# Report to the Ohio Environmental Protection Agency: Drop-off Recycling – Understanding Participation and Determining an Empirically Based Access Credit Model

**July 14, 2004**

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## I. Overview

The Ohio Environmental Protection Agency requires each of Ohio's 52 solid waste management districts (SWMDs) to meet one of two recycling goals: a "Percentage Goal," in which a SWMD shows that 25% of the residential/commercial waste generated by households and businesses in its jurisdiction is diverted from landfills; or an "Access Goal," in which a SWMD shows that 90% of the population within its jurisdiction has access to a recycling opportunity. Most of Ohio's SWMDs choose to comply with the Access Goal. The two recycling opportunities that are most often used to meet this goal are curbside recycling (in which a household stores recyclables in non-trash containers that are placed by one's curb for collection) and drop-off recycling (in which a household stores recyclables in containers that are then brought to a bin located somewhere in the community). Each SWMD receives a population access credit (or, "access credit") for each drop-off site and curbside recycling option in its jurisdiction. When these credits sum to 90% of the jurisdiction's population, the access goal has been met[1].

A drop-off site located in a rural area (i.e., a municipality with less than 2,500 people) receives an access credit of 2,500. A drop-off site located in an urban area (i.e., a municipality with more than 5,000 people) receives an access credit of 5,000. Unfortunately, these access credits are not rooted in well-documented empirical data. The primary objective of this research project was to help the Ohio EPA better understand participation and effectiveness of drop-off recycling sites and to design an empirically based, more accurate access credit model to be applied to the different types of drop-off sites throughout Ohio. In the end, an empirically based access credit model will help OEPA to confirm that the residents served by Ohio's SWMDs truly have – and are realistically counted as having – access to a drop-off recycling option.

The research was designed to answer the following questions:

- How many people utilize a particular drop-off site?
- How frequently do they visit this drop-off site?
- How far do people travel to utilize this drop-off site?
- How many pounds of recyclables do they bring?

[1] It should be noted that the Access Goal is somewhat more complicated than simply demonstrating "access" to a recycling opportunity. The concept behind the Access Goal includes not only access to a recycling opportunity but also a reasonable estimate of how many people could be expected to use the recycling opportunity (i.e., participation).

- What is the annual amount recycled per household?
- What percentage of people within a given radius utilizes this drop-off site?

The research was also designed to determine what variations exist between different types of sites (i.e., rural vs. urban, full-time vs. part-time).

The next section describes the methods used to address these research questions.

## II. Method and Participant Demographics

Working closely with the Ohio Environmental Protection Agency (OEPA) and GT Environmental, an in-person "intercept" survey and comprehensive analysis process was designed to answer the research questions at hand. A description of the method used to conduct this research is discussed below.

**Survey parameters.** Intercept surveys were conducted from March 27 to June 20, 2004. The survey was designed to take 5 minutes on average to administer to respondents (those who dropped off recyclables) and included the accurate weighing of the materials brought to the drop-off site. A copy of the survey instrument is included in Appendix A. Appendix B presents the "Drop-off Fact Sheet" that was used by the interviewers to collect background data about each drop-off site.

**Population under study.** Users of drop-off recycling sites around Ohio. Table 1 presents a demographic overview of the citizens who participated in this research project. Those observed using drop-off sites during the course of this project reflect a demographic that is more likely to be older, educated, and male than the general population of Ohio.[2] Overall, 602 surveys were completed with an average of 35 interviews completed at each site.

**Table 1: Respondent Demographics**

| | Number | % |
|---|---|---|
| **Age (n=588)** | | |
| 16 to 34 years old | 42 | 7% |
| 35 to 44 years old | 104 | 18% |
| 45 to 54 years old | 160 | 27% |
| 55 to 64 years old | 120 | 20% |
| Older than 64 years old | 162 | 28% |
| Median age | 55 | |

| | Number | % |
|---|---|---|
| **Education (n=593)** | | |
| Less than high school degree | 12 | 2% |
| High school graduate | 208 | 35% |
| Some college / vo-tech | 137 | 23% |
| College graduate | 153 | 26% |
| Graduate degree | 83 | 14% |
| **Gender (n=601)** | | |
| Female | 226 | 38% |
| Male | 375 | 62% |

Note: Unless otherwise noted, all tables and figures refer to valid percentages, which do not include those who skipped a particular question.

[2] Although men were more likely to participate in the survey process, this should not be interpreted to mean that more men make the decision to recycle within the household. Research exists to suggest that women are increasingly more likely to make and/or influence the majority of household decisions (Vertis, Customer Focus 2004: Home Electronics; SRI Consulting, 1999 Household Survey; a number of proprietary research projects conducted by TST over the past five years).

**Drop-off site selection.** The drop-off sites selected for inclusion in this research must have reported accurate recycling tonnage data to OEPA for 2001 and 2002.[3] These data were critical, as they were used to guide the formation of a more empirically based access credit model. To ensure that the survey teams had significant traffic at the drop-off sites (i.e., so that the time spent surveying at the site was productive), only those sites with above average tonnage were initially considered for on-site surveying. Additionally, efforts were made to ensure that the sites selected were representative of the various types of drop-off sites (e.g., full-time, part-time, rural, urban, companion, stand-alone) throughout the state of Ohio. A description of these site types is included below.

