Residential Recycling and Diversion

Overview

Recycling turns materials that would otherwise become waste into valuable resources. Recycling includes: 1) collecting materials that would otherwise be considered waste; 2) sorting and processing recyclables into raw materials that can be used to produce new products; and, 3) purchasing recycled product. As illustrated by the traditional recycling logo, using the collected material, in whole or in part, in new products is necessary to complete the "recycling" cycle.

When residents have materials that are no longer of value to them they make decisions on how to manage those materials. When the option of recycling is available a resident often considers several factors, including: location, convenience/opportunity, cost, environmental stewardship, and point in time options. The decision to choose recycling can be influenced by awareness, education, commitment, incentives, peer pressure and other factors. Residents in Lincoln and Lancaster County (Planning Area) have access to voluntary recycling opportunities but systems, facilities and programs may not always be convenient or may have what some consider extra costs, which serve as disincentives. Lincoln Municipal Code (LMC) 5.41.010 defines recyclables (for the purpose of recycling) as materials "separated or otherwise diverted from waste destined for disposal: wood, paper, glass, plastics, metals, automobile oil, tires, and batteries. Refuse derived fuels or other materials that are destroyed by incineration are not recyclables. Salvage material … is not a recyclable."

As a basis for this technical paper residential recycling is generally focused on recycling opportunities which include:

- Fiber or Papers:
  - Old newspaper (ONP)
  - Old corrugated containers (cardboard) (OCC) or corrugated and chip board
  - Mixed papers
- Glass (e.g., bottles and jars)
- Metals:
  - Ferrous metal (e.g., tin cans)
  - Nonferrous (e.g., aluminum cans)
- Plastics:
  - PET (#1 plastic)
  - HDPE (#2 plastic)
  - PVC (#3 plastic)
  - LDPE (#4 plastic)
  - PP (#5 plastic)
  - PS (#6 plastic)
  - Other (#7 plastic)

Separate technical papers address materials such as automobile oil, tires, batteries, yard waste and food waste composting as well as markets for recyclable materials. Other recyclable materials in the waste stream may also be discussed, but with less emphasis.

The "residential recycling" options discussed in this paper will generally focus on systems, facilities and programs serving single family and duplex dwelling units, to coincide with LMC 8.32.205, which differentiates the frequency of solid waste collection requirements based on the

number of dwelling units. However, concepts presented in this paper may be applicable to residential properties containing more than two dwellings. Multi-family recycling (three-plexes and apartments) is addressed under the technical paper on Commercial Recycling and Diversion. It is important to also note that under the definition of "refuse" in LMC 8.32.010, refuse specifically excludes recyclables (as defined in LMC 5.41.010) that have been separated out at the source. This distinction is also important because it does not subject vehicles involved in collecting source separate recyclables (as well as yard waste) to licensing requirements under LMC 8.32.

The USEPA has stated "Recycling materials reduces greenhouse gas emissions. EPA estimates that current national recycling efforts - 32 percent recycling in 2005 - yield annual greenhouse gas emission reductions of 49.9 MMTCE [million metric ton carbon equivalent], compared to landfilling/combusting the same material. This is equivalent to removing over 39.6 million cars from the road. Increasing the recycling rate to 35 percent would reduce greenhouse gas emissions by another 5.2 MMTCE, for a total reduction of over 55 MMTCE… If an average family of four were to recycle all of its mixed plastic waste, nearly 340 pounds of carbon equivalent emissions could be reduced each year."
(Source: http://www.epa.gov/climatechange/waste/measureghg.html, retrieved August 17, 2012)

Current Programs

The Lincoln Recycling Office was created in the fall of 1987. It was the first full-time municipal recycling coordinator position in the state of Nebraska. The creation of the position coincided with the development of the Bluff Road Landfill. The mission of the Recycling Office is to divert waste from the sanitary landfill in an economically and environmentally sound manner in full partnership with the private sector. The Recycling Office is a part of the City's Solid Waste Operations within the Public Works and Utilities Department.

The City supports and promotes public and private recycling efforts through its website http://lincoln.ne.gov/city/pworks/waste/sldwaste/ and by providing a wide array of services. The primary public and private services include, but are not limited to:

- Drop-off locations
- Residential recyclables collection and processing
- Education

Specific information on various system, facilities and programs can be found on the City's recycling website http://lincoln.ne.gov/city/pworks/waste/sldwaste/recycle/ and in the *Lincoln-Lancaster County's Official 2012 Waste Reduction & Recycling Guide*, which is also available through the City's Solid Waste Operations website. Also, included within these sources are information on a wide array of private and not-for-profit recycling service providers, as well as source reduction opportunities.

For the convenience of residents in the Planning Area the City operates a network of 29 multi-material recycling (drop-off) centers and 4 newspaper-only recycling (drop-off) centers in Lincoln and Lancaster County; most are open 24-hours per day. Two private recycling processing centers also operate multi-material recycling drop-off centers in the City. One village (Hallam), operates its own recycling drop-off center. All total there are 36 drop-off sites; 25 are located in the City and nine are in areas of the County outside of the City. The locations and map of these sites can be found in the *Lincoln-Lancaster County's Official 2012 Waste Reduction & Recycling Guide*. These sites provide residents locations where they can self haul and drop off select recyclable materials. The City contracts with a private hauler to collect and deliver the deposited materials from these drop-off centers to a recycling processing center, under contract

with the City to process and market these materials. The City provided facilities are funded primarily through the Occupation Tax, revenue from the sale of recyclables and grant funds.

