week 1 through Week 5, with a slight increase during Week 6. Food or Liquids was observed to be at or near 5% of the contaminants observed throughout the data collection period, reaching a maximum of 7% during Week 4.

[4] This may be due to some confusion related to material sorting that was addressed in the mid-project debrief.

As previously suggested, the "Other" category of observed contaminants was noted with more frequency than all other categories of contamination. The figure below illustrates the number of instances that the ten (10) most frequently viewed "Other" contaminants were observed throughout the six (6) week data collection period.

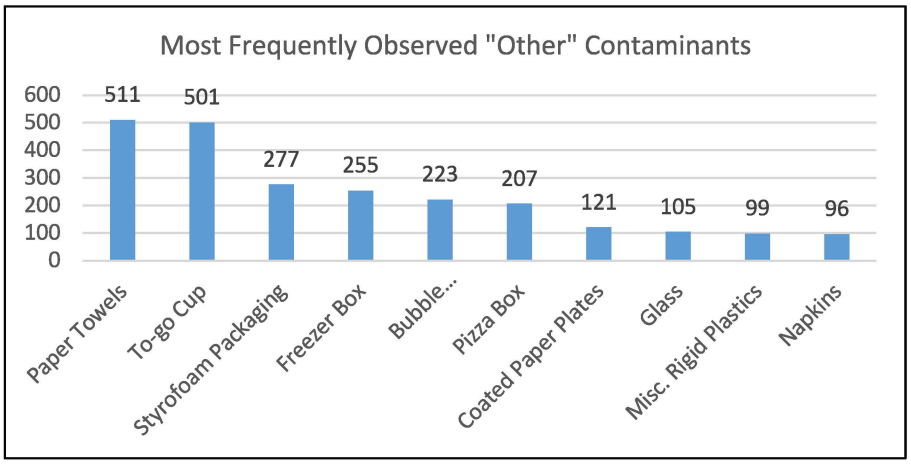


Figure #4: Most Frequently Observed "Other" Contaminants

Of the "Other" contaminants observed, Paper Towels and To-go Cups (including paper, plastic, & EPS) were observed significantly more often than additional materials in the "Other" category, representing 511 and 501 instances, respectively. Styrofoam Packaging (277), Freezer Boxes (255), Bubble Wrap/Packaging (223), and Pizza Boxes (207) also registered a substantial number of observations.

Statistical Analysis

A statistical analysis was undertaken to test whether the observed reduction in recycling contamination was statistically significant. Findings broadly supported the general outcome observed in the qualitative data, indicating that over time recycling contamination was reduced as a result of the recycling cart tags deployed.

Methodology

To evaluate statistical significance, generalized linear mixed-effects logistic regression models were conducted with the lme4 package[5] in R studio (version 1.1.453).[6] Models of this nature are an extension of generalized logistic regression that include both random intercept and random slope components and evaluate individual differences in starting values (intercept), and different trajectories over time (slope). Each individual household was examined for recycling contamination trajectories across six (6) weeks of data, which were grouped by route. A quantitative analysis of this nature allows for the effects of individual households to be "nested" (grouped) within neighborhoods, modeling individual effects within routes across time.

---

[5] Douglas Bates, Martin Maechler, Ben Bolker, Steve Walker (2015). Fitting Linear Mixed-Effects Models Using lme4. Journal of Statistical Software, 67(1), 1-48. doi:10.18637/jss.v067.i01.

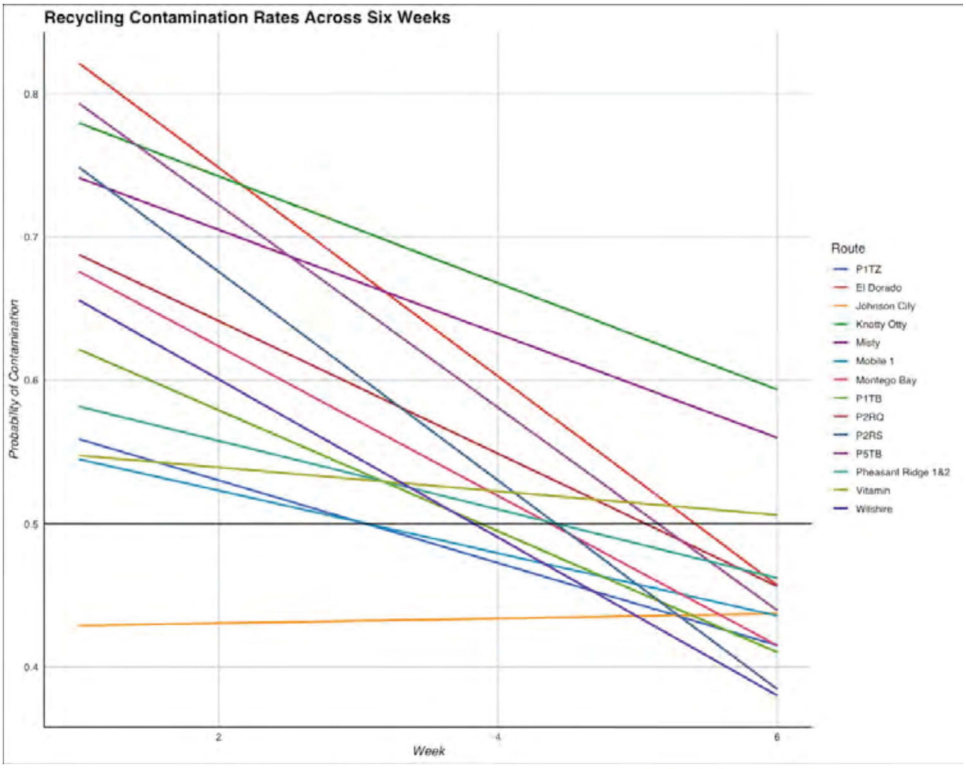
[6] Specifically, a generalized linear mixed model fit by maximum likelihood (Laplace Approximation), calling a binomial (logit) function to model binary outcome data was used.