- Full-time sites were open at least 40 hours / week; part-time sites were open less than 40 hours / week.
- Urban sites were located in a political jurisdiction of at least 5,000 people; rural sites were located in a political jurisdiction of less than 5,000 people.
- Stand-alone sites were located in a place that did not have a "natural flow of traffic" (>50 people / day); companion sites had a "natural flow of traffic," such as a grocery store or other retail establishment.

Table 2 presents a listing of the seventeen drop-off sites selected for inclusion, as well as the number of people surveyed at each site (N = completed surveys).[4]

[3] Each SWMD with a drop-off site surveyed during this research was also asked to submit this data for 2003 as well.

[4] At the time of this writing, the Delaware / Knox / Marion / Morrow SWMD commissioned supplementary research to survey users of two of its drive-through drop-off facilities. Information from this research will be shared with OEPA as it makes its access credit model decision.

## Table 2: Drop-off sites included in research

**RURAL, FULL-TIME SITES (N=5)** Average Tonnage = 64.73
+ 1 SD = 129.1

| Site Code | Location in state | ProgramName | County | Urb/Rur | FT/PT | STA/COM | 2003 TONS | 2003 LBS |
|---|---|---|---|---|---|---|---|---|
| A | N | Huron Township | Erie | RUR | FT | STA | 149 | 298,000 |
| B | NE | Hambden Township | Geauga | RUR | FT | COM | 230.53 | 461,060 |
| C | SW | Glendale Village | Hamilton | RUR | FT | STA | 135.52 | 271,040 |
| D | S | Adams West Union Village | Adams | RUR | FT | STA | 160 | 320,000 |
| E | Central | Sunbury Village | Delaware | RUR | FT | COM | 229 | 458,000 |

**URBAN, FULL-TIME SITES (N=5)** Average Tonnage = 178.4
+ 1 SD = 423

| Site Code | Location in state | ProgramName | County | Urb/Rur | FT/PT | STA/COM | 2003 TONS | 2003 LBS |
|---|---|---|---|---|---|---|---|---|
| F | N | Perkins Twp / Erie County Services Center | Erie | URB | FT | STA | 845 | 1,690,000 |
| G | NE | Rootstown Township | Portage | URB | FT | STA | 452.72 | 905,440 |
| H | SW | Anderson Township | Hamilton | URB | FT | COM | 404 | 808,000 |
| I | E | Austintown Township | Mahoning | URB | FT | STA | 449.58 | 899,160 |
| J | NE | Sagamore Hills Township | Summit | URB | FT | STA | use 2002 data | 488,460 |

**RURAL, PART-TIME SITES (N=5)** Average Tonnage = 17.65
+ 1 SD = 53.9

| Site Code | Location in state | ProgramName | County | Urb/Rur | FT/PT | STA/COM | 2003 TONS | 2003 LBS |
|---|---|---|---|---|---|---|---|---|
| K | Central | Claridon Township | Marion | RUR | PT | COM | 47.81 | 95,620 |
| L | N | Brownhelm Township | Lorain | RUR | PT | COM | 28.23 | 56,460 |
| M | E | Hopedale Village | Harrison | RUR | PT | STA | 16.35 | 32,700 |
| N | E | Freeport Village | Harrison | RUR | PT | STA | 28.29 | 56,580 |
| O | Central | New Washington | Crawford | RUR | PT | STA | 63.45 | 126,900 |

**URBAN, PART-TIME SITES (N=2)** Average Tonnage = 27.42
+ 1 SD = 70.42

| Site Code | Location in state | ProgramName | County | Urb/Rur | FT/PT | STA/COM | 2003 TONS | 2003 LBS |
|---|---|---|---|---|---|---|---|---|
| P | NW | North Baltimore Village, Henry Township | Wood | URB | PT | STA | 88.56 | 177,120 |
| Q | E | Beaver Township | Mahoning | URB | PT | STA | 32.95 | 65,901 |

**Survey procedure.** Under TST supervision, research teams from Saperstein Associates, Inc. surveyed nine of the seventeen drop-off sites while research teams from Ohio EPA surveyed the remaining eight sites. All research team members participated in training sessions led by TST and Saperstein Associates.

A two-person research team surveyed each drop-off site for at least one five-hour period, during which in-person surveys were administered. The goal for each site was to collect a minimum of 40 completed interviews at each site, which for most of the sites required two five-hour visits.[5] To help accomplish this, drop-off sites were visited on those days when they were most likely to be used – Saturday and Sunday mornings on days with good weather. For drop-off sites that were

[5] Because some sites (especially some of the rural, part-time sites) were not as busy as others, this goal was not feasible for all sites.

especially busy (e.g., 10-15 visits / hour), a sampling procedure was used to select every other arriving visitor to participate.

Citizens who arrived at a drop-off site to recycle and were selected to participate were approached by an interviewer wearing an Ohio EPA / Ohio Division of Natural Resources shirt and carrying a clipboard. This helped to establish the legitimacy of the project. Upon securing their agreement to participate, the participants were asked for permission to weigh their recyclables on a calibrated scale. The recyclables were then deposited by one of the research team members into the appropriate container(s). While this occurred, the other research team member continued with a brief and confidential survey asking how often they visit the drop-off site, their home address or nearest cross street, and other critical questions. After completing this survey, the citizens were thanked for their participation.