Several private hauling companies provide curbside collection of recyclables on a subscription basis. There are no reporting requirements for haulers, and as such the number of haulers providing curbside recycling is unknown. Most of the residential curbside recycling programs are "single stream" service, which means that all acceptable recyclable materials are placed in a common container(s) and sorted at a remote processing center. The frequency of collection and is generally once per week. The Baseline Assessment/Survey conducted as part of the Solid Waste Plan 2040 indicates that approximately 24 percent of the residents in the City have (subscribe to) curbside recycling services. Prior to the assessment/survey the City conducted limited hauler surveys which resulted in an estimate of 21 percent of the occupied single-unit to four-unit dwellings in Lancaster County subscribed to curbside recycling in 2011. The City's data did not distinguish between household participation rates for curbside recycling inside or outside the City; however, available information suggests that there are only a small number of households that subscribe to curbside recycling outside the City. The City's survey is within the confidence interval of the Baseline Assessment/Survey; as such the 24 percent value will be used for purposes of this paper. None of the municipalities in the County provide either public or franchise curbside collection service for recyclables. Curbside residential recyclables collection programs are funded by program users through subscription fees and revenue derived from the collected materials.

Recycling drop-off centers include for-profit and not-for-profit operations. Three private recycling processing centers operate in the City and accept recyclables from residential and business customers and sort and process them to meet market specifications. The capacity to process significantly larger volumes of materials would need to be evaluated if a significant increase of recyclables resulted from an expanded residential recycling program. Additionally, not all existing facilities may benefit from an expanded program.

The City has an extensive education effort to promote recycling. It is funded through the Occupation Tax, revenues from the sale of recyclables and grant funds. The City also provides a recycling hot-line that individuals may contact with recycling questions.

Generation and Diversion

Based on hauler surveys conducted by the City, it was estimated that household subscription curbside recycling services in 2011 resulted in 9,450 tons of recyclables being collected and diverted from disposal.

Since FY1990-1991, the recycling drop-off facilities have collected 114,163 tons of recyclables. The diversion rate through these facilities peaked at 7,437 tons in FY2007-2008 (see Table 1) and has declined since that time. The decline in volumes collected at the recycling drop-off sites may be attributed to: 1) global recession; 2) reduced size of newspaper and reduced subscriptions; and, 3) increase in curbside recycling subscription. Table 1 shows the distribution of material types and overall tonnages of materials collected at drop-off sites over the past eleven years.

Table 1 – Summary of Material Tonnages at Recycling Drop-off Sites

F.Y.	Newsprint	Containers				Paperboard	Mixed	Total
		Aluminum	Plastic	Glass	Metals	& OCC	Paper	Tons
00-01	3,317	27	178	577	117	732	1,239	6,187
01-02	3,222	25	176	569	118	696	1,236	6,042
02-03	3,219	32	190	594	133	738	1,349	6,255
03-04	3,154	35	200	613	123	739	1,436	6,300
04-05	3,161	36	230	628	126	865	1,511	6,557
05-06	3,162	39	228	675	129	875	1,573	6,681
06-07	3,210	43	281	726	122	966	1,727	7,075
07-08	3,101	51	336	853	127	1,138	1,831	7,437
08-09	2,474	64	396	928	125	1,180	1,641	6,808
09-10	2,155	68	413	978	128	1,210	1,449	6,401
10-11	1,932	59	392	940	120	1,209	1,370	6,022

OCC = Old Corrugated Containers (Cardboard)

While data collected at the Bluff Road Landfill does not allow a clear distinction between residential and commercial municipal solid waste (MSW), the City has utilized information on vehicle types over the past five years and concluded that approximately one-half of the waste delivered to the Bluff Road Landfill and exported to other disposal facilties represents residential waste (the other one-half would represent commercial waste). Using these City values, it was estimated that a total of 152,460 tons of residential waste was sent to disposal from Lancaster County in 2011. While it is not strictly possible to estimate recycling rates (both participation and diversion) from residential sources, if the 6,022 tons handled through the drop-off centers, and the 387 tons of metals from applicance recycling, and 19,493 tons handled through the compost and wood waste programs (FY 2010/2011) are combined with the 9,450 tons collected through residential curbside recycling service (2011 survey) (and assumed to be all from residential sources in the County) it would roughly equate to a 19 percent residential MSW diversion rate in FY 2010/2011 (or 9 percent of the total MSW generation rate). For the estimated 24 percent of residential dwellings having curbside recycling, the per dwelling recycling rate was estimated to be 28 percent. This was calculated based on the following:

- The US Census Bureau report that there were a total of 84,679 occupied housing units in single-unit to four-unit dwellings[1] in Lancaster County
- The US Census Bureau report of an average household size of 2.55 people
- A unit waste generation rate of 3.6 pounds per capita per day
- 24 percent of the single-unit to four-unit dwellings in the Planning Area have curbside recycling and that they diverted 9,450 tons of materials to recycling in FY2010/2011

Statistics from the City of Omaha, Nebraska's residential waste collection program indicate a recyclables diversion rate of approximately 11 percent (31 percent including yard waste) is achieved by curbside recycling. In Omaha residential curbside recycling is universally available to all residents, but beyond convenience there are no significant economic incentives (residents do not directly pay a fee for waste, yard waste, or recyclables colletion) or disincentives.

[1] Source: B25124: TENURE BY HOUSEHOLD SIZE BY UNITS IN STRUCTURE - Universe: Occupied housing units 2008-2010 American Community Survey 3-Year Estimates

Ranges of diversion through residential curbside recycling generally vary from 8 to 25 percent across the United States, with some locations reporting diversion rates of 50 percent.

