Improving Charlottesville's Recycling System

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Disclaimer

The author conducted this study as part of the program of professional education at the Frank Batten School of Leadership and Public Policy, University of Virginia. This paper is submitted in partial fulfillment of the course requirements for the Master of Public Policy degree. The judgments and conclusions are solely those of the author, and are not necessarily endorsed by the Batten School, by the University of Virginia, or by any other agency.

Honor Statement

On my honor as a student, I pledge that I have neither given nor received aid on this assignment.

X. *Katherine McPherson*

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Executive Summary

The City of Charlottesville is not recycling waste to its fullest potential. The city of Charlottesville most recently reported an overall recycling rate of 35% (City of Charlottesville Strategic Plan, 2022), 10 percentage points lower than the state average and 23 percentage points lower than the neighboring city of Richmond (Virginia Department of Environmental Quality, 2020). Charlottesville utilizes a single stream recycling system where all recyclable goods are placed into one bin and sorted later at a material recovery facility (MRF) as opposed to a dual stream system where paper and cardboard is placed in one bin, and plastic, cans, metal, and glass are sorted into another by the consumer before collection and transport to the MRF. Single stream has rapidly become the most dominant recycling system over the last 15 years among cities and towns as a result of its ease to users and initial benefits due to increased participation. This shift to single stream has coincided with the aggressive acquisition of small, localized waste management companies by increasingly large "corporate waste" conglomerates in the same time period. Charlottesville is not excluded from this nationwide trend, and in the last 4 years our recycling curbside provider has been acquired twice and is not run by Green For Life (GFL), the fourth largest waste management company based in North America.

Governance of waste collection systems is largely left up to individual cities and counties although there is general guidance and goals to be met provided by their respective states. Resultantly, the City of Charlottesville has relative autonomy in the way their waste system is managed. Charlottesville has set itself a recycling rate goal of 35%, which is voluntarily higher than the state of Virginia's requirements to meet 25%. However after GFL's assumption of waste pickup there has been a near elimination of competition, creating a cost prohibitive landscape for smaller recycling firms and limited Charlottesville's ability to track and improve their recycling rates as data is voluntarily self-reported by GFL.

Other external factors also led to the shift in service providers in 2018. Prior to 2018, the U.S. shipped 40% of our recycled materials overseas to be processed in China due to their lax contamination requirements. Contamination is a measurement of 1) non-recyclable items placed in recycling bins or 2) residue (food/waste) on recyclable materials that renders it non-recyclable. In 2018, China passed their National Sword Act in response to President Trump's trade war which lowered acceptable levels of contamination to near impossible levels and effectively upended the U.S. 's long existing recycling infrastructure. Because of our reliance on single stream processing, it has proven difficult to decrease contamination levels to profitable levels. There is also little political momentum for waste legislation in Virginia today after the Clean Economy Act was passed in 2020 which sated the environmental policy appetite of lawmakers.

In order to counteract our high contamination problem and improve our recycling recovery rates, I assessed 3 alternatives:

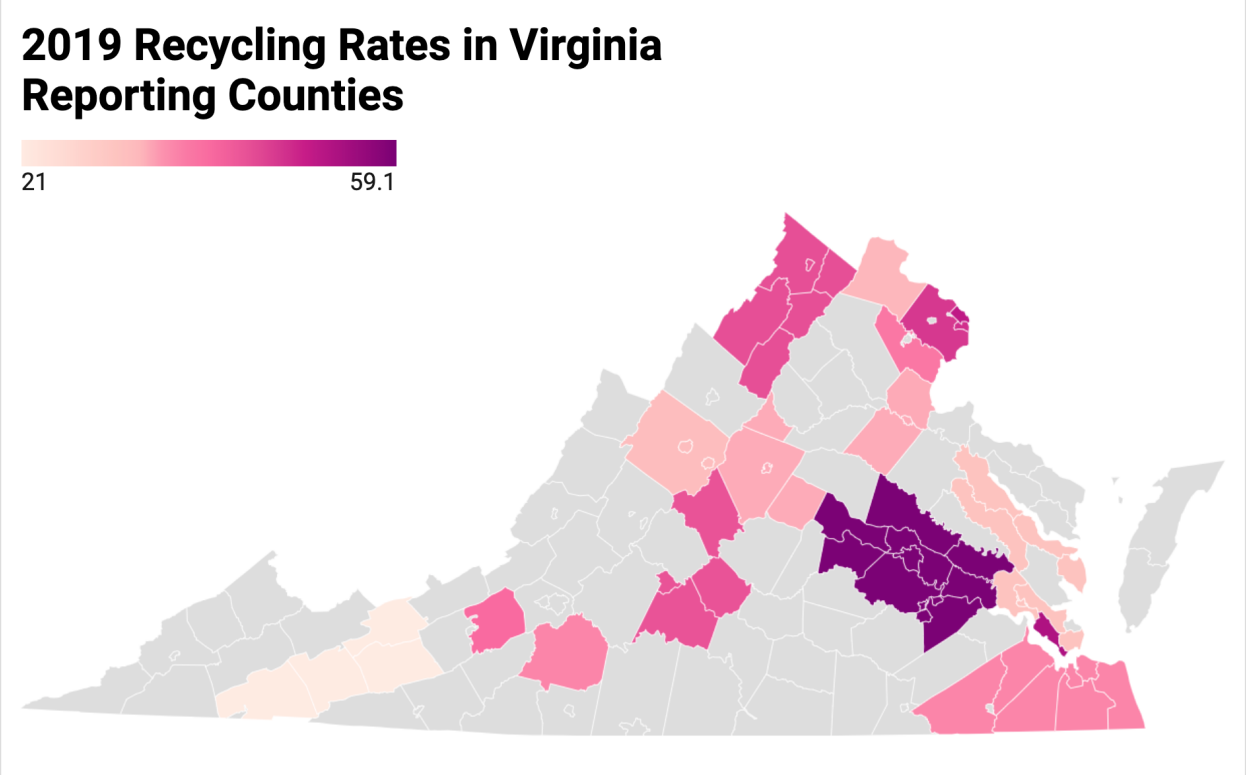
1. **Apartment Complex and Multi-Unit Dwelling Recycling Mandates –** Charlottesville does not currently require landlords to provide recycling services to tenants of multi-unit dwellings, ultimately sending recyclable material from 23% of housing units in the city to landfill. Such a mandate would require the expansion of recycling services and increase our recycling rate.
2. **Oops! Sticker Implementation + Public Education –** A form of consumer accountability where waste pickup crews grade the
3. **Switch from Single Stream to Dual Stream**

After weighing each alternative against the following criteria: cost effectiveness, political feasibility, ability to implement, and impact on the environment I ultimately recommended alternative #2 – "Oops!" sticker implementation + public education because of its extreme ease to implement quickly, low cost materials and eventual savings for the city, avoidance of political process, and substantiated effect on contamination rates. This alternative will encounter few obstacles to implement as GFL itself already has some townships that utilize "Oops!" stickers so there is an existing structure within the service provider, our neighboring city of Richmond uses this system so we can look to them for advice, and waste pickup crews will not require extensive training to adapt to the new system. Possible challenges to this alternative will be resistance from GFL to negotiate the terms of such a system into their contract with the City of Charlottesville, and negative public opinion of being reprimanded for incorrectly recycling.

Problem Statement

The City of Charlottesville is not recycling waste to its fullest potential. The city of Charlottesville most recently reported an overall recycling rate of 35% (City of Charlottesville Strategic Plan, 2022), 10 percentage points lower than the state average and 23 percentage points lower than the neighboring city of Richmond (Virginia Department of Environmental Quality, 2020). As shown in Figure 1, Charlottesville is lagging behind most of the state, and despite public commitment to improve, Charlottesville recycling has shown no progress since 2015 recycling rates (City of Charlottesville Strategic Report, 2022). National disruptions to our recycling chain of operations in 2018 have created a window of opportunity for the relocalization of waste management, and systematic improvements to help divert waste from landfills to material recovery facilities (MRF's). Doing so will improve environmental health, resident health, avoid potential inequitable landfill sprawl, and allow for a less cost prohibitive recycling market that currently disbars local waste management businesses. The City of Charlottesville should work to increase their recycling rate by either collecting more recyclable material or decreasing their contamination rates to render a greater amount of current materials collected actually recyclable.