For the purposes of this study, a reference group (route in this case) was used. Each route was compared to the reference route to test for significant change over time. The reference route utilized was Vitamin; it was chosen because it had a probability of contamination that was close to chance (i.e., near 0.5 as noted in *Figure #5* below) and a shallow slope, which indicated limited change over time.

The primary binary outcome variable utilized when running the regression models was observed contamination of curbside recycling containers, as indicated by leave behind "Oops" tags where 1 = "Oops" tag, and 0 = no "Oops" tag.

Outcome

Figure #5 below[7] presents a visualization of contamination for each route and shows the modeled probability of an "Oops" tag for each route across six (6) weeks of data collection. In essence, the visual displayed below represents the estimated probability of an outcome (contamination) based on one or more predictor variables: in this case, route and time. The goal was to determine whether being part of a particular route affected contamination rates over time. *Figure #5* below presents a simple visual representation of projected recycling contamination by route, across time.



**Black line at 0.5 is chance, or no effect.*

Figure #5: Recycling Contamination Rates Across Six Weeks

[7] Two models were run. The model represented in the figure (removed Week 1 data from Routes El Dorado and P1TZ) was a better fit as indicated by an AIC (Akaike Information Criterion) value of 15245 compared to 15479 originally deployed (included Week 1 data from Routes El Dorado and P1TZ). When comparing models fitted by maximum likelihood, a smaller AIC is indicative of a better fit for analysis. For more on AIC, see https://en.wikipedia.org/wiki/Akaike_information_criterion

Put simply, the model depicts an overall trend of lowered curbside recycling contamination over time. Most routes display a decreasing probability of contamination from week-to-week of data collection. As such, the statistical analysis generally supports the observed trends observed in the qualitative assessment of the data (see *Table #3* below). More specifically, results from the interaction model show statistically significant time-varying relationships in nine (9) of the (14) routes:

- El Dorado
- Knotty Otty
- Misty
- Montego Bay
- P1TB
- P2RQ
- P2RS
- P5TB
- Wilshire

These nine (9) routes showed statistically significant reductions in recycling contamination longitudinally as evidenced by odds ratios of lower than .90 and p-values of less than .05 for "Oops" tags. The results of the model are indicated in *Table #3* below, with statistically significant routes highlighted in grey for reference.

Interaction Model	Time (Week) x Route "Oops!" Tags		
	Odds Ratio	*CI*	*p*
(Intercept)	1.25	0.96 – 1.63	0.099
Week	0.97	0.90 – 1.04	0.348
Route*			
Week:Johnson City	1.04	0.93 – 1.17	0.503
Week:P1TZ	0.92	0.81 – 1.05	0.215
Week:El Dorado	**0.74**	**0.64 – 0.86**	**<.001**
Week:Knotty Otty	**0.87**	**0.77 – 0.98**	**0.018**
Week:Misty	**0.88**	**0.79 – 0.98**	**0.015**
Week:Mobile 1	0.95	0.86 – 1.05	0.295
Week:Montego Bay	**0.83**	**0.74 – 0.95**	**0.005**
Week:P1TB	**0.87**	**0.78 – 0.97**	**0.015**
Week:P2RQ	**0.85**	**0.77 – 0.95**	**0.003**
Week:P2RS	**0.76**	**0.68 – 0.85**	**<.001**
Week:P5TB	**0.76**	**0.68 – 0.85**	**<.001**
Week:Pheasant Ridge 1&2	0.94	0.85 – 1.04	0.225
Week:Wilshire	**0.83**	**0.74 – 0.92**	**<.001**
N_{Route}		14	

Table #3: Longitudinal Statistical Analysis Results by Route

Beyond Vitamin, three (3) routes were statistically non-significant, yet were trending towards less contamination. However, results did not indicate a significantly greater reduction in contamination compared to Vitamin (reference route) as indicated by odds ratios in the figure above, which were closer to an odds value of 1.0 while also having p-values above .05. Those routes were:

- P1TZ
- Mobile 1
- Pheasant Ridge 1&2

Johnson City was unique among the fourteen (14) routes chosen for this study in that reduction in contamination was not observed (note the odds Ratio of 1.04 and p-value of .503).

Field Notes

Tomolla is fortunate to maintain a broad network of crewmembers that are committed to materials management and available for limited-duration projects. For this effort, our field crew was comprised of thirteen (13) individuals that contributed to varying degrees over the course of the six (6) week data collection period. Many of these crewmembers maintain ongoing materials management positions, others had previous experience in the field and had moved on to other professional work. A few were new to materials management but had previous sustainability experience or were brought into the project for complimentary skills such as field data collection expertise and/or superior communication and customer service attributes. Tomolla's main pre-requisite for joining the project (beyond experience) was a strong passion for improving sustainability outcomes and demonstrated ability to work well in a team environment.