The NDEQ conducted a series of waste composition studies in 2007 and 2008. The main objectives of these studies were to determine the characteristics of Nebraska's solid waste stream and to establish a baseline of waste characterization data for the state. NDEQ's composition study included four seasonal sampling events (2007 to 2008) at the City's Bluff Road Landfill and separate characterization for residential and commercial waste streams. The figure and tables in Appendix 1 shows the NDEQ composition study results for residential waste. The NDEQ study reports that the three main components (by weight) of the residential waste stream disposed of at the Bluff Road Landfill are paper fibers (37 percent), plastics (20 percent) and food (16 percent).

Select data from the 526 page NDEQ report, relative to the Bluff Road Landfill residential waste composition, are included in Appendix 1. Because of the extensive nature of the composition study and the fact that this landfill is the principal MSW disposal site in the Planning Area this composition information is considered accurate for planning additional diversion programs and has not been modified by national data.

Recycables disposed of have a secondary market value if they can be diverted from disposal or recovered in a clean (uncontaminated) form. While estimates of detailed waste composition may be useful in evaluating future waste management systems (including increased diversion opportunities), it is equally important to recognize that waste received at the landfill is a heterogeneous mix and that most of these materials are not currently collected or managed in a form conducive to large volume recovery (e.g., they are all mixed together and cross-contaminated by other waste products). For this reason evaluation of recycling alternatives are principally focused on pre-disposal recovery/recycling options.

Program (Facility/System) Options

Residential recycling program options can take many forms and involve differing levels of participants, program/services, and materials. Methods of collecting recyclables vary from community to community across the US, but there are generally four primary methods:

- Curbside collection,
- Drop-off centers,
- Buy-back centers, and
- Deposit/refund programs.

These methods are typically complimented by education and promotional programs. Program options also exist for recovery of waste following disposal, via processing, but these are less common and not discussed in this paper.

Effective residential recycling programs often use combinations of the above options to maximize diversion and address inherent limitations with any one program type. For example, drop-off facilities are commonly utilized in conjunction with community-wide residential curbside collection to provide recycling opportunities to multi-family residents, to provide just-in-time management opportunities (large volume of OCC), and/or to capture certain materials that may not be collected in a curbside program (i.e., glass). Drop-off facilities can also serve small businesses as well as residents from outside the community.

Curbside Recycling

There are many different types and examples of residential curbside recycling programs across the US. Most utilize some form of bin or container into which residents place recyclable materials for subsequent collection. Materials targeted for recovery through residential curbside programs also vary widely based on markets, program compatibility, and management and handling considerations.

The two most distinct curbside recycling concepts are: 1) multi-stream source separated, and 2) single stream commingled. In the multi-stream concept the resident separates materials into categories such as paper, containers, or by most distinct categories (e.g., paper would be separated by ONP, mixed paper, OCC, etc.); the goal of such programs is to reduce post collection processing costs and reduce possible cross-contamination. In single stream programs all acceptable recyclable materials are placed in a common container(s) and sorted at a remote processing center; such programs are believed to generate higher participation rates and require less intense educational efforts. Single stream programs are often advocated because of the ease and efficiency of collection, but are questioned in terms of optimum diversion because of potential for cross-contamination. There does appear to be a national trend toward single stream programs.

The current subscription based system in the Planning Area is totally voluntary and estimated to serve 24 percent of the occupied households. While increased education (behavior change) may produce some increase in residential recycling, if major increases in the number of residents using curbside recycling is a goal of the Solid Waste Plan 2040, then some form of market regulation or mandated programs will likely be required; this presumes that such collection services would be provided by private service firms, as opposed to municipally operated systems. Market regulation refers to the establishment of requirements for services or that programs operate under a set of rules (regulations) established by the community. Primary types of market regulation include:

- Free market (with minimum service ordinances)
- Franchising (exclusive or non-exclusive)
- Contracts

This paper does not explore the specific legal aspects that would need to be addressed to implement any of the listed market regulation program options.

Free market - minimum service ordinances can take a variety of forms but, in the simplest sense, might obligate a refuse firm to provide (or offer) a certain minimum level of recycling service to refuse customers as part of a license to operate within the community. Ordinance(s) would typically define such aspects as: materials to be collected, frequency of collection, and possibly maximum charges. There are also examples across the United States where refuse collectors have been required to provide refuse collection and recycling at a combined monthly cost of service. One such example is Saint Louis County, Missouri; the Saint Louis County Solid Waste Management Code requires, for one and two family households that a “minimum level of service” of once weekly trash pickup, once weekly recyclables pickup, and twice a year bulky item pickup. The hauler cannot provide less than those three services for one base price. (Source:http://www.co.st-louis.mo.us/HealthandWellness/RecyclingandSolidWaste/WasteDisposal/TrashandRecyclingService#recyclingservice, retrieved August 21, 2012). This is viewed as a partial incentive to recycle because customers would be paying for the service, even if they did not use it. Current LMC defines minimum levels of service in terms of frequency of refuse collection, but provides this obligation to the home owner, and allows residents to select their hauling service on a free market basis.

Under a free market, residential-type subscription service, multiple haulers could be driving the same routes (multiple vehicles on same street) to collect materials from one or more households. Collection fees for voluntary/free market subscription curbside residential recycling in Lincoln are generally believed to range from $5 to $10 per household per month; the Baseline Assessment/Survey identified a mean value of $10 per month. Lower numbers of household participants and longer driving distances between stops are viewed as increasing the costs of providing the service. Additionally, not all refuse haulers provide this service.