Figure 1: 2019 Recycling Rates in Virginia Reporting Counties

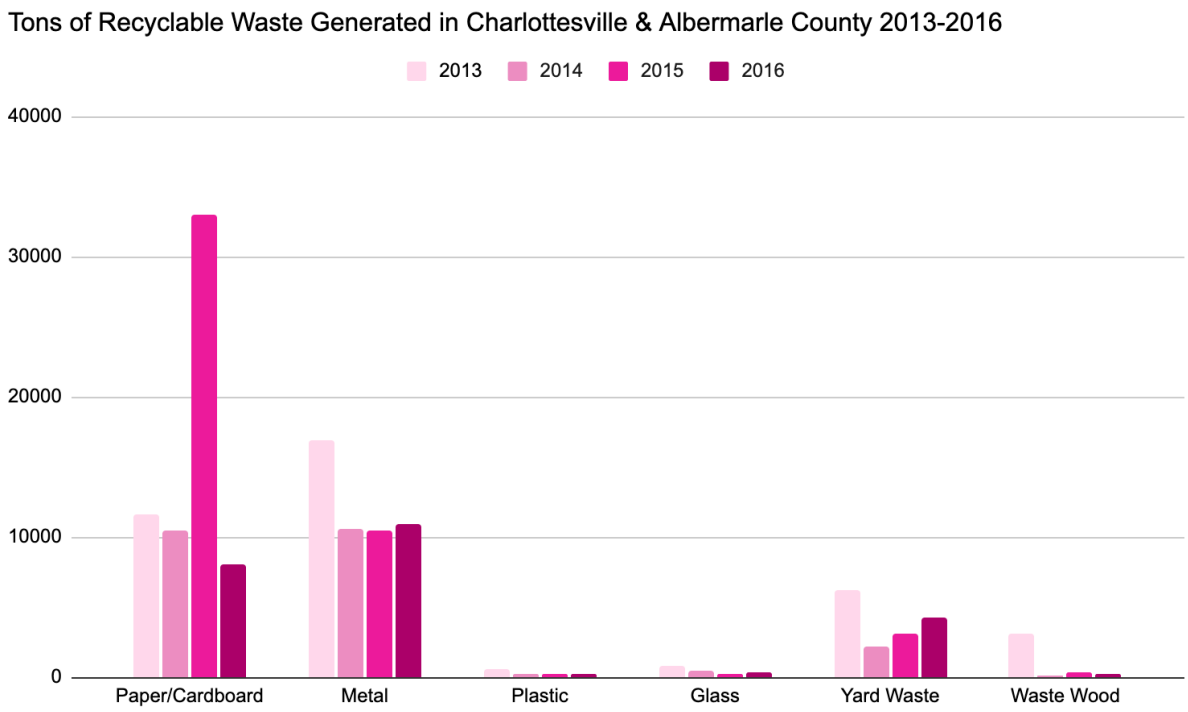


Data Source: Virginia Department of Environmental Quality | Annual Recycling Summary Report Calendar Year 2019 (2021)

Overview of Recycling in Charlottesville

Recycling is the process of reclaiming waste and processing it back to a raw state in order to be used again. Conventional curbside recycling programs generally collect plastics #1-7 (see Figure 2 in appendix for breakdown), aluminum and tin metals, paper and cardboard, and occasionally glass. The City of Charlottesville's curbside recycling program aligns with this general guidance and collects all the materials listed including glass. From 2013-2016, the City of Charlottesville and Albemarle County combined generated an average of about 133,000 tons of municipal solid waste (MSW) and 67,000 tons of recyclable waste per year. The only data available unfortunately measures both the City and County together, but just to identify relative material amounts the breakdown of recyclable goods generated are shown in Figure 2. Note that plastic and glass both fall well below other recyclable materials generated – this can be attributed to difficulties separating glass and plastic from single stream collection bins, a common pitfall of single stream recycling services that will be explored later.

Figure 2: Tons of Recyclable Waste Generated in Charlottesville & Albemarle County 2013-2016



Data Source: Susan Elliot, Head of Charlottesville's Climate Protection Program 2022

Counties or cities generally have a contract with local material recovery facilities and either supply curbside pickup services to residents, or offer the services for a fee. States have complete jurisdiction over their own recycling programs. Federal legislation merely informs and encourages states to follow a general structure, but does not bind them to any action. As a result, Virginia legislators have implemented their own incentives to recycle with varying degrees of success, as can be gathered from the wide array of recycling rates in Figure 1 and the nonuniform breakdown of materials shown in Figure 2.

Recycling Governance: Federal, State, and City

Federal Recycling Policy

The federal government has largely abstained from creating stringent solid waste disposal regulations. Instead, Congress allows each state to create their own recycling mandates following their recommendations with little oversight or incentive to improve. The first piece of legislation addressing waste was the Solid Waste Disposal Act of 1965 (SWDA). The SWDA took a broad approach to solving an escalating waste crisis that came about as a result of technological advancements in material production and booming expansion of metropolitan centers that, when

coupled together, produced more waste than municipalities were equipped to process. The SWDA provided waste management standards for municipal and industrial waste, promoted waste management technology, and charged municipalities with responsibility for the disposal of solid waste (Gordon, 2021). The Resource Recovery Act of 1970 (RRA) was the first amendment to the SWDA. The RRA emphasized the importance of the recovery of energy and materials from solid waste over disposal – recycling was gaining legislative attention and momentum. It prioritized strengthening local resource recovery and solid waste disposal programs through training grants, national research and development programs, and the promulgation of guidelines for recycling best practices (National Environmental Health Association, 1971).

Next, and most lastingly, The Resource Conservation and Recovery Act of 1976 (RCRA) offered significant amendments to the SWDA – so sweeping in fact that it has since trumped the SWDA so that legislators refer to the RCRA as our predominant solid waste policy guidance although it is technically an amendment. The RCRA notably banned the use of open-land dumping and added regulations for the treatment of hazardous waste in the US, adopting a "cradle-to-grave" approach that required producers of said waste to be ultimately responsible for its generation at any point in its existence. It created a tracking system to follow hazardous waste throughout its entire life to ensure these harmful substances were properly disposed of. The RCRA also set national goals for the reduction of waste generated through source reduction and recycling, and encouraged incentives / disincentives to be established that would increase recycling material reclamation rates (EPA, 2021). Since its genesis in 1976, the RCRA has been amended multiple times to expand its efficacy with more specific legislation, and to adapt with the evolution of new materials and disposal methods. However, the majority of these amendments concern the disposal of hazardous waste rather than recycling. The RCRA remains relevant today as the most overarching solid waste guidance from the federal government and is cited on the EPA's website as "our nation's primary law governing the disposal of solid and hazardous waste" (EPA, 2021).

Besides its advertised adherence to the RCRA, the EPA does not impose any other rules or regulations on state recycling programs. It does, however, offer guidance and suggestions. Its most recent strategy identifies a number of challenges facing the U.S. MSW recycling system including confusion about what materials can be recycled, recycling infrastructure that has not kept pace with today's diverse and changing waste stream, reduced markets for recycled materials, and varying methodologies to measure recycling system performance (EPA National Recycling Strategy, 2021). They list the following five objectives for improving our waste processing system:

1. Improve markets for recycled commodities
2. Increase collection and improve materials management infrastructure
3. Reduce contamination in the recycled materials stream
4. Enhance policies and programs to support circularity
5. Standardize measurement and increase data collection

(EPA National Recycling Strategy, 2021)

Virginia Recycling Policy

States have jurisdiction over their own recycling programs. Federal legislation merely informs and encourages states to follow a general structure, but does not bind them to any action. Resultantly, 27 states and Washington D.C. currently mandate recycling (Shultz & Hildreth, 2020). Each of these states vary in their approaches and effort levels with some enforcing more ambitious goals and programs than others. The state of Virginia is divided into 71 solid waste planning units (SWPU's) which are required to maintain and report progress on an approved solid waste management plan that considers and addresses all components of the following hierarchy: source reduction, reuse, recycling, resource recovery, incineration, and landfilling. In 1989, the Virginia General Assembly adopted legislation that requires most SWPU's to target a 25% recycling rate, or 15% for those regions with population densities less than 100 persons per square mile or with an unemployment rate 50% higher than the state average (Virginia Department of Environmental Quality, 2019). The Virginia Department of Environmental Quality (DEQ) oversees compliance with these parameters, and if a SWPU fails to meet the mandated recycling rate they may be required to submit a revised recycling action plan. The DEQ and the Department of General Services work together to provide recycling information at the state level.