Feedback from the Field Crews was essential to a successful project and informed a number of iterative changes to Tomolla's methodology and improvements during the data collection portion of the project. Upon completion of the routes, multiple crewmembers shared their thoughts about the overall success of the data collection, take-aways that may benefit future initiatives of this nature, and simply some interesting "field notes". Collected below is a selection of the most interesting "field notes" from the Tomolla crews, edited for content and brevity.

Travis McGee, Crewmember, Weeks 1-3

Although I only worked on the Clackamas County Recycling Cart Tagging project for three of the allotted six weeks, I found the experience valuable from a data collection and educational standpoint. The final data will ultimately tell the bigger story, but over the course of my time on the project, I sensed a noticeable improvement in residents' compliance with recycling standards, an increased willingness from the public in discussions about those standards, and a greater understanding among residents of the project's objectives. Ultimately, I believe this led to more trust between the communities and Clackamas as it relates to this project.

Once adjusted to the early mornings, the work proved to be enjoyable and rewarding. I loved walking through the neighborhoods as they awoke in the morning hours, and getting a full day's worth of exercise before noon was an added bonus. I also learned a lot about the nuances of the recycling processes in Clackamas County and beyond, which reinforced the value of projects like these.

In Johnson City, a woman told us her son was so excited about receiving a "Gold Star" that he took the actual "Gold Star" tag to school for show-and-tell.

Several people we interacted with expressed disappointment in themselves for receiving an "Oops" tag the prior week. In each of those interactions, they asked for clarification on how to properly identify recyclable materials. The most notable interaction was with an elderly gentleman in Johnson City, who asked us several questions while expressing his desire to recycle properly and his support for our program.

On the Mobile 1 route, we interacted with many parents each week whose children were either waiting for their school bus or had just boarded. These interactions were always cordial and even jovial, with many parents telling us they didn't want a "bad grade" for the week.

By Week 3, the comfort level of residents on each of my routes was noticeably higher than that of Week 1. I believe keeping taggers [field staff] assigned to the same routes each week helped gain trust among residents.

Rachel Zarfas, Crewmember, Weeks 1-7

Most of the people we interacted with were happy or curious about the project. Often this was because they were afraid they may be fined for improperly recycling or were interested about why certain materials aren't recyclable. For the handful of people that weren't happy about it, it was because they had trouble discerning which items resulted in "Oops" tag notices week-after-week and were frustrated by getting a "negative grade" when they tried to recycle correctly. They also worried that someone was going through their carts and possibly removing items, and just generally feeling confused and wrong about something. The "Oops" tag seems to put a minority of people in a "fight/flight defensive mode". However, the majority of people we talked to were appreciative of the educational moment.

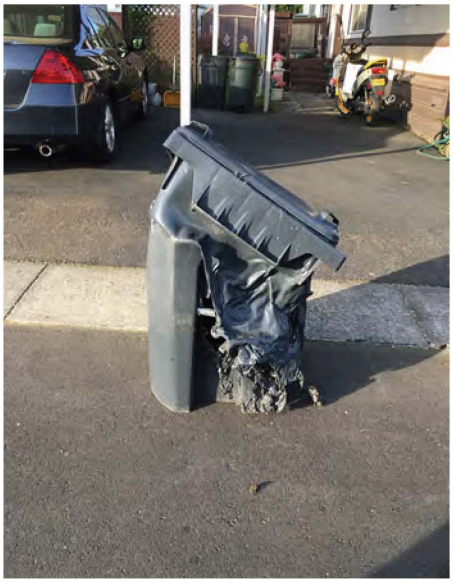


Image #1: Melted Garbage Set-out

We had a lot of great conversations with people about why certain materials are and aren't recyclable. People like to know the basics behind this, but it's useful to keep it brief.

If Clackamas will be completing more cart tagging, I would suggest changing the "Oops" tag a bit. I would recommend removing the textiles and cords categories, and adding paper towels/napkins/tissues, freezer boxes, and/or plastic-coated paper (cups, plates). Also, perhaps make the phone number (Metro Recycling Line or county phone number) more prominent so people can more easily figure out how to recycle or dispose of items that can't go in the curbside recycling.

As for contaminants, here are some items that I think people needed more guidance about:

- Caps and lids (still on bottles and containers)
- Refrigerator boxes (soda, butter, etc.)

- Breaking down boxes
- Large pieces of metal that fit in the cart
- Empty motor oil and chemical containers
- Contamination in the glass bin (ex. vases, windows glass, dish ware)
- Additionally, based on conversations with folks in the field, I still think it would be beneficial to use actual photos of items instead of clipart.

It might be helpful for crewmembers to list and photograph the actual contaminant items they saw through the project, including brands. I think it would be helpful for Clackamas to know what types of items people are using a lot of (ex. Amazon bubble envelops, Pringles, donut boxes, baby food packaging, coffee bags and cans, etc.) in case they want to obtain examples later and do a photoshoot of them for outreach.

Nick Isbister, Crewmember, Weeks 1-7

I noticed some themes when talking to people on the route. I've also heard from many folks over the past couple of months who took opportunity to share that they were part of the study when they knew I was in the recycling industry.