Curbside residential recycling costs per household decrease through organized collection systems, such as with franchises or contracts, due to inherent efficiencies. Franchising refers to granting the rights or privileges to provide a specific services or services in a specific area. Franchises can be exclusive (one provider) or non-exclusive (more than one provider). Contracts refer to an agreement entered into voluntarily by two or more parties to create a legal obligation (as opposed to a right or privilege). Examples of franchises and contracts that include curbside recycling in the Midwest region are:

- The Cities of Bellevue and Ralston, Nebraska provide once per week collection services for solid waste, recyclable materials and yard waste to all residences (single family and up to three-units or two-units, respectively) within city limits. The cities contract for these services through a private hauler on an exclusive basis. The combined collection, hauling, recycling, disposal and related services are billed to households on a monthly basis through their utility bills; current rates for these services are $12.50 and $13.38 per month for Bellevue and Ralston, respectively.
- Tulsa, Oklahoma had 50 or more independent private haulers as well as city collection crews, all operating under an “open territory” system, similar to Lincoln. Tulsa established four collection franchise districts/quadrants (one of which was serviced by the city). The private haulers formed an organization (TRI) to respond as a group to Tulsa’s request for franchise collection services and won the bid for the other three quadrants. TRI reorganized routes to provide a more efficient collection services and then split the routes among its members. Tulsa’s agreement with TRI specifically defined the services to be provided. Tulsa bills its customers for collection and disposal costs as part of its water and sewer bill and pays TRI on a household basis.
- In 2008, Metro Waste Authority (Des Moines, Iowa) solicited proposals and awarded a contract for single stream recyclables collection services for select member communities (cities surrounding but excluding Des Moines) to replace it’s “Curb-It” green bin curbside recycling system. The successful bidder’s price was $2.39 per household per month for every other week collection service; an alternate bid from this same firm was $3.60 per household per month for weekly collection services. The prices were based on an estimate that it would initially serve 72,765 households and excluded (from the above rates) the costs of new carts, cart distribution, and cart exchange/replacement.

Standardized collection also makes it easier to implement incentives to recycle (see Recycling Incentives paper). Universally available curbside collection programs have been reported to result in diversion rates of between 10 to 25 percent of the residential waste stream (based on approximately 50 percent participation), with higher rates in more aggressive programs.

The market regulated options described above presume that the availability of curbside collection services is mandated and provided universally to (all) residential dwellings, but residents’ participation is voluntary. For purposes of this paper the term “universal” recycling is used to refer to options where the availability of services is mandated but participation is voluntary.

The term "mandatory recycling" has recently taken on a different connotation across the United States; the concepts that are currently receiving significant attention are programs being implemented in locations such as Seattle, Washington; Pittsburg, Pennsylvania; and San Diego and San Francisco, California. These programs use ordinances, enforcement, and fines to ensure recycling. Two examples of such mandatory recycling programs are summarized as follows:

- In Seattle, Washington, recycling is required by law; a "City ordinance bans recyclable paper, cardboard, glass and plastic bottles, and aluminum and tin cans from garbage containers." "Garbage containers that contain more than 10 percent of recyclables will not be emptied. Haulers will leave instructions to remove recyclables before the following week's collection" (Source: Seattle Public Utilities, "Recycle at Your House," http://www.seattle.gov/util/Services/Recycling/Recycle_at_Your_House/index.asp, retrieved on 09/10/2009).
- In Pittsburg, Pennsylvania, "all residents of the City of Pittsburgh must separate recyclable items from household trash and package them for bi-weekly recycling curbside collection or take them to a City recycling drop-off center." "The operator of every business establishment [and apartment over 6 units] located within the City of Pittsburgh must establish a program to recycle high grade office paper, plastic bottles, corrugated cardboard, aluminum cans and leaf waste, where applicable" (Source: Pittsburgh Public Works, "Recycling," http://www.city.pittsburgh.pa.us/pw/html/recycling.html retrieved on 09/10/2009).

The extent of fines and degree of enforcement in these mandatory programs vary with the individual programs. In addition, the driving force for such programs may be a function of state law or other factors. Mandatory (statutorily required) recycling with imposed fines or penalties, as described above, is a social and culturally driven decision. Whereas universal programs look to expand services and provide motivation to voluntarily recycle.

While the USEPA no longer maintains its curbside collection website, it does continue to publish information that provides a relative measure of curbside residential recycling collection costs based on various frequencies of collection, set-out methods and diversion rates; this information is summarized in Table 2. This evaluation is based on a single provider within a given service area.

USEPA identifies the primary impacts on the per-ton or per-household costs of curbside collecting recyclables as being a function of the following:

- **"Costs increase with the number of separately segregated commodities collected.** Single-stream collection programs (all recyclables combined in a single bin/container) are the least costly to collect, followed by two-stream (two containers/separations), etc.
- **Costs increase with the frequency of collection.** Collecting half as frequently as waste pick-up (e.g., every other week instead of weekly) can reduce collection costs by approximately 25 percent, assuming traditional two-stream [excluding yard waste] set-outs.
- **Costs decrease as more materials are collected by the program.** If few households participate in the program and the program does not collect many commodities, the per-household cost soars, as it is costly to drive a recycling truck past household after household that has not set out recyclables."

(Source: www.epa.gov/waste/conserve/tools/localgov/economics/index.htm, retrieved on 09/10/2009).