After the survey data were collected, they were verified and entered for subsequent analysis. To better understand how residents use these sites – and to assist in the creation of a possible access credit model – Microsoft MapPoint was used to determine the distance and travel time between each drop-off recycler's home address and the drop-off site. This was accomplished by entering the street location of the drop-off site (as one's "destination") and then entering each of the survey respondents' home addresses or closest intersections. Microsoft MapPoint then calculated the relevant travel data. Additionally, ArcView GIS v.3.3 was used to map these addresses around the drop-off site. Block level census data was imported into ArcView to allow a count of the number of people who live within a certain radius of each site – and therefore may reasonably be expected to have "access" to the drop-off site.

This report now moves from a general overview of the survey method and participant demographics to a more detailed review of the survey data from each of the seventeen sites. After this information has been presented, the report then turns to a discussion of possible access credit models for OEPA's consideration.

## III. Specific Research Findings

### A. Overall trends – Pounds recycled, distance traveled

Looking across the seventeen drop-off sites included in this project, what are the major trends or findings? What do the data tell about how residents use these sites? Answering these questions can be made easier if one categorizes the sites into meaningful groups – and then looks to see what differences exist among them. One way to categorize the seventeen drop-off sites is by their full-time / part-time and rural / urban status.[6]

[6] Sites' companion or stand-alone statuses are not presented for two reasons. First, analysis of the pounds recycled at each site revealed a strong relationship between the average pounds recycled and the interaction between a site's full-time / part-time and rural / urban status. Therefore, it makes the most sense to present and interpret these strong statistical effects. Secondly, because few companion sites were included in the research – and no part-time, urban, companion sites at all – it was very difficult to detect any meaningful effects that were a result of a site's companion status.

On average, how many pounds were recycled? And how far did users of the drop-off site travel to the site, by both street mileage and by minutes traveled? These data – by full-time / part-time and rural /urban status – are presented in Table 3.

**Table 3: Overall trends by drop-off site categories**

| Respondents by site type | Pounds recycled (geometric mean) | | Average distance to site (miles) | Median distance to site (miles) | | Average distance to site (minutes) | Median distance to site (minutes) |
|---|---|---|---|---|---|---|---|
| FT, rural (n=141) | 17.2 | | 3.9 | 2.4 | | 7.1 | 5 |
| FT, urban (n=208) | 20.2 | | 3.2 | 2.4 | | 6.7 | 6 |
| PT, rural (n=147) | 35.5 | | 2.8 | 2.4 | | 5.7 | 5 |
| PT, urban (n=84) | 19.6 | | 3 | 1.8 | | 5.8 | 4 |

As shown in Table 3, those residents who were surveyed using part-time / rural drop-offs brought significantly more recyclables (a geometric average of 35.5 pounds) to the site as compared to the other three drop-off categories. [7] For both mileage and travel time, participants who use full-time drop-off sites traveled further than those residents who use part-time drop-off sites. Both of these patterns were observed to be statistically significant ($p<.05$ at the 95% confidence level), using an univariate analysis of variance (ANOVA).[8] An ANOVA is a statistical calculation used to detect the presence of statistically significant differences among various groups or variables. One possible explanation for this statistically significant result is that members of a community probably have more opportunities to drive by a site that operates 40 hours a week. Because these full-time sites are open and available to the public for a longer period of time, it is possible that more people from a greater distance around the site have the opportunity to take note of and eventually use it. Another possible explanation is that people may be more likely to load all their recyclables and bring them to a site when they are certain it will be there.

## B. Overall trends – Length of time using site

For how long have the survey respondents been using these drop-off sites? And how often do they tend to visit these sites over the course of a year?

Those who use full-time sites report doing so for an average of 62.7 months (or, a little over 5 years), while those who use part-time sites report doing so for an average of 81.1 months (or, almost 7 years). Using an univariate ANOVA, this difference was revealed to be statistically significant.

Over the course of a year, how often do respondents tend to visit these drop-off sites? Those who use a part-time / rural site reported using these sites least frequently (an average of 12.8 visits a year), as compared to those using full-time / rural sites (average of 30.2 visits a year), full-time / urban sites (average of 28.3

[7] Because the data for this question could vary greatly from person to person, geometric means are presented. Geometric means control for outliers in data while preserving the overall distribution of the data set.

[8] A statistically significant difference refers to one that is unlikely to have been caused by chance.

visits a year), or part-time / urban sites (average of 25.6 visits a year). This pattern makes sense, given the fact that many of the part-time / rural sites are only open once a month. Using an univariate ANOVA, this data pattern was revealed to be statistically significant.

### C. Overall trends – Other drop-off usage patterns

In addition to questions that asked respondents to estimate the length of time they've been using the drop-offs and frequency (over the course of a year) they use these drop-offs, a host of questions were included to help OEPA and the SWMDs better understand how these drop-off sites were used. Where do the materials brought to the drop-off come from? How does drop-off recycling fit into the greater context of the respondents' day? And what other recycling options are available to those using the drop-off sites?

**Purpose of trip to drop-off site.** Across all four major site type categories, the majority (71%) of those interviewed reported that they were doing more that day than just recycling – they were running other errands, such as shopping or visiting family. As one can see in Table 4, those who used part-time sites were slightly more likely to report they were making a trip solely to recycle.