Image #2: Crewmembers Nick Isbister and Gretchen Sandau in action

Frustration: Keep in mind I am VERY biased towards tagging for 3-5 major contamination items. I believe a lot of the frustration results from crews "over-tagging." People can only be criticized so much, and that's what it felt like when they received an oops tag all 6 weeks or a list of 7 contaminates on their tag under "other". Some folks on routes and I were not quite on the same page. They thought that if a resident doesn't know they put something wrong in the cart, they'll never change their behavior. To me, it's a "pick your battles" situation and we should not battle over such things as receipt paper or a tea bag packages. Again, I think this frustrates people to the point of giving up on trying. I talked to a certain individual that said he puts garbage in his recycling because his "labor is not free". Because we are not paying him to sort his commodities, he didn't feel the need to. There are probably more out there like him.

We changed the rules: One Clackamas County resident explained it directly, "you guys keep changing the rules." I heard this quite a lot. Many folks were actually aware of Green Sword or had heard a radio blurb about it. To them, we were going around re-educating people on the items people should no longer put in the bins because China won't buy our recycling anymore. They thought that the miscellaneous plastics we identified were permitted in the bin until this year. Getting someone to understand that a PET thermo-form (clamshell/salad container) has NEVER been on the YES list is a tough sell.

It makes me wonder if we should even tag them at all. A Cascadia Consulting staffer I was chatting with said thermoforms don't actually make up a large part of the stream. (though in Washington there

is no bottle bill, so PET bottles make up a much larger percentage of the overall PET, and thermoforms are on the YES list in Seattle, so I assume they get a little more than we do in Oregon).

I'd like to learn more about how much of this material MRF's are seeing. It seemed many carts had PET salad containers. Do these items slow down the line like a bag? Do the MRF's have so much of it to put in the mixed plastics bales that it's costing them a lot of money to move? If not, then I don't think it should be on the cart tag.

Thank you's and a desire to do the right thing: There were times when folks would thank us for correcting their neighbor's poor recycling behavior. Many were glad we were informing them of the rules because they found that recycling is very confusing.

Frequency: Perhaps 6 tagging routes in 7 weeks is overkill and if there is such a budget for this many routes, maybe considering splitting that over the year. This may potentially give residents the sense that they are always being watched for recycling error and that they should stay on top of it. I'll be interested to know if the data shows any behavior change, I feel like some households were blind to the "Oops" tag correction.

It will be interesting to see how other jurisdictions roll out cart tagging campaigns. I hope they learn from this project.

Dave Muller, Crewmember, Weeks 1-7

Over the course of the project, we saw an increase in uncontaminated carts, and a reduction of both types and number of contaminants in those carts that still received "Oops" tags. Based on this unscientific observation, it seemed that our routes on the whole were steadily improving in keeping non-recyclables out of the recycling bin. One particularly gratifying case was a house that had been one of the worst "offenders"—I'm pretty sure we checked all the boxes on the Oops tag at this over the course of the first 5 weeks, some several times, and also marked several other items, including pigeon feathers and coop materials. When this house had an uncontaminated cart on the last week, it was both surprising and gratifying.



Image #3: Permanent" Gold Star Tag applied by resident

The majority of residents we interacted with were friendly and/or curious about both the project and how to recycle properly. They would ask what we were doing out there and listen politely, and sometimes ask several follow-up questions about what they did wrong, why certain items are not accepted, what's going on with China, et. al. While these conversations sometimes slowed us down while we were racing the trucks to finish our route, they were also well worth it as those residents generally came away with a much better understanding of the system.

Some residents were certainly suspicious or alarmed at first to see people looking in their bins in the wee hours, but most were still able to ask politely and then accept our explanation. There was one encounter where a resident was particularly hostile and refused to listen to or believe any of our attempts at explanation. He cursed at us and told us we were lying, and we eventually just wished him a good day and moved on. At one point we heard someone yell "Go f*** yourself!" loudly, but we didn't actually see them, so don't know for sure if that was directed at us or someone else, but it seemed like it was meant for us (that house received a "Good Job!" tag on the day in question, for what it's worth).

Most contamination came from just a few items we saw repeatedly:

- Plastic film/bags (I think the tags should have specifically called out film, not just bags)
- Paper towels/napkins/plates/to-go boxes (the food-soiled category)
- Clamshells/other rigid plastics (again, the tag listing only "clamshell" was insufficient in my opinion)
- To-go cups (paper and plastic)
- Pizza boxes

It may be wise for Clackamas to send out large, graphic notices calling out these specific items as they made up such a large proportion of the overall contamination we found in bins.

A new batch of stickers illustrating what waste goes in which bin would be a smart investment. I don't know if these could be given to the waste haulers to place on bins or through some other method, but having a clear visual reminder right on the lid of the bin would help catch many mistakes before they happen, in my opinion.

In our brief conversations with haulers, it seemed like they had little to no means of interacting with individual customers. As they are the "boots on the ground" so to speak and see the most regular (and egregious) offenses, if they were empowered to leave a tag or otherwise message an individual residence (or warn of an impending fine?), that could be a good way to reach the worst offenders.

I think it's wise for Clackamas to periodically do projects such as this to keep their recycling system as clean, efficient, and cost-effective as possible.