Table 2 – Collection Costs for Various Frequencies of Collection, Set Out Methods and Diversion Rates

Variable	Two-Sort Set Out		Single-Stream Set Out		
	Once a Week—High Diversion	Every Other Week—High Diversion	Once a Week—High Diversion	Once a Week—Lower Diversion	Every Other Week—High Diversion
Solid waste/household (tons/year): Disposed Recycled Percent diverted	 0.60 0.40 40%	 0.60 0.40 40%	 0.60 0.40 40%	 0.80 0.20 20%	 0.60 0.40 40%
Pounds/household/collection day	15.38	30.77	15.38	7.69	30.77
Cost/household/year Cost/ton	$58.67 $141	$45.76 $103	$54.40 $139	$52.15 $278	$32.86 $89.38

Source: http://www.epa.gov/wastes/conserve/tools/localgov/economics/collection.htm

Drop-off Centers

The 36 facilities across the Planning Area provide an excellent example of residential recycling drop-off (convenience) centers. Again, the locations and map of these sites can be found in the *Lincoln-Lancaster County's Official 2012 Waste Reduction & Recycling Guide*. Drop-off centers were the predominant strategy used in many communities as they began recycling programs decades ago. They were considered easy to implement, low tech, and a cost effective way of meeting a community's demand for recycling. They require a site (possibly with some level of security), containers, service and maintenance (including contaminant removal), and a method of collection, processing and marketing materials. Multiple facilities are required in communities such as Lincoln to be truly convenient. Facilities can be staffed or un-staffed; however, staffing significantly increases costs – most drop-off centers in the US, including those in the Planning Area are un-staffed. A key issue with drop-off centers is the quality of materials deposited; the greater the failure to comply with establish program requirements the higher the cost, both in terms of contaminants and processing. Illegal dumping of household waste at un-staffed recycling drop-off centers can also be an issue.

The advantage of the drop-off center strategy for residential recycling is that it may be a low cost and low tech option. The City records indicate that over the past five fiscal years the recycling drop-off centers have operated at an average cost of $75 per ton of material recycled (operating costs divided by tons; operating costs include amortized capital costs). Over the same five fiscal years the City received an average revenue of $56 per ton of material recycled. As such, the average net cost per ton diverted has been approximately $19 over past five fiscal years. The disadvantage is that drop-off centers rely heavily on public desire and commitment to participate (e.g., collect and transport materials to the remote site(s)), because it is less convenient than curbside recycling. Participation may also require an added level of commitment to store and transport the material to the collection site. As such, this approach is not considered as effective as curbside recycling in encouraging regular participation in recycling. However, because most drop-off sites in the Planning Area are accessible 24/7 they

make it easy for residents to use. Drop-off centers also provide one option for multifamily residential dwellings that cannot be effectively served by curbside programs.

Drop-off programs are generally not well suited for the disabled, elderly, or mobility restricted.

Waste exchanges and targeted materials programs are a form of drop-off centers that generally focus on non-traditional materials (e.g., materials that are more difficult to collect and/or recycle). Keep Nebraska Beautiful currently operates the Nebraska Materials Exchange Program, which focuses more on schools and businesses than residential services. Expanding material reuse centers/waste exchange (public/private partnerships) have generally been discussed in technical papers related to source reduction. Facilities that target and process hard-to-recycle items, such as books, textiles, shoes, cooking oil, etc., are an advanced component of diversion programs. These facilities are commonly operated by public or non-profit organizations and vary widely in service levels. An example of this type of facility is the EcoCycle/City of Boulder, Colorado's Center for Hard-to-Recycle Materials (www.ecocycle.org/charm). Targeted programs can also include specific materials such as plastics (bags, film and single use containers), foods, and fibers. Targeting greater diversion of foods and fibers (i.e., organics) is further described and evaluated in the Organics Waste Diversion (Composting) paper.

Material reuse/waste exchanges and targeted materials programs are not further evaluated in this paper.

Buy-Back Centers

Buy-back centers are similar to drop-off centers except they pay users for materials brought to the center. By themselves, these do not achieve high levels of residential diversion but do provide a financial incentive to divert select materials. These are more commonly a retail business that targets select materials, such as a scrap yard, that buys metals by type (e.g., aluminum, brass, ferrous). The most common material diverted, from the standpoint of residential buy-back recycling, is aluminum cans; a more common version may be automobile and bulk metals scrap yards. Buy-back centers have also been reviewed under the paper on Source Reduction as a means of preventing materials from entering the waste management system.

Typically buy-back centers pay for materials based weight and on a percentage of commodity market prices.

Deposit/Refund Programs

From a residential recycling perspective, these programs typically target beverage cans or bottles. As such, deposit/refund programs only target a small percentage of the potentially recyclable materials generated at a residential level.

The deposit/refund is typically added to the initial sale price. When an empty bottle or can is returned to a redemption location or collection center the original deposit is refunded. Other examples applicable to residential recycling are discussed in papers under Zero Waste, Product Stewardship, and Source Reduction and include materials such as batteries.

Beverage container type recycling programs, also known as "bottle bills", are typically implemented at a state level due to management and enforcement considerations. Iowa is one near by example of a state that has a beverage container law. In California the Department of Conservation establishes a minimum per-pound repurchase rate for redeemed beverage container types: aluminum, glass, plastic and bi-metal.

Options Evaluation

The general issues associated with residential recycling programs are:

- convenience
- participation and diversion goals
- costs of services and funding
- implementation considerations

Implementation considerations are of particular relevance for a universal curbside recyclables collection option, based on the Planning Area's current curbside recyclables subscription system and free market refuse collection. Residential recycling program options can be tailored to specific community's desires, goals and policies. The preferable method for any given community is a function of community desires, costs, diversion goals, public and institutional support, and implementation processes. Educating households and encouraging participation are considered requirements to optimize the success of any residential recycling program.

Consistent with the guiding evaluation criteria developed for use in the Solid Waste Plan 2040, the residential recycling options have been further evaluated based on the considerations shown in Table 3. To significantly increase diversion of residential waste through recycling a combination of City-wide, universal curbside recycling collection along with strategic drop-off centers and continuation of private and non-profit organizations collection sites would likely be necessary. Such a combination of programs would maximize community participation and program effectiveness. Because of the specialty nature of programs such as buy-back centers and deposit/refund programs, and the relatively low level of total diversion achieved through these programs alone, they are not further evaluated. It is generally assumed that in the final Solid Waste Plan 2040 development that continuation of existing buy-back centers would be encouraged, to the extent they are compatible with the final plan.