**Table 4: Purpose of trip to drop-off site**

| Respondents by site type | Recycling trip only | Recycling + other errands |
|---|---|---|
| FT, rural (n=151) | 28% | 72% |
| FT, urban (n=208) | 24% | 76% |
| PT, rural (n=157) | 36% | 64% |
| PT, urban (n=85) | 33% | 67% |

**Location of drop-off site.** Across all four major site type categories, the majority (85%) of those interviewed reported that the drop-off site they were using was closer to home. As one can see in Table 5, those who used part-time sites were even more likely to report that the site was closer to home. No statistically significant differences were detected between full-time and part-time sites, or between urban and rural sites.

**Table 5: Location of drop-off site**

| Respondents by site type | Closer to home | Closer to where you shop | Closer to work | Other |
|---|---|---|---|---|
| FT, rural (n=150) | 80% | 8% | 7% | 5% |
| FT, urban (n=206) | 78% | 10% | 4% | 8% |
| PT, rural (n=155) | 94% | 3% | 3% | 1% |
| PT, urban (n=82) | 93% | 4% | 1% | 2% |

**Origin of recycled materials.** Across all four major site type categories, the majority (96%) of those interviewed reported that the materials they brought to the drop-off site came mostly from home. Additionally, 2.5% of those interviewed reported that the materials came mostly from work while 1.8% of those interviewed reported that the materials were "an equal mix from both home and

work." No statistically significant differences were detected between full-time and part-time sites, or between urban and rural sites.

**Comparison to normal load.** Across all four major site type categories, the majority (60%) of those interviewed reported that the materials they brought to the drop-off site that day was "similar to" their normal load to the site. Additionally, 30% of those interviewed reported that the materials brought to the site was "less than" their normal load. Only 10% reported that the materials brought to the site was "greater than" their normal load. No statistically significant differences were detected between full-time and part-time sites, or between urban and rural sites.

**Availability, use of curbside recycling option.** Across all four major site type categories, those respondents who used a full-time / urban drop-off were more likely than any other group of respondents to report that a curbside recycling option was available to them where they live (40%). A chi-square analysis revealed this effect to be statistically significant. Table 6 shows the full set of responses to this question.

Those who reported a curbside recycling option was available where they live were then asked whether they use this recycling option (in addition to using a particular drop-off site). As shown in Table 6, with the exception of those using full-time / rural drop-off sites, a plurality of those interviewed (ranging anywhere from 40% to 50%) reported that they also use a curbside recycling option.

**Table 6: Availability and use of curbside recycling option**

| Respondents by site type | Yes, curbside is available | | Respondents by site type (n = those who said curbside is available) | Yes, houshold uses curbside recycling option |
|---|---|---|---|---|
| FT, rural (n=139) | 12% | | FT, rural (n=17) | 12% |
| FT, urban (n=196) | 40% | | FT, urban (n=78) | 40% |
| PT, rural (n=149) | 8% | | PT, rural (n=12) | 42% |
| PT, urban (n=81) | 9% | | PT, urban (n=6) | 50% |

Lastly, respondents were asked whether they use any other drop-off sites in addition to the one they were using the day of surveying. As shown in Table 7, those using full-time / rural sites were more likely to say they used another drop-off (29%) than those using part-time rural sites (17%). A chi-square analysis revealed this effect to be statistically significant.

**Table 7: Use of other drop-off sites**

| Respondents by site type | Yes, use other drop-offs |
|---|---|
| FT, rural (n=150) | 29% |
| FT, urban (n=209) | 18% |
| PT, rural (n=157) | 17% |
| PT, urban (n=85) | 22% |

### D. Summary data for each drop-off site surveyed

Because every resident who was surveyed as part of this research process provided a wealth of information about their use of the site in general and their use of the site on that particular day, a two-page summary sheet has been created for each site. This summary sheet presents a snapshot of the site: background information on the site; information on how and how often residents use each site; and demographics of the site's users. These summary sheets are presented in Appendix C.

This report now turns to address one of the primary objectives of this research project: identifying possible revisions to OEPA's access credit model system, using the data collected during the course of this project as well as recycling tonnage data on file with OEPA.

## IV. Access Credit Models for OEPA's Consideration

Using data from multiple sources, four access credit models are suggested for OEPA's consideration. These models are discussed – and when appropriate, illustrated – on the pages that follow. For ease of model evaluation, a graphic at the beginning of each section reviews the model's major pros (strengths) and cons (weaknesses).

### A. Access Credit Model 1: Nearby population

**Pros and Cons of Model 1**

- Pros: Relatively easy to calculate and explain to stakeholders
- Cons: May lead to over-inflated access credit due to assumption that everyone within certain area should be counted towards credit (regardless of actual participation)

The initial challenge posed to TST was, on its surface, a simple one: assist OEPA as it builds a new access credit model system. Defining what is meant by "access," then, becomes important. At its simplest, access may be defined as the total number of people who live within some geographic proximity to a drop-off site. Given this definition, what should determine geographic proximity? What boundary should be used to indicate those who are located closer to the site versus those who are located further away (and who arguably have less "access" to it)?