Recommendations

With the insight gleaned from the Single Family Residential Recycling Cart Tagging Project, Clackamas has statistically significant results that outreach of this nature reduces recycling contamination, and a strong baseline from which to further evaluate and/or make future decisions related to residential recycling in unincorporated Clackamas County. Additionally, knowledge gained from this study may help with regional efforts to grapple with the "new normal" currently facing recycling markets. Clackamas has not only improved outreach and practices related to curbside recycling within its own backyard, it has advanced a strategy that may help address an intractable issue facing the entire metro area. The following action items would augment the findings in this study and add additional insight towards improving curbside recycling practices and outreach in Clackamas and beyond:

1. ***Perform follow-up analyses to examine more covariates such as socio-economic status and average age of resident.*** To better understand how sub-groups of this population responded to outreach, additional factors should be examined via statistical analysis. Using a similar methodology to the approach described in the *Statistical Analysis* section Clackamas could attempt to determine if factors such as annual household income, age, or education-level impacted participation levels and/or contamination rates. This could be explored across time with the 6-week data set provided while adjusting to look at variances related to cart tagging outreach among the different census tracts associated with routes in this dataset. Essential information to "fine tune" future outreach efforts for specific audiences could be gleaned from a more nuanced understanding of this type of data, allowing Clackamas to deploy outreach resources as efficiently as possible.
2. ***Evaluate how residents responded to feedback about specific types of contamination to reveal opportunities for targeted outreach.*** A more detailed understanding of how tagging specific materials affected responses from residents would augment interpretation of the data, and potentially highlight paths to targeting the most problematic material types. Specifically, additional longitudinal analysis exploring trajectories (by type) of contamination across time in the extent dataset could help determine the effectiveness of particular leave-behind messaging and help Clackamas determine what material-specific messaging worked and/or didn't work. Additional statistical analysis on the six (6) contamination categories and findings from the "Other" section would provide a more nuanced gauge of residential behavior and attitudes, and help "drill down" to more tailored messaging about materials to induce future behavior change.
3. ***Complete additional tactical outreach efforts (cart tagging and otherwise) to test and expand the data gathered from this study.*** Clackamas should explore deploying follow-up outreach efforts of a smaller scale that expand and potentially challenge the findings outlined within this report. Completing these efforts would serve to "ground truth" what has been learned from this project and could enable a process of verification that could start a set of best practices for recycling contamination protocols in the metro area. Suggested follow-up outreach projects are listed below.
    a. Data-gathering surveys that would enable more clarity about routes that were found to be statistically insignificant.
        i. For example, questionnaires with attitude-focused questions about the views and opinions of residents on issues pertaining to the recycling and waste, and how this impacts their perceived role within the community.
    b. Targeted cart-tagging routes with smaller sample sizes that would offer comparative results utilizing different variables to help determine optimal feedback parameters. These might include:
        i. Routes completed with different time intervals (fewer and/or longer total weeks of tagging outreach); and
        ii. Tagging outreach completed at alternative times of year to better understand and measure participation.

Conclusion

Targeted recycling outreach completed during the Single Family Residential Recycling Cart Tagging Project yielded a tangible reduction in commingled recycling contamination over a 6-week period from April 2018 through early June 2018. Qualitative (observed) results were supported by statistically significant results across a majority of the fourteen (14) routes where data was collected. This indicates that legitimate behavioral change was attained by utilizing the methodology deployed by Tomolla. On its own, this outcome represents a positive step forward in Clackamas County; it also has important implications for the Portland Metropolitan region with respect to improving broader recycling outcomes. Additional opportunities exist both to delve deeper into the dataset generated from this project, and to build on the learning herein with follow-up analyses and outreach efforts that improve recycling participation via feedback at the curbside. Taking further steps as indicated above in the *Recommendations* section will not only assist Clackamas in meeting their goals to improve recycling outcomes within the county, but also enable it to take a leadership role in helping the region respond to changing recycling markets and materials management systems.

Acknowledgements

Tomolla would like to recognize the following contributors, without whom the Single Family Residential Recycling Cart Tagging Project would have not been possible. A debt of gratitude goes out to each individual listed below:

Clackamas County:

Eben Polk

Rick Winterhalter

Stacy Ludington

Tomolla Data Cleaning and Analysis Team:

Philip Orlando

Elizabeth Hawkey

Tomolla Crewmembers:

Todd Ashley

Aaron Elliot

Rio Hybert-Zack

Nick Isbister

David Lewis

Travis McGee

David Muller

Amy Rohrer

Gretchen Sandau

Casey Szot

Jeremy Shockey

Teak Wall

Rachel Zarfas

Waste Haulers:

Clackamas Garbage

Hoodview Disposal

Sunset Garbage

Waste Management

Appendix 1: Waste Hauler Maps

Pages 22-36 below show the fourteen (14) different study route maps that Tomolla and Clackamas created in partnership with the four (4) waste haulers who participated in this study.

Montego Bay

Clackamas Sanitary

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

N

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

P1TB

Waste Management

- Private Road
- Project Boundaries
- Parcels
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

Waste Management

- Waste Management (JPL)
- Waste Management of Oregon
- Waste Management of Oregon (Wichita)

DRAFT

Feet

0 180 360 720

CLACKAMAS COUNTY

GEOGRAPHIC INFORMATION SYSTEMS

DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

P1TZ

Waste Management

Private Road
Project Boundaries
Parcels
Building Footprints
Clackamas Sanitary
Hoodview Sanitary
Sunset Garbage Collection
JohnsonCitySiteAddress

Waste Management
Waste Management (JPL)
Waste Management of Oregon
Waste Management of Oregon (Wichita)

DRAFT

Feet
0 180 360 720

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Johnson City

Clackamas Sanitary

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

P1RQ

Waste Management

Private Road
Project Boundaries
Parcels
Building Footprints
Clackamas Sanitary
Hoodview Sanitary
Sunset Garbage Collection
JohnsonCitySiteAddress

Waste Management
Waste Management (JPL)
Waste Management of Oregon
Waste Management of Oregon (Wichita)