Table 3 – Options Evaluation

Evaluation Criteria	Curbside Collection	Drop-off centers
Waste Reduction/ Diversion	Existing programs are considered effective for subscribers and provide diversion opportunities; Fees and lack of universal availability limit participation and diversion quantities. Current subscription curbside collection services divert approximately 2.5 percent of the Total MSW stream. Participation rates and diversion potential increase substantially with convenient, universally-provided curbside recyclables collection. Provides the highest level diversion option for residential recyclables when universally available. Higher levels of diversion can be achieved if use of such programs is mandatory. Properly implemented, single-stream collection systems have been shown to have greater participation and collect more materials per household than multi-stream, source separation systems.	Existing programs are considered effective and provide diversion opportunities; The lack of a direct fee and 24/7 access is an incentive to participated. By itself this approach will not maximize residential waste recycling. The relative convenience, compared to curbside collection, is a limiting factor in participation rates and quantities diverted. Current drop-off facilities divert approximately 1.6 percent of the Total MSW stream. Development of new drop-off center locations may not proportionally increase participation or diversion.
Technical Requirements	Recyclables processing capacity will need to be evaluated for ability to process significantly greater quantities of recyclables; not all existing processing facilities may benefit from a City wide collection program. Expanded or new processing capacity may be required. Curbside collection is compatible with other program elements. Additional service opportunities would be created by a universally available collection program. Not all	Existing processing centers are assumed to have adequate capacity for modest increase in diversion. Existing drop-off centers are compatible with other program elements. Continuing select drop-off centers in the Planning Area (in conjunction with City-wide curbside recycling) will provide convenience, accessibility and participation to residents and small businesses not served by a collection program. Drop-off programs are highly reliable due to 24/7

Evaluation Criteria	Curbside Collection	Drop-off centers
	existing haulers (recycables and waste) may benefit from a City wide collection program. Curbside collection and drop-off centers are compatible and together optimized residential recycling diversion opportunities. This approach is widely used across the US and is considered highly reliable/low risk. The primary risk is with market prices for collected materials. Under a voluntary system, residents may be provided curbside recycling opportunities but may choose not to participate.	availability. This is considered a low risk approach. The primary risk is with market prices for collected materials.
Environmental Impact	Provides greatest opportunity to divert recyclable materials from the residential waste stream disposed. Increased recycling helps further conserve resources and extends the life of Bluff Road Landfill. The USEPA has determined that recycling reduces greenhouse gas emissions and better protects the environment, as compared to disposal options. The greater the efficiency of a curbside recycling program the potentially greater net environmental benefit. Issues that would need to be addressed in a universally available curbside recycling program would include traffic (safety) and air emissions if multiple haulers were to be collecting recyclables in the same neighborhood. Similar to curbside collection of refuse, litter is a concern that needs to be addressed.	Provides for conservation of resources but does not optimized diversion. Residents may continue to dispose of recyclables with refuse due to lack of convenience. Air emissions also result from the residents traveling to the drop-off centers, although it is likely that residents combine trips to the drop-offs with other destinations. Illegally dumped refuse and litter can be issues at unattended drop-off centers. Health and safety can also be a concern at unattended drop-off centers.

Evaluation Criteria	Curbside Collection	Drop-off centers
Economics	Service providers under an expanded program would need to expend capital to provide for increased collection and handling costs. The costs of added curbside recyclables collection would likely be borne directly by residents. Current program costs are borne by those who choose to subscribe/participate. Cost per ton of material diverted (and as a result cost per household) should decreases with more efficient collection programs and higher participation rates. Curbside recycling and refuse collection could be required as a combined monthly cost of service. Expanded collection services will likely represent business and employment opportunities for firms providing such service. Assuming continued private sector collection services, this does not rely upon government funding to implement or sustain program. Selective reduction of the number of drop-off centers can reduce City funded drop-off program operating costs.	The costs of current and possibly added drop-off centers represent a cost to the City, which will ultimately be borne indirectly by all residents and businesses through the Occupation Tax. Development of new drop-off centers is a capital investment and will require a budget appropriation. NDEQ grants may be a source for capital improvements. Requires a funding commitment by the City; is not considered a net revenue generator. Potential revenue loss with theft of higher value recyclables. Not considered to have economic development potential.
Implementation Viability	Not a new technology and has been proven viable. Will likely require modification to the LMC to implement a universally available system. Some opposition to change should be anticipated. Requires promotion and education to maximize and maintain participation. Assuming private haulers provide residential curbside	Not a new technology and has been proven viable. No regulatory changes required for continuation of existing programs. Continued City funding and funding for expansion would be required to sustain the program. Requires promotion and education to maximize and maintain participation. Additional land/sites would be required for program

Evaluation Criteria	Curbside Collection	Drop-off centers
	recycling services they would likely have primary responsibility for expanded program implementation. City would likely need to work with existing haulers and/or processing facilities to implement an acceptable, expanded program. City may need to define minimum level of service; a totally voluntary program may not ensure consistency of approach. If universally available curbside program is implemented, the City will need to evaluate the network of existing drop-off centers to determine how to best serve rural areas, high density, multi-family residential units and small businesses. Implementation of an expanded curbside collection program can be implemented quickly (less than 1 year), if desired.	expansion. If the drop-off program is expanded, siting requirements for recycling drop-off centers may need to be investigated.