There are some state incentives in place to encourage recycling. Firstly, counties can apply for non-competitive litter grants, meaning anyone who is eligible and applies will receive one, to fund litter prevention and recycling program implementation. These grants are funded by a state litter tax that collects a standard amount from manufacturers, wholesalers, distributors, or retailers of consumer products based in the commonwealth and an excise tax for soft drink, beer, and wine cooler wholesale distributors. In FY 2021, these litter taxes generated almost $2.8 million (Virginia Department of Environmental Quality, 2022). Secondly, there are recycling tax credits that can be claimed with a purchase of machinery that was built with predominantly recycled materials or on the premises of a facility that processes recycling for the Commonwealth. Certified pollution control equipment and facilities are declared a separate class of property and exempt from state and local taxation. And thirdly, the Virginia Department of Transportation encourages the recycling of glass by setting specifications to use crushed glass in their roadways and bridges (Virginia Department of Environmental Quality, 2019).

In 2019 the Virginia General Assembly surveyed all 71 SWPU's looking to identify potential areas of improvement. Three major challenges facing Virginia recyclers were presented: 1) cost prohibitive operation expenses, 2) lack of public participation and education leading to high rates of contamination, and 3) a diminished market for recycled materials (Recycling in Virginia: DEQ, 2019). They recommended that the state create a Waste Diversion & Recycling Task Force to address these concerns, and legislation supporting the creation of such a group passed the VA Senate in February of 2021 but is still awaiting passage in the House. They also recommend investment into localized solutions, such as increasing grant funding to SWPU's to allow them to directly recycle materials locally in order to decrease costs, and funding public education campaigns to decrease contamination of the recycling stream.

Charlottesville Recycling Policy

The City of Charlottesville currently provides free single stream recycling bins to all single family households and offers free bi-weekly curbside collection. Opposingly, the city also enforces a "pay as you throw" system for trash collection where residents must pay for trash stickers in accordance with how much trash they create, and must affix this sticker to trash bags or cans in order to be picked up. Trash is collected weekly. Apartment complexes and multi-family dwellings do not receive any of these services and the complex owners must pay for private trash collection (but are not mandated to provide recycling for their residents). The City of Charlottesville Public Works Department sets up the system and negotiates contracts with our third party recycling service provider, while the Charlottesville Climate Protection Program works closely with the Public Works Department to oversee the system and set sustainability goals. I spoke with Susan Elliot, the head of the Charlottesville Climate Protection Program, to better understand our local abilities to adapt and better divert our waste stream from landfills. Her contributions are woven throughout this project.

The City of Charlottesville is governed by the Virginia DEQ and therefore must achieve a recycling rate of at least 25%. According to their website, the Charlottesville Recycling Department has set its own goal of 35% although this commitment is not codified into law. Public Works oversees curbside trash and recycling collection, and the Charlottesville Office of Environmental Sustainability sets the agenda for recycling goals (City of Charlottesville, 2022). After 2 acquisitions in the last 5 years, the City of Charlottesville is now serviced by County Waste (which acquired Van Der Linde Recycling in 2018), a subsidiary of GFL – Green For Life which is the fourth largest solid waste diversion company in North America (GLF Environmental Sustainability Report, 2020). The City of Charlottesville estimates it serves approximately 15,200 residences for refuse and recycling collection, and reports collecting approximately 3,700 tons of mixed recycling in 2020 (Strategic Plan City of Charlottesville, 2022). While curbside recycling is free for some residents of the City of Charlottesville, those who do not live in single family households along the trash route have the option to instead transport recyclables themselves to the centrally located McIntire Recycling Center (Rivanna Authorities, 2021). McIntire Recycling Center requires much more stringent sorting and cleaning of materials from patrons, and they accept only plastics #1 and #2 as opposed to curbside pickup which accepts plastics #1, #2, and #3-#7.

The efficacy of County Waste's single stream collection system in Charlottesville is contested. A user on Reddit posted about this interaction with County Waste (a subsidiary of GFL) this year, "Does County Waste process single stream recycling like they purport to? … 42 minutes into my phone call, the answer is no. The material hauled by County Waste Recycling from our frontload dumpster is NOT sorted for recyclables. Everything gets trashed" (Reddit, 2021). A similarly aimed 2019 investigation by Cville Tomorrow was fruitless with County Waste and Time Disposal both denying interview requests and sidestepping direct questions (Castro, 2019). Every year since 2015 the City of Charlottesville has reported meeting their recovery rate goal of 35% almost exactly, and it is worth noting that these figures are self-reported (Strategic Plan City of Charlottesville, 2022). Data collection

is a substantial obstacle to recycling policy makers, as it is not standardized among any level of governance: federal, state, county, city, etc… Local industry experts I spoke with cast aspersions on the integrity of recycling rates and other figures as reported by unchecked material recovery facilities.

Broader Contributing Factors to Low Recycling Rates

United States Recycling Industry Overtaken by "Corporate Waste"

"Corporate Waste" conglomerates have come to dominate recycling services. In Charlottesville, our recycling service provider has been vertically integrated at least twice in the last 5 years resulting in corporate ownership of what used to be small, local providers. The recycling industry resembles an oligopoly as "the top four consolidated companies [GFL being one of them] earn $30 billion of the $70 billion economic sector. These companies own or control 75% of the permitted landfill capacity in major metropolitan areas and control an estimated 50% of the national hauling market, with even higher levels of domination in certain regional markets" (Seldman & Morris, 2020).

Figure 3: Green For Life Cumulative Acquisitions

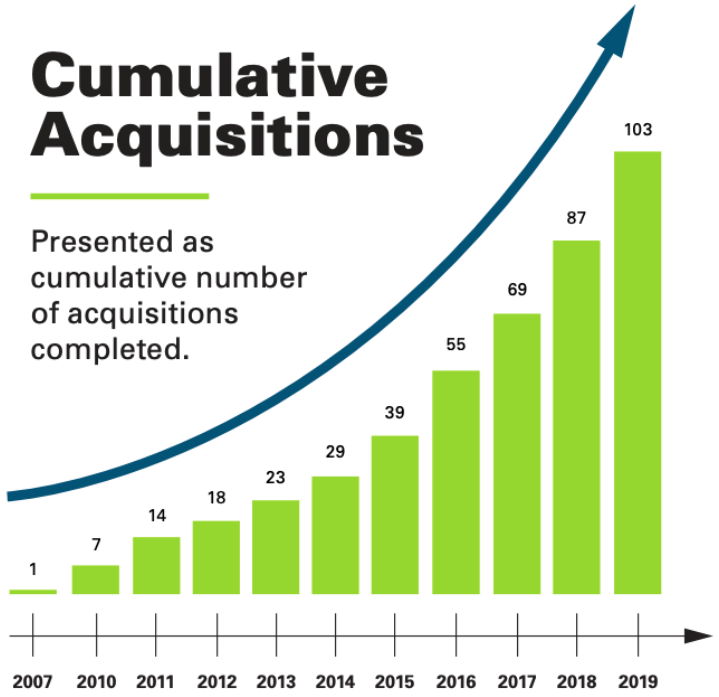
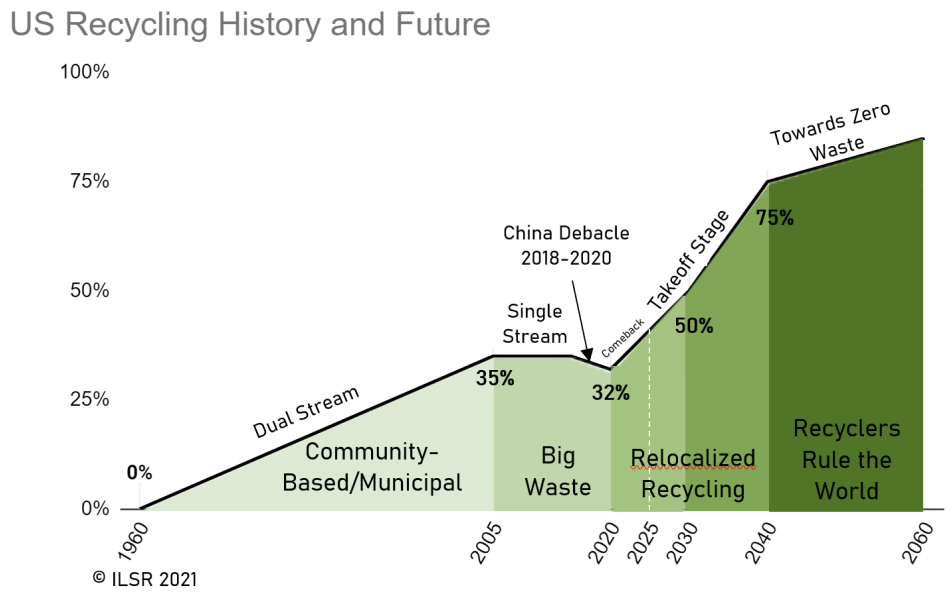


Figure 3 shows the exceptional rate at which GFL has acquired smaller, local competitors since 2007. These are the most recent figures available, but considering GFL acquired County Waste in 2020 (Charlottesville's previous provider) it is reasonable to infer these numbers have continued to increase.