Each drop-off site included in this research shared an assumption that a high majority of its recycling tonnage came from residential as opposed to commercial usage. For each site, then, within what boundary does the majority of drop-off site users live? Using ArcView GIS, maps showing the drop-off site location, the interviewees' home addresses (or closest intersections), and block level US Census data from 2000 were created. Using this information, circles were drawn to capture two sets of drop-off site users and by extension two areas on the map:

- **Model 1a: 51% of those using the drop-off site.** This circle captures an area within which a simple majority of those using the site live. This circle may be preferred if a conservative estimate of the majority "nearby

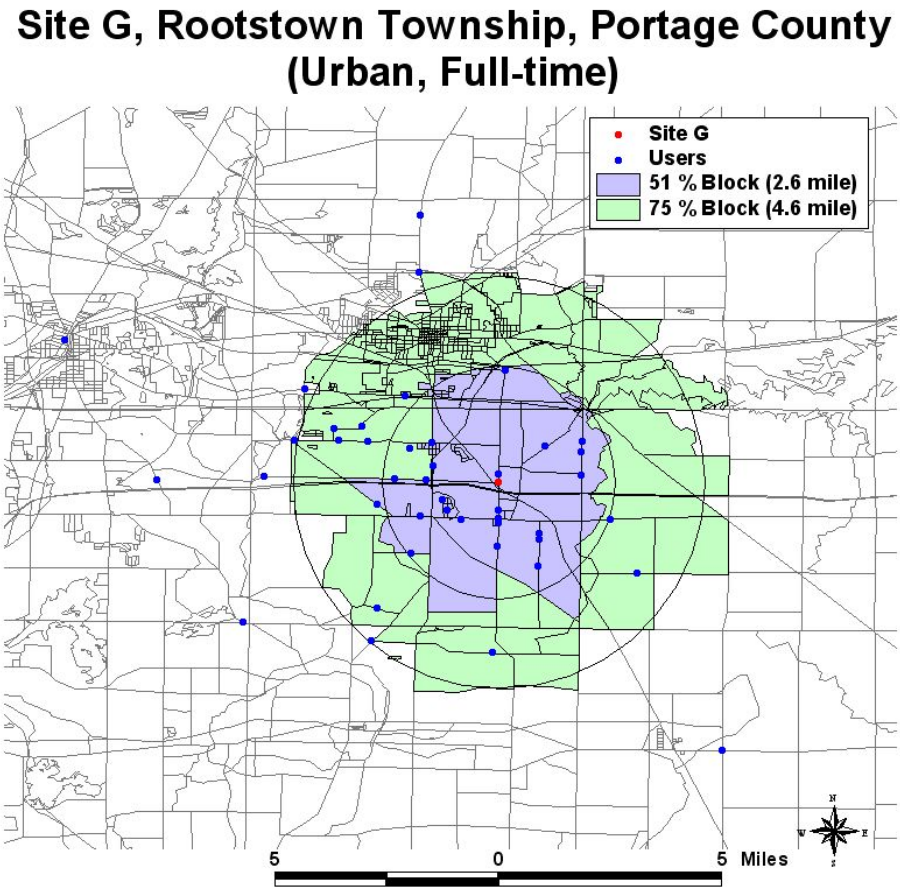
population" is desired. Note: In most cases, the average radius from the drop-off site to the 51% boundary is consistent with the average mileage reported for that drop-off site's category in Table 3.

- **Model 1b: 75% of those using the drop-off site.** Because this circle includes more of the people surveyed, in most cases it captures an area that is substantially larger than that described above. This expanded circle arguably allows for a more realistic, more representative view of the area served by the drop-off site. This expanded circle, while capturing a greater majority of drop-off site users, likely avoids the problems that would be observed with a circle that captures 90% to 100% of those using the drop-off site. A circle that captures 90% or more of those using the site would likely include outliers – residents who travel greater distances to the drop-off site and who may not be typical of the "average user."

A sample ArcView map is presented below in Figure 1. To interpret the map:

- The red dot in the middle of the circles represents the drop-off site;
- The blue dots represent the home addresses of those interviewed at the site;
- The purple area reflects those census blocks within a circle that captures 51% of those using the site (i.e., inner circle on map);
- The green area reflects additional census blocks within a circle that captures 75% of those using the site (i.e., outer circle on map).

**Figure 1: ArcView Map for Rootstown Township**



If one counts the number of people who live within the purple and green census blocks, this sum could represent the number of people who have access to the site by virtue of their living nearby. Table 8 presents the average results if one were to use this approach to calculate access credit.

**Table 8: Access Credit Model 1**

| Site type | Average population (within 75% buffer) |
|---|---|
| FT, rural (n=5) | 11,156 |
| FT, urban (n=5) | 33,956 |
| PT, rural (n=5) | 5,777 |
| PT, urban (n=2) | 9,208 |

This approach may have a fundamental flaw. It does not take into consideration those factors that may account for actual or potential usage of the site. For example, Table 8 shows that if this access credit model were used, the access credit for an average full-time / urban site could increase from 5,000 to almost 34,000. However, the survey data do not indicate that 34,000 people actually use these full-time / urban drop-off sites.