Relationship to Guiding Principles and Goals

The current recycling program of voluntary, subscription curbside recyclables collection, public and private drop-off facilities, buyback centers, and education outreach involves public/private partnerships and provides opportunities to engage the community in diverting materials to recycling. However, the absence of a universally available city-wide curbside collection program (due to rates of subscription) limits the extent of recyclables diversion. As it relates to the Guiding Principles and Goals of the Solid Waste Plan 2040, the possibility of expanding residential recycling is directly applicable, as further noted below.

- **Emphasize the waste management hierarchy**: Recycling is one of the most preferred waste management methods in the hierarchy (immediately after reduce and reuse) in that it places maximum emphasis on options to recover materials and recycle them into new products. Current programs are compatible with this hierarchy. To increase recycling above the status quo, the convenience and mandate of a city-wide, universally-provided curbside collection should result in significantly higher level of residential recyclables diversion.
- **Encourage public/private partnerships**: The current system of recycling involves both public and private efforts including subscription curbside recyclables collection provided by private firms, private recycling processing centers, City provided drop-off sites, City provided education and promotional outreach, and private buy-back centers. If a city-wide (universally available) recycling curbside collection program is selected for implementation it is expected to be developed with private parties providing collection and processing services. Services by non-profits, privates, and public/private partnership, buyback centers, special materials take-backs, and thrift stores are expected to continue and complement any decision to implement an expanded residential curbside recycling program.
- **Ensure sufficient system capacity:** Three private recycling processing centers, serving residential and business customers, operate in the City and others are available in the region. Available processing capacity may need to be evaluated as part of any program that significantly expands recycling diversion rates to determine the need for additional processing capacity and facilities.
- **Engage the community:** Any expanded residential recycling and curbside collection program would need to engage the residents and businesses to encourage them to divert more recyclables from disposal and possibly increase their knowledge of conservation, source reduction and reuse alternatives. Optimizing the success of an expanded residential curbside recycling program will also require education (behavior change) to encourage participation and sustain participation.
- **Embrace sustainable principles:** Maximizing recovery of materials though recycling into new products recognizes that waste is not inevitable and discarded materials are potentially valuable resources.

Summary

Recycling turns materials that would otherwise become waste into valuable resources. It also reduces greenhouse gas emissions and conserves space in landfills. The City supports and promotes public and private recycling efforts by providing a wide array of services. Currently an estimated 24 percent of the residential households voluntarily subscribe to curbside recycling services. It is estimated that approximately 19 percent of the residential MSW is currently recycled. It is likely that a major increase in the number of residents using curbside recycling

will required some form of market regulation or mandate. Market regulation refers to the establishment of requirements for services or that programs operate under a set of rules (regulations) established by the community. There are numerous examples across the United States of voluntary and mandatory recycling programs that achieve higher levels of residential waste diversion than are currently achieved in the Planning Area.

To significantly increase diversion of residential waste, through recycling, a combination of City-wide, universal curbside recycling collection along with strategic drop-off centers and continuation of private and non-profit organizations collection sites would likely be necessary. Drop-off centers are not as effective as curbside recycling in encouraging regular participation in recycling and are not viewed as a singular option to optimize diversion.

The general issues associated with the current Planning Area residential recycling programs are convenience, participation and diversion levels, costs of services, efficiencies, funding of new programs, service providers, processing capacity, and implementation considerations. Residential recycling program options can be tailored to specific community's desires, goals and policies. The preferable method for any given community is a function of community desires, costs, diversion goals, public and institutional support, and implementation processes.

There are many types of program options available, all of which are essentially consistent with the Solid Waste Plan 2040 guiding principles and the waste management hierarchy. Of the program options available, city-wide (universally-available) curbside recycling appears to provide the greatest opportunity to maximize residential recycling (rates and quantities) and minimize landfill disposal of solid waste. If the Solid Waste Plan 2040 incorporates universally available, city-wide curbside recycling, the City will need to evaluate the number and location for drop-off centers, to be used in conjunction with such a program. If the Solid Waste Plan 2040 incorporates universally available, city-wide curbside recycling the City would also need to evaluate minimum levels of service, how to fund such services, and how to most effectively/efficiently implement such a program.

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Appendix

APPENDIX 1

TABLE B.19
RESIDENTIAL WEIGHT DATA SUMMARY FOR THE BLUFF ROAD LANDFILL

Material Category/Component	Net Weight (pounds)	% of Material Category	% of Sorted Sample
Cardboard	257.85	4.02%	1.50%
Office Paper	683.93	10.67%	3.99%
Newsprint	1,151.88	17.97%	6.72%
Magazines	886.67	13.83%	5.17%
Paperboard/Liner Board	999.01	15.58%	5.83%
Mixed Paper	2,432.27	37.94%	14.19%
TOTAL PAPER FIBERS	**6,411.61**		**37.39%**
PET #1	488.16	14.19%	2.85%
HDPE #2	322.39	9.37%	1.88%
Other Numbered Containers	514.16	14.95%	3.00%
Plastic Film/Wrap/Bags	1,322.42	38.45%	7.71%
Other Plastics	792.27	23.04%	4.62%
TOTAL PLASTICS	**3,439.40**		**20.06%**
Clear Glass Containers	536.42	58.59%	3.13%
Brown Glass Containers	227.41	24.84%	1.33%
Green Glass Containers	115.94	12.66%	0.68%
Blue Glass Containers	1.08	0.12%	0.01%
Other Glass	34.71	3.79%	0.20%
TOTAL GLASS	**915.56**		**5.34%**
Aluminum Cans	197.10	30.70%	1.15%
Tin Cans	317.17	49.40%	1.85%
Other Aluminum	53.25	8.29%	0.31%
Other Tin	26.22	4.08%	0.15%
Other Mixed Metals	48.36	7.53%	0.28%
TOTAL METALS	**642.10**		**3.74%**
Food	2,807.68		16.38%
Diapers	782.43		4.56%
Textiles/Rubber/Leather	984.01		5.74%
Yard Waste	660.64		3.85%
Household Hazardous Waste	3.85		0.02%
Electronic Waste	80.88		0.47%
Dry-Cell Batteries	21.35		0.12%
Misc. C/D Waste	2.37		0.01%
Wood	67.65		0.39%
Empty Aerosol Cans	34.87		0.20%
Non-Distinct Waste	286.29		1.67%
Other Misc. Wastes	5.38		0.03%
TOTAL WEIGHT OF SORTED SAMPLE	**17,146.07**		**100.00%**