Source: GFL Environmental Sustainability Report, 2020

Figure 4: US Recycling History and Future



Source: Institute for Local Self-Reliance, 2021

Figure 4 shows a more expanded view of the same trend occurring across the entire nation. These timelines show that between 2005 and 2020, nearly all municipal recycling service providers were acquired and transitioned from dual stream recycling to single stream. The chart continues on to show the potential for recycling rate improvement with relocalized recycling.

The rapid consolidation of local waste firms has nearly eliminated competition across the country and diminished what once was a robust recycling system. One way "corporate waste" has achieved this is through landfill ownership – GFL owns Charlottesville's closest landfill – which gives them a competitive edge in bidding for collection and hauling contracts against companies that have to pay disposal fees to landfills, called tipping fees (Seldman & Morris, 2020). This widespread acquisition of landfill space has accelerated in parallel to MRF shifts to single stream processing because without tipping fees, there is no incentive to avoid sending potential recyclables to landfill instead of undergoing the hard work to properly sort and process them. Between 2005 and 2014, use of single stream systems grew from 29% of American communities to 80% (Berger, 2015). Resultantly, between 2008 and 2018 the percentage of recyclables that were so contaminated they were sent to landfills rose from 7% to 25% (Koerth, 2019).

2018 Chinese National Sword Policy

Prior to 2018, this rapid increase in recycling contamination drew little attention because the US relied heavily on China to process our recyclable material. An abundance of empty shipping containers on the west coast coupled with China's low standards for contamination led to 40% of our materials (70% of our plastic) landing in China for eventual processing (Eureka Recycling, 2021). However, in retaliation to President Trump's trading sanctions the Chinese Government enacted their abrupt National Sword Policy

which stated they would no longer accept 24 different materials and will only accept contamination levels of 0.5% – a nearly impossible metric to meet anywhere (Eureka Recycling, 2021). As a result, post 2018 recycling in the United States has become increasingly fragmented, inefficient, and unprofitable.

Charlottesville has not been spared from the cascading effects of the Chinese National Sword Policy. Our district's representative State Senator, R. Creigh Deeds (D-VA-25), called for action regarding Charlottesville's disappointing recycling program in 2019 labeling it a "crisis in Charlottesville and Albermarle County … because there's too much waste that has no home" as a result of these disruptions (Shulleeta, 2019). For some localities like Staunton, VA, the increased cost of processing recyclables led to a complete shutdown of their curbside recycling program (Brooks, 2021). Although this policy has upended recycling in Virginia and the U.S., it also creates new opportunities for improvement and policy interventions that fill the gap left by Chinese MRF's.

High Cost & High Contamination Single Stream Systems

For years, single-stream has been heralded as a more convenient and cost-effective waste diversion strategy than dual-stream. One Canadian case study utilizing data from 223 municipalities over the course of 10 years found that single stream is actually on average 28.5% more expensive (Lakhan, 2015) due to the extra time and labor needed to sort through waste. On convenience as a motivating factor, this study did find that the presence of single-stream recycling increased municipal recycling rates by 4.11% (Lakhan, 2015). The general consensus on single stream recycling is that it does modestly increase recycling rates, however the resulting contamination and increased costs have, over time, become greater obstacles than predicted. Contamination has decreased the quality of recycled materials that are eventually sold as raw materials for new products and crashed commodity prices (Faulkner, 2019), ultimately feeding into an environment of increased exclusivity that bars smaller, local waste companies from participating and making any profit.

Van der Linde Recycling, former curbside recycling provider for Charlottesville and current industrial recycling facility, was one such company beaten out for the City's recycling contract. During our interview, Van der Linde CEO Andrea Johnson described the difficulties of counteracting contamination and how the single stream landscape became unsustainable for their modestly sized operation. After losing the City of Charlottesville's contract, Van der Linde pivoted to processing industrial recycling and a more specific array of materials. Ms. Johnson was excited to show me what their facility was capable of processing because she feels people have a very myopic view of recycling – and she was right! Van der Linde processes a wide breadth of materials including used wood, cement, metal, plastic, cement, carpets, mattresses, tree stumps, construction site waste, like cables and shingles, and more. During our tour, Ms. Johnson pointed to an old Little Tikes plastic easel for instance and said, "When people think of recycling, they think about yogurt cups or soda cans – few people even stop to consider their other household items are not only completely recyclable, but much more impactful. Just imagine how many yogurt cups worth of plastic make up this easel!". The biggest obstacles to

the average household utilizing Van der Linde's services are that they have to transport their waste directly to the facility, which lies 15 miles outside of Charlottesville proper, and then they have to pay a weight-based fee. Van der Linde now makes most of their profit from construction site debris and large item drop offs, as their services are relatively inaccessible to Charlottesville residents.

On an individual behavioral level in single-stream localities, the recycling bin serves as a catch-all where users are often "wish-cycling" and just tossing anything in regardless of what's acceptable. Ms. Johnson spoke to the culture of convenience we have created that has been to the detriment of MRF's nationally, discussing how single stream recycling requires little to no interaction with one's waste resulting in an apathetic community. This mentality further separates humans from the waste we create and detracts from the opportunity to educate individuals about the impact of their actions. It also perpetuates the falsehood that technology (such as AI waste-sorting tech) will swoop in and save us from climate change at the end of the day. Van der Linde continues to manually sort their recycled materials to ensure as much waste as possible is recovered and returned to market in support of a more circular economy. Single stream recycling and potential technical solutions to the contamination problem are a dangerous distraction from genuine solutions that are rooted in dismantling corporate control of our society and encouraging individual behavioral change.

Low Political Momentum for Waste Legislation in Virginia

I followed up with Senator Deeds regarding his comments and had the chance to interview him in November of 2021. Senator Deeds believes that market based solutions, and especially tax incentives, would be the most effective policy tools to incentivize recycling. Senator Deeds also relayed to me an unfortunate truth – the major hurdle to enacting any new recycling regulations is, unsurprisingly, funding. In April of 2020, Virginia passed the Clean Economy Act which establishes a schedule for energy providers to phase out and retire electric generating units located in the commonwealth that emit carbon as a by-product of combusting fuel to generate electricity and instead replace them with solar or onshore wind renewable units (H.B. 1526, 2020). When I asked Senator Deeds about the political feasibility of recycling regulations in Virginia, he pointed to the Clean Economy Act for two reasons: (1) this major push for environmental sustainability indicates there is an appetite for aggressive environmental policy within Virginia, but resultantly (2) a lot of that appetite was spent in the legislative process to get the Clean Economy Act passed so there is not much momentum for more aggressive legislation regarding recycling. Despite this challenge, Senator Deeds agreed that recycling is one of the most untapped opportunities for improvement in alignment with Charlottesville's long term sustainability goals.

Evidence on Potential Solutions to Improve Recycling Rates

Over the last 60 years, a number of policies have been implemented to increase recycling rates. In my analysis, I will be categorizing potential policies in 3 categories: government intervention, market based, and public awareness. Government intervention will alter the recycling system with the passage of new legislation or logistical reorganization, economic tools inject market based solutions to vary consumer and producer behavior, and public awareness campaigns take advantage of social systems in place to emphasize the more human element of recycling and influence actors to divert their waste with proper knowledge of its ramifications. The most common of these methods across the country are charging bag fees for garbage collection in a user pay-as-you-throw scheme, increasing the number of materials accepted for collection, providing single stream collection for recyclables to increase convenience, and expanding the promotion and education activities of local recycling programs (Mueller, 2013). Other more economic policy interventions include bottle deposits/refunds, advance disposal fees, and recycling subsidies on greenhouse gas emissions (Acuff & Kaffine, 2013). It has been found that people's perceptions of recycling policy effectiveness affects their willingness to partake, so each policy's respective efficacy has the potential to increase with better public understanding (Wan, 2014). Public participation increases the sense of ownership a community feels over their waste diversion, and social influence can help to increase the public's participation by targeting their individual attitudes towards recycling (Wan, 2014; Huffman, 2014). These policy instruments are political, economic, and social in their approach to increasing recycling participation and in an ideal system should be used in strategic conjunction with one another to maximize benefits. Tailoring these policies to Charlottesville's capabilities, geography, political feasibility, and demographic will be integral to their success in increasing the rate of waste diverted to recycling centers.