### B. Access Credit Model 2: Estimated usage (version 1)

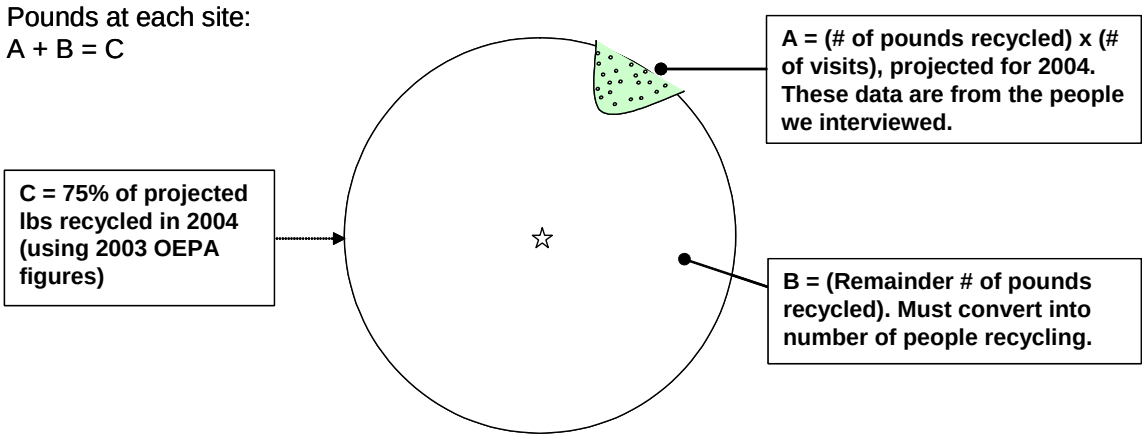
**Pros and Cons of Model 2**

- Pros: Uses OEPA tonnage data in its calculations in addition to survey data
- Cons: Requires extrapolation from 2003 tonnage to 2004 tonnage; difficult to calculate and explain to stakeholders; requires accurate tonnage data for each site; the increased complexity may diminish its usefulness, even if it yields a more useable access credit model

Because Model 1 may yield exaggerated access credits, the next step was to assist OEPA as it builds an access credit model system *while acknowledging the fact that not everyone who lives near a drop-off site uses it*. To construct an access credit model that meets this challenge, one must take into consideration the actual usage, or participation, in the sites.

Where Model 1 was relatively simple, Model 2 is relatively complex. It incorporates many elements of the survey data along with tonnage data submitted to OEPA. All of these elements are used to estimate the likely number of people who are using / participating in this recycling opportunity. To estimate usage, one must begin by understanding how many people contribute the tonnage (converted to pounds) recycled at each site. Because the map buffers used in the various models discussed thus far focus on an area bounded by 75% of those who use the site, this model focuses on projecting the number of people who will contribute 75% of the pounds in 2004 at each site.

**Figure 2: Illustration of pounds recycled**




To estimate usage at each site, one must solve the equation above for B. To do this:

- Using OEPA data, define C (75% of total pounds recycled at site for 2004) as equal to 75% of total pounds recycled at site in 2003;
- Using intercept survey data, calculate A by summing the products that result from multiplying (# of pounds) x (# of trips, annual) among all those surveyed;
- Using the calculations for C and A, subtract A from C to get B, which yields the remainder # of pounds recycled at the site.

One must now transform the remainder number of pounds recycled at each site into the number of unique households, which will be converted later into the number of unique people. To do this:

- Using intercept survey data, calculate geometric mean for pounds recycled and the geometric mean of trips to the site (annual);
- Multiply geometric mean for pounds recycled by geometric mean of trips to the site (annual);
- Divide this product into B (the remainder pounds within the 75% boundary area), which yields the remainder households that use the site;
- Add the remainder households that use the site to the number of people surveyed at the site[9];
- Multiply this sum by the average number of people who live within each household (using intercept survey data), which yields the total number of people who are estimated to use each site.

The results of these calculations are presented in Table 9. The second column of Table 9 (average population within 75% buffer) presents the same data as was initially presented in Table 8 – in effect, this column represents the results from Access Credit Model 1. The third and fourth columns present the average number and percentage (respectively) of people who are estimated to use each site type, following the calculations reviewed above. One should note that the estimated use figures for the two full-time sites approximate the existing access credits for these types of sites. The estimated use figures for the two part-time sites, however, are much lower than the existing access credits for these types of

[9] Each person surveyed represents one household.

sites. The third column of Table 9 presents the possible access credits for each site type if one were to use Access Credit Model 2.

**Table 9: Access Credit Model 2**

| Site type | Average population (within 75% buffer) | Average population estimated to use site (within 75% buffer) | Average % of population estimated to use site (within 75% buffer) |
|---|---|---|---|
| FT, rural (n=5) | 11,156 | 1,918 | 21% |
| FT, urban (n=5) | 33,956 | 4,017 | 13% |
| PT, rural (n=5) | 5,777 | 314 | 17% |
| PT, urban (n=2) | 9,208 | 579 | 13% |

### C. Access Credit Model 3: Estimated usage (version 2)

**Pros and Cons of Model 3**

- Pros: Uses OEPA tonnage data in its calculations; relatively simple formula that any SWMD can use (i.e., to calculate an access credit, all one must do is enter annual number of pounds recycled); can be used with drop-off sites that report above average recycling tonnage
- Cons: Requires accurate tonnage data for each site

A number of drop-off sites around Ohio consistently report tonnage amounts that far exceed the average amount of tonnage one would expect for their type (i.e., full-time / urban drop-off). Because these drop-off sites report above average recycling tonnage amounts – and therefore are doing an above average job in diverting waste from landfills – OEPA may want to consider offering a tonnage based access credit model that rewards drop-off sites with above average performance.