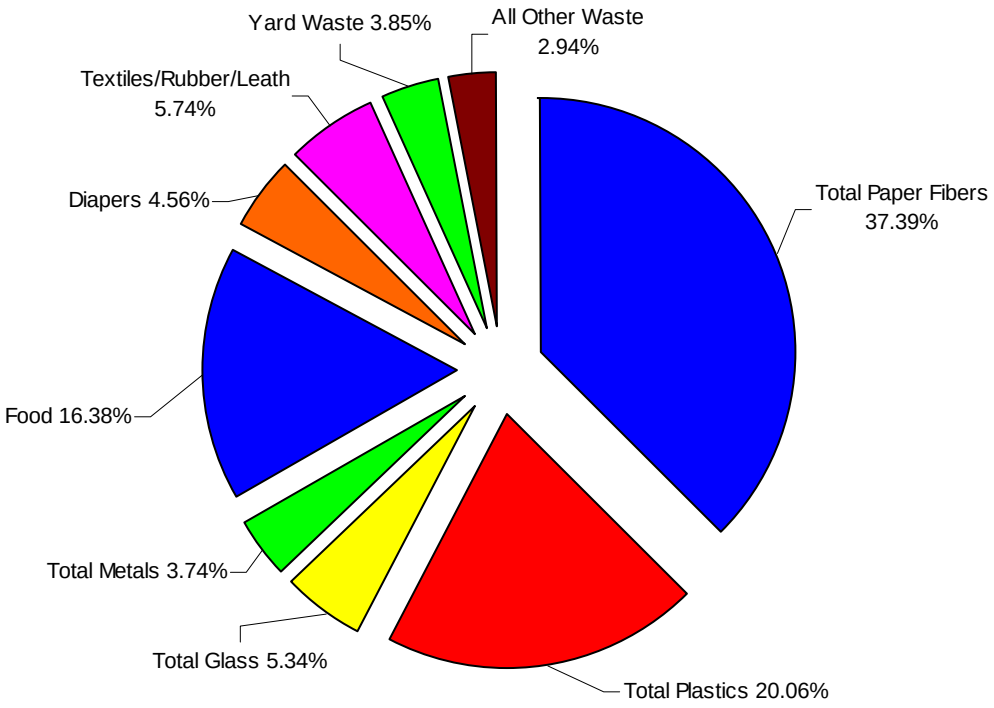

CHART B.3
DISTRIBUTION OF THE CONSOLIDATED RESIDENTIAL WEIGHT DATA FOR THE BLUFF ROAD LANDFILL

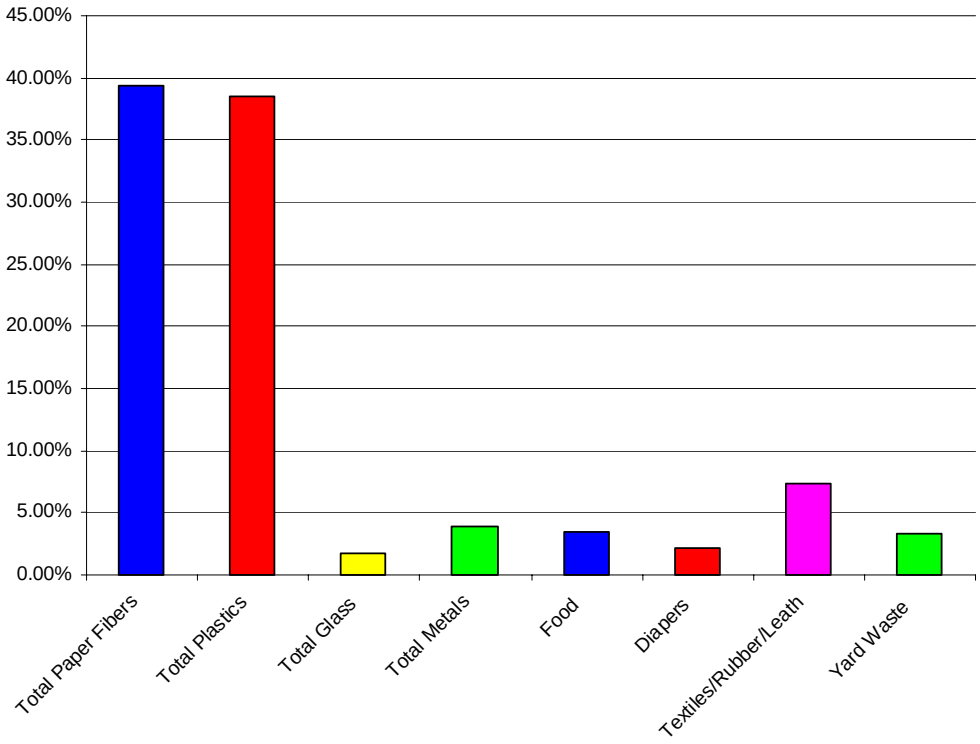

CHART B.4
DISTRIBUTION OF THE CONSOLIDATED RESIDENTIAL VOLUME DATA FOR THE BLUFF ROAD LANDFILL