Government Intervention

The two most common interventions understood to increase recycling rates are expanding the number of accepted materials, and implementing single stream curbside recycling pick up to increase convenience for residents. Expanding curbside pickup to residences that are not currently served would accomplish both of these by increasing materials and enhancing convenience. A study of recycling in Ontario, Canada found that when compared to 3 market based solutions, expanding the number of collected materials and single stream diversion are the only variables that demonstrated a significant positive association with the recovery rate of a program suggesting that convenience factors are more effective for improving recycling behavior than policies that penalize disposal like bag limits and fees (Mueller, 2013). Because both the operating costs and benefits to households of curbside recycling programs vary across municipalities, local policy decisions should also vary (Kinnaman, 2006) and the decision to offer single stream or dual stream recycling is perhaps the most impactful choice a locality can make.

In dual stream recycling source-separate their recyclables into two bins, one for paper fiber and the other for commingled plastic, metal, and glass. These two streams are collected in separate trucks or in separate compartments of the same truck. In single stream recycling, all permitted materials are combined in a single cart, collected in a single truck, and separated with a single, unified process (Fitzgerald et. al, 2012). Single stream claims to increase recycling rates with increased collection, but the combination of all waste in one bin leads to costly contamination that simultaneously decreases recycling rates. A study was conducted to explore the tradeoffs between dual and single stream by first converting a material recovery facility from dual stream to single stream processing, and then auditing its recovery rates and utility usage before and after the transition. This study concluded that a shift from dual stream to single stream resulted in an approximately 50% increase in the production of recyclable commodities. However there are many things single stream systems are dependent on to be so successful such as substantial initial investment in new vehicles, bins, and processing equipment as well as the willingness for a adopting municipality to accept higher residue, lower quality output streams which may exceed end use buyer's maximum contamination limits (Fitzgerald et. al, 2012).

The US government provides little guidance on single stream vs. dual stream benefits to localities resulting in a blind transition to single stream collection due to its upfront cost savings and simplified corporate servicing (Seldman, 2021). There are currently two bills in Congress, the Plastic Waste Reduction and Recycling Research Act (H.R. 2821, 2021) and the Break Free From Plastic Pollution Act of 2021 (S. 984, 2021) looking to close this research gap and offer a unified, national response to reduce the use of single-use plastic and to revamp our disorganized and ineffective recycling system by analyzing the effectiveness of single stream systems on a broader national scale. For some localities like Staunton, VA, the increased cost of processing contaminated recyclables led to a complete shutdown of their curbside recycling program (Brooks, 2021) in exchange for a drop off program. The effectiveness of this policy change is yet to be observed in Staunton, but it is worth mentioning that ridding of curbside services is an option because the net benefits are not positive in all municipalities, state mandates that require curbside pickup (currently active in 22 states) may be welfare subtracting (Kinnaman, 2006).

Market Based

There are many market based instruments that may be used to increase recycling rates or decrease total consumption (source reduction). Bag fees, also called "Pay as you throw" waste management policies, are unique to each location they serve, but the general premise of their implementation is to reduce the amount of landfill-bound waste produced by a person, family, or business by charging them based on either weight or volume of their trash. They support the "polluter pays principle (PPP) and the shared responsibility concept" (Batllevell & Hanf, 2008) of environmental legislation which holds individuals precisely accountable for all the waste they produce. Alternatives pathways of waste removal, such as recycling and composting, would typically be offered as free services so that individuals are incentivized to properly sort their waste into their designated bins in order to decrease the out-of-pocket cost they are forced to pay. This is the current system Charlottesville operates under, and residents pay for stickers to dispose

of each bag of trash they create. A study conducted over 5 years and collecting data on 223 different user pay schemes in Ontario, Canada found mixed results from their implementation after running multiple regression analyses, ultimately concluding that municipalities with user pay systems consistently reported higher recovery rates than those that didn't, however comparing municipalities that implemented a user pay program with those that did not during the study period did not yield significant differences in mean recovery rate increases over time (Mueller, 2013). This means there was no meaningful impetus for behavioral change in response to pay as you throw systems – user pay schemes disincentivize the disposal of garbage, but don't necessarily encourage recycling (Mueller, 2013).

Direct recycling subsidies offered by the government are another economic tool to make the market for recycled raw materials more viable for material recovery facilities. However, using a predictive model that simulates analysis based on environmental economists' data collected from 1990-2012 describing baseline prices, consumption, recycling by material, own-price elasticities for demand and supply, and greenhouse gas emissions, these have been found to generate no reductions in plastic. Despite the fact that production of consumer goods from recycled material is less emissions-intensive, the direct recycling subsidy provides the least emission savings and has the highest cost of achieving a given waste reduction (Acuff & Kaffine, 2013). Advance Disposal Fees (ADF) employ a "polluter pays" system where non-refundable fees are included at the point of purchase to cover the estimated costs of collection and processing – single use plastic bag fees are a widely known example of these (Walls, 2012). These fees result in source reduction but fail to incentivize recycling (Walls, 2012) and although they are proven to decrease consumption using that same predictive model, they do not alter emissions per unit of consumption (Acuff & Kaffine, 2013) so they do not make more meaningful dents in our greenhouse gas emissions than other interventions.

The most efficient market based solution is a deposit/refund system (Palmer et. al, 1997). Intuitively, deposit/refunds are set apart from earlier mentioned methods because they exploit both channels of waste reduction by decreasing consumption and promoting recycling of goods (Acuff & Kaffine, 2013). In a deposit/refund system, individuals purchase a product with an added tax on product consumption that is returned once the material is recycled or properly disposed of (Walls, 2012). Innovative deposit/refund systems use an upstream approach to subsidize either collectors who deliver materials to reprocessors or the reprocessors themselves when they turn collected material into usable secondary materials for production rather than just to consumers (Walls, 2012). This dips into a less seen, but increasingly attractive approach to waste reduction called extended producer responsibility (EPR) which entails making manufacturers responsible for the entire lifecycle of the products and packaging they produce (Seldman, 1993). Deposit/refund systems are well known, especially in the case of bottle sales in the US, and although this market intervention does not exist yet in Virginia there is an NGO focused on its eventual passage called The Virginia Bottle Bill Organization. This policy is not being considered for my client because it is outside of the scope of the City of Charlottesville's capabilities and would require state legislation.

Public Awareness

Finally there are social tools we can leverage to increase recycling rates such as promotion and education of recycling services, the influence of community leaders, and encouraging public ownership of policy to gain participation. A 2014 study found that social influence is an important tool to inspire those with weak recycling attitudes to participate actively in recycling programs (Huffman, 2014). This study collected responses from 118 undergraduate students at a southwestern university and looked at their self-reported recycling behavior and their actual observed recycling behavior. They found, unsurprisingly, that self-reports are often overstatements, and these lapses in action can be targeted through social influence like media depicting community leaders and local celebrities recycling, and education programs based on community values (Huffman, 2014). Public opinion of recycling services can also open a window for improvement if the public is critical and calls for action from their officials (Wan, 2014) so community organization and mobilization can also be an important tool. Because there is little incentive or budget for municipalities to undertake any recycling program other than what is least costly, organized demands from residents may be the only influence pushing decision makers to a more environmentally conscious course of action. In this same vein, coordinated communication with the public, especially during the early stages of policy design, has been shown to increase policy effectiveness and the public's perception of progress (Wan, 2014). These interventions require trust and discourse between local governments and their constituents which can be built through transparency and open communication over time.