How can these drop-off sites be identified, given OEPA data? One way to operationalize high-performing sites is to focus on those that report tonnage amounts that are two standard deviations above the average for their category (i.e., a drop-off site with a tonnage amount higher than 95% of all other drop-off sites within its category). One such site was included in the current research – the site located in Perkins Township, Erie County. In 2003, the average full-time / urban site reported recycling 178 tons, with a standard deviation of 245 tons. The Perkins Township reported recycling 845 tons – which fits the criteria of a site that has out-performed 95% of its peers. However, the Erie County SWMD receives the standard access credit of 5,000 for this site.

Using the collected survey data, an algorithm was created to help SWMDs calculate an alternative, tonnage-based access credit that estimates the number of people who are likely using the drop-off site.[10] It operates as follows:

[10] Of course, the algorithm featured in Access Credit Model 3 could be used for all drop-off sites regardless of whether or not their tonnage was above average.

- Using intercept survey data, TST calculated the geometric mean for pounds recycled and geometric mean of trips to the site (annual) for each site
- Across each category of sites (e.g., full-time / rural sites), these geometric means were averaged;
- For each category, these averages were multiplied;
- The total recycling tonnage (converted to pounds) in 2003 was divided by the product above, yielding the number of households likely to use the site;
- The number of households likely to use the site was multiplied by the average number of people who live within each household (for each category of sites), which yields the total number of people who are estimated to use a particular site.

With these calculations already complete, all a SWMD must now do is enter the total number of pounds recycled at a particular drop-off site. Table 10 (next page) shows four versions of this algorithm – one for each category of drop-off site – along with a sample calculation that uses the total number of pounds recycled at a particular, higher-performing site from among those surveyed. Note: this table is designed to be immediately useful. If one "double-clicks" the electronic version of this table, one should be able to enter in a different number of pounds and see a different access credit estimation result.

**Table 10: Access Credit Model 3 – Algorithm for SWMDs to use**

**Full-time, rural sites**

**Insert pounds recycled (annually) into cell below:**

| Pounds (annual) = | 461,060.0 | Estimated # of people using (access credit) = | **2,845.7** |
|---|---|---|---|

*Ex: 2003 pounds recycled @ Site B*

**Full-time, urban sites**

**Insert pounds recycled (annually) into cell below:**

| Pounds (annual) = | 1,690,000.0 | Estimated # of people using (access credit) = | **9,124.6** |
|---|---|---|---|

*Ex: 2003 pounds recycled @ Site F*

**Part-time, rural sites**

**Insert pounds recycled (annually) into cell below:**

| Pounds (annual) = | 95,620.0 | Estimated # of people using (access credit) = | **612.8** |
|---|---|---|---|

*Ex: 2003 pounds recycled @ Site K*

**Part-time, urban sites**

**Insert pounds recycled (annually) into cell below:**

| Pounds (annual) = | 177,120.0 | Estimated # of people using (access credit) = | **1,254.9** |
|---|---|---|---|

*Ex: 2003 pounds recycled @ Site P*

*Note: the figures for pounds (annual) reflect actual data provided to OEPA for 2003.*

### D. Access Credit Model 4: Nearby and aware population (version 1)

**Pros and Cons of Model 4**

- Pros: Uses OEPA tonnage data in its calculations in addition to survey data
- Cons: Requires extrapolation from 2003 tonnage to 2004 tonnage; assumption that awareness data from research conducted in Summit County (northeast Ohio) can be generalized across Ohio; difficult to calculate and explain to stakeholders; requires accurate tonnage data for each site; increased complexity may diminish its usefulness

One can make the argument that awareness of a drop-off site in one's community is a necessary precursor to whether one has access to this drop-off site. For those people who are unaware of a drop-off site's presence, the site is functionally inaccessible. For this model, then, access was defined as the total number of people who live within some geographic proximity to a drop-off site and who are aware of this recycling option (whether they choose to use or not).

How can awareness be estimated? One method could be to obtain survey data that provides an indication of how many people are aware of a drop-off site in their community. Although the work related to this project did not include such a component, a separate research project conducted for the Summit / Akron Solid Waste Management Authority (SASWMA) by TST did include questions that focused on drop-off site awareness.[11]

Data from the SASWMA research indicate that among those people who are aware of a drop-off site in their community, 46% report using the drop-off and 54% report not using the drop-off over the course of a year. Following this logic, if one can estimate the number of people who use a particular drop-off site over the course of a year (note: this was done earlier in Access Credit Model 2), this estimate could be doubled. This doubling would reflect an estimate of the number of people who are aware of the drop-off site – and therefore have access to it. Table 11 (below) shows the results of such an approach.