DRAFT

Feet
0 180 360 720

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

P2RS

Waste Management

Private Road
Project Boundaries
Parcels
Building Footprints
Clackamas Sanitary
Hoodview Sanitary
Sunset Garbage Collection
JohnsonCitySiteAddress

Waste Management
Waste Management (JPL)
Waste Management of Oregon
Waste Management of Oregon (Wichita)

DRAFT

Feet
0 135 270 540

N

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

El Dorado

Clackamas Sanitary

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Misty

Hoodview

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 162.5 325 650

N

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Mobile 1

Sunset

Private Road
Project Boundaries
Parcels
Building Footprints
Clackamas Sanitary
Hoodview Sanitary
Sunset Garbage Collection
JohnsonCitySiteAddress

Waste Management
Waste Management (JPL)
Waste Management of Oregon
Waste Management of Oregon (Wichita)

DRAFT

Feet
0 180 360 720

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Wilshire

Clackamas Sanitary

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet

0 162.5 325 650

CLACKAMAS COUNTY

GEOGRAPHIC INFORMATION SYSTEMS

DEPARTMENT OF INFORMATION SERVICES/GIS/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Knotty Otty

Sunset

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GRAPHIC INFORMATION SYSTEMS
121 LIBARRY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Vitamin

Hoodview

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GIS/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

P5TB

Waste Management

- Private Road
- Project Boundaries
- Parcels
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

Waste Management

- Waste Management (JPL)
- Waste Management of Oregon
- Waste Management of Oregon (Wichita)

DRAFT

Feet

0 310 620 1,240

CLACKAMAS COUNTY

GEOGRAPHIC INFORMATION SYSTEMS

DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Pheasant Ridge

Sunset

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

Feet
0 105 210 420

N

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

100

Sunset

- Private Road
- Project Boundaries
- Parcels
- City Boundary
- Building Footprints
- Clackamas Sanitary
- Hoodview Sanitary
- Sunset Garbage Collection
- JohnsonCitySiteAddress

DRAFT

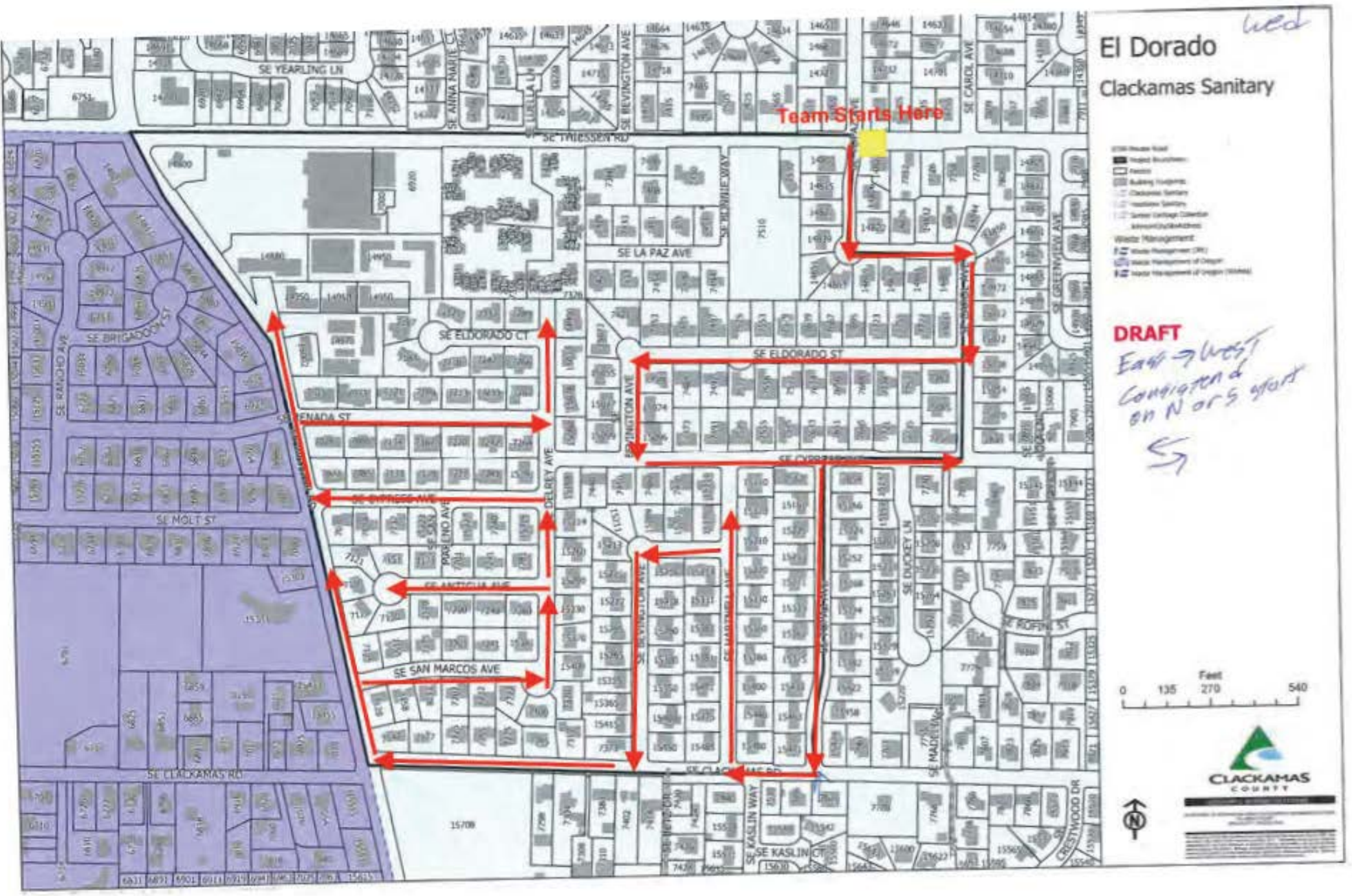
Feet
0 105 210 420

CLACKAMAS COUNTY
GEOGRAPHIC INFORMATION SYSTEMS
DEPARTMENT OF INFORMATION SERVICES/GEOGRAPHIC INFORMATION SYSTEMS
121 LIBRARY COURT
OREGON CITY, OREGON 97045