Direct feedback to households is an integral tool to increasing recycling rates and, especially, decreasing contamination levels. Contamination is created when trash is incorrectly placed in the recycling bin, or if materials are too dirty to recycle, so the most direct approach to decreasing contamination is through individual behavioral change. One way residents can be notified is through a cart tagging program where curbside pickup crews evaluate the composition of a household's recycling bin and if the amount of visible contamination surpasses a set standard (often 20% of the volume), their cart is tagged with an "Oops!" sticker that enumerates what can and cannot go in that township's recycling bin and is left behind to be collected for trash. This direct contact has been shown to hold households accountable almost immediately – a 2012 study conducted in Clark County of Washington State observed and tagged recycling carts at 1,348 households and upon returning to the same households a month later found that 78% of the recycling carts tagged for contamination during the first audit had no visible contamination during the second audit (Heubach, 2019). This study is limited in its long term applicability, however, because it only observed households during the first baseline audit and the second audit after intervention so there is no evidence to support its longer term sustainability.

Alternatives + Criteria

There are numerous potential policy interventions that could affect change within Charlottesville's waste system. As detailed before, there is no formalized, mandated structure for an idealized waste system that maximizes recycling as evidenced by the lack of stringent federal or state regulations. Cities and counties have autonomy over their own recycling services which has resulted in numerous pilot programs and creative solutions to tackle our waste problem. This leads us to the biggest limitation of recycling policy – extreme lack of sound data, and no standardized reporting mechanisms which makes it difficult to track the effectiveness of specific interventions. As such, the following policy recommendations are reflective of the data that is available in conjunction with the information learned from conversations with my client Neil Seldman of ILSR, CEO of Van der Linde Recycling Andrea Johnson, VA State Senator Creigh Deeds, and Head of Charlottesville's Climate Protection Program Susan Elliot.

Criteria

Cost Effectiveness

I will measure cost effectiveness over a forecasted 10 year timeline from 2020-2030 as discounted present direct costs from program implementation to the relevant city budget and any intangible costs. The exact cost of initial program implementation is not entirely measurable because I have no data on the current capabilities of GFL, but I will rate them qualitatively in conjunction with the alternative's ability to offset its costs further down the line by changing operational costs. The net present value of our status quo operation over the next 8 years using a standard 3% discount rate is $12,236,979.83. This criterion will be ranked qualitatively from 1 (lowest) to 3 (highest).

Political Feasibility

Low political feasibility is often cited as a primary deterrent to the passage of waste policy in the US. The Institute for Local Self-Reliance research and recommended policy changes must weigh potential political challenges to implementation along with each of these other criteria in order to provide useful advice to lawmakers. However, ILSR is a relatively radical think tank that promotes ideas of sweeping change to our current waste system in order to redistribute power back to local communities, so these policy alternatives align with their ambitious initiatives. In order to qualitatively scale the political feasibility of each alternative from low to high I will quantify the amount of press coverage in support or opposition to similar ideas, and rely heavily on the stated opinions of our State Senator Creigh Deeds and Head of Climate Protection for Charlottesville, Susan Elliot. This criterion will be ranked qualitatively from 1 (lowest) to 3 (highest).

Ability to Implement

Due to the wide variance of these alternatives, this will be a qualitative measurement of the technical feasibility of each. I will measure this by assessing the present capabilities of Charlottesville's waste system and what additional technology or materials are required to implement each alternative. Significant infrastructural changes will decrease the policy's ability to be implemented. I will also look at the staffing required for each policy and whether the decision is favorable, and if staff obtains the expertise required to implement each alternative. Lastly, I will grade the availability of information and relevant examples of such policies in other cities that may be used as examples to model Charlottesville's implementation after. Without details of how GFL's MRF currently operates, it is difficult to quantify the relative ease of implementing these policy alternatives so I will rely heavily on my conversations with Susan Elliot and Andrea Johnson to inform my ratings. Consulting with Susan Elliot offered insight into the City of Charlottesville's capacity for infrastructural change through the lens of our city's public works department, and she also works closely with GFL so she offered direct assessments of her opinion of their ability to incorporate these alternatives into their existing process. Andrea Johnson offered technical advice from her experience leading one of Charlottesville's few local MRF's and gave insight into the scale of our city's waste, and how new technical processes would be rolled out in a facility very similar to GFL's MRF. This criterion will be ranked qualitatively from 1 (lowest) to 3 (highest).

1. **Apartment Complex and Multi-Unit Dwelling Recycling Mandates**

The City of Charlottesville does not provide or mandate curbside recycling pickup from apartment complexes and multi family dwellings. 23% of housing units in Charlottesville are designated as multi-unit – therefore, the City of Charlottesville is not collecting recycling from 22,000 units (Census Reporter, 2019). Local Charlottesville recycling industry expert Andrea Johnson identified this lack of service as our recycling systems biggest missed opportunity. Those who don't have curbside services have the option to drop off their recycling and manually sort it at the McIntire Road Recycling Center. This poses an accessibility issue to Charlottesville residents who lack transportation or who work during the hours the McIntire Road drop off center is open, which are likely lower income residents who could not afford to contract a private curbside recycling provider.

A multi-unit dwelling unit recycling service inclusion mandate would require the passage of state legislation, according to the head of the City of Charlottesville's Climate Protection Program Susan Elliot, and would require property managers to provide their residents with dedicated recycling bins and collection services as they already do for other waste. Interestingly, Virginia state law currently requires that landlords "Provide and maintain appropriate receptacles and conveniences for the collection, storage, and removal of ashes, garbage, rubbish, and other waste incidental to the occupancy of dwelling units and arrange for the removal of same" (Virginia Residential Landlord and Tenant Act, 55.1, 2019). This definition is not currently

interpreted as expanding to recycling services, but clarification of "other waste" to indicate potential recyclables could lead to mandatory action on the landlord's behalf without additional legislation.

Empirical Supporting Evidence:

A 2009-2010 study conducted on the city of Chicago, Illinois' waste program tracked the progress of the Chicago High Density Residential and Commercial Source Reduction and Recycling Ordinance passed in 1993 and taking effect in 1995. This ordinance required the 'owner of each high density [a building containing more than four residential units and which receives waste collection service from a private waste hauler] residential building shall provide to the residents of each building an effective recycling programme (Schwebel, 2012). Measuring the effectiveness of a comprehensive recycling plan and recycling toolkit provided to 5 differently sized multi family dwellings (ranging from 14 units to 594 units) and audited 4 times over the course of 1 year, the study found that overall recycling rates nearly tripled from 4% to 11%. In the largest building containing 594 units, there was an increase in recycling rates from 6% to 36%, and in the smallest they saw an increase from 0% to 44%. Variance in success between buildings was found to be directly connected to the level of effort and oversight observed of building management – those that properly enforced the new policies and rigidly implemented the "toolkit" which included recycling signage, educational flyers, and recommendations for bin placement were most successful in improving their recycling rates.

The City of San Diego, CA overhauled their recycling requirements in response to a call for "Renters Right to Recycle" borne out of tenants' frustration with their exclusion from curbside collection programs. Following a phase-in plan that began with the passage of the City Recycling Ordinance (CRO) in 2007, the City of San Diego first required apartments with 100+ units to provide recycling collection for their residents by 2008, then apartments with 50+ units by 2009, and eventually all residential and business properties by 2010 (EcoCycle Solutions, 2022). On the landlord's side, logistical implementation included educating tenants about their required compliance once a year and within 14 days of move-in, where recycling bins are located, and what materials are accepted. Non-compliance from tenants or landlords results in citations or fines that increase with repeated infractions. San Diego's waste diversion rate increased from 53% in 2005 to 68% in 2010 as a direct result of the CRO (Zero Waste Plan, San Diego Environmental Services Department 2015).

Cost Effectiveness Score: 1

Apartment complex property owners would fund this policy alternative directly by contracting private recycling providers, and under current VA law they may charge their tenants for these services just as they do with trash collection because they are considered "local government fees" (Virginia Residential Landlord and Tenant Act, 55.1, 2019). For the City of

Charlottesville's government, this would be a very cost effective option considering it would cost nothing out of pocket. However, the cost to landlords and GFL would be substantial. Based on EPA estimates of the lesser cost of apartment unit collection, this alternative would increase total costs by 123% over a 10 year forecast. The extreme costs of this program awards this alternative a cost effectiveness score of 1.