**Table 11: Access Credit Model 4**

| Site type | Average population (within 75% buffer) | Average population estimated to use site (within 75% buffer) | Average % of population estimated to use site (within 75% buffer) | | Awareness: Average population estimated to use site (within 75% buffer) multiplied by 2 |
|---|---|---|---|---|---|
| FT, rural (n=5) | 11,156 | 1,918 | 21% | | 3,836 |
| FT, urban (n=5) | 33,956 | 4,017 | 13% | | 8,034 |
| PT, rural (n=5) | 5,777 | 314 | 17% | | 628 |
| PT, urban (n=2) | 9,208 | 579 | 13% | | 1,158 |

[11] Because the survey work done for SASWMA focused on Summit County and not Ohio in general, the sample statistics from this research are generalizable only to Summit County. Because of the lack of statewide awareness data, however, the SASWMA data are used as a "best guess" proxy.

Upon reviewing this table, a number of observations should be noted. First, those sites that are open full-time would receive an increased access credit – this is especially the case for full-time / urban sites. Second, access credits for part-time times would decrease from 2,500 to approximately 1,500 (for part-time / rural sites) or 800 (for part-time / urban sites).

### E. Access Credit Model 5: Nearby and aware population (version 2)

**Pros and Cons of Model 5**

- Pros: More comprehensive definition of "access" (i.e., awareness component) may result in more appropriate access credits
- Cons: Assumption that awareness data from research conducted in Summit County (northeast Ohio) can be generalized across Ohio

As was the case with Model 4, Model 5 links access to awareness. However, the method used to calculate awareness is somewhat simpler. Going back to the SASWMA research mentioned earlier, 29% of the people interviewed in Summit County communities with drop-off sites were aware of a drop-off site in their community. To determine an access credit using this information, one could multiply the population within the purple and green areas (presented in Table 8 earlier) by .29 (or, 29%). The resulting access credits for each site type are presented in Table 12.

**Table 12: Access Credit Model 5**

| Site type | Average population (within 75% buffer) | | Awareness: Average population (within 75% buffer) multiplied by .29 |
|---|---|---|---|
| FT, rural (n=5) | 11,156 | | 3,235 |
| FT, urban (n=5) | 33,956 | | 9,847 |
| PT, rural (n=5) | 5,777 | | 1,675 |
| PT, urban (n=2) | 9,208 | | 2,670 |

For most of the site types listed above in Table 12, the awareness figures approximate those calculated by Access Credit Model 4. However, the access credit for a part-time / urban site in Table 12 is substantially larger than the access credit calculated by Access Credit Model 4.

## V. Conclusion

Although a number of access credit models were identified during the course of this research, this list is not an exhaustive one. With additional thought and input from Ohio's solid waste management districts, other access credit models may be identified as viable alternatives. One example could be a hybrid access credit model that offers multiple options from which a solid waste district can select. For example, OEPA could revise its default access credit model to one that is similar to Access Credit Model 2. Simultaneously, it may want to offer a tonnage-based model similar

to Access Credit Model 3 for those districts with sites that report above average performance.

As so often happens when conducting research, the very act of asking (and answering) questions leads to the identification of new questions or unforeseen issues. Questions or issues that may merit OEPA's attention in the future include the following:

- Although attempts were made to identify a large pool of drop-off sites around Ohio from which we could sample, a surprisingly high number of sites did not meet our screening criteria that required accurate tonnage data for the site. What can OEPA do to encourage the collection of more accurate tonnage data for the bulk of Ohio's drop-off sites?
- If OEPA considers implementing Access Credit Model 5, it should first conduct telephone surveys of households arrayed around a sample of drop-off sites so that additional awareness measurements can be collected (as opposed to relying on one awareness measurement from one part of the state).
- From our work with and knowledge of different SWMDs around Ohio, we know that there are many efforts designed to increase drop-off and curbside recycling participation rates. OEPA may want to consider requesting a description of these various practices from Ohio's SWMDs, along with any data to indicate their effectiveness, with a goal of creating a pool of current efforts. This pooling of information – as well as any best practices that may emerge after a review of these efforts – could be shared as a resource with all SWMDs around the state.
- With the assistance of a research firm and an advertising / public relations firm, OEPA could engage in a creative testing process that identifies those current efforts that are most likely to succeed. This could take the form of a series of focus groups around the state involving both recyclers and non-recyclers. The primary question of interest here is the identification of residents' "hot buttons," that when pressed should lead to more frequent drop-off recycling behavior. Additionally, what promotional or educational efforts have the best chance for success in pushing these hot buttons? Using these research results, an advertising / public relations firm would then create a number of deliverables for OEPA (which in turn could share with Ohio's SWMDs). These deliverables could include: a "how-to" pamphlet describing cost-effective ways to promote drop-off sites to the general public, using both paid and unpaid media; and templates that can be used / adapted by SWMDs to create and implement communications programs that encourage not only drop-off recycling, but also other forms of recycling as well as waste stream reduction efforts in general.
- Having identified Ohio's current best practices along with other efforts that could be successful (via the creative testing process), a statewide telephone survey including both recyclers and nonrecyclers could be commissioned. This survey could be used to verify the effectiveness of these messaging concepts, likely promotional vehicles, and participation-encouragement efforts in general.
- Looking internally to OEPA's Division of Solid and Infectious Waste, what are its five-year goals? Could any of these goals be met more efficiently or accurately via research?

Overall, this research has identified a number of options for OEPA's consideration. Using the data collected during the course of this project – and the analyses that followed – OEPA can use this research as a springboard to a revised, empirically based access credit model