The information on this map was derived from digital databases from Clackamas County's GIS. Care was taken in the creation of this map but is provided "as is". Clackamas County cannot accept any responsibility for any errors, omissions, or positional accuracy, and therefore, there are no warranties which accompany this product. Although information from Land Surveys may have been used in the creation of this product, in no way does this product represent or constitute a Land Survey. Users are cautioned to field verify information on this product before making any decisions.

Appendix 2: Wednesday Clackamas El Dorado Walking Route

Page 38 shows an example of one (1) of the walking routes created to help mitigate hauler intervention in data collection efforts…


El Dorado
Clackamas Sanitary
Team Starts Here
DRAFT
East → West
Continue on N or S street
SE TWILIGHT DR
SE YEARLING LN
SE ANNA MARIE CT
SE LUELLA LN
SE BEVINGTON AVE
SE CAROL AVE
SE LA PAZ AVE
SE GREENWOOD AVE
SE ELDORADO CT
SE ELDORADO ST
SE BRIGADOON CT
SE RAMONA AVE
SE GRENADA ST
SE EXPRESS AVE
SE MOLT ST
SE POSEYO AVE
SE ANTIOCH AVE
SE SAN MARCOS AVE
SE CLACKAMAS RD
SE DUDLEY LN
SE ROFFIN ST
SE KASLIN WAY
SE KASLIN CT
CRESTWOOD DR
Feet
0 135 270 540
CLACKAMAS COUNTY

Appendix 3: Cart Tagging Summary Data

Page 40 provides a summary of the Cart Tagging data collected over the course of six (6) weeks, per route.