Political Feasibility: 2

There is no precedent for similar legislation in Virginia, or history of change in waste ordinances in Charlottesville. My conversation with our State Senator Creigh Deeds indicated there is little legislative appetite within our state or city's governing bodies to pass waste related legislation, although there is general momentum towards environmentally oriented policy in Virginia as indicated by the landmark Clean Economy Act of April 2020. Although this policy could be forced upon landlords and building managers through the passage, or reinterpretation, of a city ordinance, Susan Elliot, head of Charlottesville's climate protection program, suggested that tenants will have the most influence in accomplishing this expansion of city services. Community mobilization, well supported petitions, and conversations with the Virginia Apartment Management Association will likely be necessary to reach an agreement representing the best course of action for landlords, tenants, and the City of Charlottesville broadly. The "Renters Right to Recycle" movement in California lobbied for the passage of their bill for nearly 5 years before it was passed after being vetoed nearly 3 times (Nguyen, 2011). In Charlottesville, tenant landlord relations have been improving in the last 3 years after it was announced that Virginia held three out of the ten cities with the highest eviction rates in the U.S. and legislation was put into place to better protect both parties (Robertson, 2021). This improvement may indicate an increased potential for cooperation between residents and building managers, however as of now there is no local movement in place advocating for recycling services for apartment complexes and multi-family dwellings.

In conclusion, there are three potential routes to achieve recycling service expansion in Charlottesville:

1. Formal legislation to mandate provision of recycling services for multi-unit buildings in Charlottesville
2. Official clarification of the current Virginia Residential Landlord and Tenant Act to indicate "other waste" includes recyclable goods
3. Grassroots lobbying of residents directly to their landlords/building management/the Virginia Apartment Management Association to provide recycling services on a building by building basis

Besides option 2, which is unlikely to happen, 1 and 3 would require substantial effort from stakeholders to rally against the status quo of a governing body/managing organization that has no independent desire to expand recycling services within the City of Charlottesville. Due to the

difficult but not impossible nature of this feat as indicated by State Senator Creigh Deeds' initial support and preceded by San Diego's successful efforts to model such an effort after, this alternative is awarded a 2 for political feasibility.

Ability to Implement: 2

Additional recycling services will likely be provided by GFL, however they did not respond to any outreach for data regarding their processing capabilities so it is unclear whether they could ramp up operations to cover the extra 22,000 units producing recycling. However, considering their exceptional pace of acquisitions has not excluded Charlottesville, and in fact they have acquired 2 former independent waste contractors based in Charlottesville: County Waste and Time Disposal, it is reasonable to assume they have the facilities to manage a greater amount of waste than County Waste alone was processing prior to 2018 to provide curbside services to Charlottesville. There is also a third independent recycling provider serving Albemarle County, Neighborhood Waste, that may be utilized for apartment and multi-family dwelling recycling pickup because these contracts would be between each building manager and their chosen recycling provider – not part of the existing contract between Charlottesville and GFL. One component of apartment pickup that would add ease to implementation is that pickup would be from one consolidated area within the apartment complex rather than from each unit, creating a more efficient route. There may be difficulty in providing a dumpster location for buildings where there was not prior space carved out for it. With adequate adherence to best practices modeled by the San Diego and Chicago case studies, the implementation of such a program would take time, effort, and buy-in from apartment residents but would certainly increase waste diversion from landfills. Charlottesville's existing recycling infrastructure could be built upon to serve more residencies, but the major implementation difficulties lies in the transition within apartments themselves and where recycling may be sorted apart from trash according to Andrea Johnson. As a result, this alternative is awarded a 2 for ability to implement.

2. Oops! Sticker Implementation + Public Education

One way to hold residents directly accountable for their contaminated recyclables is to make them aware when their stream is unacceptably contaminated, and to increase punitive measures with repeated infractions. In the nearby City of Richmond, in order to counteract these same issues they have implemented an "Oops!" sticker system to hold residents accountable for the contamination of their household's recycling stream. Starting in 2018, Central Virginia Waste Management Authority (CWVMA) recycling collectors began examining curbside bins for contaminants and if they don't pass the test, the bin is left uncollected with an informational "Oops!" sticker reminding residents what types of waste are unacceptable.

The National Waste and Recycling Association estimates that approximately 25% of our single stream recyclables are too contaminated to go anywhere but the landfill (Koerth, 2019). According to Susan Elliot, head of Charlottesville's Climate Protection Program, it's impossible

to isolate the City of Charlottesville's specific contamination rate because once our waste is transported to County Waste's MRF it is mixed in with the recyclables of other localities. However, following the Chinese National Sword Policy of 2018 it is reasonable to assume that along with the rest of the country our contamination rates have reached an unacceptable level.

In fact, in a 2019 survey conducted by the Virginia Department of Environmental Quality of all the Solid Waste Planning Units (SWPUs), our SWPU County Waste identified "contamination in recycling loads" as their number one obstacle to successful recycling (VA DEQ, 2019). Rivanna Solid Waste Authority, the operators of McIntire Road Recycling Drop Off Center, indicated contamination and "wish-cycling, which destroys the quality of recyclables collected" as their second greatest obstacle (VA DEQ, 2019). Both SWPUs believe that greater investment in public education on what is truly recyclable will best help to solve our contamination problem.

Empirical Supporting Evidence

One 2008 pilot program in Westchester County, New York provided over 120,000 "Oops!" stickers throughout the county to both municipalities and private haulers and saw an 18.4% increase in their recycling rate over the following year. This was largely attributed to the success of the "Oops!" sticker program (Kotorac et. al, 2014). Another 2017 pilot program initiated by The Recycling Partnership in Atlanta, GA and Chicago, IL found that contamination of recyclables in each city decreased by 57% and 32%, respectively (Marshall & Morrigan, 2018). With the help of this program, our neighboring City of Richmond has achieved a recycling rate of 58% (Virginia DEQ, 2019) and Kim Hynes, executive director of CVWMA, feels residents have been very responsive to the feedback. "The cleaner we get the recycling stream, the more valuable it is and we'll keep those costs low to residents and local governments" (Simpson, 2019).

Cost Effectiveness: 3

The only outright cost of this policy would be for the stickers themselves and minimal additional training for recycling pickup workers. The additional cost of gas used while idling and checking bins for contamination eventually becomes negligible as it is canceled out once crews become acquainted with the system because they would actually save time and gas by not picking up the bin they've left behind with an "Oops!" sticker. One Richmond recycling collector remarked "I just think it's a good program…It saves the drivers a lot of time" regarding the recently implemented "Oops!" sticker program (Simpson, 2019). After initial investment, "Oops!" stickers will save the City of Charlottesville in its avoidance of landfill tipping fees now that more waste is being properly recycled as a result of lower contamination levels. A forecasted value of this program would only increase costs by 4% to the City of Charlottesville. Due to the potential savings from tipping fees effectively canceling out the low cost of implementation, this alternative is awarded a cost effectiveness score of 3.

Political Feasibility: 3

This alternative requires no political intervention. A decision can be made independently by the Climate Protection Program of Charlottesville in conjunction with the Public Works Department to include "Oops!" stickers once re-negotiating their contract with GFL with language such as "Contractor's Drivers will leave 'oops tags' on Recycling Carts contaminated with 20% or more unrecyclable materials based on a visual audit" (City of Issaquah, 2011, p. 35). No formal mandates, ordinances, or other legislation need to be passed to incorporate this alternative, awarding it a political feasibility of 3.

Ability to Implement: 3

Crews are already well versed in the materials allowed and prohibited from entering the recycling stream and possess the technical skills to quickly grade bins acceptable or unacceptable for pickup. Andrea Johnson of Van der Linde recycling revealed to me that the most common, incorrectly recycled material in Charlottesville is plastic film in the form of plastic wrap, bags, or packaging. The second most common contaminant is a dirty pizza box. These are both relatively easy to spot within a bin of otherwise recyclable material, and would warrant an "Oops!" sticker. In an interview with ABC 8 News, the collection workers tasked with the additional step of checking for contaminants described the transition as easy, remarking that after 4 years on the job they could spot trash within a recycling bin very quickly (Simpson, 2019). The stickers themselves are readily available online and could be procured easily. Resultantly, this alternative is awarded a 3.

3. Switch from Single Stream to Dual Stream

While contamination can be targeted from the consumer side, some contamination is endemic to single stream and cannot be improved with changes in household behavior. For instance, glass when collected mixed with other materials will often break and those shards will contaminate an entire load's paper and cardboard. Flattened tin cans and plastic bottles can be mistaken for paper by sorting machines, and paper goods may also get soiled by wetness from non-paper goods. These problems can be alleviated by transitioning our current system to a dual stream system that divides collection into two streams. Dividing the recycling stream into two different receptacles, one for paper and cardboard and another for glass, metal, and plastic would greatly minimize contamination levels with relatively little effort from the consumer's perspective.

My client ILSR advocates for widespread transition back to dual stream recycling as a key tool to revamp the struggling U.S. recycling sector. Dual stream recycling results in cleaner materials, produces less residue and contamination and therefore generates more actual recyclables, and can cost less than single stream (Seldman, 2022). However, it will be a difficult change for MRF's, local governments, and consumers – essentially creating obstacles at every

point of the recycling process. In the long run, this ambitious policy will ultimately bring the U.S. closer to zero waste than single stream ever could.

Empirical Supporting Evidence

Dual stream systems consistently achieve a contamination rate at least 10 percentage points lower than their single stream counterparts (Institute for Local Self Reliance, 2019). Additionally, single stream MRF's process recyclables with 8% higher operational costs and 35% higher capital costs than those of dual stream MRF's (Institute for Local Self Reliance, 2019). Another 2002 study conducted by Eureka Recycling in St.Paul, Minnesota over the course of 14 months comparing 5 different collection methods found that although single-stream recycling did increase participation by 20.8%, high levels of contamination resulted in 12.2% less material actually being recycled (Eureka Recycling, 2002). They concluded that the cost advantage and efficiencies of single stream collection disappear the more closely one looks at the later stages of the recycling process. These results have been echoed in more recent studies since, but the debate remains due to the overwhelming influence "corporate waste" has on the U.S. recycling landscape, and the benefits gained for large waste corporations through single stream recycling , such as increased revenue from landfill tipping fees due to private landfill ownership, would be lost with a transition to dual stream.

In light of these findings, cities around the nation are switching back to a dual stream system to increase the profitability, and therefore viability, of their recycling programs. California, for instance, passed legislation in 2019 that encourages – but does not mandate – localities to return to dual stream processing in order to counteract contamination and make recycling more profitable in both domestic and foreign markets. Those localities that do not prove a "good faith" effort to transition to dual stream may be subject to fines and increased governmental oversight. AB 815 will reduce contamination rates in the recycling stream by incentivizing local governments to adopt dual-stream recycling programs. Cleaner streams preserve the value and marketability of our recyclables so they can be used to make new products rather than being stockpiled, landfilled, or burned at home or overseas (AB 815, 2021) This law went into effect January 1, 2022 so we are yet to see the impacts.

Cost Effectiveness: 2

There is no way to estimate how much implementing this alternative would cost outright without knowledge of GFL's current capabilities. Considering the exceptional amount of infrastructural investment this would require it is the most costly alternative in terms of initial investment. Some of these changes would be new bins for consumers, collection truck retrofitting or additional trucks to accommodate two streams, MRF renovations to properly process two separate streams, staff training to alter the current system, and public education materials to help the public unlearn current habits. When forecasted through 2030 however, this alternative performs best in

returning on investment and would decrease costs of operation by 7%. Because the substantial initial investment leads to significant returns in the long run, this alternative is awarded a cost effectiveness score of 2.

Political Feasibility: 1.5

Similar to the "Oops!" tagging program, this recycling system change does not necessarily require legislation and could be achieved between contract negotiations with GFL and the City of Charlottesville's Public Works Department. However, legislation to encourage such a transition could elicit tangible change such as the previously mentioned California AB 815 is intended to achieve. California is a much more securely Democratic state and a notable champion of environmentally sustainable policy within the U.S., so their inability to codify this transition into law and only encourage such a shift speaks to the low political feasibility of dual-stream legislation. In the last 4 years, there has been an increase in press coverage of Charlottesville's single stream recycling program aligned with the turnover in service providers, some of which titled "Virginia keeps tabs on recycling rates, but they are self-reported" (Shuleeta, 2019), "Is Time up for Time Disposal Trash Service?" (Castro, 2018), and "YOU Issue: Single Stream Recycling in Charlottesville" (Haynes, 2018). This increase in media coverage points to greater constituent attention towards the efficacy of our city's waste recovery system, and could indicate potential momentum for political action in support of reverting back to dual stream recycling.

Ability to Implement: 1

In the City of Charlottesville, this would be an immense undertaking that would require first the renegotiating of our current contract with GFL. Next, County Waste would need to adapt their facility to manage dual stream material recovery which would likely require more staffing, new machinery, and a larger campus. The City of Charlottesville would have to purchase and provide residents with new bins to accommodate a dual stream system, and public education would become paramount to help the public "unlearn" the life we've adapted to under a single stream system. After significant initial investment that would be funded by taxpayer dollars, a dual stream system would result in a more profitable system that may eventually make up some funds. However, this is certainly an aggressive change in status quo that would require targeted legislation, individual behavior change, technical improvements, and massive investment.

Figure 5: Outcomes Matrix: (1 is lowest, 3 is highest)

Alternative	Cost Effectiveness	Political Feasibility	Ability to Implement	Total Score (max 9)
Apartment Complex and Multi-Unit Dwelling Recycling Mandates	1	2	2	5
Oops! Sticker Implementation + Public Education	3	3	3	9
Switch from Single Stream to Dual Stream	2	1.5	1	4.5

Recommendation

After projecting outcomes for each alternative, I recommend pursuing alternative #3 "Oops!" stickers and public education because of its extreme ease to implement quickly, low cost materials and relative cost effectiveness, avoidance of political process, and substantiated effect on contamination rates. Following the guidance of my three local experts it became abundantly clear that there is virtually no political momentum for the aggressive approaches of alternatives #2 and #4, nor is there any available funding. In a 2019 interview with the publication "c-ville" Susan Elliot, Head of Charlottesville's Recycling Program spoke to these limits and clearly stated that at present "we can only do community education and awareness," (Lofton, 2019). Through an "Oops!" sticker program the City of Charlottesville could experience decreases in contamination levels by approximately 44.5% (Marshall & Morrigan, 2018) which would increase the profitability of recycled materials and strengthen our recently weakened recycling system to better perform and divert waste from landfills at more sustainable levels. It also creates a culture of accountability and an impetus for direct environmental action from Charlottesville residents that is currently lacking. Asking residents to interact with their waste and better understand the impacts of their consumption could shift people's values to be more environmentally oriented than before, which could in turn affect change in other facets of life. Tagging contaminated carts is becoming an increasingly common practice across the country, and it is to our advantage that the City of Richmond has already adopted it so we may look to their example locally and consult with their waste department on the roll out of such a program.

Implementation

To implement this policy in the City of Charlottesville would first require a renegotiating of our contract with County Waste / GFL as the onus would be on them to evaluate the bins. The crew operating the collection truck would need to be trained to identify contaminated bins quickly, and be willing to take the extra step to apply the "Oops!" sticker in cases of contamination. Stickers would need to be designed to align with Charlottesville's particular needs, and there are websites with templates in place to do so easily. GFL already enforces "Oops!" sticker programs in 6 different Ontario Canada townships, so they may rely on the infrastructure in place to advise Charlottesville's programming (GFL, 2022).

Figure 6: Oops! Sticker Examples

Sources (Left to Right): "Oops!" tag from Kirkland, WA (City of Kirkland, n.d.), "Oops!" tag from Westchester County, NY (Kotorac et. al, 2014)), and "Oops!" tag from Richmond, VA (Simpson, 2019)

Charlottesville's Climate Protection Program would next have to establish consequences for repeated infractions. The City of Dayton, Ohio, which implemented an "Oops!" sticker program in Fall of 2020, holds residents to a 3 strike system we may model our program after:

- First Violation: Oops! Sticker left on the bin, curbside recycling collection leaves it behind, and the bin is collected by a waste collection truck.
- Second Violation: Second Oops! Sticker is left on the bin, the waste collection truck disposes of recycling, and the household receives an informational postcard in the mail.
- Third Violation: The recycling container is removed from the address and recycling service will be suspended for one year.

(City of Dayton Ohio, 2022)

Some other programs utilize a fining system, however this is likely to be ill received by the public. Which leads to the greatest challenge of implementation – poor public reception of this program which would call out individuals publicly for incorrectly recycling. In order to preempt this, adequate communication must be sent out to households so they are aware of the benefits of the program and the potential consequences of not adhering. Town hall meetings should be held to allow for dialogue between residents and the City Council in order to properly quell concerns. Data should be collected while the program is in effect and reported back to the public in order to rate its effectiveness at decreasing contamination levels and saving the city funds over time to continuously attract support.

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