2018 Clackamas County Single-Family Residential Recycling Cart Tagging Project - Summary Data

Route	Week	Recycling Bin Out?	Glass Bin Out?	Proper Recycle Bin Sorting?	Contamination ?	#1: Clamshells	#2: Plastic Bags	#3: Food or Liquids	#4: Clothing or Linens	#5: Tangles/ Electronics	#6: Other (add to Notes)	Leave Behind Tag Used?	Gold Star	Oops!
El Dorado	Week #1	70	16	29	23	8	11	0	0	0	11	52	29	23
El Dorado	Week #2	100	19	26	74	41	33	19	1	4	52	100	26	74
El Dorado	Week #3	104	14	31	69	35	28	15	0	2	43	100	31	69
El Dorado	Week #4	92	10	28	64	30	14	8	0	1	47	92	28	64
El Dorado	Week #5	91	17	42	36	8	15	4	0	0	24	78	42	36
El Dorado	Week #6	107	20	54	53	19	18	11	0	3	31	107	54	53
Johnson City	Week #1	75	5	42	33	10	19	1	0	0	11	75	42	33
Johnson City	Week #2	123	17	70	53	24	25	2	0	0	22	123	70	53
Johnson City	Week #3	87	6	48	38	10	15	0	1	0	18	86	48	38
Johnson City	Week #4	101	2	60	41	26	15	1	0	0	15	101	60	41
Johnson City	Week #5	95	6	53	39	14	18	1	1	1	20	92	53	39
Johnson City	Week #6	123	12	67	56	17	19	0	0	0	26	123	67	56
Knotty Otty	Week #1	117	9	23	94	37	53	8	6	1	53	117	23	94
Knotty Otty	Week #2	126	18	35	91	41	51	10	1	2	52	126	35	91
Knotty Otty	Week #3	133	11	38	95	35	31	12	2	2	74	133	38	95
Knotty Otty	Week #4	123	17	46	77	33	31	12	3	0	35	123	46	77
Knotty Otty	Week #5	110	19	38	72	32	34	8	0	0	31	110	38	72
Knotty Otty	Week #6	118	16	47	71	34	42	9	2	2	28	118	47	71
Misty	Week #1	177	21	40	137	76	74	5	3	2	54	177	40	137
Misty	Week #2	169	31	58	111	49	55	11	2	1	59	169	58	111
Misty	Week #3	172	35	47	125	56	60	5	0	3	92	172	47	125
Misty	Week #4	158	22	65	93	45	41	5	1	0	40	158	65	93
Misty	Week #5	168	27	76	92	46	35	6	0	0	51	168	76	92
Misty	Week #6	180	32	71	109	52	46	18	3	1	65	180	71	109
Mobile 1	Week #1	157	30	69	88	53	43	3	1	0	39	157	69	88
Mobile 1	Week #2	168	26	84	84	38	41	4	3	0	36	168	84	84
Mobile 1	Week #3	167	26	87	80	31	38	1	0	0	44	167	87	80
Mobile 1	Week #4	165	42	72	93	41	38	11	1	0	46	165	72	93
Mobile 1	Week #5	167	23	104	63	25	27	0	0	1	28	167	104	63
Mobile 1	Week #6	166	26	89	77	36	29	3	1	1	34	166	89	77
Montego Bay	Week #1	101	18	16	31	16	10	2	0	0	19	47	16	31
Montego Bay	Week #2	115	33	39	67	34	29	5	2	1	40	106	39	67
Montego Bay	Week #3	124	28	46	77	45	34	8	0	2	44	123	46	77
Montego Bay	Week #4	117	24	52	65	24	27	5	0	3	41	117	51	65
Montego Bay	Week #5	125	29	67	58	42	20	7	0	1	7	125	67	58
Montego Bay	Week #6	102	16	63	39	27	4	0	2	6	1	102	63	39
P1TB	Week #1	125	6	51	74	46	38	10	1	2	39	125	51	74
P1TB	Week #2	146	22	57	89	41	34	8	1	1	61	146	57	89
P1TB	Week #3	134	36	62	72	30	30	13	0	0	38	134	62	72
P1TB	Week #4	136	24	65	71	25	29	8	0	0	50	136	65	71
P1TB	Week #5	126	37	76	50	15	21	8	0	1	27	126	76	50
P1TB	Week #6	111	17	63	48	22	17	5	0	0	28	111	63	48
P1TZ	Week #1	148	27	61	39	5	26	1	0	0	8	100	61	39
P1TZ	Week #2	165	25	80	85	24	38	2	1	1	40	165	80	85
P1TZ	Week #3	147	33	42	56	22	25	0	0	0	31	98	42	56
P1TZ	Week #4	150	29	83	67	23	33	1	1	1	25	150	83	67
P1TZ	Week #5	165	36	93	69	23	23	0	1	2	18	162	93	69
P1TZ	Week #6	151	21	52	41	18	18	0	0	1	13	93	52	41
P2RQ	Week #1	145	17	48	92	41	50	10	2	2	49	140	48	92
P2RQ	Week #2	172	36	63	106	52	51	5	0	0	61	169	63	106
P2RQ	Week #3	160	22	47	106	38	45	8	0	4	80	153	47	106
P2RQ	Week #4	145	24	55	90	40	34	17	0	2	71	145	55	90
P2RQ	Week #5	169	30	92	77	37	30	4	0	0	40	169	92	77
P2RQ	Week #6	141	27	81	60	25	16	3	0	1	39	141	81	60
P2RS	Week #1	140	19	39	101	63	44	14	2	0	52	140	39	101
P2RS	Week #2	165	25	45	112	56	39	17	2	2	69	157	45	112
P2RS	Week #3	145	27	54	89	37	36	8	2	1	63	143	54	89
P2RS	Week #4	153	32	68	85	35	35	25	3	1	46	153	68	85
P2RS	Week #5	151	24	81	70	26	30	11	2	1	52	151	81	70
P2RS	Week #6	136	26	88	48	19	24	13	1	1	24	136	88	48
P5TB	Week #1	132	35	36	96	43	44	9	1	1	53	132	36	96
P5TB	Week #2	134	29	36	98	47	51	20	9	11	52	134	36	98
P5TB	Week #3	131	27	34	97	48	42	18	1	1	71	131	34	97
P5TB	Week #4	123	27	50	73	34	37	11	2	0	16	123	50	73
P5TB	Week #5	117	23	57	60	19	25	0	0	1	21	117	57	60
P5TB	Week #6	123	18	75	48	25	21	2	2	1	24	123	75	48
Pheasant Ridge 1&2	Week #1	164	31	62	102	57	41	6	1	1	29	164	62	102
Pheasant Ridge 1&2	Week #2	171	39	81	89	49	44	7	0	1	34	170	81	89
Pheasant Ridge 1&2	Week #3	163	42	80	83	42	32	8	0	2	29	163	80	83
Pheasant Ridge 1&2	Week #4	161	42	80	81	41	37	5	0	1	28	161	80	81
Pheasant Ridge 1&2	Week #5	159	41	75	84	36	22	14	1	0	47	159	75	84
Pheasant Ridge 1&2	Week #6	162	46	89	73	42	26	9	1	1	22	162	89	73
Vitamin	Week #1	189	16	80	107	52	55	1	5	0	42	187	80	107
Vitamin	Week #2	197	30	94	103	50	54	3	2	0	35	197	94	103
Vitamin	Week #3	193	21	92	99	44	52	2	2	0	47	191	92	99
Vitamin	Week #4	200	28	92	108	45	57	7	0	1	44	200	92	108
Vitamin	Week #5	197	18	75	81	27	28	5	2	0	41	156	75	81
Vitamin	Week #6	176	16	86	90	47	46	4	0	0	33	176	86	90
Wilshire	Week #1	114	26	38	76	35	44	10	0	2	37	114	38	76
Wilshire	Week #2	148	30	55	93	56	42	1	3	2	57	148	55	93
Wilshire	Week #3	126	31	66	60	32	26	4	0	1	34	126	66	60
Wilshire	Week #4	131	27	67	64	32	27	5	0	1	36	131	67	64
Wilshire	Week #5	133	29	71	62	25	23	3	0	1	39	133	71	62
Wilshire	Week #6	146	25	90	56	23	27	8	2	0	33	146	90	56
TOTALS:		**11809**	**2042**	**5129**	**6348**	**2904**	**2792**	**573**	**89**	**93**	**3261**	**11477**	**5128**	**6348**